# Loan default-rate predictor program

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# Our final project is a standalone program to predict loan-default rate based on machine learning algorithm

## Overview

### What is it

- A program to predict **loan default-rate based on machine algorithm**
- Default-rate is defined as **probability of person who's currently taking the loan to default** in his/her loan payment

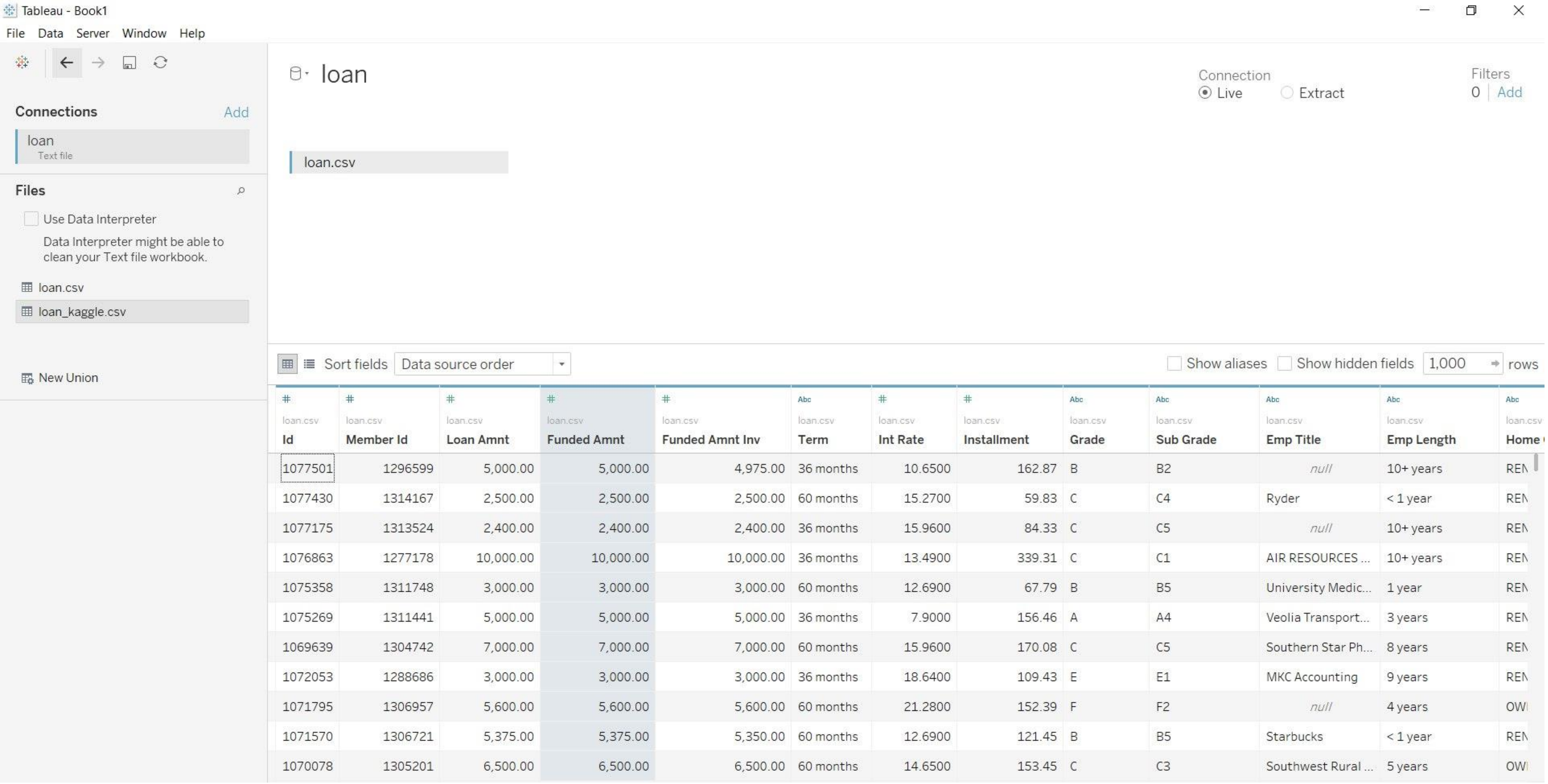
### How to do it

- The program is using **Lending Club data-set from Kaggle** (https://www.kaggle.com/wendykan/lending-club-loan-data) to train our machine learning model
  - Dataset includes detailed information for each loan issued by Lending Club from 2007 to 2015
  - Contains 2.26 million of loan records with 145 field columns for each loan record
- **Logistic regression** is used as machine learning engine to predict binary dependent variable

