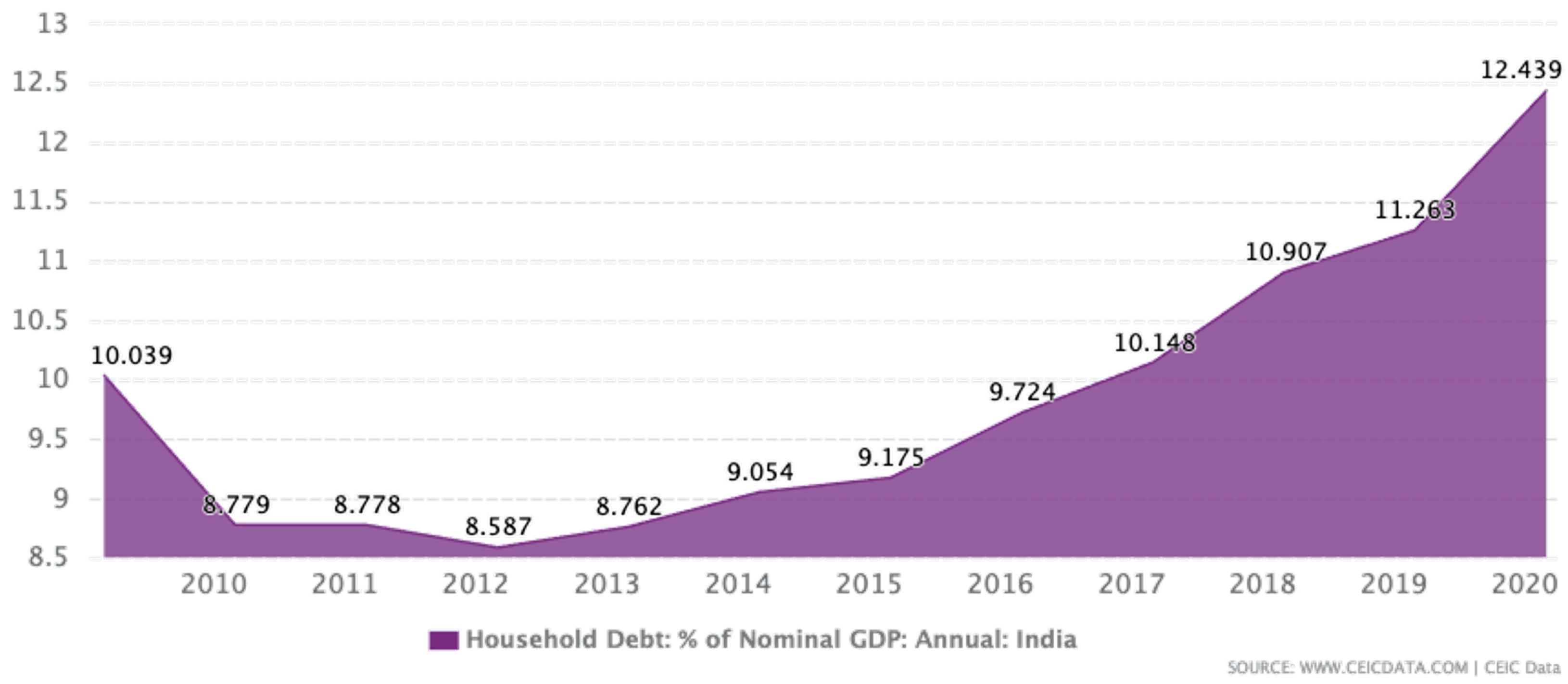
Extending a lending hand

Analyzing consumer credit data to provide financial help to consumers in need

Sam Reiff

Sept 2021

Background



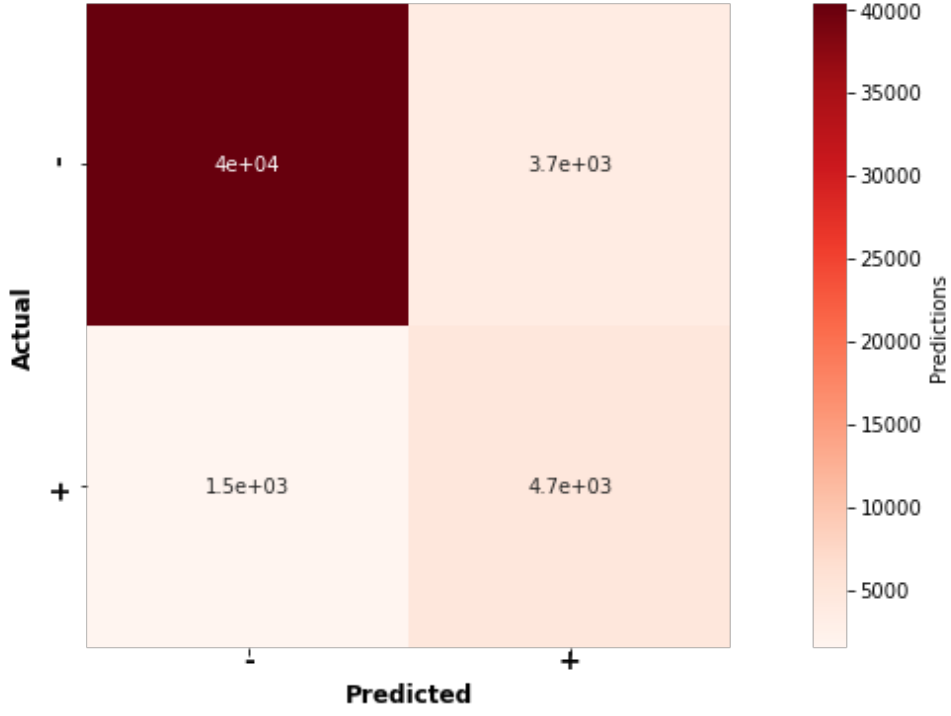
SOURCE: WWW.CEICDATA.COM | CEIC Data

- **Growing household debt** in India
- Consumer debt relief programs could **stabilize economic growth**
- Indian government seeks to **use loan data to identify citizens who may benefit** greatly from relief programs
- Solution **should be scalable** to thousands/millions more observations

Executive summary

- **Motivation:** Identify default-prone consumers for debt relief outreach
- **Objective:** Establish an effective classification algorithm with acceptable recall/F-beta
- **Conclusion:** Random Forest produces results superior to LR, in-line with KNN with better scalability
  - — **Target: default / no-default**
  - — Recall on test: 76%
  - — F-beta on test: 71%
  - — ROC on test: 94%

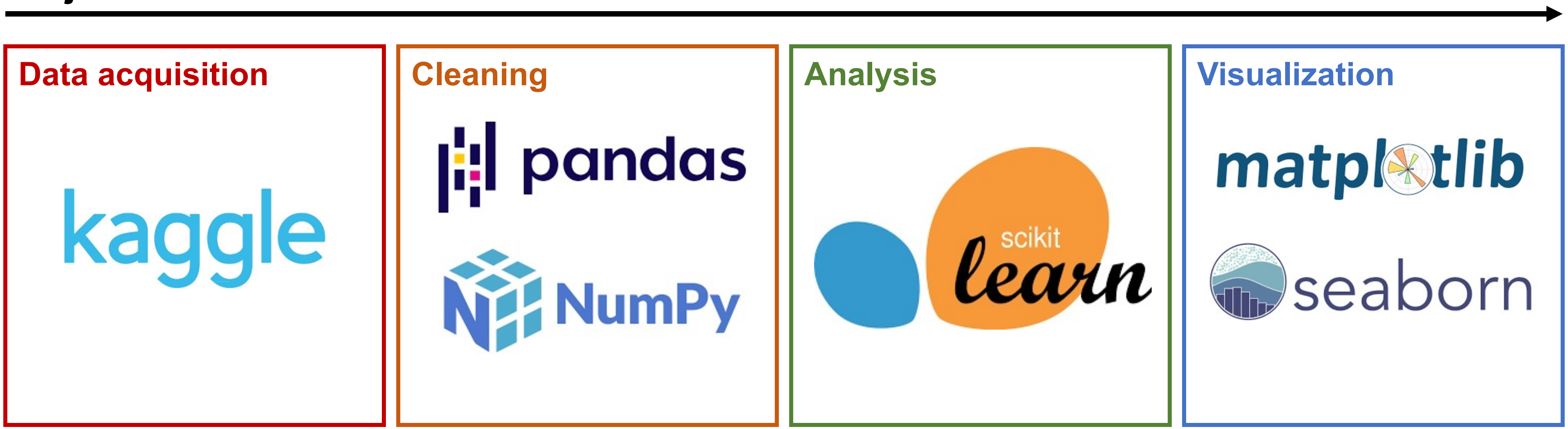
RF confusion matrix (test classification)



