

FOOD SECURITY EXCHANGE SYSTEM

[0001] The present application generally relates to an information management system as well a computer system for information management that is integrated with Internet of Things (IoT) devices More particularly, the present application relates to a risk management system that ensures food security through an early warning and monitoring system that predicts supply chain disruptions and its downstream impact thus enhancing food system resilience by enabling the users of the system to prevent or mitigate consequences and enhance rapid recovery if the event food supply chain disruptions cannot be avoided.

[0002] Currently, many threats to food security and resilience such as pandemics, natural disasters, geo-political tensions, climatic and weather changes, corporate bankruptcy and other corporate risks that have a direct as well as indirect impact on the food supply chain. The macro-environmental events include pandemics (such as Covid-19, bird flu, swine fever), natural disasters and calamities (such as typhoon, flood and drought) and climate change. The socio-political upheavals include political turmoils, policy decisions and work stoppages owing to strikes. The corporate risks include supplier in corporate trouble and scandals. The food supply chains may become robust and resilient if stakeholders in the ecosystem can be alerted of the events and guided through an early warning system that will lead to actions that can be taken strategically and operationally to prevent or mitigate the impact of such food supply chain disruptions.

[0003] The present application creates a food security system for automatically managing potential food supply chain disruptions that enhances food security and resilience which are important to the livelihoods of people and societies. The stakeholders include but not limited to food producers (such as research and development, farming, ranching and trading), food processors (such as harvesting, butchering, processing, value add processing, manufacturing and marketing and sales), food distributors (such as distrusting and retailing), food logistic providers, food exporters and importers, food consumers (such as shopping and consuming), as well as governments, non-governmental organizations (NGO) and policy makers and regulators (such as public health and safety and public policy). The food security

system focuses on multiple key areas in relation to food security management, such as physical farming whether at urban centres or rural areas, risk management practices, proactive supply chain management through an early warning system (EWS) as well as a command and control centre called the FSX Control Tower and regulatory compliance in the food ecosystem covering health and safety standards, environmental protection and sustainability. To fulfil the purposes, the food security system generally adopts the following approaches: firstly, applying “Complexity Theory” to characterize the Food Insecurity Ecosystem from four perspectives—national, regional ASEAN, Asian and global; secondly, establishing relationships between food insecurity causal factors in the ecosystem and aligning into supply chains from production to market supply; thirdly, developing algorithms (models) which predict impact of Insecurity Factors on final supply via differentiated pathways; fourthly, identifying “triggers” in each pathway and the consequences on supply; fifthly, defining resilience category and response plans; sixthly, assembling early warning system) components; seventhly, conducting pilot test EWS operational system consisting of scanning, triggers and responses, and adjusting or refining system; and finally, developing online full operational system with partner (such as the Singapore Food Agency) and providing implementation guidance.

[0004] The Food Security Exchange System has four major components. First a Monitoring System that tracks trigger events that may lead to food supply chain disruptions provides two major services, i.e. food supply risk management by establishing a diagnostic model and food value chain enhancement by establishing a predictive as well as prescriptive model. The food supply risk management monitors and evaluates risk to security of food supply chain disruption through the diagnostic model; and then the food value chain enhancement enhances value of the food supply after eliminating the risks according to predictions generated through the predictive model. As a whole, the food security system uses triggers based on an analysis with complexity theory and operationalized into a real-time system to maintain food supply resilience through appropriate response plans that could include avoidance or mitigation plans.

[0005] Exemplary applications of the diagnostic model include scenario planning, stress testing, sentiment analysis and investigations; while exemplary applications of

the predictive model include predictive analytics, data modelling and machine learning involving both unsupervised as well as supervised machine learning. In particular, the diagnostic model monitors food resilience through a control tower. The control tower is built based on machine learning technologies for data mapping to various data, including but not limited to geo-political sentiment data, climate/weather data, farm produce data, farming operations data, supplier input data, agri-food R&D data, logistics data, distributor data, market demand data, commercial data, service provider data and financial data (such as equity, debt and investment).

[0006] As a first aspect, the food security system comprises a food security exchange (FSX) platform as a unified digital platform that seeks to enhance food security and resilience through the management of food supply chain disruption risks. The food security exchange (FSX) platform has a three-layers structure, including an infrastructure layer, a data layer and an algorithm layer. The infrastructure layer has physical farms (such as cyber physical management urban farms), and modern agricultural technologies (such as drones, google satellite, internet of things (IoT), network and applications) to collect on-site information of trigger events. The data layer adopts data analytics, particularly big data to determine likelihood and severity of the trigger events to food security. The infrastructure layer and the data layer build up the diagnostic model for describing potential risks generated by the trigger events. The algorithm layer is then developed to build up the predictive model for generating possible solutions to tackle with the trigger events according to likelihood and severity thereof. Business processes (such as organization and stakeholder network, farming investment and farm business management) may finally implement the solution to the physical layer. As a whole, the food security exchange (FSX) platform is built as an integrated platform by aggregating people, process, technologies, food security assets and data to better manage food supply chain risk as well as proactive regulatory compliance. In particular, the food security exchange (FSX) platform is driven by information technologies such as data science and artificial intelligence (AI). The food security exchange (FSX) platform functions as an integrated command and control center by connecting to various relevant parties including but not limited to governance (such as GRC framework and ERM framework), law and compliance (such as food law compliance, legal documentation and legal advisory), professional services (such as data asset management, IP management and technology

commercialization), e-commerce (such as B2B, B2C, input suppliers, agri-food equipment and food supply), platform (such as risk management, learning management and performance management) and talent management (such as training and development, performance management). Therefore, the food security exchange (FSX) platform enables governments and businesses to better manage food supply vulnerabilities by providing technology tools, frameworks as well as methodologies to mitigate, if not to prevent impacts of potential food supply chain disruptions.

[0007] The infrastructure layer of food security exchange (FSX) platform collects raw data from the trigger events such as macro-environmental events, socio-political upheavals and corporate risks. The raw data are collected in relation to the trigger events to the food security. As a matter of choice, the infrastructure layer may directly retrieve on-site information of crops growth. For example, the infrastructure layer comprises a plurality of sensors deployed on farmlands. The sensors may detect various conditions for crops to grow on the farmlands, such as a light sensor for detecting light condition, a humidity sensor for detecting water condition, a temperature sensor for detecting temperature condition and a chemical sensor for detecting inorganic and organic nutrients necessary for growth of the crops.

[0008] Alternatively, the infrastructure layer may indirectly retrieve any information possibly associated with food supply and/or demand from external sources such as open data on the World Wide Web, including but not limited to government websites, business websites, professional websites and social media. Currently, the information is produced in such a huge amount that human beings are not able to collect and analysed in time. Therefore, the infrastructure layer of the food security exchange (FSX) platform is designed to automatically collect raw data from whatever information that is available anywhere. The infrastructure layer may combine the direct retrieval and the indirect retrieval of the raw data for providing a comprehensive understanding of the variables that affects food security.

[0009] The data layer is configured to detect the trigger events or differentiating the trigger events from non-relevant events which have no connection to risks that affects food security. In some implementations, the data layer adopts a search engine for

searching key words in relation to food (such as food, agriculture, chicken, fruits, milk, vegetable, rice, wheat, cereal, soybean, pork, beef, fish cooking oil, egg, sugar, duck mutton and mushroom), agricultural production sites (such as dairy farm, grain farm and livestock ranching), certain regions (such as Mekong delta and the state of Texas) or other aspects of food security. In addition to English, the key words are also expressed in other major languages such as French, Spanish, Chinese, Russian, German, Hindi, Portuguese, Italian, Polish, Dutch, Arabic, Indonesian, Vietnamese, Japanese, Korean and Thai. However, the key words cannot have an all-inclusive nature and thus some important information may be missing if the event does not have the stored key words in the data layer. For example, an event of “political turmoil in Brazil” may impact supply of frozen chicken to Singapore since the event is likely to disrupt port operations in Brazil. If neither of the words (i.e. “political”, “turmoil”, “Brazil”) is not included in the data layer, the event would not be detected by the data layer. In contrast, if including too many key words, the data layer would not be able to provide sufficient computing capacity to the purposes in time. Therefore, a nuanced balance should be made by including a proper number of key words in the data layer. It is important to note that beyond words or phrases that the machine can be taught to identify, classify and rank in terms of levels of risks, the algorithm developed can be taught to identify concepts as well as context.

[0010] The analytical method of key-word search (including Boolean or Boolean logic) has an inherent problem that some trigger events may still be missed when it does not have obvious relationship to food security. For example, the event of “Coronavirus Disease 2019 (COVID-19) breaks out in China” does not have an obvious relationship to food security before the COVID-19 is developed into the worldwide pandemic; and thus the analytical method would not consider the COVID-19 as a relevant event and include into the data layer. In some implementations, the data layer adopts a big data architecture for finding out underlying relationship in order to overcome the above problem with the analytical method. The big data architecture has an empirical nature to study past events and experience such as the event that Severe Acute Respiratory Syndrome (SARS) broke out in China in year 2002 and affected 25 more countries (such as Singapore, Canada and Vietnam) in year 2003. The COVID-19 and SARS have some critical common aspects such as cause of coronavirus, human-to-human transmission by air, and symptom of fever. Therefore, the big data architecture is likely

to include the COVID-19 as a trigger event into the data layer at an early stage before it became a recognized as a worldwide pandemic. In addition, the big data architecture has four major characteristics, i.e. volume, variety, velocity and variability. In terms of volume, more and more information is generated globally nowadays; and it would become important or even necessary to adopt the big data architecture to deal with the enormous volume of raw data. In terms of variety, the big data architecture is more efficient in dealing with unstructured data from heterogeneous sources with unknown forms or structures. In terms of velocity, the big data architecture could deal with a fast, massive and continuous flow of raw data. In terms of variability, the big data architecture could effectively handle and manage inconsistency or even fake news of same relevant events from multiple sources.

[0011] The information may be expressed in various formats such as text, image, video and hyperlink in the external sources. In some implementations, the data layer comprises a natural language processing (NLP) module for retrieving text information from the infrastructure layer. The natural language processing (NLP) module may be either rule-based NLP or statistical NLP.

[0012] The data layer optionally comprises a computer vision module for retrieving image information from the infrastructure layer. For example, the computer vision can perform high-resolution content-based image retrieval for recognizing satellite images in order to identify special content such as the macro-environmental events, the socio-political upheavals and/ or the corporate risks.

[0013] The data layer is designed to manipulate the raw data obtained from the infrastructure layer for producing meaningful information to the users. The manipulation may include validating, sorting, summarizing, aggregating, analysing, reporting and classifying the raw data. In some implementations, the data layer comprises a data engineering module for developing the raw data into engineered data; and an artificial intelligence module for automatically analyzing the engineered data.

[0014] The data engineering module involves an architectural approach for planning, analyzing, designing as well as implementing applications from the raw data. In some

implementations, the data engineering module comprises a data wrangling unit (also known as data munging unit) for transforming the raw data into transformed data; a data cleansing unit for cleansing inferior records of the transformed data; and a data preparation unit for manipulating the cleansed records into the engineered data. The data wrangling unit is designed to distinguish entities of the raw data (such as fields, rows, columns and values) and then perform further actions (such as extracting, parsing, joining, standardizing, augmenting, cleansing, consolidating and cleansing) to transform formats of the raw data for downstream analysis and the generation of insight to achieve the objectives of users.

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[0015] The data cleansing unit is designed to cleanse (such as detect, modify, correct, replace, delete or remove) inferior records (such as corrupt, incomplete, incorrect, inaccurate or irrelevant records) from the transformed data. As a matter of choice, the data cleansing may be performed interactively with data wrangling tools of the data wrangling unit. Alternatively, the data cleansing may be performed as batch processing through scripting tools. The cleansing tools include but not limited to Trifacta, Openprise, OpenRefine, Paxata, Alteryx, Data Ladder and WinPure. It is practical to use libraries such as Pandas for Python or Dplyr for R programming language.

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[0016] As mentioned above, the raw data may have different formats, particularly from disparate sources. The data preparation unit is designed to manipulate or pre-process the cleansed records into a unified form of the engineered data which can be readily and easily analyzed for business purposes. The form may have a full and detailed specification for each cleansed record and eliminate any discrepancy of specifications between two cleansed records or among more cleansed records.

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[0017] The artificial intelligence (AI) module (including but not limited to machine learning, natural language processing or a combination of both) automatically analyzes the engineered data from the data engineering module and then evaluates risks of the trigger events. The trigger events would then be separated and then grouped into a high-risk dataset, an intermediate-risk dataset and a low-risk dataset. Accordingly, the trigger events are processed from the high-risk dataset to the intermediate-risk dataset and to the low-risk dataset. The artificial intelligence (AI) module (including but not limited to machine learning, natural language processing or a combination of both)

would evaluate a certain trigger event from many aspect, such as likelihood, severity, alternative supply and length of time for recovery. For example, an event of “typhoon hits Mekong delta rice fields” have a severe effect to the rice supply in the surrounding regions and needs a long time to recover; and thus the event is identified as a high-risk event which is labelled in red color, and the raw data collected therefrom is classified into the high-risk dataset for processing with priority. For another example, although an event of “disruption of vegetable exports from Malaysia to Singapore” has an immediate and serious impact on Singapore, the disruption problem may be prevented or mitigated expeditiously without much effort. For example, Singapore may import vegetable from many other countries such as the United States, India, China, Vietnam, Australia and Thailand as alternative supply. therefore, the event is identified as an intermediate-risk event which labelled in orange colour, and the raw data collected therefrom is classified into the intermediate-risk dataset. For another example, an event of “China wants to import more rice from Vietnam” does not have an immediate and severe impact to Singapore which has enough time to import rice from many other counties such as United States, India and Thailand as alternative supply. Therefore, the event is identified as a low-risk event which is labelled in green, the raw data collected therefrom is classified into the low-risk dataset. But when the import of rice from a major importer like China will have a major impact on the demand side which pushes price up, the rules or the logic in the algorithm can be written to recognize such potential impact.

[0018] In some implementations, the Artificial Intelligence (AI) module (including but not limited to machine learning, natural language processing or a combination of both) comprises a learning unit for learning the raw data; and a validation unit for validating the raw data. The learning unit trains a computing algorithm for improving automatically through experience, which is known as machine learning. In the training process, multiple parameters (such as node weights) are derived via training. In some implementations, the learning unit comprises a machine learning algorithm. The machine learning algorithm may comprise supervised learning, semi-supervised learning or unsupervised learning. The supervised learning includes both classification and numerical regression which require humans to first label the engineered data as inputs. The classification is used to determine which category (i.e. high-risk, intermediate-risk or low-risk) the engineered data belong in; and the supervised

learning learns the classification after seeing a number of examples from several categories. The Regression approach is used to produce a function for describing relationship between the inputs and subsequent outputs and then predicting how the outputs should change as the inputs change. In contrast, the unsupervised learning does not need such manually labelled engineered data as the inputs; while The semi-supervised learning has a middle position between the supervised learning and the unsupervised learning by requiring partially such manually labelled engineered data. In addition, the machine learning algorithm may comprise reinforced learning which is rewarded for good responses and punished for bad responses. In contrast to the supervised learning, the reinforced learning also does not label input/output pairs and explicitly correct sub-optimal actions; but keeps a balance between exploration of uncharted territory and exploitation of current knowledge. For the machine learning algorithm, an original dataset from the infrastructure layer is divided into a training dataset, for training, turning and evaluating the machine learning algorithm; a validation dataset for building the predictive module; and a test dataset for making final performance estimation of the machine learning algorithm.

[0019] The validation unit is designed to provide an unbiased evaluation to the learning unit. In the validation process, hyperparameters for controlling the learning process of the learning unit is fine-tuned. The hyperparameters comprise algorithm hyperparameters (such as learning rate and mini-batch size of the learning unit) and model hyperparameters (such as topology and size of the learning unit). The algorithm hyperparameters do not have influence on performance of the learning unit, but would affect speed and quality of the learning process. The model hyperparameters cannot be inferred while fitting the learning unit to the training dataset.

[0020] The data layer may adopt a methodology of risk mapping and scoring metrics to evaluate the trigger events. The methodology is optionally driven by machine learning at the data layer for comprehensive evaluation. For example, the methodology classifies the trigger events into four classes according to estimated cost (measured in dollar) and ability to anticipate (measured in lead time), i.e. an unanticipated business disruptions (such as man-made disaster, common cyberattack, counterfeit, theft and idiosyncratic events) having low estimated cost and short lead time, an unanticipated catastrophes (such as meteoroid strike, solar storm, extreme terrorism, systemic

cyberattack, major geo-physical events, acute climatological events and terrorism) having high estimated cost and short lead time, a foreseeable disruptions (such as regulation, localized military conflict and acute climatological events) having low estimated cost and long lead time, and a foreseeable catastrophes (such as supervolcano, pandemic, global military conflict, financial crisis and trade dispute) having high estimated cost and long lead time. In addition, the methodology may also conduct the evaluation based on expected frequency of a disruption (measured in duration). In summary, the data layer combines machine learning, natural language processing (NLP) and natural language generation (NLG) for turning unstructured text into usable data and insights.

[0021] The data layer may have a legal artificial intelligence (AI) for mining legal text, concepts, context to generate insight like a legal reasoning process for compliance purposes. The legal AI ingests food laws & regulations, contracts and transactional documents as inputs; then conducts legal analytics through automated process and documentations expertise automation (such as using natural language processing (NLP), machine learning (ML) or a combination of both); and finally produce data-driven insights to policies, procedures and processes. In summary, the legal AI can on one hand simplify various compliances and on the other hand provide better insights and improved performance through data.

[0022] According to outputs of the diagnostic model, the predictive model is designed to integrate all components into a real-time system to maintain food supply resilience through appropriate response plans. The real-time system is developed and validated using historical events. The predictive model essentially comprises a risk-decisioning engine for making decisions according to the diagnostic model. The risk-decisioning engine may further have a food security exchange (FSX) software architecture. In some implementations, the food security exchange (FSX) software architecture comprises a food security exchange (FSX) command and control engine; and a food security exchange (FSX) business reporting unit. The food security exchange (FSX) command and control engine may include any known supply chain intelligence, such as SAS, IBM Sterling Supply Chain with Watson, and legal artificial intelligence (AI). The risk-decisioning engine may comprise a report library and an application programming interface (API). The report library may provide multiple functions, such

as customer intelligence, analytics, risk management, business visualization, fraud and security intelligence as well as data management. The application programming interface (API) may include IBM Watson, Java, REST API, python as well as Lua. In the food security exchange (FSX) software architecture, the food security exchange (FSX) command and control engine; and a food security exchange (FSX) business reporting unit can communicate freely; and meanwhile the food security exchange (FSX) software architecture can also communicate with the food security application platform freely since both the food security exchange (FSX) command and control engine; and a food security exchange (FSX) business reporting unit can exchange information with the food security application platform without trouble.

[0023] The algorithm layer of the predictive model optionally comprises a deep learning architecture for applying an artificial neural network to outputs of the data layer. The deep learning architecture may apply deep neural networks, deep belief networks, recurrent neural networks and convolutional neural network. The deep learning architecture use an unbounded number of layers in the network of bound size for permitting practical application and optimized implementations. The deep learning architecture has a substantial credit assignment path (CAP) depth as the chain of transformations from input to output for describing potentially causal connection between the input and the output. Each layer of the deep learning network learns to transform its input data into a slightly more abstract and composite representation.

[0024] The platform controller is designed for exchanging information with application providers. In some implementations, the platform controller further comprises an application layer for providing an integrated exchange with the application providers. The application providers include but not limited to e-commerce, logistics and supply chain, document management, learning management system (LMS), data protection management system (DPMS), Intellectual property (IP) management, cybersecurity, knowledge management, talent management, and governance, risk and regulatory compliance (GRC). For example, the documentation management deals with agreement drafting, contract management as well as smart contract. In particular, the application layer may adopt blockchain technologies for the smart contract. As a result, the platform controller provides a unified digital infrastructure to the food security exchange (FSX) platform. For another example, the governance, risk and regulatory

compliance (GRC) provides a simplified compliance at lower cost to comply with laws and regulations. In some implementations, the governance, risk and regulatory compliance (GRC) uses natural language processing (NLP) technologies to perform legal analysis of laws, regulations, contracts and transactional documents.

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[0025] The platform interface optionally comprises an operation module communicatively connected to the risk-decisioning engine for providing instructions to the users according to the risk-decisioning engine.

10 [0026] In some implementations, the operation module optionally comprises a deployment unit for deploying the operations; and a visualization module for presenting visual consequences to the users.

[0027] In addition to the platform controller for exchanging information with application
15 providers; the platform interface is designed for exchanging information with the users. The application providers and the users may be one or more of the business stakeholders and/or the relevant bodies. As a result, the food security exchange (FSX) platform enables the application providers and the users to exchange information for mitigating vulnerabilities of the food supply chains to various disruptions.

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[0028] The food security exchange (FSX) system may further comprise a platform interface for exchanging information with the users. In some implementations, the platform interface has a graphic user interface (GUI) that is friendly and easy for the users to communicate with the food security exchange (FSX) system.

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[0029] The platform interface optionally comprises a warning means for notifying the users if the potential risk is higher than a pre-determined value. The warning means optionally comprises visual (such as flashing red light), audio (such as loud sharp sound), vibrational warning signals or a combination of the foregoing objects.

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[0030] The food security exchange (FSX) system may further comprise a communication means for remotely communicating with the application providers and/or the users. In some implementations, the communication means comprises a telecommunication apparatus for calling or sending short messages to the providers

and/or the users. In some implementations, the communication means comprises an internet-based apparatus for sending emails or using mobile apps to the providers and/or the users.

5 [0031] As a second aspect, the food security exchange (FSX) system provides a three-staged approach for the users to conduct marketing, i.e. a first stage of human building capabilities in food security risk management; a second stage of creating systems, platforms and enhancing connectivity; and a third stage of implementing preventative programs to avert or mitigate risks. In particular, the first stage is very
10 critical since building human capability is far more important than technical solutions in order to better manage food security risks and enhance resilience in the food supply value chain.

[0032] As a third aspect, a food security early warning system (FIEWS) and decision-
15 making system is configured to be established on basis of the food security system which comprises a model of whole-of-government and whole-of-industry. When the food supply chain is disrupted or likely to be disrupted, the food security early warning system (FIEWS) would make the food ecosystem resilient through diversification and alternative plans. In particular, the food security early warning system (FIEWS)
20 includes a comprehensive set of indicators in food production and consumption continuum to provide timely notice when a food crisis threatens. For example, the food security early warning system (FIEWS) uses real-time scanning of specific food insecurity threats, projections by algorithms based on complexity theory, and the triggering of response plans to ensure resilience in supply; and then the food security
25 early warning system (FIEWS) can elicit appropriate responses in a very short time.