### What are the steps

- Perform **data cleansing and feature engineering** to the data-set
- Build **machine learning model** and train the data
- Use the machine learning model to **predict loan default-rate based on user input**

# Lending Club Data set from Kaggle has rich features (e.g. loan term, interest rate, income, etc.) to train ML model to make prediction



loan

Connection ● Live ○ Extract

Filters 0 | Add

Connections Add

loan
Text file

loan.csv

Files

□ Use Data Interpreter

Data Interpreter might be able to clean your Text file workbook.

loan.csv

loan_kaggle.csv

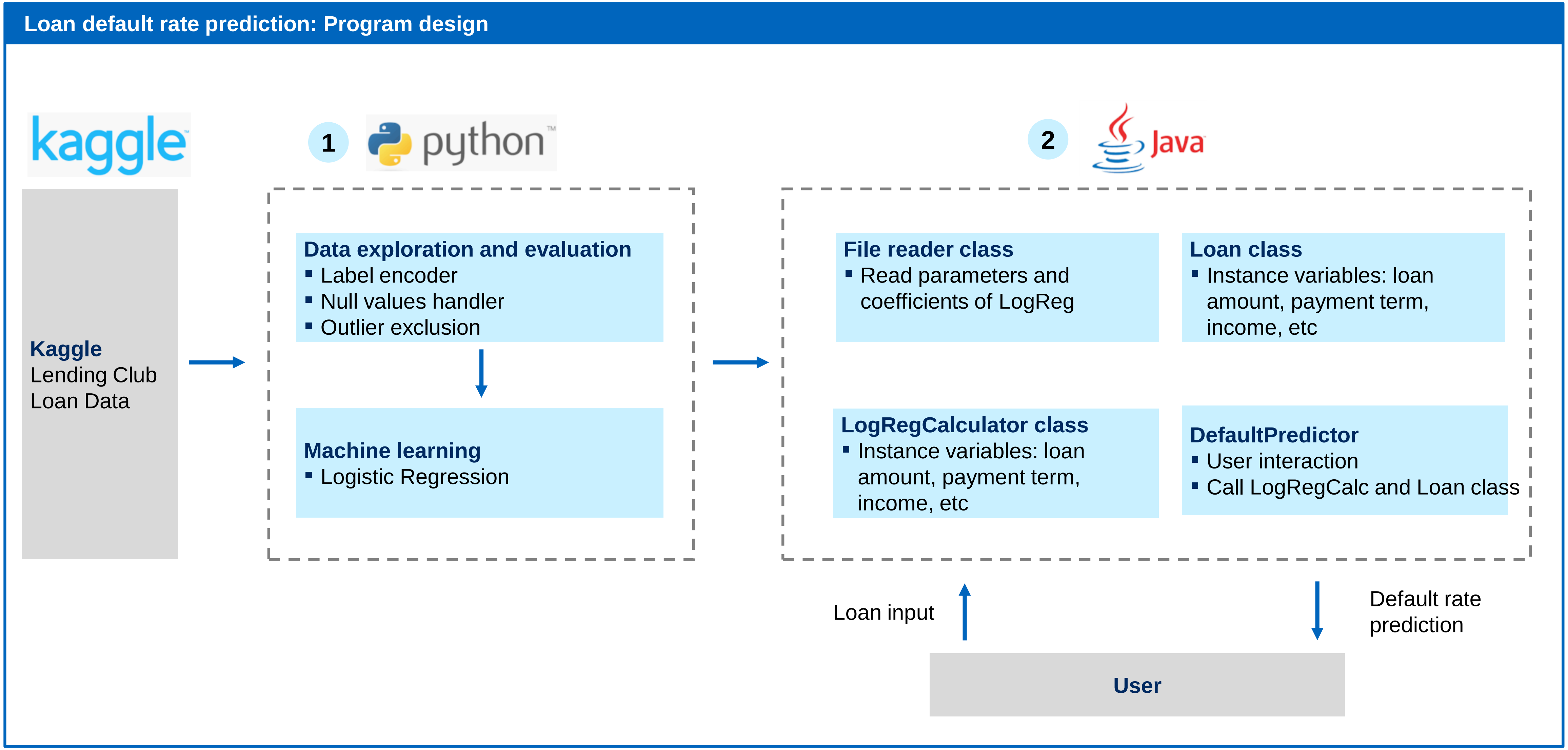
New Union

Sort fields Data source order

□ Show aliases □ Show hidden fields 1,000 rows

| #<br>loan.csv<br>Id | #<br>loan.csv<br>Member Id | #<br>loan.csv<br>Loan Amnt | #<br>loan.csv<br>Funded Amnt | #<br>loan.csv<br>Funded Amnt Inv | Abc<br>loan.csv<br>Term | #<br>loan.csv<br>Int Rate | #<br>loan.csv<br>Installment | Abc<br>loan.csv<br>Grade | Abc<br>loan.csv<br>Sub Grade | Abc<br>loan.csv<br>Emp Title | Abc<br>loan.csv<br>Emp Length | Abc<br>loan.csv<br>Home |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1077501 | 1296599 | 5,000.00 | 5,000.00 | 4,975.00 | 36 months | 10.6500 | 162.87 | B | B2 | null | 10+ years | REN |
| 1077430 | 1314167 | 2,500.00 | 2,500.00 | 2,500.00 | 60 months | 15.2700 | 59.83 | C | C4 | Ryder | < 1 year | REN |
