



Mosaics con't

CSE 455, Winter 2010

February 10, 2010

Announcements

- The Midterm:
 - **Due this Friday, Feb 12, at the beginning of class**
 - **Late exams will not be accepted**
- Additional Office Hour today:
 - 2:30 to 3:30 in CSE 212 (the normal place)

Review From Last Time

How to do it?

- Similar to Structure from Motion, but easier
- Basic Procedure
 - Take a sequence of images from the same position
 - Rotate the camera about its optical center
 - Compute transformation between second image and first
 - Transform the second image to overlap with the first
 - Blend the two together to create a mosaic
 - If there are more images, repeat

Panoramic Stitching

Input



Goal

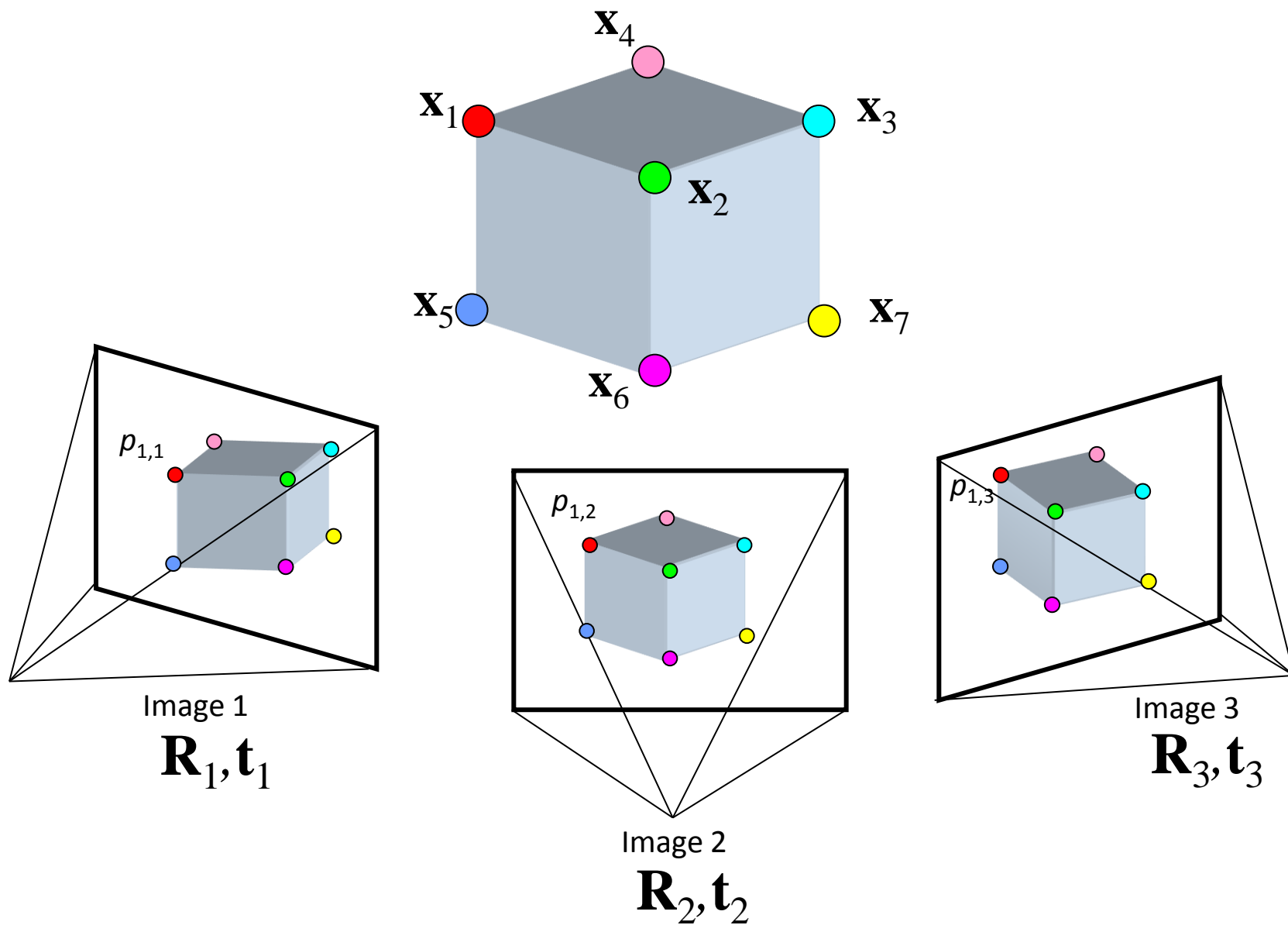


Aligning images



- How to account for warping?
 - Translations are not enough to align the images
 - **Homographies!!!**

