Lecture 4.0
From keypoints to correspondences

Trym Vegard Haavardsholm

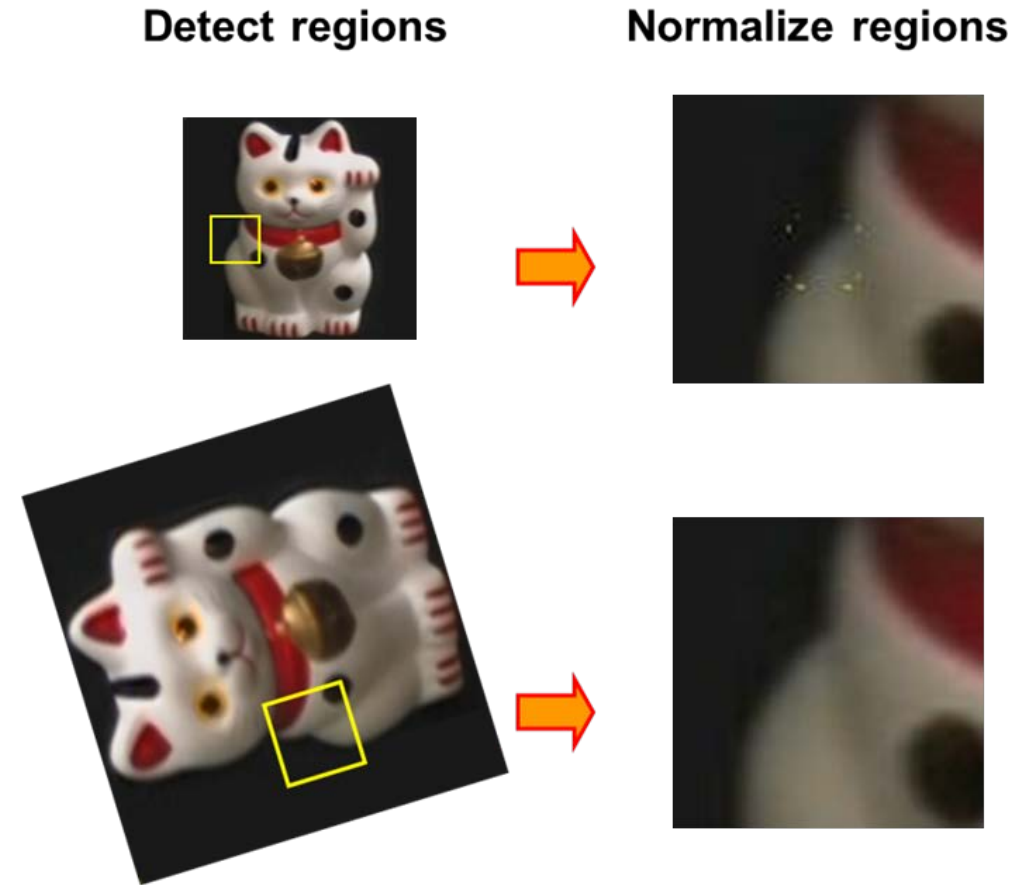UNIK4690

Point correspondences from keypoints
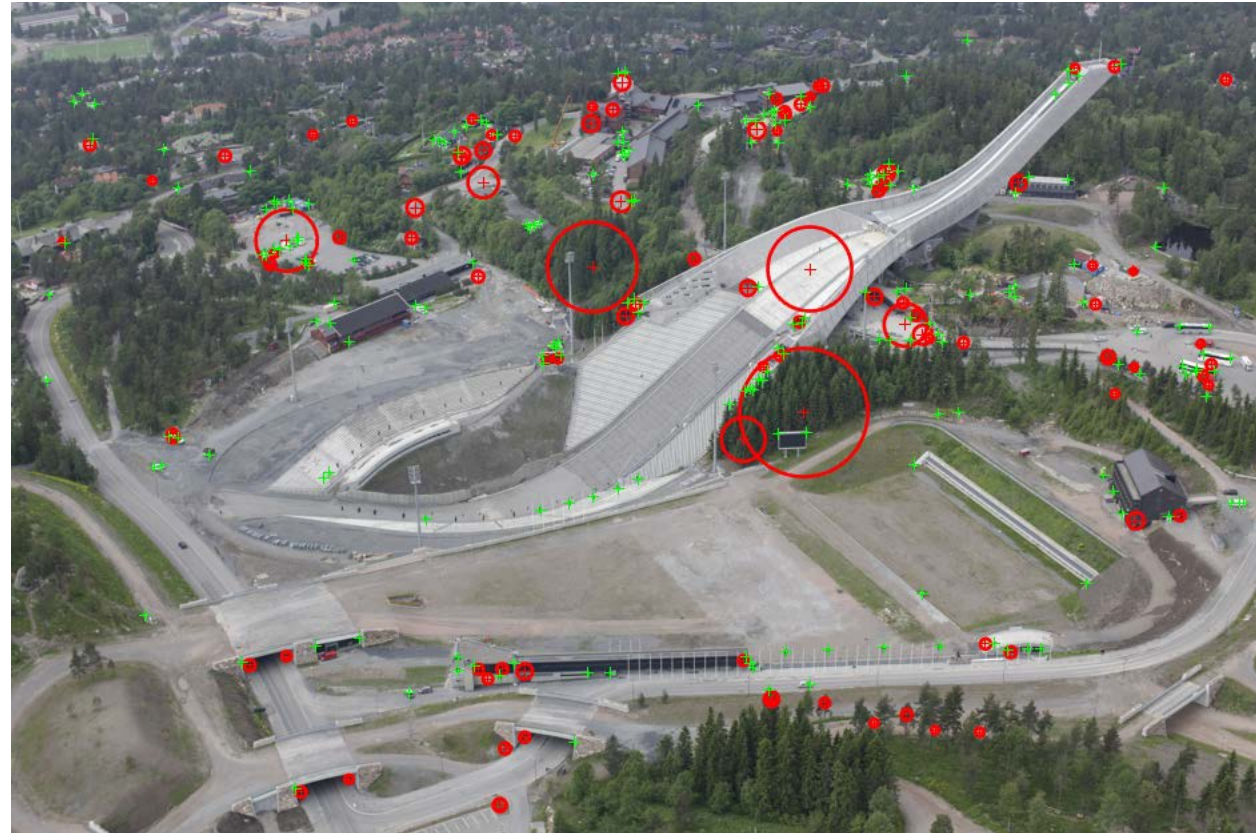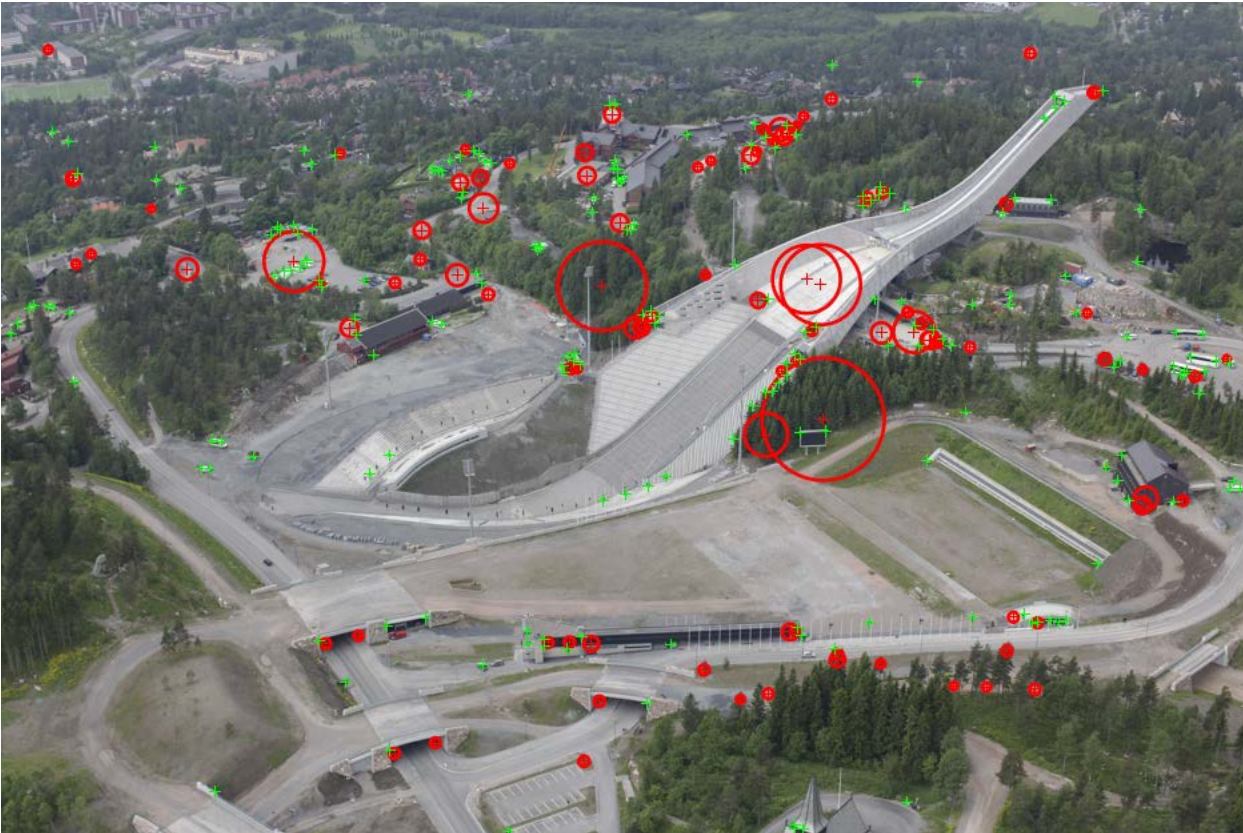
How do we match these keypoints?

Local patches

- Covariant feature point detectors
