UNIVERSITÀ DEGLI STUDI DI PADOVA

Introducing features

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Agenda

- Salient elements in an image
- Feature detection
- Feature description
- Feature matching

Image salient elements

- Consider image 1

Image salient elements

- Consider image 2

Image salient elements

- What can you say about the images?
  - Is it the same subject?
  - Are there common elements?
  - Are there different elements?

Image salient elements

- How can we automatize this process?
- What applications can you think of? List them

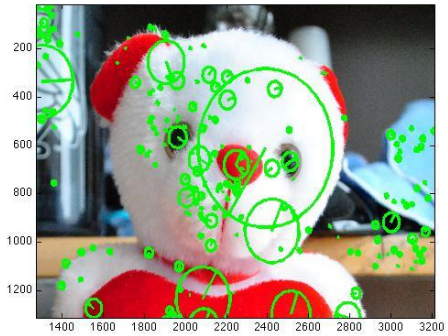
- Anti-spoiler ☺

Features

- Detecting and matching elements of the image is a **key task** in computer vision
- Such elements are called features
- A feature is a "meaningful" part of the image

Features

- Features have two main components
  - **Feature detection**: finding a "stable" (easily detectable) point
  - **Feature description**: a description of the surrounding area
- Input: image
- Output: a set of points + description of the region (AKA signature, fingerprint, …)

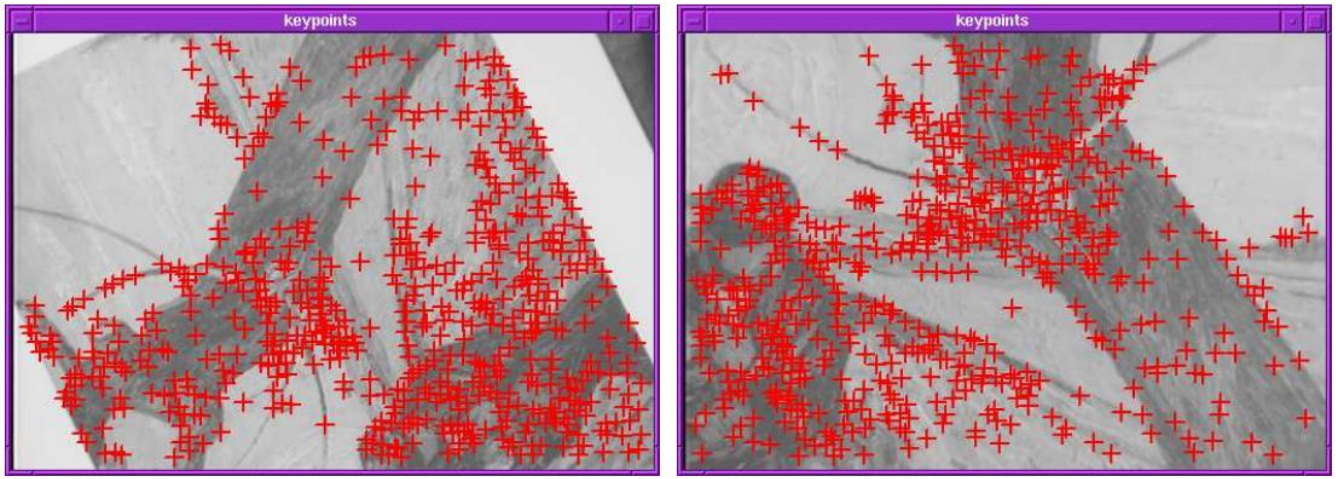


Keypoints – wishlist

- The ideal keypoints shall be
  - Stable and repeatable
  - Invariant to transformations (e.g., rotations)
  - Insensitive to illumination changes
  - Accurate

Keypoint stability

- Stability: measured by means of a repeatability score on a pair of images
- Given two images, it is defined as the ratio between
  - The number of point-to-point correspondences that can be established
  - The min number of keypoints in the two images



C. Schmid, R. Mohr, C. Bauckhage, "Comparing and evaluating interest points" Sixth International Conference on Computer Vision, 1998, IEEE

