Data Mining I

Classification

Workflow with Rapidminer

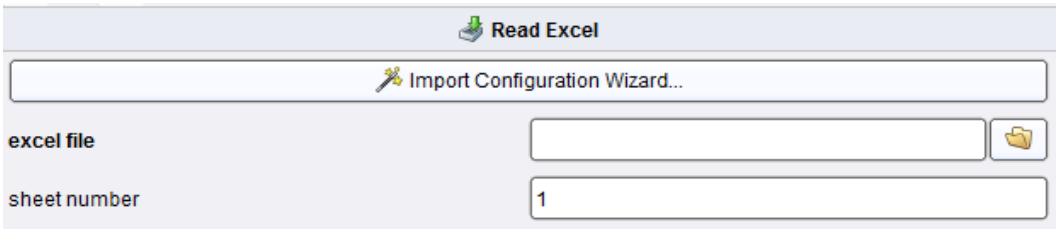
Outline

1. Data Import
2. Preprocessing
3. Classification
4. Evaluation

Data Import

- Import your data into Rapidminer Repository
  - Everything in one place
  - Valuable meta-data for further processing

- Use the import wizard, if available



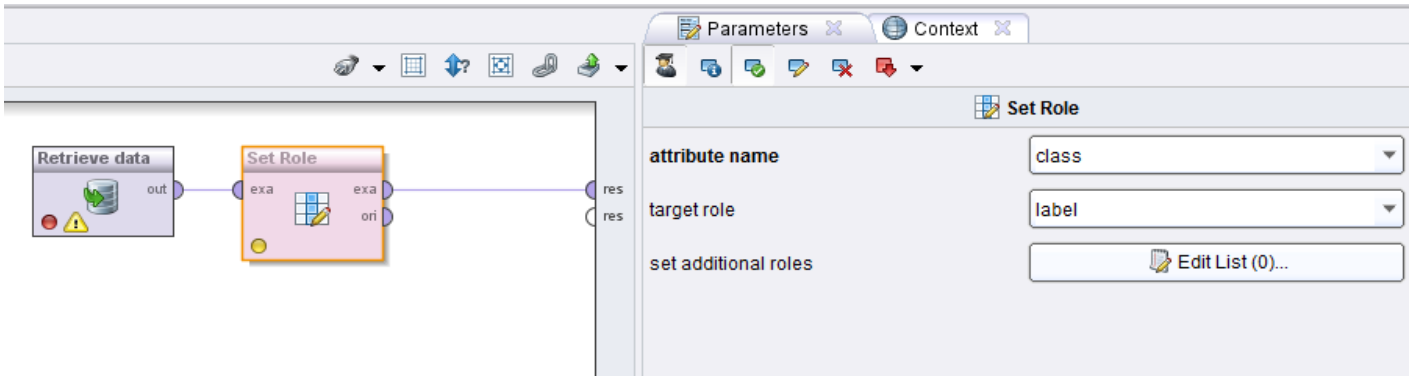
Preprocessing

- Look at your data
  - What is the target attribute?
    - Is the target attribute already a label?
  - What is the distribution of labeled examples by class?
    - Is my classifier capable of handling imbalanced data?
  - What other attributes are available?
    - Is my classifier able to handle these types of attribute?
  - What are the ranges of the attributes?
    - Is my classifier good in handling various ranges?
  - What attributes correlate?
    - Is my classifier able to handle strongly correlating attributes?

