

METHOD AND APPARATUS FOR EXAMINATION OF FINANCIAL CREDIT USING REINFORCEMENT LEARNING

TECHNICAL FIELD

5 The present disclosure relates to a method for examination of financial credit using reinforcement learning, the method performed by an apparatus for examination of financial credit using reinforcement learning. For reference, this application claims priority to Korean Patent Application No. 10-2020-0114920, filed on September 8, 2020. The entire contents of the application on which the priority is based are incorporated herein by reference.

BACKGROUND

10 In financial institutions' business, financial credits account for a large portion of yields and thus it is regarded a very important business.

15 Factors that determine yields of a financial institution according to financial credits include a credit examination approval rate, an individual interest rate, an individual limit, a default rate, the number of approvals of loan, and the like, but in an existing financial credit examination procedure, examination for financial credit has been carried out by fixing factors other than the individual interest rate and the individual limit.

SUMMARY

20 The present disclosure provides an apparatus and method for examination of financial credit using reinforcement learning by deriving a credit examination criterion, an interest rate, or a limit which may maximize a financial credit rate of change in yields or a rate of change in a yield rate according to credit management.

25 In accordance with an aspect of the present disclosure, there is provided an apparatus

for examination of financial credit using reinforcement learning, the apparatus comprising: a storage configured to store a financial credit examination program; and a processor configured to load the financial credit examination program from the storage and execute the financial credit examination program, wherein the processor is further configured to, in an environment
5 where first examination basis data and examination criterion data, for examination of financial credit corresponding to total borrower, and second examination basis data, individual interest rate data and individual limit data, for examination of financial credit corresponding to each individual borrower, are provided, generate, as status data, at least one of a credit examination approval rate corresponding to the total borrowers, a loan amount corresponding to the total
10 borrowers, and an expected default rate corresponding to the each individual borrower; generate, as reward data, a rate of change in yields or a rate of change in a yield rate on credit management according to a change in at least one of the first examination basis data for the examination of financial credit corresponding to the total borrowers, the individual interest rate data corresponding to the each individual borrower, and the individual limit data corresponding to
15 the each individual borrower; while executing an action based on status recognition using the status data, generate action data that is learned so as to maximize a value of the reward data; and adjust at least one of the examination criterion data for the examination of financial credit corresponding to the total borrowers, the individual interest rate data corresponding to the each individual borrower, and individual limit data the corresponding to each individual borrower
20 according to the action data.

In accordance with another aspect of the present disclosure, there is provided a method for examination of financial credit using reinforcement learning, the method which is performed by an apparatus for examination of financial credit and which comprises: generating, as status data, at least one of a credit examination approval rate corresponding to the total borrowers, a
25 loan amount corresponding to the total borrowers, and an expected default rate corresponding

to each individual borrower, in an environment where first examination basis data and examination criterion data, for examination of financial credit corresponding to total borrowers, and second examination basis data, individual interest rate data and individual limit data, for examination of financial credit corresponding to each individual borrower, are provided; generating, as reward data, a rate of change in yields or a rate of change in a yield rate on credit management according to a change in at least one of the first examination basis data for the examination of financial credit corresponding to the total borrowers, the individual interest rate data corresponding to the each individual borrower, and the individual limit data corresponding to the each individual borrower; generating action data that is learned so as to maximize a value of the reward data, while executing an action based on status recognition using the status data; adjusting at least one of the examination criterion data for the examination of financial credit corresponding to the total borrowers, the individual interest rate data corresponding to the each individual borrower, and the individual limit data corresponding to the each individual borrower, according to the action data for repeatedly performing the generating of the status data, the generating of the reward data, and the generating of the action data.

According to an embodiment, examination of financial credit by a financial institution may be operated in an optimal status by deriving financial credit examination criterion, an interest rate, or a credit limit using reinforcement learning in order to maximize a rate of change in yields or a rate of change in a yield rate according to credit management.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of an apparatus for examination of a financial credit using reinforcement learning according to an embodiment of the present disclosure.

FIG. 2 is a detailed configuration diagram of a reinforcement learning environment unit shown in FIG. 1.

FIG. 3 is a flowchart illustrating a method for examination of financial credit using reinforcement learning, the method which is performed by an apparatus for examination of financial credit using reinforcement learning, according to an embodiment of the present disclosure.

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DETAILED DESCRIPTION

Terms used herein will now be briefly described and then one or more exemplary embodiments will be described in detail.

General terms which are widely used nowadays are selected as the terms used in the present disclosure in consideration of functions in the present invention, but the terms may be changed depending on an appearance of a precedent or new technique or the intention of a person skilled in the art. In a specific case, a term selected by the present applicant may be used, and, in this case, the meaning of the term will be described in detail in the corresponding part of this specification. Therefore, the definition of the terms used herein should not be made by the names of the terms, but made by the meanings of the terms based on the overall disclosures set forth herein.

