Discussion 6

Automated correspondences, RANSAC

Agenda

Logistics:

- Midterm 10/23 – coming up soon!
- Project 3A due 10/8, 3B due 10/17…

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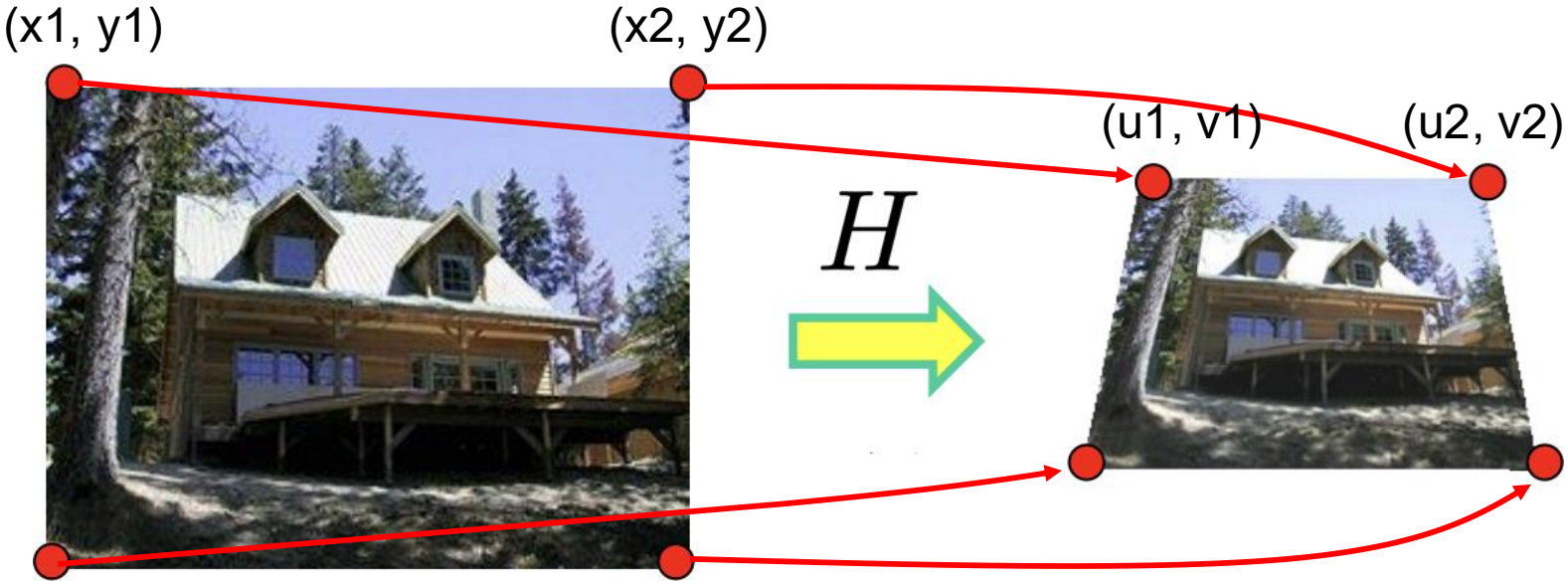
Today we'll cover:

- Harris corner detection
- Feature description
- RANSAC

Correspondences



*Clicking manually

Automated Correspondences

Which points are good points?

(Corners)

Automated Correspondences

Another image, which points are good points?

Automated Correspondences

What to do next?

(Pair them up! … but how though? 🤔)

Automated Correspondences

What to do next?

(Each point should have a “description” … Then find the closest match)

