

Activity prediction for chemical compounds

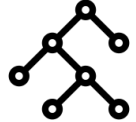
ID2214 – Data Science Project

Team members: David Happel, Albin Bååw, and Petrus Oskarsson

- **Final selected model**
- Handle of imbalance data
- Metrics
- Evaluated data sets and features
- Model comparison
- Parameter settings

The final selected model is the random forest classifier with AUC 0.77 and F1 0,69 scores on validation data

Final results



Selected model and performance

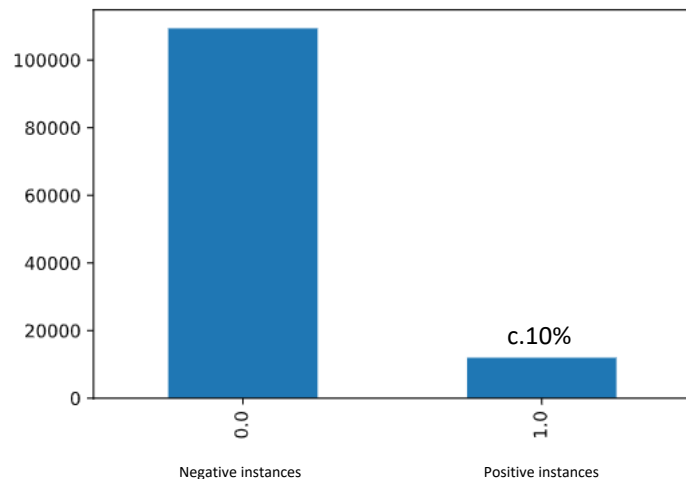
- The final selected model is the random forest classifier
- Parameter settings:
 - 300 trees and max depth 'None'
- Validation performance:
 - AUC: 0.7730 (+/- 0.01)
 - F1 0.6953 (+/- 0.01)

- Final selected model
- **Handle of imbalance data**
- Metrics
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Initial observation: c. 10 % of positive cases – undersampling have been made to balance it out

Handle of imbalanced data set

Imbalanced data set



Actions

- The imbalance could cause potential learning issues, e.g. learning to predict all instances and get a 90% acc.
- Undersampling has been applied to balance out the positive and negative cases
 - Both over and undersampling was evaluated – undersampling gave the best performance

- Final selected model
- Handle of imbalance data
- **Metrics**
- Evaluated data sets and features
- Model comparison
- Parameter settings

Multiple metrics have been applied, however, F1 and AUC score are thought to be the most important

Metrics



Metrics

- Accuracy – can be misleading...
- **AUC** – Performance for every threshold + competition metrics...
- Precision – How precise of classified positives
- Recall – Fraction of actual positives
- **F1 score** - Balances precision and recall

- Final selected model
- Handle of imbalance data
- Metrics
- **Evaluated data sets and features**
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Seven alternative data sets have been evaluated

Evaluated data sets and features

Data sets



1. All features and **minmax** scaling
2. All features and **zscore** scaling
3. All features **except 'Lipinski'**
4. Only features ['nrAtoms', 'ExactMolWT', 'Fragments']
5. Only features ['nrAtoms', 'ExactMolWT', 'Fragments', 'Lipinski']
6. **Only fingerprint binaries**
7. **PCA** dimensionality reduction

Features



- 'nrAtoms'
- 'ExactMolWT'
- 'Fragments'
- 'Lipinski'
- 124 bits fingerprint vector

- Final selected model
- Handle of imbalance data
- Metrics
- Evaluated data sets and features
- **Data set and model comparison**
- Parameter settings

Best performance: data set 3 (zscore and no 'Lipinski') and the random forest classifier model

Data set and model comparison



Selected data sets and model comparison

Best performer:
zscore and
'Lipinski' dropped

model	AUC score	f1 score
logisticregression	0.6574 (+/- 0.00)	0.6111 (+/- 0.00)
randomforestclassifier	0.7558 (+/- 0.01)	0.6794 (+/- 0.01)
gaussiannb	0.6310 (+/- 0.01)	0.6415 (+/- 0.01)
adaboostclassifier	0.5761 (+/- 0.01)	0.5762 (+/- 0.01)
mlpclassifier	0.6877 (+/- 0.00)	0.6352 (+/- 0.01)
gradientboostingclassifier	0.6870 (+/- 0.00)	0.6294 (+/- 0.00)

Table 3: 5-fold CV Scores Dataset 3

Only fingerprint
showed **similar
performance**

model	AUC score	f1 score
logisticregression	0.6476 (+/- 0.01)	0.6041 (+/- 0.01)
randomforestclassifier	0.7519 (+/- 0.01)	0.6735 (+/- 0.01)
gaussiannb	0.6232 (+/- 0.01)	0.6300 (+/- 0.01)
adaboostclassifier	0.5788 (+/- 0.01)	0.5836 (+/- 0.01)
mlpclassifier	0.6775 (+/- 0.01)	0.6340 (+/- 0.00)
gradientboostingclassifier	0.6802 (+/- 0.01)	0.6184 (+/- 0.01)

