Rain prediction using ANN

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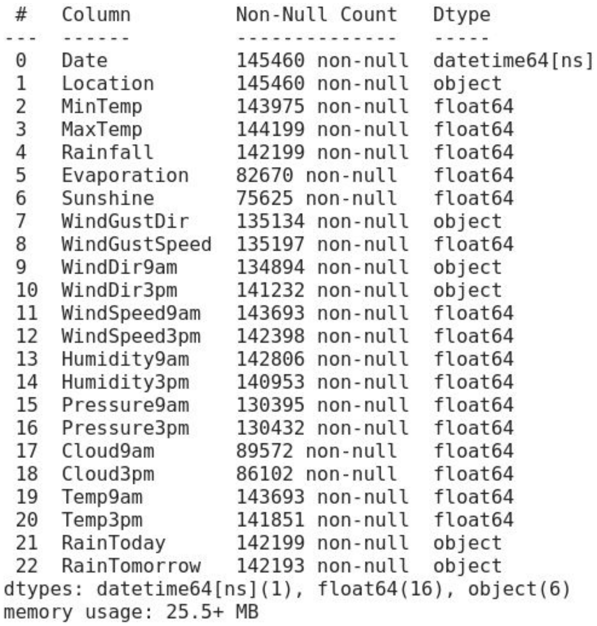
Problem statement

To predicate whether it will rain or not in Australia.

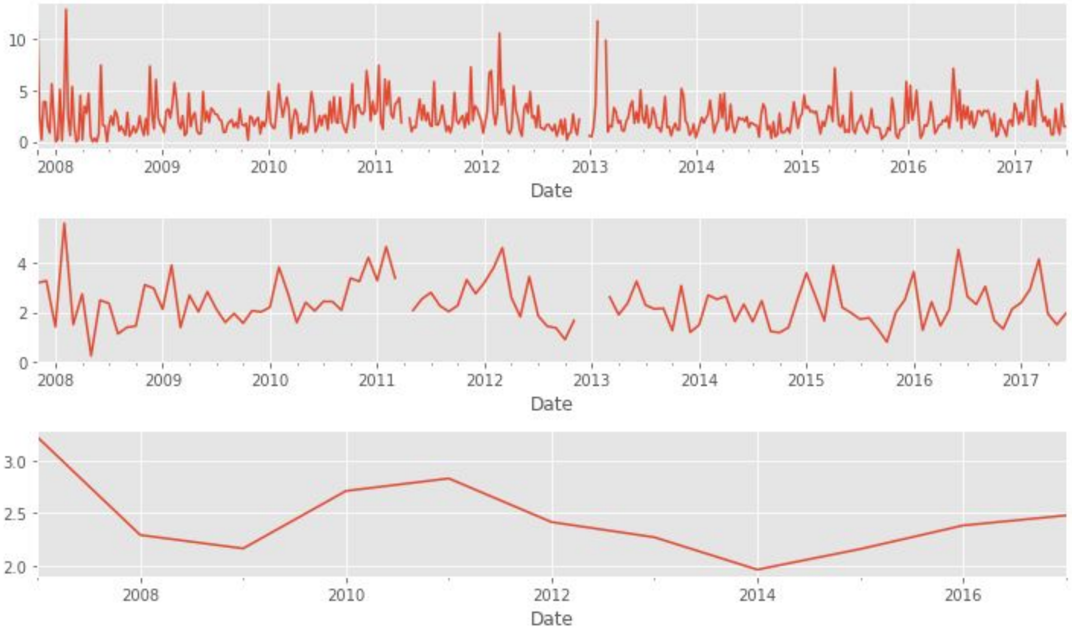
Dataset

- Outsourced from Kaggle.
- 23 Columns
    - 1 Datetime
    - 15 Numerical
    - 7 Categorical
- 145,460 observations