Random Forest has reasonable performance metrics and can scale with the business need

Methodology

Project workflow



Data acquisition

Cleaning

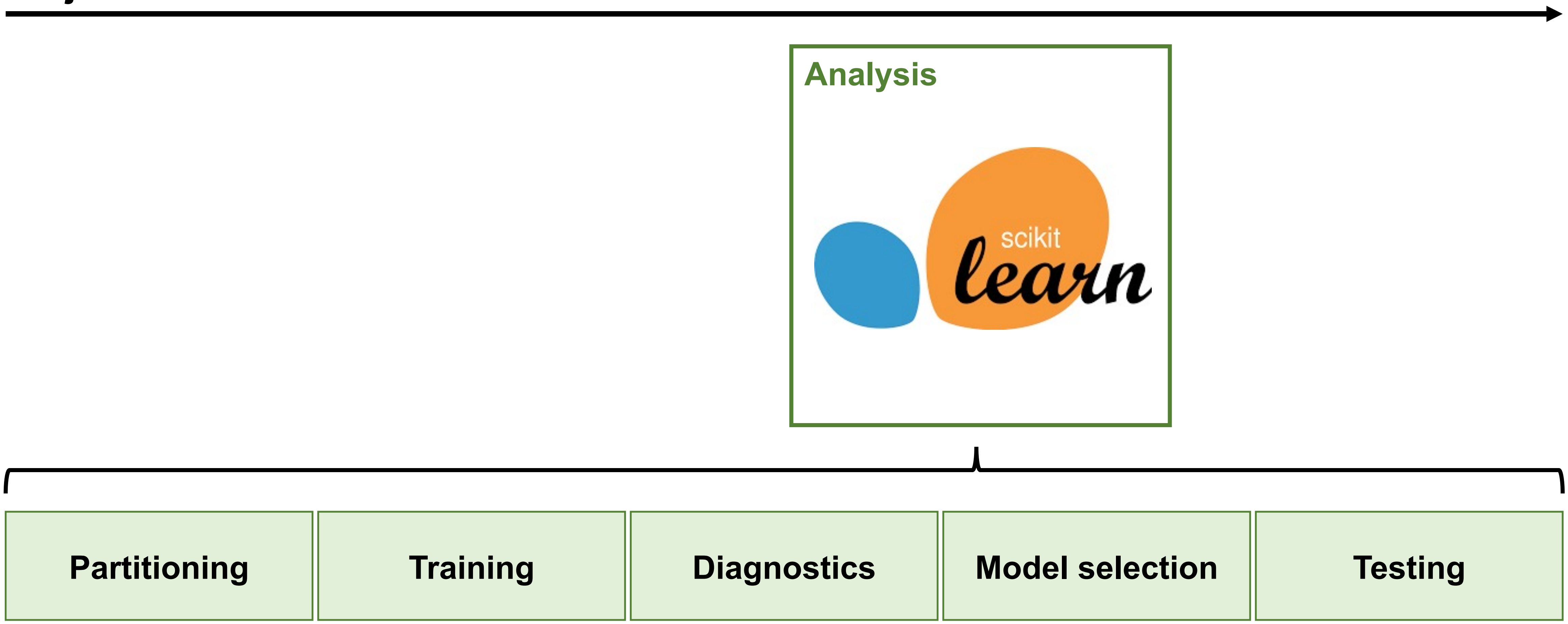
Analysis

Visualization

- **252k observations**
  - — Target class: loan default
  - — Target distr.: ~10% default rate on sample
- **11 features**
  - — Target: default/no default
  - — Numerical: income, age, work experience, employment, time at residence
  - — Categorical: marriage status, house ownership, car ownership, profession

Methodology

Project workflow



Analysis

Partitioning

Training

Diagnostics

Model selection

Testing

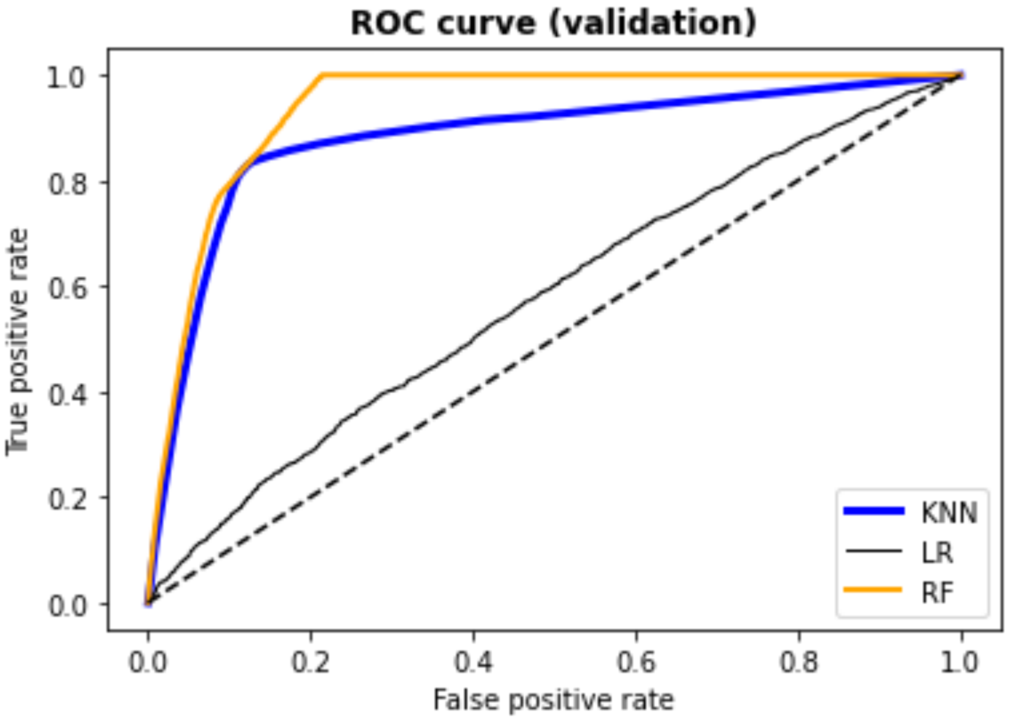
- — 60 / 20 / 20
- — Regularization
- — Resampling
- — Recall
- — Fβ
- — ROC-AUC
- — Best Fβ
- — Interpretability
- — Computational cost

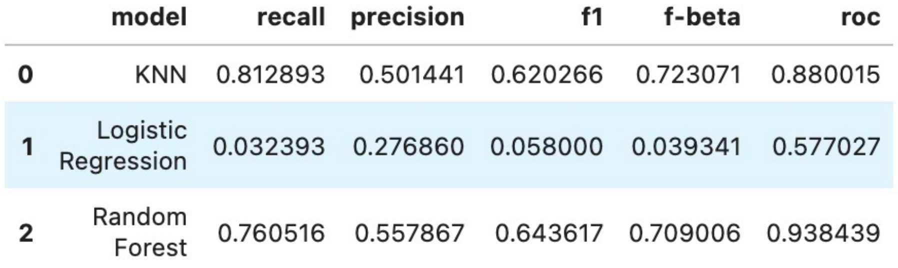
Results

Validation

- **KNN:**
  - — Recall: 0.81
  - — Fβ: 0.72
  - — ROC: 0.88
- **Logistic Regression:**
  - — Recall: 0.03
  - — Fβ: 0.04
  - — ROC: 0.58
- **Random Forest:**
  - — Recall: 0.76
  - **— Fβ: 0.71**
  - **— ROC: 0.94**