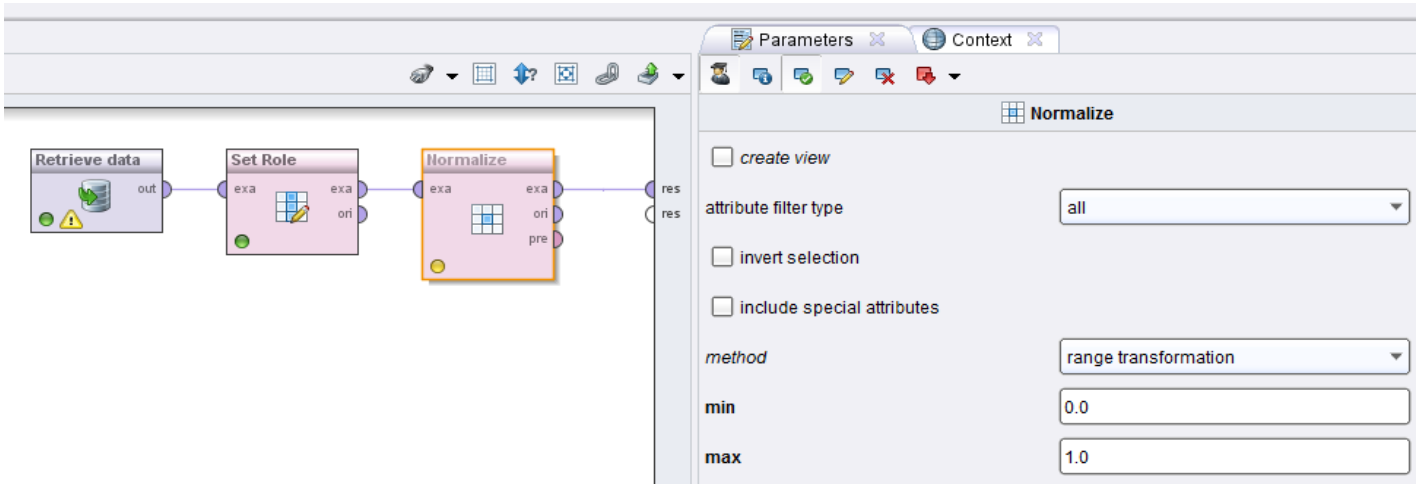
– See Exercise 1 for more information.