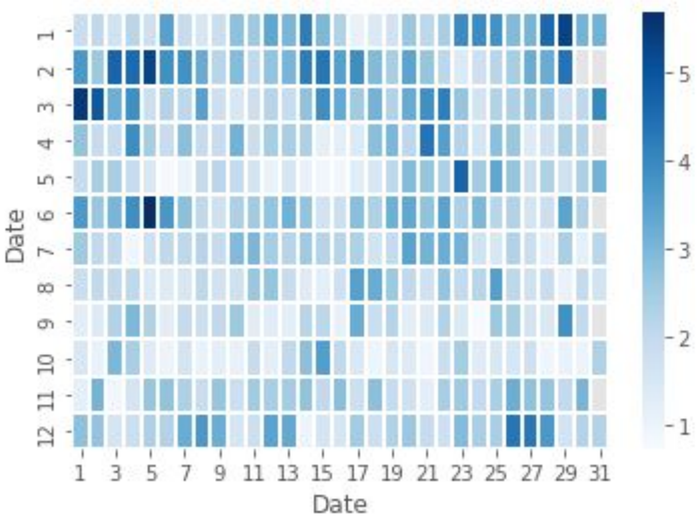


```
 #   Column         Non-Null Count   Dtype
---  ------         --------------   -----
 0   Date           145460 non-null  datetime64[ns]
 1   Location       145460 non-null  object
 2   MinTemp        143975 non-null  float64
 3   MaxTemp        144199 non-null  float64
 4   Rainfall       142199 non-null  float64
 5   Evaporation    82670 non-null   float64
 6   Sunshine       75625 non-null   float64
 7   WindGustDir    135134 non-null  object
 8   WindGustSpeed  135197 non-null  float64
 9   WindDir9am     134894 non-null  object
 10  WindDir3pm     141232 non-null  object
 11  WindSpeed9am   143693 non-null  float64
 12  WindSpeed3pm   142398 non-null  float64
 13  Humidity9am    142806 non-null  float64
 14  Humidity3pm    140953 non-null  float64
 15  Pressure9am    130395 non-null  float64
 16  Pressure3pm    130432 non-null  float64
 17  Cloud9am       89572 non-null   float64
 18  Cloud3pm       86102 non-null   float64
 19  Temp9am        143693 non-null  float64
 20  Temp3pm        141851 non-null  float64
 21  RainToday      142199 non-null  object
 22  RainTomorrow   142193 non-null  object
dtypes: datetime64[ns](1), float64(16), object(6)
memory usage: 25.5+ MB
```

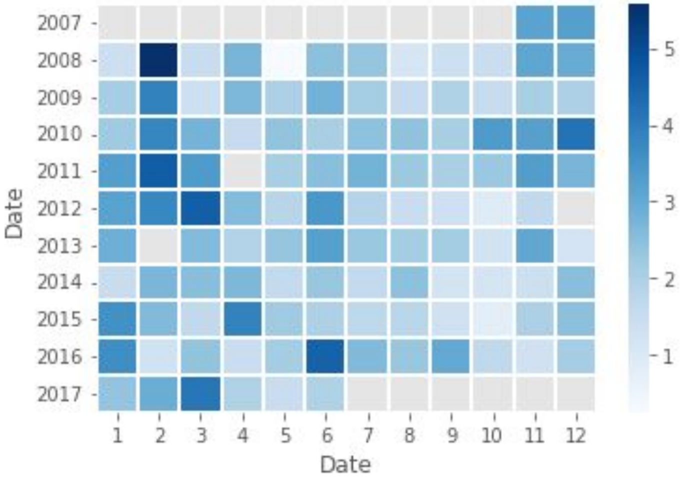
EDA


0
5
10
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Date
0
2
4
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Date
2.0
2.5
3.0
2008
2010
2012
2014
2016
Date

EDA

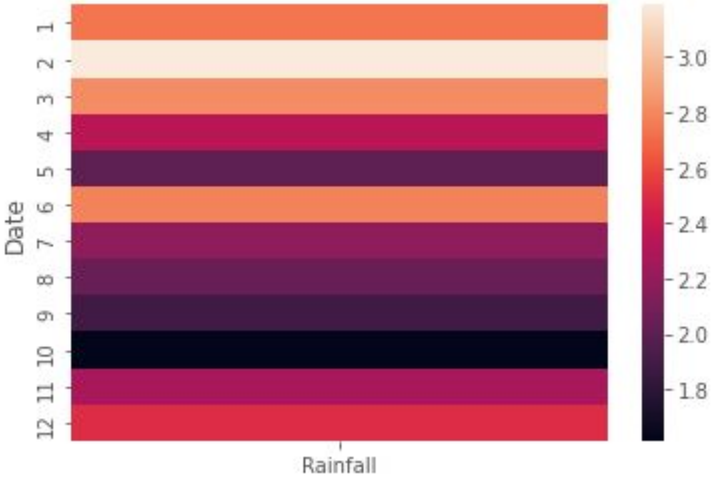


Date
1
2
3
4
5
6
7
8
9
10
11
12
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
Date
5
4
3
2
1

