

Neural FSA

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Dataset

Credit Card Approvals: [UCI Machine Learning Repository](#), [Kaggle](#)

- 690 objects
- 14 attributes:
 - 6 binary
 - 4 numeric
 - 3 categorical
- Binary target – 44% positive objects => balanced target
- Metric: F1 score (pay more attention to positive class)
- Split data: 40% train, 20% validation, 40% test

Binarization

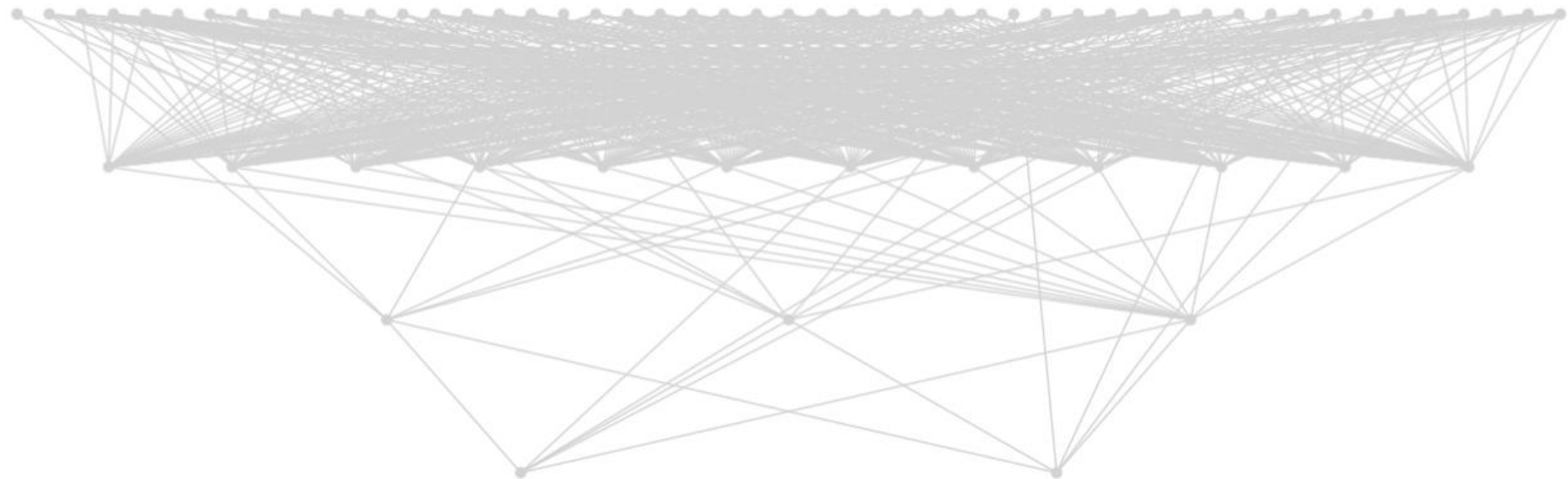
- For categorical features let's use one-hot encoding
- For numeric features compare 2 strategies:
 - Select bins (using quantiles) b_1, b_2, \dots, b_k , then use interval $[b_i, b_j]$ - win
 - Select bins (using quantiles) b_1, b_2, \dots, b_k , then use interval $(-\infty, b_j]$
- Binary features let's keep the same
- For any attribute – use it and its negation (+0.02 F1 Score)

F1 Score	train	validation	test
$[b_i, b_j]$	0.839	0.843	0.828
$(-\infty, b_j]$	0.829	0.814	0.805