Set Roles & Normalization

- Set roles for attributes

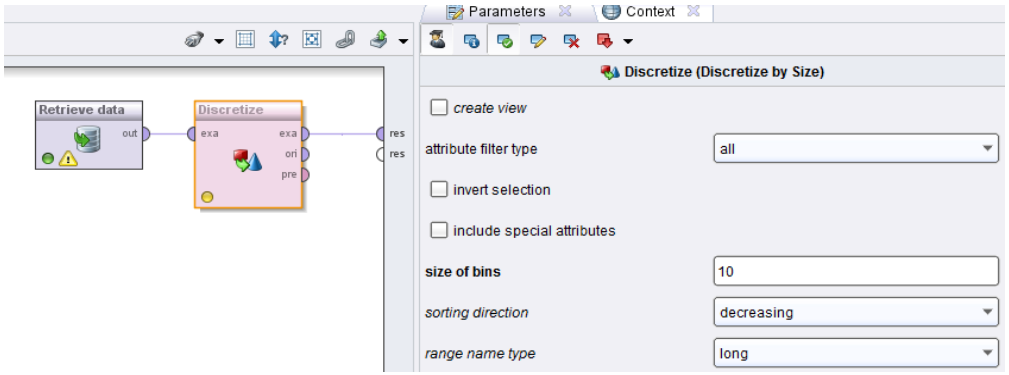


- Normalize attribute values

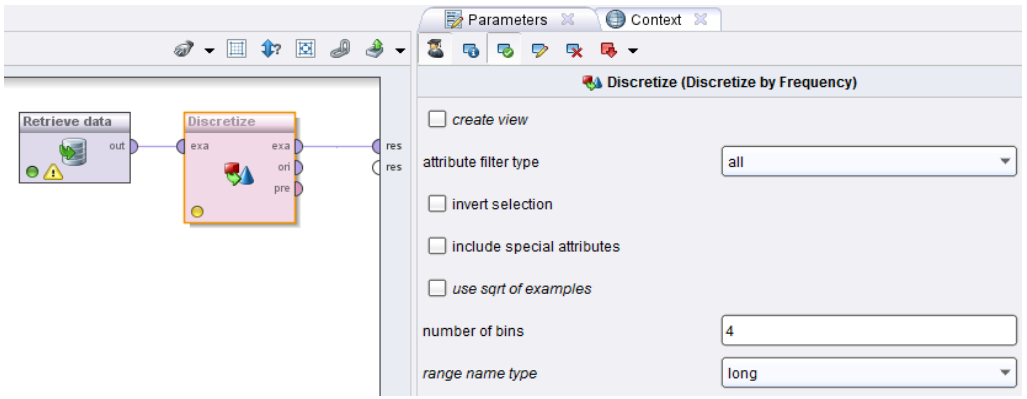


Discretize

- Numerical attributes can be devided into bins using discretization
- By Size (equally sized data ranges per bin)

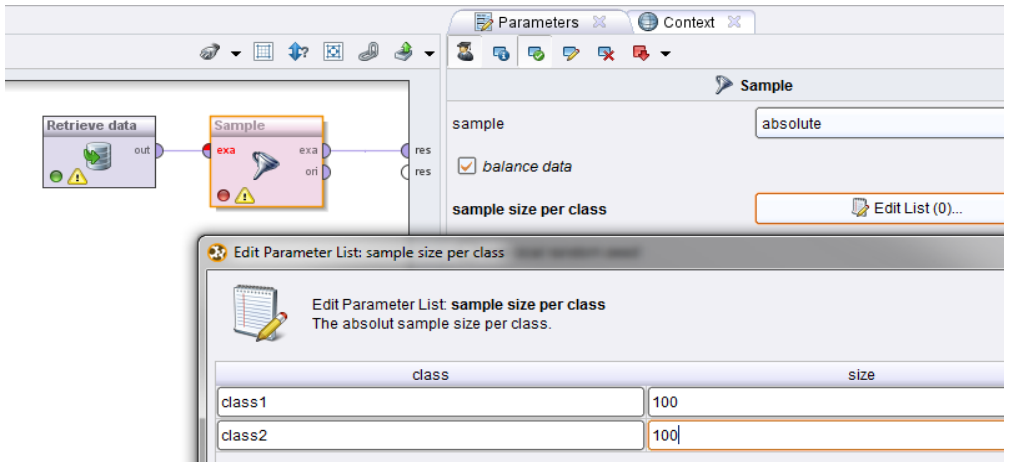


- By Frequency (equally sized number of examples per bin)

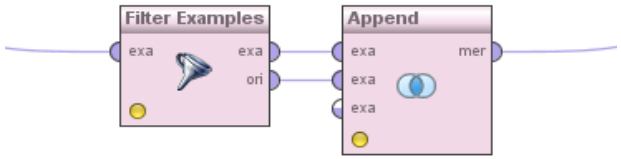


Balancing

- Sampling (with balancing)