  - Location (x, y), scale σ and orientation θ.

- Normalize local patches surrounding keypoints
  - Canonical scale

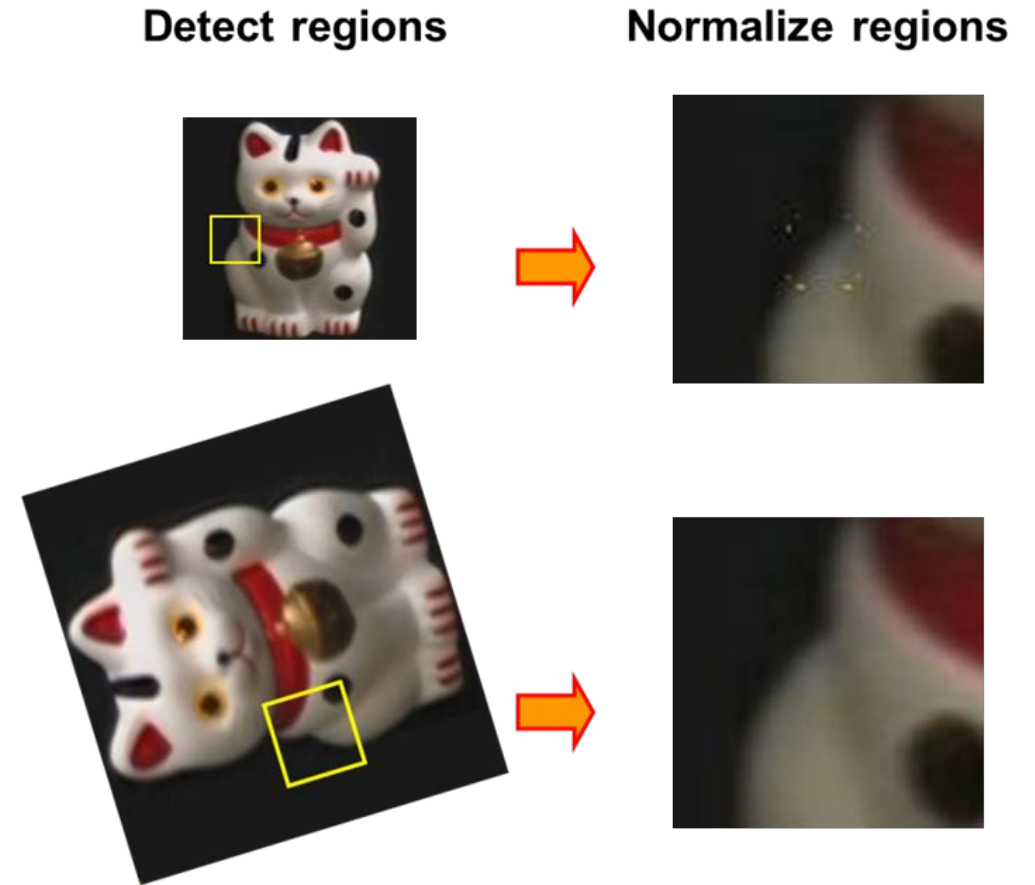**Detect regions**

Normalize regions

Local patches

- Covariant feature point detectors
  - Location (x, y), scale σ and orientation θ.

