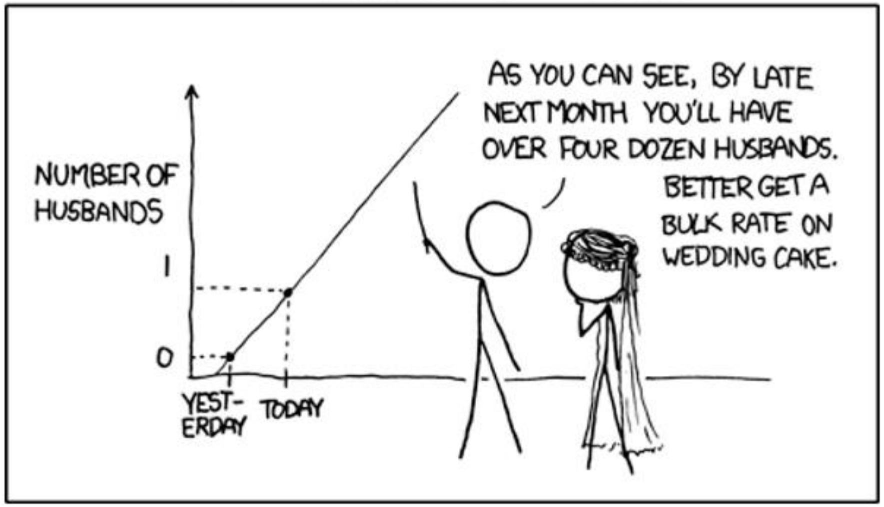
Regression

Exercise 8

Recap: Regression

- Classification predicts a *nominal* value
  - A finite set of values
- Regression predicts a *numerical* value
  - A possibly infinite set of possible values
  - Can be *interpolating* and *extrapolating*

MY HOBBY: EXTRAPOLATING



http://xkcd.com/605/

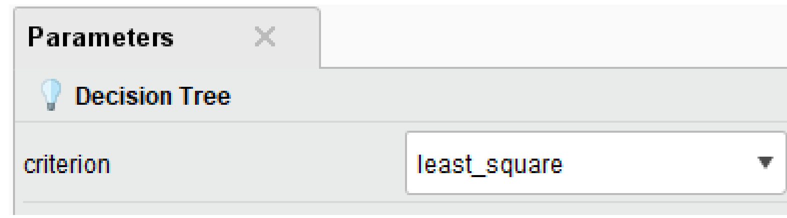
K Nearest Neighbours Regression

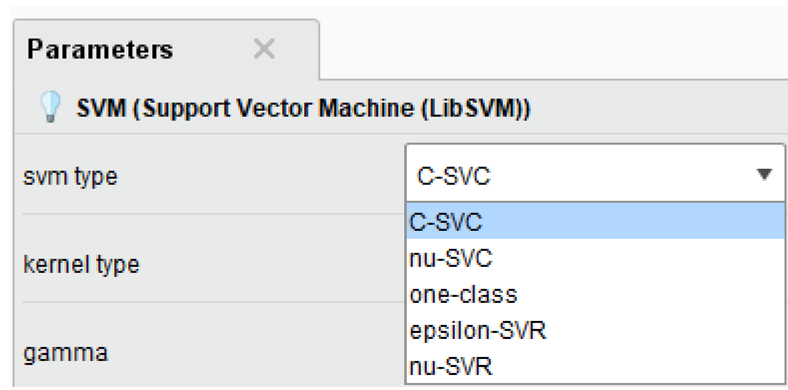
- Find the k nearest neighbours
- And use the average of their label as prediction
- Only interpolating regression possible

- It's the same operator that you already know from classification!

Regression Trees / SVM / ANN

- Other operators that you already know, which can be used for regression:





- Decision Tree
  - Set criterion to „least square“
- SVM
  - Set svm type to „epsilon-SVR“ or „nu-SVR“
- Neural Net
  - No changes required