Table 6: 5-fold CV Scores Dataset 6

Excluding
fingerprint
**decreased
performance...**

model	AUC score	f1 score
logisticregression	0.5596 (+/- 0.00)	0.5371 (+/- 0.01)
randomforestclassifier	0.5529 (+/- 0.01)	0.5426 (+/- 0.01)
gaussiannb	0.5429 (+/- 0.01)	0.6369 (+/- 0.00)
adaboostclassifier	0.5501 (+/- 0.01)	0.5498 (+/- 0.01)
mlpclassifier	0.5682 (+/- 0.00)	0.5651 (+/- 0.02)
gradientboostingclassifier	0.5662 (+/- 0.01)	0.5709 (+/- 0.02)

Table 5: 5-fold CV Scores Dataset 5

PCA 2 dimension
– **not helpful**

model	AUC score	f1 score
logisticregression	0.5551 (+/- 0.00)	0.5337 (+/- 0.01)
randomforestclassifier	0.5224 (+/- 0.01)	0.5157 (+/- 0.01)
gaussiannb	0.5570 (+/- 0.00)	0.5376 (+/- 0.01)
adaboostclassifier	0.5050 (+/- 0.01)	0.5070 (+/- 0.01)
mlpclassifier	0.5615 (+/- 0.01)	0.5295 (+/- 0.02)
gradientboostingclassifier	0.5597 (+/- 0.01)	0.5479 (+/- 0.01)

Table 7: 5-fold CV Scores Dataset 7

- Final selected model
- Handle of imbalance data
- Metrics
- Evaluated data sets and features
- Model comparison
- **Parameter settings**

Hyperparameter tuning of RF performed with AUC 0.77 and F1 0,69 on the validation data

Hypertuning



Parameter settings and performance

- Parameter settings:
 - 300 trees and max depth 'None'
- Validation performance:
 - AUC: 0.7730 (+/- 0.01)
 - F1 0.6953 (+/- 0.01)

rank	mean f1 score	no. trees	depth
1	0.6953 (+/- 0.01)	300	None
2	0.6886 (+/- 0.00)	200	None
3	0.6859 (+/- 0.01)	200	15
4	0.6854 (+/- 0.01)	300	15
5	0.6810 (+/- 0.01)	100	None

Table 8: Top 5 best performing configurations based on f1 score

rank	mean AUC score	no.trees	depth
1	0.7730 (+/- 0.01)	300	None
2	0.7700 (+/- 0.01)	200	None
3	0.7628 (+/- 0.01)	300	15
4	0.7582 (+/- 0.01)	200	15
5	0.7547 (+/- 0.01)	100	None

Table 9: Top 5 best performing configurations based on AUC score

Questions?

