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Information Management School

7

ENSEMBLES OF METHODS

Machine Learning for Marketing

Acreditações e Certificações

Instituto Superior de Estatística e Gestão da Informação
Universidade Nova de Lisboa

Summary

1. Introduction
2. Ensemble techniques
3. Considerations on the application
4. Application exercise

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Introduction

Ensembles of methods

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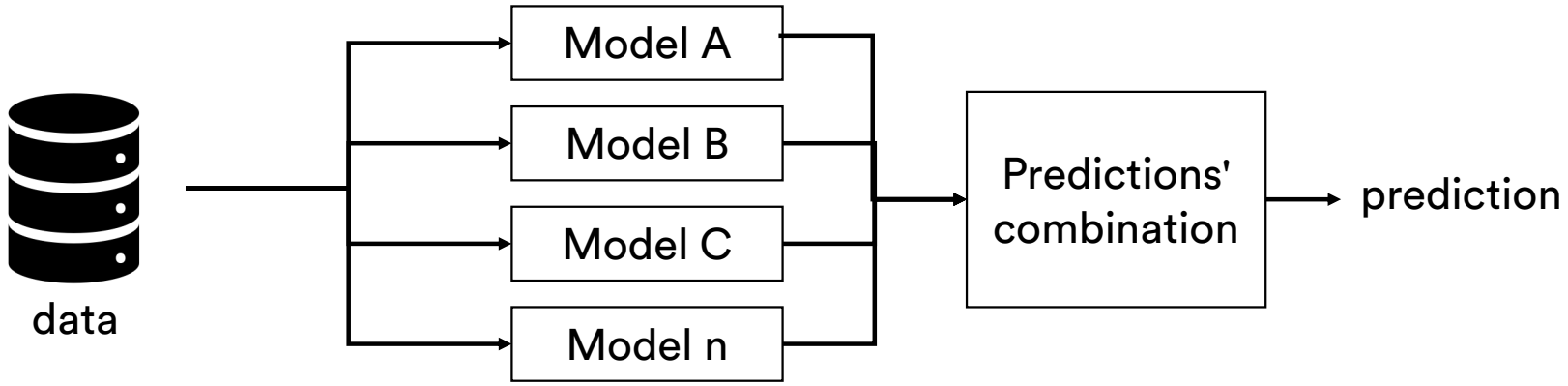
Problems that can occur from using single models

- **High variance**: the model works very well with the training data, but badly when there are changes to the inputs
- **Low accuracy**: the model does not capture the entire training data patterns, as such does not achieve the required results
- **Features' noise and bias**: the measure relies heavily on specific features to make good predictions

Ensemble learning

Combination the decisions of multiple models to improve overall performance



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Ensemble techniques

Ensembles of methods

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Bagging

- Each model learns from the previous model, which used a different version of the dataset
- Reduces variance and minimizes overfitting
- Each subset has the same number of observations, allowing the models to be trained in parallel

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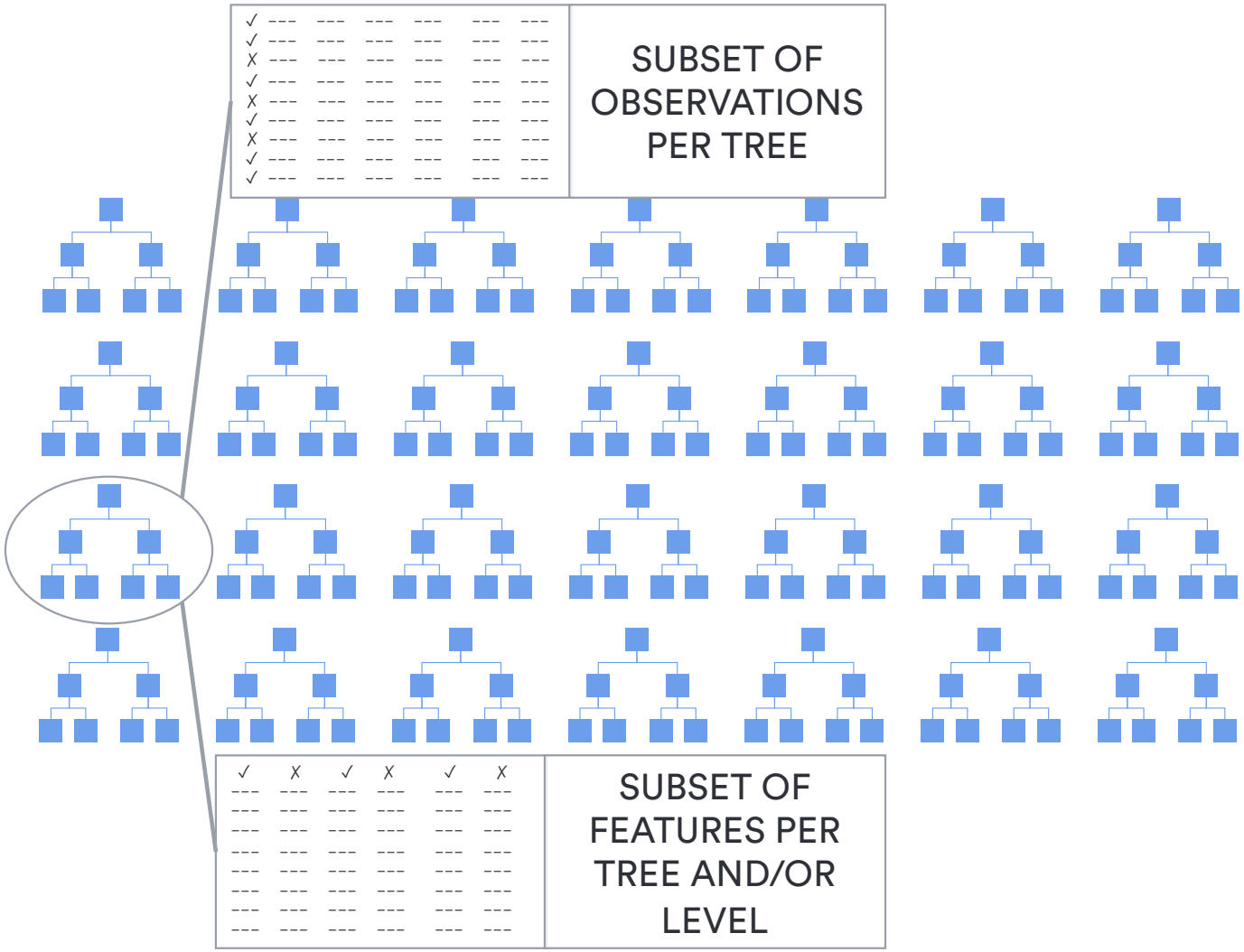
Bagging techniques