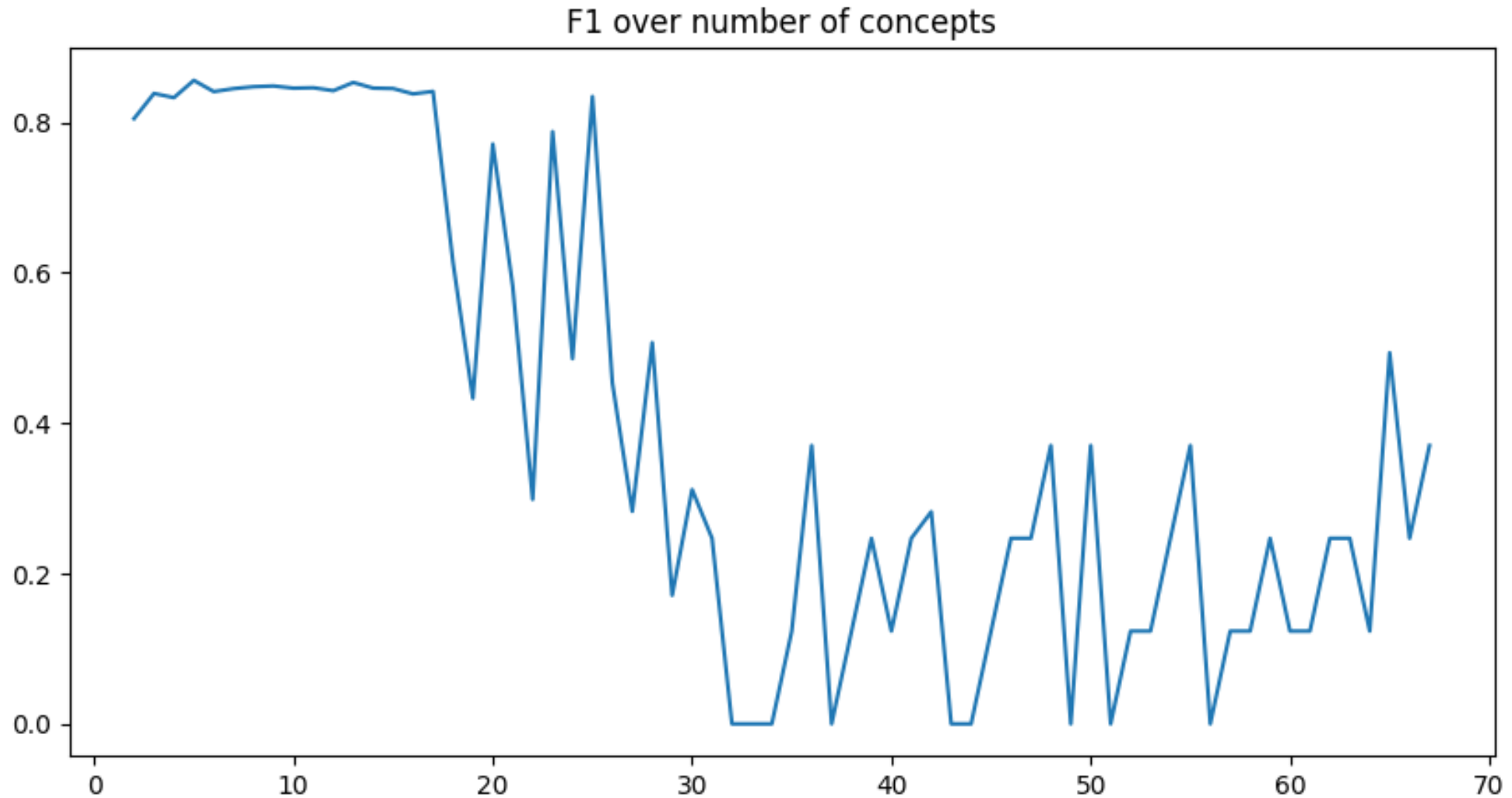
Concept Selection

- Extract concepts from train data context using Sofia algo (CbO too slow)
- Select k best concepts using F1 score
- Choose best k using validation dataset and F1 score

