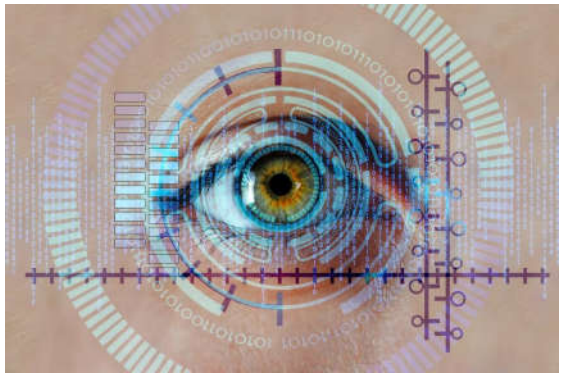
北京理工大学
BEIJING INSTITUTE OF TECHNOLOGY

Computer Vision



Lecture 9 Panorama

School of Computer Science and Technology

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Outline

- Quick review of keypoints and RANSAC
- Panorama formulation
- Matching corresponding keypoints
- Stitching images together with affine transformation

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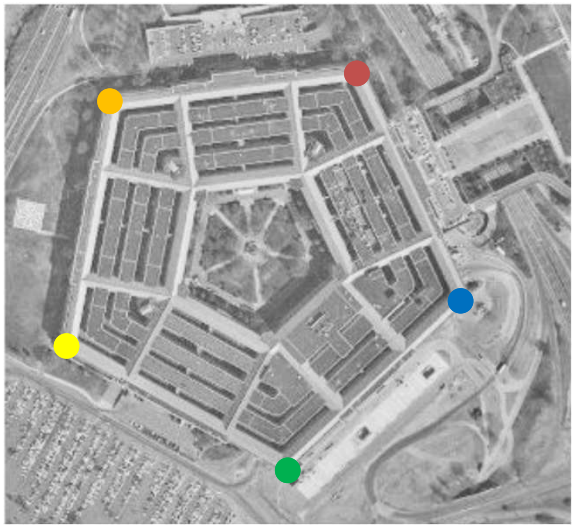
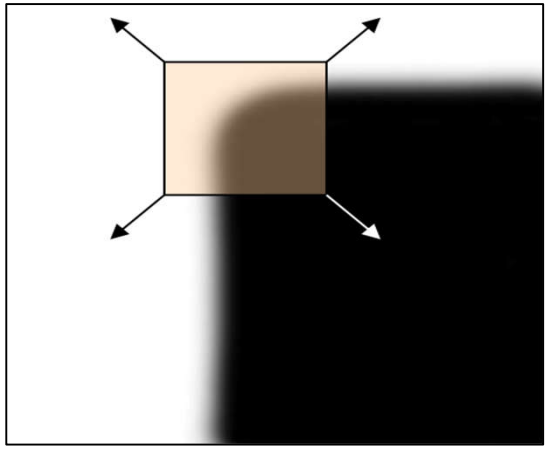
What are keypoints?



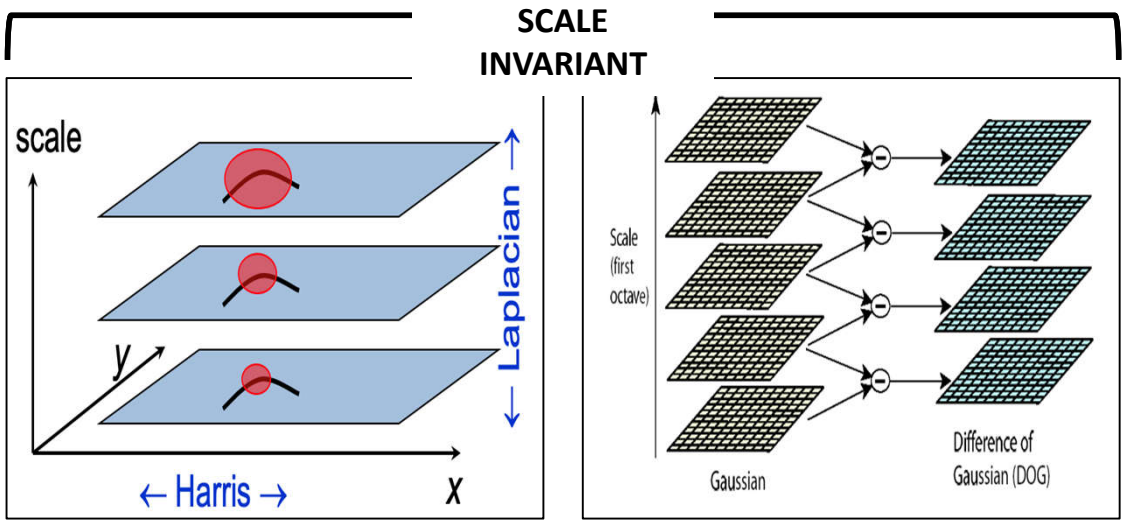
Reliable, unique points in images which can be used to find corresponding regions in different images of the same scene

