**Development Document**

**Catalogue :**



**Part One) Requirements specification**

**A . Introduction**

1 . **Preparation purpose**

The preparation of this document is to provide a basis for the project development, for the detailed understanding of the Project team members the of the needs, And provide a strong guarantee for the development work in the development process

2 . **Project Background**

The bank's main source of income is credit interest income and the revenue generated by Incidental services. Of which loans to enterprises is the larger amount of funds. Loan quality will directly related to the recovery of bank funds. However, the approval of bank lending is a very complex and onerous process. How can we a measure enterprises operating results and profitability comprehensively, it is necessary to seriously think about for banking system. As far as we know for now, in the Confirmation of line of credit and business analysis of the situation, there will be software-based standardized measure. However, in the implementation process, Many areas rely on the experience of the Account Manager and other employees. This leaves banks with greater risk of subjectivity. Therefore, our project is the establishment of a bank line of credit business credit approval system, Provide banks with a more standardized, with a broad scope of application of the credit assessment and approval system.

3 . **Reference material**

Thinking in Java ;

Eclipse Core Programming
MYSQL Database
Software document writing guide
etc.

**B. Task Overview**

1 . **Aim**

The system is mainly to achieve business rating, When users use the system, they can import the company's financial indicators excel format document and the volume of data entry, the system can persist the data, to facilitate future inquiries. Users can use financial indicators for quantitative analysis of corporate data, This part deals with neural network algorithm; also Can carry on a series of objective evaluation of business, with the use of fuzzy expert system algorithm, to conduct qualitative analysis

2 . **Operating Environment**

Hardware environment:

CPU： Pentium(R)4 more than 2.60GHZ
Physics memory： more than 512MB
Hard disk free space :100MB or more
development environment
OS:windows 7
Eclipse 3.6
Java 1.6x
Network environment: No requirements

### C. Data Description

1. Corporate financial statement data from the excel xlsx format files, One-time import
2. Average business data, such as business name, location and other information, as well as qualitative evaluation of information entered manually
3. Data collection: Corporate provide financial statements information
4. When Enter company name or code , the user can query the information the enterprise has entered.

### D. Performance Requirements

1 . Time characteristics

Short response time, timely data processing, the rapid run-time

2 . Suitability

Nothing to do with the operating system, independent of machine type and operating environment and can be used in complex system integration

## Part Two) System design and process description

### 1. Introduction

The system design specifications is to help the reader understand the system design and development summary.

### 1.1 Expected Readers

Readers may include:

- Users
- Developer
- Testers
- Documentation writers
- Etc.

### 2 . Design Overview

### 2.1 . Requirements Overview

Users input corporate financial statements, corporate average data, then carry on quantitative and qualitative analysis, and then come to corporate ratings.

### 2.2 . Two Main Parts :

According to requirements, our system is divided into two parts: qualitative and quantitative analysis

#### 2.2.1 Qualitative analysis

In order to quantify the qualitative part of the evaluation of companies, we design qualitative assessment business scoring system based on a fuzzy expert system

##### 2.2.1.1 Fuzzy expert system Introduction

We usually used common sense to solve the problem, but also vague and ambiguous language. Fuzzy logic does not mean that logic itself is ambiguous, but rather used to describe the fuzzy logic

