2018 Citi Financial Innovation Application Competition

Special Plan Simulation Process Report

Title ： Li Jin--A REITs platform for securitization of housing lease assets

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1. Part I: Introduction

1.1 Writing Purposes

The special planning process simulation report is the expected reappearance of the specific functions of the platforms after the project development. The purpose of special planning process simulation is to test the dynamic risk assessment function developed on the basis of large data technology, and also to check whether the machine learning model and a series of financial models designed on the platform can operate normally according to the expected process, and whether the Citi API is perfect or not. Enterprise access, risk assessment and control, and REITs fund valuation, customer information acquisition and a series of processes.

1.2 Background

This platform is a comprehensive service platform devoted to broadening the financing channels of domestic housing rental enterprises, enriching and improving the real estate value chain, and providing individual investors with a new way to invest in the real estate market. The platform connects the enterprise at one end and the investor at the other end. It provides both high quality and low cost financing for the enterprise and low-risk and high-yield investment projects for the investors by means of private equity fund and special plan.

The platform has two ports, one backstage and two ports, which connect the enterprises applying for REITs projects and the investors investing in REITs funds. The platform consists of four parts, namely enterprise audit, risk assessment and control, the establishment of REITs special plans and transfer of funds. After receiving the financial data submitted by the enterprise, the SPV side examines the financing

qualification of the enterprise through machine learning, then calculates the enterprise risk index by using the revised Z-score model, the improved KMV model and the "crawler" technology to capture the real-time information of the enterprise, and then calculates the enterprise risk index through the revised REITs valuation model. The scale of fund issuance is estimated.

2. Second Part: Financial Theory Background

2.1 Revised Score Model

The Z-score model was first proposed by Altman in the 1960s, and its analysis objects are bankrupt and non-bankrupt enterprises in the United States. However, in China, because of the different economic systems, bankruptcy is not equal to shutdown, so the Z-score model is more suitable for judging the existence of financial crisis in enterprises. In addition, many Chinese scholars have done a lot of research and Analysis on the applicability of Z-score model in China, and found that the Z-score model of different industries has significant differences, and over time, the financial indicators used to quantify risk should also be revised. The purpose of this module is to quantify the financial risk of real estate enterprises in China, so it is necessary to revise the Z-score model.

2.2 Improved KMV Model

KMV model has become one of the most popular risk management models in international finance because of its many advantages. Firstly, KMV can make full use of the information in the capital market to quantify and analyze the credit risk of all publicly listed companies. Secondly, because the data obtained by the model come from the stock market, it can reflect the current credit situation of enterprises in real time, and has a forward-looking, stronger predictive ability, and more effective. In addition, KMV model is based on contemporary corporate finance theory and option theory, and

has a strong theoretical basis. Therefore, we use the KMV model to predict the default risk of individual enterprises.

2.3 REITs Valuation Model - Operating Cash Flow Discount Method

The cash flow discount method is evolved from the cash flow discount method. The valuation method is to set up a financial model for the operating cash flow generated by the property, add up the cash flow of the subsequent periods and forecast the estimated amount of the final value of the property.

The formula is as follows：

$$V = \sum_{i=1}^{n} \frac{FFO_i}{(1+r)^i}$$

$$WACC \equiv KD \times \frac{TD}{V} + KE \times \frac{E}{V} \times (1 - T_C)$$

Net income = all income (including capital gains) - operating expenses - depreciation - amortization - interest expenses - general overhead

FFO= Net income - capital gains + depreciation of real estate in real estate sales

Among them, FFO_i is the operating cash flow of the first year; R is the discount rate, generally expressed in WACC; KD is the cost of debt capital; KE is the cost of equity capital; V is the total cost; TD is the total amount of debt capital; E is the total amount of equity capital, T C is the tax rate, generally taking the enterprise income tax rate.

This method is very reasonable in theory, and the research results also show that the correlation coefficient between the price index and rent index of American equity REITs has reached 0.72 in the past 20 years. It is not difficult for a financial normative REITs company to make FFO predictions because the predictions are based on existing financial data and are highly reliable. But discounting FFO in this way

exaggerates the value to a certain extent, because investors do not receive all future FFOs as early as it implies. Investors receive only REITs'cash dividends, and the remaining FFOs are retained to promote future growth. Because in reality debt interest rates are usually lower than yields, REITs can easily "buy" FFO growth by raising debt ratios, especially low-cost variable-rate debt, which makes REITs overvalued.