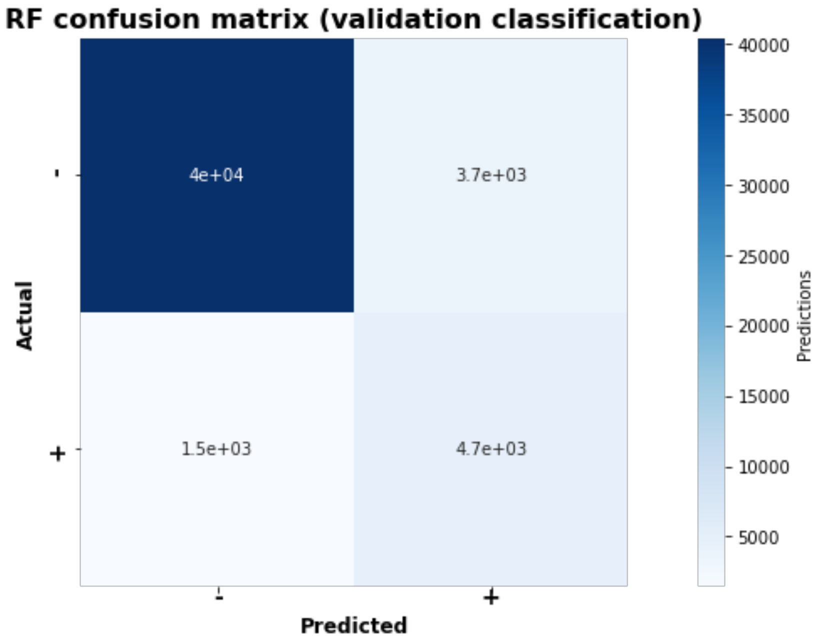
Marginally worse recall/f-beta than KNN but acceptable, and will scale better with Ks/Ms more observations

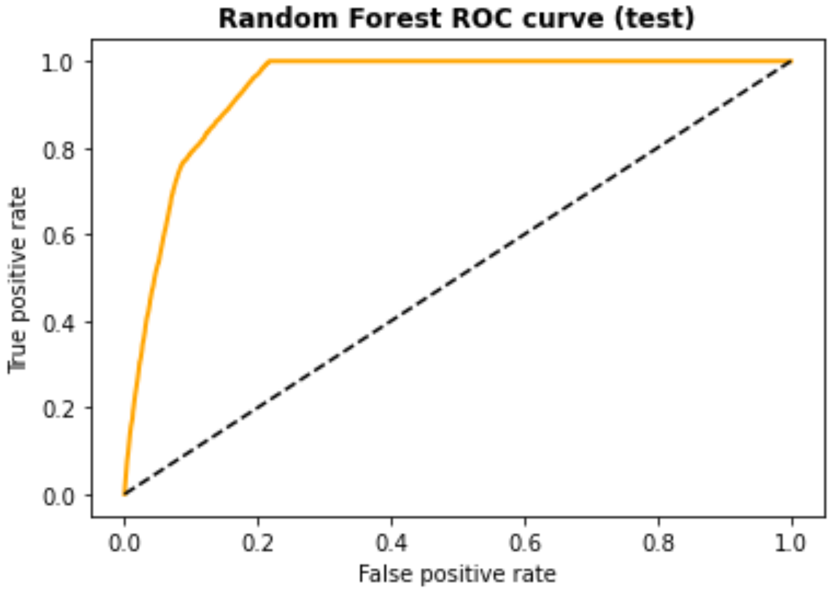


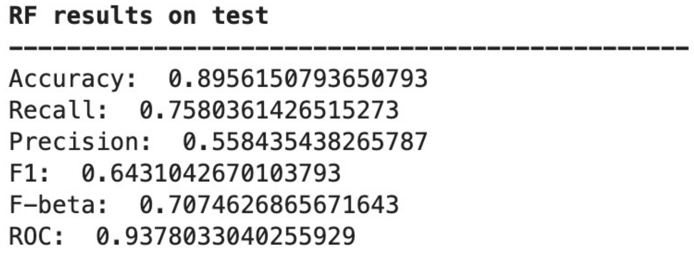


	model	recall	precision	f1	f-beta	roc
0	KNN	0.812893	0.501441	0.620266	0.723071	0.880015
1	Logistic Regression	0.032393	0.276860	0.058000	0.039341	0.577027
2	Random Forest	0.760516	0.557867	0.643617	0.709006	0.938439

Conclusions







```
RF results on test
----------------------------------------------
Accuracy:  0.8956150793650793
Recall:  0.7580361426515273
Precision:  0.558435438265787
F1:  0.6431042670103793
F-beta:  0.7074626865671643
ROC:  0.9378033040255929
```

The model holds reasonably stable on test, and could be a viable tool for credit relief outreach

Further due diligence/future work

- **Parameter tuning**
  - — Decision thresholds
  - — KNN: neighbors, distance metric
  - — RF: depth, more estimators
- **More models to employ**
  - — Boosted trees
  - — Naïve Bayes
- **Incorporate more data**
  - — Monthly payment data
  - — More demographics

