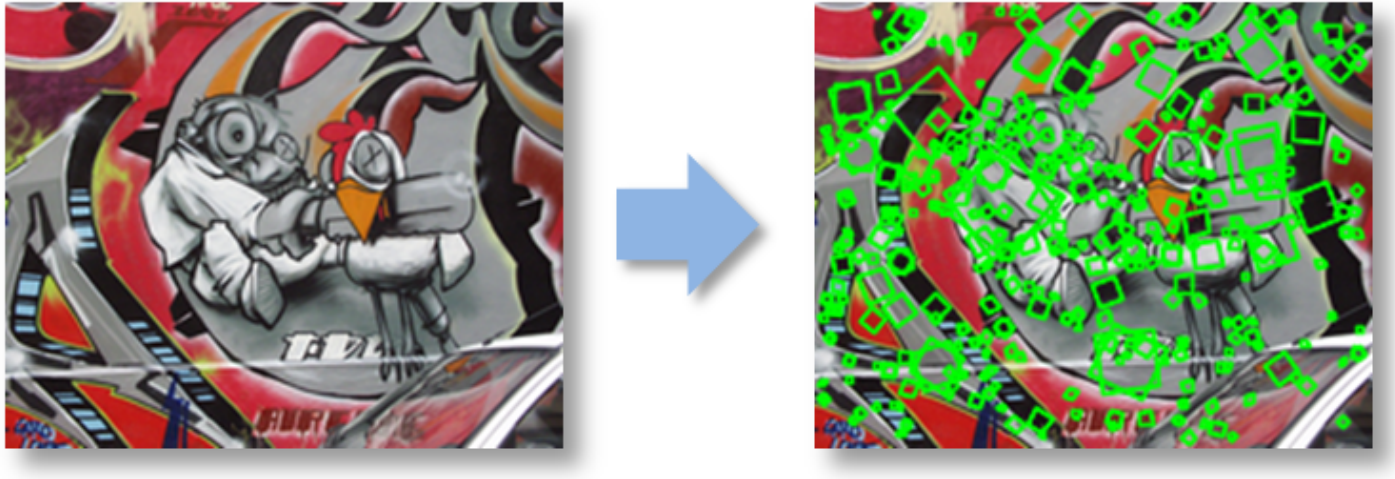
CSCI 497P/597P: Computer Vision



Lecture 8:

Image Features: Overview and Detection

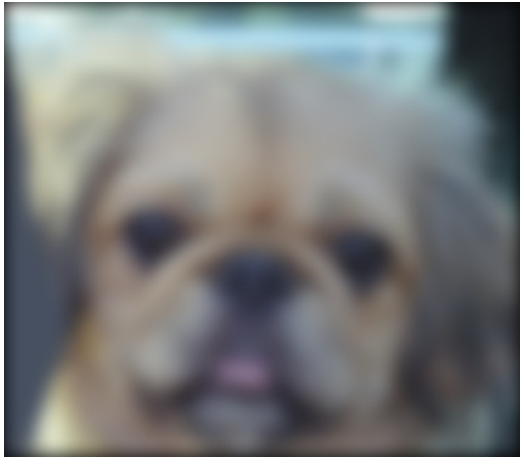
Announcements

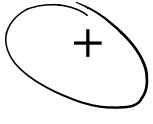
- Project 1 is out!
- Homework problems coming Soon(TM)

Project 1: Part 1

High pass

Low pass





Project 1: Part 1

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Project 1: Part 1

Project 1: Part 2

- Demo

Goals

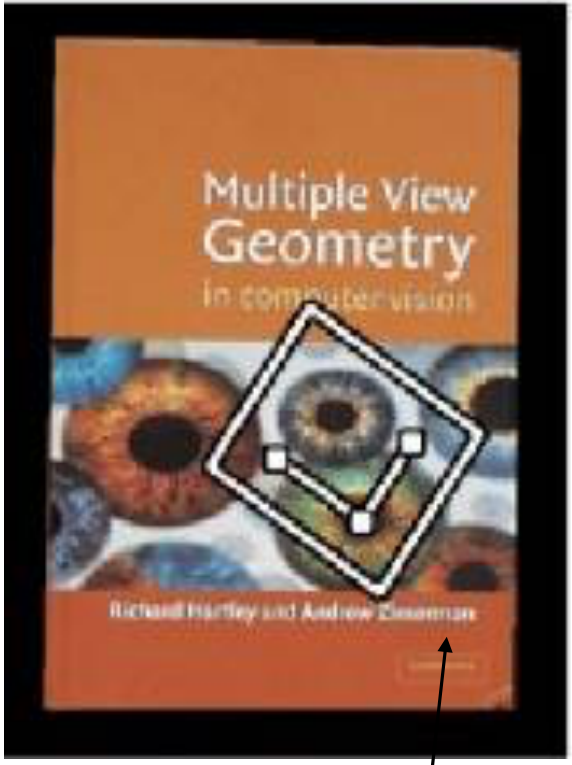
- Understand the motivation for detecting, describing, and matching local image features.
- Understand why uniqueness and invariance are desirable properties of features and their descriptors.
- Understand how to detect corner features using the Harris corner detector.