Structure from Motion: Image reprojection



Panoramas: Image reprojection

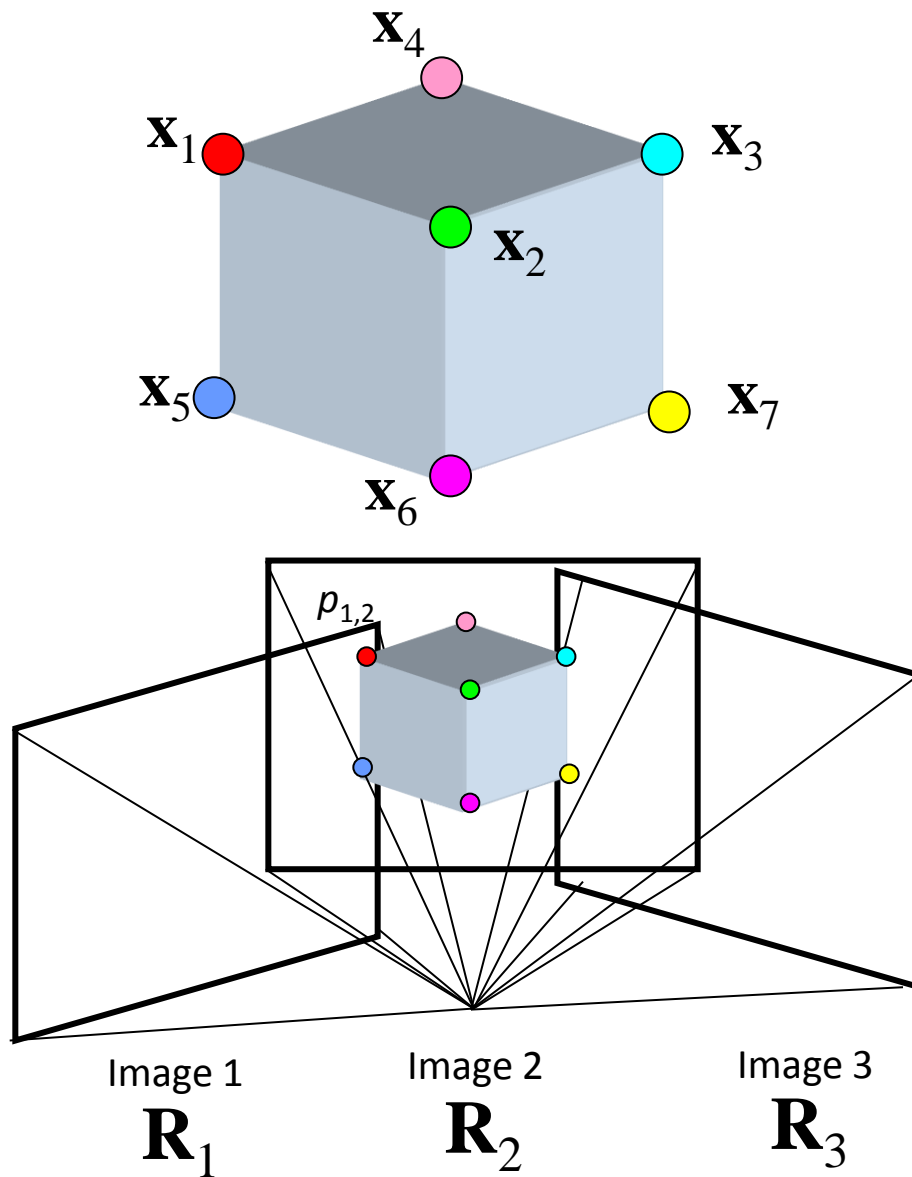
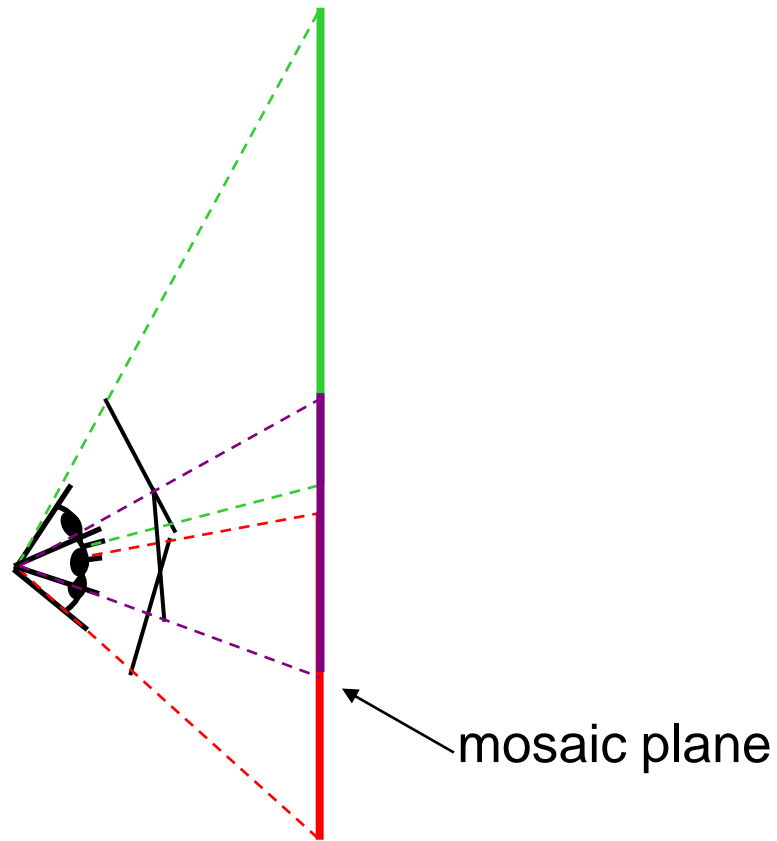


