Machine Learning 2.1 : Classification

Théo Trouillon - theo.trouillon@le-campus-numerique.fr

Regression VS Classification

- Supervised learning
  - Feature matrix $X \in \mathbb{R}^{n \times m}$, n samples, m features
  - Target vector y of size n
  - $y \approx f(X)$

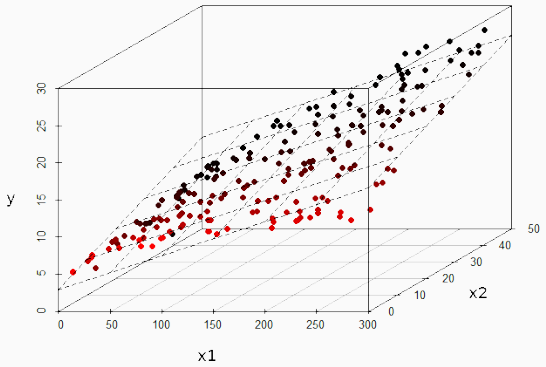
Regression VS Classification

- Supervised learning
  - Feature matrix $X \in \mathbb{R}^{n \times m}$, n samples, m features
  - Target vector y of size n
  - $y \approx f(X)$

- Regression
  - $y \in \mathbb{R}^n$
  - Linear regression :
    $y_i \approx w_1 x_{i1} + w_2 x_{i2} + ... + w_m x_{im}$

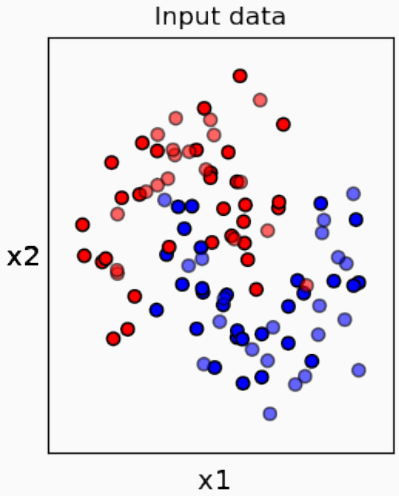
Regression VS Classification

- Supervised learning
  - Feature matrix $X \in \mathbb{R}^{n \times m}$, n samples, m features
  - Target vector y of size n
  - $y \approx f(X)$
- Regression
  - $y \in \mathbb{R}^n$
  - Linear regression :
    $y_i \approx w_1 x_{i1} + w_2 x_{i2} + ... + w_m x_{im}$

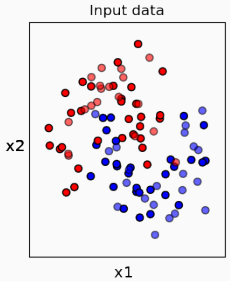


Regression VS Classification

- Supervised learning
  - Feature matrix $X \in \mathbb{R}^{n \times m}$, n samples, m features
  - Target vector y of size n
  - $y \approx f(X)$
- (Binary) Classification
  - $y \in \{0, 1\}^n$, called classes or labels
  - Red : positives, y=1
  - Blue : negatives, y=0
  - Many algorithms, today : K-Nearest-Neighbors

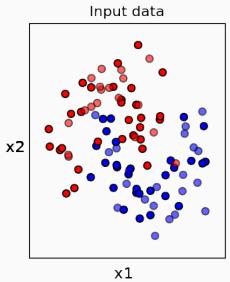


Binary classification with K-Nearest Neighbors (KNN)



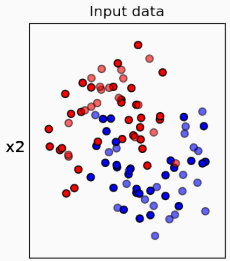
- Example of binary classification :
  - Red : positives, y=1
  - Blue : negatives, y=0

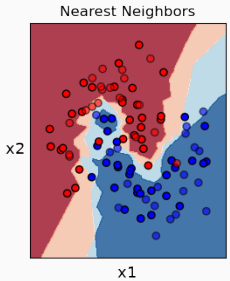
Binary classification with K-Nearest Neighbors (KNN)



- Example of binary classification :
  - Red : positives, y=1
  - Blue : negatives, y=0
- K-Nearest Neighbors :
  - Training : memorize all training points
  - Prediction : same y as the majority among K-nearest training points
  - Here : K = 3

Binary classification with K-Nearest Neighbors (KNN)





- Example of binary classification :
  - Red : positives, y=1
  - Blue : negatives, y=0
- K-Nearest Neighbors :
  - Training : memorize all training points
  - Prediction : same y as the majority among K-nearest training points
  - Here : K = 3
- Two types of error :
  - False positives (FP)
  - False negatives (FN)

Classification evaluation metrics

- Four prediction possibilities :
  - True Positives (TP): 1's correctly predicted as 1's
  - True Negatives (TN): 0's correctly predicted as 0's
  - False Negatives (FN): 1's incorrectly predicted as 0's
  - False Positives (FP): 0's incorrectly predicted as 1's

Classification evaluation metrics

- Four prediction possibilities :
  - True Positives (TP): 1's correctly predicted as 1's
  - True Negatives (TN): 0's correctly predicted as 0's
  - False Negatives (FN): 1's incorrectly predicted as 0's
  - False Positives (FP): 0's incorrectly predicted as 1's
- Accuracy $= \frac{TP+TN}{TP+TN+FP+FN}$
  - Overall classes prediction ability

Classification evaluation metrics

- Four prediction possibilities :
  - True Positives (TP): 1's correctly predicted as 1's
  - True Negatives (TN): 0's correctly predicted as 0's
  - False Negatives (FN): 1's incorrectly predicted as 0's
  - False Positives (FP): 0's incorrectly predicted as 1's
- Accuracy $= \frac{TP+TN}{TP+TN+FP+FN}$
  - Overall classes prediction ability
- Precision $= \frac{TP}{TP+FP}$
  - Ability to not predict 0's as 1's

Classification evaluation metrics

- Four prediction possibilities :
  - True Positives (TP): 1's correctly predicted as 1's
  - True Negatives (TN): 0's correctly predicted as 0's
  - False Negatives (FN): 1's incorrectly predicted as 0's
  - False Positives (FP): 0's incorrectly predicted as 1's
- Accuracy $= \frac{TP+TN}{TP+TN+FP+FN}$
  - Overall classes prediction ability
- Precision $= \frac{TP}{TP+FP}$
  - Ability to not predict 0's as 1's
- Recall $= \frac{TP}{TP+FN}$
  - Ability to not predict 1's as 0's

Today

- Heart disease diagnostic with k-nearest neighbors
  - Features : Age, cholesterol, blood pressure, ...
  - Classes : 0 : no heart disease, 1 : heart disease
  - Importance of Precision vs Recall
- Experimental setup : same as previous module : train/test, cross-validation, ...
  - Chapter 2 from *Hand's On Machine Learning ...*
- Understand the difference between regression and classification :
  - Chapter 4.1 and 4.2 from *Introduction to Statistical Learning*
- Take time to read the resources when mentioned in the notebook