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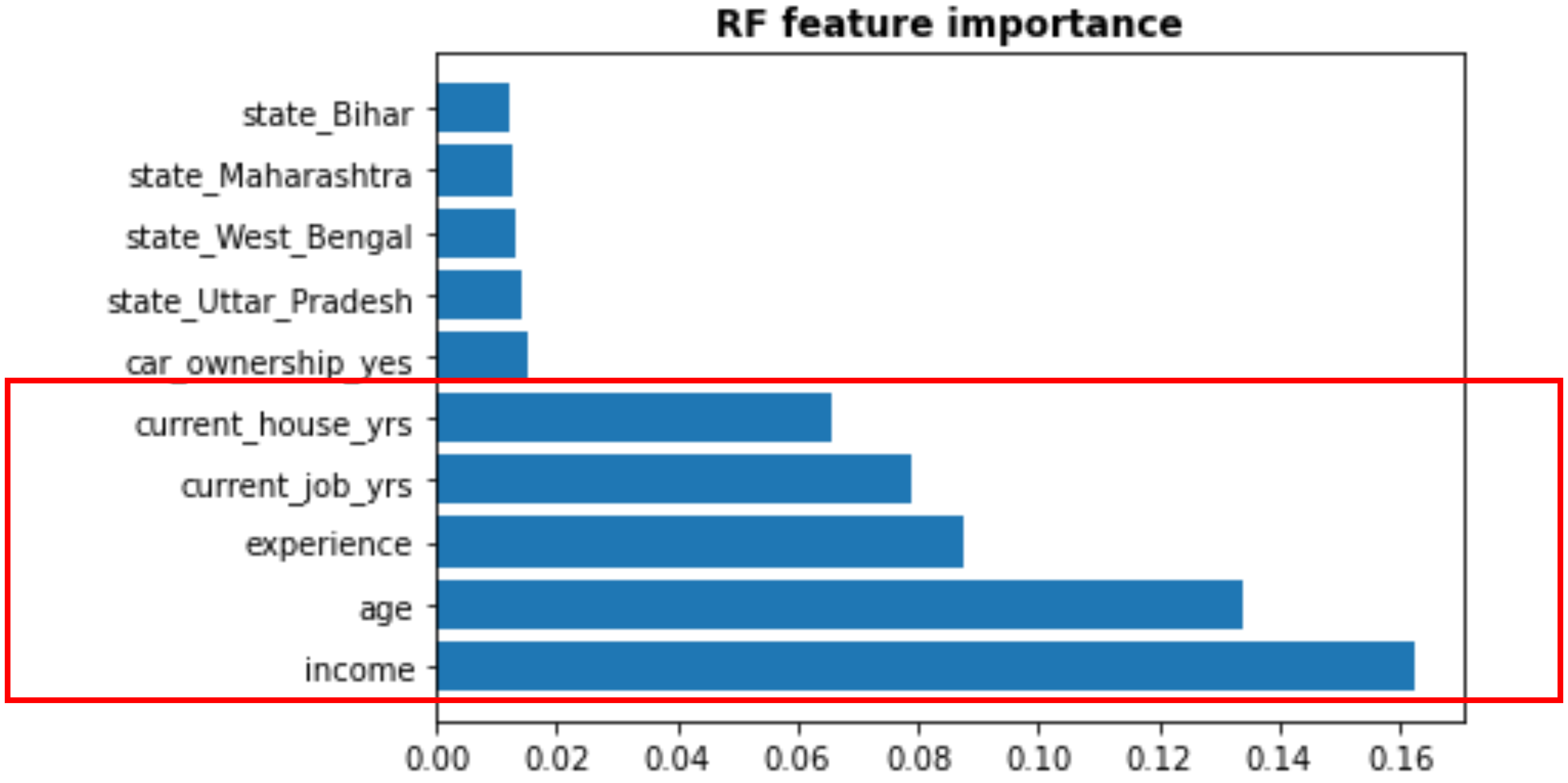
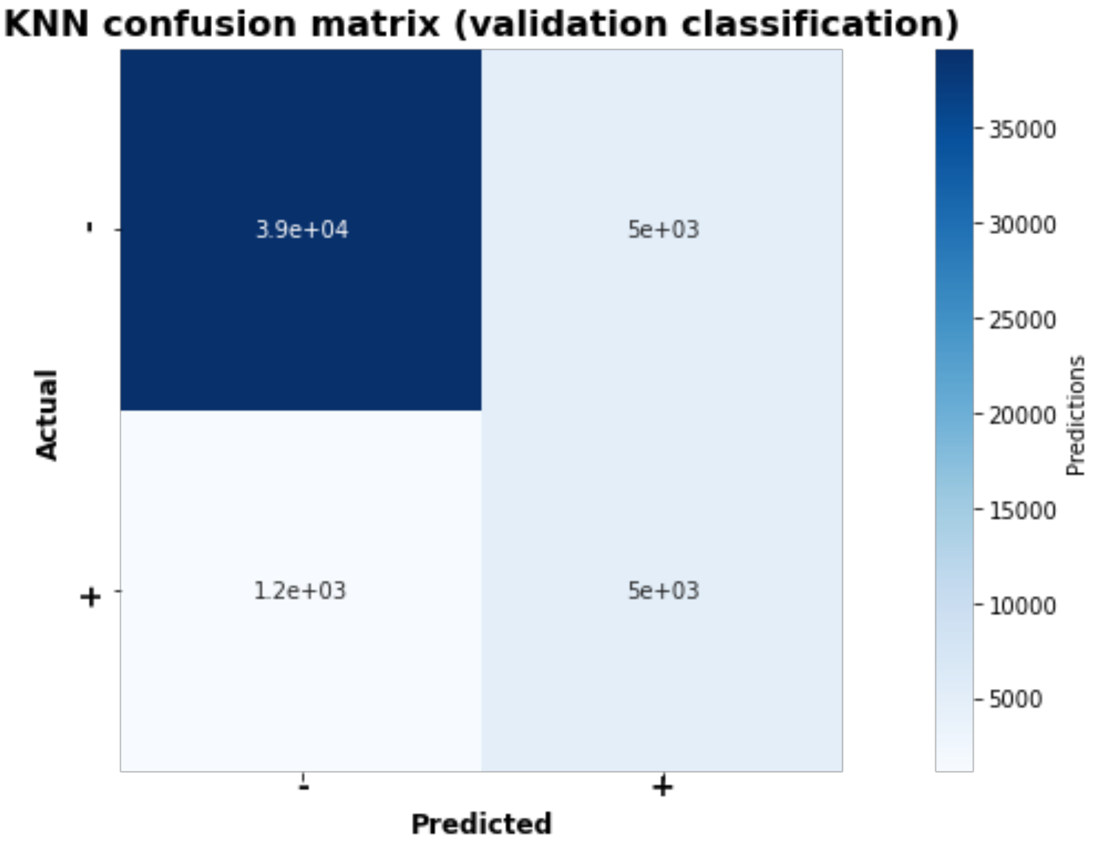
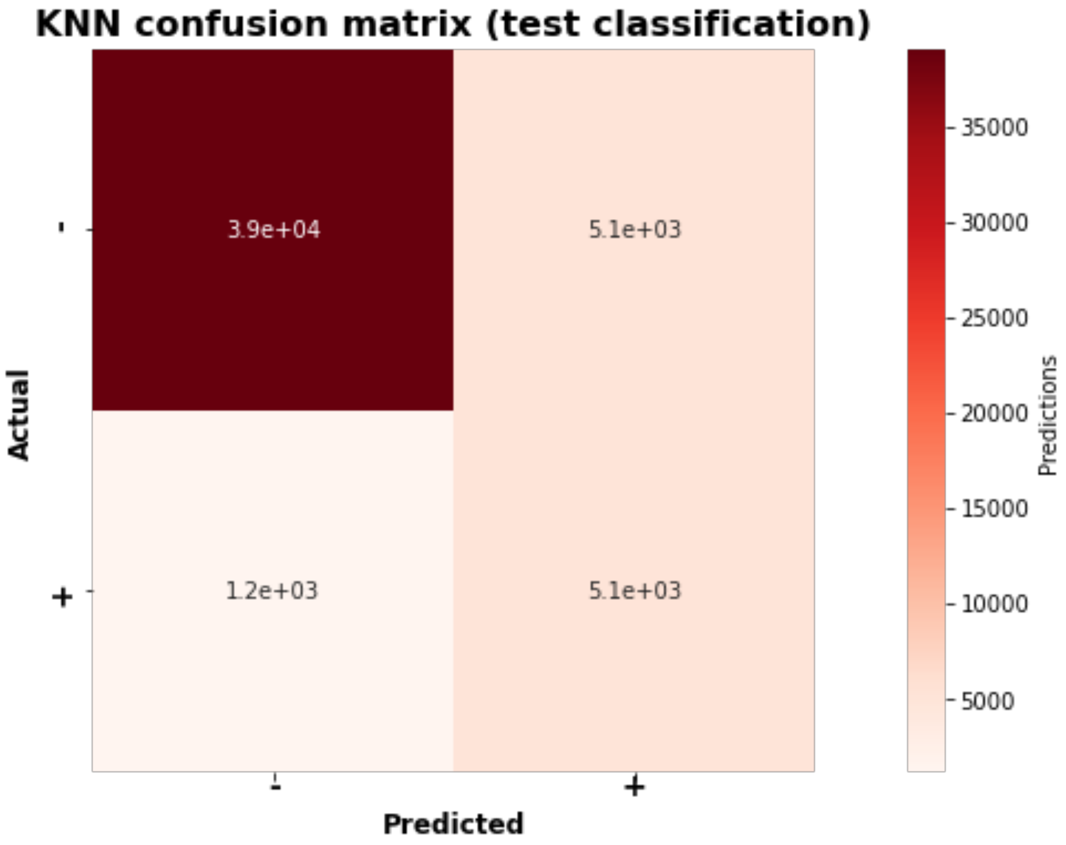
Appendix

Random Forest feature importance, top ten influential feats

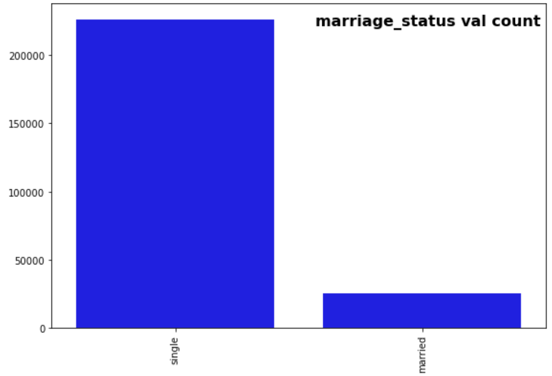


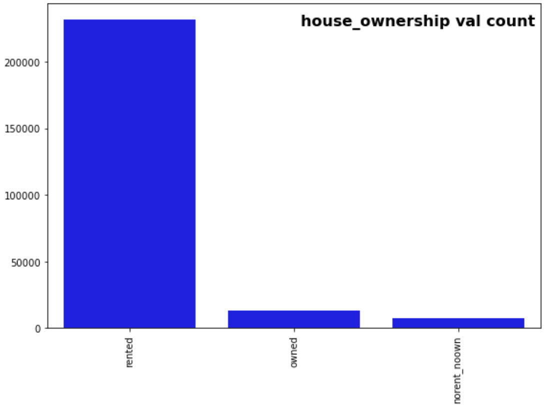
KNN confusion matrix on validation and test

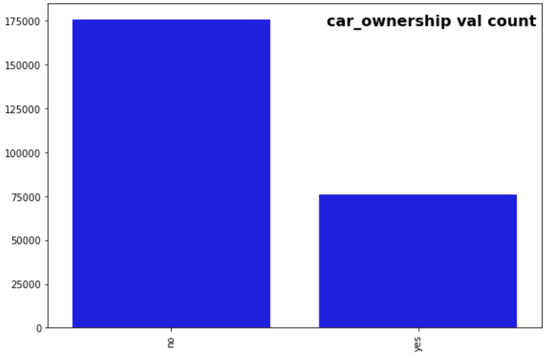

KNN confusion matrix (validation classification)