Image reprojection



- The mosaic has a natural interpretation in 3D
 - The images are reprojected onto a common plane
 - The mosaic is formed on this plane

Image warping with homographies

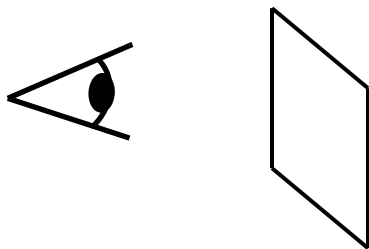
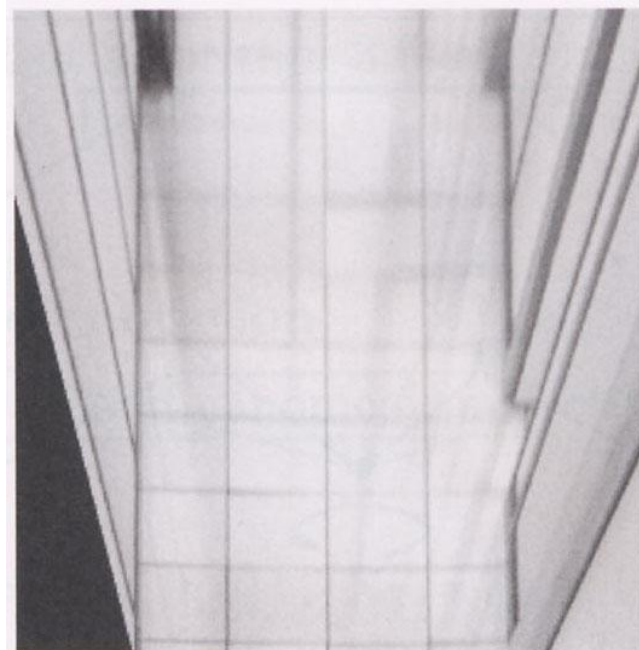


image plane in front

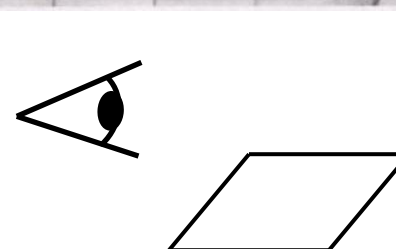




image plane below

black area
where no pixel
maps to

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Correspondence and Transformation

- Compute correspondence between second image and first
- Compute transformation between second image and first

- What kind of transformation
 - **Homography!!!**

- Do we know the correspondence?

Let's come up with an algorithm



Let's come up with an algorithm

- Guess some matches
- Compute a transformation using those matches
- Check if the transformation is good

RANSAC

- Randomly choose a set of K **potential** correspondences
 - Typically K is the minimum size that lets you fit a model
 - How many for a
 - Translation
 - rotation?
 - Affine?
 - Homography?
- Fit a model (e.g., translation, homography) to those correspondences
- Count the number of inliers that “approximately” fit the model
 - Need a threshold on the error
- Repeat as many times as you can
- Choose the model that has the largest set of inliers
- Refine the model by doing a least squares fit using ALL of the inliers