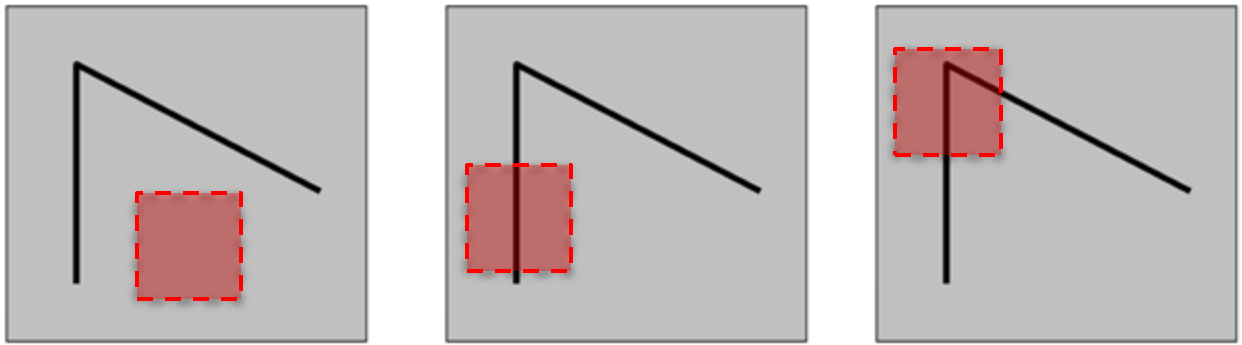
Today: Image -> Points -> Descriptors

- **Goal: Automatic correspondences**
- Find **interest points** from images (why corners? 🤔)
- Extract **features descriptors** at each interest point
- **Find the closest match! (and homography)**

How to spot corners automatically?

Auto corner detections

- **Goal: find corners**



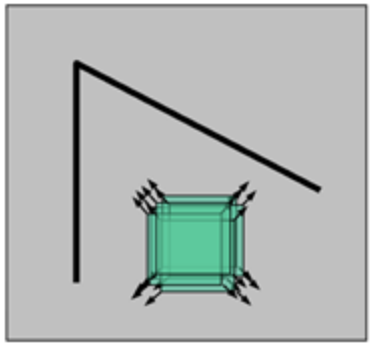
From lecture slides

Auto corner detections

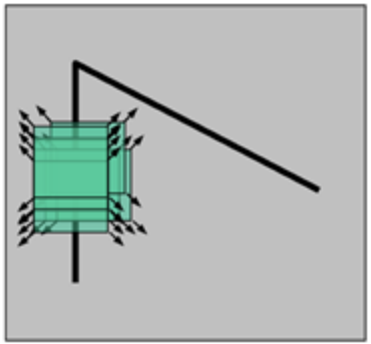
- **Key: measure changes along x and y directions**

$$E(u,v) = \sum_{(x,y)\in W} [I(x+u, y+v) - I(x,y)]^2$$

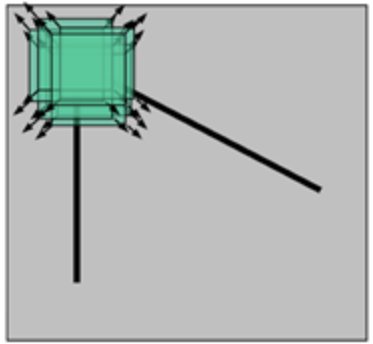
It's just move,
Compare,
...
But it's slow!
Can we do without move?