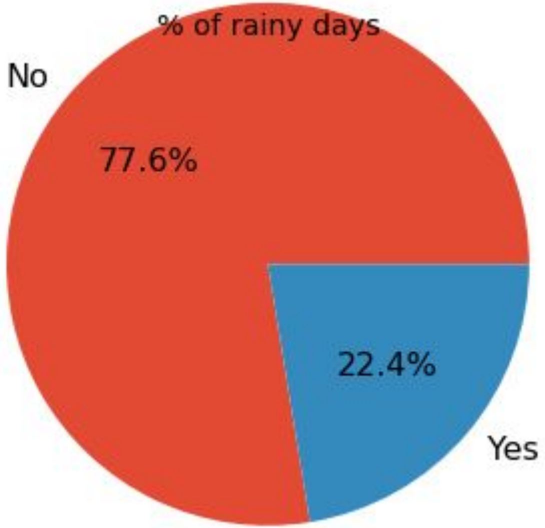


Date
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
1
2
3
4
5
6
7
8
9
10
11
12
Date
5
4
3
2
1

EDA

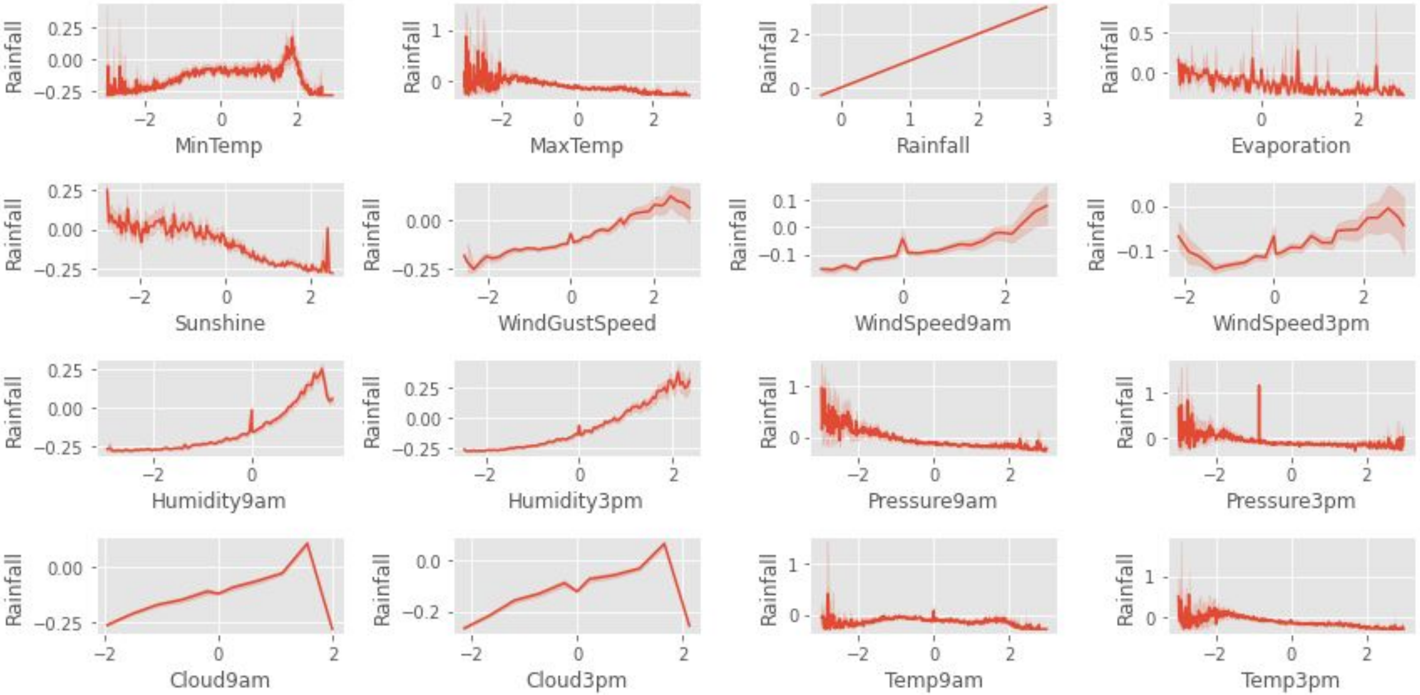


Date
1
2
3
4
5
6
7
8
9
10
11
12
Rainfall
3.0
2.8
2.6
2.4
2.2
2.0
1.8



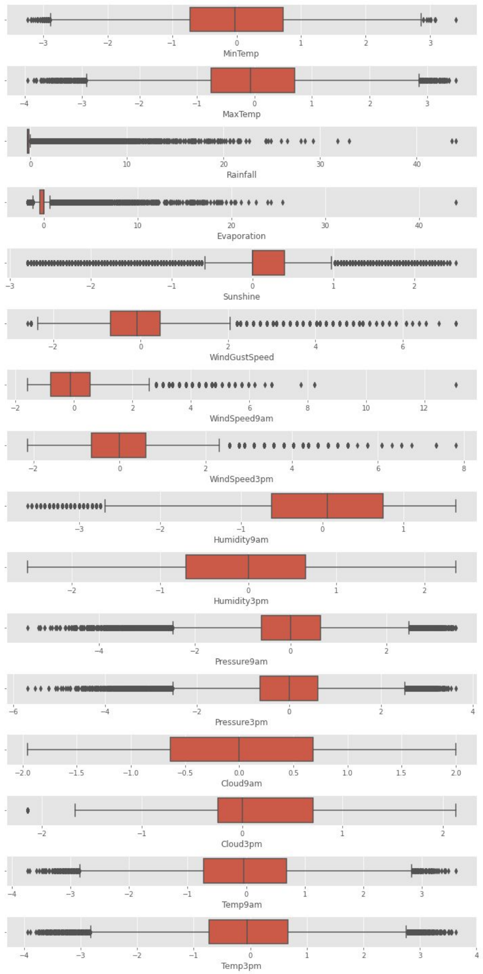
% of rainy days
No
77.6%
22.4%
Yes

EDA



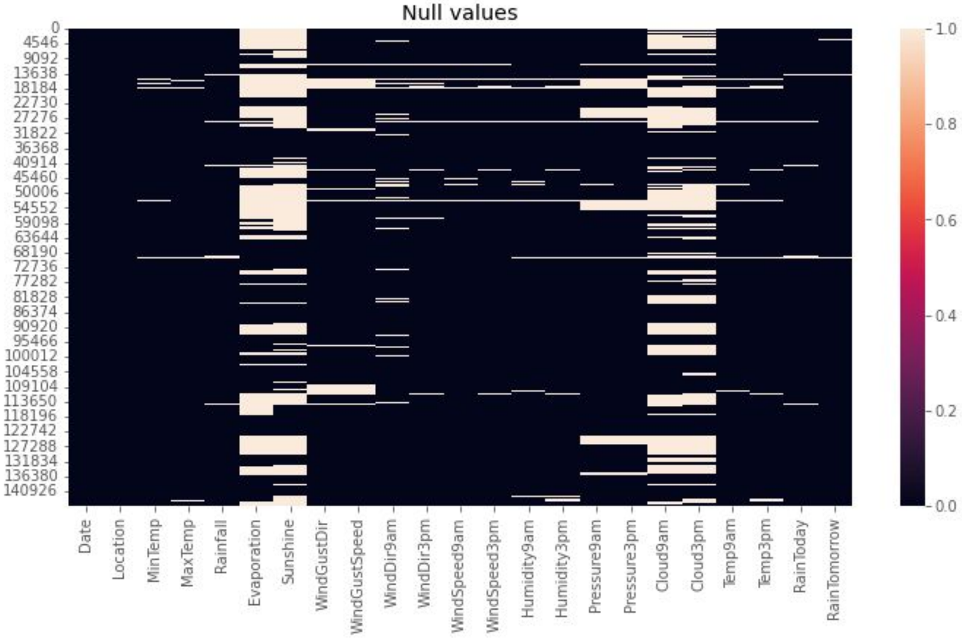
Rainfall
0.25
0.00
−0.25
−2
0
2
MinTemp
Rainfall
1
0
−2
0
2
MaxTemp
Rainfall
2
0
0
1
2
3
Rainfall
Rainfall
0.5
0.0
0
2
Evaporation
Rainfall
0.25
0.00
−0.25
−2
0
2
Sunshine
Rainfall
0.00
−0.25
−2
0
2
WindGustSpeed
Rainfall
0.1
0.0
−0.1
0
2
WindSpeed9am
Rainfall
0.0
−0.1
−2
0
2
WindSpeed3pm
Rainfall
0.25
0.00
−0.25
−2
0
Humidity9am
Rainfall
0.25
0.00
−0.25
−2
0
2
Humidity3pm
Rainfall
1
0
−2
0
2
Pressure9am
Rainfall
1
0
−2
0
2
Pressure3pm
Rainfall
0.00
−0.25
−2
0
2
Cloud9am
Rainfall
0.0
−0.2
−2
0
2
Cloud3pm
Rainfall
1
0
−2
0
2
Temp9am
Rainfall
1
0
−2
0
2
Temp3pm