- Normalize local patches surrounding keypoints
  - Canonical scale
  - Canonical orientation

Detect regions　　　　**Normalize regions**

Estimating canonical orientation

- Find dominant orientation of the image patch
  - This is given by $\mathbf{x_{max}}$, the eigenvector of $\mathbf{M}$ corresponding to λ_{max} (the *larger* eigenvalue)
  - Rotate the patch according to this angle

Estimating canonical orientation
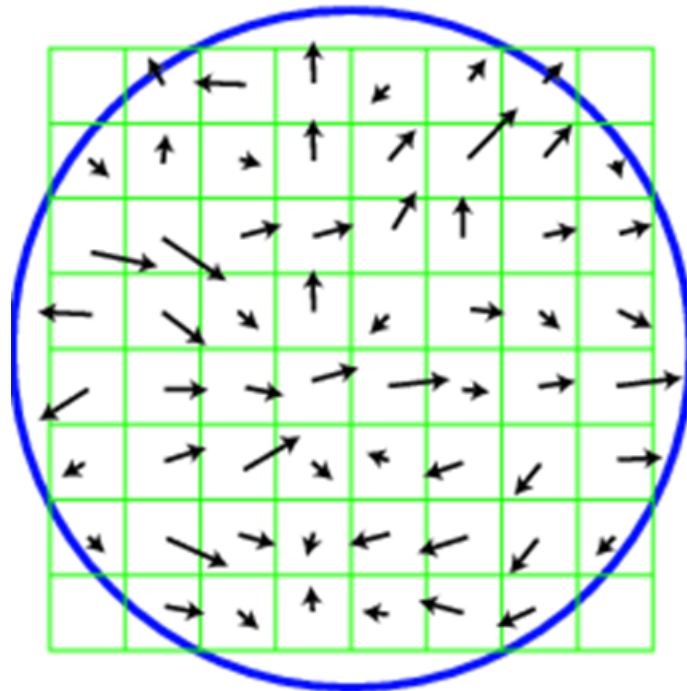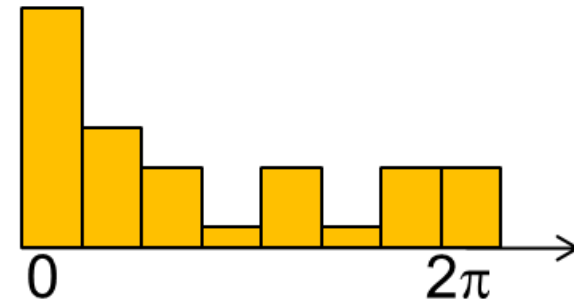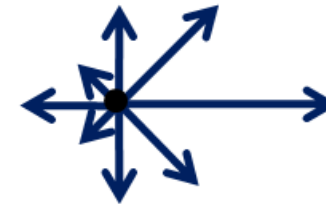
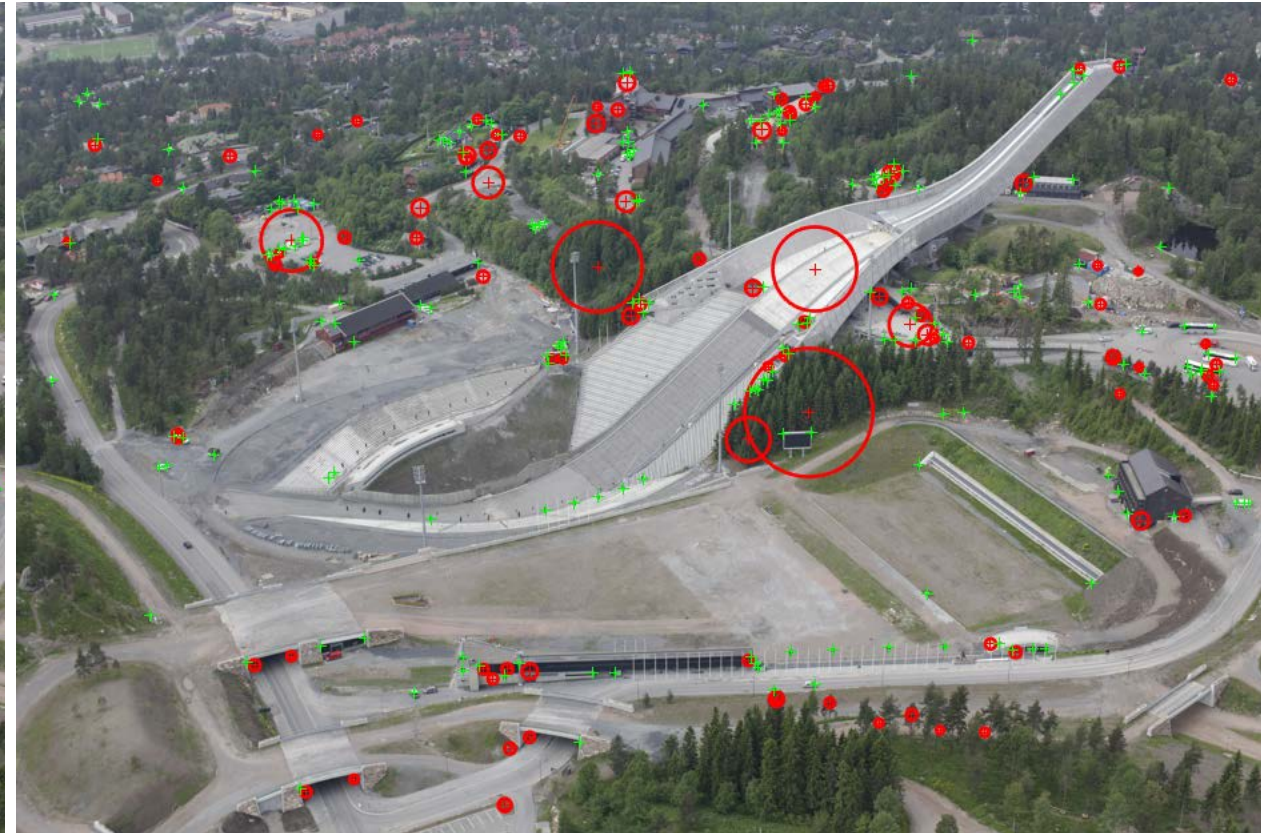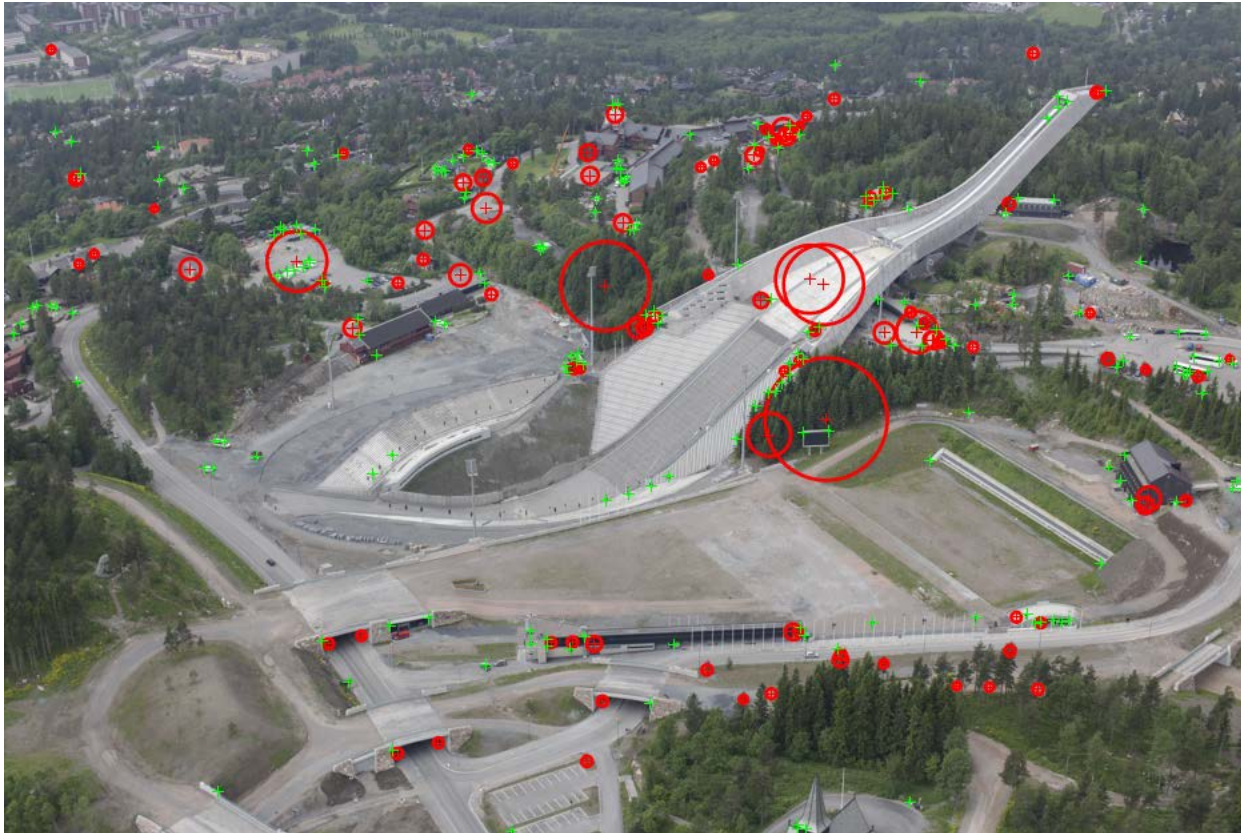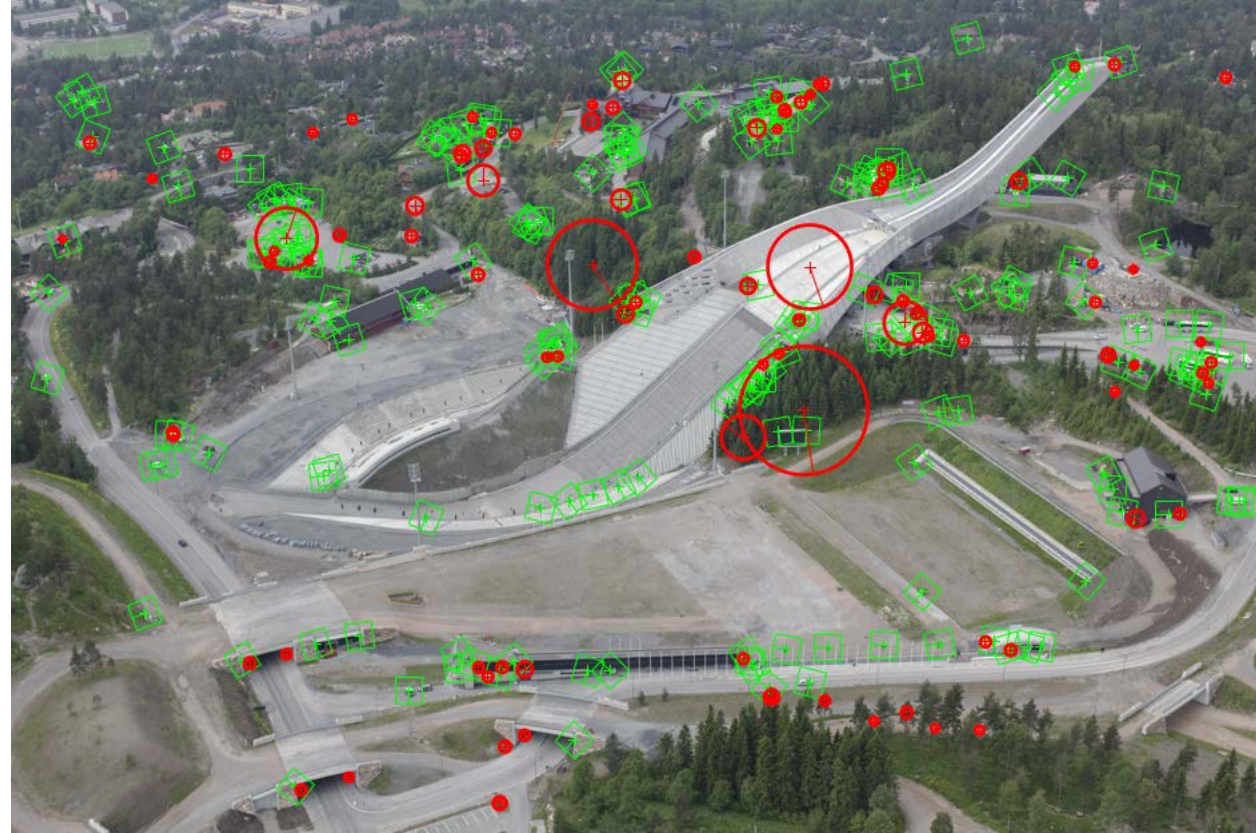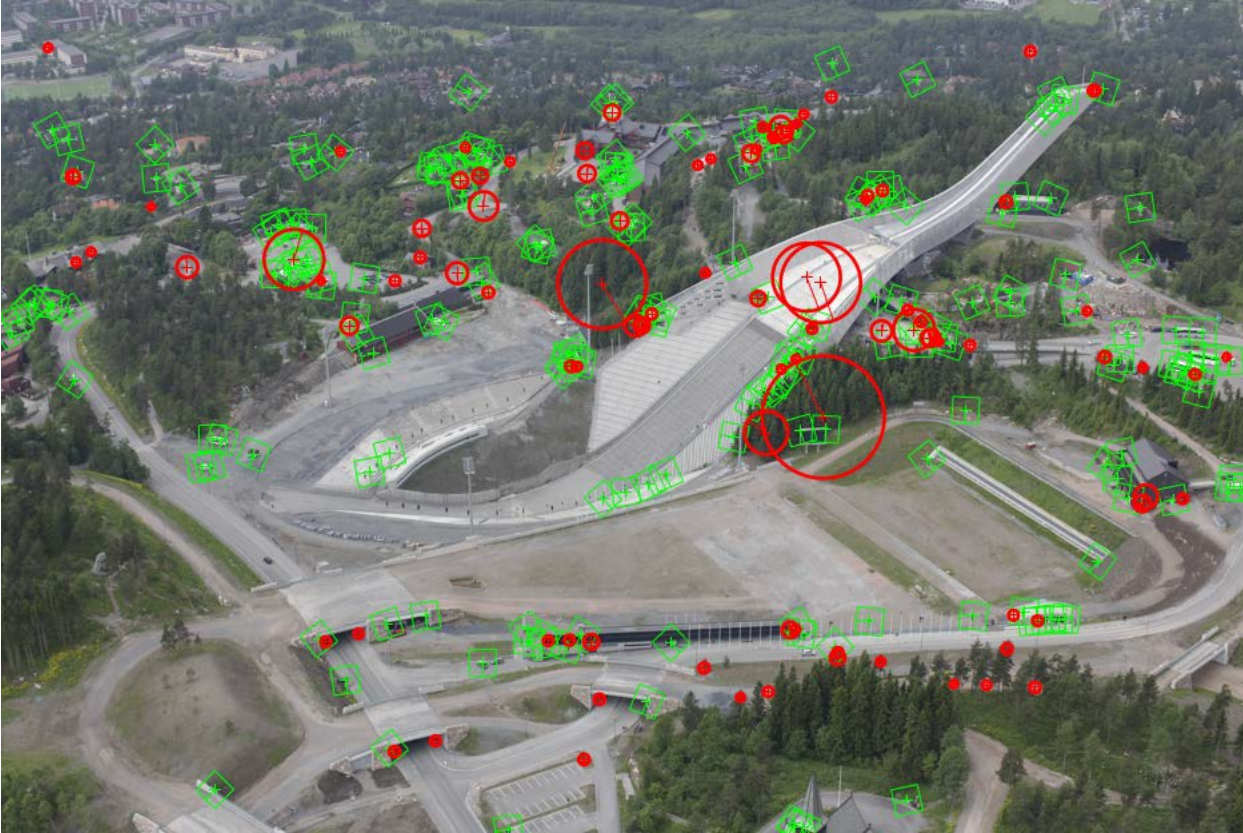- Orientation from Histogram of Gradients (HoG)

