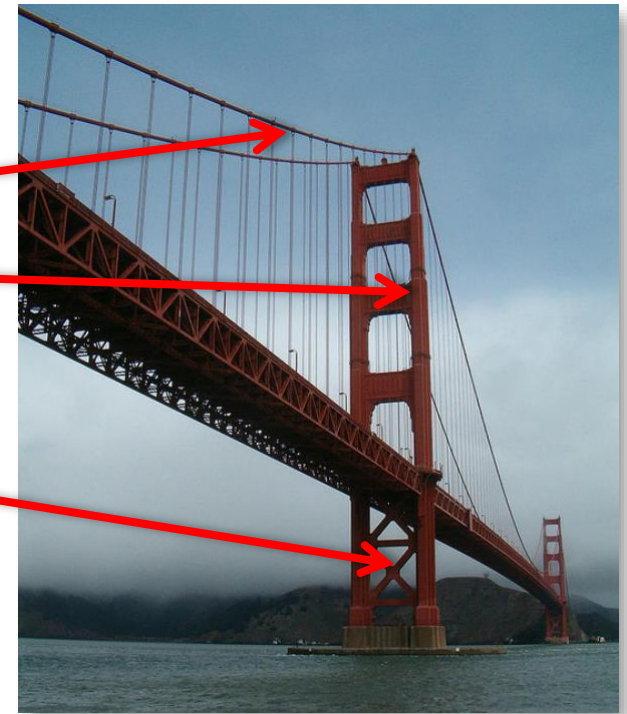# CS5670: Computer Vision
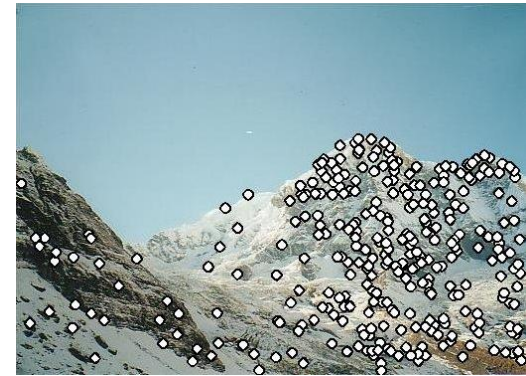## Noah Snavely