Fuzzy expert system algorithms generally process

（1） Fuzzify Inputs

（2） Apply Implication Method

（3） Aggregate All Outputs

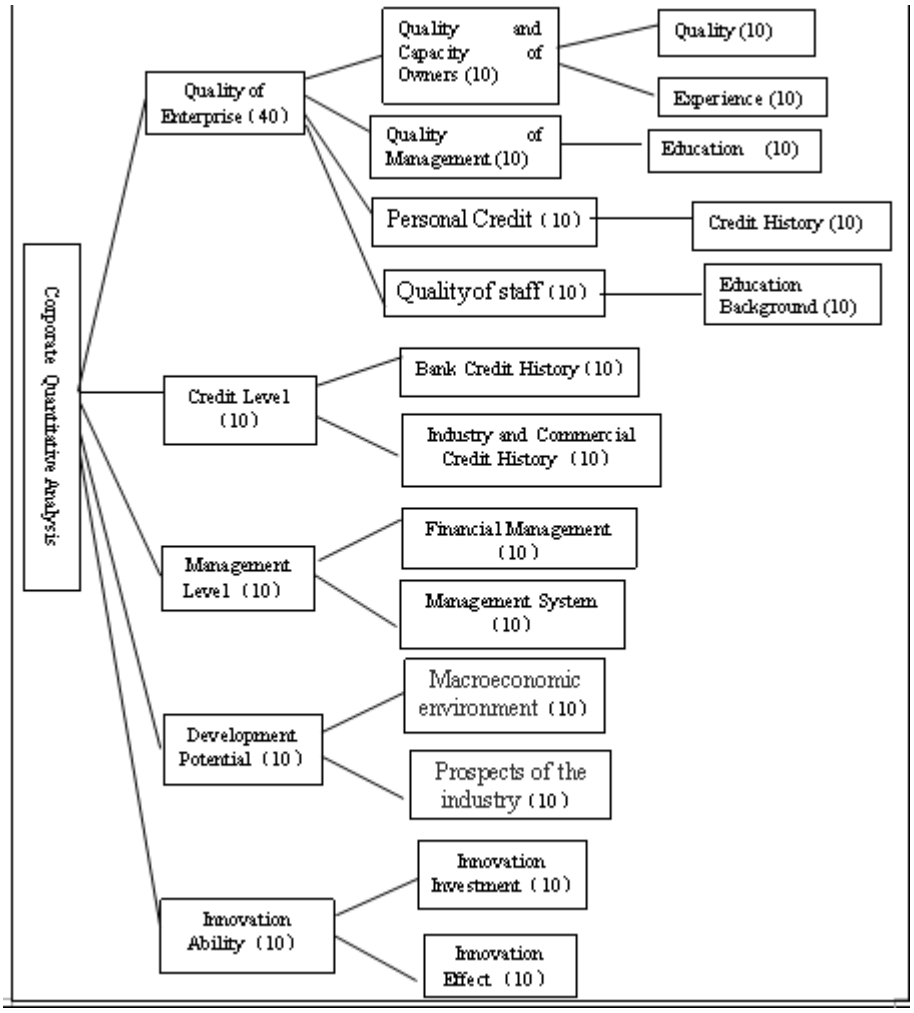
（4） Dfuzzifiy

##### 2.2.1.2 Qualitative analysis framework design

We design a qualitative rating system for companys based on the fuzzy expert system. The inputs of the system can be classified into five aspects: quality of enterprise, credit level, management level, development potential and innovation ability. Among them, each classification has different subproblem. The logic framework can be shown like the following:

Flow chart following:

:




### 2.2.1.3 The design process of Qualitative analysis

When using the software, the users can grade the inputs (0-10 points) according to the standard and other understanding of the company from other materials. After internal arithmetic of the system, the grades of the five aspects will appear. And the points for quality of enterprise ,credit level, management level, development potential and innovation ability is 40,10,10,10, respectively. And the total points of qualitative evaluation is 80, which will be converted to 30 in the total rating report.

The core algorithm in the qualitative part is Fuzzy Expert System, which is realized by combining the fuzzification of the problem and the traditional expert system. The traditional Expert System is mainly based on the knowledge acquisition, which under the most cases is obtained by experts' experience. Because of the fuzzification concept in human thinking system, it is more reasonable to optimize the expert system by fuzzifying the problem.

Different from the traditional Expert System, the rules in the Fuzzy Expert System can be activated to different degrees. In other words, the degree of the respond is determined by the credibility of each rule. If more than one rule are activated, then the result is determined by the combination of the rules. Thereafter, the Fuzzy Expert

System can be easily understood because of its consistence with the human thinking.

In the example of the 'manager's capabilities', the internal functioning can be attributed to the following steps:

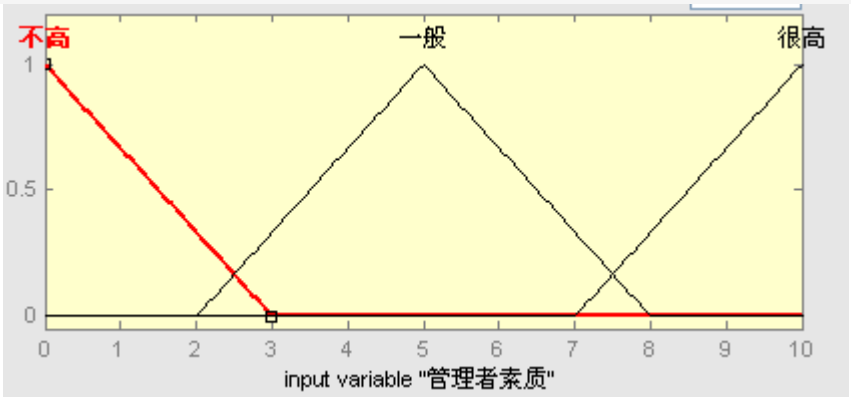
**Step1: Set the inputs and outputs:**

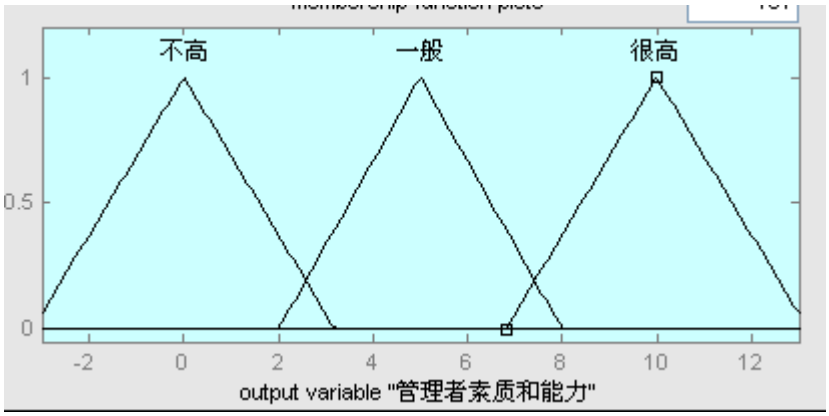
(1) Set inputs

First of all, we divide the input "manager's quality" into three levels, which is low, average and high. Its description and score can be seen in the appendix. Also, the input "manager's experience " and the output "manager's capability" can be dealt with in the same way.

(2) Determine the output level of description

Classify Quality and capacity of the managers three grades: not high, normal, high. Corresponding to 0-10 of the system output.




**Step2: Set membership function:**

The grade of membership function illustrates the degree of the input score belong to different levels mentioned in the first step. For example, if the input score of "manager's quality" is 2.5, then its contribution to the three levels can be quantize as (0.35, 0.25, 0). In the system, we apply the triangle-shaped function as our grade of membership function.

**Step3: Set rules of Expert System**

Set rules as followed:

If "manager's quality" is low or "manager's experience " is insufficient, then "manager's capability" is in low level.

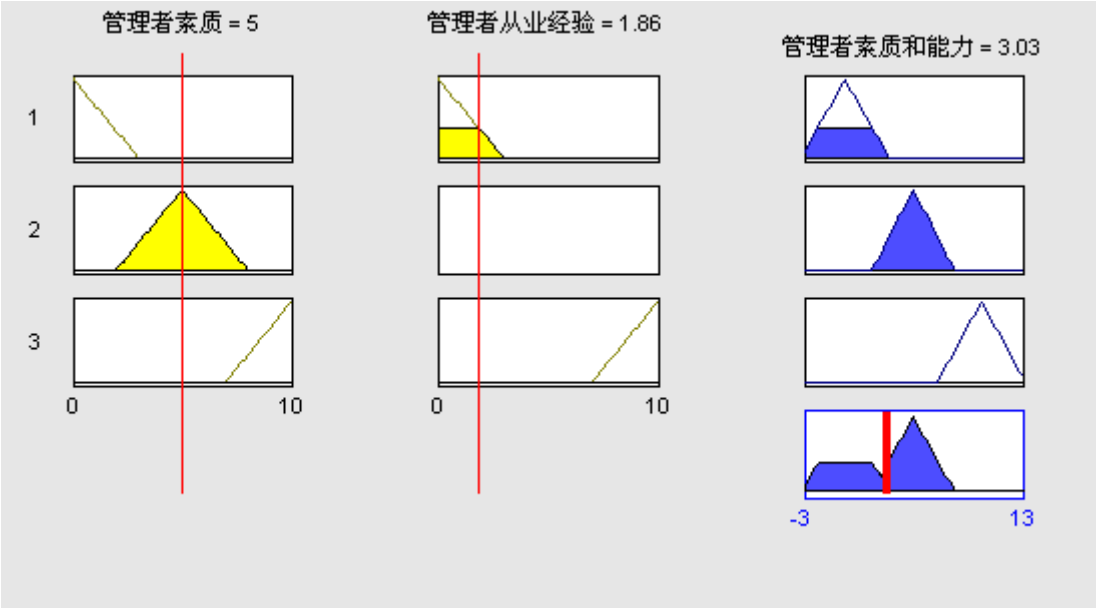
If "manager's quality" is average, then "manager's capability" is in middle level.