EDA


−3 −2 −1 0 1 2 3
MinTemp
−4 −3 −2 −1 0 1 2 3
MaxTemp
0 10 20 30 40
Rainfall
0 10 20 30 40
Evaporation
−3 −2 −1 0 1 2
Sunshine
−2 0 2 4 6
WindGustSpeed
−2 0 2 4 6 8 10 12
WindSpeed9am
−2 0 2 4 6 8
WindSpeed3pm
−3 −2 −1 0 1
Humidity9am
−2 −1 0 1 2
Humidity3pm
−4 −2 0 2
Pressure9am
−6 −4 −2 0 2 4
Pressure3pm
−2.0 −1.5 −1.0 −0.5 0.0 0.5 1.0 1.5 2.0
Cloud9am
−2 −1 0 1 2
Cloud3pm
−4 −3 −2 −1 0 1 2 3
Temp9am
−4 −3 −2 −1 0 1 2 3 4
Temp3pm

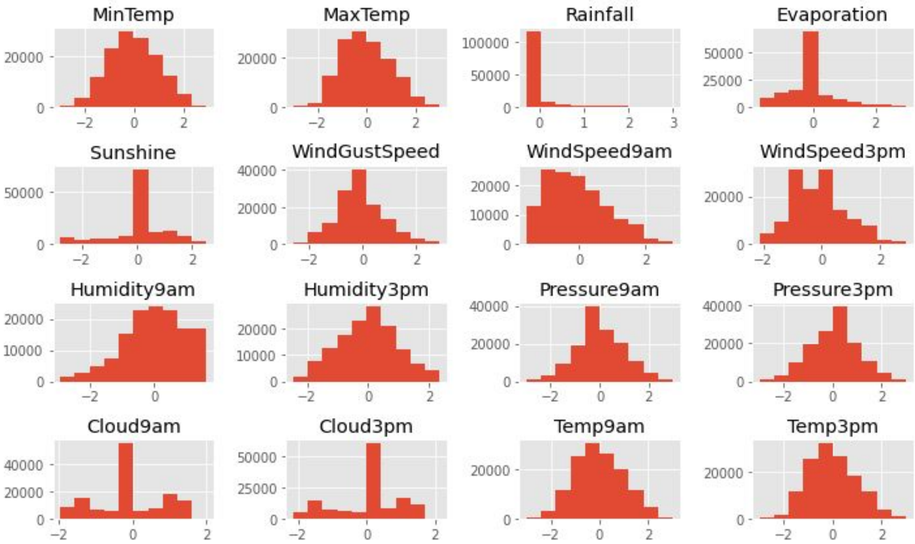
Data engineering

- Many columns with missing values!
  - Numerical values filled with the mean
  - Categorical values filled with the its neighbor.
  - Columns having >50% missing values were dropped.