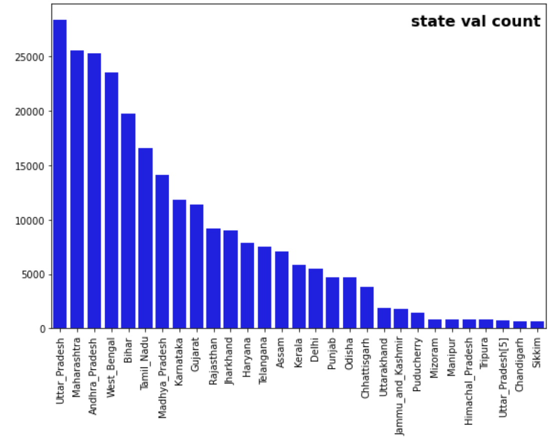

KNN confusion matrix (test classification)

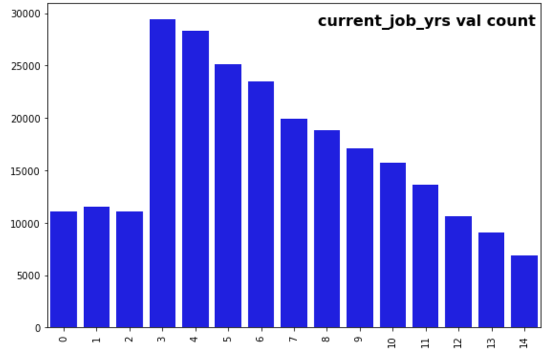
Feature value counts

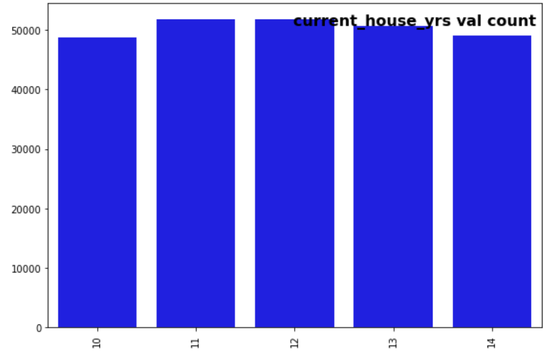

marriage_status val count

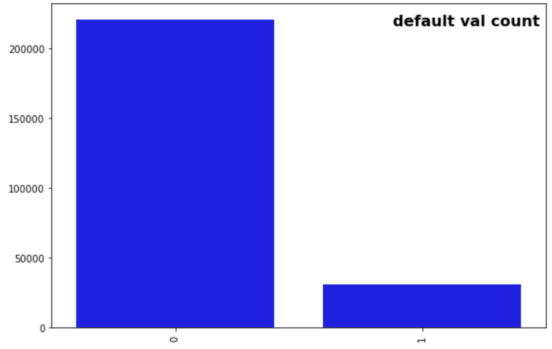

house_ownership val count


car_ownership val count

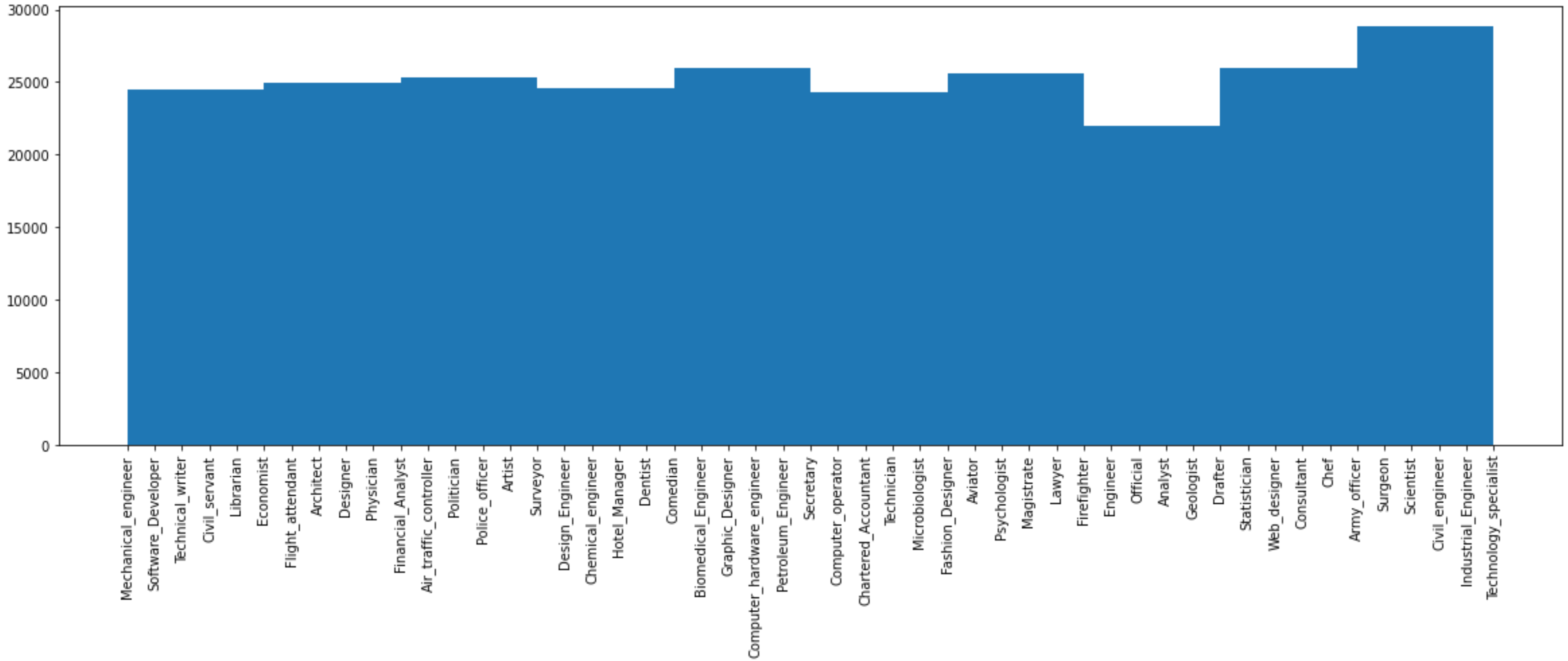

state val count


current_job_yrs val count

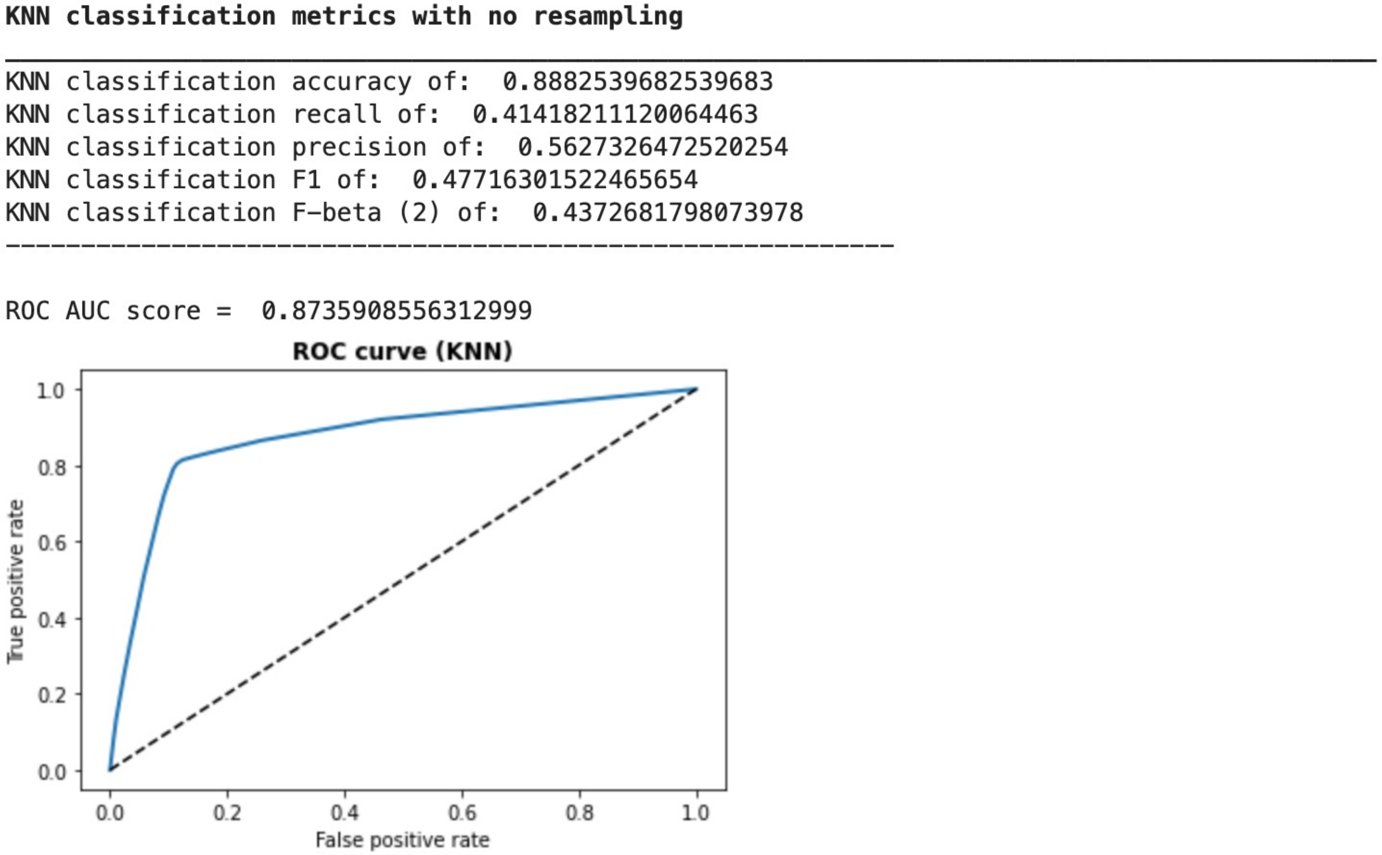

current_house_yrs val count


default val count

Profession feature distribution