[0033] In some implementations, the food security early warning system (FIEWS), comprises a complexity map of food security for a certain region (such as Singapore); a plurality of event triggers for identifying relevant events to the food security; a
30 machine learning algorithm for activating response plans to the relevant events; and an operational module for integrating all components. The response plans are developed for the event triggers and resilience categories. In particular, the machine learning algorithm has a data typology including but not limited to weather climate change, crop yield, market prices, diseases, natural disasters, logistic and movement

patterns, export and import, political or policy decisions, financial performance data and news.

[0034] The food security early warning system (FIEWS) is optionally configured to find out causal relationship between the event triggers and the food security. The food security early warning system (FIEWS) is optionally configured to develop and validate the response plans by using historical events.

[0035] The stakeholders would benefit from the food security early warning system (FIEWS). For example, weather data would help food growers in crop management; and data on market pricing would facilitate farm business management. For another example, data on supply chain disruptions would enable food processors to find alternative sources of supply. For another example, data on disruptions and financial losses would enable banks, financial companies and insurance companies to evaluate risks. For another example, data on disruption would enable governments to plan ahead to avert major political crisis and instability.

[0036] The food security exchange (FSX) system has a data collaboration platform for processing inputs data and generating output insights. The data collaboration platform has a first element of data inflow in which relevant stakeholders provide data; a second element of data insights for allowing that data-driven decisions are sent back to the relevant stakeholders to compliment the information they have previously provided in the first element; a third element of data provision in which the stakeholders provide quality and valuable data inputs into the data collaboration platform; a fourth element of data categories in which customized application programming interfaces (APIs) are developed to reconstruct and categorise raw inputs into useful and targeted data categories and also to allow access to the data; a fifth element of data acquisition in which the stakeholders can easily acquire the data required accordingly to need (information category) on the various application platforms available.

[0036] Statement (i.e. statement of invention)¹: A food security system for automatically managing food security, comprising a food security exchange (FSX) platform for managing food security to potential risks; a platform controller for exchanging information with application providers; and a platform interface for

exchanging information with users, wherein the platform controller and the platform interface are integrated with the food security exchange (FSX) platform.

Statement 2: The food security system of statement 1, wherein the food security exchange (FSX) platform comprises a diagnostic model for detecting and analyzing potential risks by trigger events; and a predictive model for predicting possible solutions to the potential risks according to the diagnostic model.

Statement 3: The food security system of statement 2, wherein the diagnostic model comprises an infrastructure layer and a data layer; and the predictive model comprises an algorithm layer.

Statement 4: The food security exchange (FSX) system of statement 3, wherein the infrastructure layer further comprises a natural language processing (NLP) module for retrieving text information from the external sources.

Statement 5: The food security exchange (FSX) system of statement 3, wherein the infrastructure layer further comprises a computer vision module for retrieving image information from the trigger events.

Statement 6: The food security exchange (FSX) system of statement 3, wherein the data layer further comprises a data engineering module for developing the raw data into engineered data; and an artificial intelligence module for automatically analyzing the engineered data.

Statement 7: The food security exchange (FSX) system of statement 6, wherein the data engineering module comprises a data wrangling unit for transforming the raw data into transformed data; a data cleansing unit for cleansing inferior records of the transformed data; and a data preparation unit for manipulating the cleansed records into the engineered data.

Statement 8: The food security exchange (FSX) system of statement 7, wherein the artificial intelligence module comprises a learning unit for learning the raw data; and a validation unit for validating the raw data.

Statement 9: The food security exchange (FSX) system of statement 8, wherein the learning unit comprises a machine learning algorithm.

Statement 10: The food security exchange (FSX) system of statement 2, wherein the algorithm layer comprises a deep learning algorithm for applying an artificial neural network to outputs of the data layer.

Statement 11: The food security exchange (FSX) system of statement 10, wherein the predictive model further comprises a risk-decisioning engine for making decisions according to the diagnostic model.

5 Statement 12: The food security exchange (FSX) system of statement 11, wherein the risk-decisioning engine has a food security exchange (FSX) architecture, wherein the food security exchange (FSX) architecture comprises a food security exchange (FSX) command and control engine; and a food security exchange (FSX) business reporting unit.

10 Statement 13: The food security exchange (FSX) system of statement 12, wherein the food security exchange (FSX) business reporting unit comprises a report library and an application programming interface (API).

Statement 14: The food security exchange (FSX) system of statement 11, wherein the platform interface comprises an operation module communicatively coupled to the risk-decisioning engine for providing instructions to the users.

15 Statement 15: The food security exchange (FSX) system of statement 14, wherein the operation module comprises a deployment unit for deploying operations according to the instructions; and a visualization module for presenting visual consequences to the users.

20 Statement 16: The food security exchange (FSX) system of statement 1, wherein the platform interface further comprises a warning means for notifying the users if the potential risk is higher than a pre-determined value (scoring metrics).

Statement 17: The food security exchange (FSX) system of statement 1, further comprising a communication means for remotely communicating with the application providers and/or the users.

25 Statement 18: A food security early warning system (FIEWS), comprising a complexity map of food security for a certain region; a plurality of event triggers for identifying relevant events to the food security; a machine learning algorithm for activating response plans to the relevant events; and an operational module for integrating all components.

30 Statement 19: The food security early warning system (FIEWS) of statement 18, wherein the food security early warning system (FIEWS) is configured to find out causal relationship between the event triggers and the food security.

Statement 20: The food security early warning system (FIEWS) of statement 18, wherein the food security early warning system (FIEWS) is configured to develop and validate the response plans by using historical events.

5 [0037] The accompanying figures (Figs.) illustrate embodiments and serve to explain principles of the disclosed embodiments. It is to be understood, however, that these figures are presented for purposes of illustration only, and not for defining limits of relevant applications.

10 Fig. 1 illustrates a flowchart of a food security system;
 Fig. 2 illustrates a food supply risk management of the food security system; and
 Fig. 3 illustrates a food value chain enhancement of the food security system.

[0038] Fig. 1 illustrates a flowchart of a food security system 100. The food security
 15 system 100 has an infrastructure layer 110 with a plurality of sensors for collecting data from a farmland; a platform 120 for receiving and preparing the collected data; a data layer 130 for processing the data; an algorithm layer 140 for making decisions according to the processed data; and an operation module 150 for implementing the decisions. In particular, the data layer 130 adopts artificial intelligence (AI) for
 20 automatically processing the data; and the algorithm layer 140 adopts deep learning for automatically generating predictions according to outputs of the data layer 130.

[0039] Fig. 2 illustrates a food supply risk management 200 of the food security system 100. The food supply management 200 conducts a first step 202 of collecting
 25 information from various external sources, including food growers 210, food processors 220, logistics 230, exporters/importers 240, supermarkets/food & beverage 250, banks, financiers & insurers 260, and policy makers & regulators of government 270. The collected information is feed into an artificial intelligence (AI) driven platform 280 for data intermediation (such as data sharing and data exchange).
 30 The food supply management 200 then conducts a second step 204 of generating insight from the intelligence (AI) driven platform 280 and a third step 206 of making decisions according to the insight.

[0040] Fig. 3 illustrates a food value chain enhancement 300 of the food security system 100. The food value chain enhancement 300 involves financial institutions 310 (such as banks/lenders, investors, insurers and brokers) who provides value enhancement services to input suppliers 320 (such as seed, fertilizer, animal feed, animal health and food ingredients), farms 330 (such as crop, meat, dairy, alternative proteins), processors 340 (such as food, beverages and dairy), traders 350 (such as distributors, wholesalers, importers and exporters), retailers 360 (such as supermarkets and corner shops), and food companies 370 (such as bakery, meat, dairy and beverages). The retailers 360 and the food companies 370 directly deal with consumers 380.

[0041] In the application, unless specified otherwise, the terms "comprising", "comprise", and grammatical variants thereof, intended to represent "open" or "inclusive" language such that they include recited elements but also permit inclusion of additional, non-explicitly recited elements.

[0042] As used herein, the term "about", in the context of concentrations of components of the formulations, typically means +/- 5% of the stated value, more typically +/- 4% of the stated value, more typically +/- 3% of the stated value, more typically, +/- 2% of the stated value, even more typically +/- 1% of the stated value, and even more typically +/- 0.5% of the stated value.

[0043] Throughout this disclosure, certain embodiments may be disclosed in a range format. The description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the disclosed ranges. Accordingly, the description of a range should be considered to have specifically disclosed all the possible sub-ranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed sub-ranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

[0044] It will be apparent that various other modifications and adaptations of the application will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the application and it is intended that all such modifications and adaptations come within the scope of the appended claims or claims.

[0045] FSX design and development

The **FSX Risk Decisioning Platform (the "Platform")** is written in python, with explanatory notes given to explain each step of our proprietary process.

10 **Concept Summary**

Conceptually, the Platform is a supervised machine learning (ML) media sentiment classifier that mines news articles automatically that deal with the subject of food supply risk, and predictively classifies them according to their risk labelling. This will utilize statistical ML models like those from scikit-learn, as well as Deep Learning/

15 Neural Networks, such as Google's open-source BERT Transformers.

Based on that risk labelling, an automated text report with visualizations is generated with insights. Initially, this will employ standard template-based code. Future versions will incorporate unsupervised text generation algorithms (e.g. GPT2) and/or commercial text-generation software (e.g. Arria NLG).

20 **Disclaimer:** Our design and development has been designed for the sake of demonstrating capability and conceptual design and development only, and is not strictly optimized for typical Machine Learning performance metrics (e.g. accuracy, precision, recall, f1 score etc.) due to the small sample dataset used here.

Design and Development Contents:

25 1. **Webscrapping:** design and development code that scrapes a sample of articles from the web for news about food supply risk using Selenium and BeautifulSoup, which are open-source libraries that help us scrape. Future versions will scrape the web as comprehensively as possible, beyond the sample. Future versions will have a far larger and statistically significant dataset that is scraped.

30 2. **Cleaning and Labelling:** design and development code that transforms sample scraped news data into a Dataframe in .csv format, that is machine readable. We use the popular Pandas library for this.

We initially manually label the risk profiles of each news article in our sample data, for the sake of being able to train our design and development model. Note

again that future versions will have a far larger and statistically significant dataset.

3. **Preprocessing and Modelling:** The text that we scraped has to be pre-processed into a machine-readable format e.g. tokenization, stop-words removal, and lemmatization. We then run models from scikit-learn or a custom Neural Network e.g. BERT on this machine-readable data in order to predictively classify news text as falling into a particular risk category e.g. high, medium, low, or neutral.

For the sake of simplicity in this design and development we will use risky, neutral and stable as our preliminary labels.

4. **Report Generator:** our report-generation algorithm is intended to provide actionable insights based on that risk assessment. In our design and development here, the report-generator will provide the following information:

- Reiterate the risk label
- Describe which keywords in the article triggered our label to be e.g. risky
- Describe which entities are being discussed in the article
- Based on the risk label, the algorithm **recommends** via text that other suppliers of the food item in question be reviewed.

1. Webscraping

You will need to run the following pip install commands in terminal or cmd line:

- pip install bs4 (for BeautifulSoup)
- pip install selenium (for Selenium)
- pip install webdriver-manager (for the automated Selenium web driver to work)

#Standard Python DS imports:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

#set column size to be larger

```
pd.set_option("display.max_colwidth", 1000)
```

We have to use Selenium because of the fact that all the articles won't show up on one webpage and it's easier to scrape them this way./

Hence, we will import Selenium and the related WebDriver Manager tool to run a Chrome instance within Selenium that will scrape our sample food supply news data.

#Selenium and WebDriver Manager imports:

```

5  from selenium import webdriver
    from webdriver_manager.chrome import ChromeDriverManager
    from bs4 import BeautifulSoup

    import time
10  from selenium.webdriver.common.keys import Keys
    For our sample news feed, we are taking all articles tagged with the keyword Rice
    from www.foodnavigator-asia.com.
    url = "https://www.foodnavigator-asia.com/tag/keyword/Food/Rice"
    Here is the scraping code for this particular website. Future versions of this code will
15  utilize a larger dataset aggregated from other news sites. For the initial phase of
    development, this would essentially involve a large-scale media analysis undertaking
    to manually label data first in order to train our supervised labelling model.
    #This code will scrape data from the URL in question
    driver = webdriver.Chrome(ChromeDriverManager().install())
20  driver.get(url)

    driver.get(url)
    time.sleep(5)
    driver_body = driver.find_element_by_tag_name('body')
25  driver_pages = driver_body.find_elements_by_class_name('Pagination-item')

    i = 0

    intro_list = []
30  title_list = []
    date_list = []
    post_url_list = []

    for i in range(1, len(driver_pages)):
```

```

html = ""
html = driver.page_source
soup = BeautifulSoup(html, 'lxml')

5    intro_elems = driver.find_elements_by_class_name("Teaser-intro")

    for intro in intro_elems:
        intro_list.append(intro.text)

10   title_elems = driver.find_elements_by_class_name("Teaser-title")

    for title in title_elems:
        title_list.append(title.text)

15   date_elems = driver.find_elements_by_class_name("Teaser-date")
    for date in date_elems:
        date_list.append(date.text)

    linksdiv = soup.find_all('h3', {'class': 'Teaser-title'})
20   for linkdiv in linksdiv:
        post_url_list.append('www.foodnavigator-asia.com'+(linkdiv.find('a')['href']))

    # div = soup.find('div', {'class': 'gsc-wrapper'})
    # linksdiv = div.find_all('div', {'class': 'gsc-webResult gsc-result'})
25   # for linkdiv in linksdiv:
    #     links.append(linkdiv.find('a')['href'])

    try:
        driver.execute_script("arguments[0].click();", driver_pages[i])
30   time.sleep(2)

    driver_body = driver.find_element_by_tag_name('body')
    driver_pages = driver_body.find_elements_by_class_name('Pagination-item')
    i+1

```

```

except exceptions.StaleElementReferenceException as e:
    pass

```

```

5  driver.close()
   [WDM] - Current google-chrome version is 84.0.4147
   [WDM] - Get LATEST driver version for 84.0.4147
   [WDM] - Driver
   [/Users/grahamlim/.wdm/drivers/chromedriver/mac64/84.0.4147.30/chromedriver]
10 found in cache
   len(post_url_list)
   75
   #checking scraped length
   print (len(intro_list))
15 print (len(title_list))
   print (len(date_list))
   print (len(post_url_list))
   75
   75
20 75
   75
   #We then write a simple function to convert and label these lists as DataFrames in
   pandas, and tells us what the `shape` of the dataframe is:

25 df = pd.DataFrame({'date': date_list,
                      'title': title_list,
                      'intro': intro_list,
                      'url': post_url_list
                      })
30
   df.shape
   (75, 4)

```

This is what the result of our initially scraped news data looks like that our algorithm uses. In future, we will not only use the title and intro text of news articles, but the full text of the actual news article for better information capturing.

```
df.head()
```

```

5  date
   title
   intro
   url
   combined
10 risk_rating
   0
   20-Jul-2020
   Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-
   COVID-19
15 Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the
   former having gained advantage due to support from traditional partner Philippines,
   and the latter having come out ahead with Malaysia in terms of price.
   www.foodnavigator-asia.com/Article/2020/07/20/Legacy-vs-price-Rice-exports-from-
   Vietnam-and-India-vie-for-ASEAN-trade-post-COVID-19
20 Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-
   COVID-19. Vietnam and India are competing for ASEAN rice trade post-COVID-19,
   with the former having gained advantage due to support from traditional partner
   Philippines, and the latter having come out ahead with Malaysia in terms of price.
   neutral
25 1
   25-Jun-2020
   Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal
   The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major
   gains in food trade for both sides, particularly in rice and seafood for Vietnam as well
30 as alcohol and meat for the EU.
   www.foodnavigator-asia.com/Article/2020/06/25/Trade-off-Rice-and-seafood-the-big-
   winners-for-Vietnam-under-EU-free-trade-deal
   Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal.
   The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major

```

gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

neutral

2

5 22-Apr-2020

Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop

Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop

Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop. Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

risky

3

17-Mar-2020

20 The rice and fall: Vietnam eyes more global opportunities as Thai supply totters
Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-more-global-opportunities-as-Thai-supply-totter

The rice and fall: Vietnam eyes more global opportunities as Thai supply totters. Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

risky

4

25-Feb-2020

Beyond rice: Indian government urged to boost cereal production in security drive

Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

[www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-](http://www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-urged-to-boost-cereal-production-in-security-drive)

5 [urged-to-boost-cereal-production-in-security-drive](http://www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-urged-to-boost-cereal-production-in-security-drive)

Beyond rice: Indian government urged to boost cereal production in security drive.

Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

10 neutral

```
cd /Users/grahamlim/Documents/FSX_and_Trainer_Stuff/scrape_risk_app/data/
/Users/grahamlim/Documents/FSX_and_Trainer_Stuff/scrape_risk_app/data
pwd
```

```
'/Users/grahamlim/Documents/FSX_and_Trainer_Stuff/scrape_risk_app/data'
```

15 df.to_csv("../data/df_raw.csv")

2. Cleaning and Labelling

Now that our data has been scraped, we have to re-format it and label the risk ratings of each our sample news feed articles in a way that our machine learning models will understand. For example, we'll initially have to combine the title text and intro text of

20 each news article:

```
df = pd.read_csv("../data/df_raw.csv", index_col = 0)
```

#checking for null values

```
df.isnull().sum()
```

25 date 0

```
title 0
```

```
intro 0
```

```
url 0
```

```
dtype: int64
```

30 *#combine title and intro text in one*

```
df["combined"] = df["title"] + ". " + df["intro"]
```

```
df["combined"]
```

0 Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-COVID-19. Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.

5 1 Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal. The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

2 Rice-ing concern: COVID-19 creates supply and price volatility for Asia's
10 most 'cost-sensitive' crop. Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

3 The rice and fall: Vietnam eyes more global opportunities as Thai supply totters. Thailand's position as the largest exporter of rice from the South East Asian
15 region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

4 Beyond rice: Indian government urged to boost cereal production in security drive. Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address
20 its triple threats of food security, climate change effects and malnutrition.

...

70

Global sustainable rice scheme launched. An international system has been
25 launched that will establish environmental standards for sustainable rice production in a bid to increase rice yields.

71 Thai
floods will have minimal impact on global rice market, according to industry expert. The severe flooding in Thailand is merely a second blow to its already unsteady rice
30 market, an industry expert has said.

72 New joint venture
between McCormick and Kohinoor Foods: India. Global spice and flavour giant McCormick has signed a joint venture contract with India's leading basmati rice production company Kohinoor Foods, forming a new company in India.

73 Singapore pledges \$8.2m to Asia rice science for the next five years. Singapore's National Research Foundation (NRF) has said it will invest \$8.2m in a joint research program that aims to ensure food security and future rice demands are met throughout Asia.

5 74 Japanese scientists to breed rice resilient to radioactive cesium. In the wake of the Fukushima nuclear disaster, Japanese scientists from the Fukushima Agricultural Technology Centre are working towards a potential solution for the future of Japanese rice farmers – a strain of rice resilient to cesium absorption.

Name: combined, Length: 75, dtype: object

10 *#we create a default risk rating of neutral first for all news articles*

df["risk_rating"]="neutral"

df.head()

date

title

15 intro

url

combined

risk_rating

0

20 20-Jul-2020

Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-COVID-19

Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.

25 www.foodnavigator-asia.com/Article/2020/07/20/Legacy-vs-price-Rice-exports-from-Vietnam-and-India-vie-for-ASEAN-trade-post-COVID-19

Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-COVID-19. Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.

30 neutral

neutral

1

25-Jun-2020

Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal
The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

5 www.foodnavigator-asia.com/Article/2020/06/25/Trade-off-Rice-and-seafood-the-big-winners-for-Vietnam-under-EU-free-trade-deal

Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal.
The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well
10 as alcohol and meat for the EU.

neutral

2

22-Apr-2020

Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-
15 sensitive' crop

Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

[www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-](http://www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop)

20 [creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop](http://www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop)

Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop. Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

25 neutral

3

17-Mar-2020

The rice and fall: Vietnam eyes more global opportunities as Thai supply totters
Thailand's position as the largest exporter of rice from the South East Asian region is
30 at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-more-global-opportunities-as-Thai-supply-totters

The rice and fall: Vietnam eyes more global opportunities as Thai supply totters.
Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

5 neutral

4

25-Feb-2020

Beyond rice: Indian government urged to boost cereal production in security drive

10 Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-urged-to-boost-cereal-production-in-security-drive

Beyond rice: Indian government urged to boost cereal production in security drive.

15 Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

neutral

#manually annotate as risky, neutral or stabilizing to Asia rice food supply

20

#going through 10 rows at a time to annotate

#all news is neutral unless otherwise annotated as risky or stabilizing

25

risky_rows = [2, 3, 7, 13, 17, 18, 20, 37, 43, 49, 53, 54, 58, 68, 71]

stabilizing_rows = [6, 8, 9, 10, 11, 12, 14, 21, 24, 25, 27, 29, 30, 32, 42,
46, 47, 48, 51, 55, 57, 61, 64, 65, 70, 73, 74]

len(risky_rows)

30 15

len(stabilizing_rows)

27

df[["combined"]][60:75]

combined

60

Vietnamese researchers find efficient way to extract Gamma Oryzanol. Researchers in Vietnam claim to have invented technology that can be used to mass-produce Gamma Oryzanol from rice bran at a far lower cost than by current techniques.

5 61

China to explore increased rice imports from India. India's newfound position as the world's leading rice exporter has not escaped the attention of China, which may look to its western neighbour for increasingly greater rice supplies over the coming years.

62

10 Greenpeace gone too far with GM Golden Rice scandal. "Human guinea pigs", "gambling with health" and "shadowy research project"—the terms came thick and fast in Greenpeace's revelation about Golden Rice earlier this year.

63

15 Why does everyone hate the Thai rice mortgage scheme?. The Thai rice mortgage scheme continues to receive a fair amount of media bashing even after completing its first anniversary last month.

64

20 'Fuel-injected' rice closing in on reality. A project to develop a cutting-edge variety rice has received a significant funding boost, and is now about to roll into its second phase.