Lecture 6: Feature matching

Reading

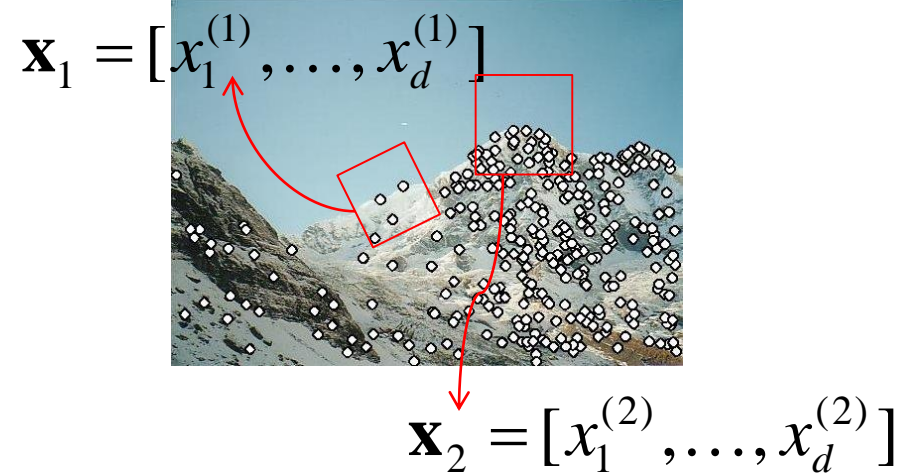- Szeliski: 4.1

Announcements

- Project 1 artifact voting online shortly

- Project 2 to be released soon

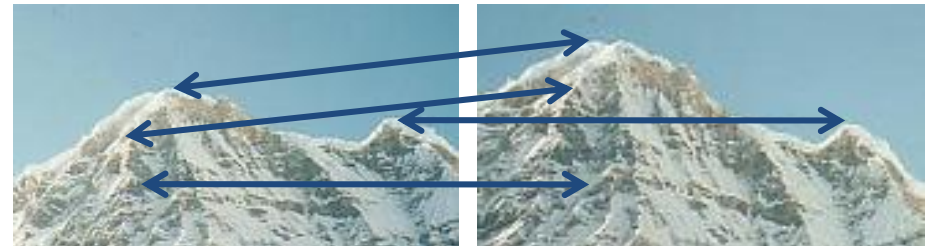- Quiz at the beginning of class today

Local features: main components
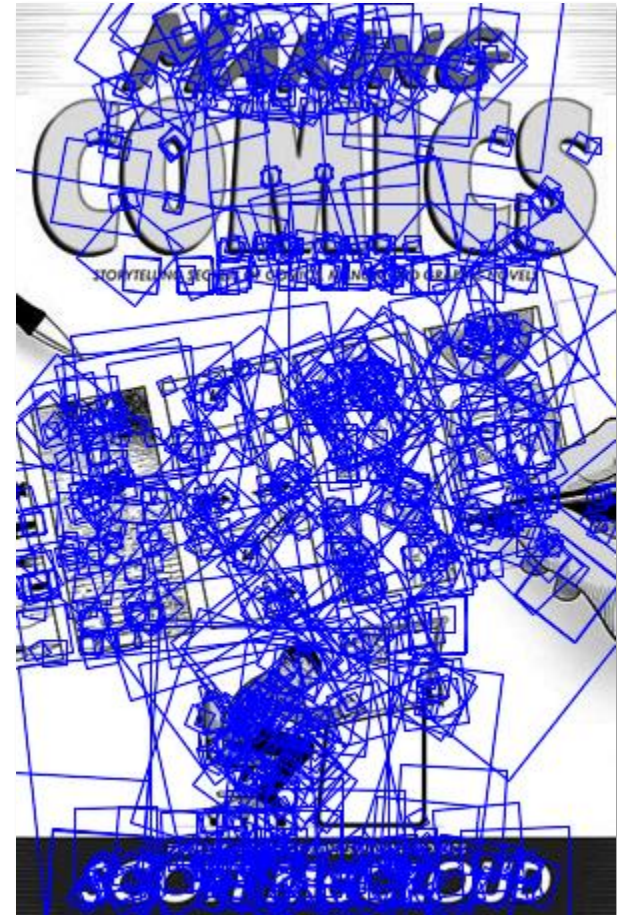
1) **Detection:** Identify the interest points

2) **Description:** Extract vector feature descriptor surrounding each interest point.

$$\mathbf{x}_1 = [x_1^{(1)}, \ldots, x_d^{(1)}]$$

3) **Matching:** Determine correspondence between descriptors in two views

$$\mathbf{x}_2 = [x_1^{(2)}, \ldots, x_d^{(2)}]$$
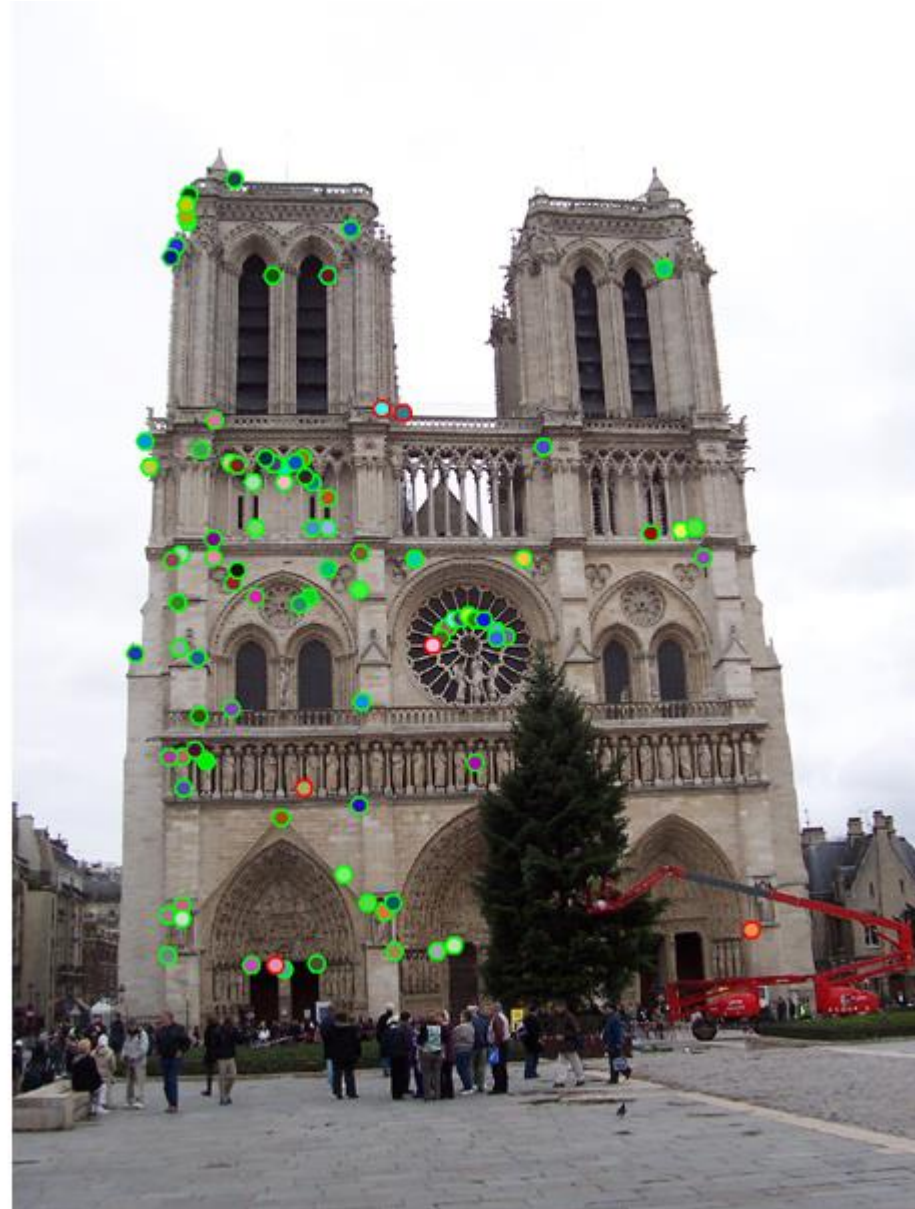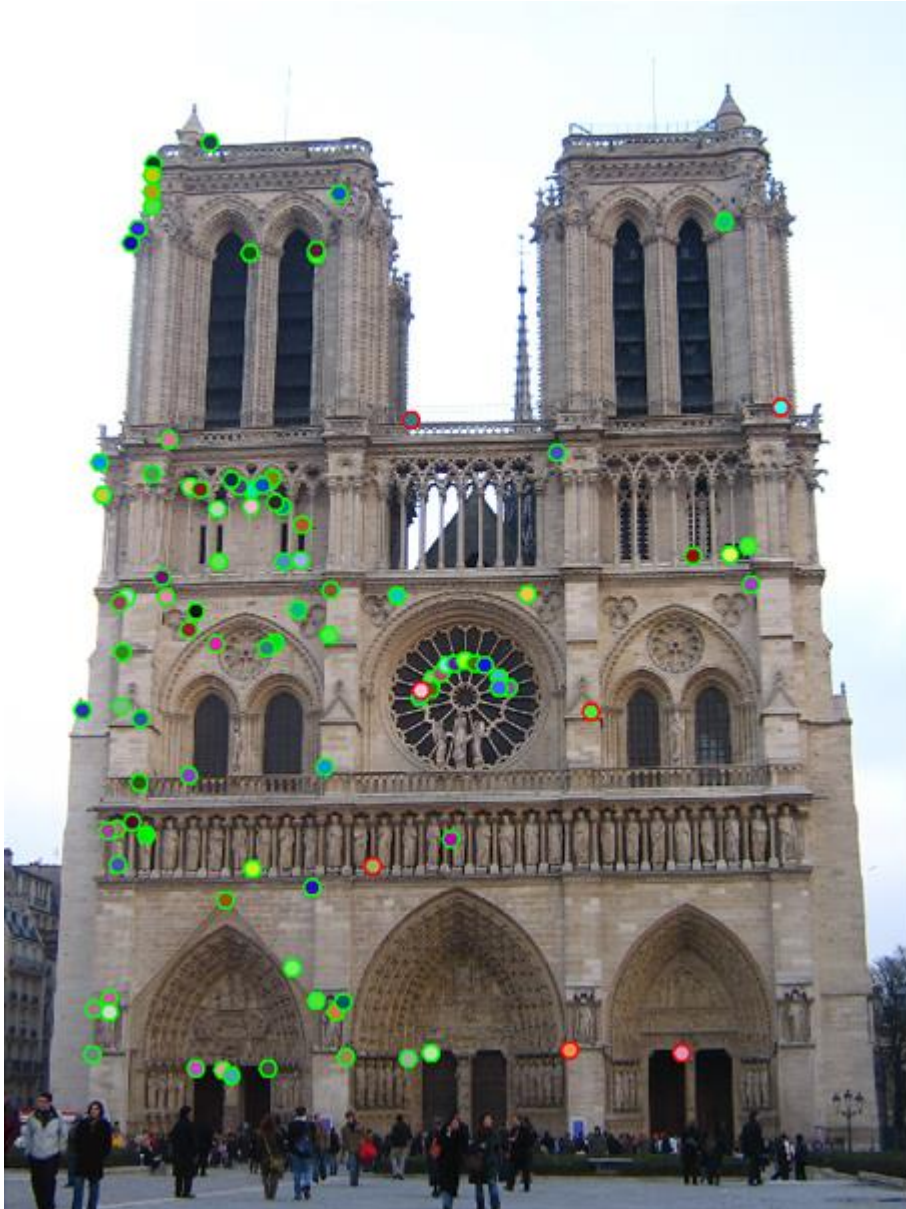
Kristen Grauman

