Claims

1. A system for determining a risk score for triage, comprising:

a first input device for measuring a first input parameter relating to physiological data of a patient, the first input parameter comprising a vital signs parameter;

a twelve-lead electrode electrocardiogram (ECG) device, for carrying out ~~a~~ an electrocardiography procedure on the patient, and establishing an ECG obtained from results of the electrocardiography procedure, the ECG device comprising an ECG extraction module to extract at least one ECG parameter from the ECG;

a heart rate variability (HRV) analysis module for determining a HRV analysis from the ECG, the HRV analysis comprising at least one HRV parameter; and

an ensemble-based scoring system, comprising:

a plurality of weighted classifiers for providing a risk score calculation, the plurality of weighted classifiers established based on past patient data in a database of accumulated past patient data; ~~and~~

an analysis module for receiving the first input parameter, the at least one HRV parameter, and the at least one ECG parameter which are communicated or transmitted to the ensemble-based scoring system;

a sorting module arranged to receive data from the database of accumulated past patient data, and sort the data into a plurality of data sets, each data set corresponding to a classifier, and comprising an imbalanced data set;

a sampling module arranged to receive a first imbalanced data set corresponding to a first classifier comprising a first majority data set comprising a first number of data samples, and a first minority data set comprising a second number of data samples, from the sorting module, and extract a first majority data subset comprising a third number of samples from the first majority data set, wherein the third number of samples in the first majority data subset is equal to the second number of samples in the first minority data set;

a classifier generation module for establishing the plurality of weighted classifiers based on past patient data, wherein the classifier generation module further comprises a training module arranged to receive the first majority data subset and the first minority data set from the sampling module and build a first classification model to represent the first classifier with the first majority data subset and the first minority data set;

an over-sampling module arranged to receive the first majority data subset and the first minority data set from the sampling module, and create a first synthetic data set by

applying a process of synthetic over-sampling with replacement on the first majority data subset and the first minority data set; and

a validation module arranged to validate the first classification model against the first synthetic data set, and obtain a resultant prediction accuracy of the first classification model representing the importance of the first classifier,

wherein the analysis module determines a risk score by comparing the first input parameter, the at least one HRV parameter, and the at least one ECG parameter to corresponding weighted classifiers.

2. A system for determining a risk score as claimed in claim 1, wherein the ensemble-based scoring system further comprises a data access module for obtaining past patient data and configured for data communication with the database of accumulated past patient data.

~~3. A system for determining a risk score as claimed in claim 1, wherein the ensemble-based scoring system further comprises a sorting module arranged to:~~

~~receive data from the database of accumulated past patient data; and~~

~~sort the data into a plurality of data sets, each data set corresponding to a classifier, and comprising an imbalanced data set.~~

~~4. A system for determining a risk score as claimed in claim 3, wherein the ensemble-based scoring system further comprises a sampling module arranged to:~~

~~receive a first imbalanced data set corresponding to a first classifier comprising a first majority data set comprising a first number of data samples, and a first minority data set comprising a second number of data samples, from the sorting module; and~~

~~extract a first majority data subset comprising a third number of samples from the first majority data set;~~

~~wherein the third number of samples in the first majority data subset is equal to the second number of samples in the first minority data set.~~

~~5. A system for determining a risk score as claimed in claim 4, wherein the ensemble-based scoring system further comprises a classifier generation module for establishing the plurality of weighted classifiers, based on past patient data provided by the data access module.~~

~~6. A system for determining a risk score as claimed in claim 5, wherein the classifier generation module further comprises a training module arranged to:~~

~~receive the first majority data subset and the first minority data set from the sampling module; and~~

~~build a first classification model to represent the first classifier with the first majority data subset and the first minority data set.~~

~~7.~~3. A system for determining a risk score as claimed in claim ~~6~~1, wherein the training module receives a plurality of majority data subsets and minority data sets from the sampling module; and builds classification models representing a plurality of classifiers with the received plurality of majority data subsets and minority data sets.

~~8. A system for determining a risk score as claimed in claim 4, wherein the ensemble-based system further comprises an over-sampling module arranged to:~~

~~receive the first majority data subset and the first minority data set from the sampling module; and~~

~~create a first synthetic data set by applying a process of synthetic over-sampling with replacement on the first majority data subset and the first minority data set.~~

~~9. A system for determining a risk score as claimed in claim 8, wherein the ensemble-based system further comprises a validation module arranged to:~~

~~build a first classification model with a training module based on the first majority data subset and the first minority data set corresponding to the first classifier;~~

~~validate the first classification model against the first synthetic data set; and~~

~~obtain a resultant prediction accuracy of the first classification model, representing the importance of the first classifier.~~

~~10.~~4. A system for determining a risk score as claimed in claim ~~9~~1, wherein the over-sampling module receives a plurality of majority data subsets and minority data sets from the sampling module and creates a plurality of synthetic data sets;

the training module builds a plurality of classification models representing a plurality of classifiers with the received plurality of majority data subsets and minority data sets;

the validation module validates the plurality of classification models against the plurality of synthetic data sets, and obtains a plurality of prediction accuracies of the classification models, representing the importance of each of the plurality of classifiers.