Finding keypoints



Harris Corner Detector

Use gradient Eigenvalues to find corners at a certain scale



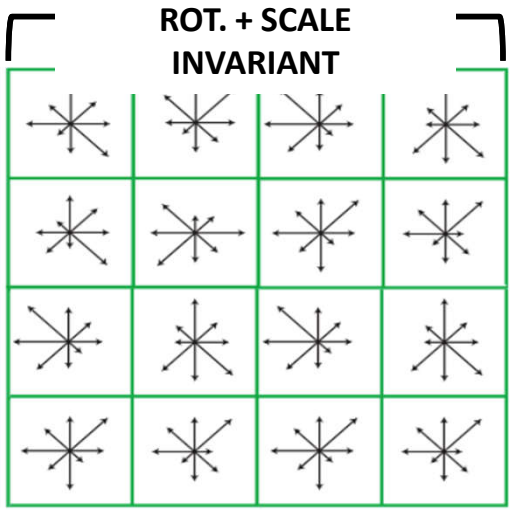
Harris-Laplacian

Find keypoints using Harris and scale using Laplacian filter

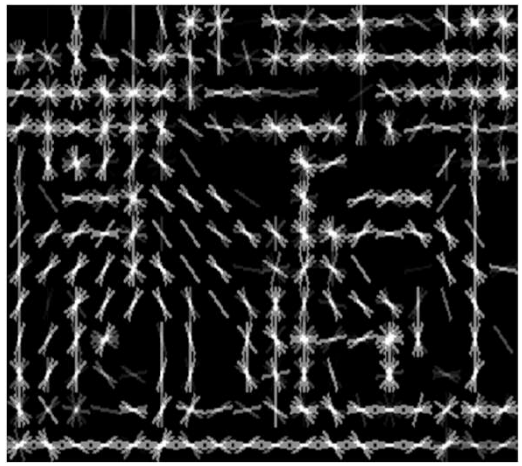
DoG

Use DoG filters to find keypoints across space and scale

Describing keypoints



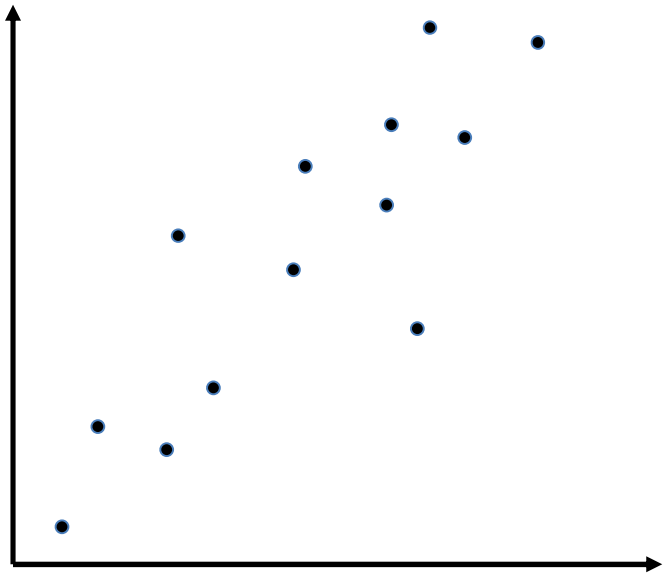
SIFT Descriptor
Keypoints as histogram of normalize gradient orientation