If "manager's quality" is high or "manager's experience " is sufficient, then "manager's capability" is in high level.

## Step4: Defuzzify outputs

After the fuzzification of the inputs and application of the rules, we may get more than one result because of different rules. The integration of these results to one single output is called "Defuzzification".

For example, if the input score is 4, we can obtain that its contribution to the evaluation "manager's quality is average" is 0.5. And then, we search in the knowledge base to find that the rule two can be applied by the input. Then we use the function "y=0.5" to cut the grade of membership function, which is used to describe the evaluation "manager's capability is in middle level", and so we can get a trapezoidal area. And if different rules are applied, then we can get more than one area. In that case, we can aggregate them by using the "maximum" method, which is to apply the greatest result as the output. Last but not the least, we use the "centroid" method to get the final output, which returns the center of area under the curve. The process can be illustrated in the following picture:




(Note: the left column for input, and the right side is the output. The output of a blue closed graph in the lowest position on the right takes the maximum income, while the intersection of the red thick thread and the abscissa, for the closed graph of the center of gravity in the horizontal coordinates of the projection, that is, the output value. Due to the limitation of the neo-

confucianism while output rules, output are from -3 to 13, and after operation, the real output of the range is 0 to 10, in line with the application background.)

### 2.2.1.4. Score standard instructions

| Score standard instructions | | |
|---|---|---|
| Quality and capacity of managers | Quality of managers | 0-3 Quality of managers is not high：Managers have evasive style of conversation，not talking clearly When turning to development goals and strategic direction of the company<br>3-7 Quality of managers is average：Managers have relatively honest style of conversation ，talking relatively clearly When turning to development goals and strategic direction of the company<br>7-10 Quality of managers is high：Managers have honest style of conversation，talking very clearly When turning to development goals and strategic direction of the company |
| | Management experience | 0-3 0-2 years management experience<br>3-7 3-6 years management experience<br>7-10 More than 7 years management experience |
| Quality of management layer | Education background of management layer | 0-3 Average Education background of management layer is in high school and below;<br>3-7 Average Education background of management layer is in undergraduate<br>7-10 Average Education background of management layer is in Master and above |
| Personal credit | Personal credit history | 0-3 Have an adverse credit record over the past<br>3-7 No adverse credit record, but there are loans not repaid<br>7-10 No adverse credit record, No loans for now. |
| Quality | Education | 0-3 Average Education background of staff is in Junior |

| | | |
|---|---|---|
| of staff | background of staff | secondary and below<br>3-7 Average Education background of staff is in high school<br>7-10 Average Education background of staff is in University and above |
| credit level | Bank credit history | 0-3 Bad bank credit history: Have an adverse credit record in the past<br>3-7 average bank credit history : No adverse bank credit record, but there are loans not repaid<br>7-10 Good bank credit history : No adverse credit record, No loans for now |
| | Industrial and commercial credit history | 0-3 Bad industrial and commercial credit history : Have an adverse credit record in the past<br>3-7 average industrial and commercial credit history : No adverse bank credit record, but there are loans not repaid<br>7-10 Good industrial and commercial credit history : No adverse credit record, No loans for now |
| management level | Financial Management | 0-3 Low level of Financial Management : Poor financial management, management is not standardized<br>3-7 average level of Financial Management : average financial management, management is relatively standardized<br>7-10 High level of Financial Management : Good financial management, management is highly standardized |
| | Management system | 0-3 Management system is not perfect , no complete company charter , no value of the company and other concepts<br>3-7 average management system , the company charter is of average clarity , company values and other concepts are implemented by employees in a average degree<br>7-10 Management system is perfect, articles of association is very clear, the company values and other concepts are well implemented by the employees |
| development potential | Macroeconomic environment | 0-3 Macroeconomic environment is not good , poor bank liquidity, tight lending policies<br>3-7 average macroeconomic environment, average the bank liquidity, more relaxed lending policies<br>7-10 Good macroeconomic environment, high the |

