

Lecture 13:  
Feature  
selection

Sophie Robert

Introduction

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Filter-based  
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Wrapper  
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selection

# Lecture 13: Feature selection

## Introduction to Machine Learning

Sophie Robert

L3 MIASHS — Semestre 2

2023-2024

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## Introduction

# Motivation

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## Question

Do you remember what is the definition of feature reduction ?

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## Question

Do you remember what is the definition of feature reduction ?

- Find the subset of variables which bears the most information

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## Question

Do you remember what is the definition of feature reduction ?

- Find the subset of variables which bears the most information
- Use only these variables to perform the learning task

# Motivation

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## Question

Why do we want to perform feature reduction ?

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## Question

Why do we want to perform feature reduction ?

- Simplification of models to make them easier to interpret by users

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## Question

Why do we want to perform feature reduction ?

- Simplification of models to make them easier to interpret by users
- Shorter training times

# Motivation

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## Question

Why do we want to perform feature reduction ?

- Simplification of models to make them easier to interpret by users
- Shorter training times
- Avoid the curse of dimensionality

# Motivation

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## Question

Why do we want to perform feature reduction ?

- Simplification of models to make them easier to interpret by users
- Shorter training times
- Avoid the curse of dimensionality
- Drop variables that do not respect models hypothesis

# Motivation

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Features can be either:

- **Redundant**: the information is already given by other features (highly correlated) (for example, late arrival and late departure).

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Features can be either:

- **Redundant**: the information is already given by other features (highly correlated) (for example, late arrival and late departure).
- **Unrelevant**: the feature does not bring any information (for example, the weather for image recognition)

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## Definition

# Feature selection

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## Feature selection

**Feature selection** consists in finding the subset of variables which bear the most information for the learning task and only using those for problem solving.

# Feature selection

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## Feature selection

**Feature selection** consists in finding the subset of variables which bear the most information for the learning task and only using those for problem solving.

Feature selection can be done using:

# Feature selection

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## Feature selection

**Feature selection** consists in finding the subset of variables which bear the most information for the learning task and only using those for problem solving.

Feature selection can be done using:

- Field specific insight

# Feature selection

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## Feature selection

**Feature selection** consists in finding the subset of variables which bear the most information for the learning task and only using those for problem solving.

Feature selection can be done using:

- Field specific insight
- Automatic rules based on objective metrics

# Feature selection

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## Feature selection

**Feature selection** consists in finding the subset of variables which bear the most information for the learning task and only using those for problem solving.

Feature selection can be done using:

- Field specific insight
- Automatic rules based on objective metrics
- Embedded within the algorithm itself (can be used as part of the data processing step)

# Possible approaches

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Approaches can be:

# Possible approaches

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Approaches can be:

- **Filter based:** ignore the learning model and select a subset of variables.

# Possible approaches

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Approaches can be:

- **Filter based:** ignore the learning model and select a subset of variables.
- **Wrapper based:** iteratively build a model with a subset of feature and select the best performing one according to a learning score.

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## Filter-based approaches

# Variance analysis

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## Variance threshold selection

Variance based selection consists in **removing features with low variance.**

# Variance analysis

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## Variance threshold selection

Variance based selection consists in **removing features with low variance.**

In practice:

- Set a minimum variance threshold (careful about bias !)

# Variance analysis

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## Variance threshold selection

Variance based selection consists in **removing features with low variance.**

In practice:

- Set a minimum variance threshold (careful about bias !)
- Remove all features not matching this criterion.

# Variance analysis

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## Variance threshold selection

Variance based selection consists in **removing features with low variance.**

In practice:

- Set a minimum variance threshold (careful about bias !)
- Remove all features not matching this criterion.

## Question

Is this a filter-based or wrapper based approach ?

# Advantages and limits

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## **Advantages:**

- Model independant
- Limited risk of overfitting

# Advantages and limits

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## **Advantages:**

- Model independant
- Limited risk of overfitting

## **Limits:**

- Does not take into account correlation between variables

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## Wrapper based selection

# Wrapper based selection

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## Wrapper based selection

**Wrapper based selection (or model-based selection)**

consists in iteratively building a model on a subset of features  
and selecting the best performing subset of features.

# Wrapper based selection

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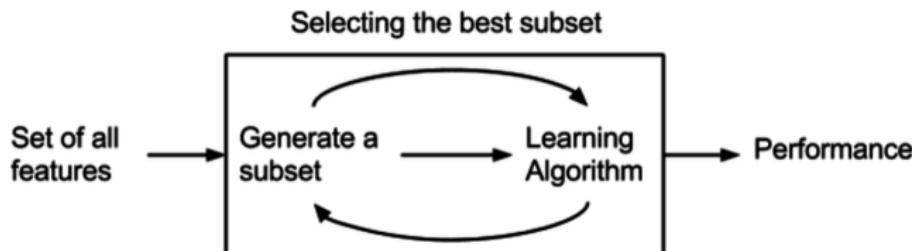
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## Wrapper based selection

**Wrapper based selection (or model-based selection)**

consists in iteratively building a model on a subset of features and selecting the best performing subset of features.



# Wrapper-based selection

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Selection can be:

- **Forward:** Start without any feature and add at each round the one which maximizes the score

# Wrapper-based selection

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Selection can be:

- **Forward:** Start without any feature and add at each round the one which maximizes the score
- **Backward:** Start with every set of feature and remove at each round the one which maximizes the score.

# Wrapper-based selection

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Selection can be:

- **Forward:** Start without any feature and add at each round the one which maximizes the score
- **Backward:** Start with every set of feature and remove at each round the one which maximizes the score.  
... and stop algorithm once a threshold is reached.

# Advantages and limits

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## **Advantages:**

# Advantages and limits

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## Advantages:

- Takes into account the specificity of the learning task

# Advantages and limits

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## Advantages:

- Takes into account the specificity of the learning task
- Takes into account correlation between variables

# Advantages and limits

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## **Advantages:**

- Takes into account the specificity of the learning task
- Takes into account correlation between variables

## **Limits:**

# Advantages and limits

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## Advantages:

- Takes into account the specificity of the learning task
- Takes into account correlation between variables

## Limits:

- Model dependent

# Advantages and limits

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## Advantages:

- Takes into account the specificity of the learning task
- Takes into account correlation between variables

## Limits:

- Model dependent
- Correlation depends on subset

# Questions

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Questions ?