HoG
Region (or image) as histograms of local gradients

RANSAC – algorithm for model fitting

- Repeat n times:
  - Sample and form hypothesis
  - Find number of inliers
  - If max_inliers, save model
- Recompute model on inliers



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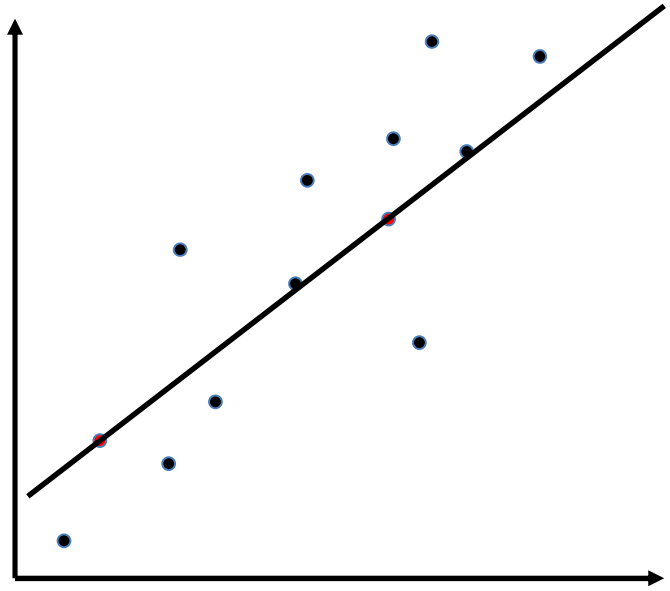

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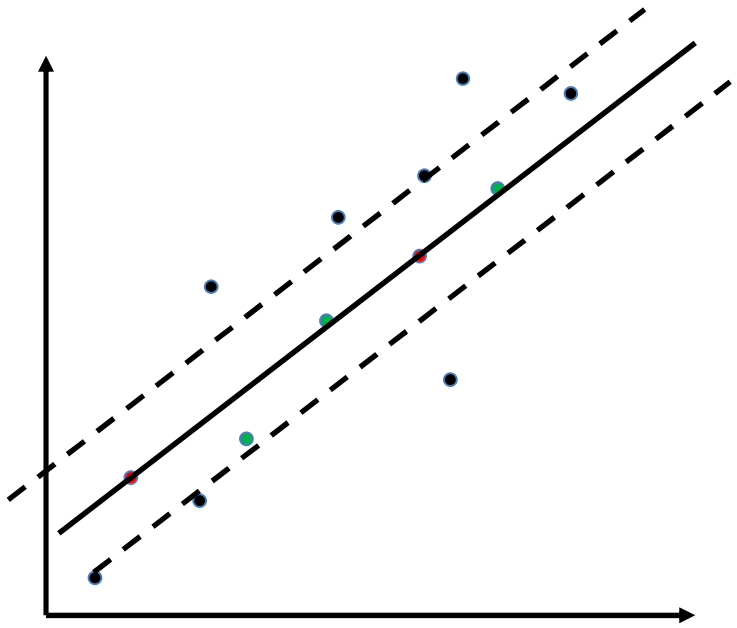

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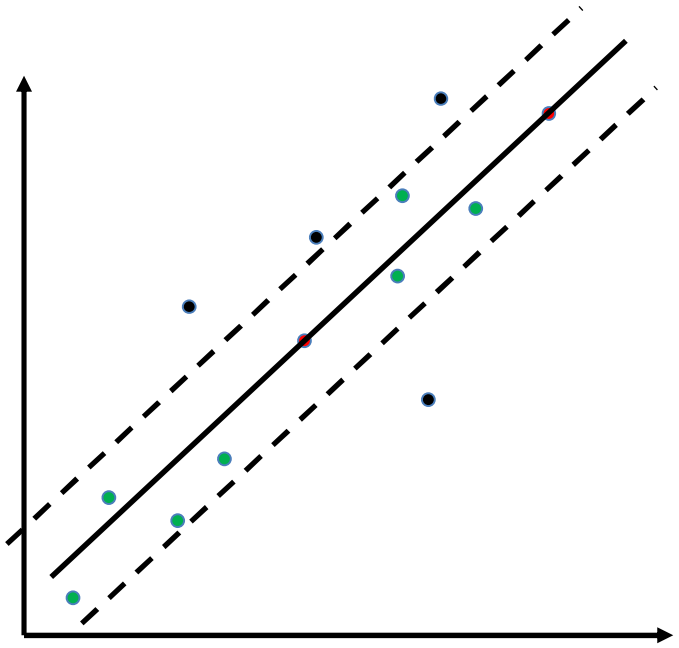