No change



Change **except** in edge direction



Change in **all** directions

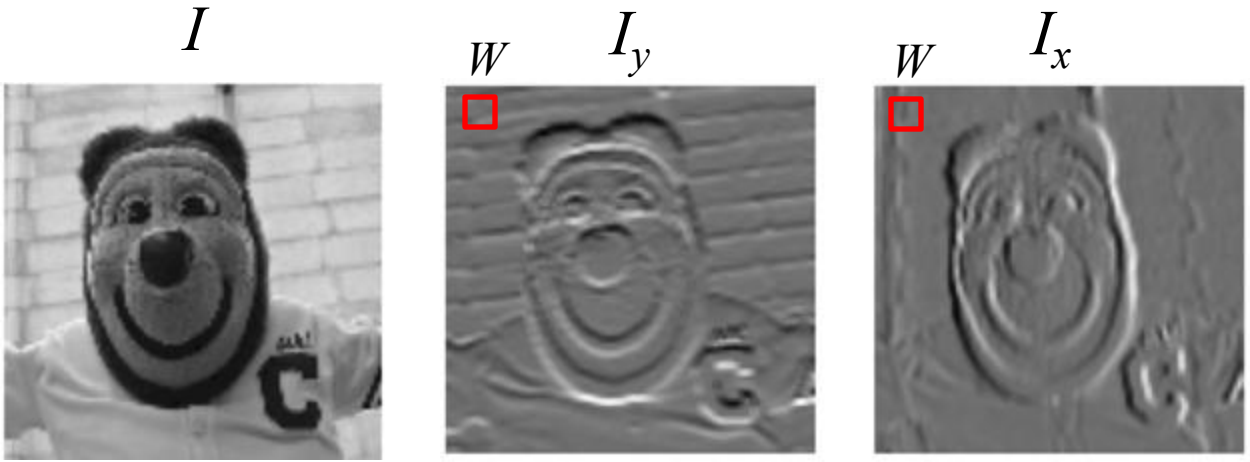
From lecture slides

Harris corner detection

Second moment matrix
"matrix of changes"

$$M = \sum_{(x,y)\in W} \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix}$$

is all you need!



Intuitively: how fast are changes in each direction
(of course, corner should have large I_x and I_y)

Harris corner detection

Second moment matrix
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I I_y I_x

Intuitively: how fast are changes in each direction
(of course, corner should have large I_x and I_y)

Okay, the corner might not align x , y (find the best align)

$$M = \sum_{(x,y)\in W} \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix} \longrightarrow M = R^{-1} \begin{bmatrix} \lambda_1 & 0 \\ 0 & \lambda_2 \end{bmatrix} R$$

Some rotation

Eigen values

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Some rotation

Eigen values

Intuitively: corner should have large λ_1 and λ_2

Product grows faster than add!

Large R!

$$\det M = \lambda_1 \lambda_2$$
$$\text{trace } M = \lambda_1 + \lambda_2$$

$$R = \frac{\det M}{\text{Trace } M}$$

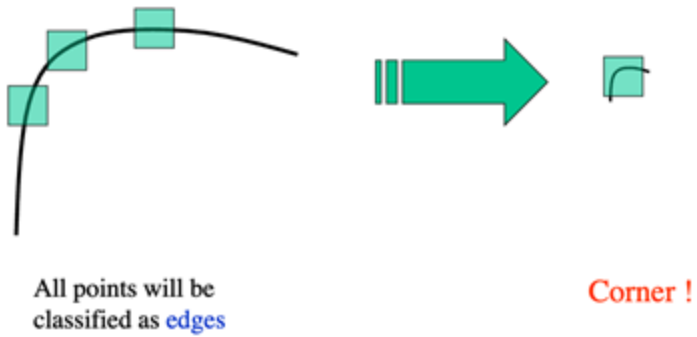
We should get corners now!

Harris corner is invariant to:

-> invariant to shift

-> partially invariant to intensity scale

-> NOT invariant to image size scale (why? Local patch size)