Throughout the specification, when an element “includes” a component, it may indicate that the element does not exclude another component unless referred to the contrary, but can further include another component.

In addition, the term “unit” used in the specification may refer to a software component or a hardware component such as Field Programmable Gate Array (FPGA) or Application Specific Integrated Circuit (ASIC), and “unit” may implement certain functions. However, “unit” is not limited to software or hardware. The “unit” may be configured to be stored in an addressable storage medium (for example, a memory) or may be configured to reproduce one or more processors. Thus, for example, the “unit” includes software elements, object-oriented

software elements, class elements, task elements and the like elements, and processes, functions, attributes, procedures, subroutines, program code segments, drivers, firmware, microcode, circuits, data, a database, data structures, tables, arrays and variables. A function provided by elements or “units” may be a combination of smaller elements and "units" or may be subdivided
5 by additional elements and “units”.

Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings so that those of ordinary skill in the art may easily implement the present disclosure. In addition, in order to clearly describe the present disclosure, elements not directly related to the description may be omitted from the drawings.

10 FIG. 1 is a configuration diagram of an apparatus for examination of financial credit using reinforcement learning according to an embodiment of the present disclosure, and FIG. 2 is a detailed configuration diagram of a reinforcement learning environment unit shown in FIG. 1.

Referring to FIGS. 1 and 2, an apparatus 100 for examination of financial credit using
15 reinforcement learning according to an embodiment includes a reinforcement learning environment unit 110, a reinforcement learning agent unit 120, and a reinforcement learning environment adjuster 130. The reinforcement learning environment unit 110 includes a data acquirer 111, a first artificial neural network model unit 112, a second artificial neural network model unit 113, a third artificial neural network model unit 114, and a data provider 115. As
20 such, each of the elements constituting the apparatus 100 for examination of financial credit may include a computing operation means such as a microprocessor, or each of the elements may be implemented as a program (e.g., a financial credit examination program) which is executed by a computing operation means such as a microprocessor.

In an environment in which examination basis data and examination criterion data for
25 examination of financial credit corresponding to the total borrowers, examination basis data for

examination of financial credit corresponding to each individual borrower, individual interest rate data corresponding to each individual borrower, and individual limit data corresponding to each individual borrower are provided, the reinforcement learning environment unit 110 may generate, as status data, at least one of the following: a credit examination approval rate and
5 loan amount corresponding to total borrowers; and an expected default rate corresponding to each individual borrower. Then, the reinforcement learning environment unit 110 provides the reinforcement learning agent unit 120 with the status data.

The examination basis data for examination of financial credit corresponding to the total borrowers, the data which is provided to the reinforcement learning environment unit 110,
10 may include, for example, the number of users introduced through a face-to-face sales channel and a non-face-to-face sales channel, an average interest rate of interest rates for borrowers for which loan has been granted, an average credit limit for the borrowers for which loan has been granted, a base rate, an inflation rate, a macroeconomic indicator for measure a risk of a corporate bond and the like, historical data which is an indicator for tracking a risk of financial
15 credit, and the like.

The examination criterion data for examination of financial credit corresponding to the total borrowers, the data which is provided to the reinforcement learning environment unit 110, may include, for example, approval cut-off strategy data in which an approval cut-off criterion according to a financial credit policy is set as a score or rating, and the like.

20 The examination basis data for examination of financial credit corresponding to each individual borrower, the data which is provided to the reinforcement learning environment unit 110, may include: financial data standardized in published materials such as financial statements; non-financial information for identifying credit information of a borrower based on information on credit, security, and the like of the borrower, address change information,
25 product market values, and the like; and a credit rating according to a credit evaluation criterion

used by a financial institution.

In addition, the reinforcement learning environment unit 110 generates, as a reward data, a rate of change in yields or a rate of change in a yield rate according to credit management based on a change in at least one of the following: the examination criterion data for examination of financial credit corresponding to the total borrowers; individual interest rate data corresponding to each individual borrower; and individual limit data corresponding to each individual borrower. Then, the reinforcement learning environment unit 110 provides the reinforcement learning agent unit 120 with the reward data.

The data acquirer 111 of the reinforcement learning environment unit 110 acquires training examination criterion data corresponding to the total borrowers, training examination basis data corresponding to each individual borrower, training individual interest rate data, and training individual limit data as a first training input dataset, and acquires credit examination approval rate data as first label data for the first training input status dataset. For example, the training examination criterion data corresponding to the total borrowers, the data which is included in the first training input dataset, may include data on whether or not to be approved according to an approval cut-off strategy, and the training examination basis data corresponding to each individual borrower, the data which is included in the first training input dataset, may include data on a score calculated based on financial/non-financial data and data on a credit rating.