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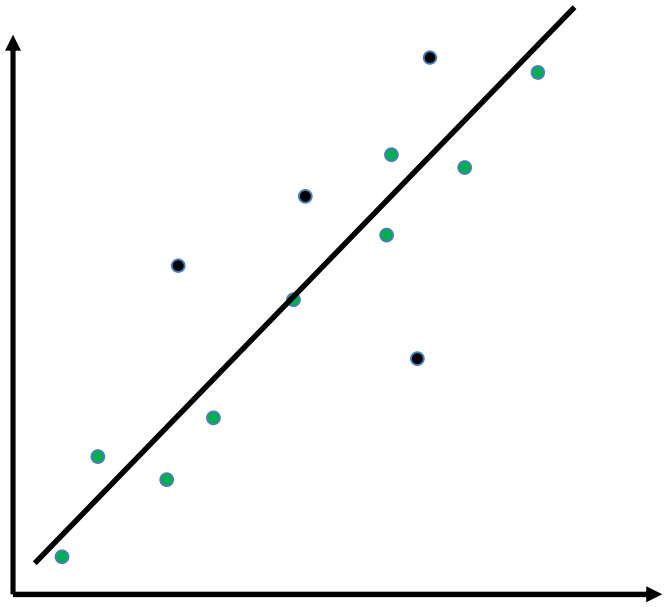