SIFT Example
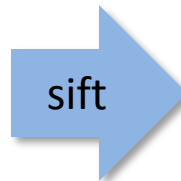
sift

868 SIFT features

Which features match?

Feature matching

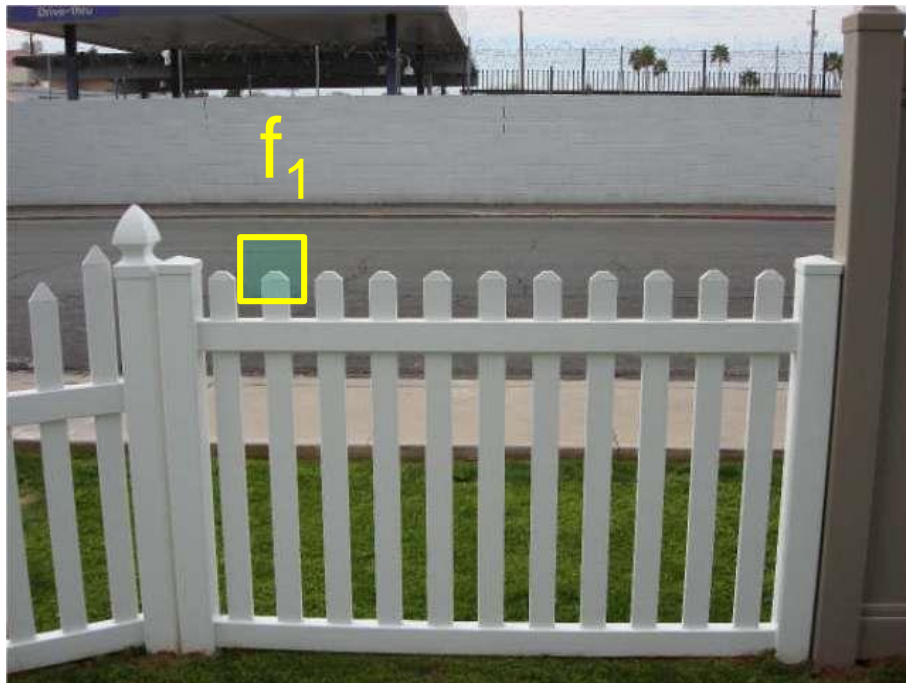Given a feature in I_1, how to find the best match in I_2?