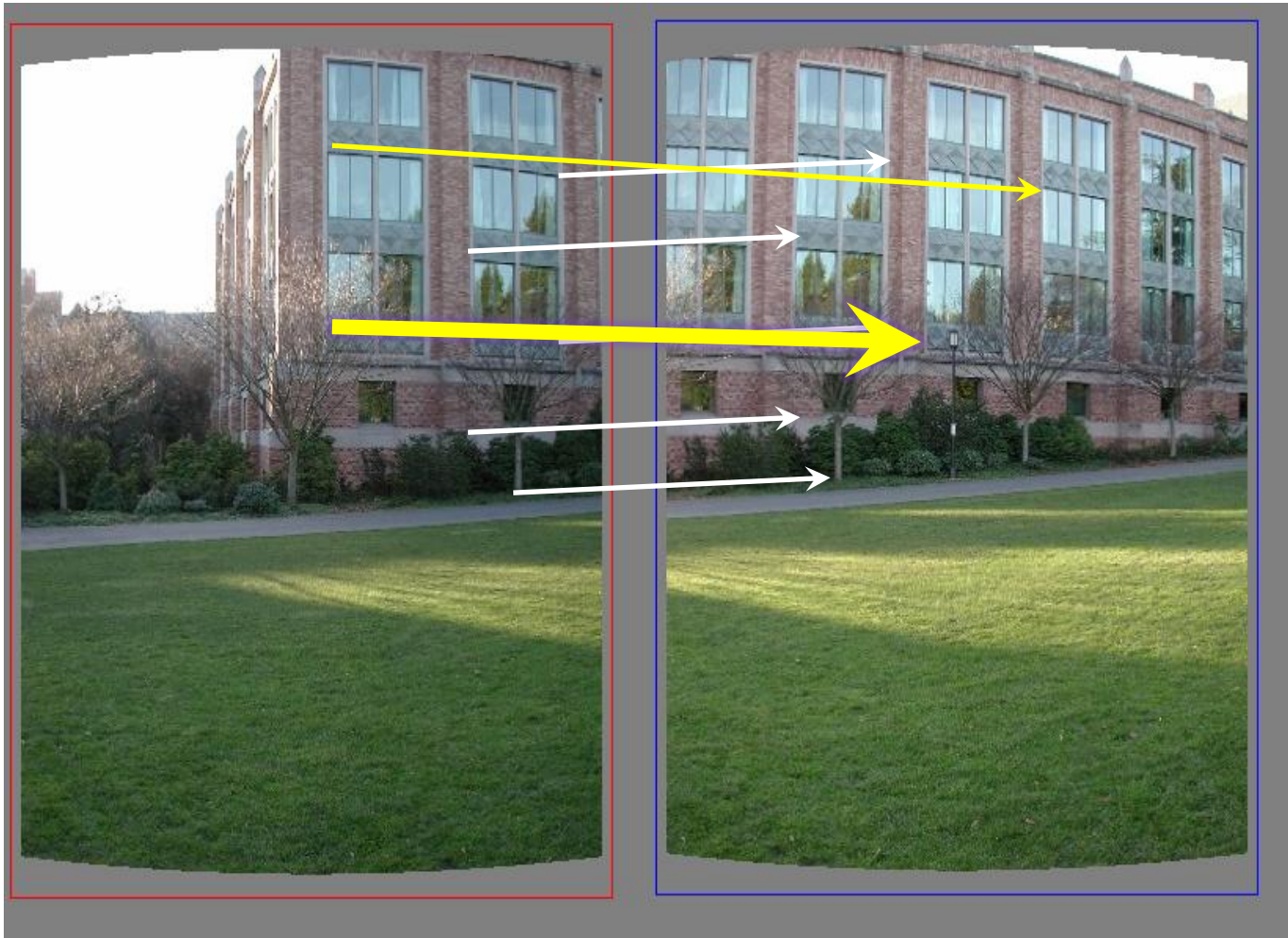
Simple Case: Translation

Computing image translations



What do we do about the “bad” matches?