Image Features

(characteristics?)

- Distinctive image elements used to help solve higher-level vision problems, like:
  - image matching
  - tracking
  - shape analysis and object recognition
- Tend to be more *compact* and more *information-dense* than raw pixels.

Image Matching



is this thing...

the same as this thing?

Image matching: applications

Stitching multiple image into a seamless panorama (Project 2)

Image matching: applications

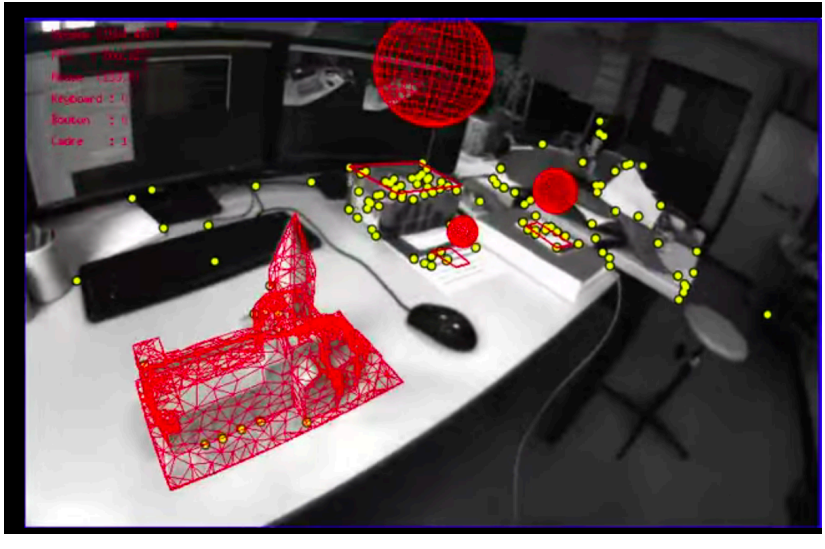
Stitching multiple image into a seamless panorama (Project 2)

Image matching: applications

Stitching multiple image into a seamless panorama (Project 2)

Tracking: applications

- Motion analysis
  https://youtu.be/1rZNb-affQg
- Augmented reality
- Segmentation
- Robot navigation



https://youtu.be/5I5pbSs-yrU

Image features

- Can be *global* or *local*
- Global features "distill" the whole image. examples:
  - average brightness
  - histogram of image intensity values
  - a tiny version of the image itself?

Image features

(our focus)

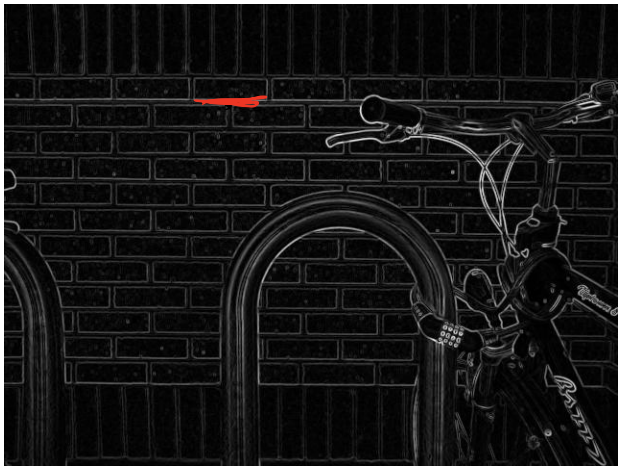
- Can be *global* or *local*
- Global features "distill" the whole image. examples:
  - average brightness
  - histogram of image intensity values
  - a tiny version of the image itself?