1. Define distance function that compares two descriptors

2. Test all the features in I_2, find the one with min distance
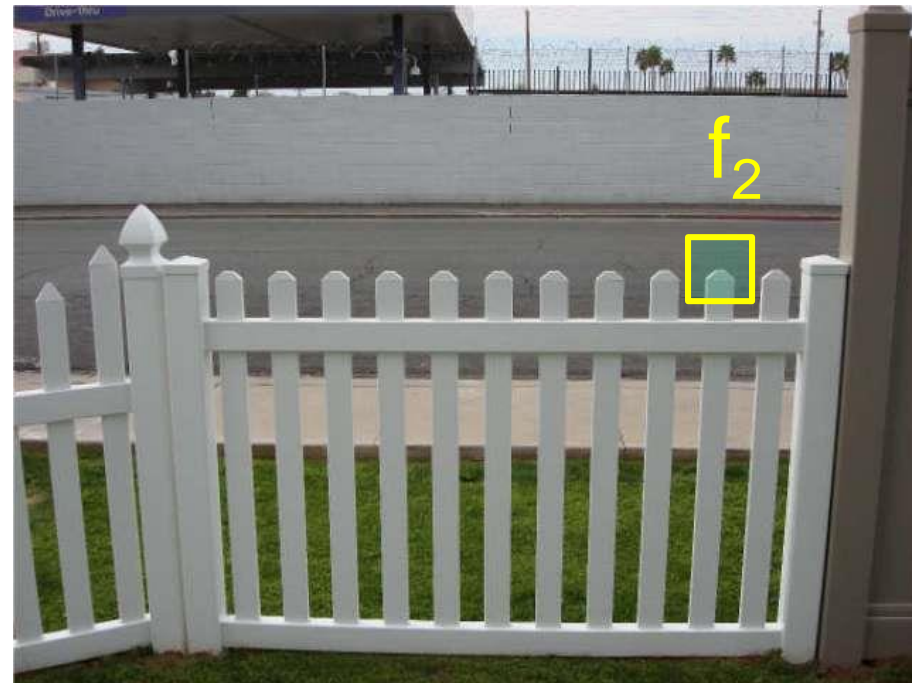
Feature distance

How to define the difference between two features f_1, f_2?

- Simple approach: L_2 distance, $||f_1 - f_2||$ (aka SSD)
- can give good scores to ambiguous (incorrect) matches
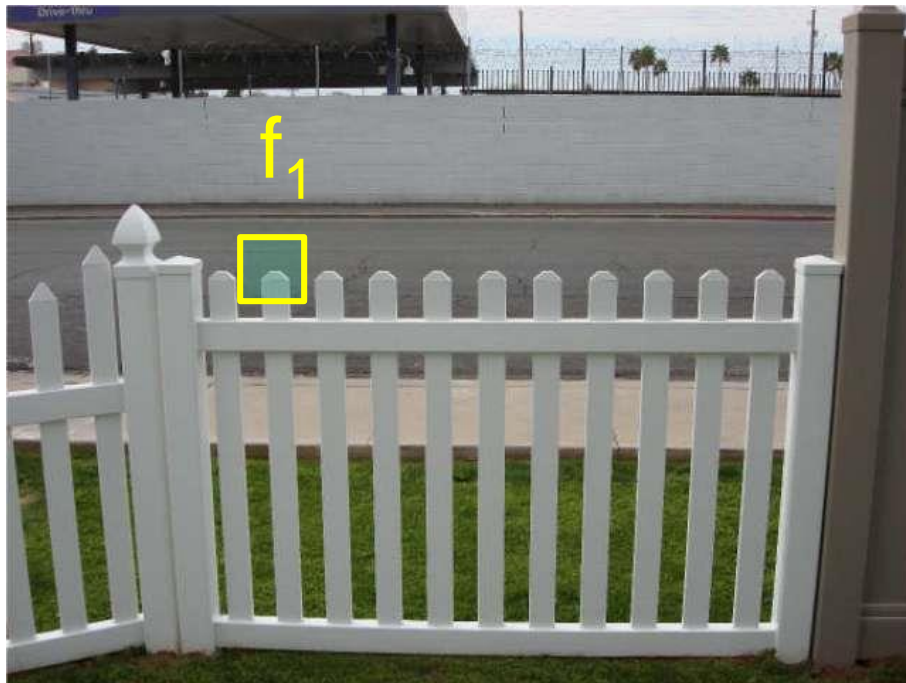