Random Sample Consensus



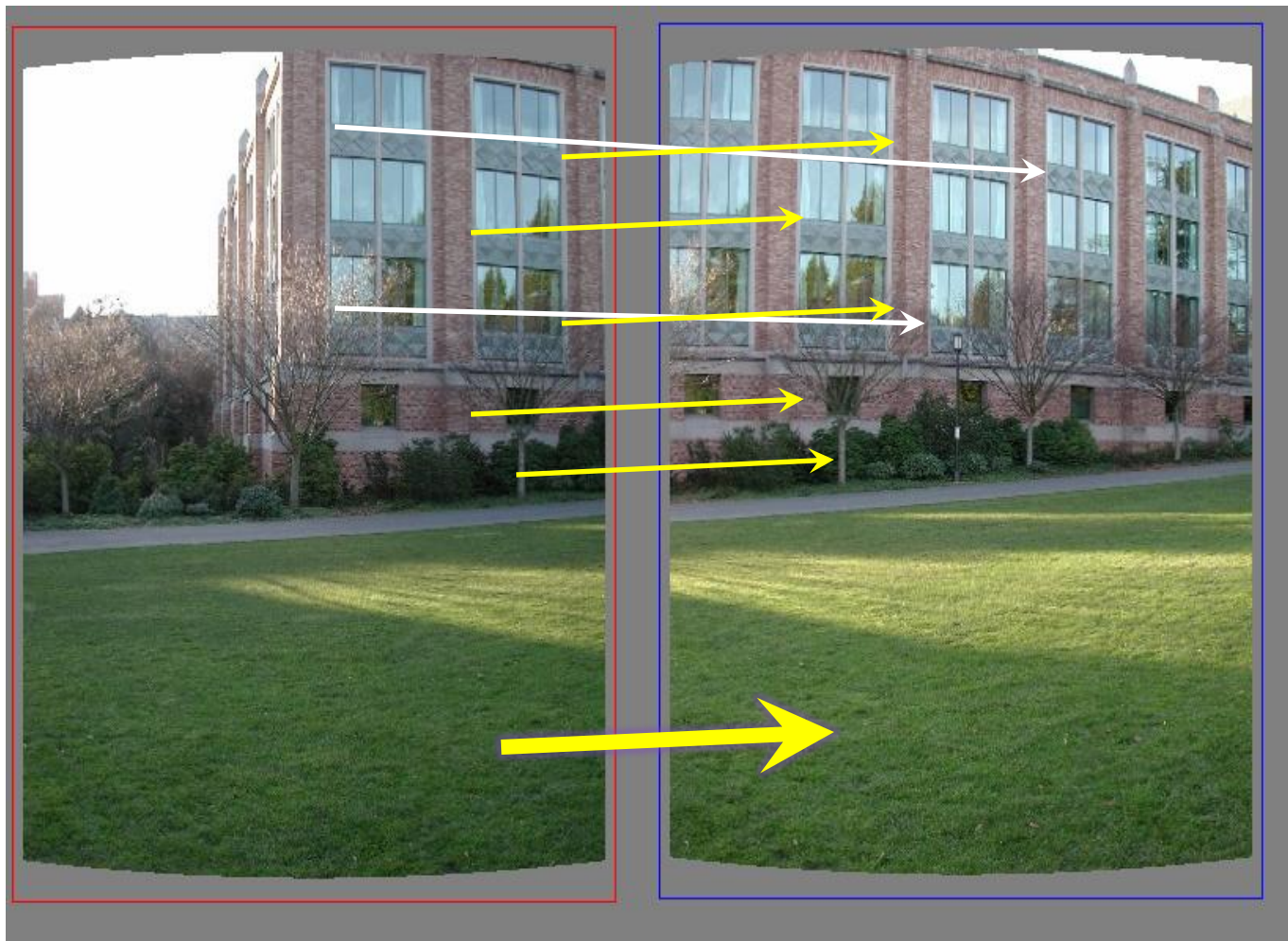
Select *one* match, count *inliers*
(in this case, only one)

Random Sample Consensus



Select *one* match, count *inliers*
(4 inliers)

Least squares fit





Find "average" translation vector
for largest set of inliers

RANSAC

- Same basic approach works for any transformation
 - Translation, rotation, homographies, etc.
 - Very useful tool

- General version
 - Randomly choose a set of K correspondences
 - Typically K is the minimum size that lets you fit a model
 - Fit a model (e.g., homography) to those correspondences
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Basic Procedure