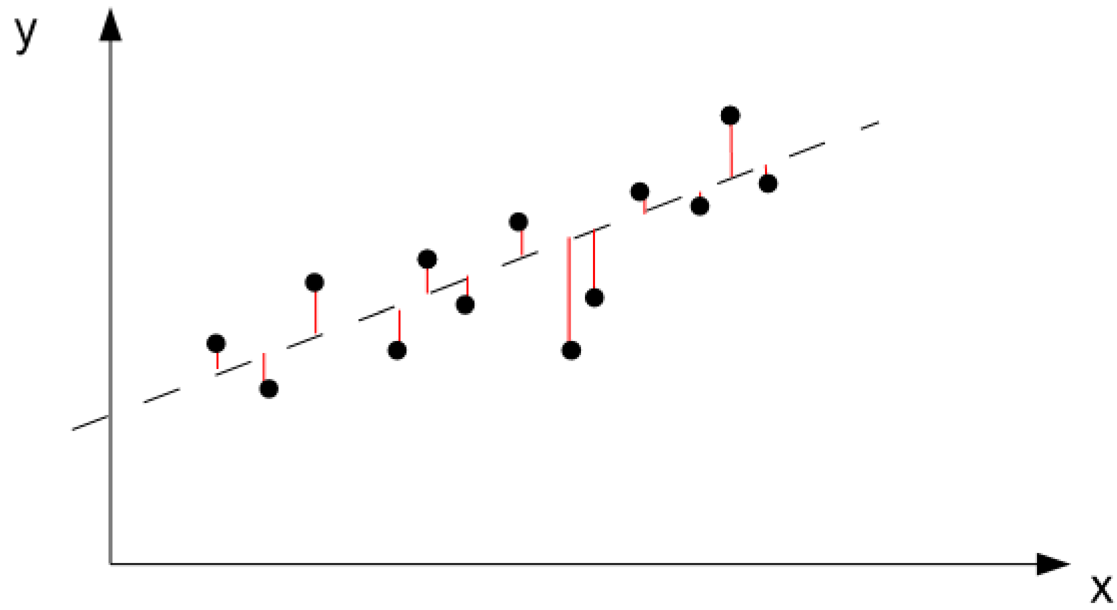
Linear Regression

- Finds a linear function

$$f(x)=w_0 + w_1x_1 + w_2x_2 + \ldots + w_nx_n$$

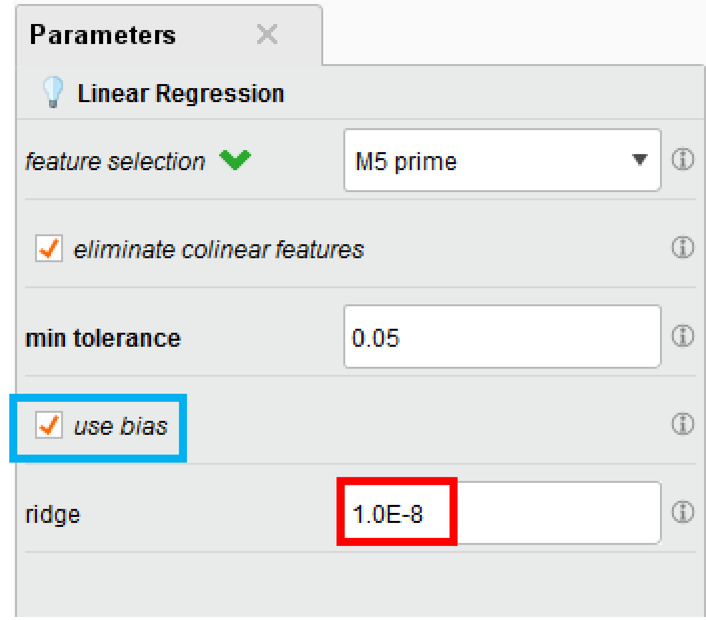
- That minimises the error

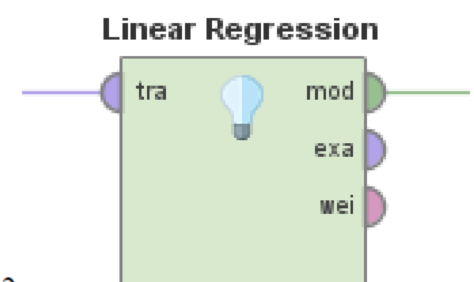
$$\sum_{all\ examples} \left(w_0 + w_1 \cdot x_1 + w_2 \cdot x_2 + \ldots + w_n \cdot x_n - y\right)^2$$