65

Future Group inks deal with agri-processor. Food major Future Group has announced that it has inked a deal with rice processor LT Foods that includes the setting up of the latter's new facility at the group's new food park.

25 66

The GM rice problem: Food fraud from China?. Genetic modification is an on-going problem in Asia's basmati rice network and it is a problem that importers need to be vigilant in curbing, according to an industry expert.

67

30 Half of Hong Kong foods contain arsenic (but aren't dangerous). A new report from the Center for Food Safety in Hong Kong has revealed almost half of food samples contain inorganic arsenic – but not in amounts sufficient to pose serious threats to health.

68

Pest plagues drive Asian insecticide marketing crackdown. Unregulated insecticide marketing in Asia is driving overuse and misuse by farmers leading to widespread pest infestations and damaging millions of tonnes of rice each year, according to industry experts.

5 69

Stalled Indian rice exports to US now being cleared. Indian consignments of basmati rice held up at US ports because of the presence of a banned pesticide are now being cleared, according to ministerial sources.

70

10 Global sustainable rice scheme launched. An international system has been launched that will establish environmental standards for sustainable rice production in a bid to increase rice yields.

71

15 Thai floods will have minimal impact on global rice market, according to industry expert. The severe flooding in Thailand is merely a second blow to its already unsteady rice market, an industry expert has said.

72

20 New joint venture between McCormick and Kohinoor Foods: India. Global spice and flavour giant McCormick has signed a joint venture contract with India's leading basmati rice production company Kohinoor Foods, forming a new company in India.

73

25 Singapore pledges \$8.2m to Asia rice science for the next five years. Singapore's National Research Foundation (NRF) has said it will invest \$8.2m in a joint research program that aims to ensure food security and future rice demands are met throughout Asia.

74

30 Japanese scientists to breed rice resilient to radioactive cesium. In the wake of the Fukushima nuclear disaster, Japanese scientists from the Fukushima Agricultural Technology Centre are working towards a potential solution for the future of Japanese rice farmers – a strain of rice resilient to cesium absorption.

#we replace our placeholder "neutral" rating in our manual annotations of risky rows for i in risky_rows:

```
df.at[i, "risk_rating"] = "risky"
```

```
for i in stabilizing_rows:
```

```
    df.at[i, "risk_rating"] = "stable"
```

```
#risky ratings are in, looks ok
```

```
df.head(10)
```

```
5  date
```

```
    title
```

```
    intro
```

```
    url
```

```
    combined
```

```
10 risk_rating
```

```
    0
```

```
    20-Jul-2020
```

```
    Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-
    COVID-19
```

```
15 Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the
    former having gained advantage due to support from traditional partner Philippines,
    and the latter having come out ahead with Malaysia in terms of price.
```

```
    www.foodnavigator-asia.com/Article/2020/07/20/Legacy-vs-price-Rice-exports-from-
    Vietnam-and-India-vie-for-ASEAN-trade-post-COVID-19
```

```
20 Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-
    COVID-19. Vietnam and India are competing for ASEAN rice trade post-COVID-19,
    with the former having gained advantage due to support from traditional partner
    Philippines, and the latter having come out ahead with Malaysia in terms of price.
```

```
    neutral
```

```
25 1
```

```
    25-Jun-2020
```

```
    Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal
    The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major
    gains in food trade for both sides, particularly in rice and seafood for Vietnam as well
    as alcohol and meat for the EU.
```

```
    www.foodnavigator-asia.com/Article/2020/06/25/Trade-off-Rice-and-seafood-the-big-
    winners-for-Vietnam-under-EU-free-trade-deal
```

```
    Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal.
    The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major
```

gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

neutral

2

5 22-Apr-2020

Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop

Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop

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risky

3

17-Mar-2020

20 The rice and fall: Vietnam eyes more global opportunities as Thai supply totters
Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

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The rice and fall: Vietnam eyes more global opportunities as Thai supply totters. Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

risky

4

25-Feb-2020

Beyond rice: Indian government urged to boost cereal production in security drive

Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

[www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-](http://www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-urged-to-boost-cereal-production-in-security-drive)

5 [urged-to-boost-cereal-production-in-security-drive](http://www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-urged-to-boost-cereal-production-in-security-drive)

Beyond rice: Indian government urged to boost cereal production in security drive.

Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

10 neutral

5

17-Feb-2020

Arsenic snack shock: RMIT study finds almost 75% of children rice snacks exceed EU recommendations

15 Nearly 75% of infant and children rice snack samples in Australia have been found to exceed the European Union (EU) maximum levels of inorganic arsenic levels.

www.foodnavigator-asia.com/Article/2020/02/17/Arsenic-snack-shock-RMIT-study-finds-almost-75-of-children-rice-snacks-exceed-EU-recommendations

Arsenic snack shock: RMIT study finds almost 75% of children rice snacks exceed

20 EU recommendations. Nearly 75% of infant and children rice snack samples in Australia have been found to exceed the European Union (EU) maximum levels of inorganic arsenic levels.

neutral

6

25 14-Jan-2020

Rice and shine: Expansion plans in the pipelines for Japan's low carbohydrate rice
Japanese health food company KBS Corporation is rapidly expanding its sales channels for its low carbohydrate rice, Trice.

[www.foodnavigator-asia.com/Article/2020/01/14/Rice-and-shine-Expansion-plans-in-](http://www.foodnavigator-asia.com/Article/2020/01/14/Rice-and-shine-Expansion-plans-in-the-pipelines-for-Japan-s-low-carbohydrate-rice)

30 [the-pipelines-for-Japan-s-low-carbohydrate-rice](http://www.foodnavigator-asia.com/Article/2020/01/14/Rice-and-shine-Expansion-plans-in-the-pipelines-for-Japan-s-low-carbohydrate-rice)

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neutral

7

10-Dec-2019

Philippines rice saga: Government confirms stricter import controls despite President's pledge to ban them

- 5 The Philippines Department of Agriculture (DA) has opted to control rice imports and prices, even though President Rodrigo Duterte previously said all imports would be halted.

www.foodnavigator-asia.com/Article/2019/12/10/Philippines-rice-saga-Government-confirms-stricter-import-controls-despite-President-s-pledge-to-ban-them

- 10 Philippines rice saga: Government confirms stricter import controls despite President's pledge to ban them. The Philippines Department of Agriculture (DA) has opted to control rice imports and prices, even though President Rodrigo Duterte previously said all imports would be halted.

risky

- 15 8

15-Oct-2019

Thai rice specialist firm MediFoods looks to expand local market after overseas success

- 20 Thailand rice specialist company MediFoods has its eye on local market expansion after a successful run overseas with its rice-based products and ingredients portfolio.
www.foodnavigator-asia.com/Article/2019/10/15/Thai-rice-specialist-firm-MediFoods-looks-to-expand-local-market-after-overseas-success

- 25 Thai rice specialist firm MediFoods looks to expand local market after overseas success. Thailand rice specialist company MediFoods has its eye on local market expansion after a successful run overseas with its rice-based products and ingredients portfolio.

neutral

9

08-May-2019

- 30 Rice crisis over? Philippines looks at removal of suggested retail prices as market stabilises

The Philippines Department of Trade and Industry (DTI) is considering the removal of suggested retail prices (SRPs) for rice in the wake of the rice tariffication law being signed earlier this year.

www.foodnavigator-asia.com/Article/2019/05/08/Rice-crisis-over-Philippines-looks-at-removal-of-suggested-retail-prices-as-market-stabilises

Rice crisis over? Philippines looks at removal of suggested retail prices as market stabilises. The Philippines Department of Trade and Industry (DTI) is considering the removal of suggested retail prices (SRPs) for rice in the wake of the rice tariffication law being signed earlier this year.

neutral

```
df["risk_rating"].value_counts()
```

```
neutral    33
```

```
10  stable    27
```

```
risky      15
```

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Name: risk_rating, dtype: int64
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stable_ratings = df["combined"][df["risk_rating"]=="stable"]
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df[df["risk_rating"]=="stable"]
```

```
15  date
```

```
title
```

```
intro
```

```
url
```

```
combined
```

```
20  risk_rating
```

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6
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14-Jan-2020
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30
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8
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5 www.foodnavigator-asia.com/Article/2019/10/15/Thai-rice-specialist-firm-MediFoods-looks-to-expand-local-market-after-overseas-success

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10 ingredients portfolio.

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08-May-2019

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20 [removal-of-suggested-retail-prices-as-market-stabilises](http://www.foodnavigator-asia.com/Article/2019/05/08/Rice-crisis-over-Philippines-looks-at-removal-of-suggested-retail-prices-as-market-stabilises)

Rice crisis over? Philippines looks at removal of suggested retail prices as market stabilises. The Philippines Department of Trade and Industry (DTI) is considering the removal of suggested retail prices (SRPs) for rice in the wake of the rice tariffication law being signed earlier this year.

25 neutral

10

07-May-2019

'Affordable fortification': Indian supplier gets government contract to produce fortified rice for Kerala

30 India's SupplyCo has received a government contract to produce and provide fortified rice in Kerala, after figures revealed that 19.7% of children below the age of five are stunted and 15.7% are underweight.

www.foodnavigator-asia.com/Article/2019/05/07/Affordable-fortification-Indian-supplier-gets-government-contract-to-produce-fortified-rice-for-Kerala

'Affordable fortification': Indian supplier gets government contract to produce fortified rice for Kerala. India's SupplyCo has received a government contract to produce and provide fortified rice in Kerala, after figures revealed that 19.7% of children below the age of five are stunted and 15.7% are underweight.

5 neutral

11

06-Feb-2019

'No more limit': Philippines import cap removal could see 1.2m MT of rice entering the country

10 The Philippines' lifting of a 20-year old rice import cap is likely to result in some 1.2 million metric tons of rice being imported into the country in the wake of ongoing shortages and price hikes, the National Food Agency (NFA) has said.

www.foodnavigator-asia.com/Article/2019/02/06/No-more-limit-Philippines-import-cap-removal-could-see-1.2m-MT-of-rice-entering-the-country

15 'No more limit': Philippines import cap removal could see 1.2m MT of rice entering the country. The Philippines' lifting of a 20-year old rice import cap is likely to result in some 1.2 million metric tons of rice being imported into the country in the wake of ongoing shortages and price hikes, the National Food Agency (NFA) has said.

neutral

20 12

19-Dec-2018

Mandatory rice fortification for public programmes in India by December 2019

The use of fortified rice will be mandatory in all midday meal schemes, and public nutrition programmes under the Integrated Child Development Services (ICDS) in

25 India by December 2019.

www.foodnavigator-asia.com/Article/2018/12/19/Mandatory-rice-fortification-for-public-programmes-in-India-by-December-2019

Mandatory rice fortification for public programmes in India by December 2019. The use of fortified rice will be mandatory in all midday meal schemes, and public nutrition programmes under the Integrated Child Development Services (ICDS) in India by

30 December 2019.

neutral

14

29-Oct-2018

'No more fancy brand names': Rice labelling and pricing rules introduced in Philippines amid supply crisis

Food companies have been warned to avoid fancy 'nicknames' for rice as suggested retail prices (SRPs) are implemented in the Philippines, in a move that the government hopes will alleviate the country's rising food troubles.

www.foodnavigator-asia.com/Article/2018/10/29/No-more-fancy-brand-names-Rice-labelling-and-pricing-rules-introduced-in-Philippines-amid-supply-crisis

'No more fancy brand names': Rice labelling and pricing rules introduced in Philippines amid supply crisis. Food companies have been warned to avoid fancy 'nicknames' for rice as suggested retail prices (SRPs) are implemented in the Philippines, in a move that the government hopes will alleviate the country's rising food troubles.

neutral

21

28-Jun-2018

Low-GI outfit SunRice reveals business growth plans with proposed capital raise
Australian low-GI rice firm SunRice is seeking to raise up to AU\$30m to accelerate new product development and expansion across Asia Pacific.

www.foodnavigator-asia.com/Article/2018/06/28/Low-GI-outfit-SunRice-reveals-business-growth-plans-with-proposed-capital-raise

Low-GI outfit SunRice reveals business growth plans with proposed capital raise. Australian low-GI rice firm SunRice is seeking to raise up to AU\$30m to accelerate new product development and expansion across Asia Pacific.

neutral

24

18-Jan-2018

China rice bran oil debuts in Japan to take on domestic brands

China rice bran oil brand Arawana has made its first move into the ultra-competitive Japan market with its first supermarket launch.

www.foodnavigator-asia.com/Article/2018/01/18/China-rice-bran-oil-debuts-in-Japan-to-take-on-domestic-brands

China rice bran oil debuts in Japan to take on domestic brands. China rice bran oil brand Arawana has made its first move into the ultra-competitive Japan market with its first supermarket launch.

neutral

25

03-Jan-2018

Foods containing GM golden rice can be sold in Australia and New Zealand

- 5 Products containing traces of golden rice, which is genetically modified to produce beta-carotene, should be able to be sold in Australia and New Zealand, regulators have ruled.

www.foodnavigator-asia.com/Article/2018/01/03/Foods-containing-GM-golden-rice-can-be-sold-in-Australia-and-New-Zealand

- 10 Foods containing GM golden rice can be sold in Australia and New Zealand. Products containing traces of golden rice, which is genetically modified to produce beta-carotene, should be able to be sold in Australia and New Zealand, regulators have ruled.

neutral

- 15 27

06-Apr-2017

FAO and Irri collaborate for Apac rice sustainability programme

- The International Rice Research Institute will work more closely with the UN's agriculture agency to support sustainable rice production in developing countries in a bid to improve food security.

www.foodnavigator-asia.com/Article/2017/04/06/FAO-and-Irri-collaborate-for-Apac-rice-sustainability-programme

- 25 FAO and Irri collaborate for Apac rice sustainability programme. The International Rice Research Institute will work more closely with the UN's agriculture agency to support sustainable rice production in developing countries in a bid to improve food security.

neutral

29

16-Feb-2017

- 30 Rice diversity could be central to more productive crops

Scientists have found that they can improve rice productivity by selecting varieties that are better at capturing sunlight to produce grains, instead of reflecting it as heat.

www.foodnavigator-asia.com/Article/2017/02/16/Rice-diversity-could-be-central-to-more-productive-crops

Rice diversity could be central to more productive crops. Scientists have found that they can improve rice productivity by selecting varieties that are better at capturing sunlight to produce grains, instead of reflecting it as heat.

neutral

5 30

06-Dec-2016

Amira joins select few firms with permission to ship rice to China

Dubai-based Amira Nature Foods, which manufactures packaged Indian specialty rice, is now one of only a select few Indian companies allowed to export rice to China after they were granted approval for basmati shipments.

10

www.foodnavigator-asia.com/Article/2016/12/06/Amira-joins-select-few-firms-with-permission-to-ship-rice-to-China

Amira joins select few firms with permission to ship rice to China. Dubai-based Amira Nature Foods, which manufactures packaged Indian specialty rice, is now one of only a select few Indian companies allowed to export rice to China after they were granted approval for basmati shipments.

15

neutral

32

12-Sep-2016

20 Korean TV and Asian demand drive freekah sales from Australia

Korean television and a partnership in Singapore have been helping an Australian super grain producer reach new markets.

www.foodnavigator-asia.com/Article/2016/09/12/Korean-TV-and-Asian-demand-drive-freekah-sales-from-Australia

25 Korean TV and Asian demand drive freekah sales from Australia. Korean television and a partnership in Singapore have been helping an Australian super grain producer reach new markets.

neutral

42

30 25-Sep-2014

White gold: How the EU has been central to the rise of Cambodian rice

With its rice industry going through salad days, Cambodia is nevertheless at a crossroads. While on the international front, it is shipping more rice overseas than

ever before; domestically, there is still a number issues for producers and exporters to...

www.foodnavigator-asia.com/Article/2014/09/25/White-gold-How-the-EU-has-been-central-to-the-rise-of-Cambodian-rice

- 5 White gold: How the EU has been central to the rise of Cambodian rice. With its rice industry going through salad days, Cambodia is nevertheless at a crossroads. While on the international front, it is shipping more rice overseas than ever before; domestically, there is still a number issues for producers and exporters to...

neutral

10 46

27-Feb-2014

Rice institute developed 44 new or improved rice varieties in 2013

Last year, the International Rice Research Institute (IRRI) and its partners released 44 new and improved rice varieties, taking the number to around a thousand since it was launched in 1960.

15

www.foodnavigator-asia.com/Article/2014/02/27/Rice-institute-developed-44-new-or-improved-rice-varieties-in-2013

Rice institute developed 44 new or improved rice varieties in 2013. Last year, the International Rice Research Institute (IRRI) and its partners released 44 new and improved rice varieties, taking the number to around a thousand since it was launched in 1960.

20

neutral

47

10-Feb-2014

- 25 Al Dahra plans \$150m rice mill for Abu Dhabi

Al Dahra Agriculture will build a US\$150m basmati rice processing facility it announced this week, as regional firms work to secure basmati imports.

www.foodnavigator-asia.com/Article/2014/02/10/Al-Dahra-plans-150m-rice-mill-for-Abu-Dhabi

30

Al Dahra plans \$150m rice mill for Abu Dhabi. Al Dahra Agriculture will build a US\$150m basmati rice processing facility it announced this week, as regional firms work to secure basmati imports.

neutral

48

04-Dec-2013

Rice gene discovery can increase crop productivity by up to one-third

Scientists in the Far East have discovered a rice gene that in preliminary testing increased production by 13-36% in modern long-grain indica rice varieties—the world's most widely grown types of rice.

www.foodnavigator-asia.com/Article/2013/12/04/Rice-gene-discovery-can-increase-crop-productivity-by-up-to-one-third

Rice gene discovery can increase crop productivity by up to one-third. Scientists in the Far East have discovered a rice gene that in preliminary testing increased production by 13-36% in modern long-grain indica rice varieties—the world's most widely grown types of rice.

neutral

51

24-Sep-2013

Near record crops likely to make dent in India's record food inflation

Consumers are hoping for a respite from the crippling food inflation India has been witnessing after the government revealed a bumper harvest.

www.foodnavigator-asia.com/Article/2013/09/24/Near-record-crops-likely-to-make-dent-in-India-s-record-food-inflation

Near record crops likely to make dent in India's record food inflation. Consumers are hoping for a respite from the crippling food inflation India has been witnessing after the government revealed a bumper harvest.

neutral

55

27-May-2013

Contest might realise Pinoy dream of half-cost rice production

Competition for improving Filipino rice yields is heating up quite literally with a major challenge issued to farmers there.

www.foodnavigator-asia.com/Article/2013/05/27/Contest-might-realise-Pinoy-dream-of-half-cost-rice-production

Contest might realise Pinoy dream of half-cost rice production. Competition for improving Filipino rice yields is heating up quite literally with a major challenge issued to farmers there.

neutral

57

16-Apr-2013

New salt-tolerant rice strain could help in fight for food security

A newly developed strain of rice tolerant to levels of salt found in seawater might

5 become available to farmers in the next four to five years, and its impact on food security could be massive.

www.foodnavigator-asia.com/Article/2013/04/16/New-salt-tolerant-rice-strain-could-help-in-fight-for-food-security

New salt-tolerant rice strain could help in fight for food security. A newly developed strain of rice tolerant to levels of salt found in seawater might become available to farmers in the next four to five years, and its impact on food security could be massive.

10

neutral

61

15 14-Jan-2013

China to explore increased rice imports from India

India's newfound position as the world's leading rice exporter has not escaped the attention of China, which may look to its western neighbour for increasingly greater rice supplies over the coming years.

20 www.foodnavigator-asia.com/Article/2013/01/14/China-to-explore-increased-rice-imports-from-India

China to explore increased rice imports from India. India's newfound position as the world's leading rice exporter has not escaped the attention of China, which may look to its western neighbour for increasingly greater rice supplies over the coming years.

25 neutral

64

08-Nov-2012

'Fuel-injected' rice closing in on reality

A project to develop a cutting-edge variety rice has received a significant funding boost, and is now about to roll into its second phase.

30

www.foodnavigator-asia.com/Article/2012/11/08/Fuel-injected-rice-getting-closer-to-becoming-a-reality

'Fuel-injected' rice closing in on reality. A project to develop a cutting-edge variety rice has received a significant funding boost, and is now about to roll into its second phase.

neutral

5 65

04-Jun-2012

Future Group inks deal with agri-processor

Food major Future Group has announced that it has inked a deal with rice processor LT Foods that includes the setting up of the latter's new facility at the group's new food park.

10

www.foodnavigator-asia.com/Article/2012/06/04/Future-Group-inks-deal-with-agri-processor

Future Group inks deal with agri-processor. Food major Future Group has announced that it has inked a deal with rice processor LT Foods that includes the setting up of the latter's new facility at the group's new food park.

15

neutral

70

05-Dec-2011

Global sustainable rice scheme launched

An international system has been launched that will establish environmental standards for sustainable rice production in a bid to increase rice yields.

20

www.foodnavigator-asia.com/Article/2011/12/05/Global-sustainable-rice-scheme-launched

Global sustainable rice scheme launched. An international system has been launched that will establish environmental standards for sustainable rice production in a bid to increase rice yields.

25

neutral

73

22-Sep-2011

Singapore pledges \$8.2m to Asia rice science for the next five years

Singapore's National Research Foundation (NRF) has said it will invest \$8.2m in a joint research program that aims to ensure food security and future rice demands are met throughout Asia.

30

www.foodnavigator-asia.com/Article/2011/09/22/Singapore-pledges-8.2m-to-Asia-rice-science-for-the-next-five-years

Singapore pledges \$8.2m to Asia rice science for the next five years. Singapore's National Research Foundation (NRF) has said it will invest \$8.2m in a joint research program that aims to ensure food security and future rice demands are met throughout Asia.

neutral

74

05-Sep-2011

10 Japanese scientists to breed rice resilient to radioactive cesium

In the wake of the Fukushima nuclear disaster, Japanese scientists from the Fukushima Agricultural Technology Centre are working towards a potential solution for the future of Japanese rice farmers – a strain of rice resilient to cesium absorption.

15 www.foodnavigator-asia.com/Article/2011/09/05/Japanese-scientists-to-breed-rice-resilient-to-radioactive-cesium

Japanese scientists to breed rice resilient to radioactive cesium. In the wake of the Fukushima nuclear disaster, Japanese scientists from the Fukushima Agricultural Technology Centre are working towards a potential solution for the future of

20 Japanese rice farmers – a strain of rice resilient to cesium absorption.

neutral

`df.loc[stabilizing_rows, "risk_rating"] = "stable"`

We now label the risk rating in this initial training dataset so that our machine learning models will be able to learn what text ought to be classified as what rating in the future automatically.

25 Again, for simplicity's sake, we use simpler labels like risky, neutral, and stable; future version will have more nuanced risk labelling.

`df.head(10)`

date

30 title

intro

url

combined

risk_rating

0

20-Jul-2020

Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-COVID-19

- 5 Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.

www.foodnavigator-asia.com/Article/2020/07/20/Legacy-vs-price-Rice-exports-from-Vietnam-and-India-vie-for-ASEAN-trade-post-COVID-19

- 10 Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-COVID-19. Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.
neutral

- 15 1

25-Jun-2020

Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal
The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

- 20 www.foodnavigator-asia.com/Article/2020/06/25/Trade-off-Rice-and-seafood-the-big-winners-for-Vietnam-under-EU-free-trade-deal

Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal.

- 25 The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

neutral

2

22-Apr-2020

- 30 Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop

Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop

Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop. Lockdowns and trade barriers across Asia due to the COVID-19

- 5 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

risky

3

17-Mar-2020

- 10 The rice and fall: Vietnam eyes more global opportunities as Thai supply totters
Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-more-global-opportunities-as-Thai-supply-totter

- 15 The rice and fall: Vietnam eyes more global opportunities as Thai supply totters.
Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

- 20 risky

4

25-Feb-2020

Beyond rice: Indian government urged to boost cereal production in security drive

Researchers are pushing for India to focus on enhancing its production of crops other

- 25 than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-urged-to-boost-cereal-production-in-security-drive

Beyond rice: Indian government urged to boost cereal production in security drive.

- 30 Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

neutral

5

17-Feb-2020

Arsenic snack shock: RMIT study finds almost 75% of children rice snacks exceed EU recommendations

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neutral

6

14-Jan-2020

Rice and shine: Expansion plans in the pipelines for Japan's low carbohydrate rice Japanese health food company KBS Corporation is rapidly expanding its sales channels for its low carbohydrate rice, Trice.

www.foodnavigator-asia.com/Article/2020/01/14/Rice-and-shine-Expansion-plans-in-the-pipelines-for-Japan-s-low-carbohydrate-rice

Rice and shine: Expansion plans in the pipelines for Japan's low carbohydrate rice. Japanese health food company KBS Corporation is rapidly expanding its sales channels for its low carbohydrate rice, Trice.

stable

7

10-Dec-2019

Philippines rice saga: Government confirms stricter import controls despite President's pledge to ban them

The Philippines Department of Agriculture (DA) has opted to control rice imports and prices, even though President Rodrigo Duterte previously said all imports would be halted.

www.foodnavigator-asia.com/Article/2019/12/10/Philippines-rice-saga-Government-confirms-stricter-import-controls-despite-President-s-pledge-to-ban-them

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risky

8

5 15-Oct-2019

Thai rice specialist firm MediFoods looks to expand local market after overseas success

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10 www.foodnavigator-asia.com/Article/2019/10/15/Thai-rice-specialist-firm-MediFoods-looks-to-expand-local-market-after-overseas-success

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stable

9

08-May-2019

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[www.foodnavigator-asia.com/Article/2019/05/08/Rice-crisis-over-Philippines-looks-at-](http://www.foodnavigator-asia.com/Article/2019/05/08/Rice-crisis-over-Philippines-looks-at-removal-of-suggested-retail-prices-as-market-stabilises)

25

removal-of-suggested-retail-prices-as-market-stabilises
Rice crisis over? Philippines looks at removal of suggested retail prices as market stabilises. The Philippines Department of Trade and Industry (DTI) is considering the removal of suggested retail prices (SRPs) for rice in the wake of the rice tariffication law being signed earlier this year.

30

stable

`df["risk_rating"].value_counts()`

neutral 33

stable 27

risky 15

Name: risk_rating, dtype: int64

pwd

'/Users/grahamlim/Documents/FSX_and_Trainer_Stuff/scrape_risk_app/code'

5 df.to_csv("../data/df_ratings_raw.csv")

3A. Pre-processing our Data

df = pd.read_csv("../data/df_ratings_raw.csv", index_col = 0)

We will require a number of pre-processing tools that we import into our python scripts. The purpose of these tools is to further convert the dataset into a machine-readable format, by splitting our data into a training, validation and test set, as well as utilizing Natural Language Processing to convert our text into ML-compatible Word Vectors.

The tools we use are: * Preprocessing tools from scikit-learn, which is a commercially-used open-source Python-based machine-learning library (<https://scikit-learn.org/stable/>), and * Preprocessing tools from spaCy, which is an "Industrial-Strength" open-source Python-based Natural Language Processing library (<https://spacy.io>).

#sklearn modelling tools

from sklearn.model_selection import GridSearchCV
20 from sklearn.model_selection import train_test_split
from sklearn.pipeline import Pipeline
from sklearn.preprocessing import RobustScaler
from sklearn.model_selection import cross_val_score

25 *#for multilabel classification and oversampling*

from skmultilearn.problem_transform import BinaryRelevance
from sklearn.multiclass import OneVsRestClassifier
from imblearn.over_sampling import SMOTE
from sklearn.preprocessing import label_binarize

30

#for PCA - Dimensionality Reduction

from sklearn.decomposition import TruncatedSVD

#for word vectorization

0192P00578C