Descriptor

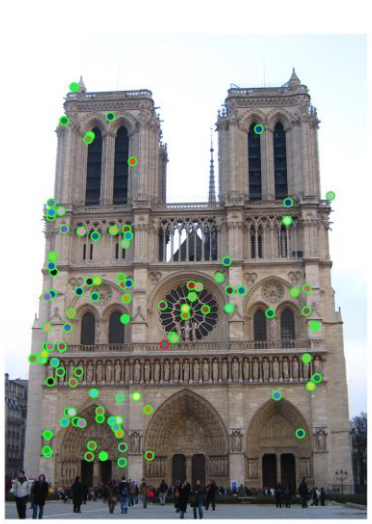
- The descriptor is a vector representation of the **local patch** (the surrounding area)
- The ideal descriptor is based on
  - Color
  - Texture
  - Orientation
  - …

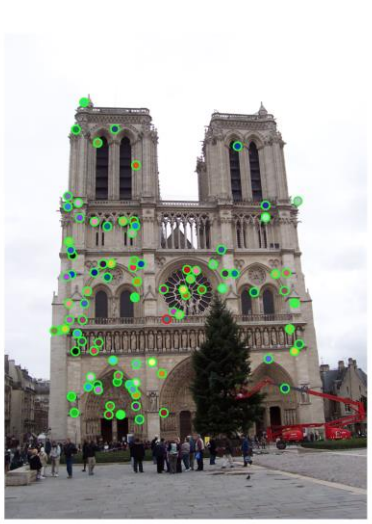
Descriptor

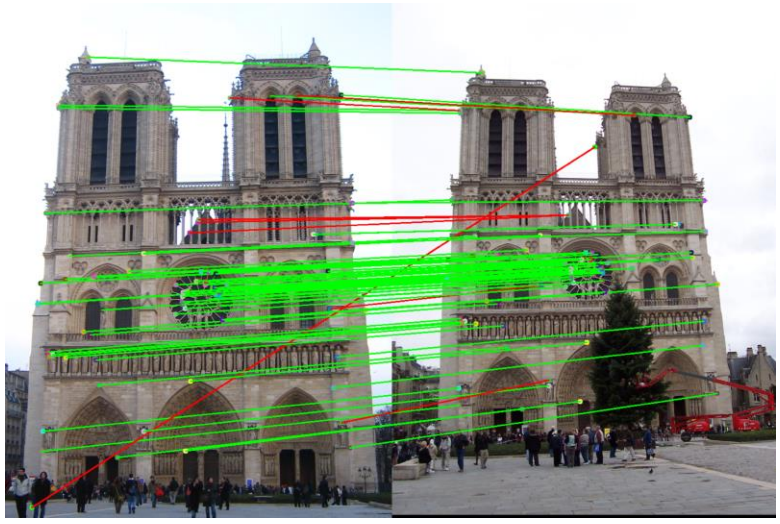
- The descriptor is a vector representation of the **local patch** (the surrounding area)
- The ideal descriptor shall be
  - Robust to occlusion and clutter
  - Robust to noise, blur, compression, discretization
  - Discriminative
  - Stable over changes in viewing angle and illumination
  - Computationally efficient (many features per image)

