Multi-Perspective Panoramas

CS194: Image Manipulation & Computational Photography

Alexei Efros, UC Berkeley, Fall 2022

Slides from Lihi Zelnik

Objectives

1. Better looking panoramas

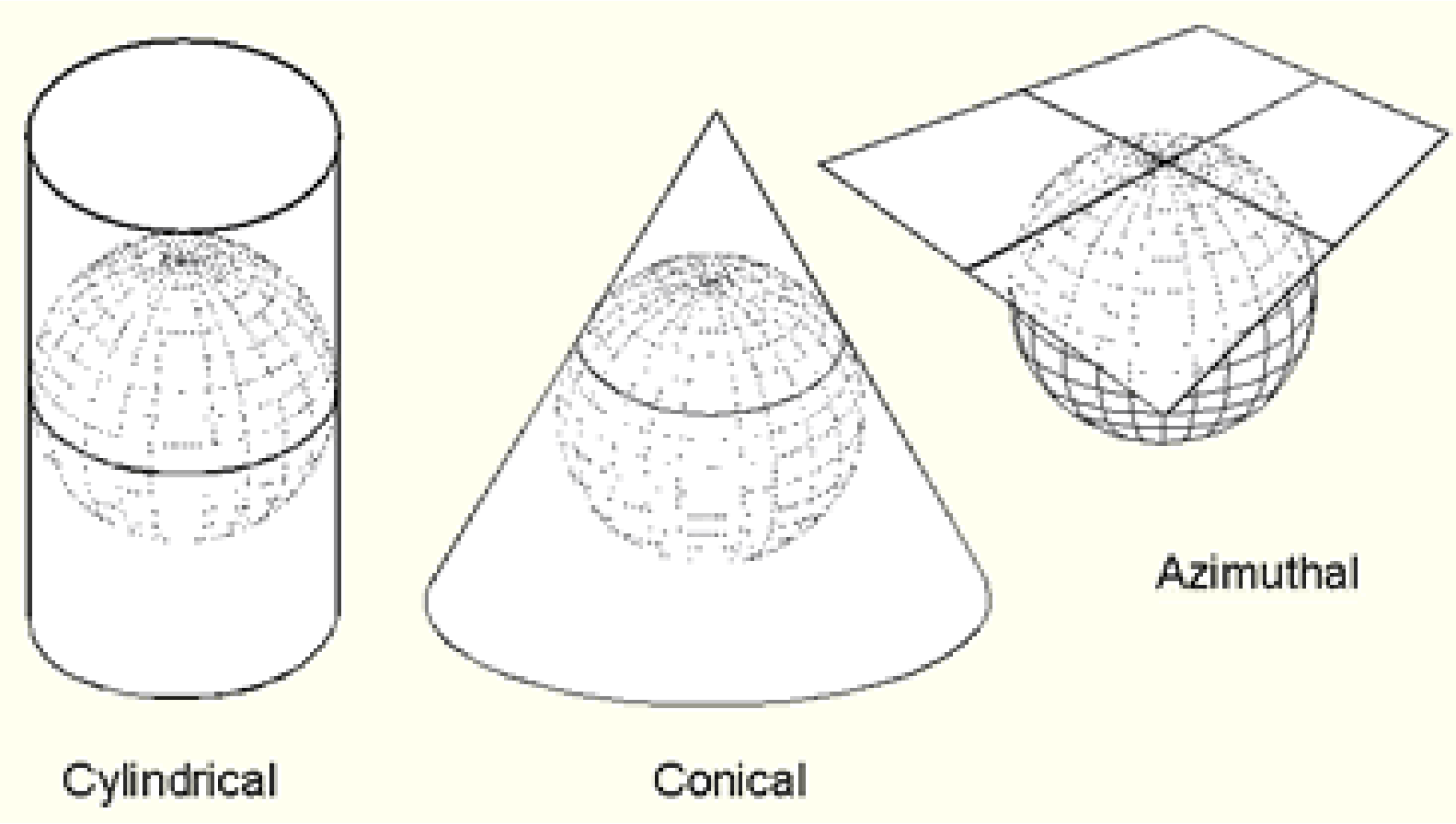
2. Let the camera move:
   - Any view
   - Natural photographing