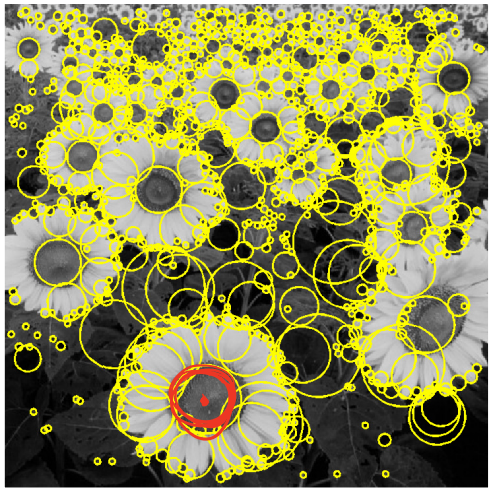
Image features

- Local features identify salient / distinctive / useful points in the image. Examples:

filters filters

Edges Blobs Corners





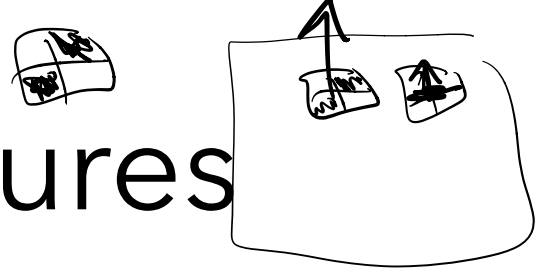
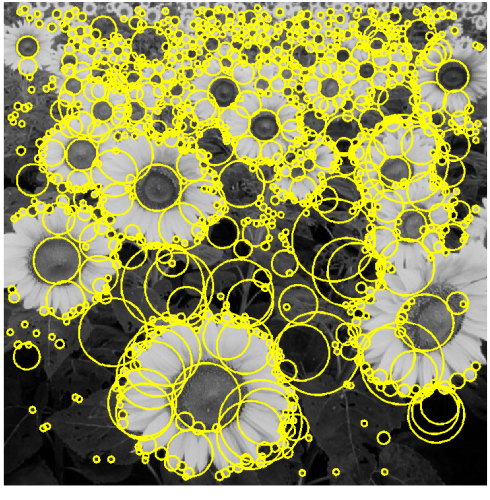


Image features

- Local features identify salient / distinctive / useful points in the image. Examples:

Edges

Blobs

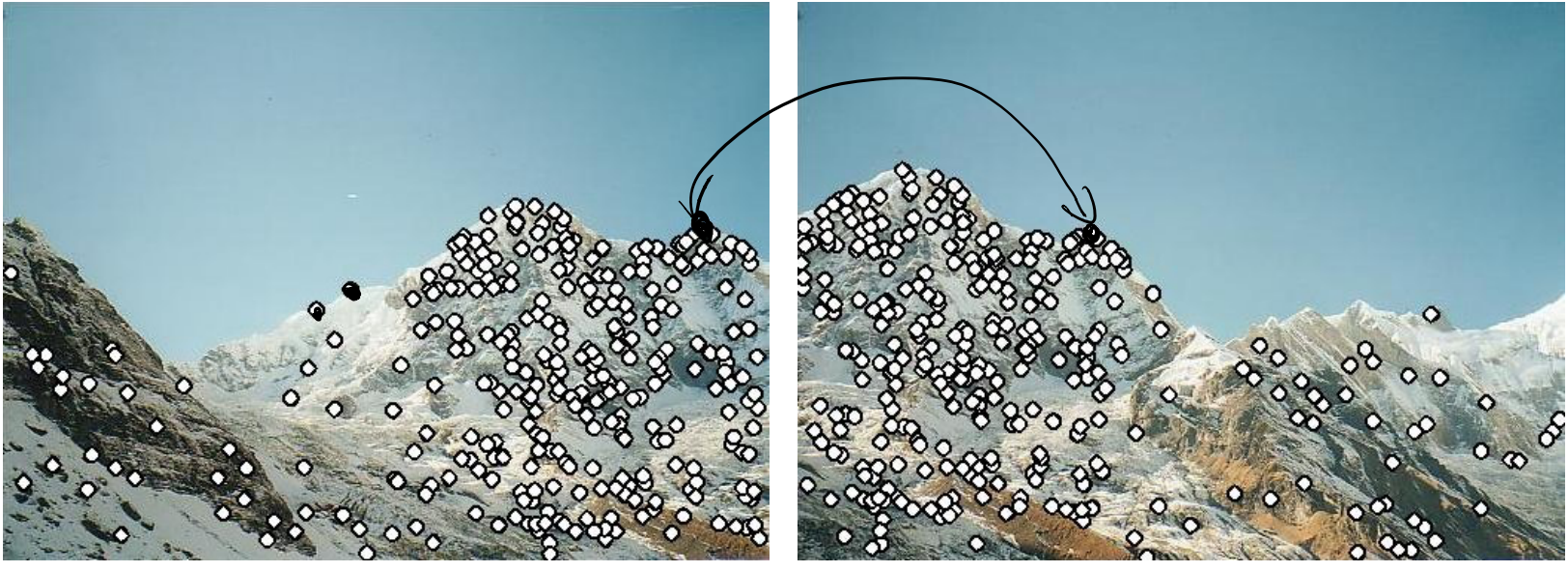


(our focus)

Corners

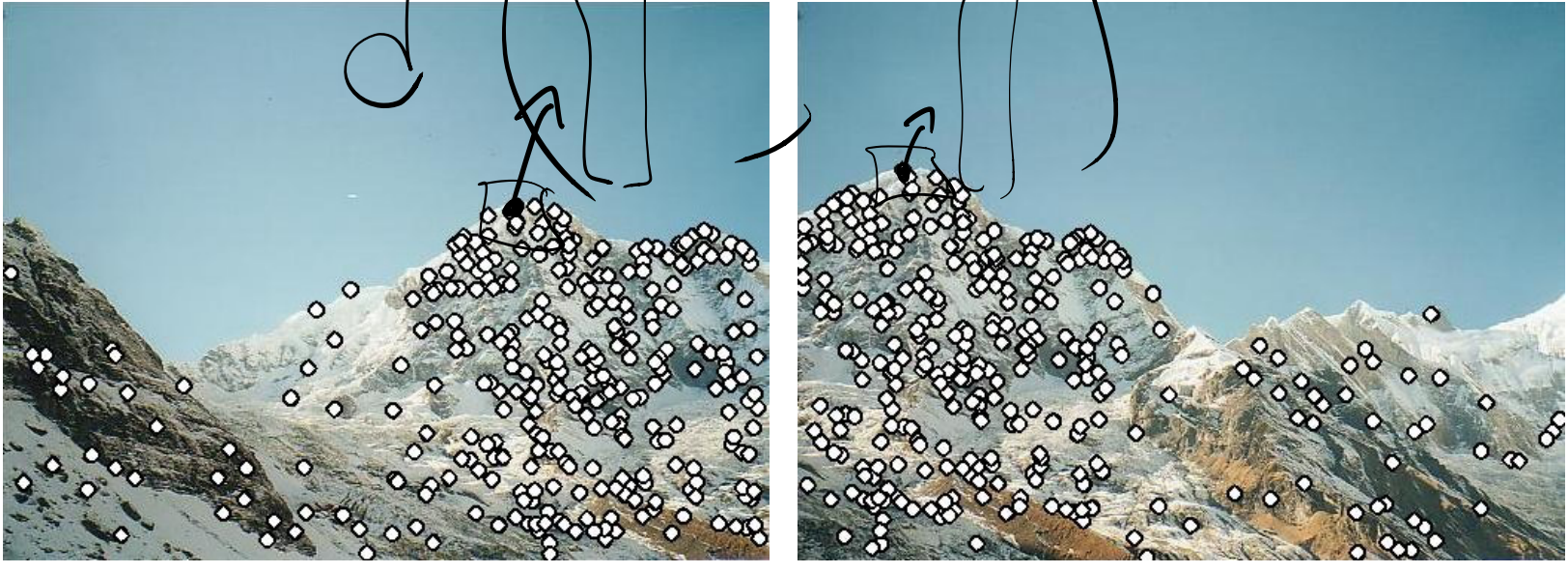
Running motivational example: Panorama Stitching