| | | |
|---|---|---|
| | | bank liquidity, very loose lending policies |
| | Prospects of the industry development | 0-3 Bad prospects for development of the industry, pressed by macroeconomic policies of the state or the market is already very saturated or in a sunset industry<br>3-7 Better prospects for development of the industry, supported by national policy or the development of the market is in a period of rising<br>7-10 Good prospects for development of the industry, greatly supported by national policy or the market is in a developing stage |
| innovation level | Innovation investment | 0-3 Innovation investment is small relative to the industry average<br>3-7 Innovation investment is average relative to the industry average<br>7-10 Innovation investment is large relative to the industry average |
| | Innovation effect | 0-3 Ineffective, did not meet predetermined sales targets<br>3-7 average , meet predetermined sales targets, but the cost-income ratio increased<br>7-10 Good effect , Achieve the sales targets and the cost-income ratio has not increased |

#### 2.2.1.5 The rules of Qualitative analysis within the system

**A quality of enterprise**

**1. Quality and capacity of managers**

Input1 Quality of managers （0-10）

Input 2 Management experience （0-10）

If Quality of managers is not high or Little management experience
then Quality and capacity of managers is low
If Quality of managers is average then Quality and capacity of managers is average
If Quality of managers is high or abundant management experience
then Quality and capacity of managers is very high

**2. Quality of management layer**

Input1 Education background of management layer （0-10）

If Education background of management layer is not high then Quality of management layer is not high
If Education background of management layer is average then Quality of management layer is average
If Education background of management layer is high then Quality of management layer is high.

### 3. Personal credit

Input1 Personal credit history （0-10）

If bad personal credit history then Low personal credit
If average personal credit history then average personal credit
If good personal credit history then High personal credit

### 4. Quality of staff

Input1 Quality of staff （0-10）

If educational attainment of staff is low then Quality of staff is low
If educational attainment of staff is average then Quality of staff is average
If educational attainment of staff is high then Quality of staff is high

**B credit level**

Input1: Bank credit history （0-10）
Input 2: Industrial and commercial credit history （0-10）
If Bad Bank credit history or bad Industrial and commercial credit history then bad credit level
If average Bank credit history then average credit level
If Good Bank credit history or good Industrial and commercial credit history then good credit level

**C management level**

Input 2 Financial Management （0-10）
Input 3 Management system （0-10）
If Low level of Financial Management or Management system is not perfect then low management level
If average level of Financial Management then average management level
If High level of Financial Management or Management system is perfect then High management level

**D management potential**

Input1 Macroeconomic environment （0-10）
Input2 Prospects of the industry development （0-10）

If No-good Macroeconomic environment or Bad prospects for development of the industry then Little management potential
If average Macroeconomic environment then average management potential
If good Macroeconomic environment or good prospects for development of the industry then Large management potential

**E innovation ability**
Input1 Innovation investment
Input2 Innovation effect
If Innovation investment is small or Ineffective then Weak innovation ability
If Innovation investment is average then average innovation ability
If Innovation investment is large or Good effect then Strong innovation ability