POSet with 15 best concepts from monotone concept lattice



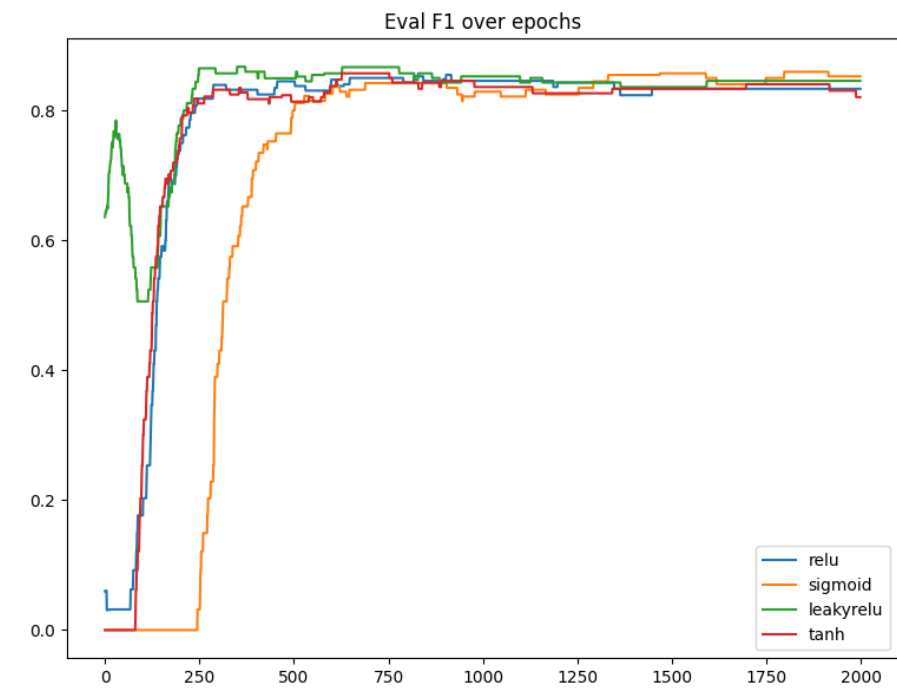
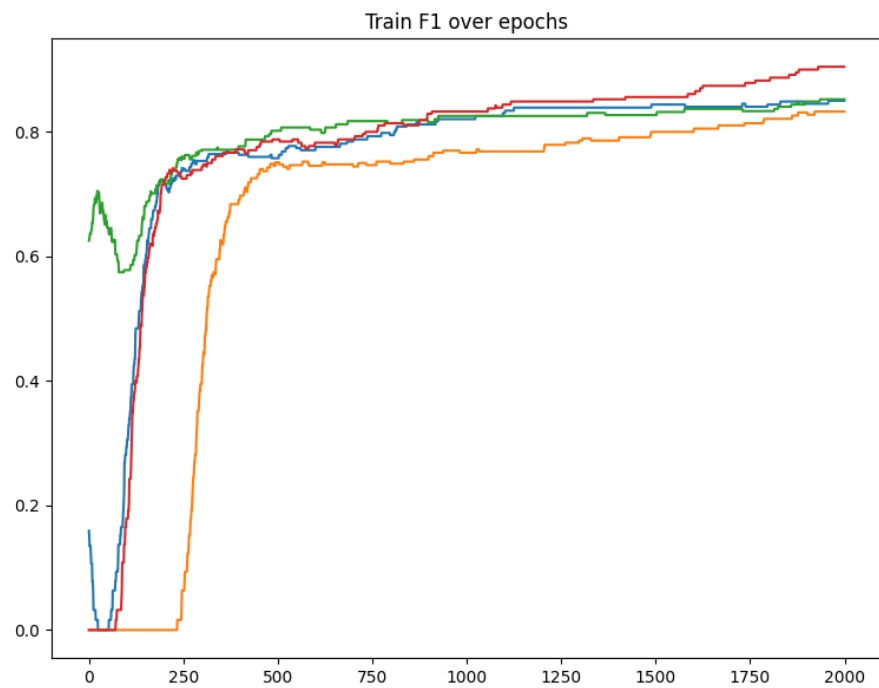