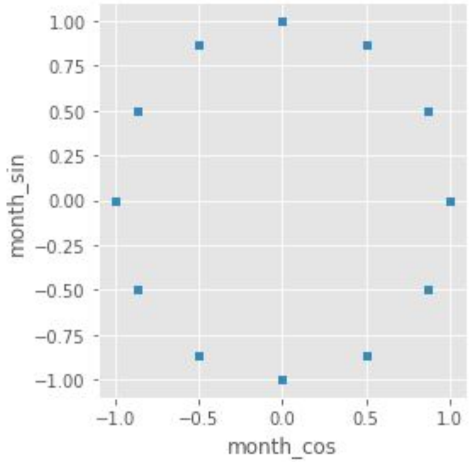
Data engineering

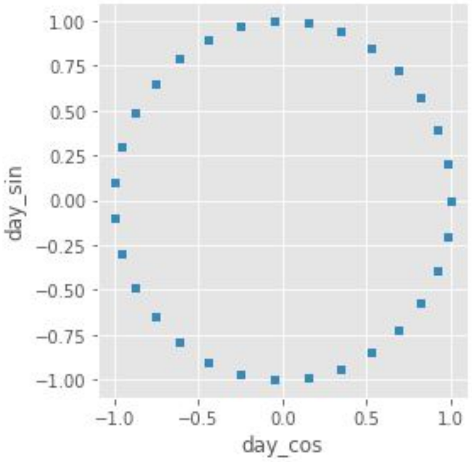
- Standardized the numerical values to have range within -1,1.
- Removed outliers whose values exceeded [-3, 3]
    - n = 8,674
- Removed columns with high collinearity VIF > 5.
    - n = 4



Data engineering

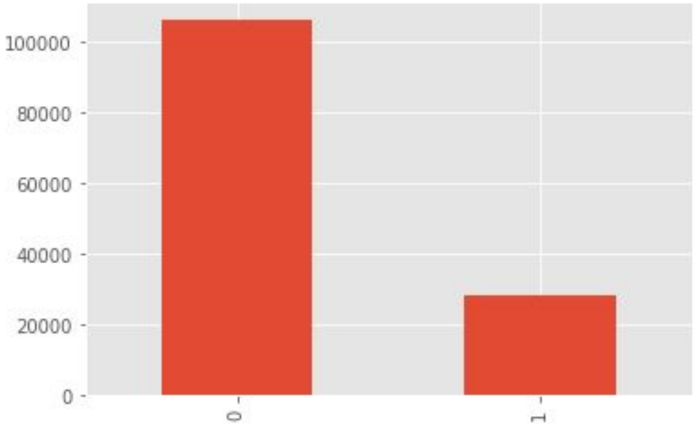
- Encoded categorical values to integers.
- Created vector embeddings for categorical values.
- Encoded Month/Day values into cyclical features.

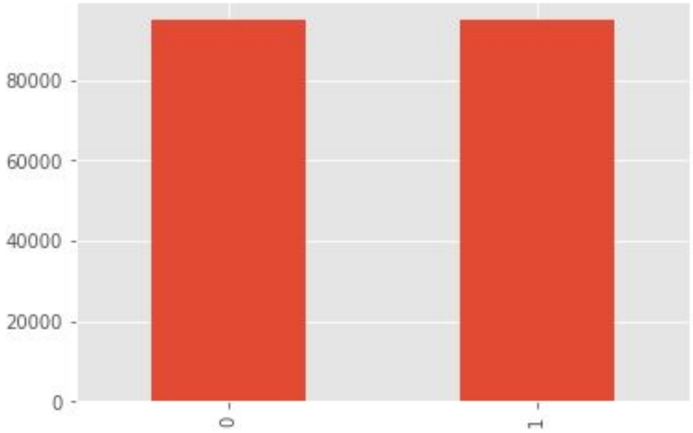




Data split & balance

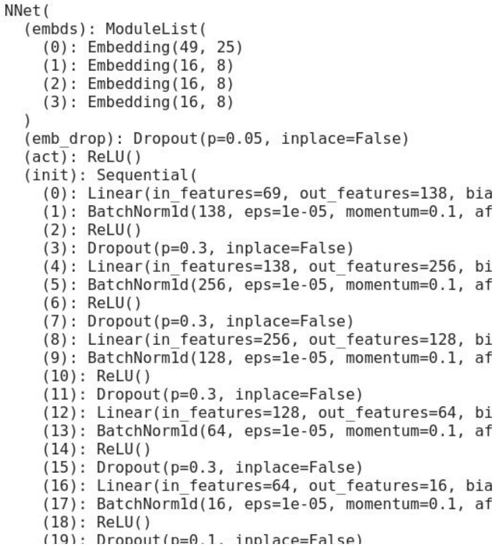
- 90% Training data
  - Balanced classes using SMOTE
  - (n = 189,680)
- 5% Validation
- 5% Testing





Model architecture

- ANN with 6 layers
- Used embeddings to encode categorical data.
- ReLU activation functions.
- Included dropout and Batch normalization.
- Adam.
- Binary cross entropy loss.