Image gradients

angle histogram

Estimating canonical orientation: Example
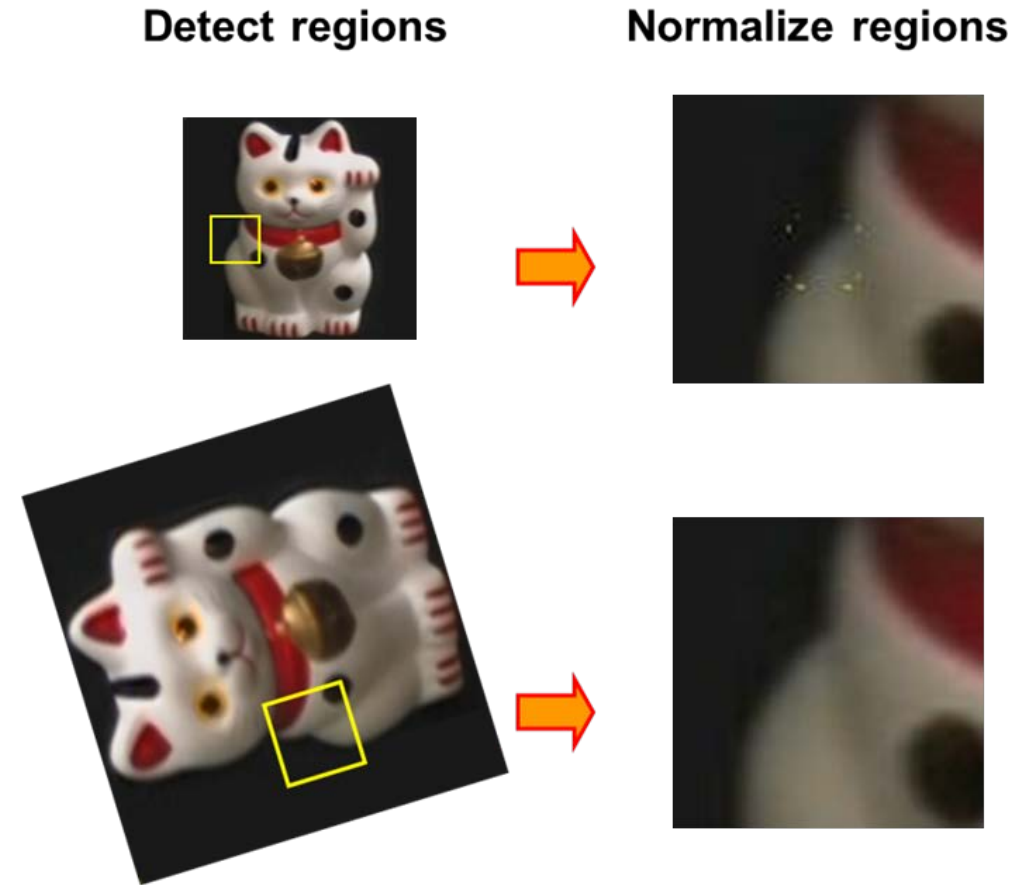
Estimating canonical orientation: Example