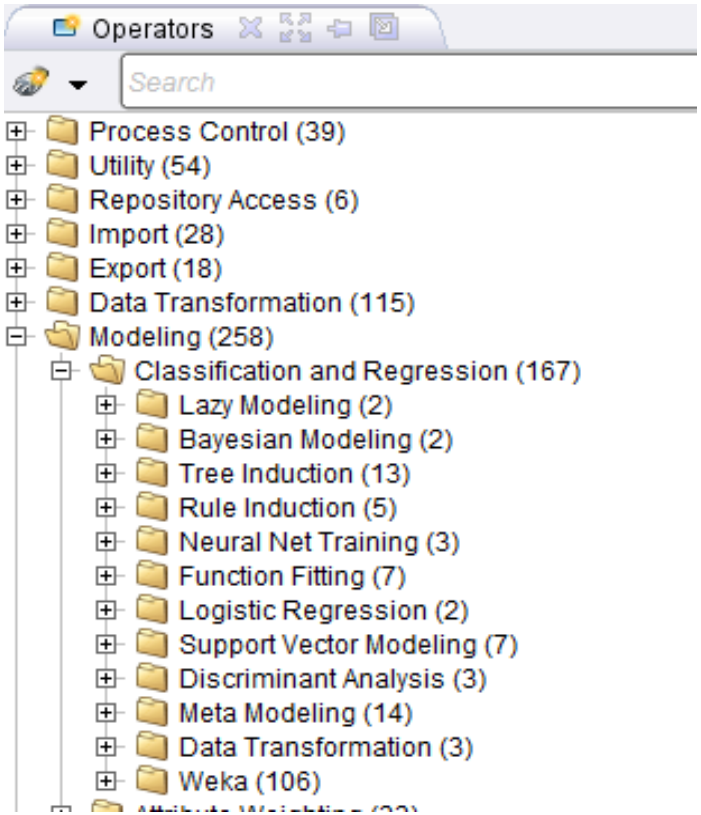


- Multiplication of data
  - Filter under-represented class examplse
  - Append them to original example set



Classification

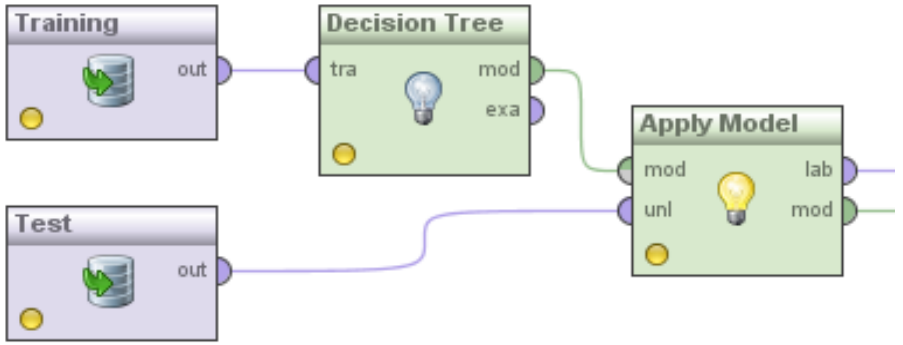
- Input: data set with labels
- Output: classification modell



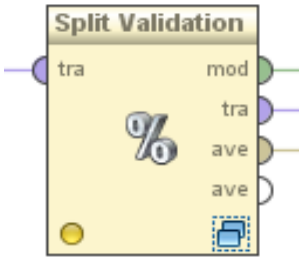
- Known Classifiers:
  - K-NN
  - Naive Bayes
  - Decision Tree (Hunts & ID3)
  - Rule Induction & Tree to Rules
  - Support Vector Machine (libSVM)
  - Neural Networks

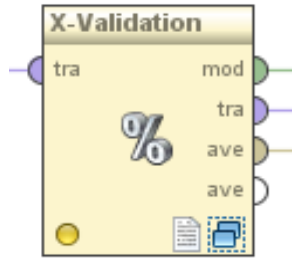
Evaluation

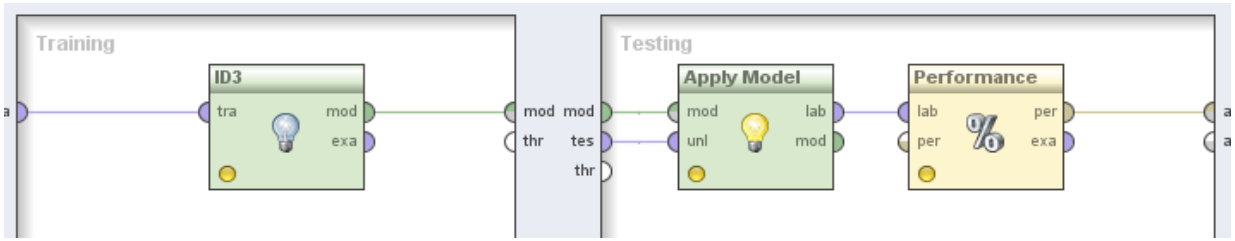
- Evaluate on dedicated test data set



- Evaluate on one data set using
  - Split valiation
  - X-Validation



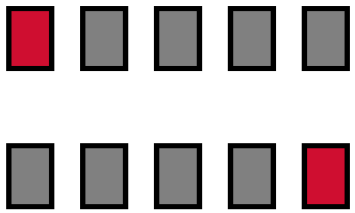




Split-/Cross-Validation

- Split-validation is a *holdout* method, which reserves a certain amount for testing and uses the remainder for training.
  - First step: split data at a ratio in test and training set
  - Second step: learn a model on the training set and evaluate the model on the test set

- *Cross-validation* avoids overlapping test sets
  - First step: data is split into *k* subsets of equal size
  - Second step: each subset in turn is used for testing and the remainder for training



Important: Never ever use the same example set for training & testing!