```
from sklearn.feature_extraction.text import TfidfTransformer, CountVectorizer,  
TfidfVectorizer
```

```
#our dummy baseline
```

```
5 from sklearn.dummy import DummyClassifier
```

```
#advanced supervised classification models
```

```
from sklearn.neighbors import KNeighborsClassifier
```

```
from sklearn.ensemble import RandomForestClassifier, GradientBoostingClassifier,
```

```
10 AdaBoostClassifier
```

```
from sklearn.tree import DecisionTreeClassifier
```

```
from sklearn import svm
```

```
from sklearn.svm import SVC
```

```
from xgboost import XGBClassifier
```

```
15
```

```
from sklearn.dummy import DummyClassifier
```

```
from sklearn.linear_model import SGDClassifier
```

```
from sklearn.naive_bayes import GaussianNB
```

```
20 #classification metrics imports
```

```
from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score,  
roc_curve, auc, confusion_matrix
```

```
from scipy import interp
```

```
from itertools import cycle
```

```
25
```

```
from sklearn.metrics import balanced_accuracy_score
```

```
from sklearn.metrics import confusion_matrix, classification_report, roc_auc_score,  
hinge_loss
```

```
from sklearn import metrics
```

```
30 #pre-process text for EDA and later modelling too using spacy and string libraries
```

```
import spacy
```

```
from spacy.lang.en import English # updated
```

```

import re
import string
from spacy.lang.en.stop_words import STOP_WORDS
from spacy.lang.en import English
5  from spacy import displacy
import spacy.cli
from spacy.pipeline import EntityRuler
from spacy.matcher import Matcher
from spacy.tokens import Doc
10  from spacy import displacy

from collections import Counter

Now that we've imported our tools, we write code using spaCy to transform words
into numerical arrays known as Word Vectors. This involves a process coded out
15  below known as tokenization.

We also convert all of the words in our dataset into their lemmatized form (base
word-format e.g. the base format of "disappointed" is "disappoint", as well remove
punctuation, stop-words, numbers.

Again, all of these steps are necessary to allow our models to "read" the language
20  and predict what risk scoring should be assigned to any given news article.

Here is what the pre-processing code:

#stopwords removal

# Create our list of punctuation marks
25  punctuations = string.punctuation

# Create our list of stopwords
nlp = spacy.load('en_core_web_sm')
stop_words = spacy.lang.en.stop_words.STOP_WORDS
30

# Load English tokenizer, tagger, parser, NER and word vectors
parser = English()

# Creating our tokenizer function

```

```
def spacy_tokenizer(sentence):
```

```
    #remove non-words
```

```
    tokens = re.sub("[^a-zA-Z]", " ", sentence)
```

```
5    tokens = re.sub("[0-9]+", "", tokens)
```

```
    # Creating our token object, which is used to create documents with linguistic annotations.
```

```
    tokens = parser(tokens)
```

```
10
```

```
    # Lemmatizing each token and converting each token into lowercase
```

```
    tokens = [ word.lemma_.lower().strip() if word.lemma_ != "-PRON-" else  
word.lower_ for word in tokens ]
```

```
15    # Removing stop words
```

```
    tokens = [ word for word in tokens if word not in stop_words and word not in  
punctuations]
```

```
    # return preprocessed list of tokens
```

```
20    return(" ".join(tokens))
```

```
df["bag_cleaned_text"]=df["combined"].apply(spacy_tokenizer)
```

```
df.head(7)
```

```
date
```

```
title
```

```
25 intro
```

```
url
```

```
combined
```

```
risk_rating
```

```
bag_cleaned_text
```

```
30 0
```

```
20-Jul-2020
```

```
Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-  
COVID-19
```

Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.

[www.foodnavigator-asia.com/Article/2020/07/20/Legacy-vs-price-Rice-exports-from-](http://www.foodnavigator-asia.com/Article/2020/07/20/Legacy-vs-price-Rice-exports-from-Vietnam-and-India-vie-for-ASEAN-trade-post-COVID-19)

5 Vietnam-and-India-vie-for-ASEAN-trade-post-COVID-19

Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-COVID-19. Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.

10 neutral

legacy vs price rice exports vietnam india vie asean trade post covid vietnam india competing asean rice trade post covid having gained advantage support traditional partner philippines having come ahead malaysia terms price

1

15 25-Jun-2020

Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal
The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

20 www.foodnavigator-asia.com/Article/2020/06/25/Trade-off-Rice-and-seafood-the-big-winners-for-Vietnam-under-EU-free-trade-deal

Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal.
The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

25 neutral

trade rice seafood big winners vietnam eu free trade deal recently ratified eu vietnam free trade agreement evfta seen major gains food trade sides particularly rice seafood vietnam alcohol meat eu

30 2

22-Apr-2020

Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop

Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

[www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-](http://www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop)

5 [creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop](http://www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop)

Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop. Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

10 risky

rice ing concern covid creates supply price volatility asia s cost sensitive crop
lockdowns trade barriers asia covid pandemic thrust rice region s largest agricultural
commodities firmly spotlight potential volatility supply cost

3

15 17-Mar-2020

The rice and fall: Vietnam eyes more global opportunities as Thai supply totters
Thailand's position as the largest exporter of rice from the South East Asian region is
at risk as the country struggles to handle weather, economical and quality changes,
whereas Vietnam looks to be going from strength to strength.

20 [www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-](http://www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-more-global-opportunities-as-Thai-supply-totter)
[more-global-opportunities-as-Thai-supply-totter](http://www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-more-global-opportunities-as-Thai-supply-totter)

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at risk as the country struggles to handle weather, economical and quality changes,
25 whereas Vietnam looks to be going from strength to strength.

risky

rice fall vietnam eyes global opportunities thai supply totters thailand s position
largest exporter rice south east asian region risk country struggles handle weather
economical quality changes vietnam looks going strength strength

30 4

25-Feb-2020

Beyond rice: Indian government urged to boost cereal production in security drive

Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-urged-to-boost-cereal-production-in-security-drive

Beyond rice: Indian government urged to boost cereal production in security drive. Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

neutral

rice indian government urged boost cereal production security drive researchers pushing india focus enhancing production crops rice country s traditional staple wishes effectively address triple threats food security climate change effects malnutrition

5

17-Feb-2020

Arsenic snack shock: RMIT study finds almost 75% of children rice snacks exceed EU recommendations

Nearly 75% of infant and children rice snack samples in Australia have been found to exceed the European Union (EU) maximum levels of inorganic arsenic levels.

www.foodnavigator-asia.com/Article/2020/02/17/Arsenic-snack-shock-RMIT-study-finds-almost-75-of-children-rice-snacks-exceed-EU-recommendations

Arsenic snack shock: RMIT study finds almost 75% of children rice snacks exceed EU recommendations. Nearly 75% of infant and children rice snack samples in Australia have been found to exceed the European Union (EU) maximum levels of inorganic arsenic levels.

neutral

arsenic snack shock rmit study finds children rice snacks exceed eu recommendations nearly infant children rice snack samples australia found exceed european union eu maximum levels inorganic arsenic levels

6

14-Jan-2020

Rice and shine: Expansion plans in the pipelines for Japan's low carbohydrate rice

Japanese health food company KBS Corporation is rapidly expanding its sales channels for its low carbohydrate rice, Trice.

www.foodnavigator-asia.com/Article/2020/01/14/Rice-and-shine-Expansion-plans-in-the-pipelines-for-Japan-s-low-carbohydrate-rice

- 5 Rice and shine: Expansion plans in the pipelines for Japan's low carbohydrate rice. Japanese health food company KBS Corporation is rapidly expanding its sales channels for its low carbohydrate rice, Trice.

stable

- 10 rice shine expansion plans pipelines japan s low carbohydrate rice japanese health food company kbs corporation rapidly expanding sales channels low carbohydrate rice trice

- Our algorithm will also assign a numerical risk score based on the risk categories with this dictionary of values for multiclass classification to work in sklearn. The purpose of this is for future risk-weighted scoring for our report-writing algorithm, which is explained later:

```
df["risk_rating_numerical"] = df["risk_rating"].copy()
print(df["risk_rating_numerical"])
0    neutral
1    neutral
20  2    risky
   3    risky
   4    neutral
   ...
   70   stable
25  71   risky
   72   neutral
   73   stable
   74   stable
Name: risk_rating_numerical, Length: 75, dtype: object
30 #numerical risk rating score impact
df["risk_rating_numerical"].replace({'neutral':0,
                                     'stable':1,
                                     'risky':-1})
```

0192P00578C

```
0  0
1  0
2 -1
3 -1
5  4  0
   ..
70  1
71 -1
72  0
10 73  1
   74  1
```

Name: risk_rating_numerical, Length: 75, dtype: int64

In the final part of our pre-processing, we now write code to actually transform our text into individual word and 2-word phrase (bigram) tokens, which will attach numerical scores that are weighted tf: term frequency(count of the words present in document from its own vocabulary), idf: inverse document frequency(importance of the word to each document).

#Creating the features (tf-idf weights) for the processed text

```
20 texts = df['bag_cleaned_text'].astype('str')

tfidf_vectorizer = TfidfVectorizer(ngram_range=(1, 2),
                                   min_df = 2,
                                   max_df = .95)
```

```
25 X = tfidf_vectorizer.fit_transform(texts) #features
   y = df['risk_rating_numerical'].values #target
```

```
print(X.shape)
30 print(y.shape)
   (75, 304)
   (75,)
```

3B. Modelling: Multilabel Text Classification using scikit-learn

Here, we're going to train our data using the following scikit-learn machine learning models: * Random Forest, * XGBoost, * SVC, and * K-Nearest Neighbours.

We'll split the data into a train, validation and test set. We'll only run our models on

5 the validation set to understand generalization of each model, which we compare against sklearn's own DummyClassifier as our baseline model.

The purpose of all this is to evaluate whether these conventional sci-kit learn machine learning models will perform better at predicting the right risk label for any given piece of news. We also compare this against an NLP-focused Deep Neural

10 Network known as BERT, which is Google's own open-source Deep Learning model: ([https://en.wikipedia.org/wiki/BERT_\(language_model\)](https://en.wikipedia.org/wiki/BERT_(language_model)))

Once the first phase of our training data has been compiled and labelled, our risk decisioning engine will constantly be evaluated for performance. We will, at all times, be asking ourselves - are the models we are using good at

15 **predicting risk correctly?**

#General model evaluation using default parameters on Validation Set

#Creating a dict of the models

```
model_dict = {'Random Forest': RandomForestClassifier(random_state=3),
20         'XGBoost': XGBClassifier(random_state=3),
        'SVC': SVC(),
        'K Nearest Neighbor': KNeighborsClassifier(),
        'Dummy Baseline': DummyClassifier()}
```

25

#Train test split with stratified sampling for evaluation

```
X_train, X_val, y_train, y_val = train_test_split(X,
30         y,
        test_size = .3,
        shuffle = True,
        stratify = y,
        random_state = 3)
```

```
print("Multiclass Clause Classification - Validation Scores")
```

```
#Function to get the scores for each model in a dataframe
```

```
def model_score_df(model_dict):
```

```
5
```

```
    model_name, ac_score_list, p_score_list, r_score_list, f1_score_list, auc_list = [],  
    [], [], [], [], []
```

```
    for k,v in model_dict.items():
```

```
10
```

```
        model_name.append(k)  
        v.fit(X_train, y_train)  
        y_pred = v.predict(X_val)  
        ac_score_list.append(accuracy_score(y_val, y_pred))  
        p_score_list.append(precision_score(y_val, y_pred, average='micro'))  
15        r_score_list.append(recall_score(y_val, y_pred, average='micro'))  
        f1_score_list.append(f1_score(y_val, y_pred, average='micro'))
```

```
    model_comparison_df = pd.DataFrame([model_name, ac_score_list,  
p_score_list, r_score_list, f1_score_list]).T
```

```
20
```

```
    model_comparison_df.columns = ['model_name', 'accuracy_score',  
'precision_score', 'recall_score', 'f1_score']  
    model_comparison_df = model_comparison_df.sort_values(by='f1_score',  
ascending=False)  
    return model_comparison_df
```

```
25
```

```
model_score_df(model_dict)  
Multiclass Clause Classification - Validation Scores
```

```
30
```

```
/Users/grahamlim/opt/anaconda3/lib/python3.7/site-packages/sklearn/dummy.py:132:  
FutureWarning: The default value of strategy will change from stratified to prior in  
0.24.  
"stratified to prior in 0.24.", FutureWarning)  
model_name
```

0192P00578C

accuracy_score

precision_score

recall_score

f1_score

5 0

Random Forest

0.434783

0.434783

0.434783

10 0.434783

2

SVC

0.434783

0.434783

15 0.434783

0.434783

1

XGBoost

0.391304

20 0.391304

0.391304

0.391304

4

Dummy Baseline

25 0.347826

0.347826

0.347826

0.347826

3

30 K Nearest Neighbor

0.304348

0.304348

0.304348

0.304348

3C. BERT Modelling

We also will utilize a Deep Learning Neural Network known as BERT, mentioned earlier.

Kaushal Trivedi defines BERT as a "multilingual transformer based model that has achieved state-of-the-art results on various NLP tasks. BERT is a bidirectional model that is based on the transformer architecture, it replaces the sequential nature of RNN (LSTM & GRU) with a much faster Attention-based approach. The model is also pre-trained on two unsupervised tasks, masked language modeling and next sentence prediction. This allows us to use a pre-trained BERT model by fine-tuning the same on downstream specific tasks such as sentiment classification, intent detection, question-answering and more." (Source:

<https://medium.com/huggingface/multi-label-text-classification-using-bert-the-mighty-transformer-69714fa3fb3d>)

For our purposes, it is another model on top of scikit-learn's ML models that can help us predict the correct risk label for a given set of news. The code below allows us to use a wrapper called ktrain that trains a BERT model on our news risk classifier:

#Please install ktrain on Google Colab: `pip install ktrain`

#BERT ktrain wrapper imports

import ktrain

from ktrain import text

df.head()

date

title

intro

url

combined

risk_rating

bag_cleaned_text

0

20-Jul-2020

Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-COVID-19

Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.

[www.foodnavigator-asia.com/Article/2020/07/20/Legacy-vs-price-Rice-exports-from-](http://www.foodnavigator-asia.com/Article/2020/07/20/Legacy-vs-price-Rice-exports-from-Vietnam-and-India-vie-for-ASEAN-trade-post-COVID-19)

5 Vietnam-and-India-vie-for-ASEAN-trade-post-COVID-19

Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-COVID-19. Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.

10 neutral

legacy vs price rice exports vietnam india vie asean trade post covid vietnam india competing asean rice trade post covid having gained advantage support traditional partner philippines having come ahead malaysia terms price

1

15 25-Jun-2020

Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal
The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

20 www.foodnavigator-asia.com/Article/2020/06/25/Trade-off-Rice-and-seafood-the-big-winners-for-Vietnam-under-EU-free-trade-deal

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25 neutral

trade rice seafood big winners vietnam eu free trade deal recently ratified eu vietnam free trade agreement evfta seen major gains food trade sides particularly rice seafood vietnam alcohol meat eu

30 2

22-Apr-2020

Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop

Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

[www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-](http://www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop)

5 [creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop](http://www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop)

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10 risky

rice ing concern covid creates supply price volatility asia s cost sensitive crop

lockdowns trade barriers asia covid pandemic thrust rice region s largest agricultural commodities firmly spotlight potential volatility supply cost

3

15 17-Mar-2020

The rice and fall: Vietnam eyes more global opportunities as Thai supply totters

Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

20 www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-more-global-opportunities-as-Thai-supply-totter

The rice and fall: Vietnam eyes more global opportunities as Thai supply totters.

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25 whereas Vietnam looks to be going from strength to strength.

risky

rice fall vietnam eyes global opportunities thai supply totters thailand s position

largest exporter rice south east asian region risk country struggles handle weather economical quality changes vietnam looks going strength strength

30 4

25-Feb-2020

Beyond rice: Indian government urged to boost cereal production in security drive

Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

[www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-](http://www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-urged-to-boost-cereal-production-in-security-drive)

5 urged-to-boost-cereal-production-in-security-drive

Beyond rice: Indian government urged to boost cereal production in security drive.

Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

10 neutral

rice indian government urged boost cereal production security drive researchers pushing india focus enhancing production crops rice country s traditional staple wishes effectively address triple threats food security climate change effects malnutrition

15 `X = df["combined"]`

`y = df["risk_rating"]`

`X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.33)`

#I have to change our train test split objects into a list of strings.

`X_train = X_train.values.tolist()`

20 `X_test = X_test.values.tolist()`

`y_train = y_train.values.tolist()`

`y_test = y_test.values.tolist()`

25 `print("classes to predict")`

`print(y.value_counts())`

classes to predict

neutral 33

stable 27

30 risky 15

Name: risk_rating, dtype: int64

#recalling our Y label dictionary

encoding = {'neutral':0,

'stable':1,

'risky':-1}

Integer values for each class

y_train = [encoding[x] for x in y_train]

5 *y_test = [encoding[x] for x in y_test]*

#we now run BERT-specific preprocessing:

class_names = ['neutral','stable','risky']

*(x_train, y_train), (x_test, y_test), preproc = text.texts_from_array(x_train=X_train,
y_train=y_train,*

10 *x_test=X_test, y_test=y_test,
class_names=class_names,
preprocess_mode='bert',
maxlen=512,
max_features=100000)*

15 *task: text classification*

preprocessing train...

language: en

done.

Is Multi-Label? False

20 *preprocessing test...*

language: en

done.

model = text.text_classifier('bert', train_data=(x_train, y_train), preproc=preproc)

Is Multi-Label? False

25 *maxlen is 512*

done.

learner = ktrain.get_learner(model, train_data=(x_train, y_train),

val_data=(x_test, y_test),

batch_size=12)

30 *learner.fit_onecycle(2e-5, 10)*

#print out a performance report

learner.validate(val_data=(x_test, y_test), class_names=class_names)

precision recall f1-score support

neutral	0.44	0.29	0.35	14
stable	0.20	0.50	0.29	6
risky	1.00	0.20	0.33	5

5	accuracy		0.32	25	
	macro avg	0.55	0.33	0.32	25
	weighted avg	0.50	0.32	0.33	25

10

15 array([[4, 10, 0],
 [3, 3, 0],
 [2, 2, 1]])

Remember that once again neither BERT nor the scikit-learn models in this design and development has a large enough dataset that is optimized for ML classification metrics accuracy/precision/recall/f1 score in the design and development; the
 20 production model will still involve a team of media analysts supervising and correcting the initial risk labelling so as to "teach" our AI models what it needs to predict. The purpose of showing the programming and logic here for our design and development here is a showcase of capability that we have.

What the output of our Classification/Labelling Models looks like

25 The modelling phase explained earlier will **generate a .csv file** that will look like the DataFrame below. Since we are still developing the models, we have created a preview of what 2 AI-classified/labelled news articles would look like:

```
df_report = pd.read_csv("../data/df_report_demo.csv", index_col=0)
df_report
30 date
   title
  intro
   url
combined
```

risk_rating

bag_cleaned_text

risk_rating_numerical

commodity

5 main_entities

is_supply_shock

0

17-Mar-2020

The rice and fall: Vietnam eyes more global opportunities as Thai supply totters

10 Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-more-global-opportunities-as-Thai-supply-totTERS

15 The rice and fall: Vietnam eyes more global opportunities as Thai supply totters. Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

risky

20 rice fall vietnam eyes global opportunities thai supply totters thailand s position largest exporter rice south east asian region risk country struggles handle weather economical quality changes vietnam looks going strength strength

-1

rice

25 thailand

1

1

13-Sep-2018

'Full-blown food crisis': Philippines president denies rice shortage amidst calls for state of calamity

30

Philippines president Rodrigo Duterte has denied that there is any rice shortage in the country despite senators calling it a 'full-blown food crisis' and urging him to declare a state of calamity.

www.foodnavigator-asia.com/Article/2018/09/13/Full-blown-food-crisis-Philippines-president-denies-rice-shortage-amidst-calls-for-state-of-calamity

'Full-blown food crisis': Philippines president denies rice shortage amidst calls for state of calamity. Philippines president Rodrigo Duterte has denied that there is any rice shortage in the country despite senators calling it a 'full-blown food crisis' and urging him to declare a state of calamity.

risky

blown food crisis philippines president denies rice shortage amidst calls state calamity philippines president rodrigo duterte denied rice shortage country despite senators calling blown food crisis urging declare state calamity

-1

rice

philippines

0

We see that the model will predict the risk rating (both verbally and numerically), the main_entities discussed, the commodity at risk, and whether or not the risk concerned is on the supply-side or demand side (is_supply_shock).

This data, as well as the risk-scoring ramifications based on this, will then be procedurally generated by our text report generator.

4. Report Generating Script

Once we have our risk-labelling AI model, we can then create a separate algorithm that generates a risk report on any given news article based on the risk label predicted using our chosen AI model.

The report will contain the following key components: * NLP Multi-label: What is the commodity in question? * NLP Multi-label: Which country is mainly in question? What other entities are talked about here? * NLP Binary-class: Is the shock demand-based or supply-based shock? * NLP Multi-label: Based on the risk label, What is the new risk score of country or countries in question for that commodity? Do we apply +1, 0 - 1? * Update all countries's risk ratings accordingly * If the risk score of the country in question is lowered, can we recommend other countries with a better risk score for supply of this commodity?

- What does the AI-summarized text of the entire article look like?

The report can be generated as a table with an accompanying visualization uses spaCy's Named Entity Recognition, and our production model will be able to generate an individual report for each news article that relates to food supply.

Risk Matrices

- 5 For the report generator to readjust risk-weighted scores from food suppliers, we will require not only the model-generated .csv file, but we'll also have to create professionally curated risk matrices of commodity suppliers worldwide. Similar to credit scoring, this will be based on proprietary risk-weighting methods pioneered by FSX.ai's supply chain and risk experts. A score is assigned to individual
- 10 country suppliers, with the idea being that the higher the number, the more secure that supplier's capacity to supply a particular commodity is, and vice-versa. For example, because India is now the largest supplier of rice worldwide (~32.5% of worldwide supply), their supply risk score is higher than say Spain, which only accounts for 0.9% of worldwide rice supply.
- 15 This also therefore means that negative news (resulting in a risk rating of -1) is more impactful on the new risk score for India than it is to Spain, and it suffers a risk penalty multiplier of 3.25. Therefore, negative news about India's rice supplying capacity will result in its score being subtracted by -3.25, whereas Spain's penalty will only be -0.09.
- 20 For the sake of our demo, we have employed this simplistic calculation. We also assigned risk scores and penalties arbitrarily for ease of demonstration. Again, our production model will incorporate the fully articulated risk-scoring calculations based on curated weightages divined from our supply chain and risk experts. Accordingly, we create here a sample risk score matrix of rice suppliers worldwide for
- 25 demo purposes:
- #example matrix based on <http://www.worldstopexports.com/rice-exports-country/>*
- ```
supplier_data = [['india', 32.5], ['thailand', 19.2], ['united_states', 8.6], ['vietnam', 6.6],
 ['pakistan', 5.6], ['china', 4.8], ['italy', 2.9],
 ['myanmar_burma', 2.6], ['cambodia', 2], ['uruguay', 1.7],
 ['brazil', 1.7], ['netherlands', 1.7], ['belgium', 1.2],
 ['paraguay', 1], ['spain', 0.9]]
```
- 30
- ```
df_rice_supplier_matrix = pd.DataFrame(supplier_data, columns =
["supplier_country", "current_risk_score"])
```

#applying demo risk penalty multiplier as a new column in the matrix dataframe

```
df_rice_supplier_matrix['risk_penalty_multiplier'] =
```

```
df_rice_supplier_matrix['current_risk_score'].map(lambda x: x / 10)
```

```
df_rice_supplier_matrix
```

```
5 Unnamed: 0
```

```
supplier_country
```

```
current_risk_score
```

```
risk_penalty_multiplier
```

```
0
```

```
10 0
```

```
india
```

```
32.5
```

```
3.25
```

```
1
```

```
15 1
```

```
thailand
```

```
19.2
```

```
1.92
```

```
2
```

```
20 2
```

```
united_states
```

```
8.6
```

```
0.86
```

```
3
```

```
25 3
```

```
vietnam
```

```
6.6
```

```
0.66
```

```
4
```

```
30 4
```

```
pakistan
```

```
5.6
```

```
0.56
```

```
5
```

0192P00578C

5

china

4.8

0.48

5 6

6

italy

2.9

0.29

10 7

7

myanmar_burma

2.6

0.26

15 8

8

cambodia

2.0

0.20

20 9

9

uruguay

1.7

0.17

25 10

10

brazil

1.7

0.17

30 11

11

netherlands

1.7

0.17

0192P00578C

12

12

belgium

1.2

5 0.12

13

13

paraguay

1.0

10 0.10

14

14

spain

0.9

15 0.09

other_countries = [state **for** state in df_rice_supplier_matrix["supplier_country"] **if**
state!="thailand"]

df_rice_supplier_matrix[df_rice_supplier_matrix["supplier_country"] != "thailand"]
supplier_country

20 current_risk_score

risk_penalty_multiplier

0

india

32.5

25 3.25

2

united_states

8.6

0.86

30 3

vietnam

6.6

0.66

4

0192P00578C

pakistan

5.6

0.56

5

5 china

4.8

0.48

6

italy

10 2.9

0.29

7

myanmar_burma

2.6

15 0.26

8

cambodia

2.0

0.20

20 9

uruguay

1.7

0.17

10

25 brazil

1.7

0.17

11

netherlands

30 1.7

0.17

12

belgium

1.2

0192P00578C

0.12

13

paraguay

1.0

5 0.10

14

spain

0.9

0.09

10 df_rice_supplier_matrix[(df_rice_supplier_matrix["supplier_country"] != "thailand")
& (df_rice_supplier_matrix["current_risk_score"] >= 2.0)]

supplier_country

current_risk_score

risk_penalty_multiplier

15 0

india

32.5

3.25

2

20 united_states

8.6

0.86

3

vietnam

25 6.6

0.66

4

pakistan

5.6

30 0.56

5

china

4.8

0.48

0192P00578C

6

italy

2.9

0.29

5 7

myanmar_burma

2.6

0.26

8

10 cambodia

2.0

0.20

#backing up this matrix

df_rice_supplier_matrix.to_csv("../data/df_supplier_matrix.csv")

15 state_prior_score =

df_rice_supplier_matrix["current_risk_score"][df_rice_supplier_matrix["supplier_country"] == "thailand"]

state_prior_score.iloc[0]

19.2

20 In [3]: sub_df Out[3]: A B 2 -0.133653 -0.030854

In [4]: sub_df.iloc[0] Out[4]: A -0.133653 B -0.030854 Name: 2, dtype: float64

In [5]: sub_df.iloc[0]['A'] Out[5]: -0.13365288513107493

Design and Development Code for How The Report Generator Works

We now write a function that transforms this data into a text report with entity

25 visualization using spaCy's NER:

row_0 = df_report.loc[0]

row_0["combined"]

'The rice and fall: Vietnam eyes more global opportunities as Thai supply totters.

Thailand's position as the largest exporter of rice from the South East Asian region is

30 at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.'

type(row_0["date"])

str

For Windows Power BI Python Script compatibility:

0192P00578C

- pip install pandas
- pip install numpy
- pip install matplotlib
- pip install -U spacy

```
5 • python -m spacy download en_core_web_sm
df_report = pd.read_csv("../data/df_report_demo.csv")
df_rice_supplier_matrix = pd.read_csv("../data/df_supplier_matrix.csv")
```

#Standard Python DS imports:

10

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

15 *#spacy imports*

```
import spacy
from spacy.lang.en import English # updated
```

```
import re
```

20

```
import string
from spacy.lang.en.stop_words import STOP_WORDS
from spacy.lang.en import English
from spacy import displacy
import spacy.cli
```

25

```
from spacy.tokens import Doc
```

def report_writer(row):

#assign values into callable instances

30

```
date = row["date"]
title = row["title"]
url = row["url"]
risk_rating = row["risk_rating"]
risk_rating_numerical = row["risk_rating_numerical"]
```

```

    commodity = row["commodity"]
    main_entities = row["main_entities"]
    supply_shock = row["is_supply_shock"]
    minimum_score = 2
5
    nlp = spacy.load('en_core_web_sm')
    current_text = row['combined']
    doc = nlp(current_text)

10    print (f"*****START OF REPORT*****")
    print ("\n")

    print (f"This is an automatically generated report for:")
    print (f'\n{title}', \ndated {date}, \nscraped from the url \n{url}.")
15    print ("\n")
    print (f"Our FSX.ai Risk Model has identified that the article concerns risk towards
the supply of {commodity.title()} by {main_entities.title()}.")
    print("\n")

20    #get previous score of this country's rice supply risk
    state_prior_score =
df_rice_supplier_matrix["current_risk_score"][df_rice_supplier_matrix["supplier_count
ry"] == main_entities].iloc[0]

25    print (f'{main_entities.title()}'s prior risk score for {commodity.title()} supply is
{state_prior_score}")

    #get previous score of this country's rice supply risk
    state_penalty =
30 df_rice_supplier_matrix["risk_penalty_multiplier"][df_rice_supplier_matrix["supplier_c
ountry"] == main_entities].iloc[0]

    print (f'{main_entities.title()}'s risk penalty multiplier is {state_penalty}")

```

```

new_score = state_prior_score - (risk_rating_numerical*state_penalty)

print ("\n")
print (f'{main_entities.title()}'s new risk score for {commodity.title()} supply is
5 {new_score}")

print ("\n")

print (f'Currently, FSX.ai recommends choosing suppliers with a minimum risk
10 score of {minimum_score}.')
minimum_score_suppliers =
df_rice_supplier_matrix[(df_rice_supplier_matrix["supplier_country"] != main_entities)
                        & (df_rice_supplier_matrix["current_risk_score"] >=
minimum_score)]
15

print (f'Accordingly, FSX.ai recommends reviewing the increase of imports from
other suppliers of {commodity.title()}:')
print ("\n")
print (minimum_score_suppliers)
20 print ("\n")

print (f'FSX.ai's spaCy NER has also highlighted the following related entities in
25 this article that should be reviewed \nin relation to this news article:')
print ("\n")
print (displacy.render(doc, style='ent', jupyter=True))

print (f'*****END OF REPORT*****')
30 # # return df_rice_supplier_matrix
#   print (f'Accordingly, FSX.ai recommends reviewing the increase of imports from
other suppliers of {commodity.title()}:')
#   print ("\n")

```

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```
# print(df_rice_supplier_matrix[df_rice_supplier_matrix["supplier_country"] !=  
main_entities])  
report_writer(df_report.loc[0])  
*****START OF REPORT*****
```

5

This is an automatically generated report for:

10 'The rice and fall: Vietnam eyes more global opportunities as Thai supply totters',
dated 17-Mar-2020,
scraped from the url
www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-more-global-opportunities-as-Thai-supply-totters.

15

Our FSX.ai Risk Model has identified that the article concerns risk towards the supply of Rice by Thailand.

20 Thailand's prior risk score for Rice supply is 19.2
Thailand's risk penalty multiplier is 1.92

Thailand's new risk score for Rice supply is 21.119999999999997

25

Currently, FSX.ai recommends choosing suppliers with a minimum risk score of 2. Accordingly, FSX.ai recommends reviewing the increase of imports from other suppliers of Rice:

30

	Unnamed: 0	supplier_country	current_risk_score	risk_penalty_multiplier
0	0	india	32.5	3.25
2	2	united_states	8.6	0.86

	3		vietnam	6.6	0.66
	4		pakistan	5.6	0.56
	5		china	4.8	0.48
	6		italy	2.9	0.29
5	7	7	myanmar_burma	2.6	0.26
	8	8	cambodia	2.0	0.20

FSX.ai's spaCy NER has also highlighted the following related entities in this article
 10 that should be reviewed
 in relation to this news article:

The rice and fall: Vietnam GPE eyes more global opportunities as Thai NORP
 supply totters. Thailand GPE 's position as the largest exporter of rice from the
 15 South East Asian region LOC is at risk as the country struggles to handle weather,
 economical and quality changes, whereas Vietnam GPE looks to be going from
 strength to strength.

None

20 *****END OF REPORT*****

Design and Development Article Summarizer

Finally, the last component of our report addresses this query: * NLG Text

Summarization: What is the AI-summarized version of the entire article?

We have design and development code that summarizes entire news articles using
 25 huggingface's T5 Transformer:

https://huggingface.co/transformers/model_doc/t5.html

Let's first use a new example of an entire news article taken from Channel News
 Asia:<https://www.channelnewsasia.com/news/asia/thailand-wetland-conservation-boon-reuang-special-economic-zone-12886250>.

30 text = ""

DUTTA NAGAR, India: Until late March, Ashish Kumar was helping to make plastic
 boxes for

Ferrero Rocher praline chocolates and the plastic spoons tucked inside Kinder Joy
 eggs to scoop out the

milky sweet cream inside.

With a diploma in plastic mould technology, the 20-year-old had a foot on his chosen career ladder. His younger brother Aditya chose law, but Ashish had his sights set on plastic.

"I want to start a business of my own," he said, explaining how he wants to recycle plastic to make day-to-day products at his own factory.

India's coronavirus lockdown has thrown those plans into disarray. Educated but unemployed, Ashish Kumar is one of countless people across the globe whose social progress has been halted by the coronavirus that has infected more than 2 million people in India alone, and thrown the economy into reverse. With it, the aspirations of millions are fading.

For years, people in rural India have been gaining prosperity and moving into what economists call a burgeoning middle class of consumers – those who earn more than US\$10 a day, by some definitions. This group has been a keystone of plans for economic development in the world's second most populous country.

In the COVID-19 pandemic, India's economy is forecast to shrink by 4.5 per cent this year, according to the International Monetary Fund. At least 400 million Indian workers are at risk of falling deeper into poverty, according to the International Labour Organization (ILO).

Kumar is one of around 131,000 people whom local officials estimate returned from working around India to Gonda, the district in the northern state of Uttar Pradesh that he left last June.

Nationwide, about 10 million people made long, hard journeys back to rural villages they had left. Some have gone back to the cities, but many of those who had been sending back funds are still stuck in the countryside.

Working in a factory in Baramati in the western state of Maharashtra, Kumar was

earning 13,000 rupees (US\$173) every month, more than twice his father's pay from a job in a grain market near Kumar's home village in Uttar Pradesh, a sprawling agrarian state. Of that, the young man was sending home around 9,000 rupees every month, much of which was helping to fund his younger brother's studies.

5

No longer. Once a provider for his family, now he has become a financial burden.

Kumar whiles away his time back home in the village of Dutta Nagar, bantering with friends in the muddy courtyard – they jokingly call it their "office" – outside the ramshackle primary school where he studied. In Uttar Pradesh, around 60 million of the state's population of more than 200 million lives in poverty, according to the World Bank.

10

He said he has applied for several jobs at plastic factories in western Gujarat state and other parts of northern India but has not found work.

15

"No matter what," he said, sitting near his parent's single-storey home, surrounded by jade green paddy fields. "I need a job."

20 PLASTIC FOR PRALINES

As a schoolboy, Kumar was obsessed with plastics.

A chance conversation with a cousin who had studied plastic engineering got him hooked, Kumar said, and he started researching. In Dutta Nagar, where there were no Internet connections, that often meant asking one of a handful of locals with a smartphone to Google the opportunities.

25

Kumar's ambitions were a world removed from his father Ashok's early years. The 47-year-old, who assists with weighing and pricing grain harvests, remembers when the family had neither enough food, nor proper clothes.

30

A slight man with a weather-beaten face, he never finished high school.

"I thought that the children shouldn't fall into our rut. They should be pushed ahead," he said.

5 Kumar, who says he has never tasted a Ferrero Rocher praline, finished his diploma in Gujarat last June, and took the train to start work as a technician at an Italian-owned factory 1,500km away from home.

10 The factory that employed him is run by Dream Plast India, a subsidiary of Gruppo Sunino, an Italian plastics maker with 10 plants around the world.

"The factory was first class," Kumar said. His contract included a monthly contribution from the company into a retirement fund and a bonus. Workers were served one meal every day, the supervisors were friendly, and the salary came on time, he said.

15 Six days a week, his work typically involved overseeing two machines and a couple of contract workers. At the end of the day, he would relax with a game of badminton or watch wrestling on YouTube.

20 His income over the past year helped his parents build a proper four-roomed brick home, after decades of living in a tumble-down mud hut where the roof let in heavy monsoon rains. It helped pay the fees for his brother to go to law school in Bahraich, an hour-and-a-half's drive away from their home village.

25 Then COVID-19 struck.

BROKE IN BARAMATI

30 Kumar first heard of the coronavirus in early March. When India's lockdown forced Dream Plast India to temporarily shut its plant in Baramati on Mar 21, he had enough cash to wait it out in town.

As the pandemic swept through India, a survey of some 5,000 workers in April and May found 66 per cent of participants had lost their jobs, and 77 per cent of households were consuming less food than before.

Prime Minister Narendra Modi's government announced a 20 trillion rupee package promising free rice, wheat and pulses for millions of people and a programme to provide employment in rural areas.

5

Even for those with work, trade unions and labour experts say conditions are deteriorating, for migrants particularly.

10

In May, India's state governments issued health and safety guidelines for factories as they re-opened after lockdown, which included compulsory face masks, thermal screening, social distancing and frequent sanitisation. Union leaders allege many companies did not follow all protocols and cut corners, but they have not identified Kumar's.

15

Indian states including Uttar Pradesh and Gujarat said in May they were looking to relax workers' rights, including weakening regulations on wages and working hours, to support industry. That proposal drew criticism from workers' unions and the ILO. The amendments have only taken effect in some states.

20

Kumar's factory, which reopened in early May, did not respond to a question on measures taken there, but Dream Plast India's managing director Nitin Gupta said in an email the "company takes utmost precautions to adhere to the laws at all times". He declined to elaborate further.

25

Even so, Kumar and another worker Reuters spoke to said they did not feel safe to return.

Ferrero, the Italian confectioner, said it had audited the plant where Kumar worked in March and found no irregularities, but would further review subsequent months.

30

Reuters was unable to independently determine what safety measures the factory took.

By early June, Kumar's funds had run out. Even buying food became difficult.

His parents grew increasingly worried. "Whatever little money I had here in the bank, I sent some of that so he could eat," said his father, Ashok. "At that time, I was very scared. The biggest challenge was for him to come home."

5

India's railway network reopened in early May. On Jun 3, Kumar borrowed money to pay for a 48-hour journey home by train, bus and shared taxi. Then he went into a 14-day quarantine.

10 On Jun 25, Dream Plast India sent him an email, which was seen by Reuters, asking him to report to work within four days or face termination. Instead, he resigned on Jul 20.

15 His parents are apprehensive about him leaving home again, although they said they realise that without their elder son's earnings, his younger brother will not be able to finish law school.

Kumar is not ready to give up on his plastics factory.

20 "I will do it," he said. "No matter what it takes, I will fulfil my dream."