| 1077175 | 1313524 | 2,400.00 | 2,400.00 | 2,400.00 | 36 months | 15.9600 | 84.33 | C | C5 | null | 10+ years | REN |
| 1076863 | 1277178 | 10,000.00 | 10,000.00 | 10,000.00 | 36 months | 13.4900 | 339.31 | C | C1 | AIR RESOURCES ... | 10+ years | REN |
| 1075358 | 1311748 | 3,000.00 | 3,000.00 | 3,000.00 | 60 months | 12.6900 | 67.79 | B | B5 | University Medic... | 1 year | REN |
| 1075269 | 1311441 | 5,000.00 | 5,000.00 | 5,000.00 | 36 months | 7.9000 | 156.46 | A | A4 | Veolia Transport... | 3 years | REN |
| 1069639 | 1304742 | 7,000.00 | 7,000.00 | 7,000.00 | 60 months | 15.9600 | 170.08 | C | C5 | Southern Star Ph... | 8 years | REN |
| 1072053 | 1288686 | 3,000.00 | 3,000.00 | 3,000.00 | 36 months | 18.6400 | 109.43 | E | E1 | MKC Accounting | 9 years | REN |
| 1071795 | 1306957 | 5,600.00 | 5,600.00 | 5,600.00 | 60 months | 21.2800 | 152.39 | F | F2 | null | 4 years | OW |
| 1071570 | 1306721 | 5,375.00 | 5,375.00 | 5,350.00 | 60 months | 12.6900 | 121.45 | B | B5 | Starbucks | < 1 year | REN |
| 1070078 | 1305201 | 6,500.00 | 6,500.00 | 6,500.00 | 60 months | 14.6500 | 153.45 | C | C3 | Southwest Rural ... | 5 years | OW |

# Loan default-rate prediction program has 2 parts: ML program at back-end with Python and Loan predictor program at front-end with Java