In addition, the data acquirer 111 acquires training examination basis data and training delinquency rate data corresponding to the total borrowers and training examination basis data corresponding to each individual borrower as a second training input dataset, and acquires default rate data as second label data for the second training input dataset. For example, the training examination basis data corresponding to the total borrowers and included in the second training input dataset may include macroeconomic indicator data, and the training examination

basis data corresponding to each individual borrower and included in the second training input dataset may include financial/non-financial data and data on a credit rating.

In addition, the data acquirer 111 acquires training individual interest rate data corresponding to each individual borrower, training individual limit data corresponding to each individual borrower, the total number of approvals of loan corresponding to the total borrowers, and a training expected default rate corresponding to each individual borrower as a third training input dataset, and acquires principal loss data according to credit management as third label data for the third training input dataset.

When first credit examination data corresponding to each individual borrower is input to a first artificial neural network model after the first artificial neural network model learns the first training input dataset and the first label data, the first artificial neural network model unit 112 of the reinforcement learning environment unit 110 outputs a credit examination approval rate corresponding to the total borrowers.

When the second credit examination data corresponding to each individual borrower is input to a second artificial neural network model after the second artificial neural network model learns the second training input dataset and the second label data, the second artificial neural network model unit 113 of the reinforcement learning environment unit 110 outputs an expected default rate corresponding to each individual borrower.

When the third credit examination data corresponding to each individual borrower is input to a third artificial neural network model after the third artificial neural network model learns the third training input dataset and the third label data, the third artificial neural network model unit 114 of the reinforcement learning environment unit 110 outputs principal loss data corresponding to the total number of approvals of loan.

The data provider 115 of the reinforcement learning environment unit 110 calculates a rate of change in yields or a rate of change in a yield rate according to credit management based

on the following: a credit examination approval rate corresponding to the total borrowers and output from the first artificial neural network model unit 112; an expected default rate corresponding to each individual borrower and output from the second artificial neural network model unit 113; principal loss data corresponding to the total number of approvals of loan and output from the third artificial neural network model unit 114; and a loan amount corresponding to the total number of approvals of loan. Then, the data provider 115 provides the reinforcement learning agent unit 120 with the calculated rate of change in yields or the calculated rate of change in a yield rate as reward data. For example, in addition to the credit examination approval rate corresponding to the total borrowers, the loan amount corresponding to the total borrowers, the expected default rate corresponding to each individual borrower, the status data provided by the data provider 115 to the reinforcement learning agent unit 120 may include a default amount, the number of applications for loan, yields, a yield rate, and the like.

While executing an action based on status recognition according to the status data provided from the reinforcement learning environment unit 110, the reinforcement learning agent unit 120 may provide the reinforcement learning environment adjuster 130 with action data that is learned so as to maximize a value of the reward data provided from the reinforcement learning environment unit 110.

The reinforcement learning environment adjuster 130 adjusts at least one of the following according to the action data provided from the reinforcement learning agent unit 120: the examination criterion data for examination for financial credit corresponding to the total borrowers; individual interest rate data corresponding to each individual borrower; and individual limit data corresponding to each individual borrower. Then, the reinforcement learning environment adjuster 130 provides the reinforcement learning environment unit 110 with a result of the adjustment.

FIG. 3 is a flowchart illustrating a method for examination of financial credit using

reinforcement learning, the method which is performed by an apparatus for examination of financial credit using reinforcement learning, according to an embodiment of the present disclosure.

Hereinafter, a method for examination of financial credit using reinforcement learning, the method which is performed by an apparatus for examination of financial credit using reinforcement learning, according to an embodiment of the present disclosure will be described in detail with reference to FIGS. 1 to 3.

First, for financial credit management using the apparatus 100 for examination of financial credit using reinforcement learning, it is necessary to perform learning on the first artificial neural network model unit 112, the second artificial neural network model unit 113, and the third artificial neural network model unit 114 included in the reinforcement learning environment unit 110. In order to perform such learning, it is necessary to provide the reinforcement learning environment unit 110 with training data and label data corresponding thereto, and the first artificial neural network model unit 112, the second artificial neural network model unit 113, and the third artificial neural network model unit 114 included in the reinforcement learning environment unit 110 receive the training data and the label data from the data acquirer 111 and perform the learning.

For such pre-learning, the data acquirer 111 of the reinforcement learning environment unit 110 performs operations including: acquiring training examination criterion data corresponding to the total borrowers, training examination basis data corresponding each individual borrower, training individual interest rate data corresponding each individual borrower, and training individual limit data corresponding each individual borrower as a first training input dataset; acquiring credit examination approval rate data as first label data for the first training input status dataset; and providing the first artificial neural network model unit 112 with the first training input dataset and the first label data. For example, the training

examination criterion data corresponding to the total borrowers and included in the first training input dataset may include data on whether or not to be approved according to an approval cut-off strategy, and the training examination criterion data corresponding to each individual borrower and included in the first training input dataset may include data on a score calculated based on financial/non-financial data and data on a credit rating in operation S301.