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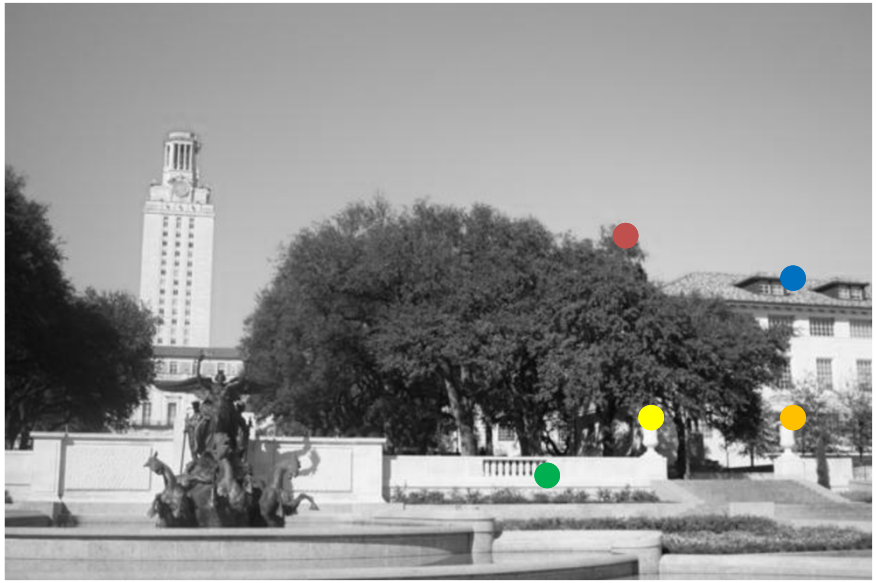
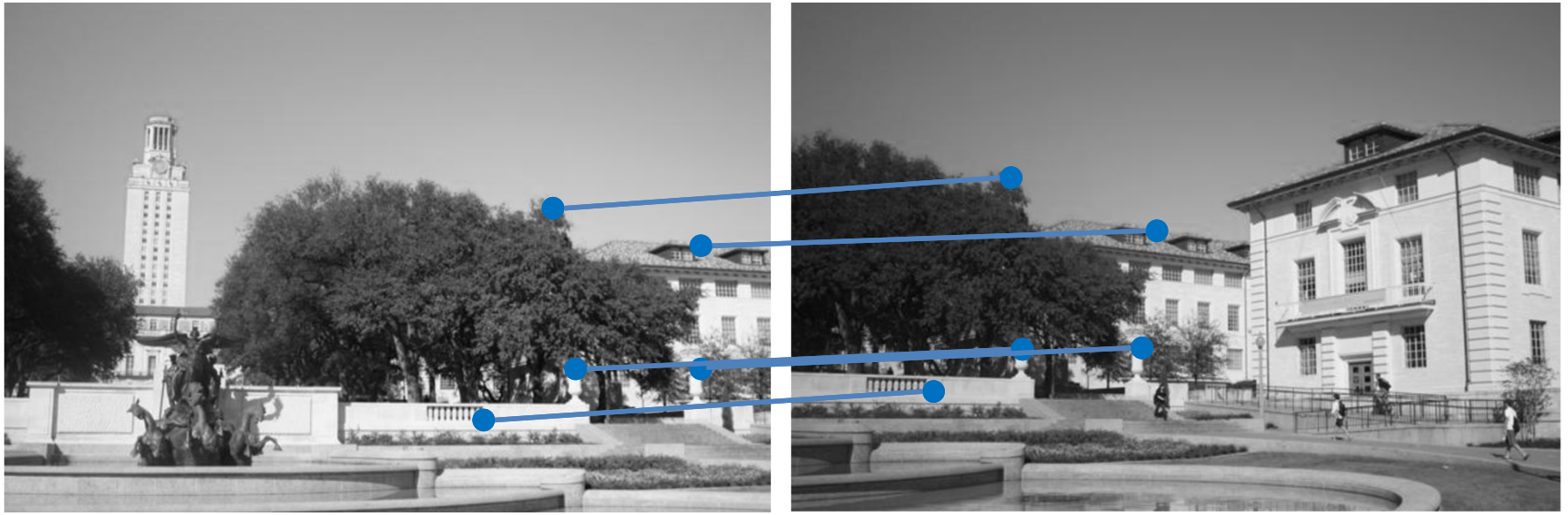
Panorama

Panorama

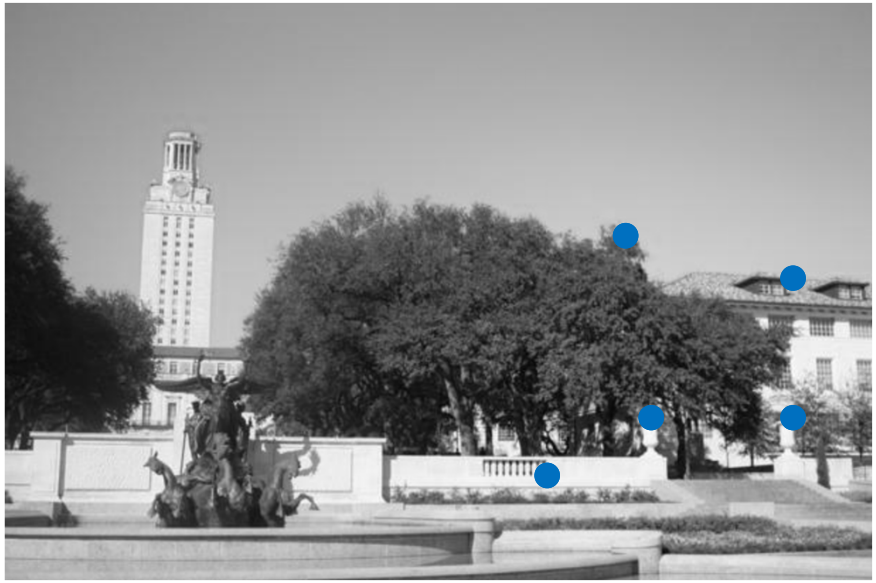
Key insight: leverage corresponding keypoints



Problem 1: how to match keypoints?