**Loan default rate prediction: Program design**

**Kaggle**
Lending Club
Loan Data

**Data exploration and evaluation**
- Label encoder
- Null values handler
- Outlier exclusion

**Machine learning**
- Logistic Regression

**File reader class**
- Read parameters and coefficients of LogReg

**Loan class**
- Instance variables: loan amount, payment term, income, etc

**LogRegCalculator class**
- Instance variables: loan amount, payment term, income, etc

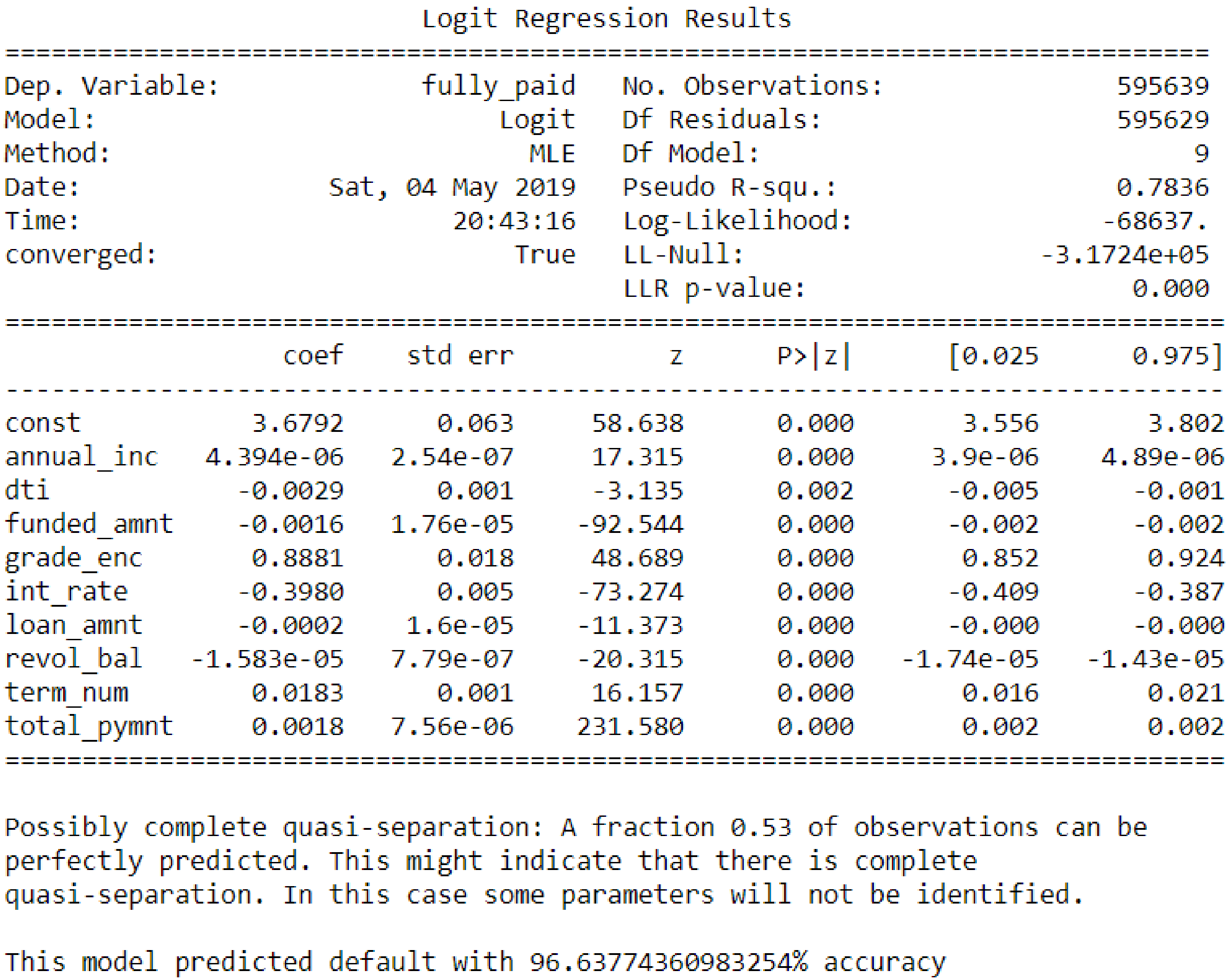
**DefaultPredictor**
- User interaction
- Call LogRegCalc and Loan class