Local patches

- Covariant feature point detectors
  - Location (x, y), scale σ and orientation θ.

- Normalize local patches surrounding keypoints
  - Canonical scale
  - Canonical orientation

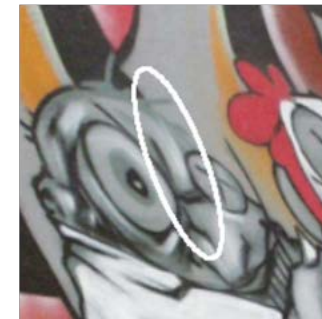Detect regions   Normalize regions

Local patches

- Covariant feature point detectors
  - Affine transformation *A*

- Normalize local patches surrounding keypoints
  - Canonical affine transformation
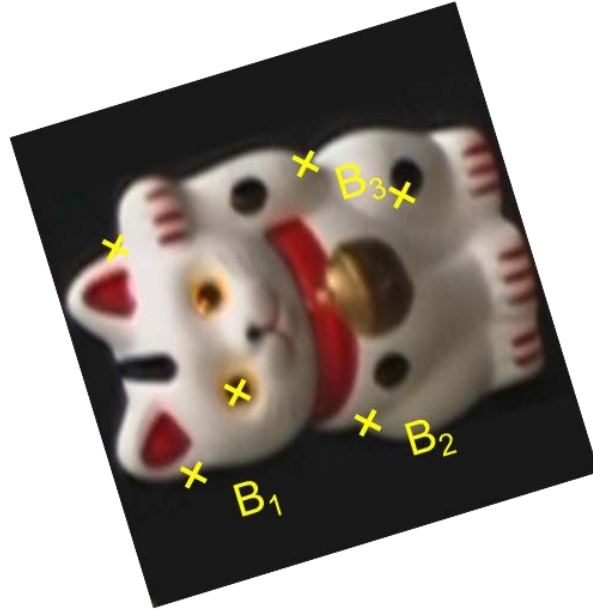
Detect regions

Normalize regions
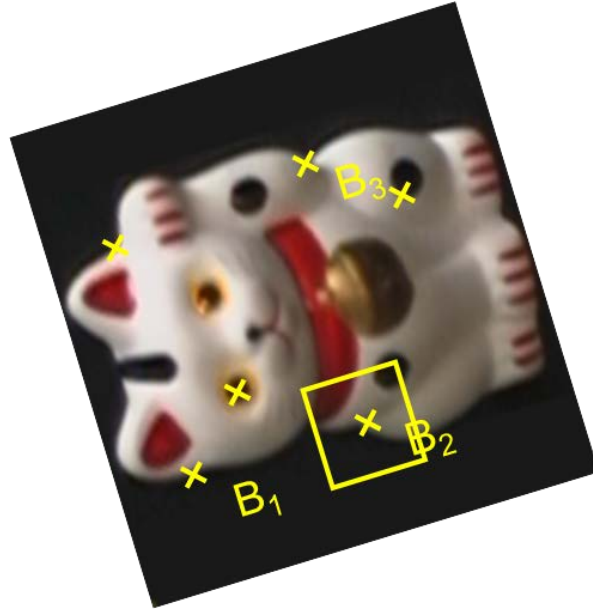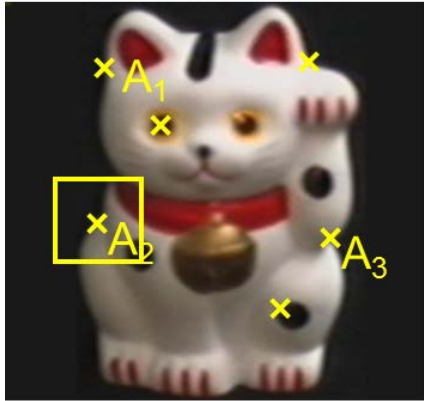
Overview of point feature matching
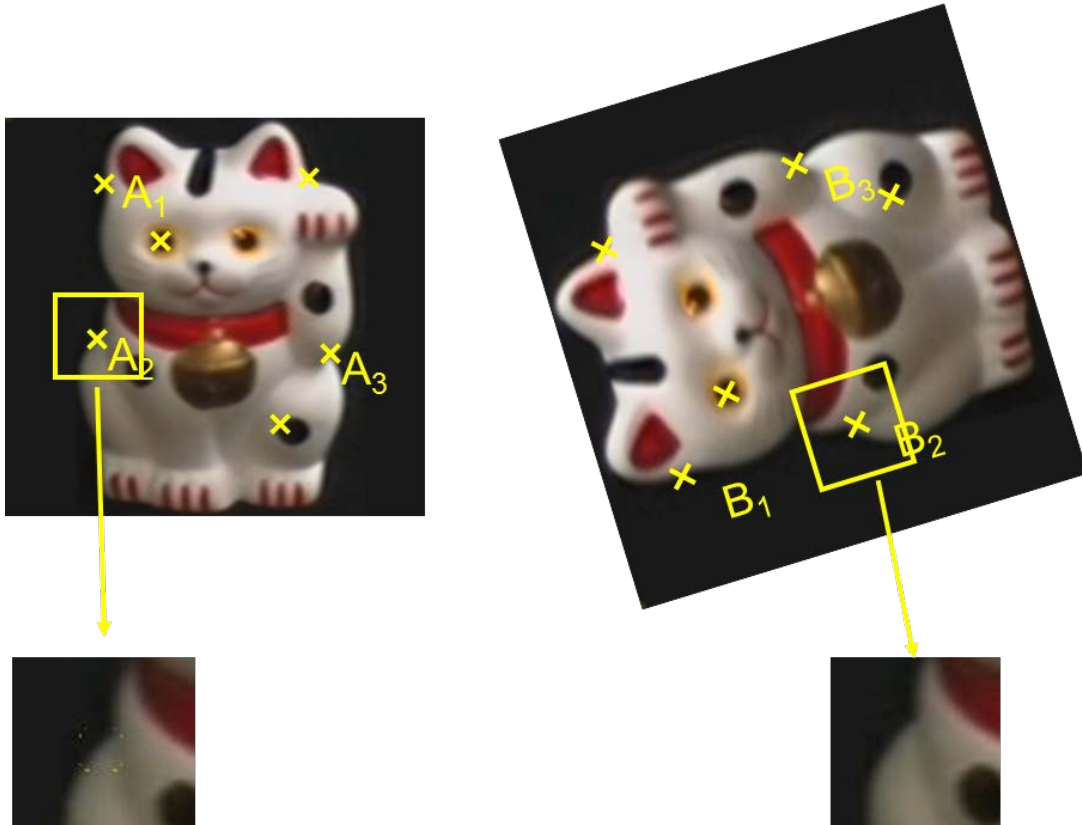
Overview of point feature matching