Then, a first artificial neural network model included in the first artificial neural network model unit 112 of the reinforcement learning environment unit 110 performs learning on the first training input dataset and the first label data, which are provided from the data acquirer 111, in operation S302.

Thereafter, when the first credit examination data corresponding to each individual borrower is provided to the reinforcement learning environment unit 110, the data acquirer 111 acquires and provides the first credit examination data corresponding to each individual borrower to the first artificial neural network model unit 112, and, when the first credit examination data is input, the first artificial neural network model unit 112 which has been trained outputs a credit examination approval rate corresponding to the total borrowers to the data provider 115. Here, the first credit examination data is data corresponding to the first training input dataset that is previously learned by the first artificial neural network model unit 112. For example, the first credit examination data may include examination criterion data for examination of financial credit corresponding to the total borrowers, examination basis data for examination of financial credit corresponding to each individual borrower, individual interest rate data corresponding to each individual borrower, and individual limit data corresponding to each individual borrower.

In addition, the data acquirer 111 performs operations including: acquiring, as a second training input dataset, training examination basis data corresponding to the total borrowers, training delinquency rate data corresponding to the total borrowers, training examination basis

data corresponding to each individual borrower; acquiring default rate data as second label data for the second training input dataset; and providing the second training input dataset and the second label data to the second artificial neural network model unit 113. For example, the training examination basis data corresponding to the total borrowers and included in the second training input dataset may include macroeconomic indicator data, and the training examination basis data corresponding to each individual borrower and included in the second training input dataset may include financial or non-financial data and data on a credit rating in operation S303.

Then, a second artificial neural network model included in the second artificial neural network model unit 113 of the reinforcement learning environment unit 110 performs learning on the second training input dataset and the second label data, which are provided from the data acquirer 111, in operation S304.

Thereafter, when the second credit examination data corresponding to each individual borrower is provided to the reinforcement learning environment unit 110, the data acquirer 111 acquires and provides the second credit examination data corresponding to each individual borrower to the second artificial neural network model unit 113, and, when the second credit examination data is input, the second artificial neural network model unit 113 which has been trained outputs an expected default rate corresponding to each borrower to the data provider 115. Here, the second credit examination data is data corresponding to the second training input dataset that is previously learned by the second artificial neural network model unit 113. For example, the second credit examination data may include the examination basis data for examination of financial credit corresponding to the total borrowers, the delinquency rate data corresponding to the total borrowers, and the examination basis data for examination of financial credit corresponding to each individual borrower.

In addition, the data acquirer 111 performs operations including: acquiring, as a third training input dataset, training individual interest rate data and training individual limit data

corresponding to each individual borrower, the total number of approvals of loan corresponding to the total borrowers, and a training expected default rate corresponding to each individual borrower; acquiring principal loss data according to credit management as third label data for the third training input dataset; and providing the third artificial neural network model unit 114 with the third training input dataset and the third label data to in S305.

Then, a third artificial neural network model included in the third artificial neural network model unit 114 of the reinforcement learning environment unit 110 performs learning on the third input dataset for training and the third label data, which are provided from the data acquirer 111, in operation S306.

Thereafter, when the third credit examination data corresponding to each individual borrower is provided to the reinforcement learning environment unit 110, the data acquirer 111 acquires and provides the third credit examination data corresponding to each individual borrower to the third artificial neural network model unit 114, and, when the third credit examination data is input, the third artificial neural network model unit 114 which has been trained outputs principal loss data corresponding to the total number of approvals of loan to the data provider 115. Here, the third credit examination data is data corresponding to the third training input dataset that is previously learned by the third artificial neural network model unit 114. For example, the third credit examination data may include the individual interest rate data corresponding to each individual borrower, the individual limit data corresponding to each individual borrower, the total number of approvals of loan corresponding to the total borrowers, and the expected default rate output from the second artificial neural network model unit 113. For example, the expected default rate may be provided in a manner in which the third artificial neural network model unit 114 receives an output from the second artificial neural network model unit 113 or may be provided from the second artificial neural network model unit 113 to the third artificial neural network model unit 114 through relaying of the data acquirer 111.

Operation S301 to S306 described above explains the order of implementation according to an embodiment, and the order of implementation may change. For example, operation S302, S304, and S306 may be performed after operation S301, S303, and S305 are performed first.