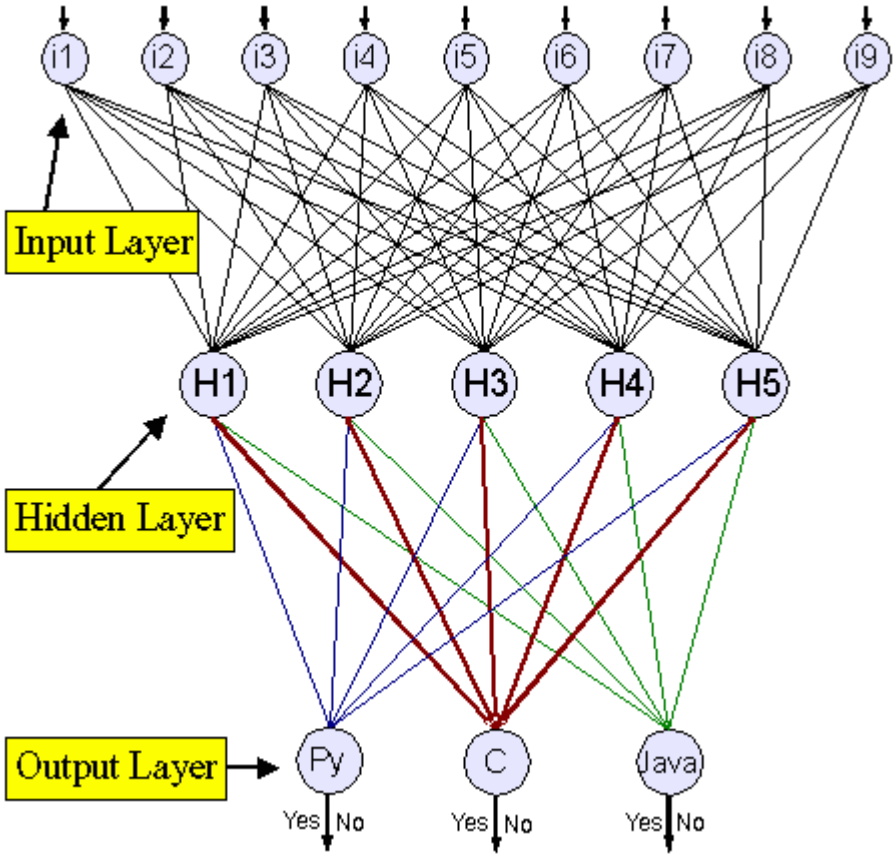
### 2.2.1 Quantitative analysis

Quantitative analysis uses neural network simulating the human brain thinking, to score the test company.

#### 2.2.2.1 BP neural networks Introduction

Neural network is an mathematical models of information processing , the application of which is similar to the structure of the Brain synaptic. It consists of a large number of nodes (neurons) and connections between them. Each node represents a specific output function, called activation function. Each connection between two nodes represents weights which go through the signal connection: the neural network memory. Output of the network varies by network connection, the weights and activation function

Neural networks are averagely divided into three layers: Input layer, hidden layer, output layer, each layer has a different number of neurons




neural network Is a system which can learn, the can do summary, Through the use of known experimental data to learn and summarize. Learning process: through the correction of training sample, the correction (learning) of the weight of each layer and model building process, known as the automatic learning process

#### 2.2.2.2 Quantitative analysis program design and analysis

We design business auto-quantitative score function based on BP neural network

1) neural network hierarchy

   By the previous knowledge, our neural network is three-tier structure, as follows: the input layer, hidden layer and output layer.

2) Neural network performance function

   The system uses the BP neural network with additional momentum, Network transfer function uses logsig function (with threshold): logsig(n,x) = 1 / (1 + exp(-n+x))  x is the threshold. Other Functions can be referenced from mainstream BP neural network.

Neural network parameters

Neural network algorithm itself has the following parameters can be adjusted

| Parameter Name | Parameter Meaning | Parameter Values |
|---|---|---|
| Neural network layer | Input layer, hidden layer, output layer | 3 |
| The number of Neurons in Input Layer | number of variables entered | 20 |
| The number of Neurons in hidden layer | the channel number between Input layer, output layer | 15 |
| The number of Neurons in output layer | The number of system output variables | 1 |
| Learning rate | The greater learning rate , the greater network weights and threshold adjustment, but stability will reduce | 0.9 |
| Momentum factor | to avoid local minimum problems arise in Algorithm | 0.5 |
| Error accuracy | requires of expected results and actual results of error when Training algorithm | 0.01 |
| Maximum number of cycles | Adjust the weight once when training Algorithm counts a cycle. | 2000 |

### 2.2.2.3 Quantitative analysis of data samples

Quantitative analysis has two parts: training samples, test samples

**1) Training samples**

Training sample consist of different enterprises data analysis. the sample size of the program is 16 companies records. Each business record consists 20 ratings indicators and 1 business score. 20 indicators for the input of the Input Layer, 1 score for the desired output of the Output. Index information as follows