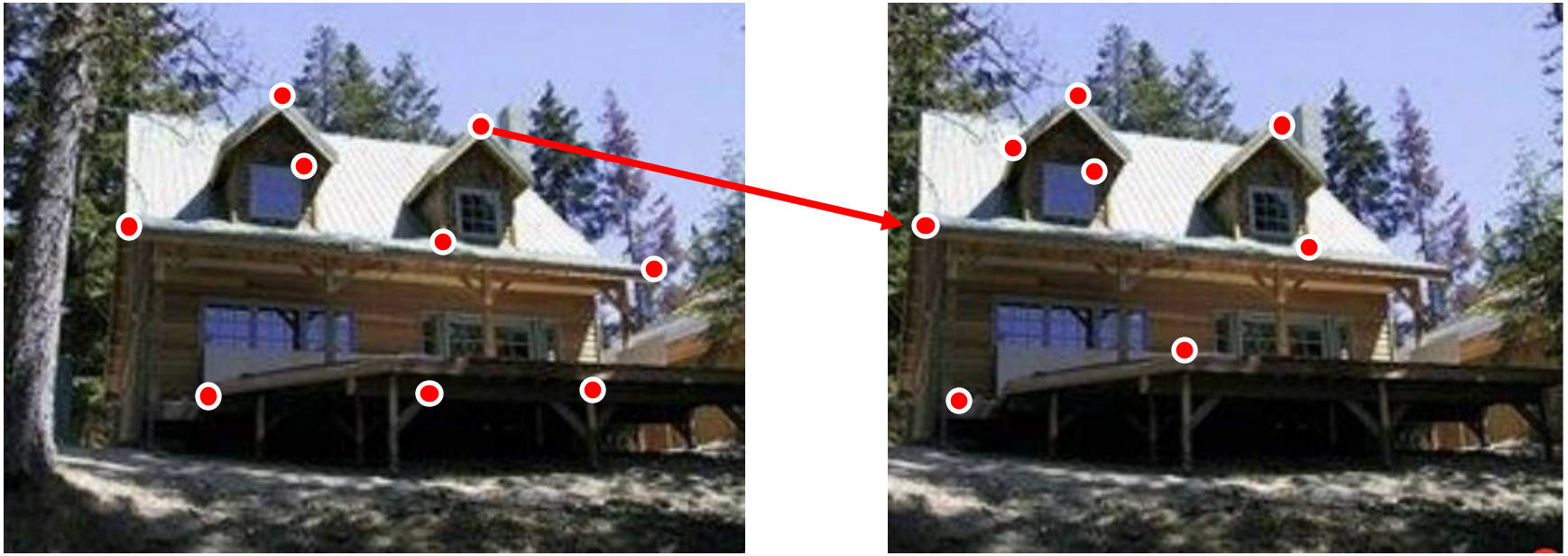


From lecture slides

Q1 with your friends!

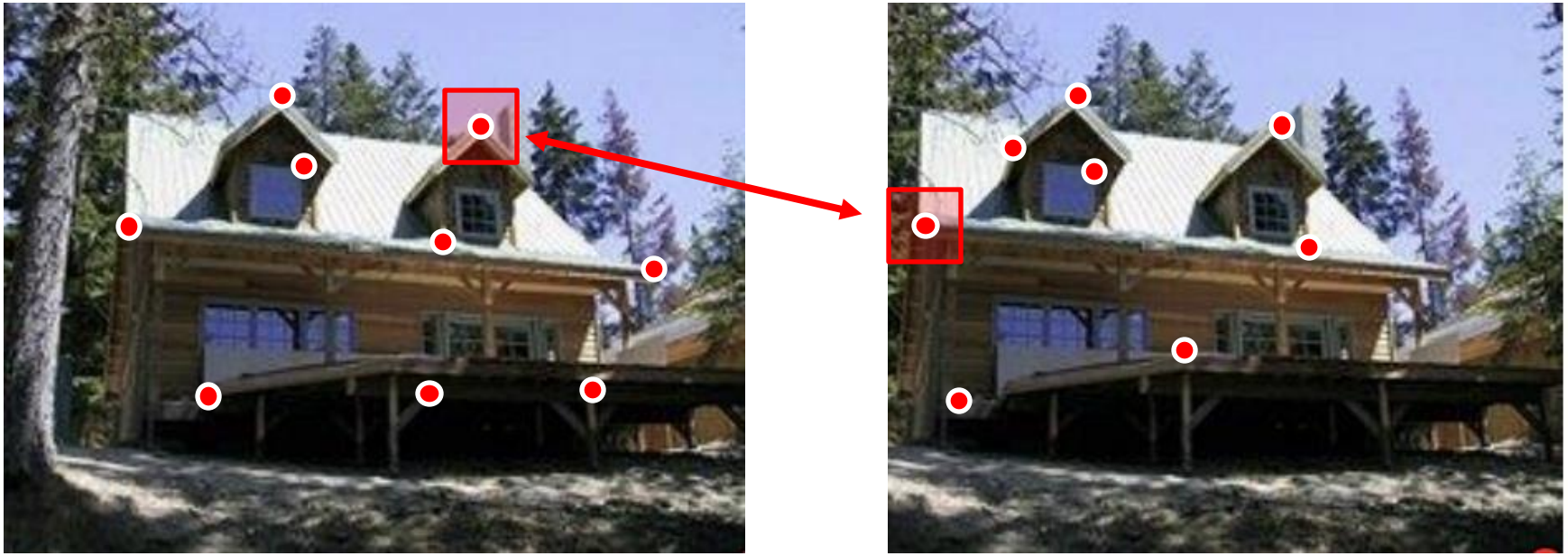
“Describe” each corner point

Automated Correspondences



Same points?
Ideas?