"""

#from adapting https://huggingface.co/transformers/model_doc/t5.html

import torch

import json

25 from transformers import T5Tokenizer, T5ForConditionalGeneration, T5Config

model = T5ForConditionalGeneration.from_pretrained('t5-small')

tokenizer = T5Tokenizer.from_pretrained('t5-small')

device = torch.device('cpu')

30

preprocess_text = text.strip().replace("\n","")

t5_prepared_Text = "summarize: "+preprocess_text

print ("original text preprocessed: \n", preprocess_text)

```
tokenized_text = tokenizer.encode(t5_prepared_Text, return_tensors="pt").to(device)
```

```
# summarize
```

```
5 summary_ids = model.generate(tokenized_text,
                               num_beams=4,
                               no_repeat_ngram_size=2,
                               min_length=30,
                               max_length=500,
10                               early_stopping=True)
```

```
output = tokenizer.decode(summary_ids[0], skip_special_tokens=True)
```

```
print ("\n\nSummarized text: \n",output)
```

```
15 original text preprocessed:
```

```
"DUTTA NAGAR, India: Until late March, Ashish Kumar was helping to make plastic
boxes for Ferrero Rocher praline chocolates and the plastic spoons tucked inside
Kinder Joy eggs to scoop out the milky sweet cream inside. With a diploma in plastic
mould technology, the 20-year-old had a foot on his chosen career ladder. His
20 younger brother Aditya chose law, but Ashish had his sights set on plastic. "I want to
start a business of my own," he said, explaining how he wants to recycle plastic to
make day-to-day products at his own factory. India's coronavirus lockdown has
thrown those plans into disarray. Educated but unemployed, Ashish Kumar is one of
countless people across the globe whose social progress has been halted by the
25 coronavirus that has infected more than 2 million people in India alone, and thrown
the economy into reverse. With it, the aspirations of millions are fading. For years,
people in rural India have been gaining prosperity and moving into what economists
call a burgeoning middle class of consumers – those who earn more than US$10 a
day, by some definitions. This group has been a keystone of plans for economic
30 development in the world's second most populous country. In the COVID-19
pandemic, India's economy is forecast to shrink by 4.5 per cent this year, according
to the International Monetary Fund. At least 400 million Indian workers are at risk of
falling deeper into poverty, according to the International Labour Organization
(ILO). Kumar is one of around 131,000 people whom local officials estimate returned
```

from working around India to Gonda, the district in the northern state of Uttar Pradesh that he left last June. Nationwide, about 10 million people made long, hard journeys back to rural villages they had left. Some have gone back to the cities, but many of those who had been sending back funds are still stuck in the

5 countryside. Working in a factory in Baramati in the western state of Maharashtra, Kumar was earning 13,000 rupees (US\$173) every month, more than twice his father's pay from a job in a grain market near Kumar's home village in Uttar Pradesh, a sprawling agrarian state. Of that, the young man was sending home around 9,000 rupees every month, much of which was helping to fund his younger brother's

10 studies. No longer. Once a provider for his family, now he has become a financial burden. Kumar whiles away his time back home in the village of Dutta Nagar, bantering with friends in the muddy courtyard – they jokingly call it their "office" – outside the ramshackle primary school where he studied. In Uttar Pradesh, around 60 million of the state's population of more than 200 million lives in poverty, according

15 to the World Bank. He said he has applied for several jobs at plastic factories in western Gujarat state and other parts of northern India but has not found work. "No matter what," he said, sitting near his parent's single-storey home, surrounded by jade green paddy fields. "I need a job." PLASTIC FOR PRALINES As a schoolboy, Kumar was obsessed with plastics. A chance conversation with a cousin who had

20 studied plastic engineering got him hooked, Kumar said, and he started researching. In Dutta Nagar, where there were no Internet connections, that often meant asking one of a handful of locals with a smartphone to Google the opportunities. Kumar's ambitions were a world removed from his father Ashok's early years. The 47-year-old, who assists with weighing and pricing grain harvests, remembers when the

25 family had neither enough food, nor proper clothes. A slight man with a weather-beaten face, he never finished high school. "I thought that the children shouldn't fall into our rut. They should be pushed ahead," he said. Kumar, who says he has never tasted a Ferrero Rocher praline, finished his diploma in Gujarat last June, and took the train to start work as a technician at an Italian-owned factory 1,500km away from

30 home. The factory that employed him is run by Dream Plast India, a subsidiary of Gruppo Sunino, an Italian plastics maker with 10 plants around the world. "The factory was first class," Kumar said. His contract included a monthly contribution from the company into a retirement fund and a bonus. Workers were served one meal every day, the supervisors were friendly, and the salary came on time, he said. Six days a

week, his work typically involved overseeing two machines and a couple of contract workers. At the end of the day, he would relax with a game of badminton or watch wrestling on YouTube. His income over the past year helped his parents build a proper four-roomed brick home, after decades of living in a tumble-down mud hut where the roof let in heavy monsoon rains. It helped pay the fees for his brother to go to law school in Bahraich, an hour-and-a-half's drive away from their home village. Then COVID-19 struck.

Kumar first heard of the coronavirus in early March. When India's lockdown forced Dream Plast India to temporarily shut its plant in Baramati on Mar 21, he had enough cash to wait it out in town. As the pandemic swept through India, a survey of some 5,000 workers in April and May found 66 per cent of participants had lost their jobs, and 77 per cent of households were consuming less food than before. Prime Minister Narendra Modi's government announced a 20 trillion rupee package promising free rice, wheat and pulses for millions of people and a programme to provide employment in rural areas. Even for those with work, trade unions and labour experts say conditions are deteriorating, for migrants particularly.

In May, India's state governments issued health and safety guidelines for factories as they re-opened after lockdown, which included compulsory face masks, thermal screening, social distancing and frequent sanitisation. Union leaders allege many companies did not follow all protocols and cut corners, but they have not identified Kumar's. Indian states including Uttar Pradesh and Gujarat said in May they were looking to relax workers' rights, including weakening regulations on wages and working hours, to support industry. That proposal drew criticism from workers' unions and the ILO. The amendments have only taken effect in some states.

Kumar's factory, which reopened in early May, did not respond to a question on measures taken there, but Dream Plast India's managing director Nitin Gupta said in an email the "company takes utmost precautions to adhere to the laws at all times". He declined to elaborate further. Even so, Kumar and another worker Reuters spoke to said they did not feel safe to return. Ferrero, the Italian confectioner, said it had audited the plant where Kumar worked in March and found no irregularities, but would further review subsequent months. Reuters was unable to independently determine what safety measures the factory took. By early June, Kumar's funds had run out. Even buying food became difficult. His parents grew increasingly worried. "Whatever little money I had here in the bank, I sent some of that so he could eat," said his father, Ashok. "At that time, I

was very scared. The biggest challenge was for him to come home."India's railway network reopened in early May. On Jun 3, Kumar borrowed money to pay for a 48-hour journey home by train, bus and shared taxi. Then he went into a 14-day quarantine. On Jun 25, Dream Plast India sent him an email, which was seen by Reuters, asking him to report to work within four days or face termination. Instead, he resigned on Jul 20. His parents are apprehensive about him leaving home again, although they said they realise that without their elder son's earnings, his younger brother will not be able to finish law school. Kumar is not ready to give up on his plastics factory. "I will do it," he said. "No matter what it takes, I will fulfil my dream."

10

Summarized text:

india's coronavirus has infected more than 2 million people in India alone. a u.s.-based company has reopened its factory in baramati in early may, citing lack of food and sanitisation in rural areas. the government has issued health and safety guidelines for factories in the country.

15

Other Features in Development: Macro events

20 [0046] FSX Design and Development of Concept

The **FSX Risk Decisioning Platform (the "Platform")** is written in python, with explanatory notes given to explain each step of our proprietary process.

Concept Summary

Conceptually, the Platform is a supervised machine learning (ML) media sentiment classifier that mines news articles automatically that deal with the subject of food supply risk, and predictively classifies them according to their risk labelling. This will utilize statistical ML models like those from scikit-learn, as well as Deep Learning/ Neural Networks, such as Google's open-source BERT Transformers.

25

Based on that risk labelling, an automated text report with visualizations is generated with insights. Initially, this will employ standard template-based code. Future versions will incorporate unsupervised text generation algorithms (e.g. GPT2) and/or commercial text-generation software (e.g. Arria NLG).

30

Disclaimer: Our design and development has been designed for the sake of demonstrating capability and conceptual design and development only, and is not

strictly optimized for typical Machine Learning performance metrics (e.g. accuracy, precision, recall, f1 score etc.) due to the small sample dataset used here.

Design and Development Contents:

1. **Web scraping:** design and development code that scrapes a sample of articles from the web for news about food supply risk using Selenium and BeautifulSoup, which are open-source libraries that help us scrape. Future versions will scrape the web as comprehensively as possible, beyond the sample. Future versions will have a far larger and statistically significant dataset that is scraped.
2. **Cleaning and Labelling:** design and development code that transforms sample scraped news data into a Dataframe in .csv format, that is machine readable. We use the popular Pandas library for this.
We initially manually label the risk profiles of each news article in our sample data, for the sake of being able to train our design and development model. Note again that future versions will have a far larger and statistically significant dataset.
3. **Preprocessing and Modelling:** The text that we scraped has to be pre-processed into a machine-readable format e.g. tokenization, stop-words removal, and lemmatization. We then run models from scikit-learn or a custom Neural Network e.g. BERT on this machine-readable data in order to predictively classify news text as falling into a particular risk category e.g. high, medium, low, or neutral.
For the sake of simplicity in this design and development we will use risky, neutral and stable as our preliminary labels.
4. **Report Generator:** our report-generation algorithm is intended to provide actionable insights based on that risk assessment. In our design and development here, the report-generator will provide the following information:
 - Reiterate the risk label
 - Describe which keywords in the article triggered our label to be e.g. risky
 - Describe which entities are being discussed in the article
 - Based on the risk label, the algorithm **recommends** via text that other suppliers of the food item in question be reviewed.

1. Web scraping

#Standard Python DS imports:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

- 5 We have to use Selenium because of the fact that all the articles won't show up on one webpage and it's easier to scrape them this way.

Hence, we will import Selenium and the related WebDriver Manager tool to run a Chrome instance within Selenium that will scrape our sample food supply news data.

#Selenium and WebDriver Manager imports:

10

```
from selenium import webdriver
from webdriver_manager.chrome import ChromeDriverManager
from bs4 import BeautifulSoup
```

15 import time

```
from selenium.webdriver.common.keys import Keys
```

For our sample news feed, we are taking all articles tagged with the keyword Rice from www.foodnavigator-asia.com.

```
url = "https://www.foodnavigator-asia.com/tag/keyword/Food/Rice"
```

- 20 Here is the scraping code for this particular website. Future versions of this code will utilize a larger dataset aggregated from other news sites. For the initial phase of development, this would essentially involve a large-scale media analysis undertaking to manually label data first in order to train our supervised labelling model.

#This code will scrape data from the URL in question

- 25 driver = webdriver.Chrome(ChromeDriverManager().install())
driver.get(url)

```
driver.get(url)
```

```
time.sleep(5)
```

- 30 driver_body = driver.find_element_by_tag_name('body')
driver_pages = driver_body.find_elements_by_class_name('Pagination-item')

```
i = 0
```

```

intro_list = []
title_list = []
date_list = []
post_url_list = []

```

5

```

for i in range(1, len(driver_pages)):

```

```

    html = ""

```

```

    html = driver.page_source

```

```

    soup = BeautifulSoup(html, 'lxml')

```

10

```

    intro_elems = driver.find_elements_by_class_name("Teaser-intro")

```

```

    for intro in intro_elems:

```

```

        intro_list.append(intro.text)

```

15

```

    title_elems = driver.find_elements_by_class_name("Teaser-title")

```

```

    for title in title_elems:

```

```

        title_list.append(title.text)

```

20

```

    date_elems = driver.find_elements_by_class_name("Teaser-date")

```

```

    for date in date_elems:

```

```

        date_list.append(date.text)

```

25

```

    linksdiv = soup.find_all('h3', {'class': 'Teaser-title'})

```

```

    for linkdiv in linksdiv:

```

```

        post_url_list.append('www.foodnavigator-asia.com'+(linkdiv.find('a')['href']))

```

```

# div = soup.find('div', {'class': 'gsc-wrapper'})

```

30

```

# linksdiv = div.find_all('div', {'class': 'gsc-webResult gsc-result'})

```

```

# for linkdiv in linksdiv:

```

```

#     links.append(linkdiv.find('a')['href'])

```

```

try:

```

```
driver.execute_script("arguments[0].click();", driver_pages[i])
time.sleep(2)
```

```
driver_body = driver.find_element_by_tag_name('body')
5 driver_pages = driver_body.find_elements_by_class_name('Pagination-item')
  i+1
```

```
except exceptions.StaleElementReferenceException as e:
```

```
    pass
```

10

```
driver.close()
```

```
[WDM] - Current google-chrome version is 84.0.4147
```

```
[WDM] - Get LATEST driver version for 84.0.4147
```

```
[WDM] - Driver
```

```
15 [/Users/grahamlim/.wdm/drivers/chromedriver/mac64/84.0.4147.30/chromedriver]
   found in cache
```

This is what the result of our initially scraped news data looks like that our algorithm uses. In future, we will not only use the title and intro text of news articles, but the full text of the actual news article for better information capturing.

```
20 df.head()
```

```
date
```

```
title
```

```
intro
```

```
url
```

```
25 0
```

```
20-Jul-2020
```

```
Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-
COVID-19
```

```
30 Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the
   former having gained advantage due to support from traditional partner Philippines,
   and the latter having come out ahead with Malaysia in terms of price.
```

```
www.foodnavigator-asia.com/Article/2020/07/20/Legacy-vs-price-Rice-exports-from-
Vietnam-and-India-vie-for-ASEAN-trade-post-COVID-19
```

```
1
```

25-Jun-2020

Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal
The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

www.foodnavigator-asia.com/Article/2020/06/25/Trade-off-Rice-and-seafood-the-big-winners-for-Vietnam-under-EU-free-trade-deal

2

22-Apr-2020

Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop

Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop

3

17-Mar-2020

The rice and fall: Vietnam eyes more global opportunities as Thai supply totters

Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-more-global-opportunities-as-Thai-supply-totter

4

25-Feb-2020

Beyond rice: Indian government urged to boost cereal production in security drive

Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-urged-to-boost-cereal-production-in-security-drive

`df.to_csv("../data/df_raw.csv")`

2. Cleaning and Labelling

Now that our data has been scraped, we have to re-format it and label the risk ratings of each our sample news feed articles in a way that our machine learning models will understand. For example, we'll initially have to combine the title text and intro text of

5 each news article:

#combine title and intro text in one

```
df["combined"] = df["title"] + ". " + df["intro"]
```

10 df["combined"]

0 Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-COVID-19. Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.

15 1 Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal. The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

2 Rice-ing concern: COVID-19 creates supply and price volatility for Asia's
20 most 'cost-sensitive' crop. Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

3 The rice and fall: Vietnam eyes more global opportunities as Thai supply
25 totters. Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

4 Beyond rice: Indian government urged to boost cereal production in security
drive. Researchers are pushing for India to focus on enhancing its production of
30 crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

...

70

Global sustainable rice scheme launched. An international system has been

launched that will establish environmental standards for sustainable rice production in a bid to increase rice yields.

71

Thai

floods will have minimal impact on global rice market, according to industry expert.

- 5 The severe flooding in Thailand is merely a second blow to its already unsteady rice market, an industry expert has said.

72

New joint venture

between McCormick and Kohinoor Foods: India. Global spice and flavour giant

McCormick has signed a joint venture contract with India's leading basmati rice

- 10 production company Kohinoor Foods, forming a new company in India.

73

Singapore pledges \$8.2m to Asia

rice science for the next five years. Singapore's National Research Foundation (NRF) has said it will invest \$8.2m in a joint research program that aims to ensure food security and future rice demands are met throughout Asia.

- 15 74 Japanese scientists to breed rice resilient to radioactive cesium. In the wake of the Fukushima nuclear disaster, Japanese scientists from the Fukushima Agricultural Technology Centre are working towards a potential solution for the future of Japanese rice farmers – a strain of rice resilient to cesium absorption.

Name: combined, Length: 75, dtype: object

- 20 We now label the risk rating in this initial training dataset so that our machine learning models will be able to learn what text ought to be classified as what rating in the future automatically.

Again, for simplicity's sake, we use simpler labels like risky, neutral, and stable; future version will have more nuanced risk labelling.

- 25 df.head(10)

date

title

intro

url

- 30 combined

risk_rating

0

20-Jul-2020

Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-COVID-19

Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.

www.foodnavigator-asia.com/Article/2020/07/20/Legacy-vs-price-Rice-exports-from-Vietnam-and-India-vie-for-ASEAN-trade-post-COVID-19

Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-COVID-19. Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.

neutral

1
25-Jun-2020

Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal
The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

www.foodnavigator-asia.com/Article/2020/06/25/Trade-off-Rice-and-seafood-the-big-winners-for-Vietnam-under-EU-free-trade-deal

Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal.
The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

neutral

2

22-Apr-2020

Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop

Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop

Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop. Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

5 risky

3

17-Mar-2020

The rice and fall: Vietnam eyes more global opportunities as Thai supply totters
Thailand's position as the largest exporter of rice from the South East Asian region is
10 at risk as the country struggles to handle weather, economical and quality changes,
whereas Vietnam looks to be going from strength to strength.

www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-more-global-opportunities-as-Thai-supply-totter

The rice and fall: Vietnam eyes more global opportunities as Thai supply totters.

15 Thailand's position as the largest exporter of rice from the South East Asian region is
at risk as the country struggles to handle weather, economical and quality changes,
whereas Vietnam looks to be going from strength to strength.

risky

4

20 25-Feb-2020

Beyond rice: Indian government urged to boost cereal production in security drive
Researchers are pushing for India to focus on enhancing its production of crops other
than rice, the country's traditional staple, if it wishes to effectively address its triple
threats of food security, climate change effects and malnutrition.

25 www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-urged-to-boost-cereal-production-in-security-drive

Beyond rice: Indian government urged to boost cereal production in security drive.

30 Researchers are pushing for India to focus on enhancing its production of crops other
than rice, the country's traditional staple, if it wishes to effectively address its triple
threats of food security, climate change effects and malnutrition.

neutral

5

17-Feb-2020

Arsenic snack shock: RMIT study finds almost 75% of children rice snacks exceed EU recommendations

Nearly 75% of infant and children rice snack samples in Australia have been found to exceed the European Union (EU) maximum levels of inorganic arsenic levels.

- 5 www.foodnavigator-asia.com/Article/2020/02/17/Arsenic-snack-shock-RMIT-study-finds-almost-75-of-children-rice-snacks-exceed-EU-recommendations

Arsenic snack shock: RMIT study finds almost 75% of children rice snacks exceed EU recommendations. Nearly 75% of infant and children rice snack samples in Australia have been found to exceed the European Union (EU) maximum levels of inorganic arsenic levels.

neutral

6

14-Jan-2020

Rice and shine: Expansion plans in the pipelines for Japan's low carbohydrate rice Japanese health food company KBS Corporation is rapidly expanding its sales channels for its low carbohydrate rice, Trice.

www.foodnavigator-asia.com/Article/2020/01/14/Rice-and-shine-Expansion-plans-in-the-pipelines-for-Japan-s-low-carbohydrate-rice

Rice and shine: Expansion plans in the pipelines for Japan's low carbohydrate rice.

Japanese health food company KBS Corporation is rapidly expanding its sales channels for its low carbohydrate rice, Trice.

stable

7

10-Dec-2019

Philippines rice saga: Government confirms stricter import controls despite President's pledge to ban them

The Philippines Department of Agriculture (DA) has opted to control rice imports and prices, even though President Rodrigo Duterte previously said all imports would be halted.

www.foodnavigator-asia.com/Article/2019/12/10/Philippines-rice-saga-Government-confirms-stricter-import-controls-despite-President-s-pledge-to-ban-them

Philippines rice saga: Government confirms stricter import controls despite President's pledge to ban them. The Philippines Department of Agriculture (DA) has

opted to control rice imports and prices, even though President Rodrigo Duterte previously said all imports would be halted.

risky

8

5 15-Oct-2019

Thai rice specialist firm MediFoods looks to expand local market after overseas success

Thailand rice specialist company MediFoods has its eye on local market expansion after a successful run overseas with its rice-based products and ingredients portfolio.

10 www.foodnavigator-asia.com/Article/2019/10/15/Thai-rice-specialist-firm-MediFoods-looks-to-expand-local-market-after-overseas-success

Thai rice specialist firm MediFoods looks to expand local market after overseas success. Thailand rice specialist company MediFoods has its eye on local market expansion after a successful run overseas with its rice-based products and

15 ingredients portfolio.

stable

9

08-May-2019

Rice crisis over? Philippines looks at removal of suggested retail prices as market stabilises

20

The Philippines Department of Trade and Industry (DTI) is considering the removal of suggested retail prices (SRPs) for rice in the wake of the rice tariffication law being signed earlier this year.

[www.foodnavigator-asia.com/Article/2019/05/08/Rice-crisis-over-Philippines-looks-at-](http://www.foodnavigator-asia.com/Article/2019/05/08/Rice-crisis-over-Philippines-looks-at-removal-of-suggested-retail-prices-as-market-stabilises)

25

removal-of-suggested-retail-prices-as-market-stabilises
Rice crisis over? Philippines looks at removal of suggested retail prices as market stabilises. The Philippines Department of Trade and Industry (DTI) is considering the removal of suggested retail prices (SRPs) for rice in the wake of the rice tariffication law being signed earlier this year.

30

stable

`df.to_csv("../data/df_ratings_raw.csv")`

3A. Pre-processing our Data

`df = pd.read_csv("../data/df_ratings_raw.csv", index_col = 0)`

We will require a number of pre-processing tools that we import into our python scripts. The purpose of these tools is to further convert the dataset into a machine-readable format, by splitting our data into a training, validation and test set, as well as utilizing Natural Language Processing to convert our text into ML-compatible Word

5 Vectors.

The tools we use are: * Preprocessing tools from scikit-learn, which is a commercially-used open-source Python-based machine-learning library (<https://scikit-learn.org/stable/>), and * Preprocessing tools from spaCy, which is an "Industrial-Strength" open-source Python-based Natural Language Processing library

10 (<https://spacy.io>).