Meanwhile, the data provider 115 generates a credit examination approval rate corresponding to the total borrowers, a loan amount corresponding to the total borrowers, an expected default rate corresponding to each individual borrower, the number of applications for loans, yields, a yield rate, and the like as status data, and provides the reinforcement learning agent unit 120 with the status data in operation S307. In addition, the data provider 115 calculates a rate of change in yields or a rate of change in a yield rate according to credit management based on the following: the credit examination approval rate corresponding to the total borrowers and output from the first artificial neural network model unit 112; the expected default rate corresponding to each individual borrower and output from the second artificial neural network model unit 113; the principal loss data corresponding to the total number of approvals of loan and output from the third artificial neural network model unit 114; and the loan amount corresponding to the total number of approvals of loan. The, the data provider 115 provides the reinforcement learning agent unit 120 with the rate of change in yields or the rate of change in a yield rate as reward data to in operation S308. For example, the data provider 115 may calculate yields according to credit management using Equation 1.

【Equation 1】

Yields = Number of applications of loan × Credit examination approval rate

$$\times \sum_{t=0}^n (\text{limit} \times \text{Interest rate} \times (1 - \text{Expected default rate}))$$

– Default amount

Then, while executing an action based on status recognition according to the status data

provided from the reinforcement learning environment unit 110, the reinforcement learning agent unit 120 provides the reinforcement learning environment adjuster 130 with action data that is learned so as to maximize a value of reward data provided from the reinforcement learning environment unit 110. In a process in which the reinforcement learning agent unit 120 learns the action data so as to maximize the value of the reward data, a well-known reinforcement learning method may be employed in operation S309.

Then, the reinforcement learning environment adjuster 130 may provide the reinforcement learning environment unit 110 with adjustment data in which at least one of the following is adjusted according to the action data provided from the reinforcement learning agent unit 120: examination criterion data for examination of financial credit corresponding to the total borrowers; and individual interest rate data and individual limit data corresponding to each individual borrower in operation S310. For example, the financial credit examination criterion data corresponding to the total borrowers, the data which is provided from the reinforcement learning environment adjuster 130, may include approval cut-off strategy data in which an approval cut-off criterion according to a financial credit policy is set as a score or rating. Here, the reinforcement learning environment adjuster 130 may selectively choose action data according to feedback from the reinforcement learning agent unit 120 based on the action data provided from the reinforcement learning environment adjuster 130, by fixing at least one of the following or designating a range thereof according to various strategies shown in Table 1: examination criterion data for examination of financial credit corresponding to the total borrowers; individual interest rate data corresponding to each individual borrower; and individual limit data corresponding to each individual borrower.

【Table 1】

	Strategy	Strategy	Strategy	Strategy	Strategy	Strategy	Strategy
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	1	2	3	4	5	6	7
Examination criterion data	Fix	Fix	Range	Fix	Range	Range	Range
Individual interest rate	Fix	Range	Fix	Range	Fix	Range	Range
Individual limit	Range	Fix	Fix	Range	Range	Fix	Range

When the reinforcement learning environment adjuster 130 is operated according to Strategy 1, it is possible to find an optimal individual limit value within a range, the value which could produce a maximum yield in a given environment. When the reinforcement learning environment adjuster 130 is operated according to Strategy 2, it is possible to find an optimal individual interest rate value within a range, the value which could produce a maximum yield in a given environment. When the reinforcement learning environment adjuster 130 is operated according to Strategy 3, it is possible to find an optimal examination criterion data value within a range, the value which could produce a maximum yield in a given environment. When the reinforcement learning environment adjuster 130 is operated according to Strategy 4, it is possible to find an optimal individual interest rate value and an optimal individual limit value within a range, the values which could produce a maximum yield in a given environment. When the reinforced learning environment adjuster 130 is operated according to Strategy 5, it is possible to find an optimal examination criterion data value and an individual limit value within a range, the values which could produce a maximum yield in a given environment. When the reinforcement learning environment adjuster 130 is operated according to Strategy 6, it is possible to find an optimal examination criterion data value and an individual interest rate value within a range, the values which could produce a maximum yield in a given environment. When the reinforcement learning environment adjuster 130 is operated according to Strategy 7, it is possible to find an optimal examination criterion data value and an individual limit value

within a range, the values which could produce a maximum yield in a given environment. That is, it is possible to find an optimal result value by repeatedly performing operations which include: operation S307 in which the reinforcement learning environment unit 110 generates status data and provides the generated status data to the reinforcement learning agent unit 120; operation S308 in which the reinforcement learning environment unit 110 generates reward data and provides the generated reward data to the reinforcement learning agent unit 120; operation S309 in which the reinforcement learning agent unit 120 provides action data to the reinforcement learning environment adjuster 130; and operation S310 in which the reinforcement learning environment adjuster 130 provides adjustment data to the reinforcement learning environment unit 110.