Stand on the shoulders of giants

Cartographers

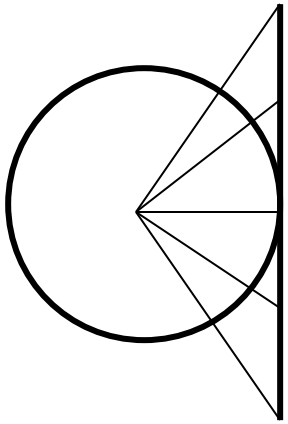
Artists

Cartographic projections

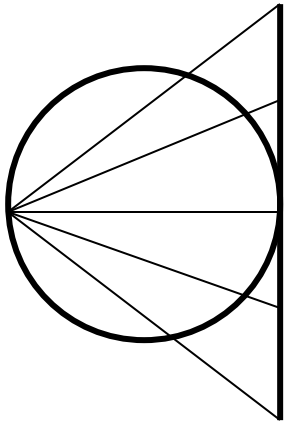


Common panorama projections

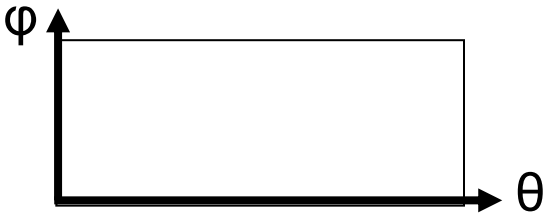
Perspective



Stereographic



Cylindircal



Global Projections