Running motivational example: Panorama Stitching



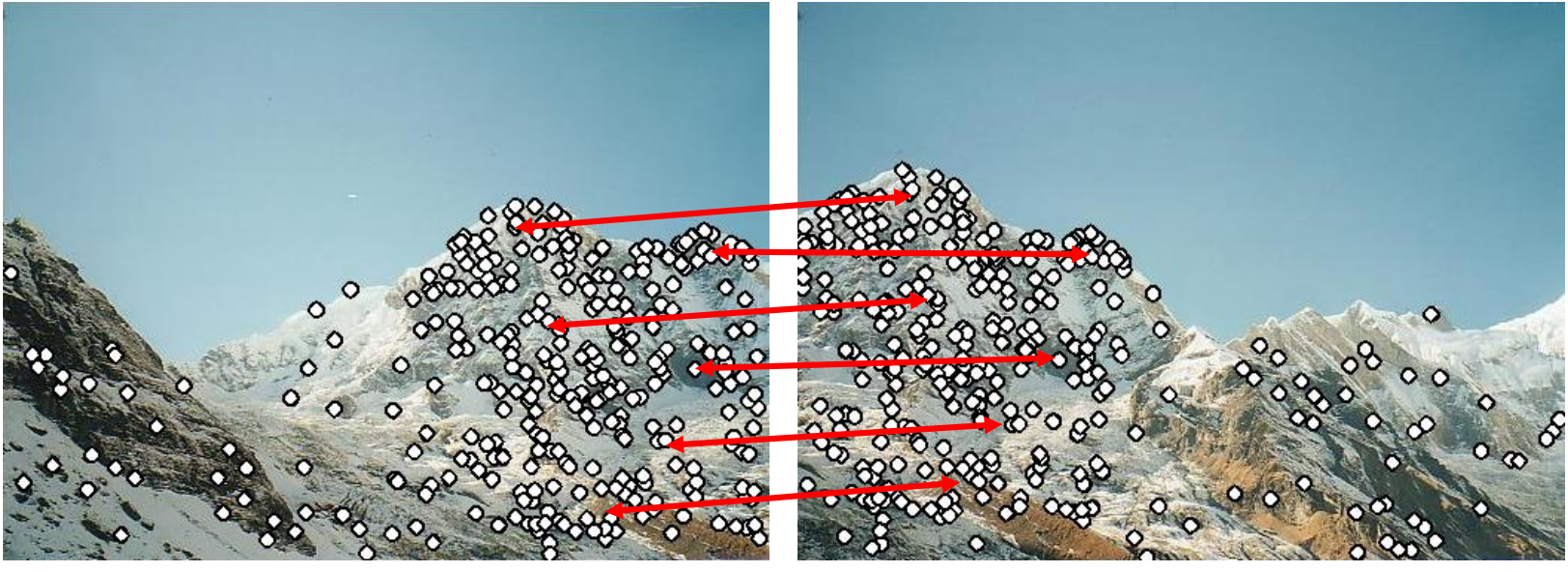
1. **Detect** corner features

Running motivational example: Panorama Stitching



2. Compute feature **descriptors**

Running motivational example: Panorama Stitching



3. **Match** features based on their descriptors.

Running motivational example: Panorama Stitching

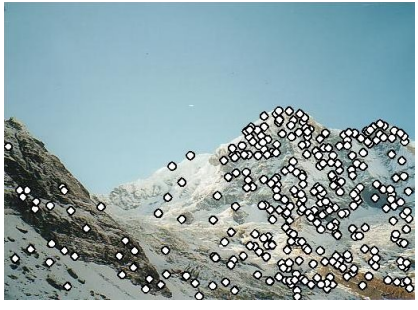
4. Warp images into alignment

Running motivational example: Panorama Stitching

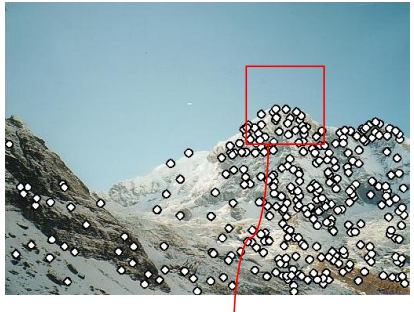
5. Blend images to eliminate seams

Features - Overview

1. Detect

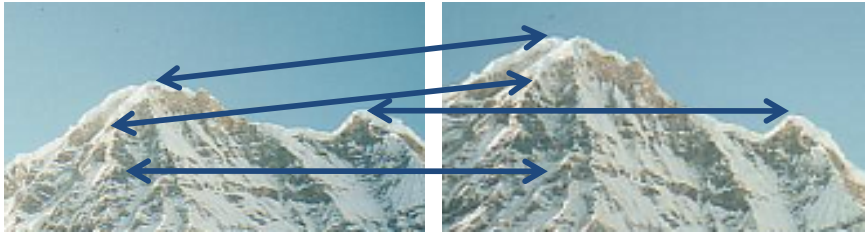


2. Describe



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

3. Match



What makes a good feature?