Operators: Linear Regression

- A learning operator that learns a linear regression model
  - Selects the features automatically
- Parameters:
  - Feature selection:
    - none, M5 prime, greedy, T-Test, Iterative T-Test
  - Use bias:
    - determines if an intercept should be used in the regression
  - Ridge:
    - Controls the slope of the learned function, higher ridge results in smaller coefficients



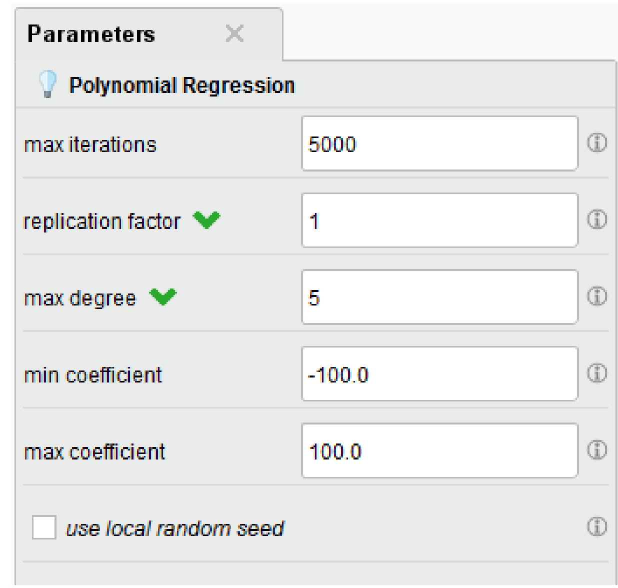


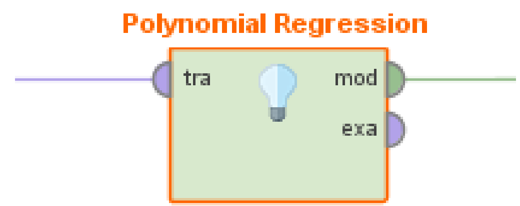
$$\sum_{\textit{all examples}} \left(\underline{w_0} + w_1 \cdot x_1 + w_2 \cdot x_2 + \ldots + w_n \cdot x_n - y\right)^2 + \underline{\lambda} \sum_{\textit{all variables}} w_i^2$$

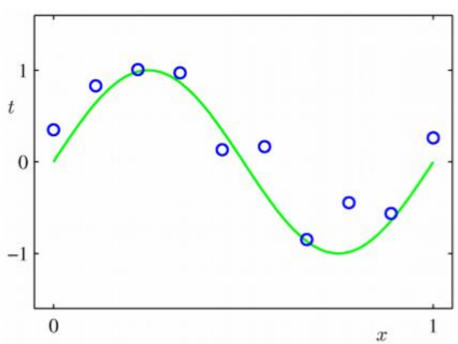
Operators: Polynomial Regression

Original attributes are transformed before running a linear regression

- Parameters:
  - Replication factor:
    - How often can a feature be replicated in the transformation?
  - Max degree:
    - Maximal degree of the final polynomial
  - Min/Max coefficient:
    - Limit the values of the coefficients