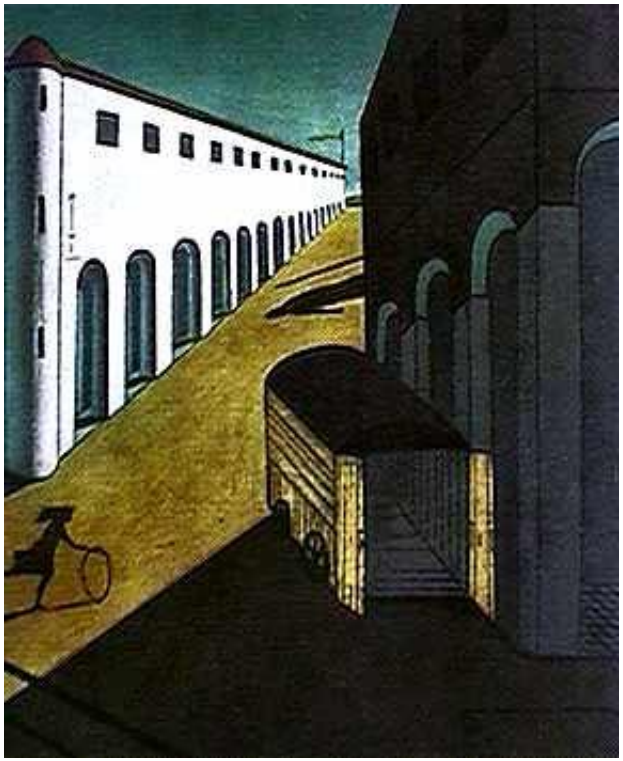
Perspective

Stereographic

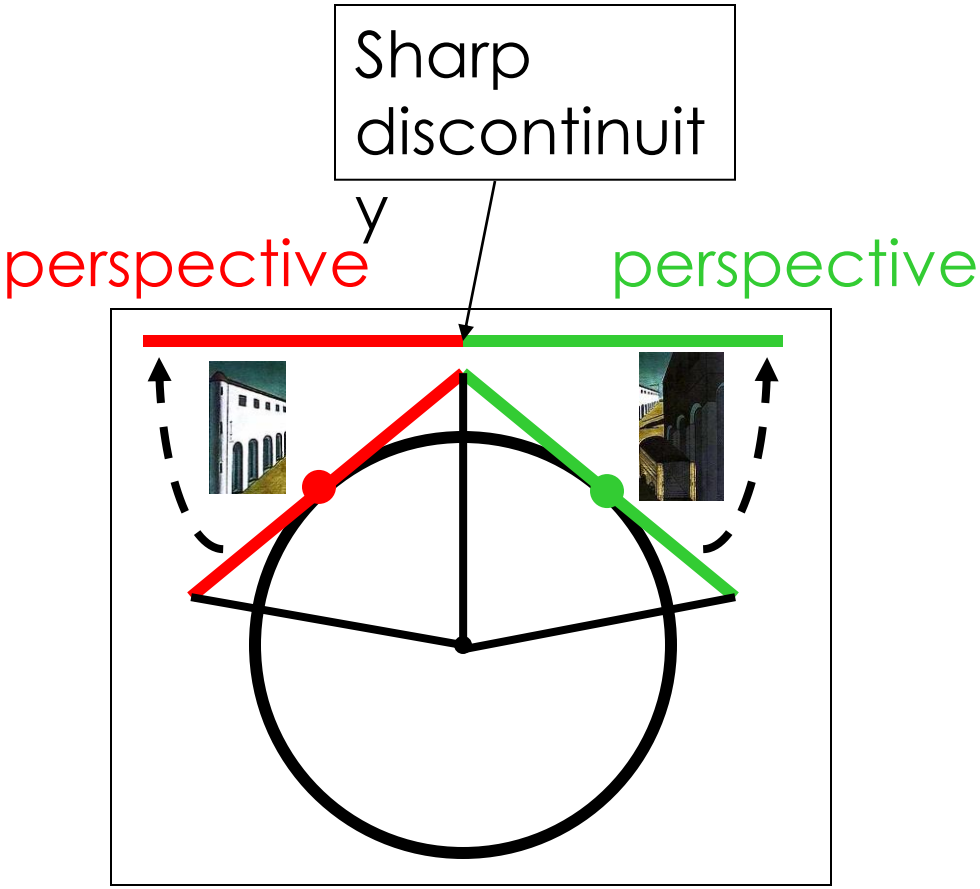
Cylindircal

Learn from the artists

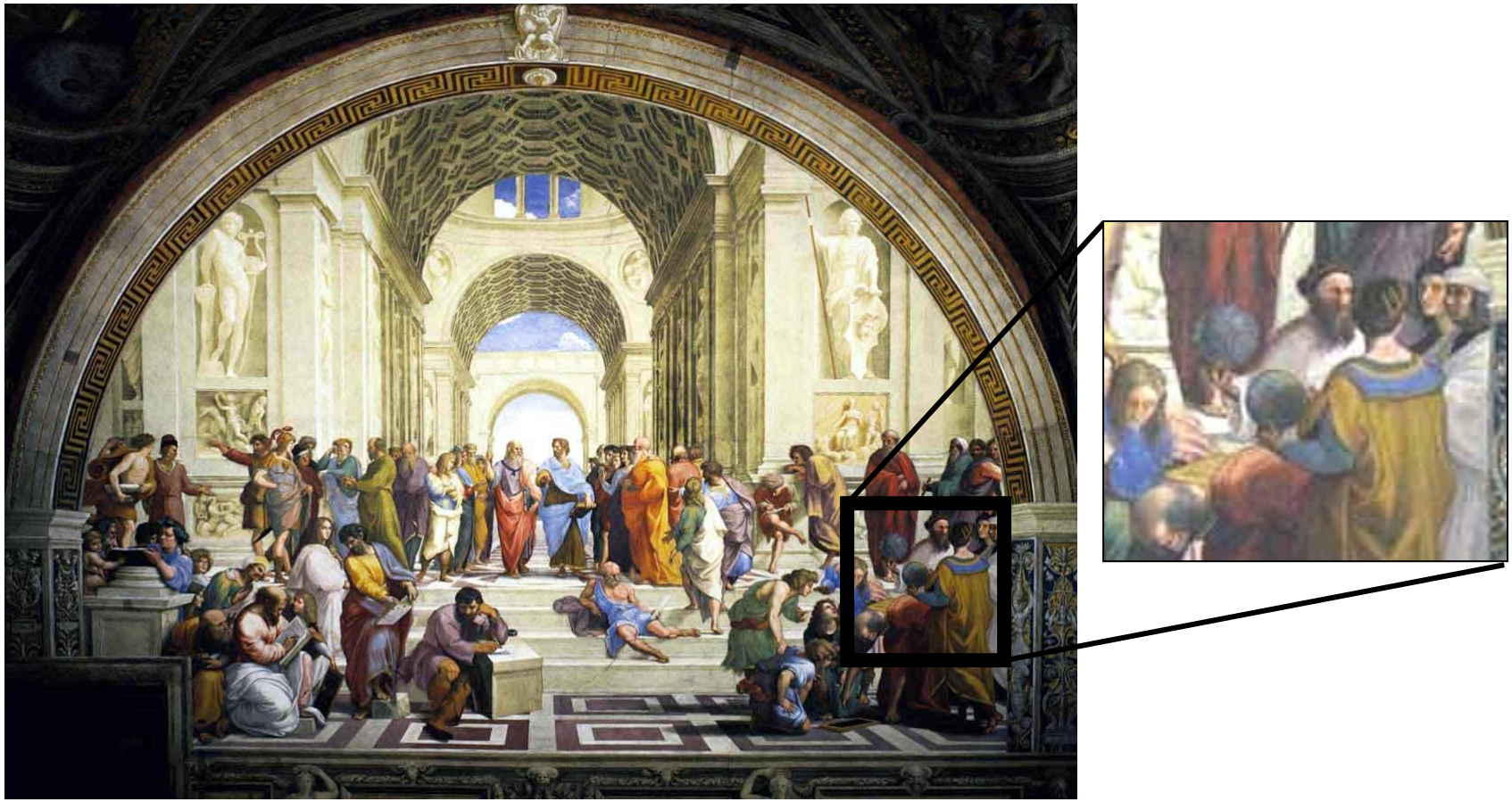
Multiple view points



De Chirico "Mystery and Melancholy of a Street", 1914



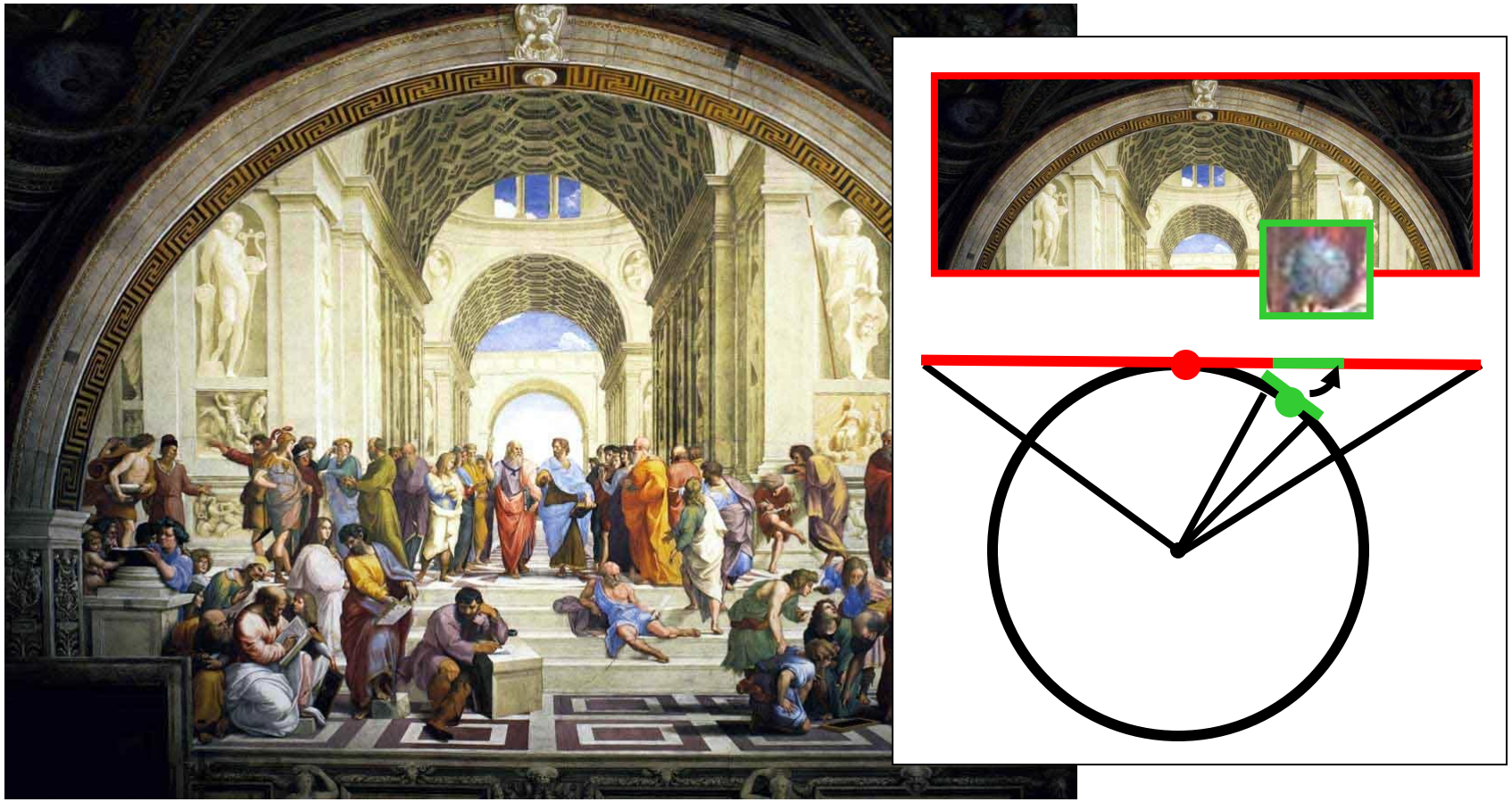