Two desirable properties:

- Uniqueness: features **shouldn't** match if they're from different points in the scene.

→ distinct

- Invariance: features **should** match if they do come from the same point in the scene.

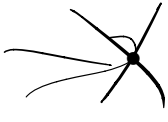
invariant to environmental factors

- lighting
- camera angle

I have a bad idea.

- Let's use **single pixels** as features.
- In terms of these two properties, do pixels make good features?

Uniqueness: features **shouldn't** match if they're from different points in the scene.

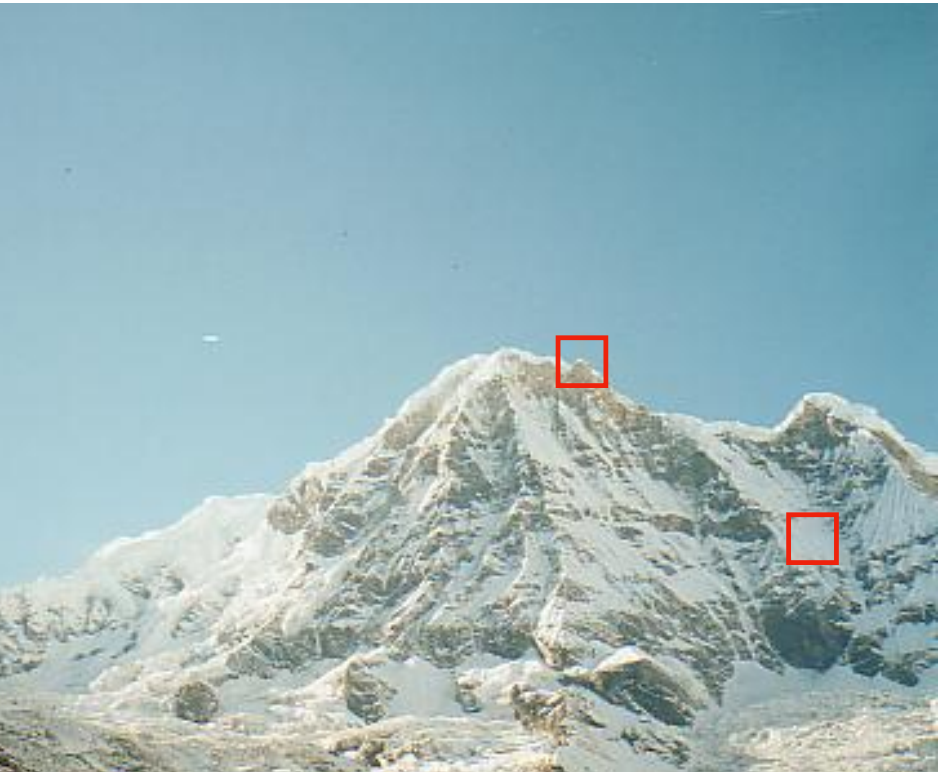


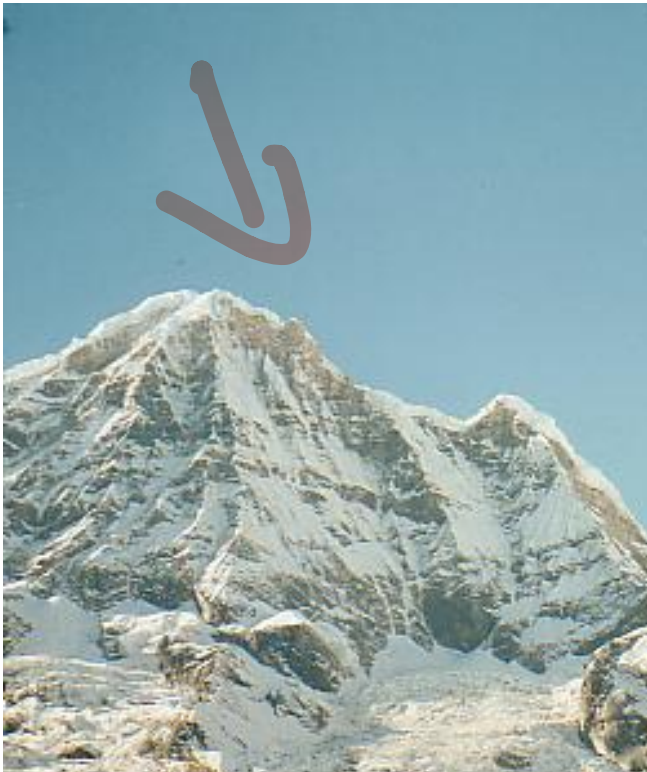
Invariance: features **should** match if they do come from the same point in the scene.