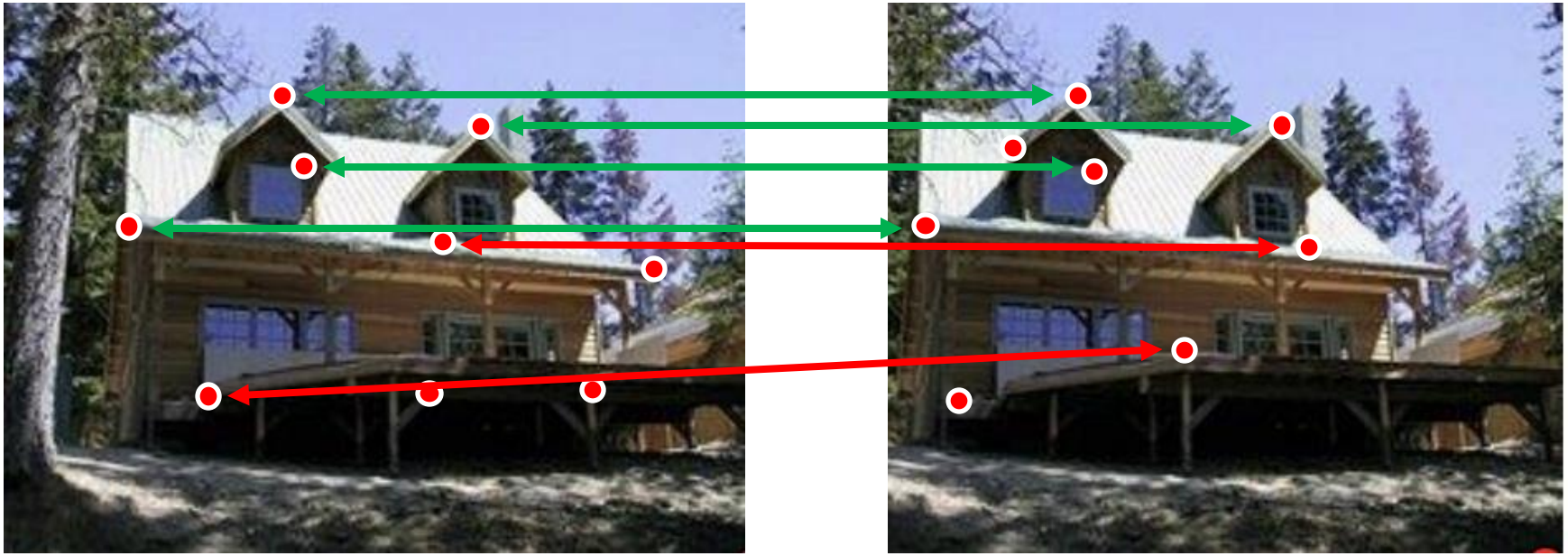
Describe each point



Naïve: Just compare nearby pixel
Fancy: MOPs (and more…)