Renaissance painters solution



"School of Athens", Raffaello Sanzio ~1510

Give a separate treatment to different parts of the scene!!

Personalized projections

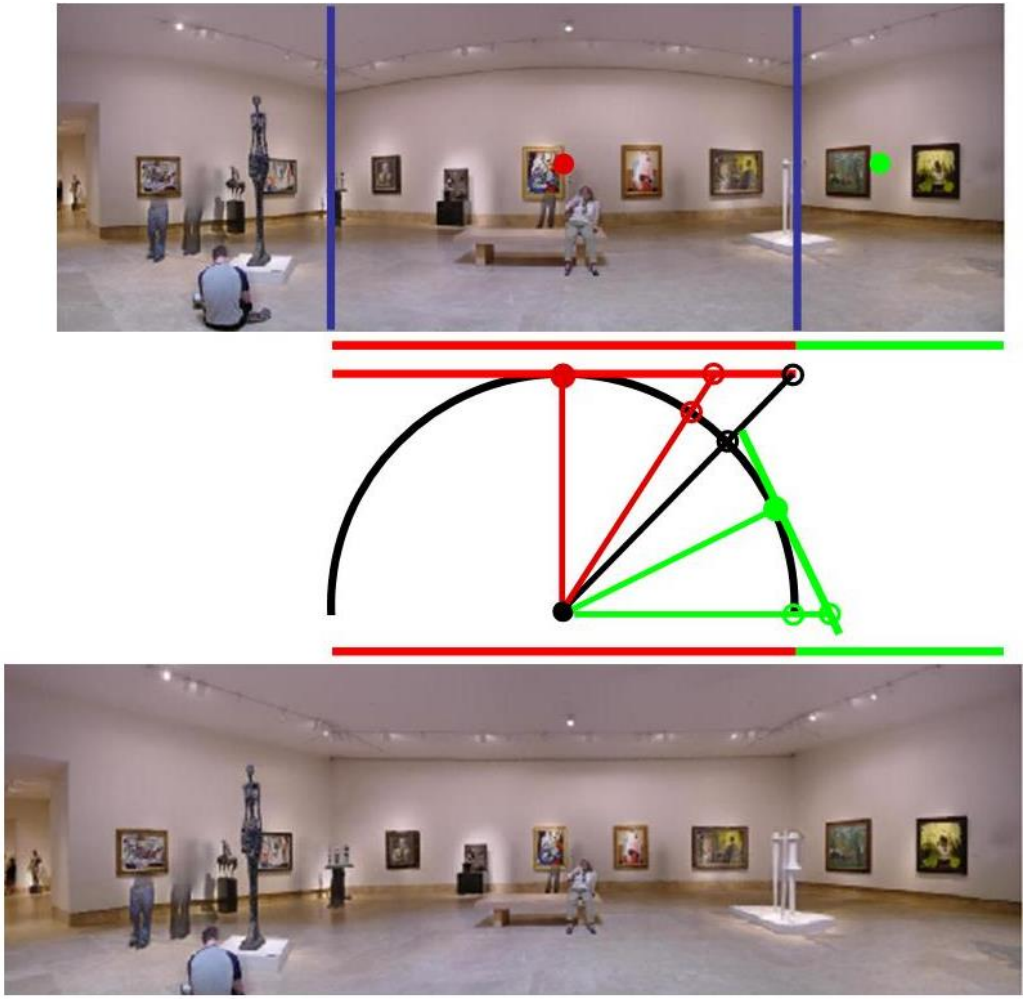


"School of Athens", Raffaello Sanzio ~1510

Give a separate treatment to different parts of the scene!!