Feature matching

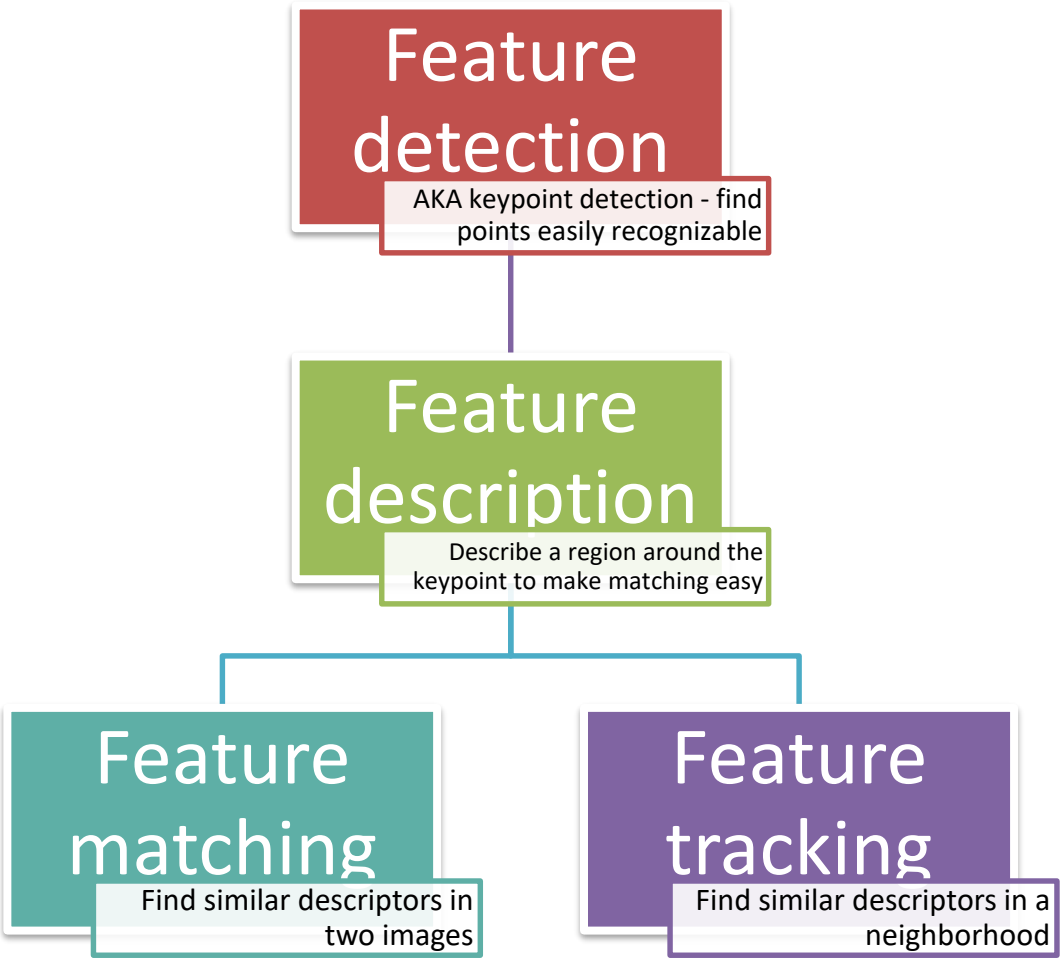
- Matching features is a key task in computer vision
- Matching means:
  - Evaluate features in two images
  - Find similar features (good matches)
    - Similarity is applied to the descriptor using a distance





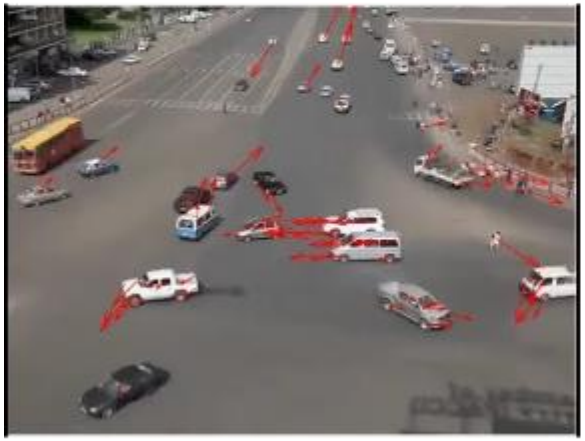


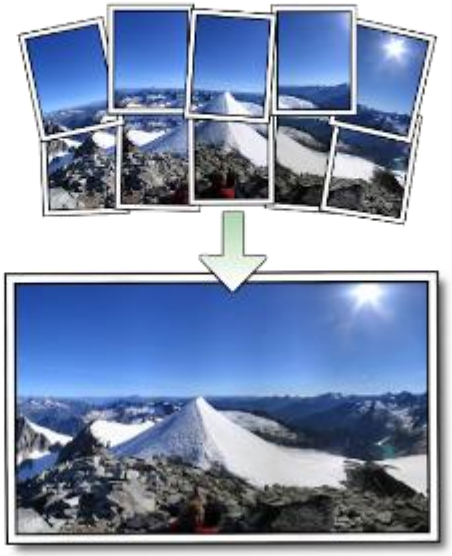
Feature pipeline

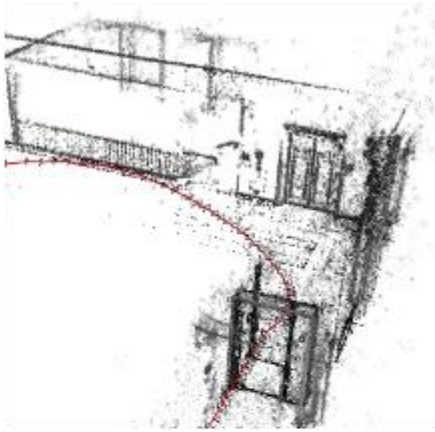


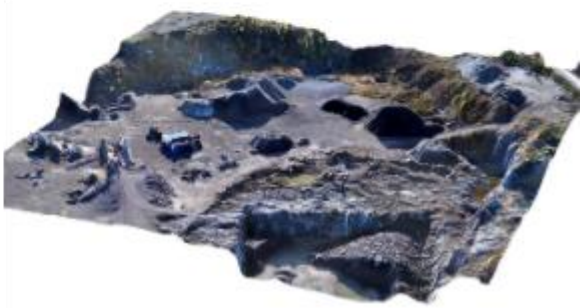
Features - applications

- Several CV systems are based on features
  - Motion detection
  - Stitching
  - 3D reconstruction