~~11.~~5. A system for determining a risk score as claimed in claim ~~10~~4, wherein the classifier generation module further comprises a weighing module for allocating each of the plurality of classifiers with a weightage according to its importance, to obtain the plurality of weighted classifiers.

~~12.~~6. A method of determining a risk score, comprising:

measuring a first input parameter relating to physiological data of a patient, the first input parameter comprising a vital signs parameter;

carrying out a twelve-lead electrocardiography procedure on the patient;

establishing a ECG from results of the electrocardiography procedure, the ECG comprising at least one ECG parameter extractable from the ECG;

extracting the at least one ECG parameter from the ECG;

determining a heart rate variability (HRV) analysis from the ECG, the HRV analysis comprising at least one HRV parameter;

providing the first input parameter, the at least one HRV parameter, and the at least one ECG parameter to an ensemble-based scoring system;

the ensemble-based scoring system comprising a plurality of weighted classifiers for providing a risk score calculation, the plurality of weighted classifiers established based on past patient data in a database of accumulated past patient data; and

determining a risk score with the ensemble-based scoring system by comparing the first input parameter, the at least one HRV parameter, and the at least one ECG parameter to corresponding weighted classifiers,

wherein the ensemble-based scoring system is configured to:

receive a first imbalanced dataset corresponding to a first classifier and sample the data samples to form a first balanced data set;

create a first synthetic data set by applying a process of synthetic over-sampling with replacement on the first balanced data set;

build a first classification model based on the first balanced data set corresponding to the first classifier;

validate the first classification model against the first synthetic data set; and

obtain a resultant prediction accuracy of the first classification model, representing the importance of the first classifier.

~~13.~~7. A method of determining a risk score as claimed in claim ~~12~~6, wherein the at least one ECG parameter is any one of a ST elevation, a T wave inversion, a Q wave, a QT interval correction (QTc), a QRS axis, a left bundle branch block (BBB), a right BBB, an IntraVentricular Conduction Delay (IVCD), a left atrial abnormality (LAA), a left ventricular hypertrophy (VH), a right VH, and an atrial fibrillation.

~~14.~~8. A method of determining a risk score as claimed in claim ~~12~~6, comprising extracting a plurality of RR intervals from the ECG and performing any one of a time domain analysis and a frequency domain analysis to obtain the at least one HRV parameter.

~~15.~~9. A method of determining a risk score as claimed in claim ~~14~~6, wherein the at least one HRV parameter is any one of an average length of the RR intervals, standard deviation of all RR intervals, a mean heart rate, a standard deviation of all instantaneous heart rate values, a NN50 count, a pNN50 percentage, a square root of mean squared differences of successive RR intervals, a HRV triangular index, a baseline width of triangular fit into a RR interval histogram, a total power, a very low frequency power, a low frequency power (LF), a high frequency power (HF), a normalized low frequency power, a normalized high frequency power, and a ratio of LF/HF.

~~16.~~10. A method of determining a risk score as claimed in claim ~~12~~6, wherein the first input parameter is any one of a heart rate, a respiratory rate, a blood pressure reading, a temperature reading, a Glasgow Coma Score (GCS), an oxygen saturation reading, and a pain score.

~~17.~~11. A method of determining a risk score as claimed in claim ~~12~~6, further comprising establishing a second input parameter relating to a medical status of the patient, providing the second input parameter to the ensemble-based scoring system, and determining the risk score by further comparing the second input parameter to a corresponding weighted classifier.

~~18.~~12. A method of determining a risk score as claimed in claim ~~17~~11, wherein the second input parameter is any one of a medical history, a drug history, a smoking history, a family history of heart disease, and a number of angina events in the past 24 hours.

~~19. A method of determining a risk score, comprising:~~

~~receiving a first imbalanced dataset corresponding to a first classifier and sampling the data samples to form a first balanced data set;~~

~~creating a first synthetic data set by applying a process of synthetic over-sampling with replacement on the first balanced data set;~~

~~building a first classification model based on the first balanced data set corresponding to the first classifier;~~

~~validating the first classification model against the first synthetic data set; and~~

~~obtaining a resultant prediction accuracy of the first classification model, representing the importance of the first classifier.~~

~~20.~~13. A method of determining a risk score as claimed in claim ~~19~~6, wherein the ensemble-based scoring system is further ~~comprising~~configured to:

~~obtaining~~ obtain a plurality of prediction accuracies relating to a plurality of classification models;

~~sorting~~ sort the plurality of classification models according to its prediction accuracy;

~~allocating~~ allocate each of the plurality of classification models with a weightage according to its importance to obtain a plurality of weighted classifiers;

~~evaluating~~ evaluate an input parameter with its corresponding weighted classifier; and

~~generating~~ generate a binary prediction output of either 0 or 1 for each evaluated weighted classifier; and

~~calculating~~ calculate the risk score based on a normalized summation of the binary prediction outputs of all evaluated weighted classifiers.