I_1 I_2

Feature distance

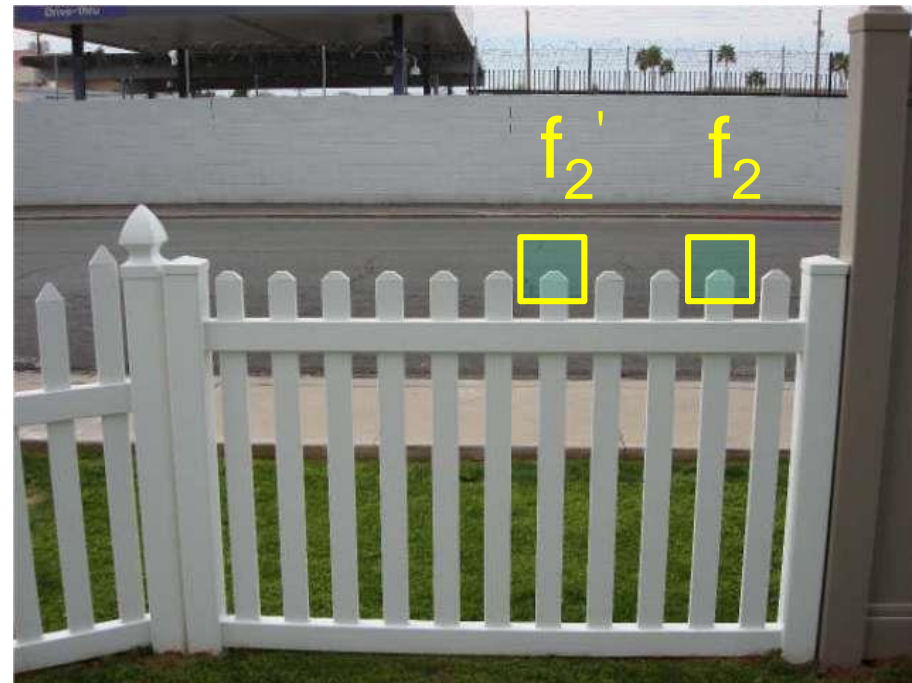## How to define the difference between two features f_1, f_2?

- Better approach: ratio distance = $||f_1 - f_2|| / ||f_1 - f_2'||$
    - f_2 is best SSD match to f_1 in I_2
    - f_2' is 2nd best SSD match to f_1 in I_2
    - gives large values for ambiguous matches
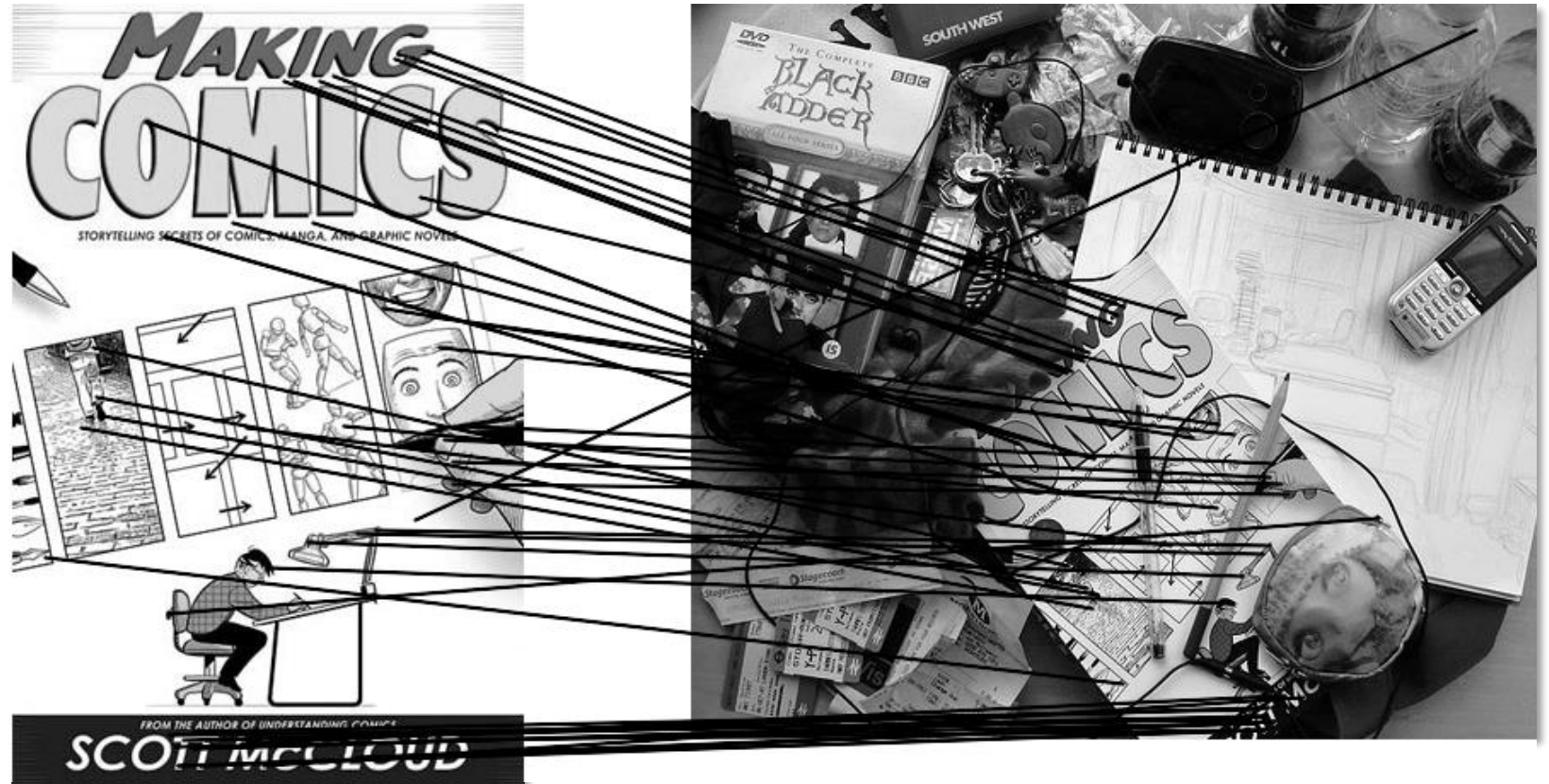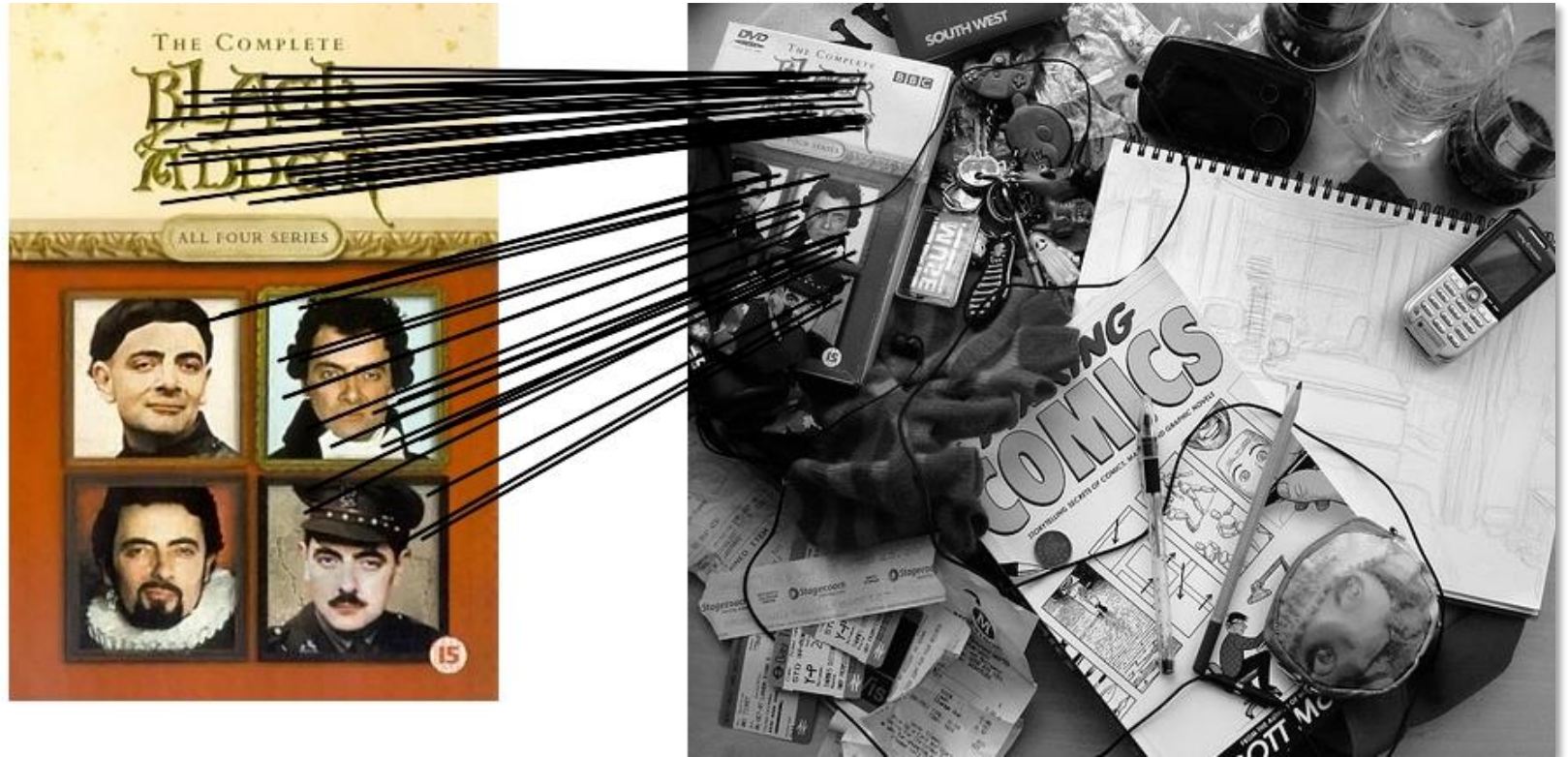