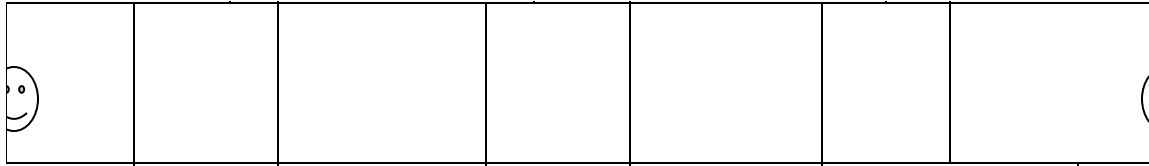
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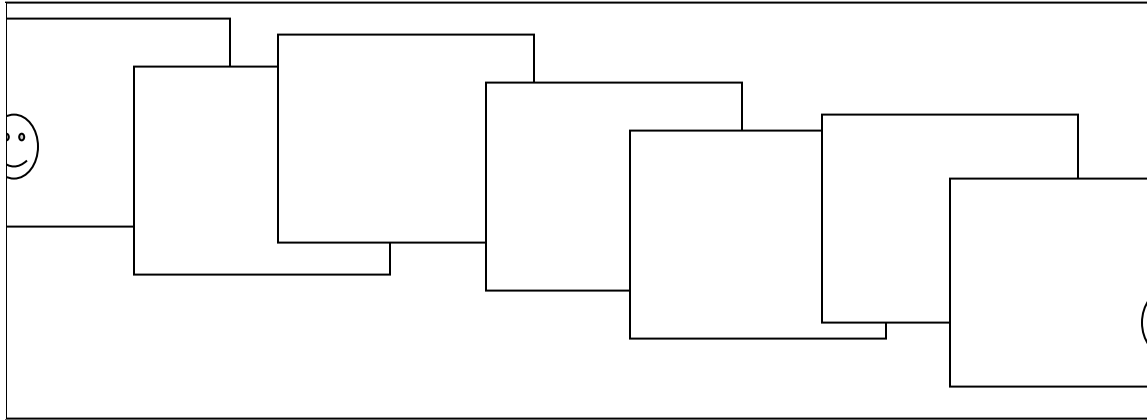


Assembling the panorama



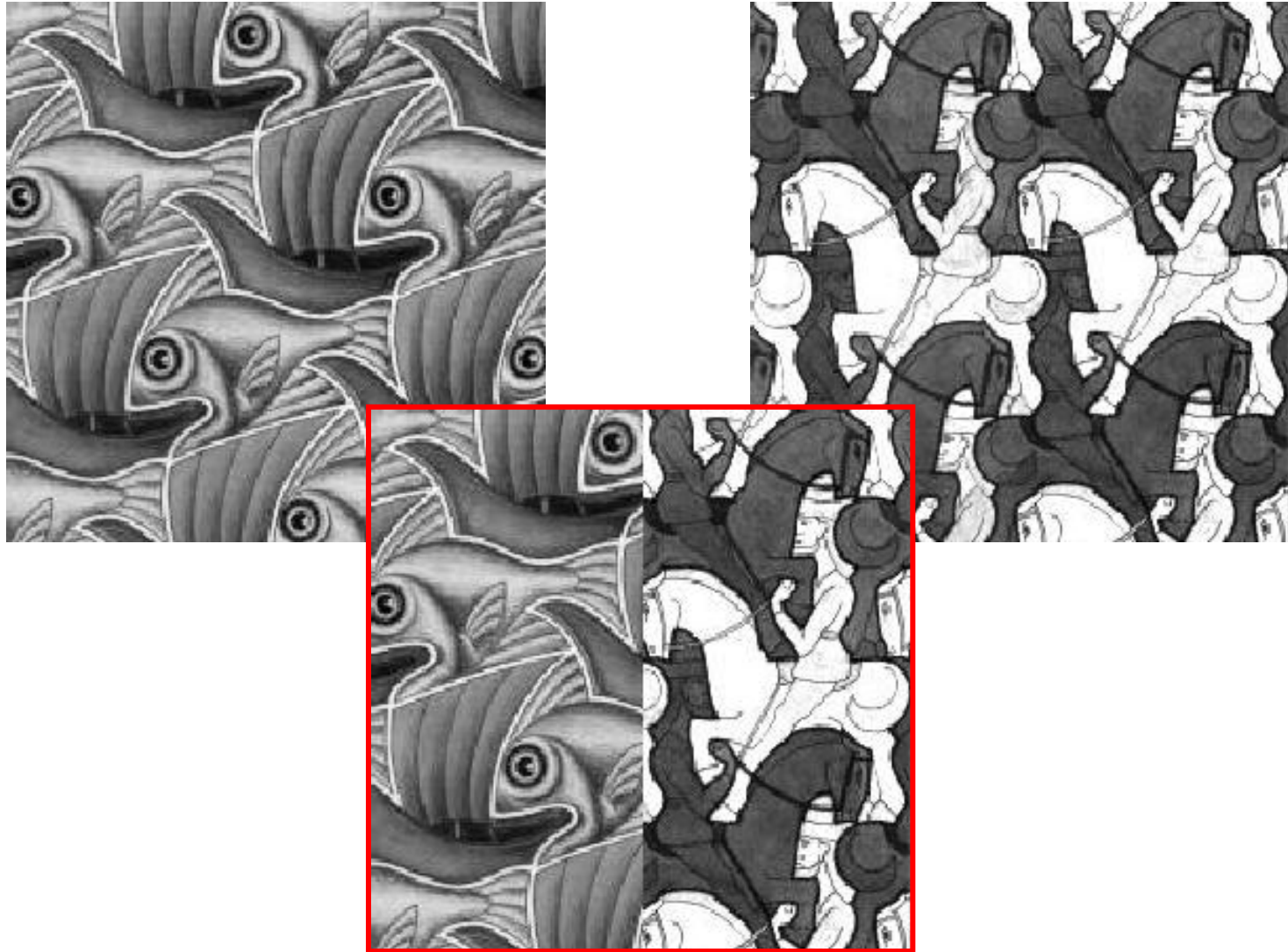
- Stitch pairs together, blend, then crop