Accuracy and Error Rate

		PREDICTED CLASS	
		Class=Yes	Class=No
ACTUAL CLASS	Class=Yes	TP	FN
	Class=No	FP	TN

– Most widely-used metrics:

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

$$\text{Error Rate} = 1 - Accuracy$$

Limitation of Accuracy: Unbalanced Data

- Sometimes, classes have very unequal frequency
  - Fraud detection: 98% transactions OK, 2% fraud
  - eCommerce: 99% don't buy, 1% buy
  - Intruder detection: 99.99% of the users are no intruders
  - Security: >99.99% of Americans are not terrorists
- The class of interest is commonly called the positive class, and the rest negative classes.
- Consider a 2-class problem
  - Number of Class 0 examples = 9990, Number of Class 1 examples = 10
  - If model predicts everything to be class 0, accuracy is 9990/10000 = 99.9 %
  - Accuracy is misleading because model does not detect any class 1 example

Precision and Recall

Alternative: Use measures from information retrieval which are biased towards the positive class.

	Classified Positive	Classified Negative
Actual Positive	TP	FN
Actual Negative	FP	TN

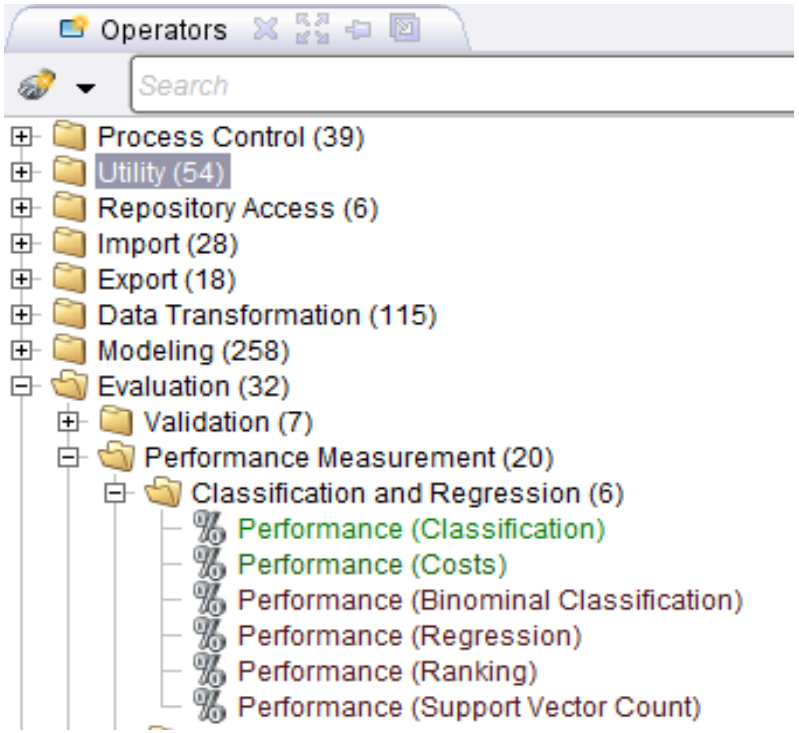
$$p = \frac{TP}{TP + FP}. \qquad r = \frac{TP}{TP + FN}.$$

Precision *p* is the number of correctly classified positive examples divided by the total number of examples that are classified as positive.

Recall *r* is the number of correctly classified positive examples divided by the total number of actual positive examples in the test set.

Performance

- Standard Measures
  - Accuracy
  - Precision
  - Recall
- Task Specific
  - Misclassification Costs



Questions?