Introduction to Machine Learning

Lecture 6: Conclusion

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Outline

This lecture includes:

- A **model selection** lab
- A few aspects of machine learning we have not mentioned
  - **Feature engineering**
  - **Dimensionality reduction**
- Feedback and final Q&A

Dimensionality reduction

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Hence, there is a need to pre-process the data.

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In case there are too many samples, a simple solution is to apply subsampling, *e.g.* just take into account 10% of the samples.

- Recall the mini-batch k-means
- Be careful with the **class balance**
  - Imbalanced classes: **subsample the majority class**
  - Little to no imbalance: **Stratified sampling**

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It is also important to use common sense and expert knowledge when possible:

- Some variables might be intuitively meaningless to solve the ML problem
- ML often aims at mimicking/automatic a human logic

Dimensionality reduction with PCA

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Rough idea:

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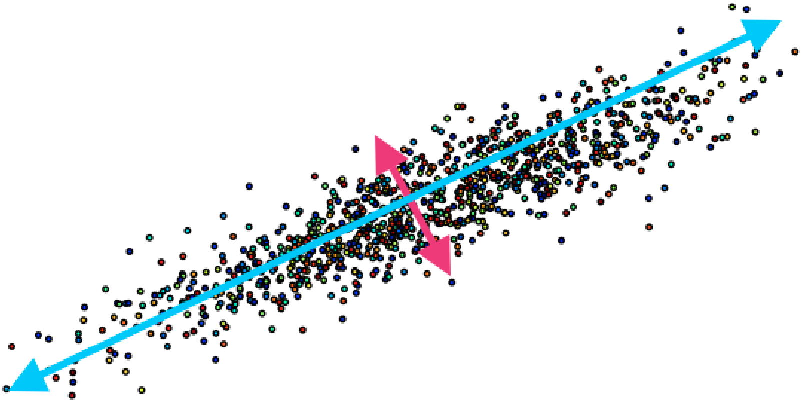

Feature engineering

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Sometimes, on the same data, most algorithm would give roughly the same accuracy (or any other metric). In this case, feature engineering could be the best solution to improve classification/regression results.

Feature engineering is often **data-dependent**: You won't use the same features from text data and from images or videos.

Feature engineering in text analysis

There are several challenges when dealing with text data:

- Mining text can lead to a huge amount of data to process
- Not all the data is relevant
- Texts can be of different size
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Hence, there is **a need to preprocess** it before giving it to any ML algorithm.

Feature engineering in text analysis with TF-IDF

Given terms $t \in T$ and documents $d \in D$, we can define:

$$\text{TF}(t, d) = \text{Frequency of term } t \text{ in the document } d$$

$$\text{IDF}(t, D) = \log \left(\frac{|D|}{|\{d \in D, t \in d\}|} \right)$$

(there are alternative formulas)

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this	1
is	1
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sample	1

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Exercice: Cf. Board

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Exercice: Cf. Board Note: We can go further, *e.g.* with *n*-grams.

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In images, we often want to detect interest points such as **edges** and **corners**.

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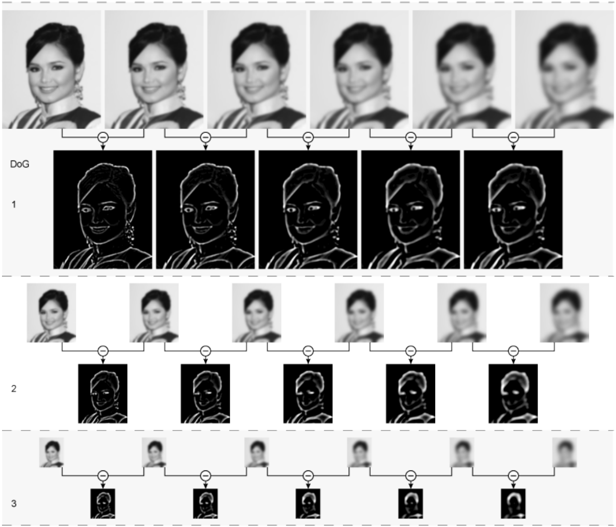
SIFT is patented and cannot be used in all situations: There exist alternatives based on the same idea such as SURF (Speeded-Up Robust Features)

SIFT algorithm

Key steps:

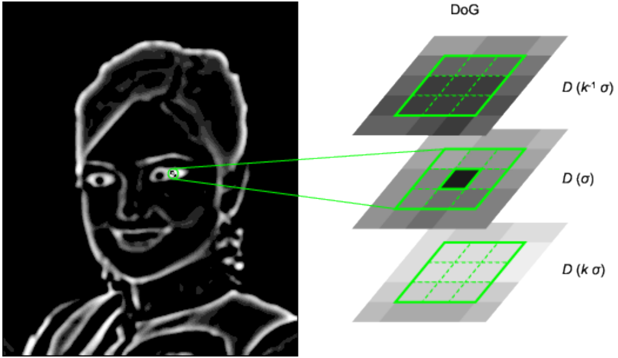
- Detect extrema at different scale by difference of gaussians
- Detect interest points in the image
- Assign orientations to create SIFT features