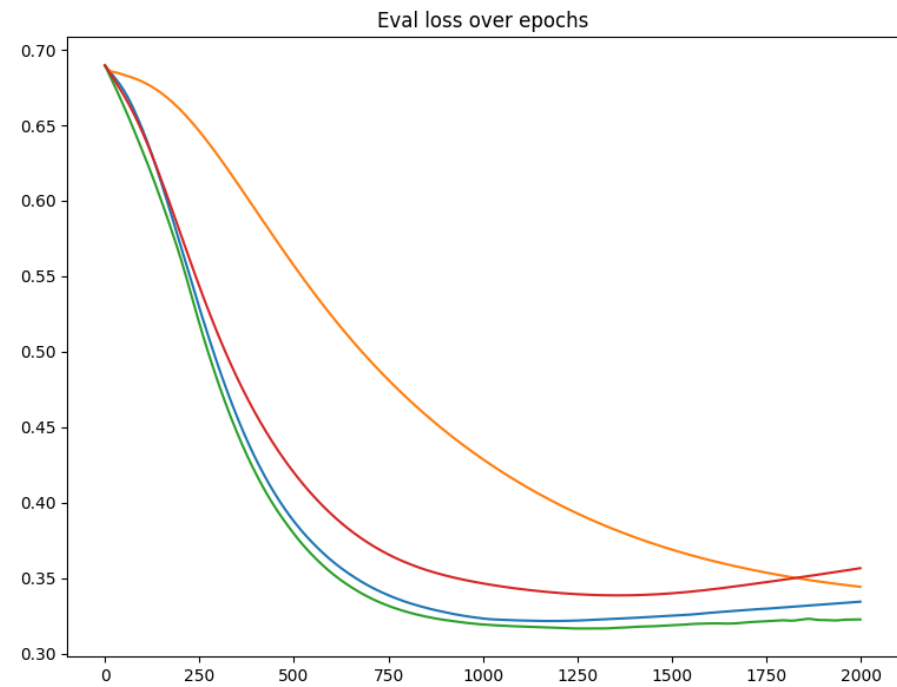
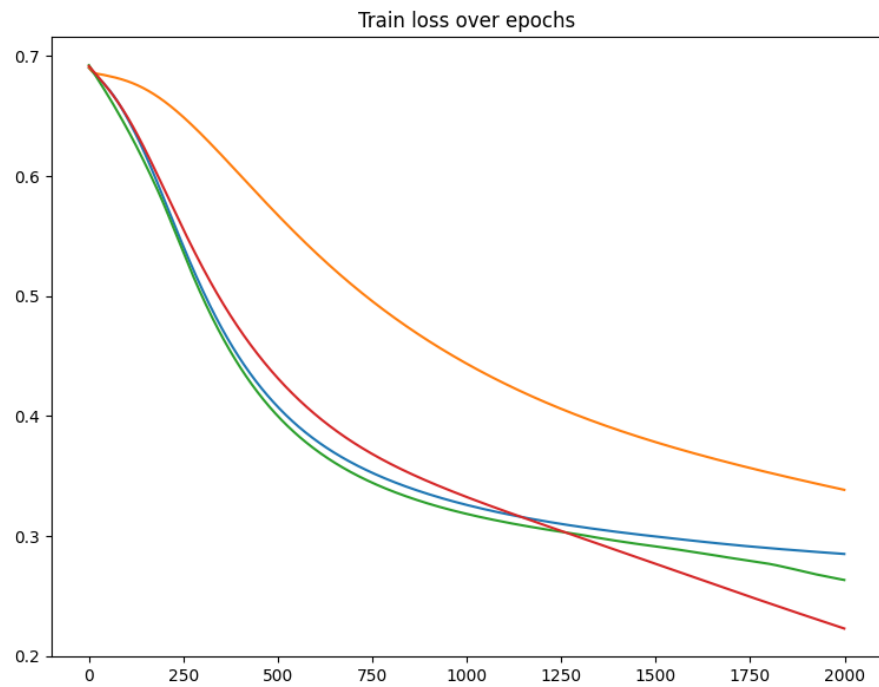
5 best concepts is enough