| 20 indicators name | Indicators score formula | Excellent A | Good B | Average C | Lower D | Bad E |
|---|---|---|---|---|---|---|
| All capitalization ratio(%) | (short-term borrowing + a maturity of non-current liabilities and | 7.6 | 12.62 | 28.77 | 47.47 | 63.09 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | long-term loans + bonds payable) / (short-term borrowing + a maturity of non-current liabilities and long-term loans + bonds payable + total owners' rights and interests (or shareholders' equity)) | | | | | |
| Has been interest multiples | (net profit + + income tax+ depreciation of fixed assets, oil and gas assets depletion, productive biological assets depreciation + long-term deferred expenses amortize + financial expenses) / financial expenses | 23.55 | 14.15 | 6.57 | 2.83 | 1.62 |
| Quick Ratio(%) | ((current assets-inventory) / current liabilities) * 100% | 290.87 | 218.5 | 129.2 | 74.91 | 41.17 |
| Net cash Flows from Operating /total debt | Cash Flows from Operating /total liabilities * 100% | 0.71 | 0.45 | 0.12 | 0.01 | -0.12 |
| asset-liability ratio | (total liability/total assets)*100% | 13.88 | 23.02 | 41.62 | 63.92 | 78.85 |
| Liquidity ratio | ( Current Assets/current liability)*100% | 309.09 | 237.9 | 155.2 | 90.17 | 53.62 |
| The total debt/EBITDA | total liabilities /(net profit + income tax+ depreciation of fixed assets, oil and gas assets depletion, productive biological assets depreciation + long-term deferred | 1.29 | 2.84 | 6.78 | 13.66 | 21.06 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | expenses amortize + financial expenses) | | | | | |
| ROA | (total profit + financial expenses) / [(total assets early + total assets at the end of the period) / 2] * 100% | 24.53 | 16.69 | 7.52 | 2.27 | -0.01 |
| Cash inflows from operating activities / sales revenue | net cash flow from operating activities / operating income * 100% | 1.73 | 1.43 | 1.17 | 0.99 | 0.59 |
| The ratio of profits to cost | (total profit / (business cost + sales charge +management cost +financial cost)) * 100% | 46.15 | 29.52 | 14.15 | 4.27 | 0.29 |
| ROE | net profit / [(owner's equity at the beginning + owner's equity in the end of the year) / 2] * 100% | 41.7 | 22.57 | 9.87 | 1.64 | -0.28 |
| Sales profit margin | operating profit/operating income * 100% | 57.11 | 43.54 | 25.35 | 12.73 | 6.5 |
| Inventory turnover | business cost / [(beginning inventory+year-end inventory) / 2] * 100% | 13.62 | 8.64 | 3.83 | 1.15 | 0.53 |
| Accounts receivable turnover | operating income / [(early accounts receivable + accounts receivable at the end of the period) / 2] * 100% | 23.14 | 14.97 | 6.71 | 2.59 | 1.13 |
| Total asset turnover | operating income / [(total assets early +total assets at the end of the period) / | 2.21 | 1.35 | 0.57 | 0.19 | 0.08 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 2] * 100% | | | | | |
| Current assets turnover | operating income / [(total current assets at the beginning + total current assets at the end of the period) / 2] * 100% | 4.67 | 2.56 | 1.19 | 0.45 | 0.19 |
| Total assets growth rate | [(number of year-end total assets - total assets at beginning of the year) / owners' equity at beginning of the year] * 100% | 29.64 | 22.57 | 8.78 | -1.8 | -12.43 |
| Three-year average profit growth rate | [(total profits of the end - the end of three years ago, the total profit) ^ (1 / 3) -1] * 100% | 31.36 | 20.83 | 2.93 | -12.45 | -32.81 |
| Sales growth rate | (operating income this year - operating income prior year) / operating income prior year * 100% | 40.68 | 27.32 | 7.55 | -7.92 | -25.11 |
| Capital accumulation rate | [(The owners' equity at the end of the period- Owners' equity for early) / Owners' equity for early] * 100% | 29.16 | 20.05 | 8.26 | -1.39 | -11.13 |

Form excellent value A, good B, average C, low average D, to poor value E ,five values, according to the formula 2B-A, 2C-B, 3D-C, 3E-D, can be calculated by the four values X1 X2 X3, X4,that can be divided into 5 real interval. The 20 index scores will be compared with the five interval respectively, giving points by grade1, 2, 3, 4, and 5. And the software will eventually plus the 20 scores together and get the enterprise expected score between 0-100 interval.
Specific training sample data stored in a database.

**2) Test samples**

Types of Test samples is the same as those of training samples. Actually, when using this system, there is no result which enterprises are expected to, only the actual program results. test samples are composed of 16 Data.