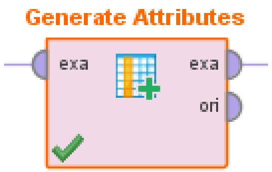


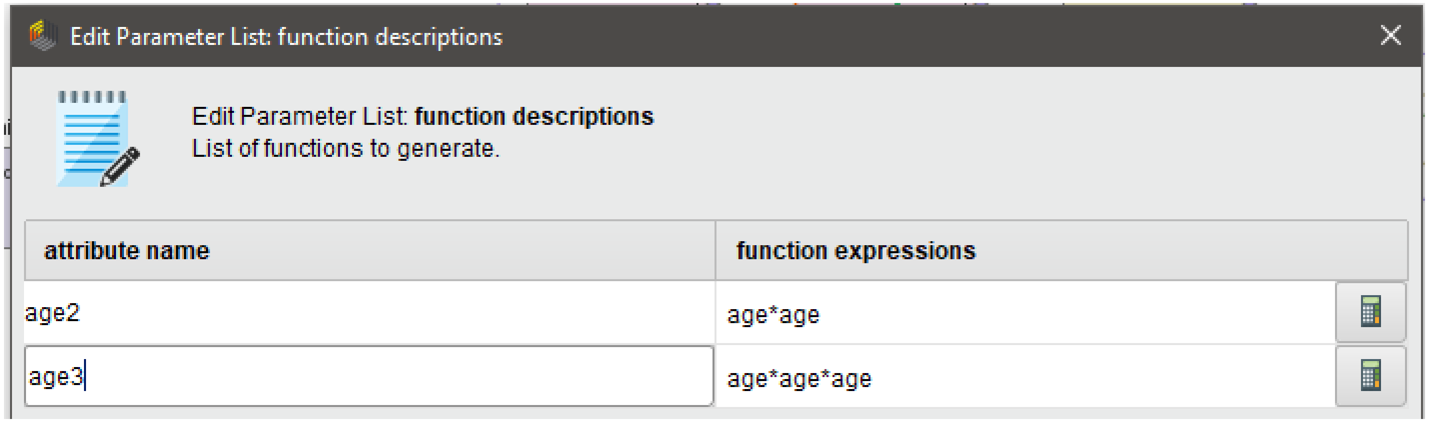


$$y(x, \mathbf{w}) = w_0 + w_1 x + w_2 x^2 + \ldots + w_M x^M$$

Operators: Polynomial Regression

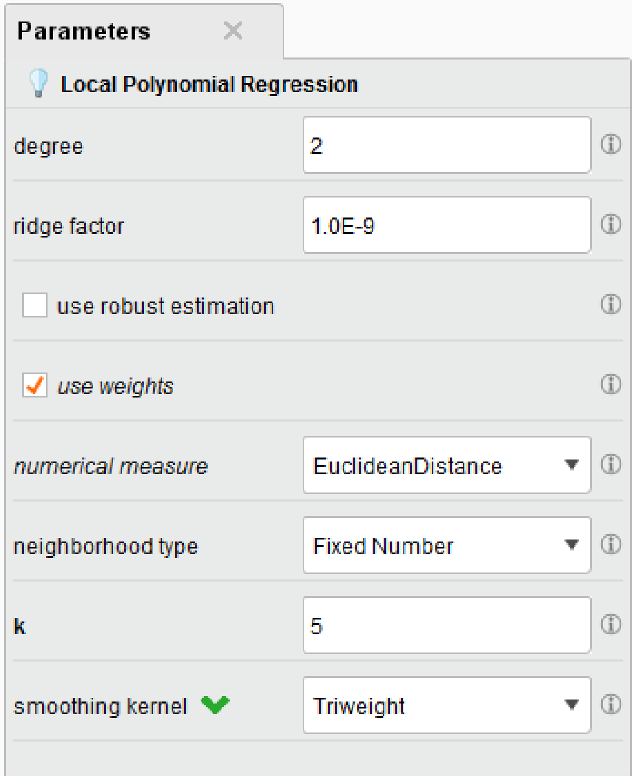
- Careful: the polynomial regression operator does not always produce the expected result!
- Alternative: Manually create a polynomial regression
  - Using the generate attributes operator
  - And a linear regression afterwards

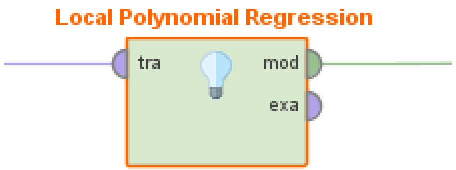




Operators: Local Regression

- Lazy Learning!
- Retrieves the k nearest neighbours, calculates a regression model, then predicts the value
- Parameters:
  - Degree:
    - Degree of the locally fitted polynomial
  - Measure, neighbourhood type, k:
    - Used to select the nearest neighbours





Performance Measures for Regression

- Mean Absolute Error
  - How far are we off on average?

$$\text{MAE} = \frac{\sum_{\text{all examples}} |\textit{predicted} - \textit{actual}|}{N}$$

- Root Mean Squared Error
  - Re-scales the errors:
    - Large errors have more influence
    - Small errors have less influence

$$\text{RMSE} = \sqrt{\frac{\sum_{\text{all examples}} |\textit{predicted} - \textit{actual}|^2}{N}}$$

- Coefficient of Determination (R^2)
  - Tells you how much of the variation of your target variable is explained by the model

$$R^2 = \frac{\sum_{i=1}^{n} (\hat{y}_i - \bar{y})^2}{\sum_{i=1}^{n} (y_i - \bar{y})^2}$$