I have a different idea

(okay, so it wasn't my idea)

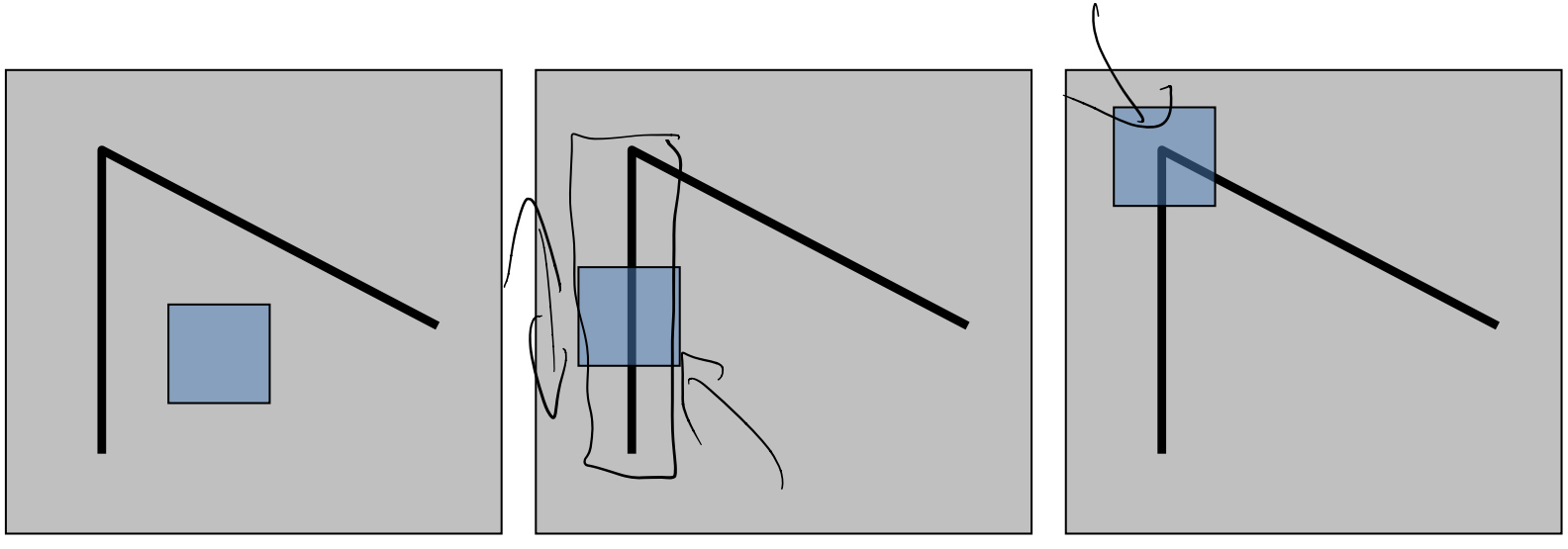
- Let's use patches surrounding **corners** as features.