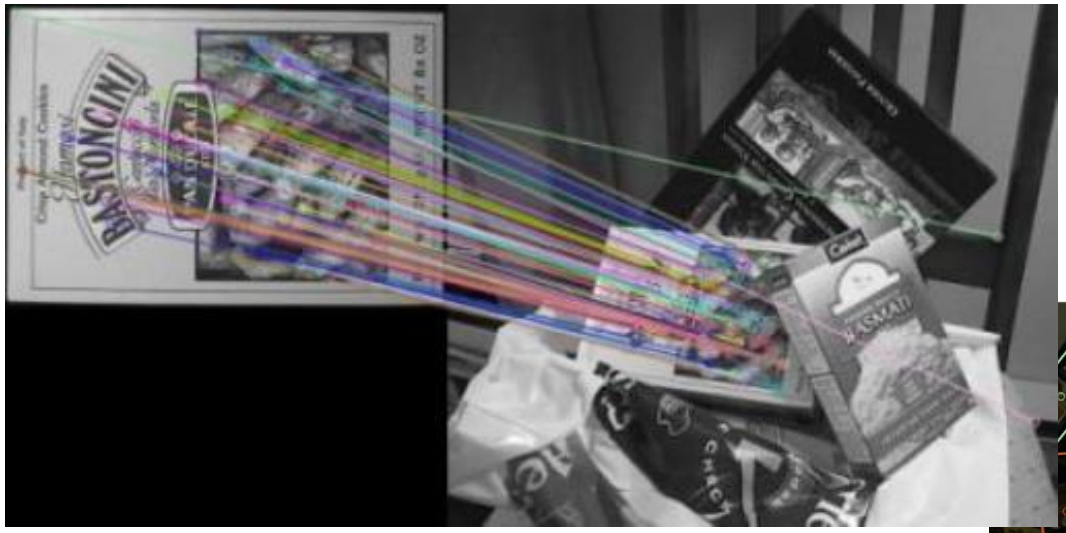






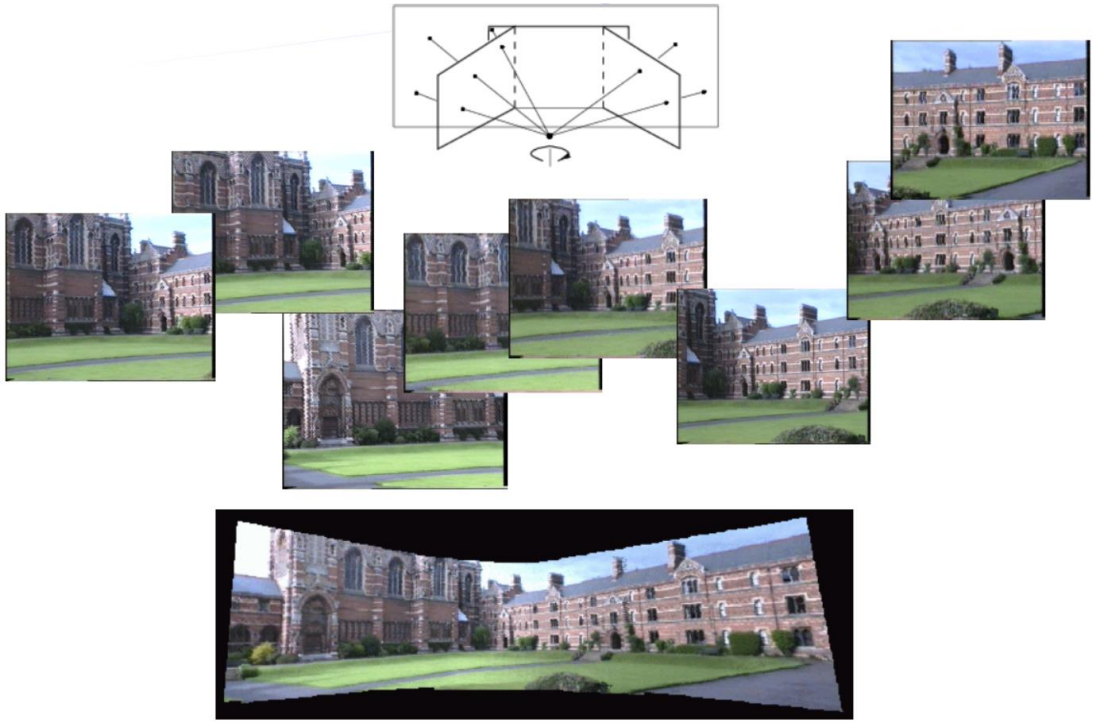
Features - applications

- **Matching**
  - Instance matching/object localization



Features - applications

- **Matching**
  - Stitching image mosaics

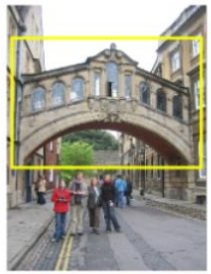


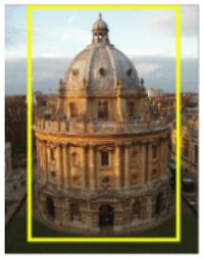
Features - applications

- **Matching**