Meanwhile, the respective operations included in the method for examination of financial credit using reinforcement learning according to the above-described embodiments may be implemented in a computer-readable recording medium having a computer program recorded thereon, the program which includes instructions for performing the respective operations.

Meanwhile, the respective operations included in the method for examination of financial credit using reinforcement learning according to the above-described embodiments may be implemented as a computer program recorded in a computer-readable recording medium, the program which is programmed to include instructions for performing the respective operations.

The reinforcement learning environment unit 110, the reinforcement learning agent unit 120, and the reinforcement learning environment adjuster 130 may be configured by one or more processors, and the respective operations included in the method for examination of financial credit using reinforcement learning may be performed by a processor.

According to the embodiments of the present disclosure as described, examination of

financial credit by a financial institution may be operated in an optimal status by deriving financial credit examination criterion, an interest rate, or a credit limit using reinforcement learning in order to maximize a rate of change in yields or a rate of change in a yield rate according to credit management.

5 According to an embodiment, examination of financial credit by a financial institution may be operated in an optimal status by deriving financial credit examination criterion, an interest rate, or a credit limit using reinforcement learning in order to maximize a rate of change in yields or a rate of change in a yield rate according to credit management.

10 The combinations of the respective sequences of a flow diagram attached herein may be carried out by computer program instructions. The computer program instructions may be executed by the processor of a general purpose computer, a special purpose computer, or other programmable data processing apparatus, and therefore, the instructions, which are to be executed by the processor of the computer or other programmable data processing apparatus, may create means for performing functions described in the respective sequences of the
15 sequence diagram. The computer program instructions, in order to implement functions in a specific manner, may be stored in a computer-readable storage medium or a computer-useable storage medium for other programmable data processing apparatus, and therefore, the instructions stored in the computer-readable storage medium or the computer-useable storage medium may produce manufacturing items that include means for instructions to perform the
20 functions described in the respective operations of the flowchart. The computer program instructions may be loaded in a computer or other programmable data processing apparatus, and therefore, the instructions, which are a series of sequences executed in a computer or other programmable data processing apparatus to create processes executed by a computer to operate a computer or other programmable data processing apparatus, may provide operations for
25 executing functions described in the respective operations of the flowchart.

Moreover, each operation may refer to two or more modules, segments, or codes including at least one executable instruction for executing a specific logic function(s). In some alternative embodiments, it is noted that the functions described in the sequences may be run out of order. For example, two consecutive sequences may be executed simultaneously or in reverse order according to a corresponding function.

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WHAT IS CLAIMED IS:

1. An apparatus for examination of financial credit using reinforcement learning,
the apparatus comprising:

a storage configured to store a financial credit examination program; and

5 a processor configured to load the financial credit examination program from the
storage and execute the financial credit examination program,

wherein the processor is further configured to:

in an environment where first examination basis data and examination criterion
data, for examination of financial credit corresponding to total borrower, and second
10 examination basis data, individual interest rate data and individual limit data, for
examination of financial credit corresponding to each individual borrower, are
provided, generate, as status data, at least one of a credit examination approval rate
corresponding to the total borrowers, a loan amount corresponding to the total
borrowers, and an expected default rate corresponding to the each individual borrower;

15 generate, as reward data, a rate of change in yields or a rate of change in a yield
rate on credit management according to a change in at least one of the first examination
basis data for the examination of financial credit corresponding to the total borrowers,
the individual interest rate data corresponding to the each individual borrower, and the
individual limit data corresponding to the each individual borrower;

20 while executing an action based on status recognition using the status data,
generate action data that is learned so as to maximize a value of the reward data; and

adjust at least one of the examination criterion data for the examination of
financial credit corresponding to the total borrowers, the individual interest rate data
corresponding to the each individual borrower, and individual limit data the
25 corresponding to each individual borrower according to the action data.

2. The apparatus of claim 1, wherein the processor is further configured to execute the financial credit examination program to:

output a credit examination approval rate corresponding to the total borrowers, when
5 first credit examination data corresponding the each individual borrower is input to a first artificial neural network model, the first artificial neural network model having learned by inputting a first training status data set including training examination criterion data corresponding to the total borrowers, first training examination basis data corresponding to the
10 each individual borrower, training individual interest rate data corresponding to the each individual borrower, and training individual limit data corresponding to the each individual borrower, and credit examination approval rate data as first label data for the first training status dataset, and

output an expected default rate corresponding to the each individual borrower, when
15 second credit examination data corresponding to the each individual borrower is input to a second artificial neural network model, second artificial neural network model having learned by inputting a second training input dataset including second training examination basis data corresponding to the total borrowers, training delinquency rate corresponding to the total borrowers, and the first training examination basis data corresponding to each individual borrower, and default rate data as second label data for the second training input dataset..