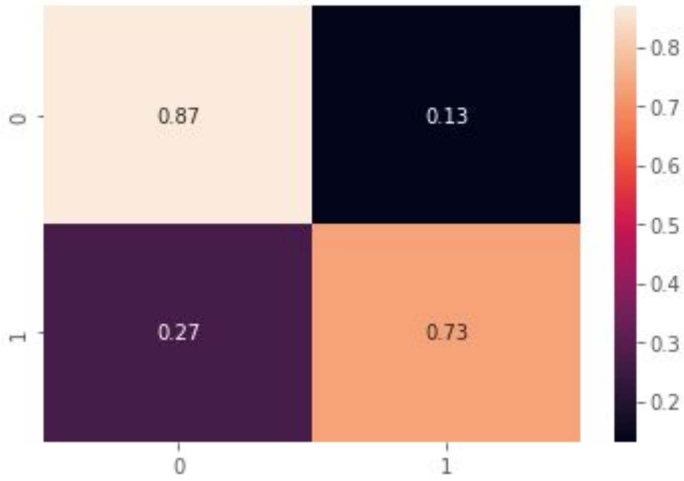


```
NNet(
  (embds): ModuleList(
    (0): Embedding(49, 25)
    (1): Embedding(16, 8)
    (2): Embedding(16, 8)
    (3): Embedding(16, 8)
  )
  (emb_drop): Dropout(p=0.05, inplace=False)
  (act): ReLU()
  (init): Sequential(
    (0): Linear(in_features=69, out_features=138, bia
    (1): BatchNorm1d(138, eps=1e-05, momentum=0.1, af
    (2): ReLU()
    (3): Dropout(p=0.3, inplace=False)
    (4): Linear(in_features=138, out_features=256, bi
    (5): BatchNorm1d(256, eps=1e-05, momentum=0.1, af
    (6): ReLU()
    (7): Dropout(p=0.3, inplace=False)
    (8): Linear(in_features=256, out_features=128, bi
    (9): BatchNorm1d(128, eps=1e-05, momentum=0.1, af
    (10): ReLU()
    (11): Dropout(p=0.3, inplace=False)
    (12): Linear(in_features=128, out_features=64, bi
    (13): BatchNorm1d(64, eps=1e-05, momentum=0.1, af
    (14): ReLU()
    (15): Dropout(p=0.3, inplace=False)
    (16): Linear(in_features=64, out_features=16, bia
    (17): BatchNorm1d(16, eps=1e-05, momentum=0.1, af
    (18): ReLU()
    (19): Dropout(p=0.1, inplace=False)
```

Results

	Training	Validation	Testing
Loss	0.339279	0.365065	0.362375
Accuracy	84.71%	84.23%	84.02%
F1	0.8428	0.6689	0.6517

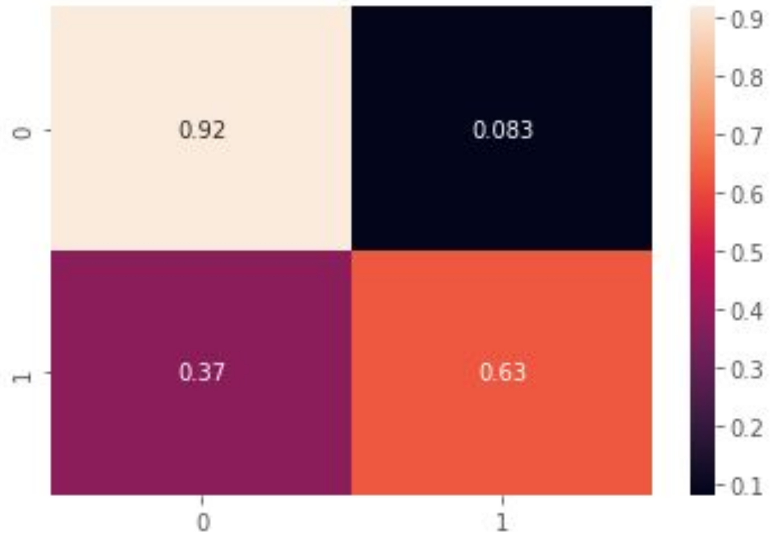
Results: Test data



Results: Random Forest Classifier

	Training	Validation	Testing
Accuracy	100%	84.89%	85.58%
F1	1.0	0.6473	0.6448

Results: Test data



Libraries used

- Numpy
- Pandas
- Sklearn
- PyTorch
- imbalanced-learn
- seaborn & matplotlib