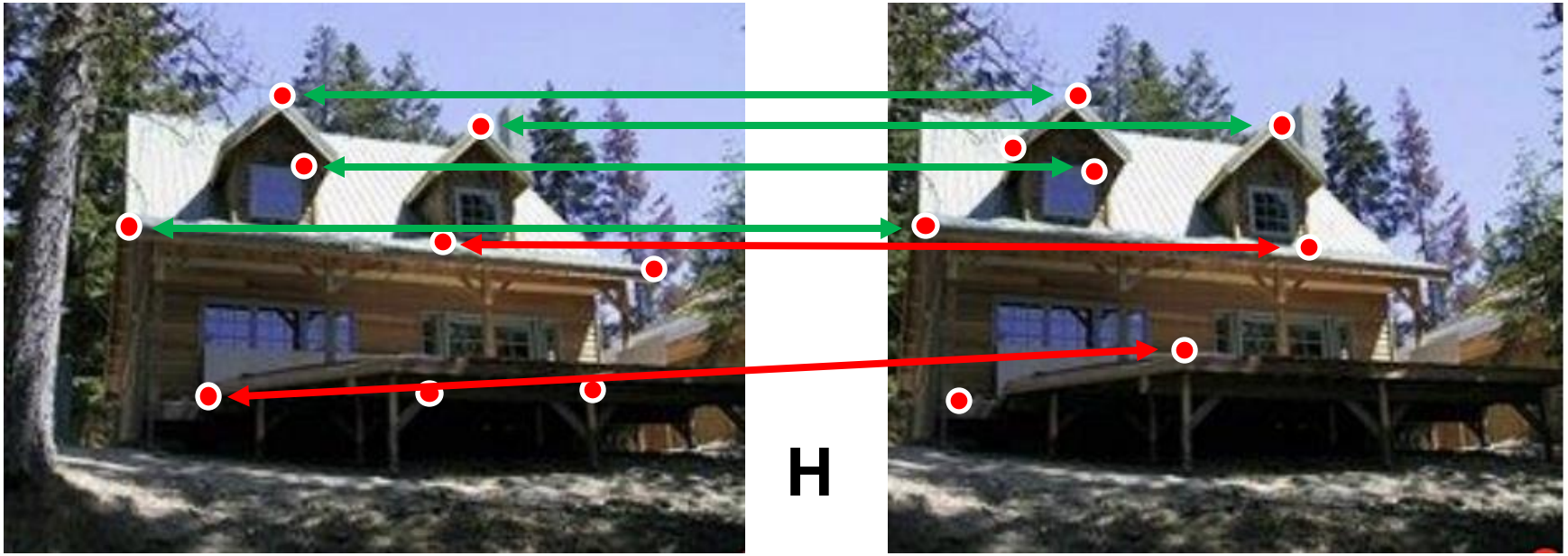
*good qualities: distinct & invariant to tiny changes

Find the best match



Some of them will be wrong! (or really wrong)

Solve for homography



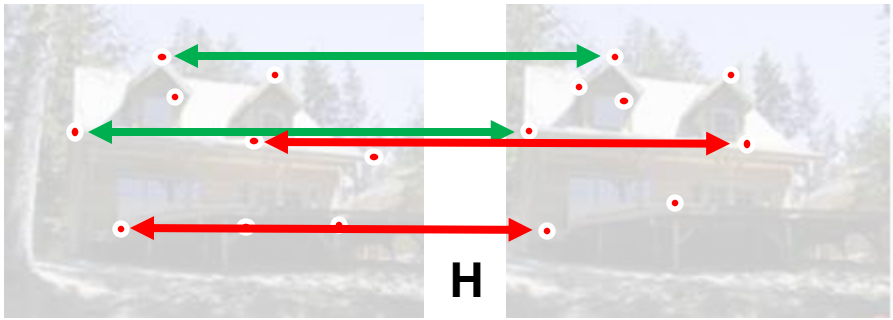
Solve homography!
How to deal with some of them being really wrong?

RANSAC

RANSAC

Random **Sa**mple **C**onsensus

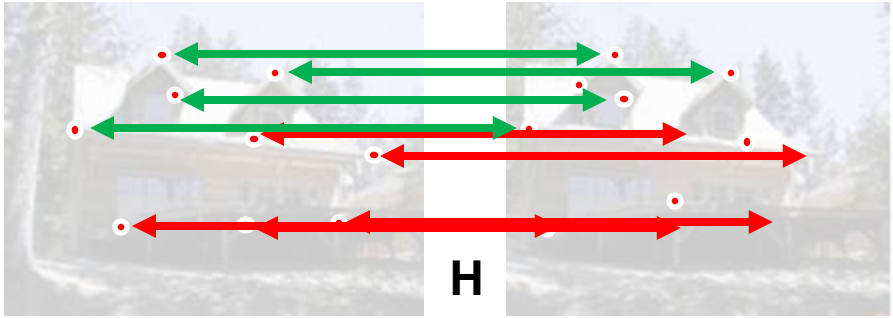
1. Select (minimum) pairs (at random)
2. Compute homography H



*why minimum pairs? Not maximum?

RANSAC

Random **Sa**mple **C**onsensus



1. Select 4 pairs (at random)
2. Compute homography H
3. Check how well homography H explains (Count inliers, good matches)
4. Keep the best H (most inliers)
5. Recompute H (with all inliers)

Q2 with your friends!