3. Third Part: Simulation Process

3.1 Enterprise Side Process

3.1.1 Simulation Process

We have adopted 13 indicators，Machine learning is done according to the earnings data of 57 companies.

```
A = xlsread('D:\pingji.xlsx');
n=13;
for i=1:n
     A(i,:)=(A(i,:)-min(A(i,:)))/(max(A(i,:))-min(A(i,:)));
end
A=A';    %%%取转置矩阵
AA=A([1:1:30],:)';
net=newsom(minmax(AA),[1 3]);

a=[1000 2000 3000 4000 5000 6000];
for i=1:6
    net.trainParam.epochs=a(i);
    net=train(net,AA);
    y=sim(net,AA);
    yc=vec2ind(y);
end

pt=AA;
C=yc;
T=ind2vec(C);
n1=1;
n2=1;n3=1;n4=1;
n5=1;n6=1;n7=1;
n8=1;n9=1;n10=1;
n11=1;n12=1;n13=1;
a1=[];a2=[];a3=[];
a4=[];a5=[];a6=[];
```

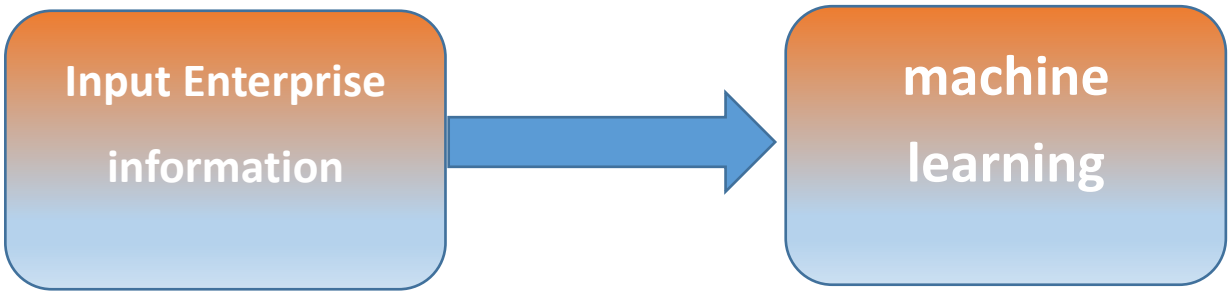
```
    if C(i)==7
        a7(n7)=i;
        n7=n7+1;
    end
    if C(i)==8
        a8(n8)=i;
        n8=n8+1;
    end
    if C(i)==9
        a9(n9)=i;
        n9=n9+1;
    end
    if C(i)==10
        a10(n10)=i;
        n10=n10+1;
    end
    if C(i)==11
        a11(n11)=i;
        n11=n11+1;
    end
    if C(i)==12
        a12(n12)=i;
        n12=n12+1;
    end
    if C(i)==13
        a13(n13)=i;
        n13=n13+1;
```

After reading the data from 57 companies, machine learning is done with SOM，Then we use LVQ to further credit rating.

```
    Pt=PP;
    C=yc;
    T=ind2vec(C);
    n1=1;
    n2=1;n3=1;n4=1;

    a1=[];a2=[];a3=[];
    a4=[];
    for i=1:57
        if C(i)==1
            a1(n1)=i;
            n1=n1+1;
        end
        if C(i)==2
            a2(n2)=i;
            n2=n2+1;
        end
        if C(i)==3
            a3(n3)=i;
            n3=n3+1;
        end
        if C(i)==4
            a4(n4)=i;
            n4=n4+1;
        end
    end
    B=[(n1-1);(n2-1);(n3-1);(n4-1)]'/57;

    lvqnet=newlvq(minmax(Pt),4,B);
    lvqnet.IW{1,1}=net.IW{1,1};
    a=[20 40 60 80 100];
    for i=1:5
        lvqnet.trainParam.epochs=a(i);
        lvqnet=train(lvqnet,Pt,T);
        yy=sim(lvqnet,Pt);
        C=vec2ind(yy);
    end


```

If we reach the credit standard, we will enter the next process; if we fail to meet the standards, we will conduct offline audits.

3.1.2 Flow Chart



3.2 Backend Process

3.2.1 Simulation Process

When the information of the enterprise side is transmitted, the following processes are carried out:

1、Call the KMV algorithm to calculate the risk value based on the incoming data.

```
function F=KMVfun(EtoD, r, T, EquityTheta, x)
d1=(log(x(1)*EtoD)+(r+0.5*x(2)^2)*T)/(x(2)*sqrt(T));
d2=d1-x(2)*sqrt(T);
F=[x(1)*normcdf(d1)-exp(-r*T)*normcdf(d2)/EtoD-1;
   normcdf(d1)*x(1)*x(2)-EquityTheta];
end
```

```
function [Va, AssetTheta]=KMVOptSearch(E, D, r, T, EquityTheta)
EtoD=E/D;
x0=[1, 1];
VaThetaX=fsolve(@(x)KMVfun(EtoD, r, T, EquityTheta, x), x0);
Va=VaThetaX(1)*E;
AssetTheta=VaThetaX(2);

end
```

```
r=0.03551;
T=1 ;
SD=31800014304.2900;%流动负债
LD=18189406581.0500;%长期负债
DP=1.108*SD+1.126*LD;%修正后DP
D=DP;
PriceTheta=0.074676757;%日波动率
EquityTheta=0.074676757*sqrt(252);%年化波动率
E=4150345758.1967;%总市值均值
[Va,AssetTheta]=KMVOptSearch(E,D,r,T,EquityTheta);
DD=(Va-DP)/(Va*AssetTheta); %计算违约距离
EDF=normcdf(-DD); %计算违约率
```