Team members: David Happel, Albin Bååw, and Petrus Oskarsson

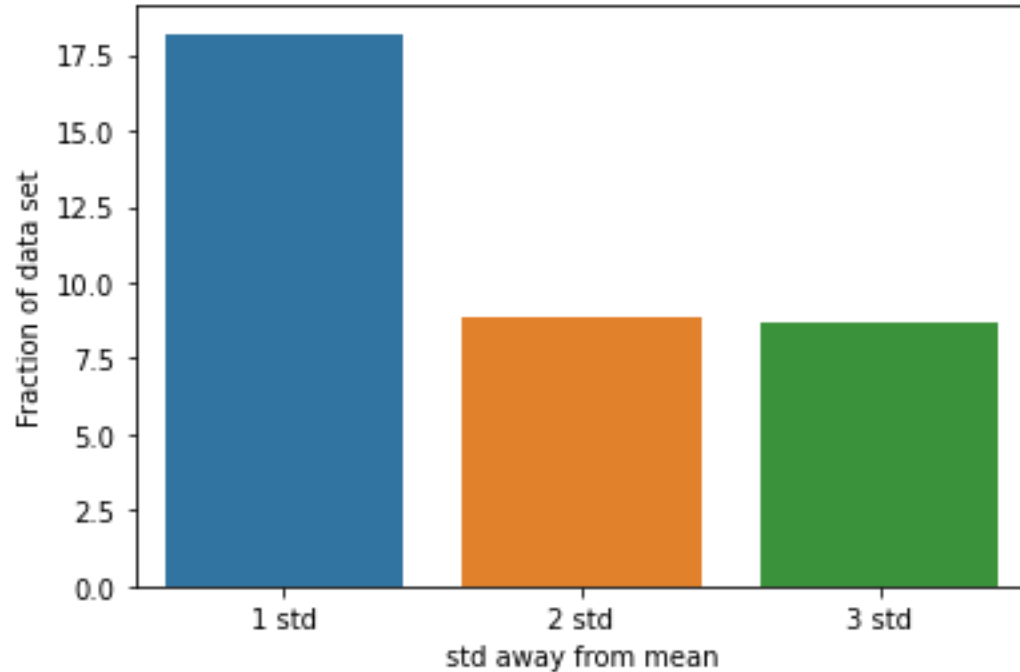
Appendix A – Data Fram view

	INDEX	SMILES	nrAtoms	ExactMolWT	Fragments	Lipinski	fp_0	fp_1	fp_2	fp_3	...	fp_114	fp_115	fp_116	fp_117	fp_118	fp_119	fp_120	fp_1
	0	121375.0	0.0	28.0	390.115047	0.0	28.0	0.0	0.0	0.0	1.0	...	0.0	0.0	0.0	0.0	0.0	1.0	0.0
	1	121376.0	0.0	28.0	381.185255	0.0	28.0	0.0	0.0	1.0	1.0	...	0.0	0.0	0.0	0.0	0.0	0.0	1.0
	2	121377.0	0.0	20.0	282.096420	0.0	20.0	0.0	0.0	1.0	1.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	121378.0	0.0	26.0	391.029663	0.0	26.0	0.0	0.0	0.0	0.0	...	1.0	0.0	0.0	1.0	0.0	0.0	1.0
	4	121379.0	0.0	34.0	500.191583	0.0	34.0	0.0	0.0	0.0	0.0	...	0.0	1.0	0.0	0.0	0.0	0.0	1.0

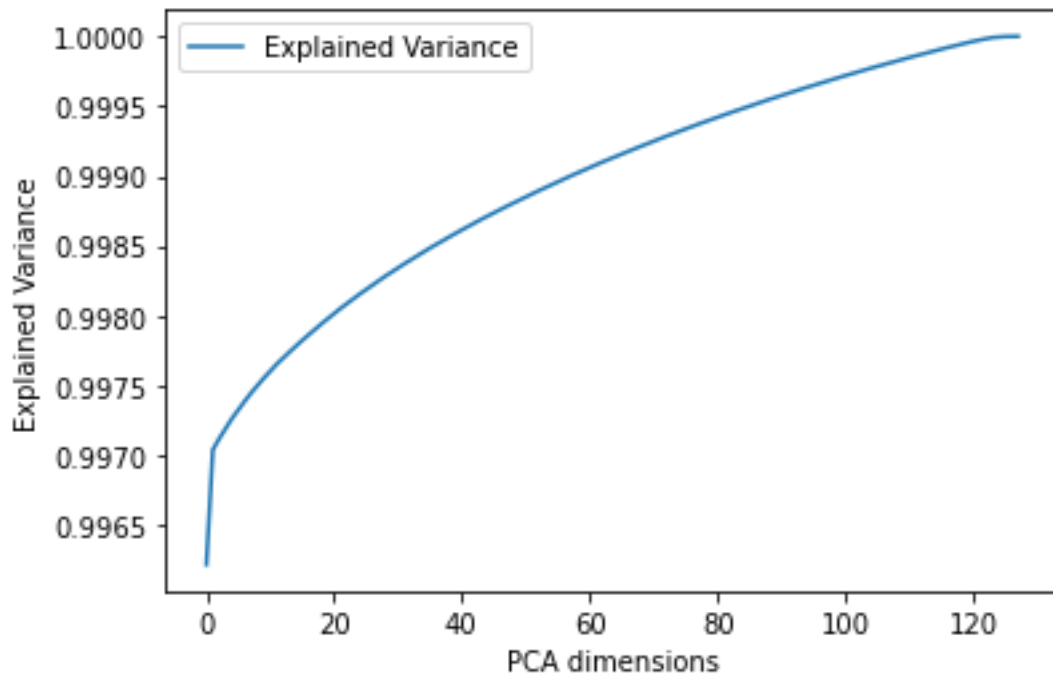
	40453	161828.0	0.0	25.0	352.099397	0.0	25.0	0.0	0.0	0.0	1.0	...	0.0	0.0	0.0	0.0	0.0	0.0	1.0
	40454	161829.0	0.0	26.0	416.037975	0.0	26.0	0.0	0.0	1.0	0.0	...	0.0	0.0	1.0	0.0	0.0	1.0	0.0
	40455	161830.0	0.0	26.0	353.101171	0.0	26.0	0.0	1.0	1.0	1.0	...	0.0	0.0	0.0	0.0	1.0	0.0	1.0
	40456	161831.0	0.0	25.0	338.137890	0.0	25.0	1.0	1.0	1.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	40457	161832.0	0.0	31.0	447.102846	0.0	31.0	0.0	0.0	0.0	1.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0

40458 rows x 130 columns

Appendix B - outliers



Appendix C – PCA explained variance



Appendix D – Hierarchical clustering