Multiple planes of projection

Sharp discontinuities can often be well hidden



Single view

multi-view result

Single view

multi-view result

Single view

multi-view result

Single view

multi-view result

Objectives - revisited

1. Better looking panoramas

2. Let the camera move:
   - Any view
   - Natural photographing

Multiple views can live together

Multi-view compositions

3D!!

David Hockney, Place Furstenberg, (1985)

Why multi-view?

Multiple viewpoints

David Hockney,
Place Furstenberg, 1985

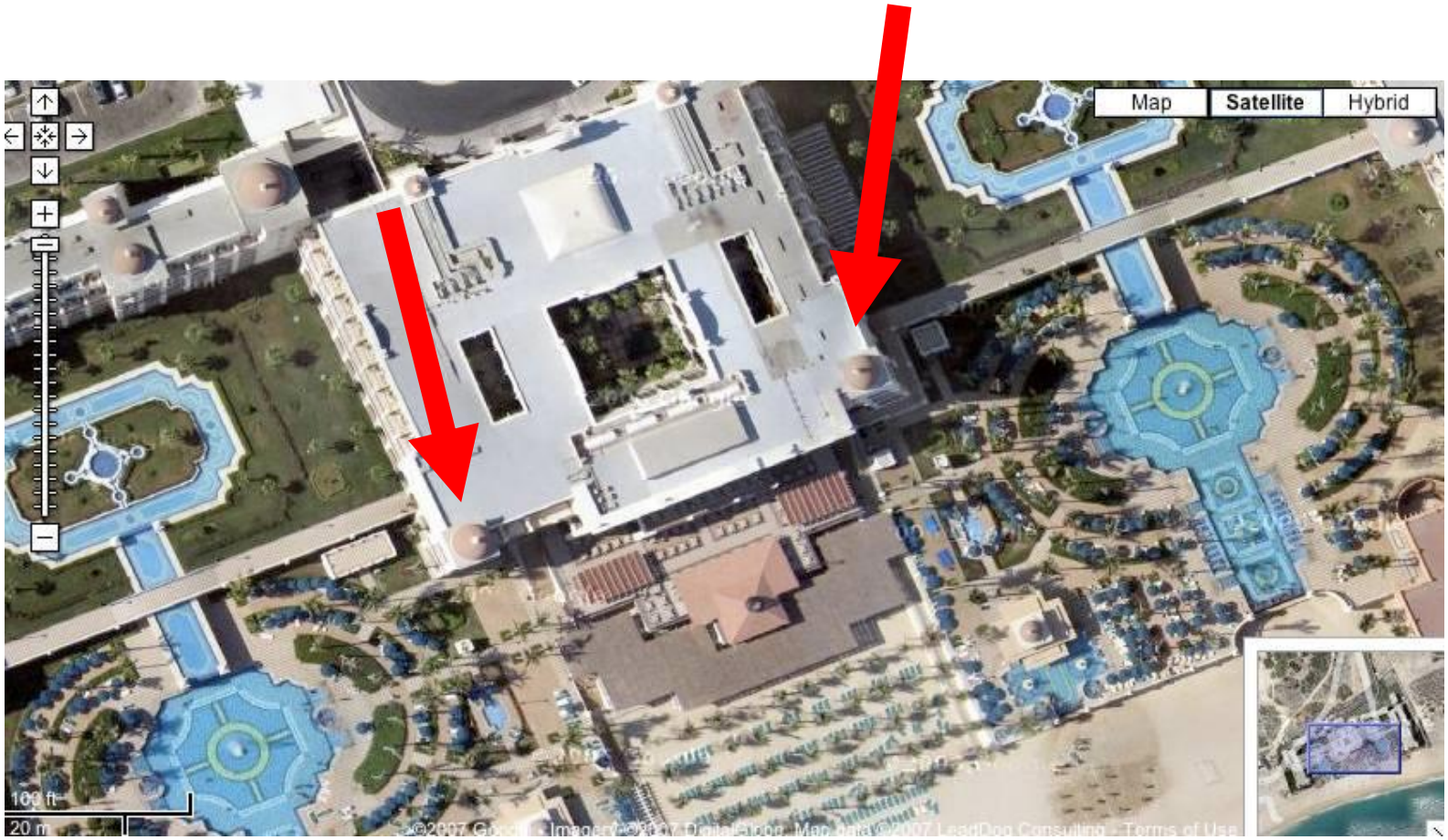
Single viewpoint

Melissa Slemin,
Place Furstenberg, 2003

Long Imaging

Agarwala et al. (SIGGRAPH 2006)