**3) Training samples, test sample size analysis**

In Quantitative analysis of the system , training sample and test sample consists of 16 records each. According to the requirements of the actual artificial intelligence and machine learning area, the size of Training samples, test sample is relatively small, there will be some error in the results of the training algorithm. We have taken this into consideration in the development process, and there are two solutions:

1. Expand the size of the sample data: However, for a student team ,corporate credit data is difficult to obtain. With great effort , we get 32 authority, true, reliable, enterprise-proven data. Therefore, this solution is not practicable. But for companies such as Citibank, they have their own database, therefore, this solution can be adopted to complete the program, and get good algorithm results.
2. Adjust the weight of algorithm: By adjusting the weight of algorithm, although not completely compensate for the error caused by the small-size sample, but to some extent, errors can be reduced in order to improve accuracy of the program. In the development process, by adopting this solution, the final error of the algorithm is 5% -10%, and the results of the algorithm has a high reference value.

**Part Three）：Description of the system implementation**

1 Technical framework to achieve the program

**1.1Database**

Database uses MYSQL. It is primarily used to store business-related external data, such as financial statements, to facilitate the program calls.

**1.2Core code**

Written in Java, taking object-oriented feature of Java into account mainly. In addition, the neural network need to be addressed in parallel and multi-threading, and Java can achieve better multi-threaded programming

**1.3Ghaphical interface development**

Adopt SWT / JFACE to develop graphical interface, mainly on account of SWT’s use of operating system graphical elements API, and SWT run faster than swing.

**1.4Simulation tests**

Matlab is adopted in training and testing of neural networks and fuzzy expert system. Matlab provides a neural network and fuzzy expert system-related approach , which can be more convenient to call for training and testing data


2 Interface interaction design

**2.1The main interface**

**2.2 The interface of Qualitative analysis**

| First-Level indicators | Second-Level indicators | Third-Level indicators | Score（0-10） |
|---|---|---|---|
| quality of enterprise | Quality and capacity of managers | Quality of managers | |
| | | Management experience | |
| | Quality of management layer | Education background of management layer | |
| | Personal credit | Personal credit history | |
| | Quality of staff | Education background of staff | |
| credit level | Bank credit history | Bank credit history | |
| | Industrial and commercial credit history | Industrial and commercial credit history | |
| management level | Financial Management | Financial Management | |
| | Management system | Management system | |
| development potential | Macroeconomic environment | Macroeconomic environment | |
| | Prospects of the industry development | Prospects of the industry development | |
| innovation level | Innovation investment | Innovation investment | |
| | Innovation effect | Innovation effect | |

There is an OK button on the interface of Qualitative analysis, click OK, the scores of the indicators appear.

| First-Level indicators | Score |
|---|---|
| quality of enterprise | |
| credit level | |
| management level | |
| development potential | |
| innovation level | |

| | |
|---|---|
| Qualitative score | |

### 2.3 The interface of Quantitative analysis

the indicators scores of Quantitative analysis list:

| No. | Indicators portfolio | Indicators Name | Score |
|---|---|---|---|
| 1 | Debt paying ability | asset-liability ratio (%) | |
| 2 | | Has been interest multiples | |
| 3 | | Quick Ratio (%) | |
| 4 | | Net cash Flows from Operating /total debt | |
| 5 | | asset-liability ratio (%) | |
| 6 | | Liquidity ratio (%) | |
| 7 | | The total debt/EBITDA | |
| 8 | Financial benefit | ROA (%) | |
| 9 | | Cash inflows from operating activities / sales revenue | |
| 10 | | The ratio of profits to cost (%) | |
| 11 | | ROE (%) | |
| 12 | | Sales profit margins (%) | |
| 13 | Capital operation | Inventory turnover (times) | |
| 14 | | Accounts receivable turnover (times) | |
| 15 | | Total asset turnover (times) | |
| 16 | | Current assets turnover (times) | |
| 17 | Capacity development: | Total assets growth rate (%) | |
| 18 | | Three-year average profit growth rate (%) | |
| 19 | | Sales growth rate (%) | |
| 20 | | Capital accumulation rate (%) | |

There is an OK button on the interface of Quantitative analysis, click OK, the system's internal operation is inputting the 20 indicators into neural networks, neural network can then get a total score

| | | |
|---|---|---|
| total score | Quantitative total score | |