Loan input

Default rate prediction

**User**

# 1. Python: Machine Learning Engine



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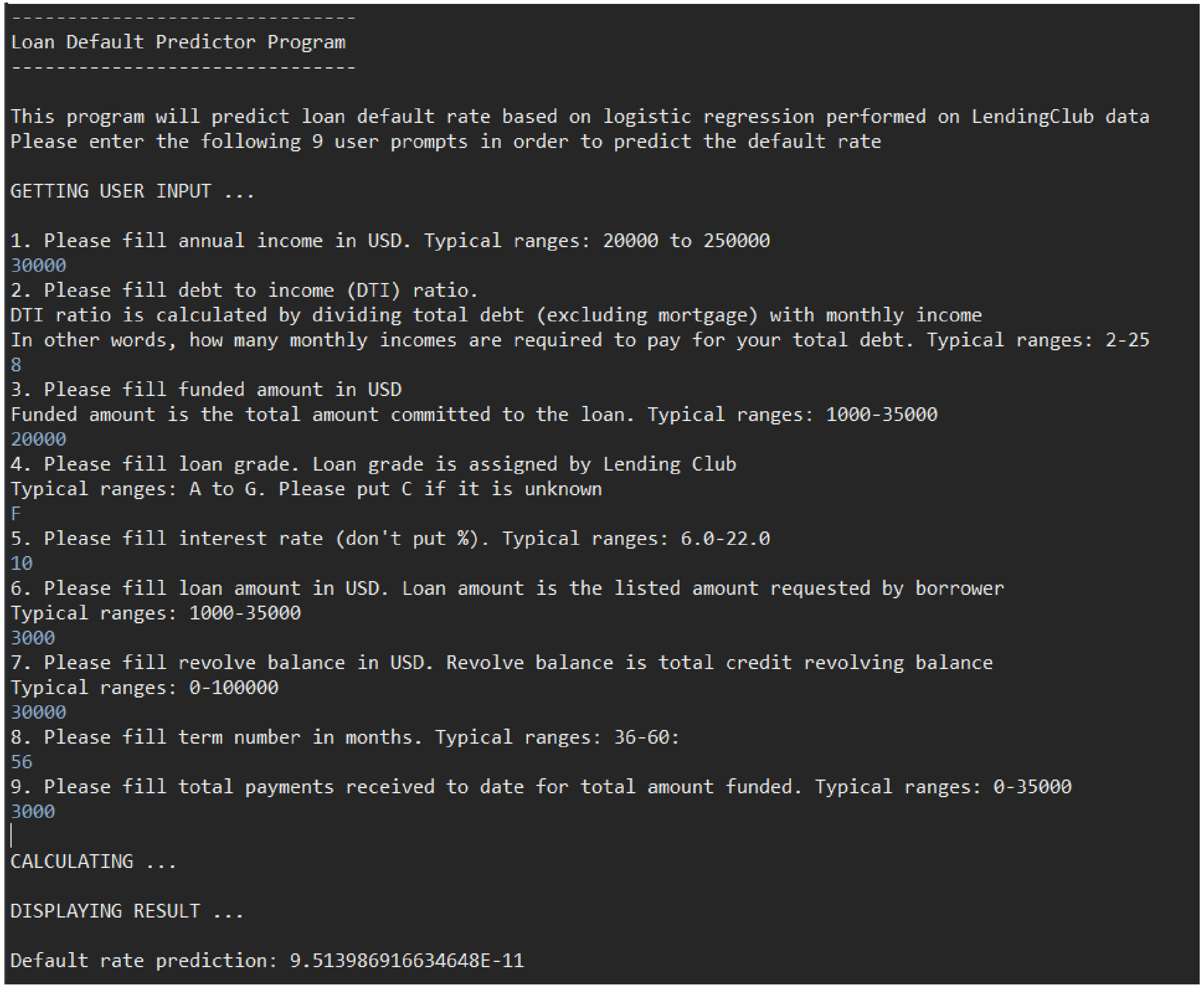
                           Logit Regression Results
==============================================================================
Dep. Variable:              fully_paid   No. Observations:               595639
Model:                           Logit   Df Residuals:                   595629
Method:                            MLE   Df Model:                            9
Date:                 Sat, 04 May 2019   Pseudo R-squ.:                  0.7836
Time:                         20:43:16   Log-Likelihood:                -68637.
converged:                        True   LL-Null:                   -3.1724e+05
                                         LLR p-value:                     0.000
================================================================================
                   coef    std err          z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
const            3.6792      0.063     58.638      0.000       3.556       3.802
annual_inc    4.394e-06   2.54e-07     17.315      0.000     3.9e-06    4.89e-06
dti             -0.0029      0.001     -3.135      0.002      -0.005      -0.001
funded_amnt     -0.0016   1.76e-05    -92.544      0.000      -0.002      -0.002
grade_enc        0.8881      0.018     48.689      0.000       0.852       0.924
int_rate        -0.3980      0.005    -73.274      0.000      -0.409      -0.387
loan_amnt       -0.0002    1.6e-05    -11.373      0.000      -0.000      -0.000
revol_bal    -1.583e-05   7.79e-07    -20.315      0.000   -1.74e-05   -1.43e-05
term_num         0.0183      0.001     16.157      0.000       0.016       0.021
total_pymnt      0.0018   7.56e-06    231.580      0.000       0.002       0.002
================================================================================