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3. The apparatus of claim 2, wherein the processor is further configured to execute the financial credit examination program to,

output principal loss data corresponding to a total number of approvals of loan, when
25 third credit examination data the corresponding to each individual borrower is input to a third artificial neural network model, the third artificial neural network model having learned by

inputting a third training input dataset and training principal loss data according to the credit management as third label data for the third training input dataset,

wherein the third training input dataset comprises the training individual interest rate data corresponds to the each individual borrower, the training individual limit data corresponds to each individual borrower, the total number of approvals of loan corresponding to the total borrowers, and a training expected default rate corresponding to the each individual borrower.

4. The apparatus of claim 2,

wherein the training examination criterion data corresponding to the total borrowers and included in the first training input dataset comprises approval data according to an approval cut-off strategy,

wherein the first training examination basis data corresponding to the each individual borrower and included in the first training input dataset comprises data on a score calculated based on financial or non-financial data and data on a credit rating.

5. The apparatus of claim 2,

wherein the second training examination basis data corresponding to the total borrowers and included in the second training input dataset comprises macroeconomic indicator data,

wherein the first training examination basis data corresponding to each individual borrower and included in the second training input dataset comprises financial or non-financial data and data on credit a rating.

6. The apparatus of claim 3,

wherein the first credit examination data comprises the examination criterion data for

examination of financial credit corresponding to the total borrowers, the second examination basis data for examination of financial credit corresponding to the each individual borrower, the individual interest rate data corresponding to the each individual borrower, and the individual limit data corresponding to the each individual borrower,

5 wherein the second credit examination data comprises the first examination basis data for examination of financial credit corresponding to the total borrowers, the delinquency rate data corresponding to the total borrowers ,and the second examination basis data for examination of financial credit corresponding to the each individual borrower,

10 wherein the third credit examination data comprises the individual interest rate data corresponding to the each individual borrower, individual limit data corresponding to the each individual borrower, a total number of approvals of loan corresponding to the total borrowers, and an expected default rate corresponding to the each individual borrower.

15 7. The apparatus of claim 3, wherein the processor is further configured to execute the credit examination program to,

20 calculate a rate of change in yields or a rate of change in a yield rate according to the credit management based on the following: a credit examination approval rate corresponding to the total borrowers and output from the first artificial neural network model; an expected default rate corresponding to each individual borrower and output from the second artificial neural network model; principal loss data corresponding to the total number of approvals of loan and output from the third artificial neural network model; and a loan amount corresponding to the total number of approvals of loan.

25 8. A method for examination of financial credit using reinforcement learning, the method which is performed by an apparatus for examination of financial credit and which

comprises:

generating, as status data, at least one of a credit examination approval rate corresponding to the total borrowers, a loan amount corresponding to the total borrowers, and an expected default rate corresponding to each individual borrower, in an environment where
5 first examination basis data and examination criterion data, for examination of financial credit corresponding to total borrowers, and second examination basis data, individual interest rate data and individual limit data, for examination of financial credit corresponding to each individual borrower, are provided;

generating, as reward data, a rate of change in yields or a rate of change in a yield rate
10 on credit management according to a change in at least one of the first examination basis data for the examination of financial credit corresponding to the total borrowers, the individual interest rate data corresponding to the each individual borrower, and the individual limit data corresponding to the each individual borrower;

generating action data that is learned so as to maximize a value of the reward data,
15 while executing an action based on status recognition using the status data; and

adjusting at least one of the examination criterion data for the examination of financial credit corresponding to the total borrowers, the individual interest rate data corresponding to the each individual borrower, and the individual limit data corresponding to the each individual borrower, according to the action data for repeatedly performing the generating of the status
20 data, the generating of the reward data, and the generating of the action data.

9. The method of claim 8, wherein the generating the state data comprises:

outputting a credit examination approval rate corresponding to the total borrowers when first credit examination data corresponding the each individual borrower is input to a first
25 artificial neural network model, the first artificial neural network model having learned by

inputting a first training status dataset including training examination criterion data corresponding to the total borrowers, first training examination basis data corresponding to the each individual borrower, training individual interest rate data corresponding to the each individual borrower, and training individual limit data corresponding to the each individual
5 borrower, and credit examination approval rate data as first label data for the first training status dataset; and

outputting an expected default rate corresponding to each individual borrower when second credit examination data corresponding to the each individual borrower is input to a second artificial neural network model, the second artificial neural network model having
10 learned by inputting a second training input dataset including second training examination basis data corresponding to the total borrowers, training delinquency rate corresponding to the total borrowers, and the first training examination basis data corresponding to each individual borrower, and default rate data as second label data for the second training input dataset.