Problem 2: how to fit images?



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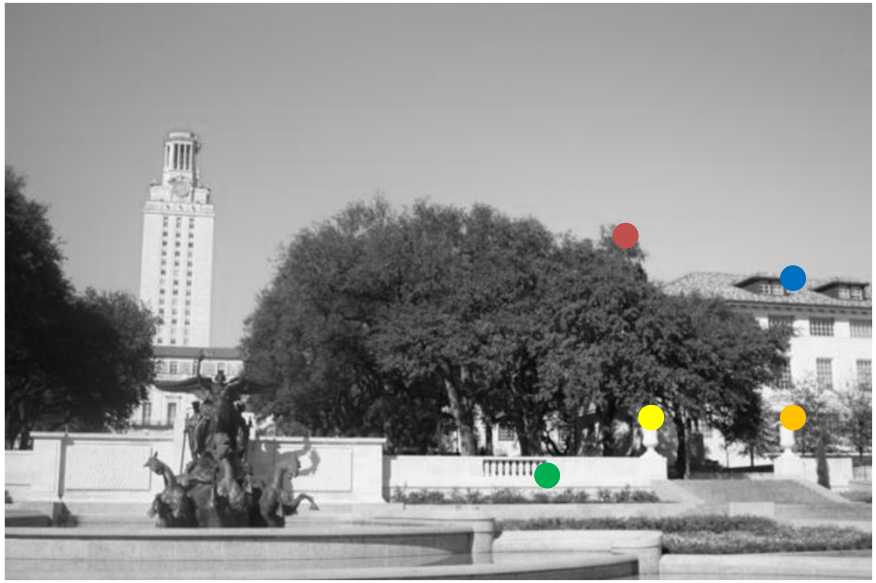
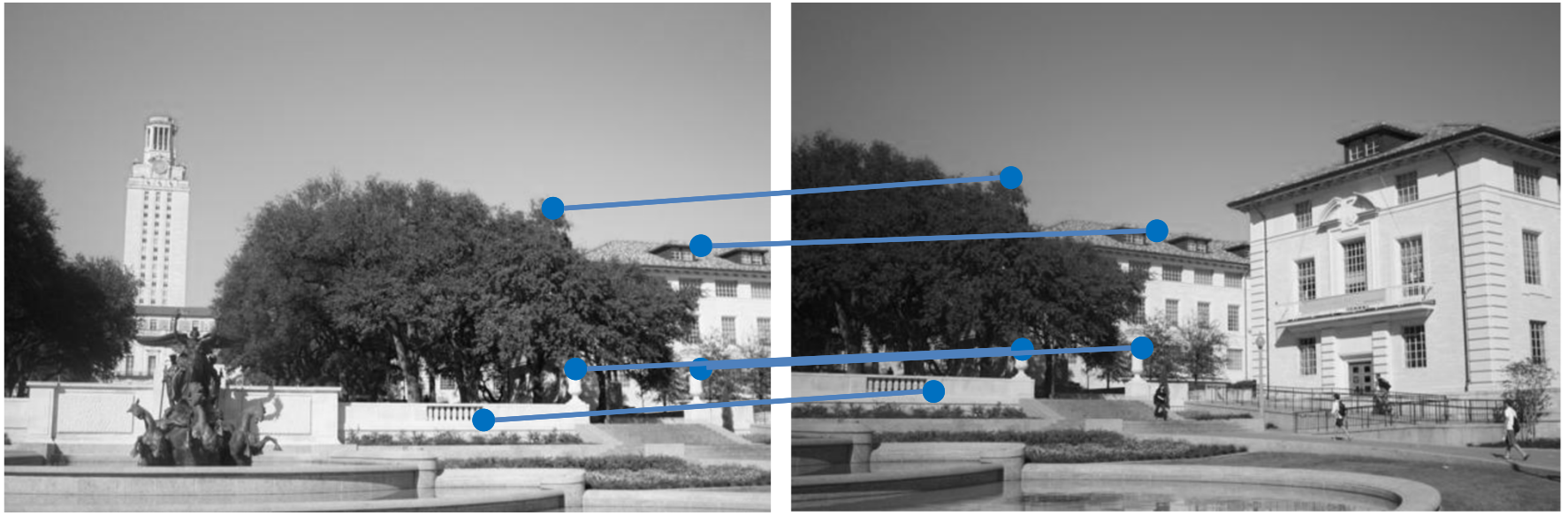
How to know if keypoints are “the same”?