Possibly complete quasi-separation: A fraction 0.53 of observations can be
perfectly predicted. This might indicate that there is complete
quasi-separation. In this case some parameters will not be identified.

This model predicted default with 96.63774360983254% accuracy
```

# 2. JAVA: Default predictor with user input



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Loan Default Predictor Program
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This program will predict loan default rate based on logistic regression performed on LendingClub data
Please enter the following 9 user prompts in order to predict the default rate

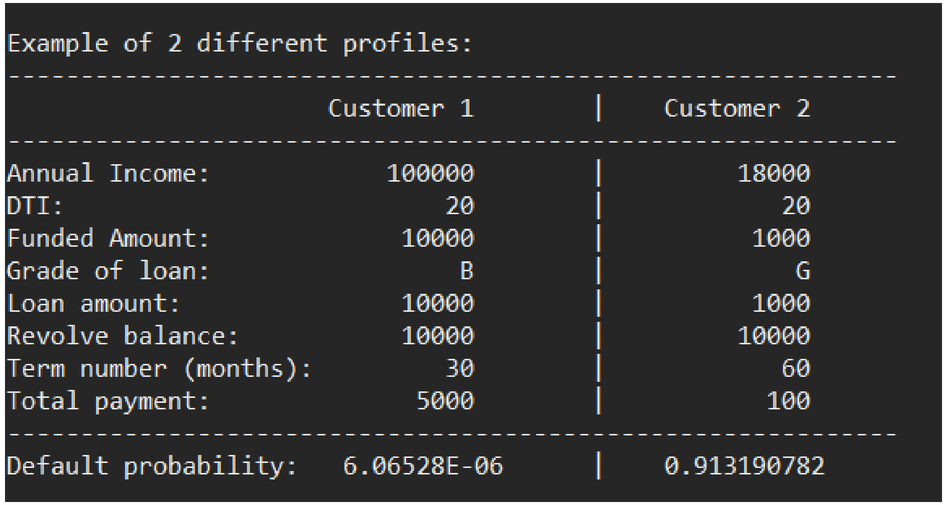
GETTING USER INPUT ...

1. Please fill annual income in USD. Typical ranges: 20000 to 250000
30000
2. Please fill debt to income (DTI) ratio.
DTI ratio is calculated by dividing total debt (excluding mortgage) with monthly income
In other words, how many monthly incomes are required to pay for your total debt. Typical ranges: 2-25
8
3. Please fill funded amount in USD
Funded amount is the total amount committed to the loan. Typical ranges: 1000-35000
20000
4. Please fill loan grade. Loan grade is assigned by Lending Club
Typical ranges: A to G. Please put C if it is unknown
F
5. Please fill interest rate (don't put %). Typical ranges: 6.0-22.0
10
6. Please fill loan amount in USD. Loan amount is the listed amount requested by borrower
Typical ranges: 1000-35000
3000
7. Please fill revolve balance in USD. Revolve balance is total credit revolving balance
Typical ranges: 0-100000
30000
8. Please fill term number in months. Typical ranges: 36-60:
56
9. Please fill total payments received to date for total amount funded. Typical ranges: 0-35000
3000

CALCULATING ...

DISPLAYING RESULT ...

Default rate prediction: 9.513986916634648E-11
```



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Example of 2 different profiles:
--------------------------------------------------------------
                      Customer 1         |    Customer 2
--------------------------------------------------------------
Annual Income:            100000         |        18000
DTI:                          20         |           20
Funded Amount:             10000         |         1000
Grade of loan:                 B         |            G
Loan amount:               10000         |         1000
Revolve balance:           10000         |        10000
Term number (months):         30         |           60
Total payment:              5000         |          100
--------------------------------------------------------------
Default probability:   6.06528E-06       |    0.913190782
```