15 10. The method of claim 9, wherein the generating as the state data further comprises:

outputting principal loss data corresponding to a total number of approvals of loan when third credit examination data corresponding to the each individual borrower is input to a third artificial neural network model, the third artificial neural network model having learned
20 by inputting a third training input dataset and training principal loss data according to the credit management as third label data for the third training input dataset,

wherein the third training input dataset comprises the training individual interest rate data corresponds to each individual borrower, the training individual limit data corresponds to each individual borrower, the total number of approvals of loan corresponding to the total
25 borrowers, and a training expected default rate corresponding to the each individual borrower.

11. The method of claim 9,

wherein the training examination criterion data corresponding to the total borrowers and included in the first training input dataset comprises approval data according to an approval cut-off strategy,

wherein the first training examination basis data corresponding to the each individual borrower and included in the first training input dataset comprises data on a score calculated based on financial or non-financial data and data on a credit rating.

12. The method of claim 9,

wherein the second training examination basis data corresponding to the total borrowers and included in the second training input dataset comprises macroeconomic indicator data,

wherein the first training examination basis data corresponding to each individual borrower and included in the second training input dataset comprises financial or non-financial data and data on credit a rating.

13. The method of claim 10,

wherein the first credit examination data comprises the examination criterion data for examination of financial credit corresponding to the total borrowers, the second examination basis data for examination of financial credit corresponding to the each individual borrower, the individual interest rate data corresponding to the each individual borrower, and the individual limit data corresponding to the each individual borrower,

wherein the second credit examination data comprises the first examination basis data for examination of financial credit corresponding to the total borrowers, the delinquency rate

data corresponding to the total borrowers, and the second examination basis data for examination of financial credit corresponding to the each individual borrower,

wherein the third credit examination data comprises the individual interest rate data corresponding to the each individual borrower, individual limit data corresponding to thte each individual borrower, a total number of approvals of loan corresponding to the total borrowers, and an expected default rate corresponding to the each individual borrower.

14. The method of claim 10, wherein a rate of change in yields or a rate of change in a yield rate according to the credit management is calculated based on the following: a credit examination approval rate corresponding to the total borrowers and output from the first artificial neural network model; an expected default rate corresponding to each individual borrower and output from the second artificial neural network model; principal loss data corresponding to the total number of approvals of loan and output from the third artificial neural network model; and a loan amount corresponding to the total number of approvals of loan.

15. A non-transitory computer-readable storage medium including computer executable instructions, wherein the instructions, when executed by a processor, cause the processor to perform a method comprising:

generating, as status data, at least one of a credit examination approval rate corresponding to the total borrowers, a loan amount corresponding to the total borrowers, and an expected default rate corresponding to each individual borrower, in an environment where first examination basis data and examination criterion data, for examination of financial credit corresponding to total borrowers, and second examination basis data, individual interest rate data and individual limit data, for examination of financial credit corresponding to each individual borrower, are provide;

generating, as reward data, a rate of change in yields or a rate of change in a yield rate on credit management according to a change in at least one of the first examination basis data for the examination of financial credit corresponding to the total borrowers, the individual interest rate data corresponding to the each individual borrower, and the individual limit data corresponding to the each individual borrower;

generating action data that is learned so as to maximize a value of the reward data, while executing an action based on status recognition using the status data;

adjusting at least one of the examination criterion data for the examination of financial credit corresponding to the total borrowers, the individual interest rate data corresponding to the each individual borrower, and the individual limit data corresponding to the each individual borrower, according to the action data for repeatedly performing the generating of the status data, the generating of the reward data, and the generating of the action data.

16. A computer program stored in a non-transitory computer-readable storage medium and comprising computer executable instructions, wherein the instructions, when executed by a processor, cause the processor to perform a method comprising:

generating, as status data, at least one of a credit examination approval rate corresponding to the total borrowers, a loan amount corresponding to the total borrowers, and an expected default rate corresponding to each individual borrower, in an environment where first examination basis data and examination criterion data, for examination of financial credit corresponding to total borrowers, and second examination basis data, individual interest rate data and individual limit data, for examination of financial credit corresponding to each individual borrower, are provide;

generating, as reward data, a rate of change in yields or a rate of change in a yield rate on credit management according to a change in at least one of the first examination basis data

for the examination of financial credit corresponding to the total borrowers, the individual interest rate data corresponding to the each individual borrower, and the individual limit data corresponding to the each individual borrower;

generating action data that is learned so as to maximize a value of the reward data,
5 while executing an action based on status recognition using the status data;

adjusting at least one of the examination criterion data for the examination of financial credit corresponding to the total borrowers, the individual interest rate data corresponding to the each individual borrower, and the individual limit data corresponding to the each individual borrower according to the action data for repeatedly performing the generating of the status
10 data, the generating of the reward data, and the generating of the action data.