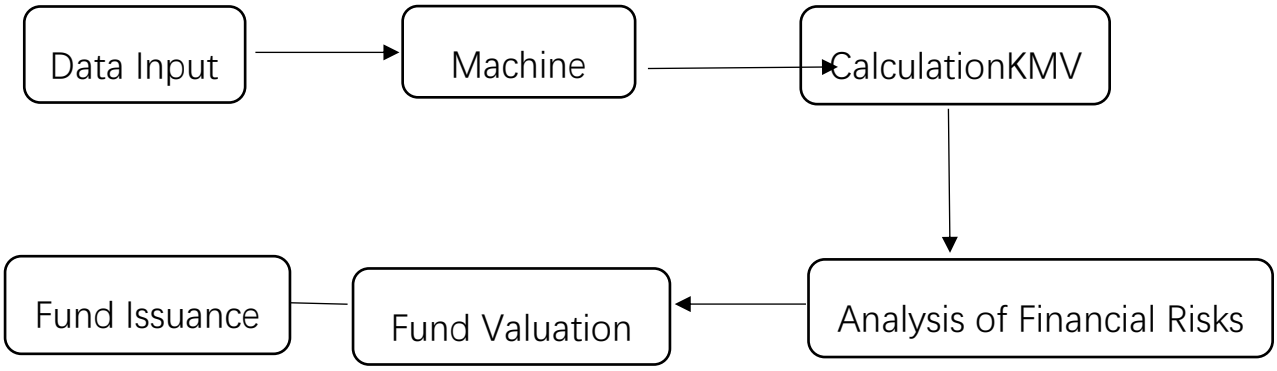
2、Calculate the Z value and analyze the financial situation:

```
package com.Servlet;

import java.io.IOException;
import javax.servlet.ServletException;
import javax.servlet.annotation.WebServlet;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;

@WebServlet("/listZscoreServlet")
public class ListZscoreServlet extends HttpServlet {
    private static final long serialVersionUID = 1L;

    private double x;
    private double y;
    private double z;

    protected void doGet(HttpServletRequest request, HttpServletResponse response) throws ServletException, IOExceptio
        // TODO Auto-generated method stub

        x=(double) request.getAttribute("A");
        y=(double) request.getAttribute("B");
        z=(double) request.getAttribute("C");

        request.setAttribute("zscore",zs(x,y,z) );
        request.getRequestDispatcher("zscore.jsp");

    }

    public  String zs(double a, double b,double c) {
        double z;
        z=-3.812+4.721*a+9.078*b+0.039*c;

        if(z>0.747048)
            return ("财务健康");
        else if(-0.74173<z)
                return ("灰色地带");
        else if(z<-0.74173 )
            return ("财务危机");
        return null;
```

3、Call the valuation algorithm to calculate the expected value of the fund V:

```java
package com.Servlet;

import java.io.IOException;
import javax.servlet.ServletException;
import javax.servlet.annotation.WebServlet;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;


@WebServlet("/listV")
public class ListVServlet extends HttpServlet {
            private static final long serialVersionUID = 1L;
            private double RF;
            private double Beta;
            private double RM;
            private double KD;
            private double TD;
            private double Tc;
            private double V1;
            private double TE;



    protected void doGet(HttpServletRequest request, HttpServletResponse response) throws ServletException,
        // TODO Auto-generated method stub

            RF=(double) request.getAttribute("RF");
            Beta=(double) request.getAttribute("Beta");
            RM=(double) request.getAttribute("RM");
            KD=(double) request.getAttribute("KD");
            TD=(double) request.getAttribute("TD");
            Tc=(double) request.getAttribute("Tc");
            V1=(double) request.getAttribute("V1");
            TE=(double) request.getAttribute("TE");

            double AFFO[] = new double[5];

            request.setAttribute("v", comV(RF,Beta, RM, KD, TD, Tc, AFFO, V1, TE));
            request.getRequestDispatcher(".jsp");
    }


    public double comV(double RF,double Beta,double RM,double KD,double TD,double Tc,double AFFO[],double V
    {
        double KE;
        double r;
        double V=0;
        int i=AFFO.length;
        KE=RF+Beta*(RM-RF);
        r=KD*(TD/V1)+KE*(TE/V1)*(1-Tc);
        for(int j=0;j<i;j++)
        {
            V+=AFFO[j]/Math.pow((1+r), j);
        }
        return V;
    }

}
```