Problem: Drift

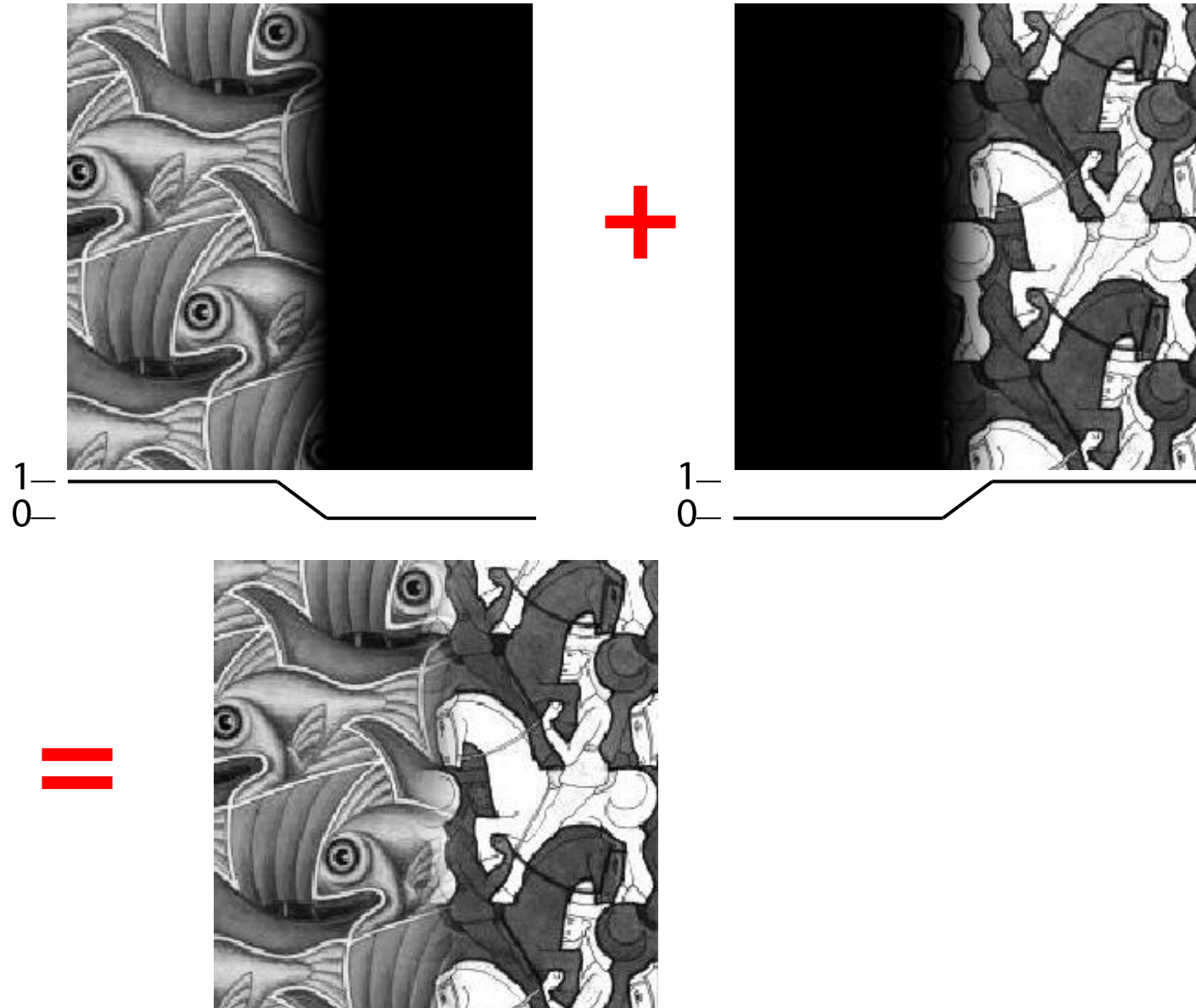


- Error accumulation
 - small errors accumulate over time

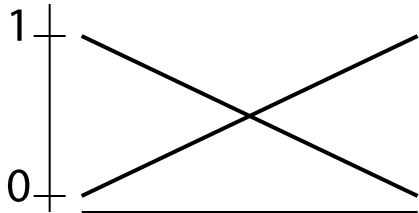
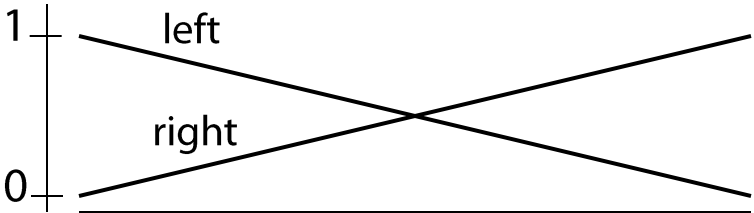
Image Blending



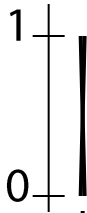