Smooth Multi-View



Google maps

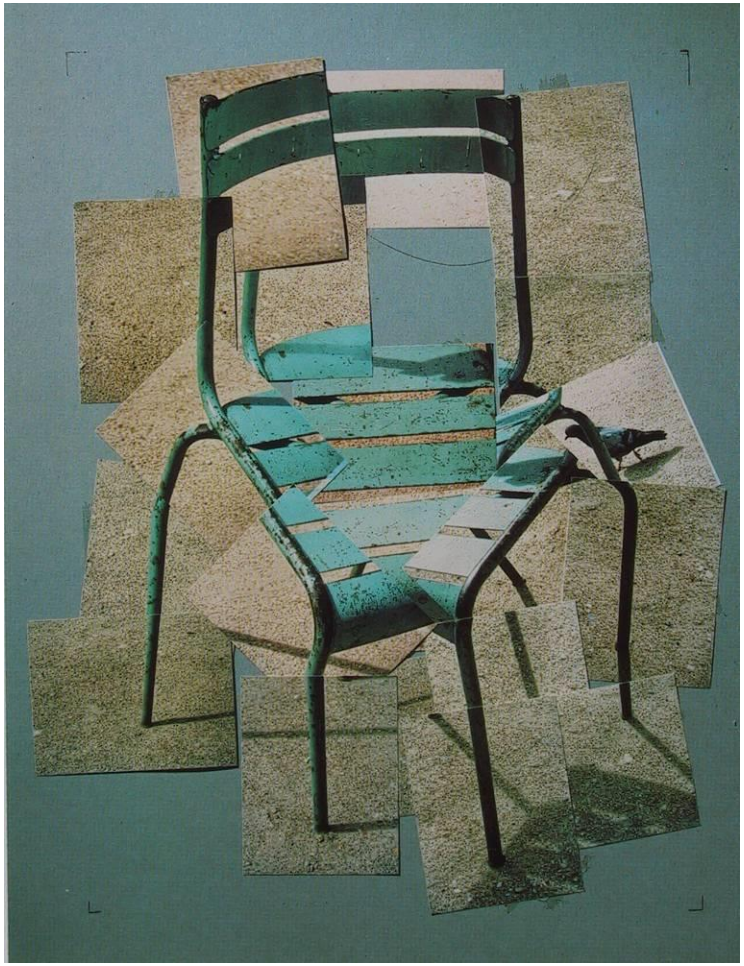
What's wrong in the picture?

Google maps

Non-smooth

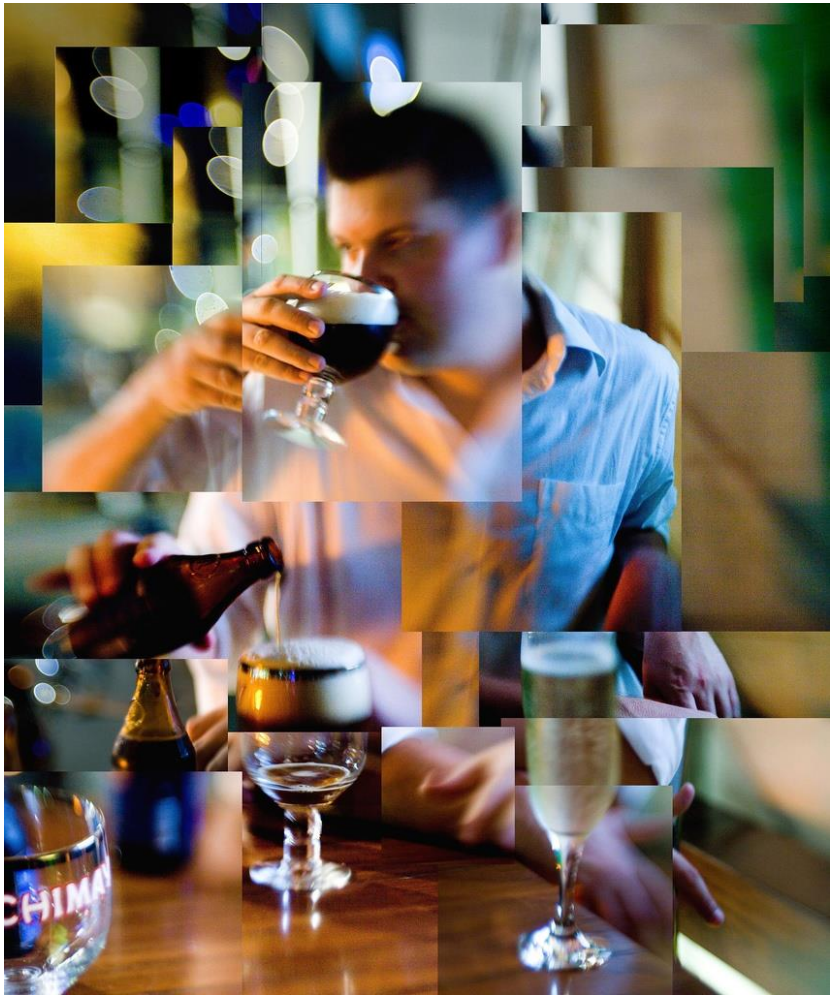
Google maps

The Chair



David Hockney (1985)

Joiners are popular



Flickr statistics (Aug'07):

4,985 photos matching joiners.