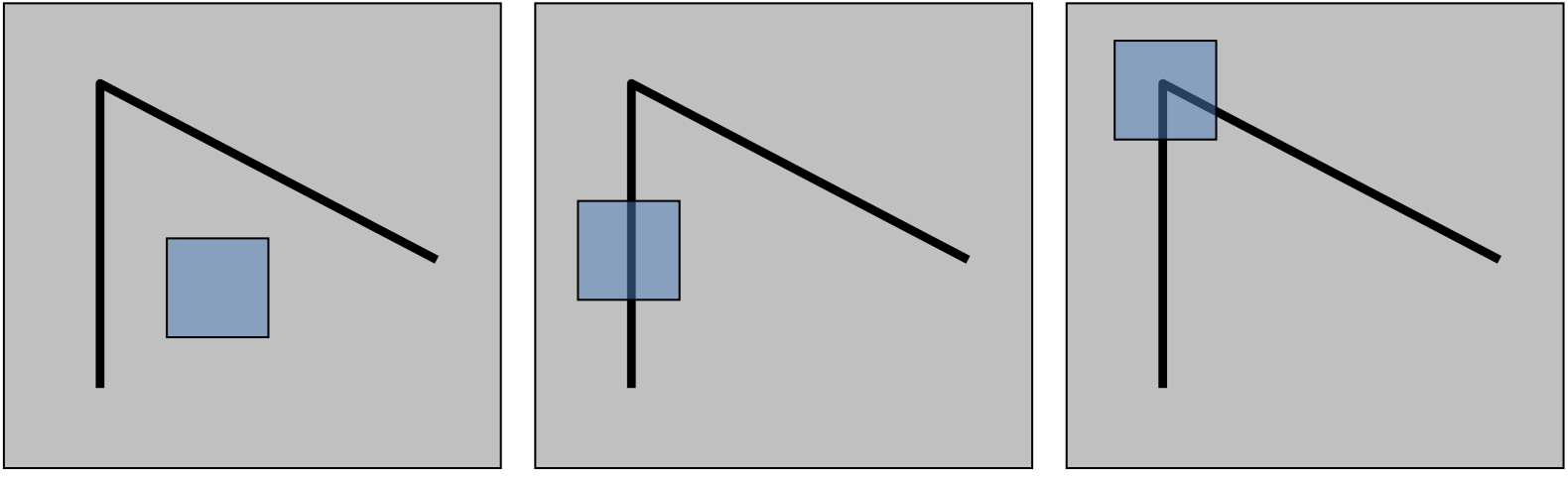


Corner features: a cartoon view

- Which of these patches is most distinctive?



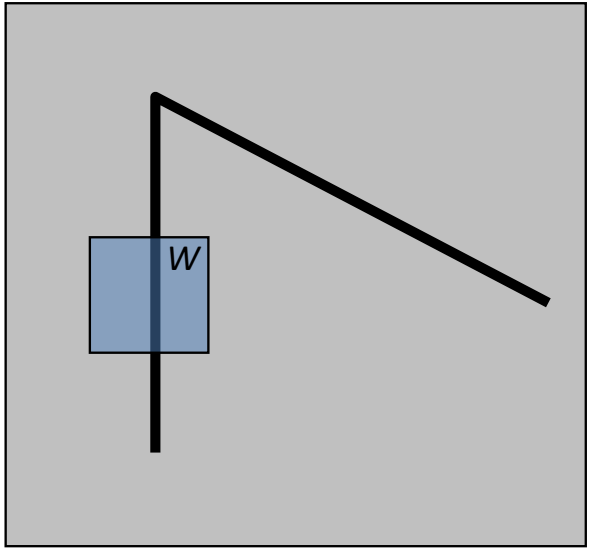
How can we measure that?



An expensive idea: compare each patch to **every other** patch

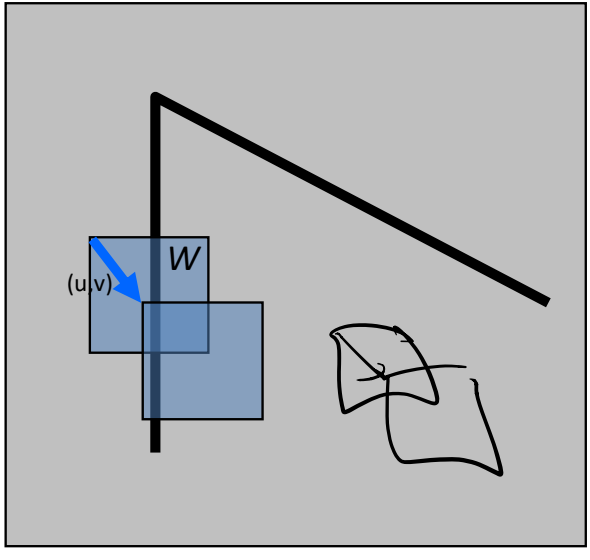
A less expensive idea: compare each patch to **nearby** patches.

In other words,



if you **nudge** the patch by (u, v), how much does its appearance change?

In other words,



if you **nudge** the patch by (u, v), how much does its appearance change?

A lot? This patch is unique.
A little? This patch is less unique.

In mathier words,