I_1

I_2

Feature distance

- Does the SSD vs "ratio distance" change the best match to a given feature in image 1?

Feature matching example

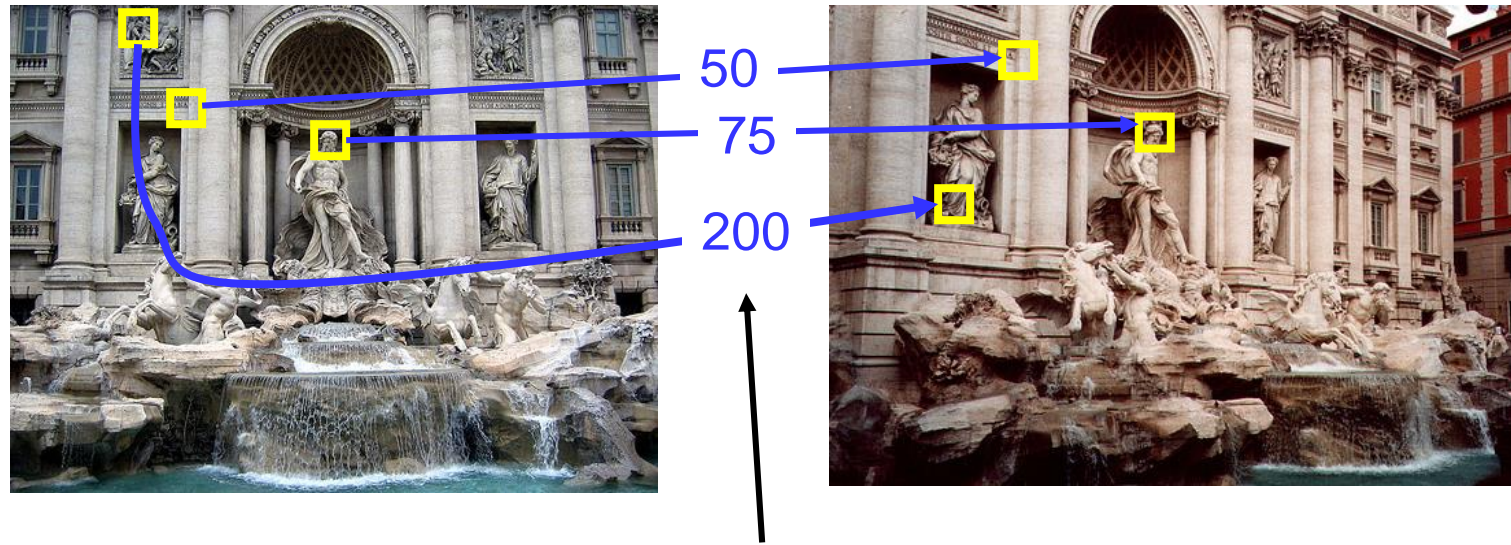**51 matches (thresholded by ratio score)**