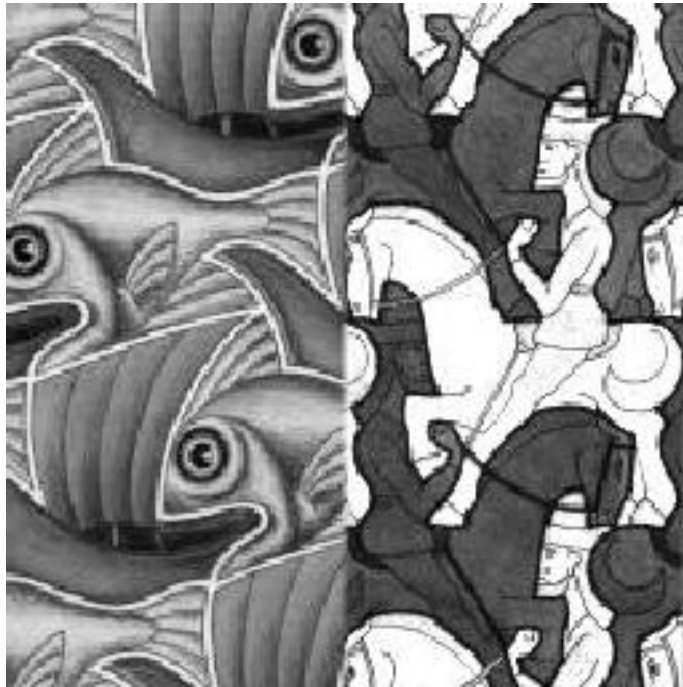
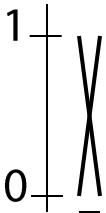
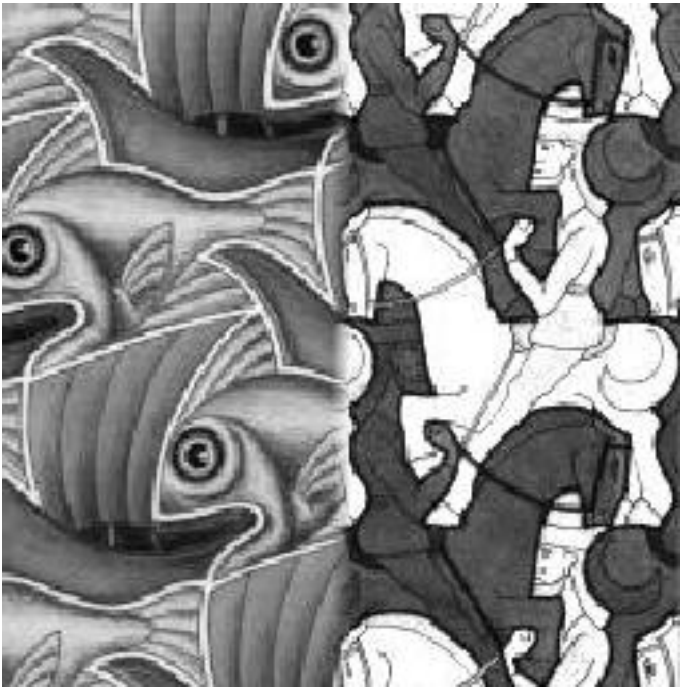
Feathering



Effect of window size



Effect of window size



Good window size



“Optimal” window: smooth but not ghosted

- Doesn't always work...