SIFT: Difference of Gaussians (DoG)



SIFT: Extrema detection

Interest points are among the local extrema in the $3 \times 3 \times 3$ neighborhood:



SIFT: Extrema detection

Post-processing:

- Remove low-contrast points
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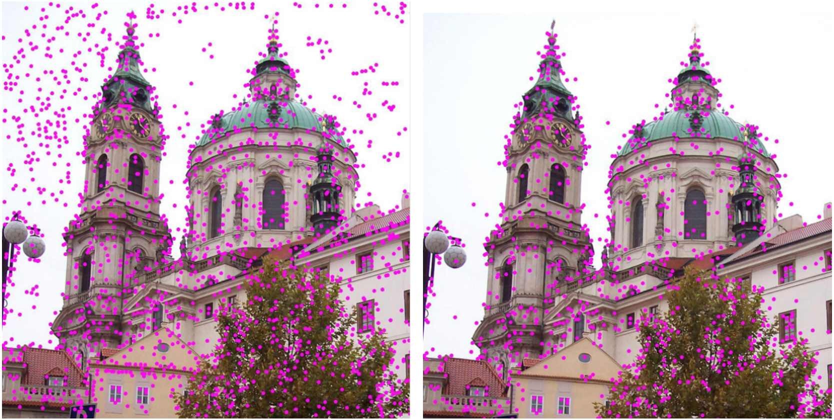
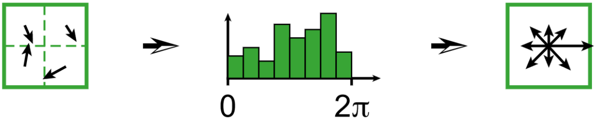
Before/after:

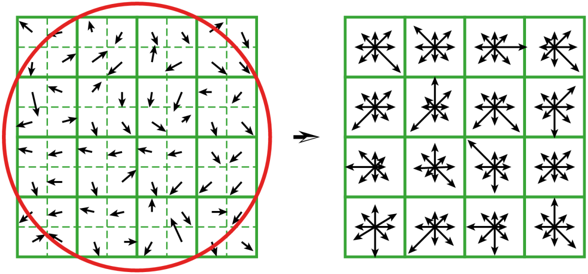


SIFT: Orientation assignment

For each interest point, compute the orientation histogram:



Do it for a neighborhood of the interest point:



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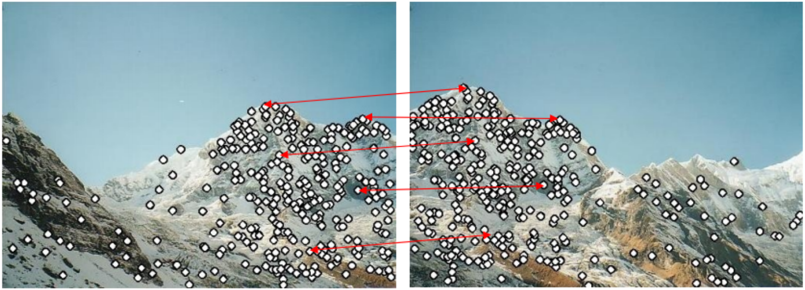
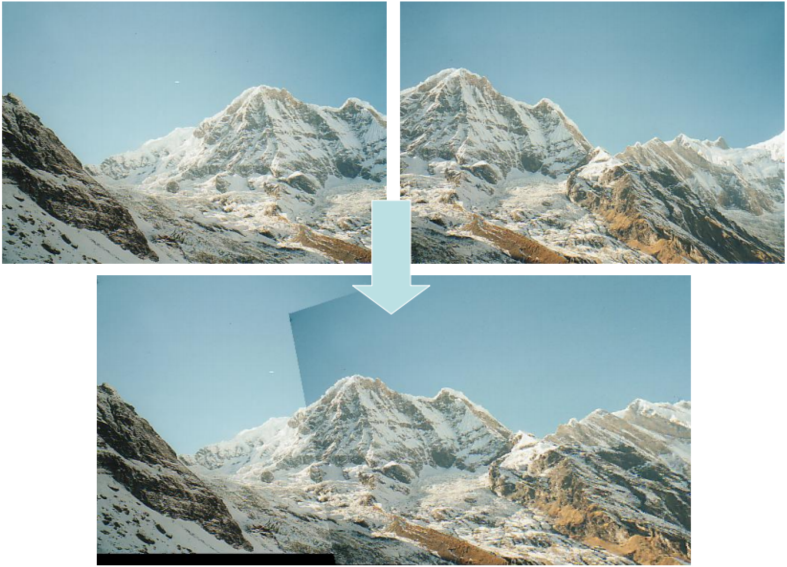


SIFT illustration: Panorama



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There are plenty of libraries and examples available online... Don't hesitate to play with it!

Thank you! Questions?
Any feedback?