  - Scene reconstruction & Structure from Motion (SfM)

Features - applications

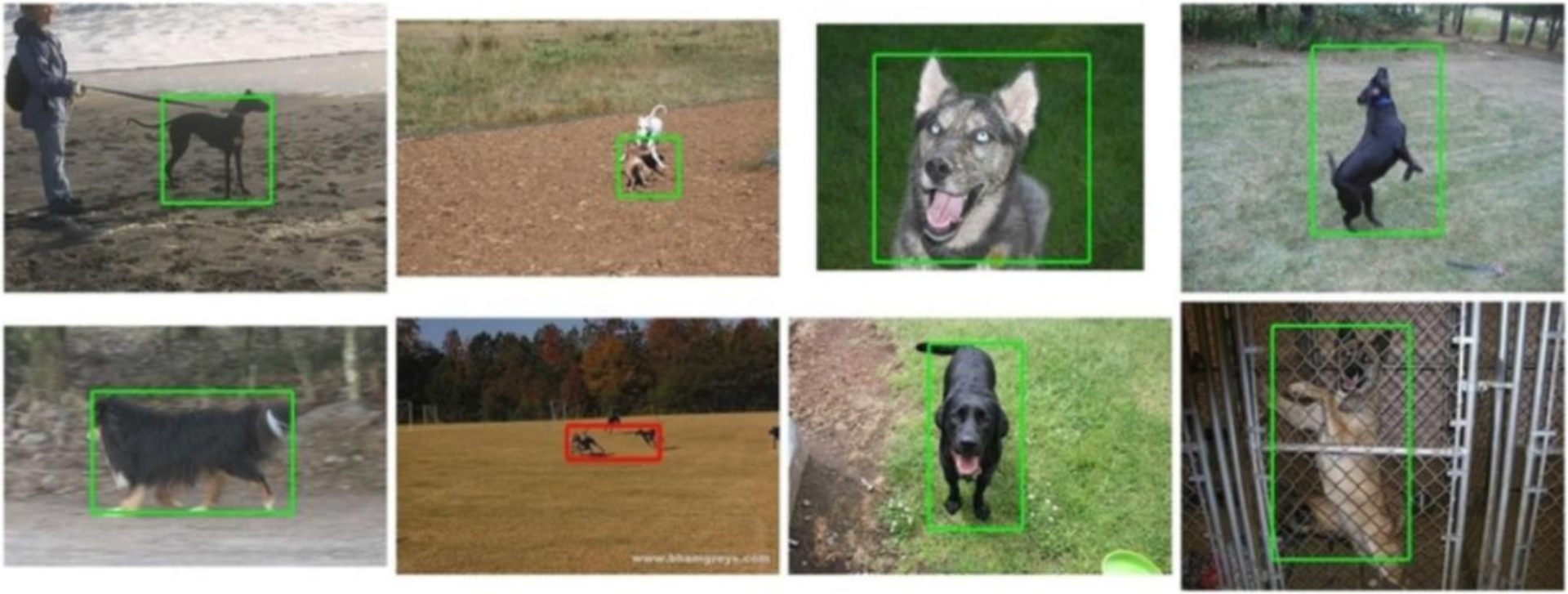
- **Matching**
  - Query by example, place recognition





Features - applications

- **Matching**
  - Object detection (set of features)



Features - applications

- **Tracking**
  - Follow patterns in video flows

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