Neural Network

- Optimizer Adam, lr=3e-4, n_epoch=2000
- Compare different activation functions: LeakyReLU - best test quality

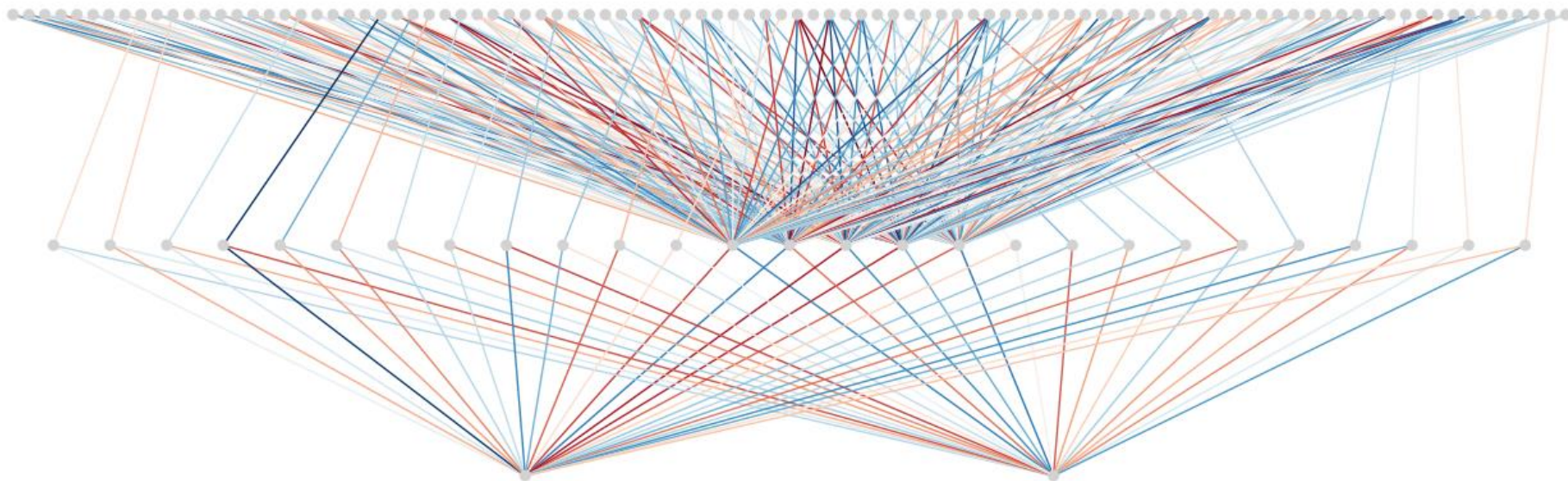
F1 Score	train	validation	test
ReLU	0.850	0.833	0.828
Sigmoid	0.833	0.852	0.812
LeakyReLU	0.852	0.846	0.833
Tanh	0.904	0.821	0.81



Combining all – Best FCA-based NN

- Interval binarization for numeric features + add negations
- 5 best concepts
- LeakyReLU

Fitted Context Network



Comparison with SotA approaches

model	train	validation	test
DT(max_depth=4)	0.871	0.835	0.808
Catboost(n_trees=17)	0.842	0.934	0.869
RF(max_depth=9, n_trees=28)	0.975	0.847	0.832
LogReg	0.835	0.857	0.790
KNN(n_neighbors=19)	0.747	0.789	0.772
ContextNetwork	0.851	0.846	0.833

Conclusion

- Binarization greatly expands the number of attributes (98 vs 14 initial)
- Building concepts is computationally expensive
- Tuning activation function may increase quality
- The FCA-based NN can outperform some classical methods and achieve SotA quality level
- It was fun to apply FCA-based neural network!