1. Detect a set of distinct feature points
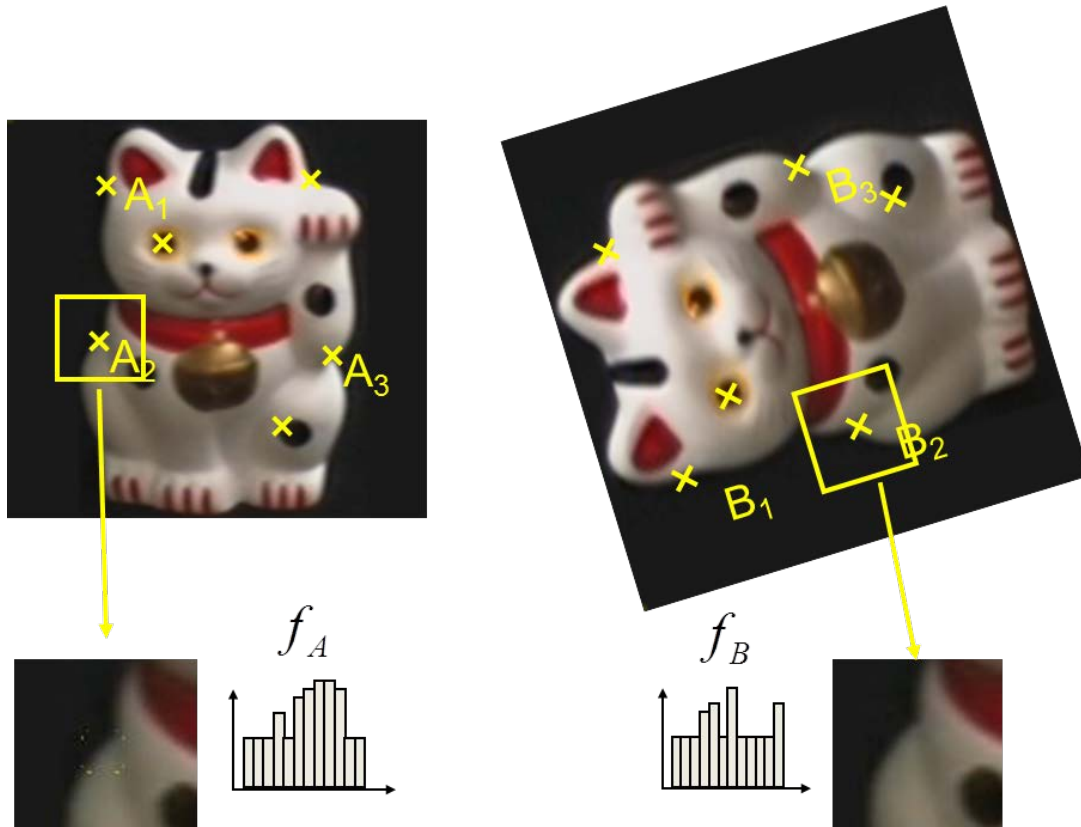
Overview of point feature matching

1. Detect a set of distinct feature points

2. Define a patch around each point
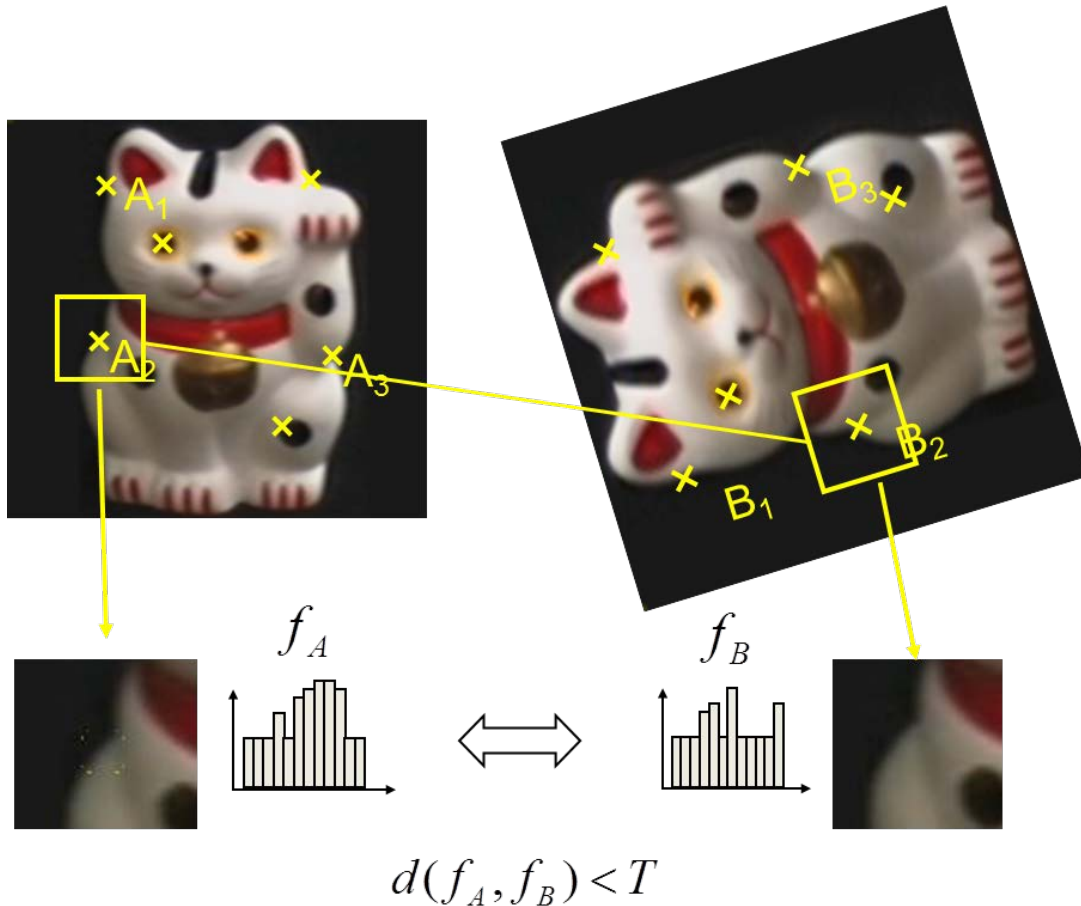
Overview of point feature matching

1. Detect a set of distinct feature points

2. Define a patch around each point

3. Extract and normalize the patch

Overview of point feature matching

1. Detect a set of distinct feature points

2. Define a patch around each point

3. Extract and normalize the patch

4. Compute a local descriptor
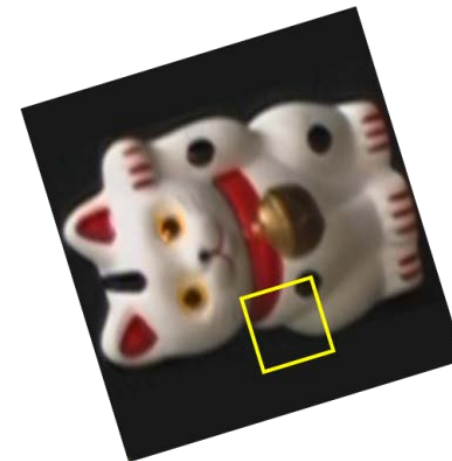
Overview of point feature matching

1. Detect a set of distinct feature points

2. Define a patch around each point

3. Extract and normalize the patch

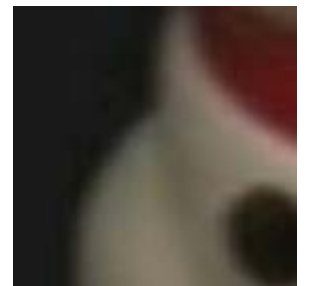4. Compute a local descriptor

5. Match local descriptors

$$d(f_A, f_B) < T$$

Feature descriptors

- Simplest descriptor: Vector of raw intensity values