#sklearn modelling tools

from sklearn.model_selection import GridSearchCV

from sklearn.model_selection import train_test_split

from sklearn.pipeline import Pipeline

15 from sklearn.preprocessing import RobustScaler

from sklearn.model_selection import cross_val_score

#for multilabel classification and oversampling

from skmultilearn.problem_transform import BinaryRelevance

20 from sklearn.multiclass import OneVsRestClassifier

from imblearn.over_sampling import SMOTE

from sklearn.preprocessing import label_binarize

#for PCA - Dimensionality Reduction

25 from sklearn.decomposition import TruncatedSVD

#for word vectorization

from sklearn.feature_extraction.text import TfidfTransformer, CountVectorizer,
TfidfVectorizer

30

#our dummy baseline

from sklearn.dummy import DummyClassifier

#advanced supervised classification models

```

from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import RandomForestClassifier, GradientBoostingClassifier,
AdaBoostClassifier
from sklearn.tree import DecisionTreeClassifier
5  from sklearn import svm
    from sklearn.svm import SVC
    from xgboost import XGBClassifier

    from sklearn.dummy import DummyClassifier
10  from sklearn.linear_model import SGDClassifier
    from sklearn.naive_bayes import GaussianNB

#classification metrics imports
    from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score,
15  roc_curve, auc, confusion_matrix
    from scipy import interp
    from itertools import cycle

    from sklearn.metrics import balanced_accuracy_score
20  from sklearn.metrics import confusion_matrix, classification_report, roc_auc_score,
    hinge_loss
    from sklearn import metrics

#pre-process text for EDA and later modelling too using spacy and string libraries

25  import spacy
    from spacy.lang.en import English # updated

    import re
    import string
30  from spacy.lang.en.stop_words import STOP_WORDS
    from spacy.lang.en import English
    from spacy import displacy
    import spacy.cli
    from spacy.pipeline import EntityRuler

```

```

from spacy.matcher import Matcher
from spacy.tokens import Doc
from spacy import displacy

```

```

5 from collections import Counter

```

Now that we've imported our tools, we write code using spaCy to transform words into numerical arrays known as Word Vectors. This involves a process coded out below known as tokenization.

We also convert all of the words in our dataset into their lemmatized form (base word-format e.g. the base format of "disappointed" is "disappoint", as well remove punctuation, stop-words, numbers.

Again, all of these steps are necessary to allow our models to "read" the language and predict what risk scoring should be assigned to any given news article.

Here is what the pre-processing code:

```

15 #stopwords removal

```

```

# Create our list of punctuation marks

```

```

punctuations = string.punctuation

```

```

20 # Create our list of stopwords

```

```

nlp = spacy.load('en_core_web_sm')

```

```

stop_words = spacy.lang.en.stop_words.STOP_WORDS

```

```

# Load English tokenizer, tagger, parser, NER and word vectors

```

```

25 parser = English()

```

```

# Creating our tokenizer function

```

```

def spacy_tokenizer(sentence):

```

```

30 #remove non-words

```

```

tokens = re.sub("[^a-zA-Z]", " ", sentence)

```

```

tokens = re.sub("[0-9]+", "", tokens)

```

```

# Creating our token object, which is used to create documents with linguistic

```

annotations.

tokens = parser(tokens)

Lemmatizing each token and converting each token into lowercase

5 tokens = [word.lemma_.lower().strip() **if** word.lemma_ != "-PRON-" **else**
word.lower_ **for** word in tokens]

Removing stop words

10 tokens = [word **for** word in tokens **if** word not in stop_words and word not in
punctuations]

return preprocessed list of tokens

return(" ".join(tokens))

df["bag_cleaned_text"]=df["combined"].apply(spacy_tokenizer)

15 df.head(7)

date

title

intro

url

20 combined

risk_rating

bag_cleaned_text

0

20-Jul-2020

25 Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-
COVID-19

Vietnam and India are competing for ASEAN rice trade post-COVID-19, with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.

30 www.foodnavigator-asia.com/Article/2020/07/20/Legacy-vs-price-Rice-exports-from-Vietnam-and-India-vie-for-ASEAN-trade-post-COVID-19

Legacy vs price: Rice exports from Vietnam and India vie for ASEAN trade post-COVID-19. Vietnam and India are competing for ASEAN rice trade post-COVID-19,

with the former having gained advantage due to support from traditional partner Philippines, and the latter having come out ahead with Malaysia in terms of price.
neutral

legacy vs price rice exports vietnam india vie asean trade post covid vietnam india

- 5 competing asean rice trade post covid having gained advantage support traditional partner philippines having come ahead malaysia terms price

1

25-Jun-2020

Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal

- 10 The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

www.foodnavigator-asia.com/Article/2020/06/25/Trade-off-Rice-and-seafood-the-big-winners-for-Vietnam-under-EU-free-trade-deal

- 15 Trade-off: Rice and seafood the big winners for Vietnam under EU free trade deal. The recently-ratified EU-Vietnam Free Trade Agreement (EVFTA) has seen major gains in food trade for both sides, particularly in rice and seafood for Vietnam as well as alcohol and meat for the EU.

neutral

- 20 trade rice seafood big winners vietnam eu free trade deal recently ratified eu vietnam free trade agreement evfta seen major gains food trade sides particularly rice seafood vietnam alcohol meat eu

2

22-Apr-2020

- 25 Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop

Lockdowns and trade barriers across Asia due to the COVID-19 pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

- 30 www.foodnavigator-asia.com/Article/2020/04/22/Rice-ing-concern-COVID-19-creates-supply-and-price-volatility-for-Asia-s-most-cost-sensitive-crop

Rice-ing concern: COVID-19 creates supply and price volatility for Asia's most 'cost-sensitive' crop. Lockdowns and trade barriers across Asia due to the COVID-19

pandemic have thrust rice - one of the region's largest agricultural commodities – firmly into the spotlight potential volatility in both supply and cost.

risky

rice ing concern covid creates supply price volatility asia s cost sensitive crop

- 5 lockdowns trade barriers asia covid pandemic thrust rice region s largest agricultural commodities firmly spotlight potential volatility supply cost

3

17-Mar-2020

The rice and fall: Vietnam eyes more global opportunities as Thai supply totters

- 10 Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-more-global-opportunities-as-Thai-supply-totTERS

- 15 The rice and fall: Vietnam eyes more global opportunities as Thai supply totters. Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

risky

- 20 rice fall vietnam eyes global opportunities thai supply totters thailand s position largest exporter rice south east asian region risk country struggles handle weather economical quality changes vietnam looks going strength strength

4

25-Feb-2020

- 25 Beyond rice: Indian government urged to boost cereal production in security drive
Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

[www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-](http://www.foodnavigator-asia.com/Article/2020/02/25/Beyond-rice-Indian-government-urged-to-boost-cereal-production-in-security-drive)

- 30 urged-to-boost-cereal-production-in-security-drive

Beyond rice: Indian government urged to boost cereal production in security drive. Researchers are pushing for India to focus on enhancing its production of crops other than rice, the country's traditional staple, if it wishes to effectively address its triple threats of food security, climate change effects and malnutrition.

neutral

rice indian government urged boost cereal production security drive researchers pushing india focus enhancing production crops rice country s traditional staple wishes effectively address triple threats food security climate change effects

5 malnutrition

5

17-Feb-2020

Arsenic snack shock: RMIT study finds almost 75% of children rice snacks exceed EU recommendations

10 Nearly 75% of infant and children rice snack samples in Australia have been found to exceed the European Union (EU) maximum levels of inorganic arsenic levels.
www.foodnavigator-asia.com/Article/2020/02/17/Arsenic-snack-shock-RMIT-study-finds-almost-75-of-children-rice-snacks-exceed-EU-recommendations

15 Arsenic snack shock: RMIT study finds almost 75% of children rice snacks exceed EU recommendations. Nearly 75% of infant and children rice snack samples in Australia have been found to exceed the European Union (EU) maximum levels of inorganic arsenic levels.

neutral

20 arsenic snack shock rmit study finds children rice snacks exceed eu recommendations nearly infant children rice snack samples australia found exceed european union eu maximum levels inorganic arsenic levels

6

14-Jan-2020

25 Rice and shine: Expansion plans in the pipelines for Japan's low carbohydrate rice Japanese health food company KBS Corporation is rapidly expanding its sales channels for its low carbohydrate rice, Trice.
www.foodnavigator-asia.com/Article/2020/01/14/Rice-and-shine-Expansion-plans-in-the-pipelines-for-Japan-s-low-carbohydrate-rice

30 Rice and shine: Expansion plans in the pipelines for Japan's low carbohydrate rice. Japanese health food company KBS Corporation is rapidly expanding its sales channels for its low carbohydrate rice, Trice.

stable

rice shine expansion plans pipelines japan s low carbohydrate rice japanese health food company kbs corporation rapidly expanding sales channels low carbohydrate rice trice

Our algorithm will also assign a numerical risk score based on the risk categories with this dictionary of values for multiclass classification to work in sklearn. The purpose of this is for future risk-weighted scoring for our report-writing algorithm, which is explained later:

#numerical risk rating score impact

```
df["risk_rating_numerical"].replace({'neutral':0,
10         'stable':1,
        'risky':-1})
```

```
0    0
```

```
1    0
```

```
2   -1
```

```
15 3   -1
```

```
4    0
```

```
..
```

```
70   1
```

```
71  -1
```

```
20 72   0
```

```
73   1
```

```
74   1
```

Name: risk_rating_numerical, Length: 75, dtype: int64

In the final part of our pre-processing, we now write code to actually transform our text into individual word and 2-word phrase (bigram) tokens, which will attach numerical scores that are weighted tf: term frequency(count of the words present in document from its own vocabulary), idf: inverse document frequency(importance of the word to each document).

#Creating the features (tf-idf weights) for the processed text

```
30
```

```
texts = df["bag_cleaned_text"].astype('str')
```

```
tfidf_vectorizer = TfidfVectorizer(ngram_range=(1, 2),
min_df = 2,
```

```
max_df = .95)
```

```
X = tfidf_vectorizer.fit_transform(texts) #features
```

```
y = df['risk_rating_numerical'].values #target
```

5

```
print (X.shape)
```

```
print(y.shape)
```

```
(75, 304)
```

```
(75,)
```

10 **3B. Modelling: Multilabel Text Classification using scikit-learn**

Here, we're going to train our data using the following scikit-learn machine learning models: * Random Forest, * XGBoost, * SVC, and * K-Nearest Neighbours.

We'll split the data into a train, validation and test set. We'll only run our models on the validation set to understand generalization of each model, which we compare

15 against sklearn's own DummyClassifier as our baseline model.

The purpose of all this is to evaluate whether these conventional sci-kit learn machine learning models will perform better at predicting the right risk label for any given piece of news. We also compare this against an NLP-focused Deep Neural Network known as BERT, which is Google's own open-source Deep Learning model:

20 ([https://en.wikipedia.org/wiki/BERT_\(language_model\)](https://en.wikipedia.org/wiki/BERT_(language_model)))

Once the first phase of our training data has been compiled and labelled, our risk decisioning engine will constantly be evaluated for performance. We will, at all times, be asking ourselves - are the models we are using good at predicting risk correctly?

25 *#General model evaluation using default parameters on Validation Set*

#Creating a dict of the models

```
model_dict = {'Random Forest': RandomForestClassifier(random_state=3),
```

```
            'XGBoost': XGBClassifier(random_state=3),
```

30

```
            'SVC': SVC(),
```

```
            'K Nearest Neighbor': KNeighborsClassifier(),
```

```
            'Dummy Baseline': DummyClassifier()}
```

#Train test split with stratified sampling for evaluation

```
X_train, X_val, y_train, y_val = train_test_split(X,
                                                    y,
                                                    test_size = .3,
5                                                    shuffle = True,
                                                    stratify = y,
                                                    random_state = 3)
```

```
10 print("Multiclass Clause Classification - Validation Scores")
```

#Function to get the scores for each model in a dataframe

```
def model_score_df(model_dict):
```

```
15     model_name, ac_score_list, p_score_list, r_score_list, f1_score_list, auc_list = [],
    [], [], [], []
```

```
     for k,v in model_dict.items():
```

```
         model_name.append(k)
20         v.fit(X_train, y_train)
         y_pred = v.predict(X_val)
         ac_score_list.append(accuracy_score(y_val, y_pred))
         p_score_list.append(precision_score(y_val, y_pred, average='micro'))
         r_score_list.append(recall_score(y_val, y_pred, average='micro'))
25         f1_score_list.append(f1_score(y_val, y_pred, average='micro'))
```

```
     model_comparison_df = pd.DataFrame([model_name, ac_score_list,
p_score_list, r_score_list, f1_score_list]).T
```

```
     model_comparison_df.columns = ['model_name', 'accuracy_score',
30 'precision_score', 'recall_score', 'f1_score']
     model_comparison_df = model_comparison_df.sort_values(by='f1_score',
ascending=False)
```

```
     return model_comparison_df
```

```
model_score_df(model_dict)
```

Multiclass Clause Classification - Validation Scores

5

```
/Users/grahamlim/opt/anaconda3/lib/python3.7/site-packages/sklearn/dummy.py:132:
```

```
FutureWarning: The default value of strategy will change from stratified to prior in 0.24.
```

```
"stratified to prior in 0.24.", FutureWarning)
```

10

```
model_name
```

```
accuracy_score
```

```
precision_score
```

```
recall_score
```

```
f1_score
```

15

```
0
```

```
Random Forest
```

```
0.434783
```

```
0.434783
```

```
0.434783
```

20

```
0.434783
```

```
2
```

```
SVC
```

```
0.434783
```

```
0.434783
```

25

```
0.434783
```

```
0.434783
```

```
1
```

```
XGBoost
```

```
0.391304
```

30

```
0.391304
```

```
0.391304
```

```
0.391304
```

```
4
```

```
Dummy Baseline
```

0192P00578C

0.347826

0.347826

0.347826

0.347826

5 3

K Nearest Neighbor

0.304348

0.304348

0.304348

10 0.304348

3C. BERT Modelling

We also will utilize a Deep Learning Neural Network known as BERT, mentioned earlier.

15 Kaushal Trivedi defines BERT as a "multilingual transformer based model that has achieved state-of-the-art results on various NLP tasks. BERT is a bidirectional model that is based on the transformer architecture, it replaces the sequential nature of RNN (LSTM & GRU) with a much faster Attention-based approach. The model is also pre-trained on two unsupervised tasks, masked language modeling and next sentence prediction. This allows us to use a pre-trained BERT model by fine-tuning

20 the same on downstream specific tasks such as sentiment classification, intent detection, question-answering and more." (Source: <https://medium.com/huggingface/multi-label-text-classification-using-bert-the-mighty-transformer-69714fa3fb3d>)

25 For our purposes, it is another model on top of scikit-learn's ML models that can help us predict the correct risk label for a given set of news. The code below allows us to use a wrapper called ktrain that trains a BERT model on our news risk classifier:

#Please install ktrain on Google Colab: `pip install ktrain`

#BERT ktrain wrapper imports

30 import ktrain

from ktrain import text

X = df["combined"]

y = df["risk_rating"]

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.33)

#I have to change our train test split objects into a list of strings.

```
X_train = X_train.values.tolist()
```

```
X_test = X_test.values.tolist()
```

```
5 y_train = y_train.values.tolist()
```

```
y_test = y_test.values.tolist()
```

```
print("classes to predict")
```

```
print(y.value_counts())
```

```
10 classes to predict
```

```
neutral    33
```

```
stable     27
```

```
risky      15
```

```
Name: risk_rating, dtype: int64
```

```
15 #recalling our Y label dictionary
```

```
encoding = {'neutral':0,
```

```
           'stable':1,
```

```
           'risky':-1}
```

```
20 # Integer values for each class
```

```
y_train = [encoding[x] for x in y_train]
```

```
y_test = [encoding[x] for x in y_test]
```

```
#we now run BERT-specific preprocessing:
```

```
class_names = ['neutral','stable','risky']
```

```
25 (x_train, y_train), (x_test, y_test), preproc = text.texts_from_array(x_train=X_train,  
y_train=y_train,
```

```
x_test=X_test, y_test=y_test,
```

```
class_names=class_names,
```

```
preprocess_mode='bert',
```

```
30 maxlen=512,
```

```
max_features=100000)
```

```
task: text classification
```

```
preprocessing train...
```

```
language: en
```

done.

Is Multi-Label? False

preprocessing test...

language: en

5 done.

model = text.text_classifier('bert', train_data=(x_train, y_train), preproc=preproc)

Is Multi-Label? False

maxlen is 512

done.

10 learner = ktrain.get_learner(model, train_data=(x_train, y_train),
val_data=(x_test, y_test),
batch_size=12)

learner.fit_onecycle(2e-5, 10)

begin training using onecycle policy with max lr of 2e-05...

15 Train on 50 samples, validate on 25 samples

Epoch 1/10

50/50 [=====] - 198s 4s/sample - loss: 1.0321 -
accuracy: 0.4400 - val_loss: 1.0870 - val_accuracy: 0.3600

Epoch 2/10

20 50/50 [=====] - 202s 4s/sample - loss: 0.9820 -
accuracy: 0.4800 - val_loss: 1.0727 - val_accuracy: 0.3600

Epoch 3/10

50/50 [=====] - 205s 4s/sample - loss: 0.8635 -
accuracy: 0.6800 - val_loss: 1.1083 - val_accuracy: 0.2800

25 Epoch 4/10

50/50 [=====] - 204s 4s/sample - loss: 0.8029 -
accuracy: 0.7200 - val_loss: 1.0363 - val_accuracy: 0.2400

Epoch 5/10

30 50/50 [=====] - 209s 4s/sample - loss: 0.6139 -
accuracy: 0.8800 - val_loss: 0.9989 - val_accuracy: 0.2800

Epoch 6/10

50/50 [=====] - 212s 4s/sample - loss: 0.5157 -
accuracy: 0.8600 - val_loss: 1.2530 - val_accuracy: 0.3600

Epoch 7/10

50/50 [=====] - 209s 4s/sample - loss: 0.4253 -
accuracy: 0.8200 - val_loss: 1.2164 - val_accuracy: 0.3200

Epoch 8/10

50/50 [=====] - 208s 4s/sample - loss: 0.2895 -

5 accuracy: 0.9800 - val_loss: 1.0004 - val_accuracy: 0.4000

Epoch 9/10

50/50 [=====] - 208s 4s/sample - loss: 0.2648 -

accuracy: 0.9800 - val_loss: 1.0385 - val_accuracy: 0.2800

Epoch 10/10

10 50/50 [=====] - 219s 4s/sample - loss: 0.2278 -

accuracy: 1.0000 - val_loss: 1.0817 - val_accuracy: 0.3200

15

<tensorflow.python.keras.callbacks.History at 0x7fa99b834250>

#print out a performance report

learner.validate(val_data=(x_test, y_test), class_names=class_names)

20 precision recall f1-score support

neutral 0.44 0.29 0.35 14

stable 0.20 0.50 0.29 6

risky 1.00 0.20 0.33 5

25

accuracy 0.32 25

macro avg 0.55 0.33 0.32 25

weighted avg 0.50 0.32 0.33 25

30

```
array([[ 4, 10,  0],
       [ 3,  3,  0],
       [ 2,  2,  1]])
```

Remember that once again neither BERT nor the scikit-learn models in this design and development has a large enough dataset that is optimized for ML classification metrics accuracy/precision/recall/f1 score in the design and development; the production model will still involve a team of media analysts supervising and correcting the initial risk labelling so as to "teach" our AI models what it needs to predict. The purpose of showing the programming and logic here for our design and development here is a showcase of capability that we have.

What the output of our Classification/Labelling Models looks like

The modelling phase explained earlier will **generate a .csv file** that will look like the DataFrame below. Since we are still developing the models, we have created a preview of what 2 AI-classified/labelled news articles would look like:

```
15 df_report = pd.read_csv("../data/df_report_demo.csv", index_col=0)
```

```
df_report
```

```
date
```

```
title
```

```
intro
```

```
20 url
```

```
combined
```

```
risk_rating
```

```
bag_cleaned_text
```

```
risk_rating_numerical
```

```
25 commodity
```

```
main_entities
```

```
is_supply_shock
```

```
0
```

```
17-Mar-2020
```

30 The rice and fall: Vietnam eyes more global opportunities as Thai supply totters
Thailand's position as the largest exporter of rice from the South East Asian region is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-more-global-opportunities-as-Thai-supply-totters

The rice and fall: Vietnam eyes more global opportunities as Thai supply totters.

Thailand's position as the largest exporter of rice from the South East Asian region is

5 at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam looks to be going from strength to strength.

risky

rice fall vietnam eyes global opportunities thai supply totters thailand s position

largest exporter rice south east asian region risk country struggles handle weather

10 economical quality changes vietnam looks going strength strength

-1

rice

thailand

1

15 1

13-Sep-2018

'Full-blown food crisis': Philippines president denies rice shortage amidst calls for state of calamity

Philippines president Rodrigo Duterte has denied that there is any rice shortage in

20 the country despite senators calling it a 'full-blown food crisis' and urging him to declare a state of calamity.

www.foodnavigator-asia.com/Article/2018/09/13/Full-blown-food-crisis-Philippines-president-denies-rice-shortage-amidst-calls-for-state-of-calamity

'Full-blown food crisis': Philippines president denies rice shortage amidst calls for

25 state of calamity. Philippines president Rodrigo Duterte has denied that there is any rice shortage in the country despite senators calling it a 'full-blown food crisis' and urging him to declare a state of calamity.

risky

blown food crisis philippines president denies rice shortage amidst calls state

30 calamity philippines president rodrigo duterte denied rice shortage country despite senators calling blown food crisis urging declare state calamity

-1

rice

philippines

0

We see that the model will predict the risk rating (both verbally and numerically), the main_entities discussed, the commodity at risk, and whether or not the risk concerned is on the supply-side or demand side (is_supply_shock).

- 5 This data, as well as the risk-scoring ramifications based on this, will then be procedurally generated by our text report generator.

4. Report Generating Script

Once we have our risk-labelling AI model, we can then create a separate algorithm that generates a risk report on any given news article based on the risk label

- 10 predicted using our chosen AI model.

The report will contain the following key components: * NLP Multi-label: What is the commodity in question? * NLP Multi-label: Which country is mainly in question? What other entities are talked about here? * NLP Binary-class: Is the shock demand-based or supply-based shock? * NLP Multi-label: Based on the risk label, What is the new risk score of country or countries in question for that commodity? Do we apply +1, 0 - 1? * Update all countries's risk ratings accordingly * If the risk score of the country in question is lowered, can we recommend other countries with a better risk score for supply of this commodity?

- What does the AI-summarized text of the entire article look like?

- 20 The report can be generated as a table with an accompanying visualization uses spaCy's Named Entity Recognition, and our production model will be able to generate an individual report for each news article that relates to food supply.

Risk Matrices

For the report generator to readjust risk-weighted scores from food suppliers, we will require not only the model-generated .csv file, but we'll also have to create professionally curated risk matrices of commodity suppliers worldwide.

Similar to credit scoring, this will be based on proprietary risk-weighting methods pioneered by FSX.ai's supply chain and risk experts. A score is assigned to individual country suppliers, with the idea being that the higher the number, the more secure that supplier's capacity to supply a particular commodity is, and vice-versa.