4,007 photos matching Hockney

41 groups about Hockney

Thousands of members

Main goals:

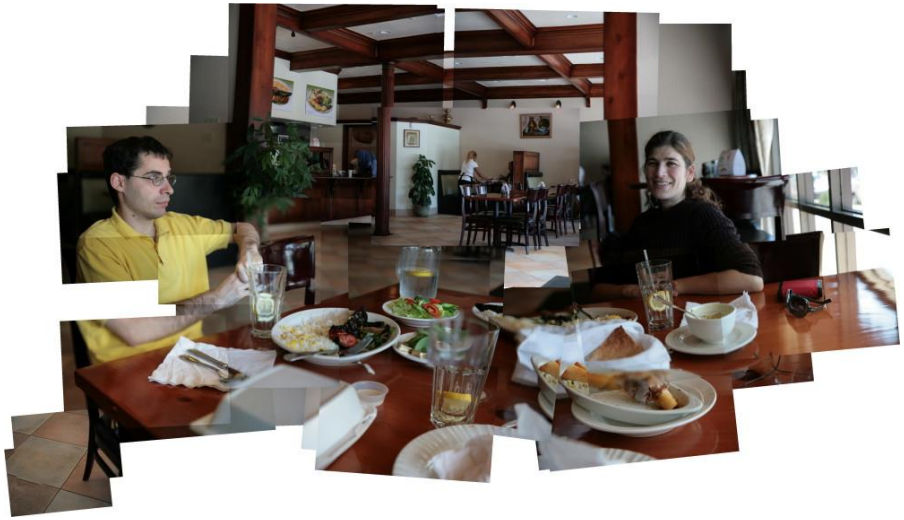
Automate joiners

Generalize panoramas to general image collections

Objectives

- For Artists:
  Reduce manual labor

Manual: ~40min.



Fully automatic

Objectives

- For Artists:
  Reduce manual labor

- For non-artists:
  Generate pleasing-to-the-eye joiners

Objectives

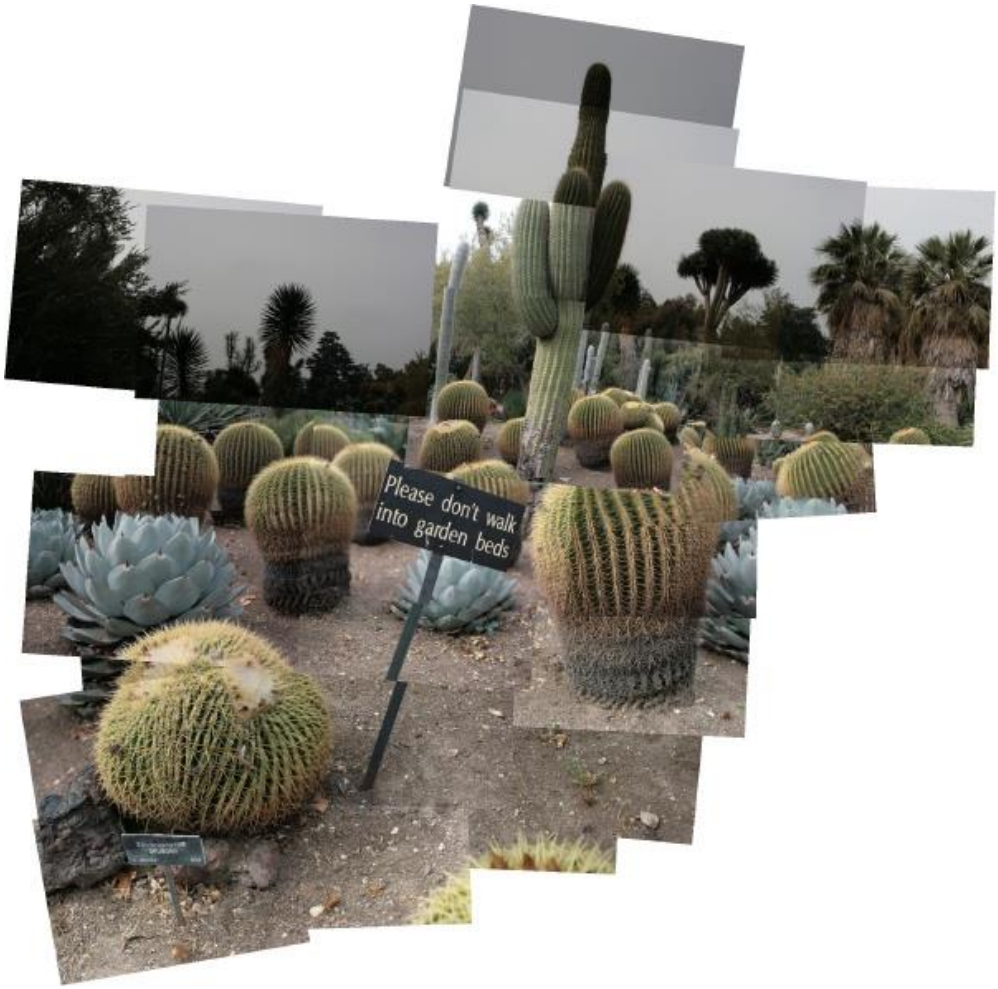
- For Artists:
  Reduce manual labor

- For non-artists:
  Generate pleasing-to-the-eye joiners

- For data exploration:
  Organize images spatially

What's going on here?