Feature matching example

58 matches (thresholded by ratio score)

Evaluating the results

How can we measure the performance of a feature matcher?

50

75

200

feature distance

True/false positives

How can we measure the performance of a feature matcher?

50
true match

75

200
false match

feature distance
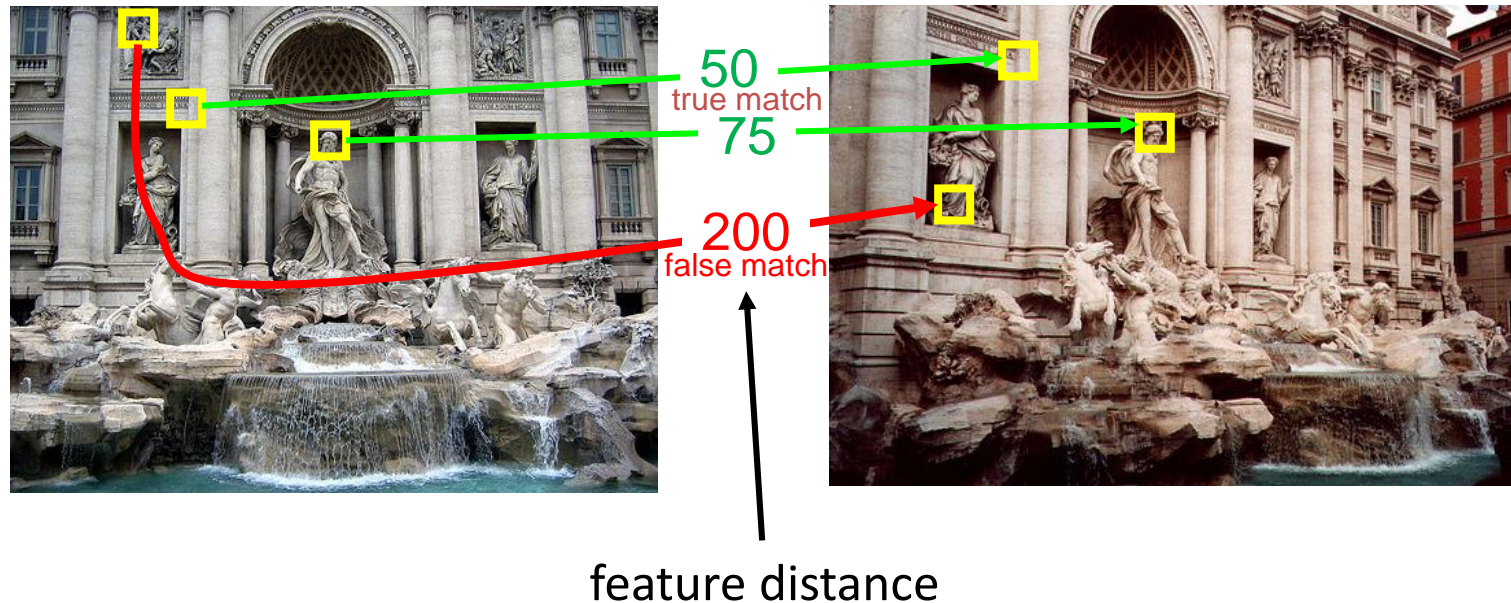
The distance threshold affects performance
- – True positives = # of detected matches that are correct
    - • Suppose we want to maximize these—how to choose threshold?
- – False positives = # of detected matches that are incorrect
    - • Suppose we want to minimize these—how to choose threshold?

