Missing values

Data Mining

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Outline

Missing Values

Collaborative filtering

Linear regression

Outliers

Introduction

Finding missing values in real date is rather common.

Different alternatives can be put in place to handle missing values.

- Ignore.
- Fill in (imputation).
- Gather more data.

Ignore record

If only a small number of values are missing, we can simply ignore (delete) record from our analysis.

- This might become a problem as the number of missing values increases. E.g., Consider a dataset of 30 variables, with 5% of missing values, uniformly spread across all data.

Filling in

- Assign the mean, median or mode of such a variable.
- Use a constant value.
- Find a proxy variable.
- Find a highly correlated variable and use it for prediction (collaborative filtering, similar to linear regression).

Notice: No new information is added. It only allows us to perform computations.
Moreover, we induce some sort of bias when filling in the blanks.

Gathering more data

- Requires designing a data collection plan.
- In practice, it might be infeasible.

Missing same feature in many records

- Mean or median might lack of actual meaning.
- If feature is not crucial, drop it.
- Find a highly correlated variable.
- Gather more data.

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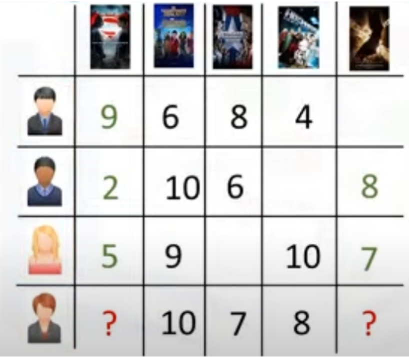
It is base on the assumption that there exists a relationship between points and variables.

Also used by recommender systems to find relationships between users and products: “I might like things that my friends like”.



	9	6	8	4	
	2	10	6		8
	5	9		10	7
	?	10	7	8	?

Process

For a given incomplete data point,

1. Using the available (filled in) features, find the most similar point in the dataset.
2. A common choice is to use the cosine similarity,

$$s_{i,j} = \frac{\langle \mathbf{x}_i, \mathbf{x}_j \rangle}{\|\mathbf{x}_i\| \|\mathbf{x}_j\|}.$$

Fill in the missing value (n-feature) of the i-th point by,

- the value corresponding to the most similar point, or
- a weighted average of the values of (all) other points,

$$\mathbf{x}_{i,n} = \frac{\sum_j (s_{i,j})(\mathbf{x}_{j,n})}{\sum_j s_{i,j}}.$$

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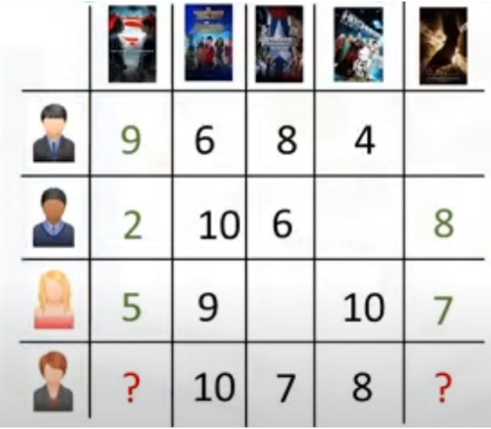
Filling it by linear regression

We could also learn a regressor for our incomplete variable, using a complete feature from the dataset.

For instance, predict feature x_1 using x_2 as its predictor.



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Outlier detection

We can process outliers with similar treatments as missing values.

- Simply ignore them, if the dataset is large enough.
- Replace their value using a scaling process (to be seen).

References

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Q&A

Thank you!

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