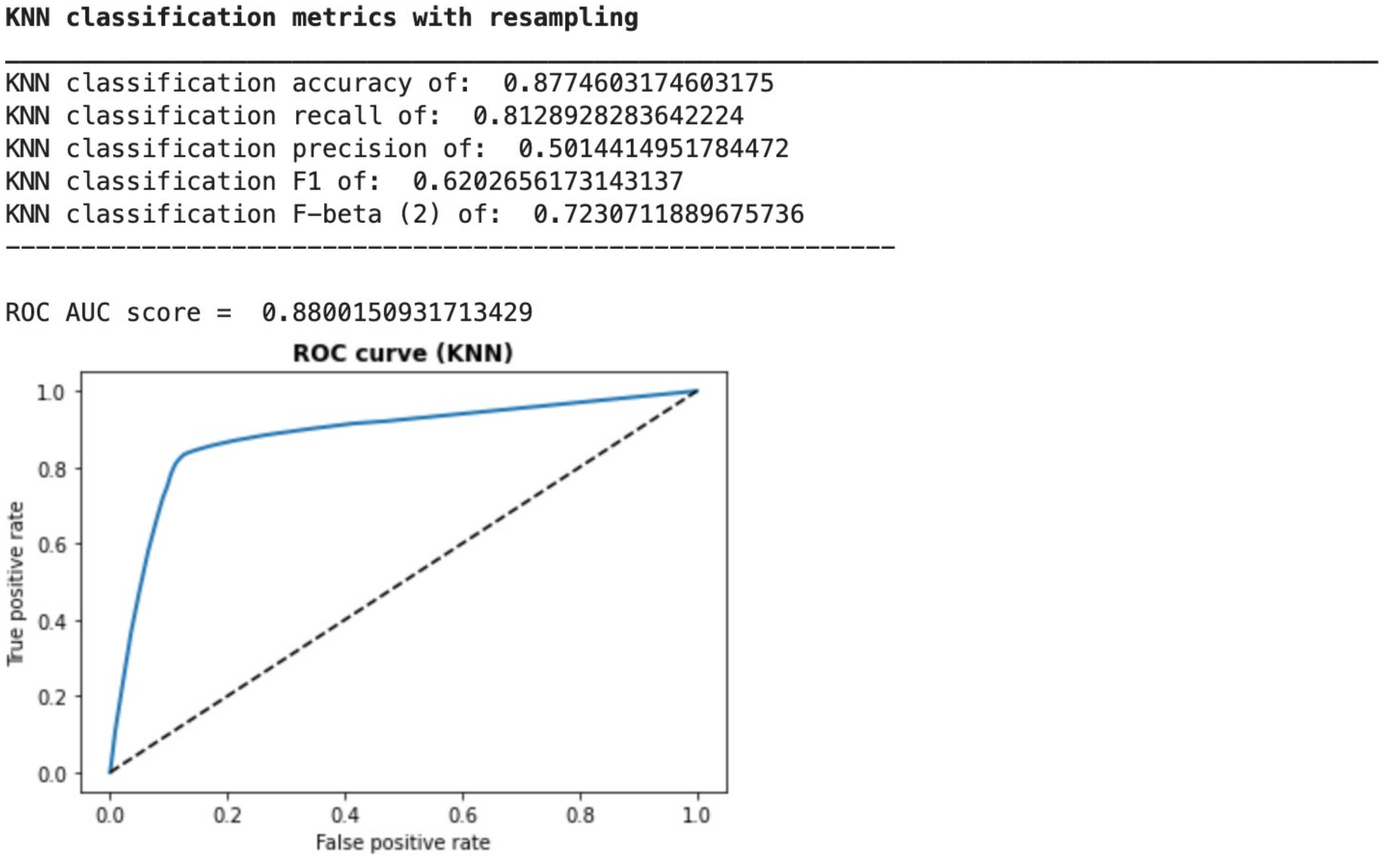
KNN validation results



```
KNN classification metrics with no resampling
__________________________________________________________________________________________
KNN classification accuracy of:  0.8882539682539683
KNN classification recall of:  0.41418211120064463
KNN classification precision of:  0.5627326472520254
KNN classification F1 of:  0.47716301522465654
KNN classification F-beta (2) of:  0.4372681798073978
-----------------------------------------------------------

ROC AUC score =  0.8735908556312999
```