3.2.2 Flow Chart



Appendix I Implementation of Python Code Crawler

```python
from bs4 import BeautifulSoup
import requests
from parsel import Selector
import pandas as pd
import time
from pandas.core.frame import DataFrame
from fake_useragent import UserAgent
ua = UserAgent()
headers={
    "User-Agent":ua.ie
}
requests.adapters.DEFAULT_RETRIES = 40
```

```python
def j_par(url):

    wr=requests.get(url,headers=headers,stream=True)
    sel=Selector(wr.text)
    soup = BeautifulSoup(wr.text, 'lxml')
    oth= soup.find_all(class_="special clearfix")
    oth_2=soup.find_all(class_="des")

    '''房源名'''
    h_nam=sel.xpath('//div[@class="content"]/div[@class="wrap pb80"]/ul[@class="fyuan-list"]/li/a/div[@class="des"]/p[@class="tit"]/text()')

    '''房型'''
    h_typ=sel.xpath('//div[@class="content"]/div[@class="wrap pb80"]/ul[@class="fyuan-list"]/li/a/div[@class="des"]/div[@class="room"]/span[

    '''面积'''
    h_siz=sel.xpath('//div[@class="content"]/div[@class="wrap pb80"]/ul[@class="fyuan-list"]/li/a/div[@class="des"]/div[@class="room"]/span[

    '''楼层'''
    h_flo=sel.xpath('//div[@class="content"]/div[@class="wrap pb80"]/ul[@class="fyuan-list"]/li/a/div[@class="des"]/div[@class="room"]/span[

    '''优势'''
    h_sep=[]
    for tag in oth:
        if tag.get_text()=="\n":
            h_sep.append(" ")
        else:
            h_sep.append(tag.get_text().strip().replace('\n','',0).replace('\n',','))

    h_tra2=[]
```

```
    for tag in oth_2:
        if tag.find(class_="distance"):
            h_tra2.append(tag.find(class_="distance").get_text().replace('\n',''))
        else:
            h_tra2.append(" ")

    '''价格'''
    h_pri=sel.xpath('//div[@class="content"]/div[@class="wrap pb80"]/ul[@class="fyuan-list"]/li/a/div[@class="price"]/span[@class="num"]/
    
    '''房源号'''
    a=soup.find_all("a",class_="clearfix")
    h_cod=[]
    for t in a:
        h_cod.append(t.get('href'))

    '''地址&交通及周边设施'''
    h_add=[]
    h_des=[]
    for c in h_cod:
        ur = "http://zufang.jiwu.com"+c
        wr = requests.get(ur,headers=headers,stream=True)
        wesoup=BeautifulSoup(wr.text,'lxml')
        wesoup_1=wesoup.find_all('td') #用于地址
        wesoup_2=wesoup.find('p',class_='fwms').get_text()  #用于设施

        ''' 地址 '''
        td_content=[]
        for i in wesoup_1:
            td_content.append(i.text)
        length=len(wesoup_1)
        wetd=td_content[length-1]#筛选地址
        h_add.append(wetd)
```

```
        '''交通及周边设施'''
        wesoup_2_des=wesoup_2
        h_des.append(wesoup_2_des)

    #将列表转换成字典
    c={"h_cod" : h_cod,
       "h_nam" : h_nam,
       "h_loc" : h_add,
       "h_typ" : h_typ,
       "h_siz" : h_siz,
       "h_pri" : h_pri,
       "h_flo" : h_flo,
       "h_sep" : h_sep,
       "h_des" : h_des}

    #将字典转换成为数据框
    pages_info=DataFrame(c)

    return pages_info
```

```
def pp(pages):
    count=0
    for page in pages:
        a=j_par(page)
        count=count+1
        print ('the '+str(count)+' page is sucessful')
        time.sleep(5)
        l=pd.DataFrame(columns=['h_cod','h_nam','h_loc','h_typ','h_siz','h_flo','h_pri','h_sep','h_d
        l=pd.concat([l,a],ignore_index=True)
    return l
```

```
for p in range(1,8):
    pages=[]
    if p==1:
        pages.append('http://zufang.jiwu.com/gz/gongyu46/')
    else:
        pages.append('http://zufang.jiwu.com/gz/gongyu46/page'+str(p)+'/')

    lj=pp(pages)
    lj.to_csv('d:\\boyu_gz_futian_10__'+str(p)+'.csv')
```