Evaluating the results

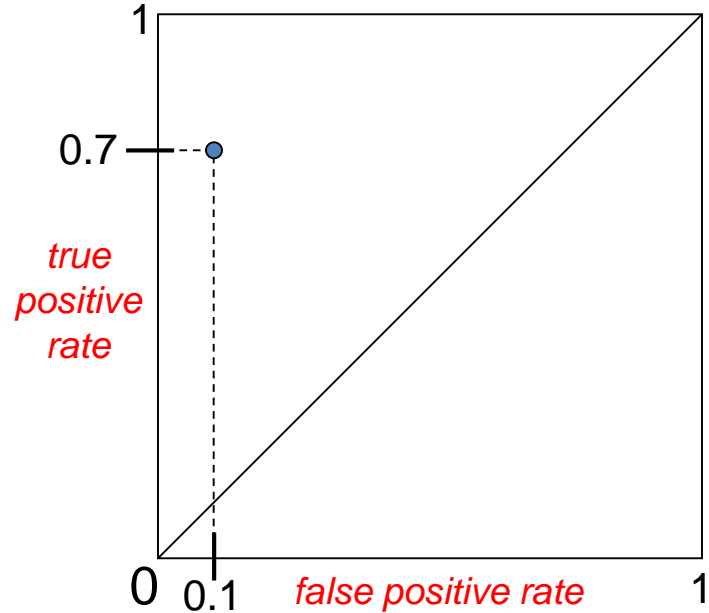How can we measure the performance of a feature matcher?

$$\frac{\text{\# true positives}}{\text{\# matching features (positives)}}$$

"recall"

true positive rate

false positive rate

$$\frac{\text{\# false positives}}{\text{\# unmatched features (negatives)}}$$

1 - "precision"

Evaluating the results

How can we measure the performance of a feature matcher?

ROC curve ("Receiver Operator Characteristic")

$$\frac{\text{# true positives}}{\text{# matching features (positives)}}$$

"recall"

true positive rate

false positive rate

$$\frac{\text{# false positives}}{\text{# unmatched features (negatives)}}$$

1 - "precision"
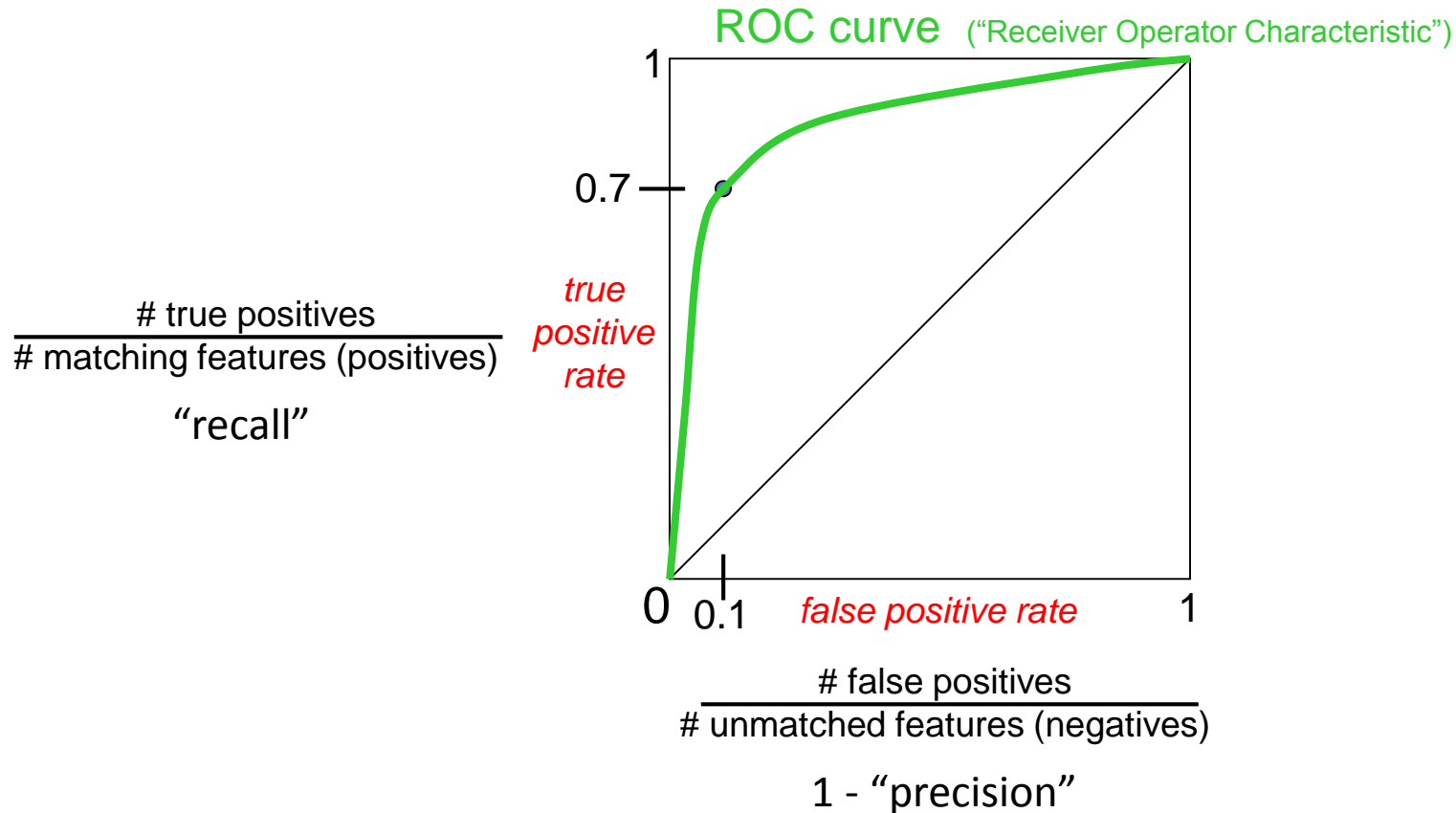
Available at a web site near you…

- For most local feature detectors, executables are available online:
    - http://www.robots.ox.ac.uk/~vgg/research/affine
    - http://www.cs.ubc.ca/~lowe/keypoints/
    - http://www.vision.ee.ethz.ch/~surf

Questions?