KNN validation results

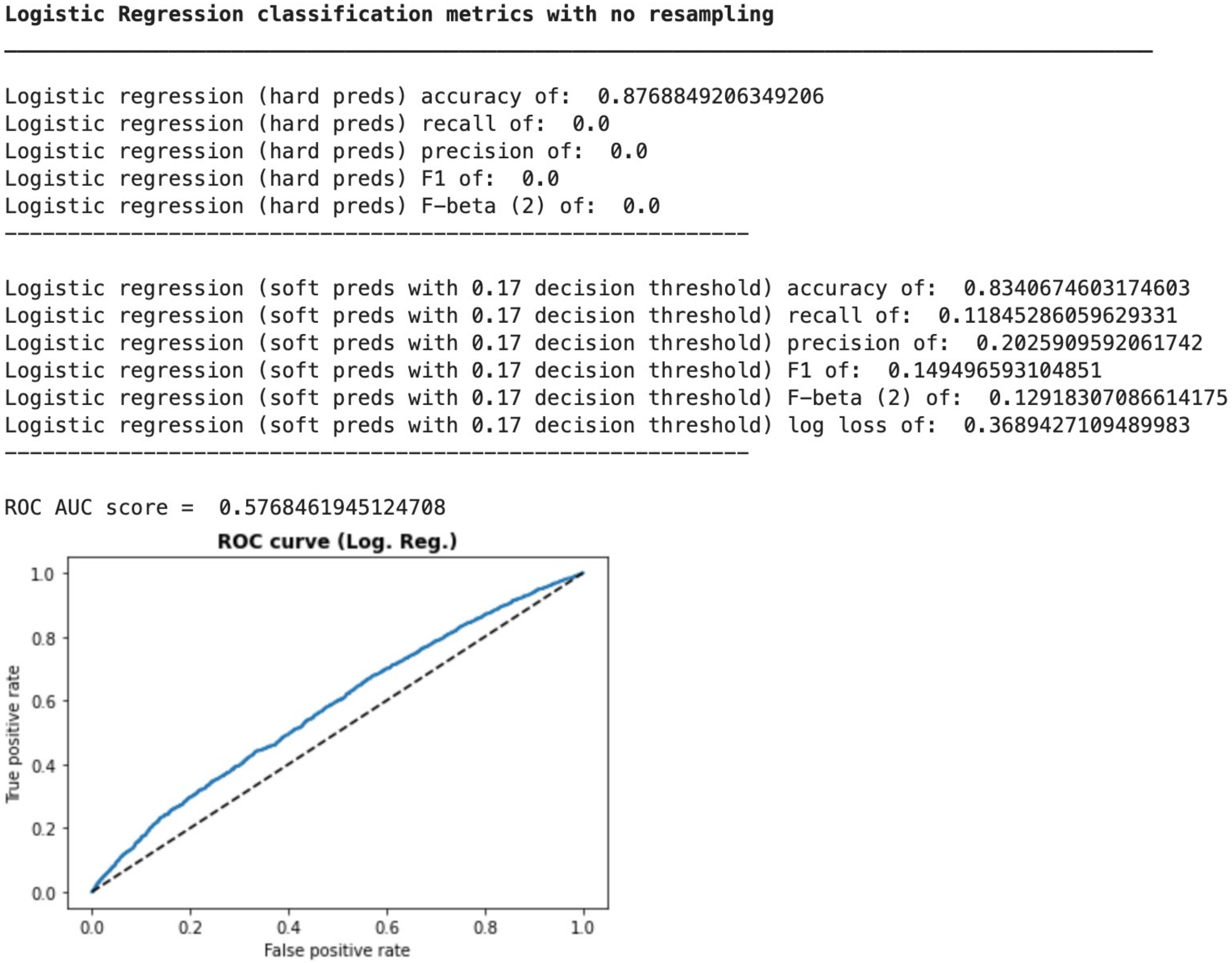


KNN classification metrics with resampling

```
______________________________________________________________________________
KNN classification accuracy of:  0.8774603174603175
KNN classification recall of:  0.8128928283642224
KNN classification precision of:  0.5014414951784472
KNN classification F1 of:  0.6202656173143137
KNN classification F-beta (2) of:  0.7230711889675736
-----------------------------------------------------------

ROC AUC score =  0.8800150931713429
```

Logistic regression validation results



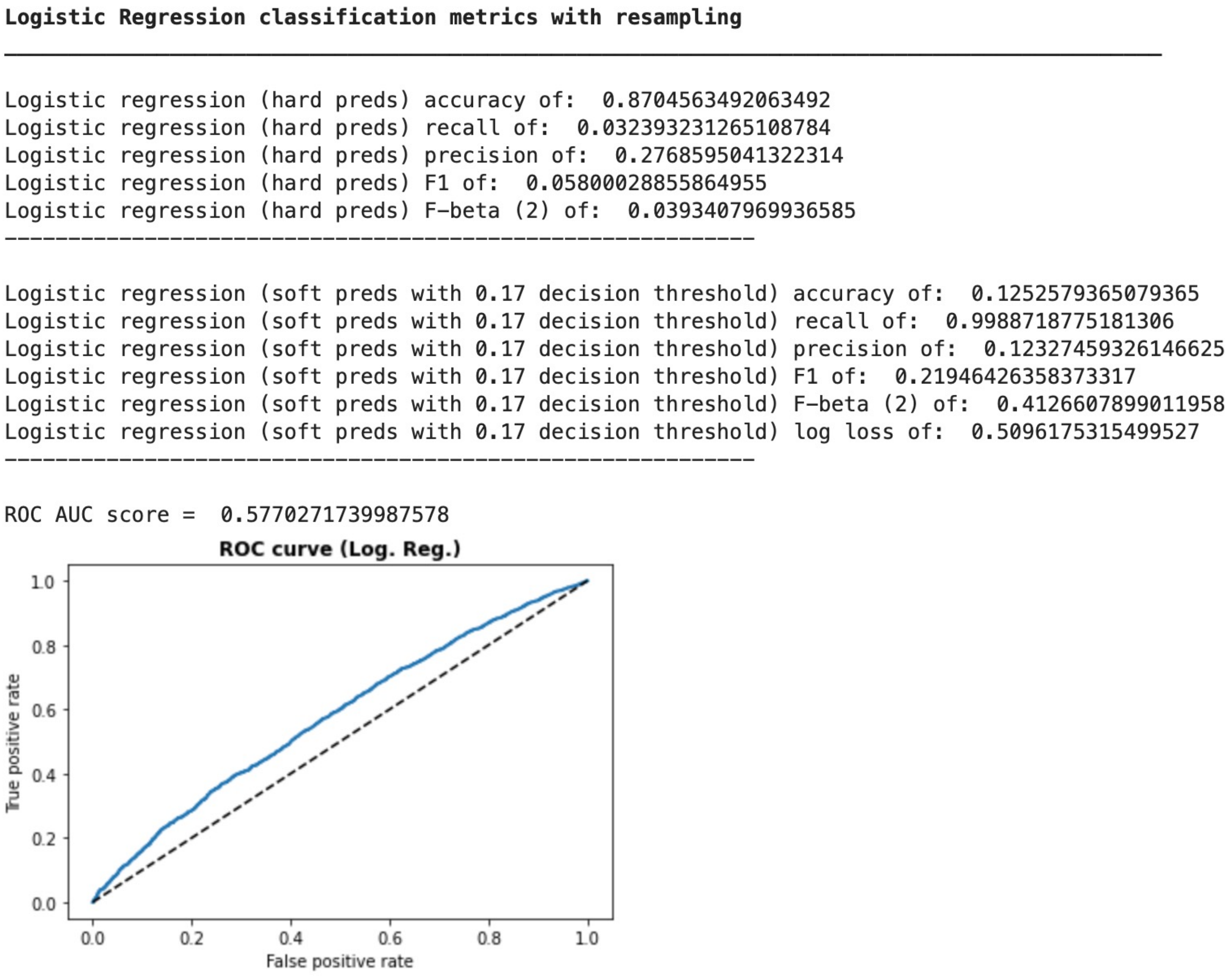
```
Logistic Regression classification metrics with no resampling
___________________________________________________________________________________________

Logistic regression (hard preds) accuracy of:  0.8768849206349206
Logistic regression (hard preds) recall of:  0.0
Logistic regression (hard preds) precision of:  0.0
Logistic regression (hard preds) F1 of:  0.0
Logistic regression (hard preds) F-beta (2) of:  0.0
-----------------------------------------------------------

Logistic regression (soft preds with 0.17 decision threshold) accuracy of:  0.8340674603174603
Logistic regression (soft preds with 0.17 decision threshold) recall of:  0.11845286059629331
Logistic regression (soft preds with 0.17 decision threshold) precision of:  0.2025909592061742
Logistic regression (soft preds with 0.17 decision threshold) F1 of:  0.149496593104851
Logistic regression (soft preds with 0.17 decision threshold) F-beta (2) of:  0.12918307086614175
Logistic regression (soft preds with 0.17 decision threshold) log loss of:  0.3689427109489983
-----------------------------------------------------------

ROC AUC score =  0.5768461945124708
```