- Bootstrap aggregation:
  - Creates subsets of data with replacement
- Random forest:
  - Each model besides using only a subset of samples, only uses a subsample of features
  - Observations and features are typically selected randomly
- Extra-trees:
  - Similar to Random Forest, but uses all observations

Bootstrap aggregation (bagging)

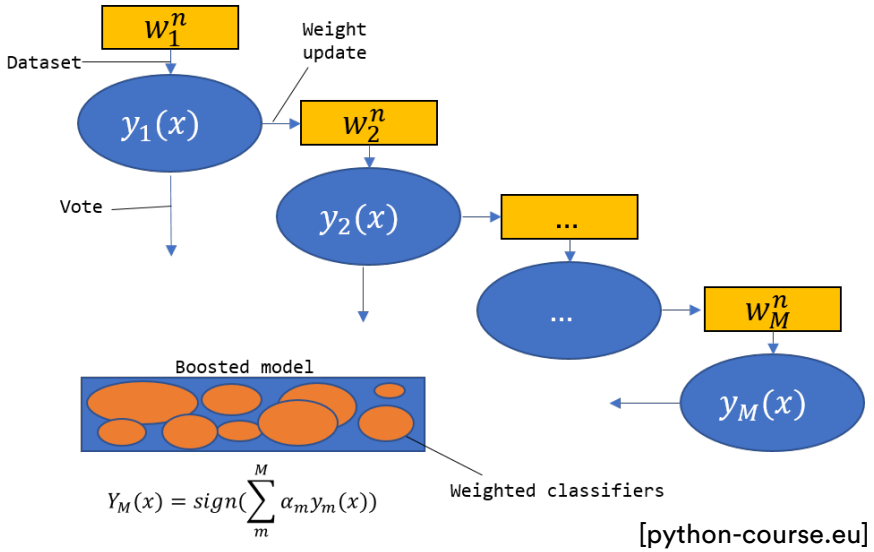
Example algorithms:

- XGBoost
- LightGBM
- CATBoost



Boosting

1. It starts by giving a weight of 1 to all observations and generates a first hypothesis
2. Incorrectly classified observations are given a greater weight. Correctly classified observations are given a smaller weight
3. Generates new hypothesis
4. Repeat 2 and 3 to generate K hypotheses
5. The end result is the result of the combined majority of the various hypotheses generated



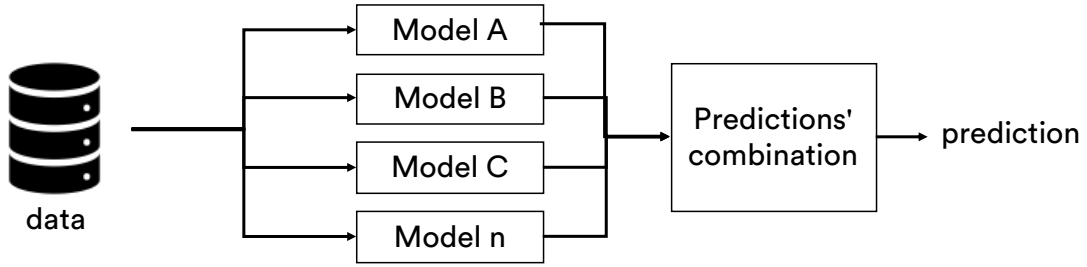
[python-course.eu]