Use keypoint descriptors!

Matching result



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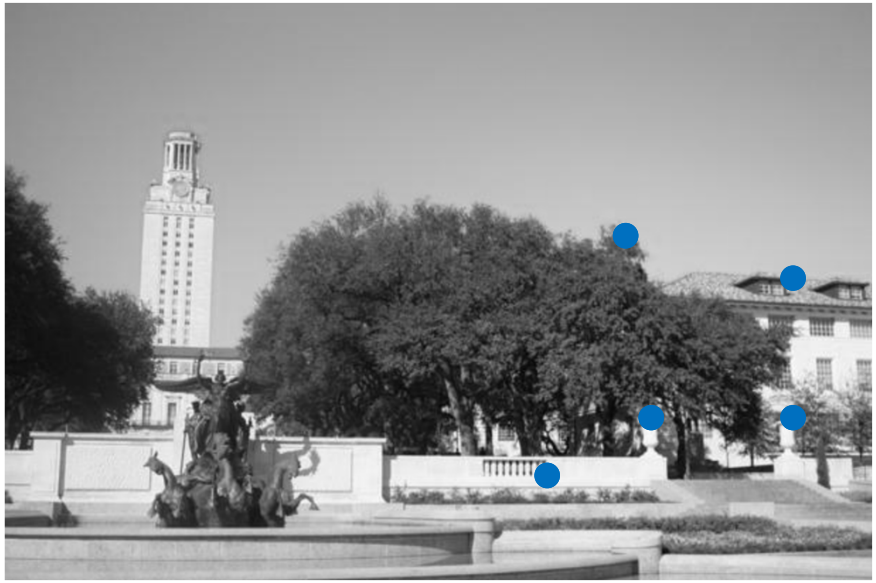
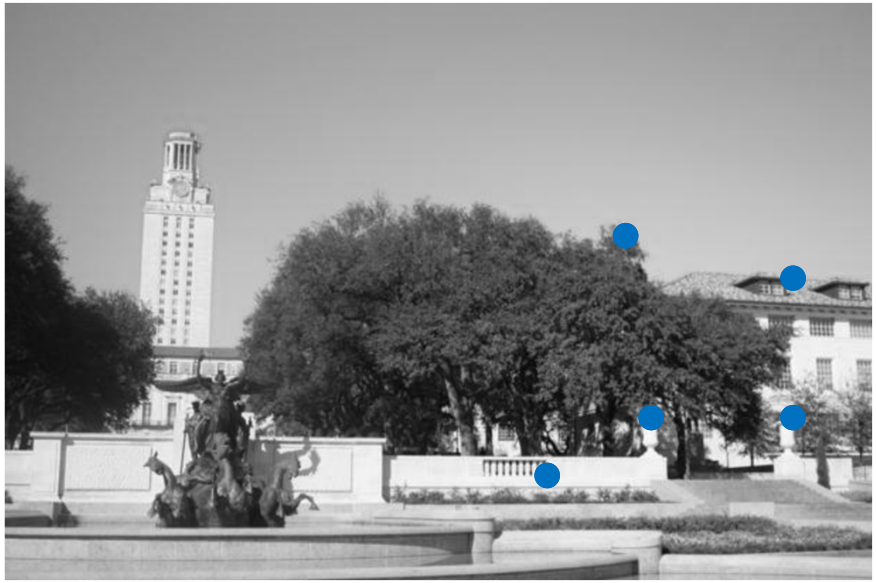
Easy case: pictures taken from same angle



Hard case: pictures taken from diff angles



Find transformation between matches

Given:

$p1$

$m_{1,x}^{1}$	$m_{1,y}^{1}$	1
$m_{1,x}^{2}$	$m_{1,y}^{2}$	1
$m_{1,x}^{3}$	$m_{1,y}^{3}$	1
$m_{1,x}^{4}$	$m_{1,y}^{4}$	1