Logistic regression validation results



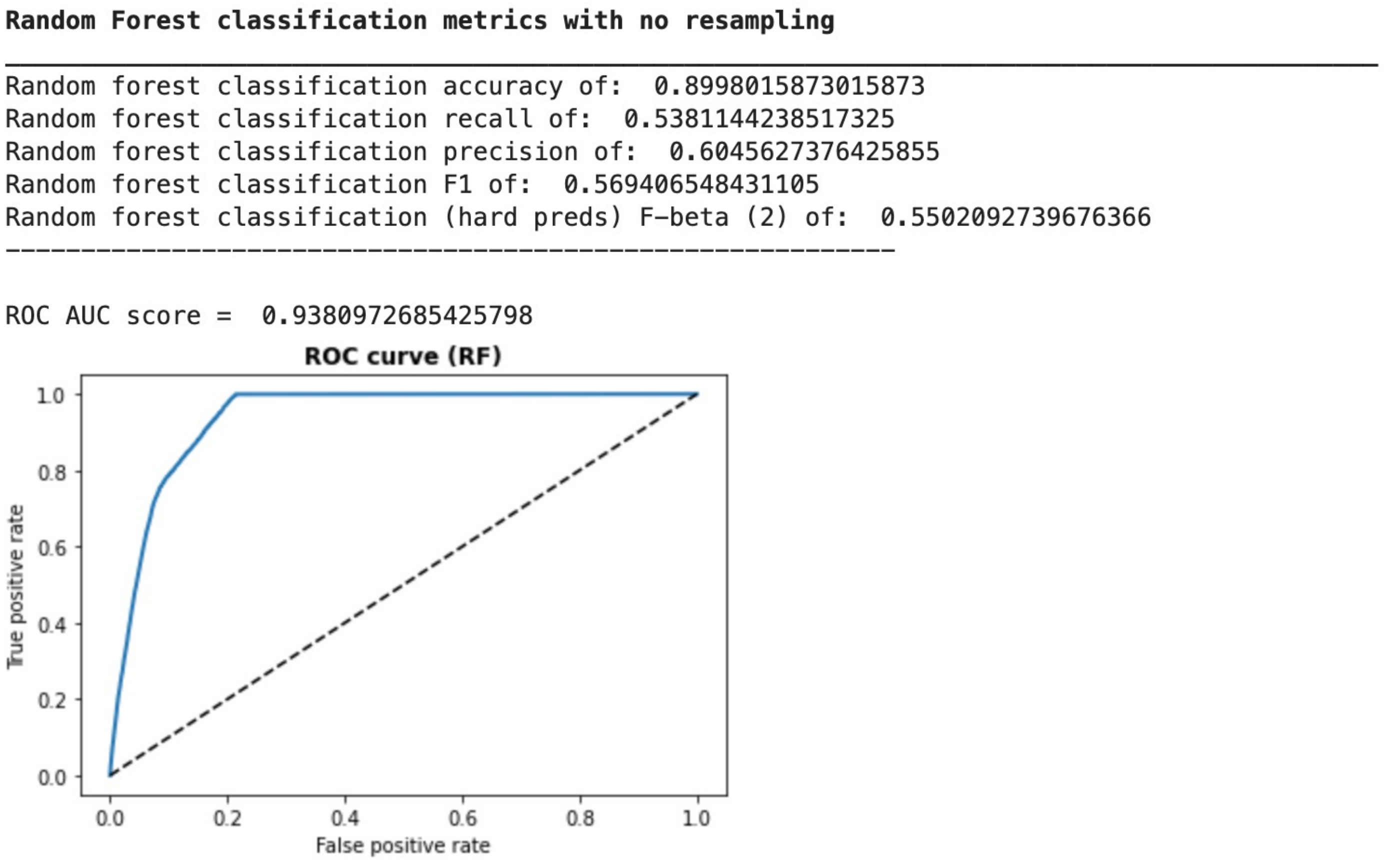
Logistic Regression classification metrics with resampling

```
Logistic regression (hard preds) accuracy of:  0.8704563492063492
Logistic regression (hard preds) recall of:  0.032393231265108784
Logistic regression (hard preds) precision of:  0.2768595041322314
Logistic regression (hard preds) F1 of:  0.05800028855864955
Logistic regression (hard preds) F-beta (2) of:  0.0393407969936585
-----------------------------------------------------------

Logistic regression (soft preds with 0.17 decision threshold) accuracy of:  0.1252579365079365
Logistic regression (soft preds with 0.17 decision threshold) recall of:  0.9988718775181306
Logistic regression (soft preds with 0.17 decision threshold) precision of:  0.12327459326146625
Logistic regression (soft preds with 0.17 decision threshold) F1 of:  0.21946426358373317
Logistic regression (soft preds with 0.17 decision threshold) F-beta (2) of:  0.4126607899011958
Logistic regression (soft preds with 0.17 decision threshold) log loss of:  0.5096175315499527
-----------------------------------------------------------

ROC AUC score =  0.5770271739987578
```

Random forest validation results

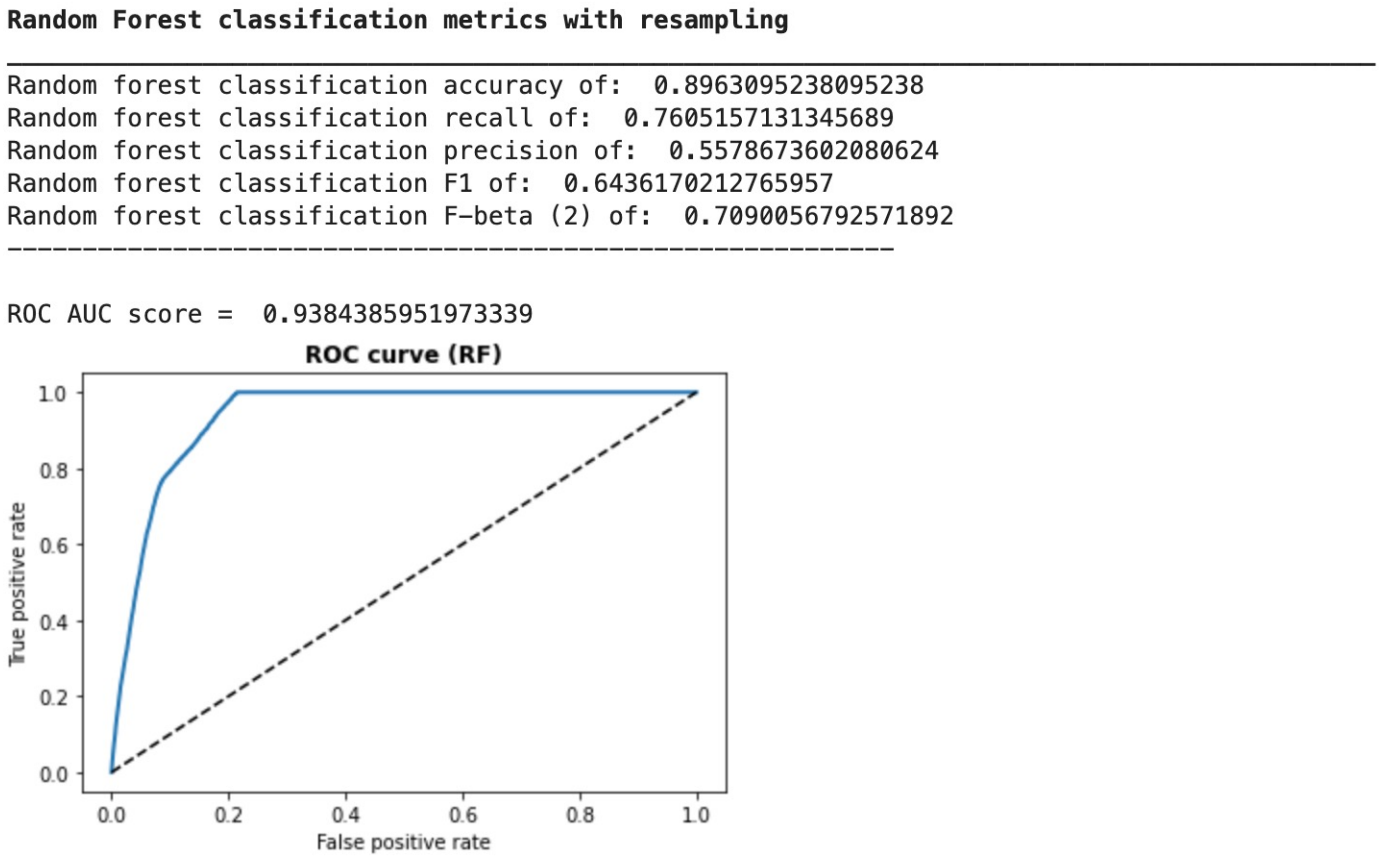


Random Forest classification metrics with no resampling

```
________________________________________________________________________________________
Random forest classification accuracy of:  0.8998015873015873
Random forest classification recall of:  0.5381144238517325
Random forest classification precision of:  0.6045627376425855
Random forest classification F1 of:  0.569406548431105
Random forest classification (hard preds) F-beta (2) of:  0.5502092739676366
-----------------------------------------------------------

ROC AUC score =  0.9380972685425798
```

Random forest validation results



```
Random Forest classification metrics with resampling

Random forest classification accuracy of:  0.8963095238095238
Random forest classification recall of:  0.7605157131345689
Random forest classification precision of:  0.5578673602080624
Random forest classification F1 of:  0.6436170212765957
Random forest classification F-beta (2) of:  0.7090056792571892
-----------------------------------------------------------

ROC AUC score =  0.9384385951973339
```