For example, because India is now the largest supplier of rice worldwide (~32.5% of worldwide supply), their supply risk score is higher than say Spain, which only accounts for 0.9% of worldwide rice supply.

This also therefore means that negative news (resulting in a risk rating of -1) is more impactful on the new risk score for India than it is to Spain, and it suffers a risk penalty multiplier of 3.25. Therefore, negative news about India's rice supplying capacity will result in its score being subtracted by -3.25, whereas Spain's penalty will

5 only be -0.09.

For the sake of our demo, we have employed this simplistic calculation. We also assigned risk scores and penalties arbitrarily for ease of demonstration. Again, our production model will incorporate the fully articulated risk-scoring calculations based on curated weightages divined from our supply chain and risk experts.

10 Accordingly, we create here a sample risk score matrix of rice suppliers worldwide for demo purposes:

#example matrix based on <http://www.worldstopexports.com/rice-exports-country/>

```
supplier_data = [['india', 32.5], ['thailand', 19.2], ['united_states', 8.6], ['vietnam', 6.6],
                 ['pakistan', 5.6], ['china', 4.8], ['italy', 2.9],
15                 ['myanmar_burma', 2.6], ['cambodia', 2], ['uruguay', 1.7],
                 ['brazil', 1.7], ['netherlands', 1.7], ['belgium', 1.2],
                 ['paraguay', 1], ['spain', 0.9]]
```

```
df_rice_supplier_matrix = pd.DataFrame(supplier_data, columns =
```

```
20 ["supplier_country", "current_risk_score"])
```

#applying demo risk penalty multiplier as a new column in the matrix dataframe

```
df_rice_supplier_matrix['risk_penalty_multiplier'] =
```

```
df_rice_supplier_matrix['current_risk_score'].map(lambda x: x / 10)
```

```
df_rice_supplier_matrix
```

```
25 supplier_country
```

```
current_risk_score
```

```
risk_penalty_multiplier
```

```
0
```

```
india
```

```
30 32.5
```

```
3.25
```

```
1
```

```
thailand
```

```
19.2
```

0192P00578C

1.92

2

united_states

8.6

5 0.86

3

vietnam

6.6

0.66

10 4

pakistan

5.6

0.56

5

15 china

4.8

0.48

6

italy

20 2.9

0.29

7

myanmar_burma

2.6

25 0.26

8

cambodia

2.0

0.20

30 9

uruguay

1.7

0.17

10

0192P00578C

brazil

1.7

0.17

11

5 netherlands

1.7

0.17

12

belgium

10 1.2

0.12

13

paraguay

1.0

15 0.10

14

spain

0.9

0.09

20 *#backing up this matrix*

df_rice_supplier_matrix.to_csv("../data/df_supplier_matrix.csv")

Design and Development Code for How The Report Generator Works

We now write a function that transforms this data into a text report with entity visualization using spaCy's NER:

25 **def** report_writer(row):

#assign values into callable instances

date = row["date"]

title = row["title"]

30 url = row["url"]

risk_rating = row["risk_rating"]

risk_rating_numerical = row["risk_rating_numerical"]

commodity = row["commodity"]

main_entities = row["main_entities"]

```

supply_shock = row["is_supply_shock"]
minimum_score = 2

nlp = spacy.load('en_core_web_sm')
5 current_text = row['combined']
doc = nlp(current_text)

print (f"*****START OF REPORT*****")
print ("\n")
10
print (f"This is an automatically generated report for:")
print (f"\n'{title}', \ndated {date}, \nscraped from the url \n{url}.")
print ("\n")
print (f"Our FSX.ai Risk Model has identified that the article concerns risk towards
15 the supply of {commodity.title()} by {main_entities.title()}")
print("\n")

#get previous score of this country's rice supply risk
state_prior_score =
20 df_rice_supplier_matrix["current_risk_score"][df_rice_supplier_matrix["supplier_count
ry"] == main_entities].iloc[0]

print (f'{main_entities.title()}'s prior risk score for {commodity.title()} supply is
{state_prior_score}")
25

#get previous score of this country's rice supply risk
state_penalty =
df_rice_supplier_matrix["risk_penalty_multiplier"][df_rice_supplier_matrix["supplier_c
ountry"] == main_entities].iloc[0]
30

print (f'{main_entities.title()}'s risk penalty multiplier is {state_penalty}")

new_score = state_prior_score - (risk_rating_numerical*state_penalty)

```

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```
print ("\n")
print (f'{main_entities.title()}'s new risk score for {commodity.title()} supply is
{new_score}")
```

5 print ("\n")

```
print (f'Currently, FSX.ai recommends choosing suppliers with a minimum risk
score of {minimum_score}.')
```

```
minimum_score_suppliers =
10 df_rice_supplier_matrix[(df_rice_supplier_matrix["supplier_country"] != main_entities)
                           & (df_rice_supplier_matrix["current_risk_score"] >=
minimum_score)]
```

```
print (f'Accordingly, FSX.ai recommends reviewing the increase of imports from
15 other suppliers of {commodity.title()}:')
print ("\n")
print (minimum_score_suppliers)
print ("\n")
```

20

```
print (f'FSX.ai's spaCy NER has also highlighted the following related entities in
this article that should be reviewed \nin relation to this news article:')
print ("\n")
```

```
25        print (displacy.render(doc, style='ent', jupyter=True))
```

```
print (f'*****END OF REPORT*****')
```

We now run our function on the first news article in our sample dataframe.

```
30        report_writer(df_report.loc[0])
```

```
*****START OF REPORT*****
```

This is an automatically generated report for:

'The rice and fall: Vietnam eyes more global opportunities as Thai supply totters',
dated 17-Mar-2020,
scraped from the url

5 www.foodnavigator-asia.com/Article/2020/03/17/The-rice-and-fall-Vietnam-eyes-more-global-opportunities-as-Thai-supply-totters.

10 Our FSX.ai Risk Model has identified that the article concerns risk towards the supply of Rice by Thailand.

Thailand's prior risk score for Rice supply is 19.2

Thailand's risk penalty multiplier is 1.92

15

Thailand's new risk score for Rice supply is 21.119999999999997

20 Currently, FSX.ai recommends choosing suppliers with a minimum risk score of 2. Accordingly, FSX.ai recommends reviewing the increase of imports from other suppliers of Rice:

25	supplier_country	current_risk_score	risk_penalty_multiplier
0	india	32.5	3.25
2	united_states	8.6	0.86
3	vietnam	6.6	0.66
4	pakistan	5.6	0.56
30 5	china	4.8	0.48
6	italy	2.9	0.29
7	myanmar_burma	2.6	0.26
8	cambodia	2.0	0.20

FSX.ai's spaCy NER has also highlighted the following related entities in this article that should be reviewed in relation to this news article:

5

The rice and fall: Vietnam GPE eyes more global opportunities as Thai NORP supply totters. Thailand GPE 's position as the largest exporter of rice from the South East Asian region LOC is at risk as the country struggles to handle weather, economical and quality changes, whereas Vietnam GPE looks to be going from strength to strength.

10

None

*****END OF REPORT*****

Design and Development Article Summarizer

15

Finally, the last component of our report addresses this query: * NLG Text

Summarization: What is the AI-summarized version of the entire article?

We have design and development code that summarizes entire news articles using huggingface's T5 Transformer:

https://huggingface.co/transformers/model_doc/t5.html

20

Let's first use a new example of an entire news article taken from Channel News Asia:<https://www.channelnewsasia.com/news/asia/thailand-wetland-conservation-boon-reuang-special-economic-zone-12886250>.

text = ""

25

DUTTA NAGAR, India: Until late March, Ashish Kumar was helping to make plastic boxes for

Ferrero Rocher praline chocolates and the plastic spoons tucked inside Kinder Joy eggs to scoop out the milky sweet cream inside.

30

With a diploma in plastic mould technology, the 20-year-old had a foot on his chosen career ladder. His younger brother Aditya chose law, but Ashish had his sights set on plastic.

"I want to start a business of my own," he said, explaining how he wants to recycle

plastic to make day-to-day products at his own factory.

India's coronavirus lockdown has thrown those plans into disarray. Educated but unemployed, Ashish Kumar is one of countless people across the globe whose social progress has been halted by the coronavirus that has infected more than 2 million people in India alone, and thrown the economy into reverse. With it, the aspirations of millions are fading.

For years, people in rural India have been gaining prosperity and moving into what economists call a burgeoning middle class of consumers – those who earn more than US\$10 a day, by some definitions. This group has been a keystone of plans for economic development in the world's second most populous country.

In the COVID-19 pandemic, India's economy is forecast to shrink by 4.5 per cent this year, according to the International Monetary Fund. At least 400 million Indian workers are at risk of falling deeper into poverty, according to the International Labour Organization (ILO).

Kumar is one of around 131,000 people whom local officials estimate returned from working around India to Gonda, the district in the northern state of Uttar Pradesh that he left last June.

Nationwide, about 10 million people made long, hard journeys back to rural villages they had left. Some have gone back to the cities, but many of those who had been sending back funds are still stuck in the countryside.

Working in a factory in Baramati in the western state of Maharashtra, Kumar was earning 13,000 rupees (US\$173) every month, more than twice his father's pay from a job in a grain market near Kumar's home village in Uttar Pradesh, a sprawling agrarian state. Of that, the young man was sending home around 9,000 rupees every month, much of which was helping to fund his younger brother's studies.

No longer. Once a provider for his family, now he has become a financial burden.

Kumar whiles away his time back home in the village of Dutta Nagar, bantering with friends in the muddy courtyard – they jokingly call it their "office" – outside the ramshackle primary school where he studied. In Uttar Pradesh, around 60 million of the state's population of more than 200 million lives in poverty, according to the

5 World Bank.

He said he has applied for several jobs at plastic factories in western Gujarat state and other parts of northern India but has not found work.

10 "No matter what," he said, sitting near his parent's single-storey home, surrounded by jade green paddy fields. "I need a job."

PLASTIC FOR PRALINES

15 As a schoolboy, Kumar was obsessed with plastics.

A chance conversation with a cousin who had studied plastic engineering got him hooked, Kumar said, and he started researching. In Dutta Nagar, where there were no Internet connections, that often meant asking one of a handful of locals with a
20 smartphone to Google the opportunities.

Kumar's ambitions were a world removed from his father Ashok's early years. The 47-year-old, who assists with weighing and pricing grain harvests, remembers when the family had neither enough food, nor proper clothes.

25

A slight man with a weather-beaten face, he never finished high school.

"I thought that the children shouldn't fall into our rut. They should be pushed ahead," he said.

30

Kumar, who says he has never tasted a Ferrero Rocher praline, finished his diploma in Gujarat last June, and took the train to start work as a technician at an Italian-owned factory 1,500km away from home.

The factory that employed him is run by Dream Plast India, a subsidiary of Gruppo Sunino, an Italian plastics maker with 10 plants around the world.

5 "The factory was first class," Kumar said. His contract included a monthly contribution from the company into a retirement fund and a bonus. Workers were served one meal every day, the supervisors were friendly, and the salary came on time, he said.

10 Six days a week, his work typically involved overseeing two machines and a couple of contract workers. At the end of the day, he would relax with a game of badminton or watch wrestling on YouTube.

15 His income over the past year helped his parents build a proper four-roomed brick home, after decades of living in a tumble-down mud hut where the roof let in heavy monsoon rains. It helped pay the fees for his brother to go to law school in Bahraich, an hour-and-a-half's drive away from their home village.

Then COVID-19 struck.

20 BROKE IN BARAMATI

Kumar first heard of the coronavirus in early March. When India's lockdown forced Dream Plast India to temporarily shut its plant in Baramati on Mar 21, he had enough cash to wait it out in town.

25 As the pandemic swept through India, a survey of some 5,000 workers in April and May found 66 per cent of participants had lost their jobs, and 77 per cent of households were consuming less food than before.

30 Prime Minister Narendra Modi's government announced a 20 trillion rupee package promising free rice, wheat and pulses for millions of people and a programme to provide employment in rural areas.

Even for those with work, trade unions and labour experts say conditions are deteriorating, for migrants particularly.

In May, India's state governments issued health and safety guidelines for factories as they re-opened after lockdown, which included compulsory face masks, thermal screening, social distancing and frequent sanitisation. Union leaders allege many companies did not follow all protocols and cut corners, but they have not identified Kumar's.

Indian states including Uttar Pradesh and Gujarat said in May they were looking to relax workers' rights, including weakening regulations on wages and working hours, to support industry. That proposal drew criticism from workers' unions and the ILO. The amendments have only taken effect in some states.

Kumar's factory, which reopened in early May, did not respond to a question on measures taken there, but Dream Plast India's managing director Nitin Gupta said in an email the "company takes utmost precautions to adhere to the laws at all times". He declined to elaborate further.

Even so, Kumar and another worker Reuters spoke to said they did not feel safe to return.

Ferrero, the Italian confectioner, said it had audited the plant where Kumar worked in March and found no irregularities, but would further review subsequent months.

Reuters was unable to independently determine what safety measures the factory took.

By early June, Kumar's funds had run out. Even buying food became difficult.

His parents grew increasingly worried. "Whatever little money I had here in the bank, I sent some of that so he could eat," said his father, Ashok. "At that time, I was very scared. The biggest challenge was for him to come home."

India's railway network reopened in early May. On Jun 3, Kumar borrowed money to pay for a 48-hour journey home by train, bus and shared taxi. Then he went into a

14-day quarantine.

On Jun 25, Dream Plast India sent him an email, which was seen by Reuters, asking him to report to work within four days or face termination. Instead, he resigned on Jul

5 20.

His parents are apprehensive about him leaving home again, although they said they realise that without their elder son's earnings, his younger brother will not be able to finish law school.

10

Kumar is not ready to give up on his plastics factory.

"I will do it," he said. "No matter what it takes, I will fulfil my dream."

.....

15 *#from adapting https://huggingface.co/transformers/model_doc/t5.html*

import torch

import json

from transformers import T5Tokenizer, T5ForConditionalGeneration, T5Config

20 model = T5ForConditionalGeneration.from_pretrained('t5-small')

tokenizer = T5Tokenizer.from_pretrained('t5-small')

device = torch.device('cpu')

preprocess_text = text.strip().replace("\n", "")

25 t5_prepared_Text = "summarize: "+preprocess_text

print ("original text preprocessed: \n", preprocess_text)

tokenized_text = tokenizer.encode(t5_prepared_Text, return_tensors="pt").to(device)

30

summarize

summary_ids = model.generate(tokenized_text,

num_beams=4,

no_repeat_ngram_size=2,

```

min_length=30,
max_length=500,
early_stopping=True)

```

```

5 output = tokenizer.decode(summary_ids[0], skip_special_tokens=True)

```

```

print ("\n\nSummarized text: \n",output)

```

Some weights of T5ForConditionalGeneration were not initialized from the model checkpoint at t5-small and are newly initialized: ['encoder.embed_tokens.weight',

```

10 'decoder.embed_tokens.weight', 'lm_head.weight']

```

You should probably TRAIN this model on a down-stream task to be able to use it for predictions and inference.

Token indices sequence length is longer than the specified maximum sequence length for this model (1893 > 512). Running this sequence through the model will

```

15 result in indexing errors

```

original text preprocessed:

```

20 "DUTTA NAGAR, India: Until late March, Ashish Kumar was helping to make plastic
boxes for Ferrero Rocher praline chocolates and the plastic spoons tucked inside
Kinder Joy eggs to scoop out the milky sweet cream inside. With a diploma in plastic
mould technology, the 20-year-old had a foot on his chosen career ladder. His
younger brother Aditya chose law, but Ashish had his sights set on plastic."I want to
start a business of my own," he said, explaining how he wants to recycle plastic to
25 make day-to-day products at his own factory. India's coronavirus lockdown has
thrown those plans into disarray. Educated but unemployed, Ashish Kumar is one of
countless people across the globe whose social progress has been halted by the
coronavirus that has infected more than 2 million people in India alone, and thrown
the economy into reverse. With it, the aspirations of millions are fading. For years,
30 people in rural India have been gaining prosperity and moving into what economists
call a burgeoning middle class of consumers – those who earn more than US$10 a
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development in the world's second most populous country. In the COVID-19
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```

to the International Monetary Fund. At least 400 million Indian workers are at risk of falling deeper into poverty, according to the International Labour Organization (ILO). Kumar is one of around 131,000 people whom local officials estimate returned from working around India to Gonda, the district in the northern state of Uttar

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25 one of a handful of locals with a smartphone to Google the opportunities. Kumar's ambitions were a world removed from his father Ashok's early years. The 47-year-old, who assists with weighing and pricing grain harvests, remembers when the family had neither enough food, nor proper clothes. A slight man with a weather-beaten face, he never finished high school. "I thought that the children shouldn't fall
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factory took. By early June, Kumar's funds had run out. Even buying food became difficult. His parents grew increasingly worried. "Whatever little money I had here in the bank, I sent some of that so he could eat," said his father, Ashok. "At that time, I was very scared. The biggest challenge was for him to come home." India's railway network reopened in early May. On Jun 3, Kumar borrowed money to pay for a 48-hour journey home by train, bus and shared taxi. Then he went into a 14-day quarantine. On Jun 25, Dream Plast India sent him an email, which was seen by Reuters, asking him to report to work within four days or face termination. Instead, he resigned on Jul 20. His parents are apprehensive about him leaving home again, although they said they realise that without their elder son's earnings, his younger brother will not be able to finish law school. Kumar is not ready to give up on his plastics factory. "I will do it," he said. "No matter what it takes, I will fulfil my dream."

Summarized text:

India's coronavirus has infected more than 2 million people in India alone. a U.S.-based company has reopened its factory in baramati in early may, citing lack of food and sanitisation in rural areas. the government has issued health and safety guidelines for factories in the country.

Other Features in Development: Macro events

So far, we've only covered supply shocks. Demand-side shocks can also have an impact on supply chains - for example, if Iran, the largest importer of rice in the world, were to suddenly face a massive rice shortage, it is reasonable to presume that this will lead to it increasing imports.

Doing so will cause a demand-driven shortage of rice in our top rice suppliers like India or Thailand, which is another risk worth assessing. We are also writing algorithms to account for this just like we did in the example above from a straightforward supply risk scenario.

Reference Numerals

	100	food security system;
	110	infrastructure layer;
5	120	platform;
	130	data layer;
	140	algorithm layer;
	150	operation module;
	200	food supply risk management;
10	202	first step;
	204	second step;
	206	third step;
	210	food growers;
	220	food processors;
15	230	logistics;
	240	exporters/importers;
	250	supermarkets/food & beverage;
	260	banks, financiers & insurers;
	270	government;
20	280	artificial intelligence (AI) driven platform;
	300	food value chain enhancement;
	310	financial institutions;
	320	input suppliers;
	330	farms;
25	340	processors;
	350	traders;
	360	retailers;
	370	food companies;
	380	consumers;
30		

Claims

1. A food security system for automatically managing food security, comprising:
 - a food security exchange (FSX) platform for managing food security to potential risks;
 - a platform controller for exchanging information with application providers; and
 - a platform interface for exchanging information with users, wherein the platform controller and the platform interface are integrated with the food security exchange (FSX) platform.
2. The food security system of claim 1, wherein the food security exchange (FSX) platform comprises
 - a diagnostic model for detecting and analyzing potential risks by trigger events; and
 - a predictive model for predicting possible solutions to the potential risks according to the diagnostic model.
3. The food security system of claim 2, wherein
 - the diagnostic model comprises an infrastructure layer and a data layer; and
 - the predictive model comprises an algorithm layer.
4. The food security exchange (FSX) system of claim 3, wherein the infrastructure layer further comprises a natural language processing (NLP) module for retrieving text information from the external sources.
5. The food security exchange (FSX) system of claim 3, wherein the infrastructure layer further comprises a computer vision module for retrieving image information from the trigger events.

6. The food security exchange (FSX) system of claim 3, wherein the data layer further comprises
 - a data engineering module for developing the raw data into engineered data; and
 - an artificial intelligence module for automatically analyzing the engineered data.
7. The food security exchange (FSX) system of claim 6, wherein the data engineering module comprises
 - a data wrangling unit for transforming the raw data into transformed data;
 - a data cleansing unit for cleansing inferior records of the transformed data; and
 - a data preparation unit for manipulating the cleansed records into the engineered data.
8. The food security exchange (FSX) system of claim 7, wherein the artificial intelligence module comprises
 - a learning unit for learning the raw data; and
 - a validation unit for validating the raw data.
9. The food security exchange (FSX) system of claim 8, wherein the learning unit comprises a machine learning algorithm.
10. The food security exchange (FSX) system of claim 2, wherein the algorithm layer comprises a deep learning algorithm for applying an artificial neural network to outputs of the data layer.
11. The food security exchange (FSX) system of claim 10, wherein the predictive model further comprises a risk-decisioning engine for making decisions according to the diagnostic model.

12. The food security exchange (FSX) system of claim 11, wherein the risk-decisioning engine has a food security exchange (FSX) architecture, wherein the food security exchange (FSX) architecture comprises

- a food security exchange (FSX) command and control engine; and
- a food security exchange (FSX) business reporting unit.

13. The food security exchange (FSX) system of claim 12, wherein the food security exchange (FSX) business reporting unit comprises a report library and an application programming interface (API).

14. The food security exchange (FSX) system of claim 11, wherein the platform interface comprises an operation module communicatively coupled to the risk-decisioning engine for providing instructions to the users.

15. The food security exchange (FSX) system of claim 14, wherein the operation module comprises

- a deployment unit for deploying operations according to the instructions; and
- a visualization module for presenting visual consequences to the users.

16. The food security exchange (FSX) system of claim 1, wherein the platform interface further comprises a warning means for notifying the users if the potential risk is higher than a pre-determined value (scoring metrics).

17. The food security exchange (FSX) system of claim 1, further comprising: a communication means for remotely communicating with the application providers and/or the users.

18. A food security early warning system (FIEWS), comprising:
- a complexity map of food security for a certain region;
 - a plurality of event triggers for identifying relevant events to the food security;
 - a machine learning algorithm for activating response plans to the relevant events; and
 - an operational module for integrating all components.
19. The food security early warning system (FIEWS) of claim 18, wherein the food security early warning system (FIEWS) is configured to find out causal relationship between the event triggers and the food security.
20. The food security early warning system (FIEWS) of claim 18, wherein the food security early warning system (FIEWS) is configured to develop and validate the response plans by using historical events.