$p2$

$m_{2,x}^{1}$	$m_{2,y}^{1}$	1
$m_{2,x}^{2}$	$m_{2,y}^{2}$	1
$m_{2,x}^{3}$	$m_{2,y}^{3}$	1
$m_{2,x}^{4}$	$m_{2,y}^{4}$	1

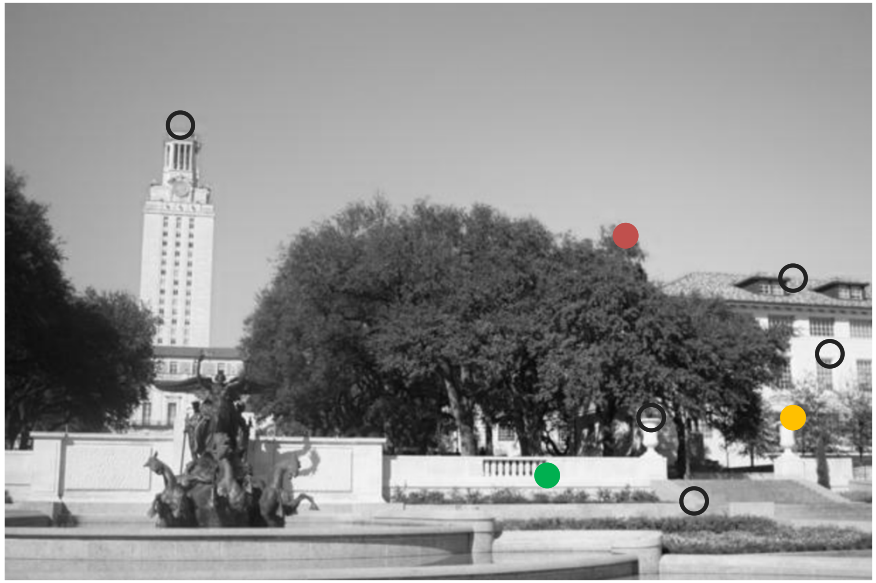
Find transformation matrix H such that:

$$p2 \cdot H = p1$$

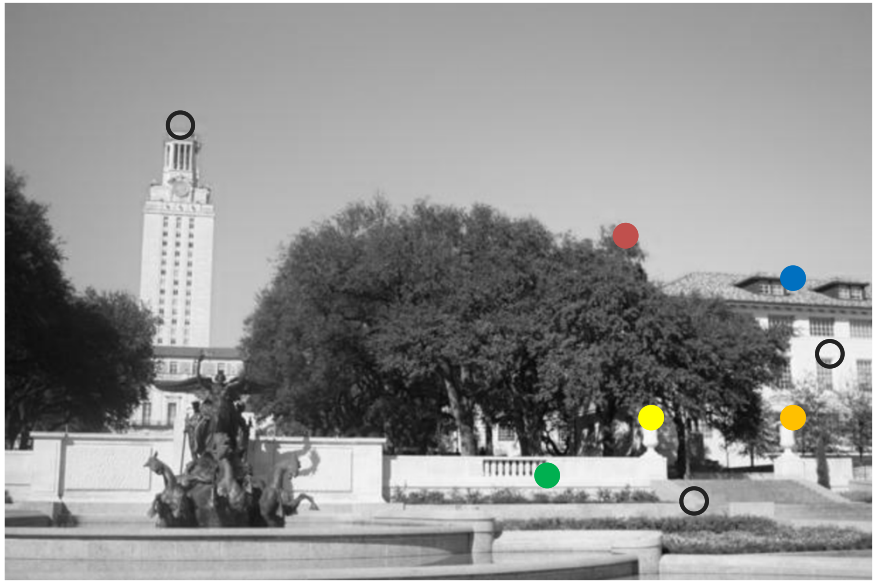
What if we have noisy matches?

Refine transformation matrix with RANSAC!

Pick subset



Fit affine matrix and find inliers



Recompute matrix with all inliers and stitch!

Reading

- Szeliski (2st edition): Chapter 8