- How to compare two such vectors?

Detect regions

Normalize regions

Feature descriptors

- Simplest descriptor: Vector of raw intensity values

- How to compare two such vectors?
  - Sum of squared differences (SSD)

$$\mathrm{SSD}(u,v) = \sum_i \left(u_i - v_i \right)^2$$

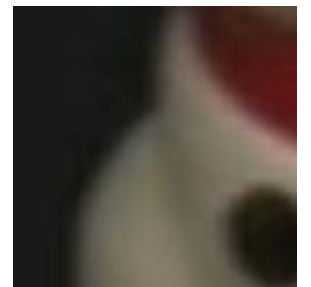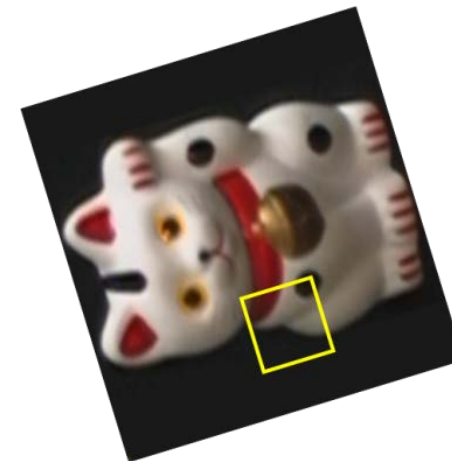**Detect regions**   **Normalize regions**

Feature descriptors

- Simplest descriptor: Vector of raw intensity values

- How to compare two such vectors?
  - Sum of squared differences (SSD)

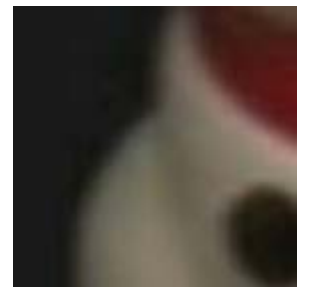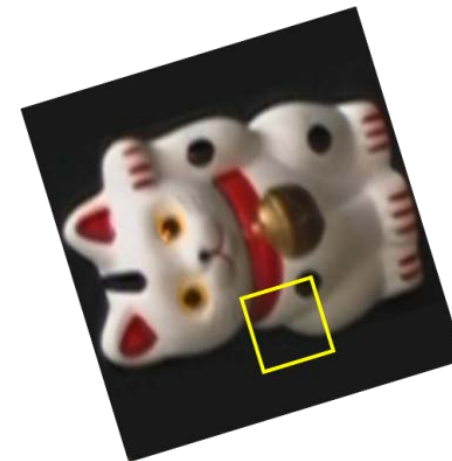$$\text{SSD}(u,v) = \sum_i \left(u_i - v_i \right)^2$$

  - Normalized correlation

$$\rho(u,v) = \frac{\sum_i (u_i - \bar{u})(v_i - \bar{v})}{\sqrt{\left(\sum_j (u_j - \bar{u})^2 \right)\left(\sum_j (v_j - \bar{v})^2 \right)}}$$

Detect regions

Normalize regions

A better descriptor

- Robust to small deformations

- Distinctive
- Fast to construct
- Fast to compare