Boosting techniques

- Adaptive boosting:
  - Adjust the model parameters to the training data based on the performance of the current iteration
  - Both the weights for re-weighting and the final aggregation weights are recomputed iteratively
  - Minimizes the exponential loss function, which makes the algorithm more sensitive to outliers
- Gradient boosting:
  - Combination of *gradient descent* and boosting
  - By using a *gradient* it means it uses two or more derivatives of the same function
  - It has three components: additive model, loss function, and a *weak learner*

Stacking

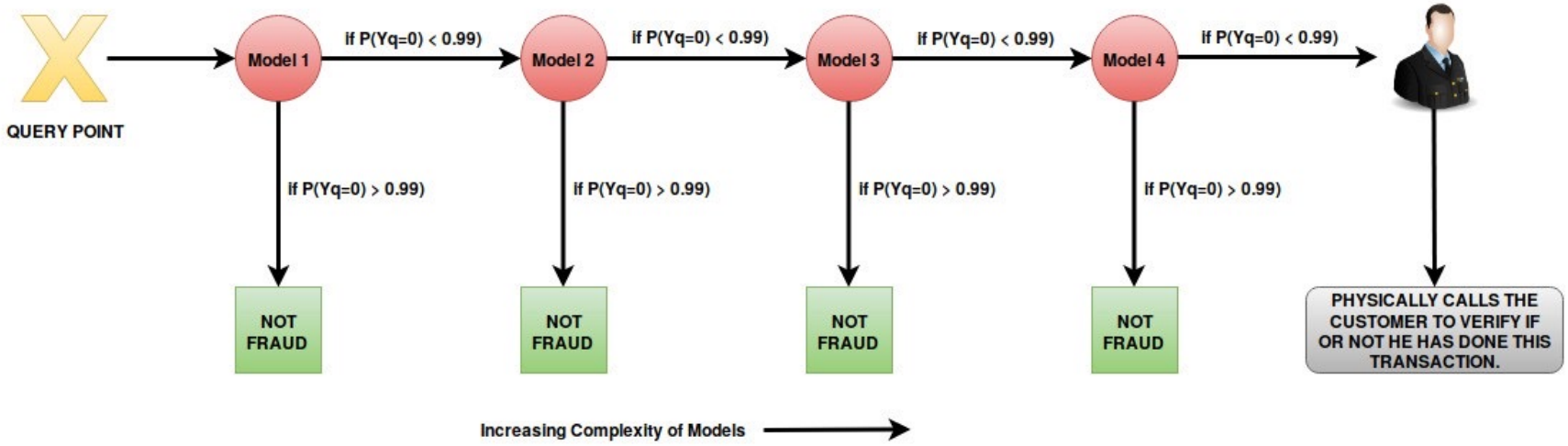
- Each model makes a prediction for each of the observation
- The results of each model are aggregated



- Aggregation methods:
  - Majority voting: used in classification problems. Based on what the majority of models predicted for each observation
  - Averaging: used in regression problems. Based on the average of the predictions for each observation
  - Weighted average: similar to Averaging, but with different weights given to different algorithms/models

Cascading

- Based on the concatenation of several models
- Mostly used when predictions need to ”absolutely” true
- Output of a model is the input in other model of high complexity



DIFFERENT STAGES OF QUERING CASCADE CLASSIFIERS IN A FOUR MODEL CASCADE SYSTEM

[medium.com]

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Considerations on the application

Ensembles of methods

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Considerations on ensemble of models

- **Simplicity and interpretability**: if simplicity and interpretability are a requirement, then using an ensemble of models may not be a good choice
- **Generalization**: if training parameters are not defined carefully, ensemble models can start working bad with unseen data (overfitting)
- **Inference time**: in many deployment situations, inference time is crucial. The more models are used, the the more time it will need to make the inference
- **Noise, bias, and variance**: if the use of ensemble models does not improve the performance of weak learners, its use should be questioned

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Application exercise

Ensembles of methods

Ensemble learning in Python with Scikit

- **Random Forest**: algorithm that builds multiple decision trees, each based on a dataset sample with replacement
- **Ada Boost**: algorithm that from small decision trees, with small variations, makes predictions based on majority vote (or average)
- **Gradient Tree Boosting**: powerful boosting algorithm to create classification and regression Models
- **Voting Classifier:** allows the use of various algorithms to make predictions and select the result based on most votes or average odds
- More info at https://scikit-learn.org/stable/modules/ensemble.html

Predicting customers who will leave the bank in the following 6 months

1. Copy from the datasets folder the dataset “Bank_Churn_Modelling.csv”
2. Copy and open the Jupyter notebook “PredictBankChurn_DF.ipynb”
3. Follow the presentation of the notebook, answer the questions and explore the challenges

Questions?

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