A cacti garden



Principles

Principles

- Convey topology

Correct

Incorrect

Principles

- Convey topology
- A 2D layering of images

Blending:
blurry

Graph-cut:
cuts hood

Desired joiner

Principles

- Convey topology
- A 2D layering of images
- Don’t distort images

translate

rotate

scale

Principles

- Convey topology
- A 2D layering of images
- Don’t distort images
- Minimize inconsistencies

Bad

Good

Algorithm

Step 1: Feature matching

Brown & Lowe, ICCV'03

Step 2: Align

Large inconsistencies

Brown & Lowe, ICCV'03

Step 3: Order

Reduced inconsistencies

Ordering images

Try all orders: only for small datasets

Ordering images

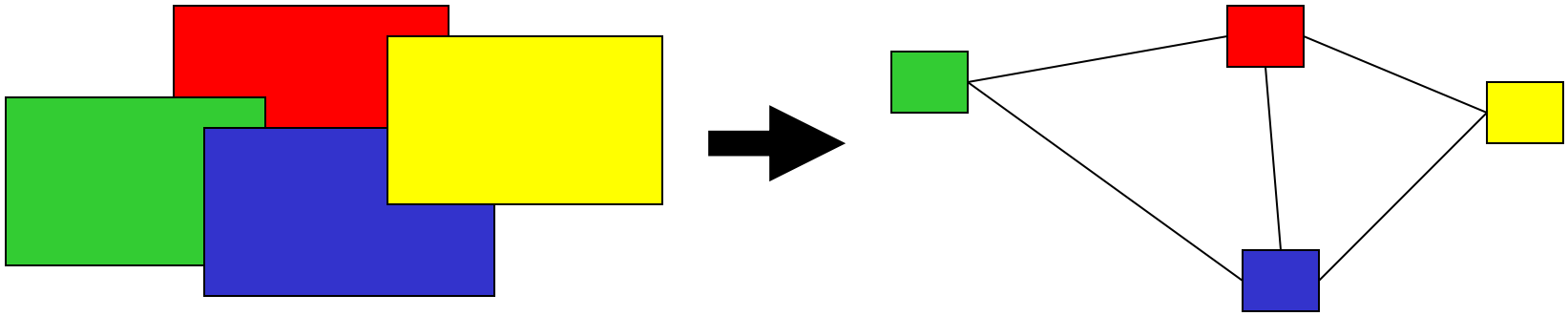
Try all orders: only for small datasets

complexity: $(m+n)\alpha$

m = # images

n = # overlaps

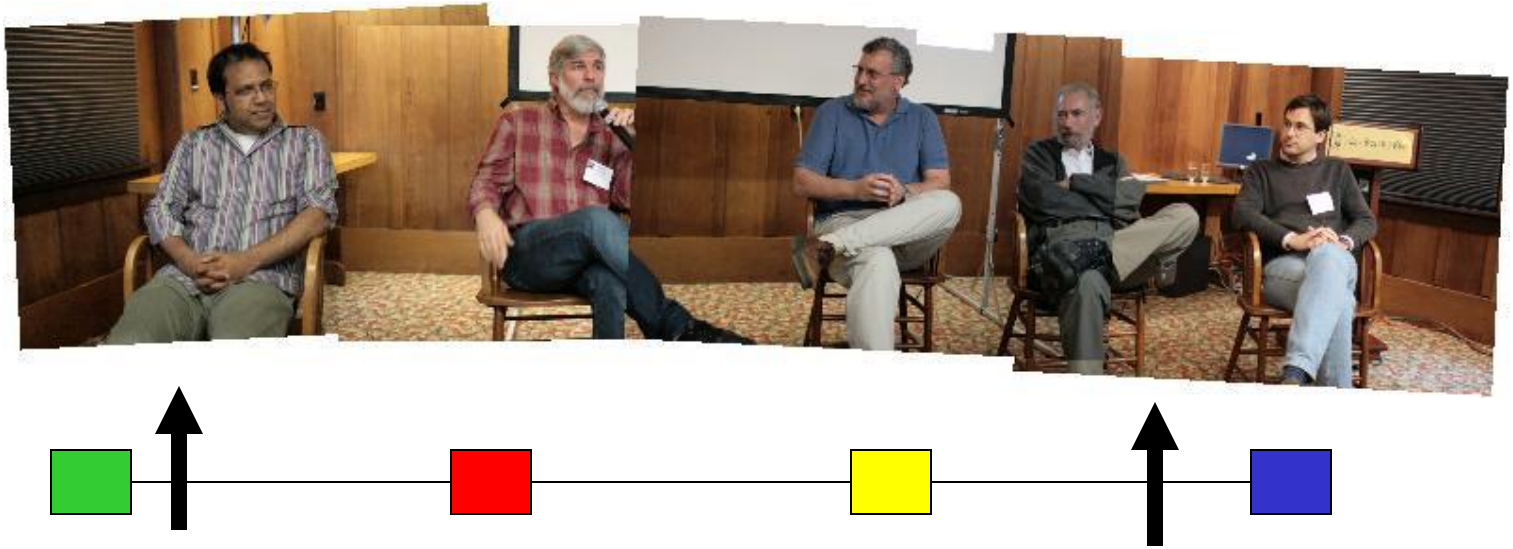
α = # acyclic orders



Ordering images

Observations:

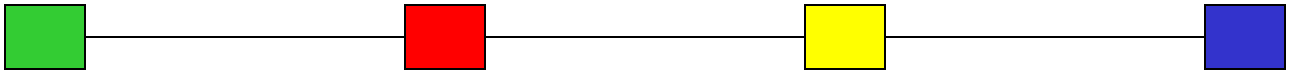
- Typically each image overlaps with only a few others
- Many decisions can be taken locally



Ordering images

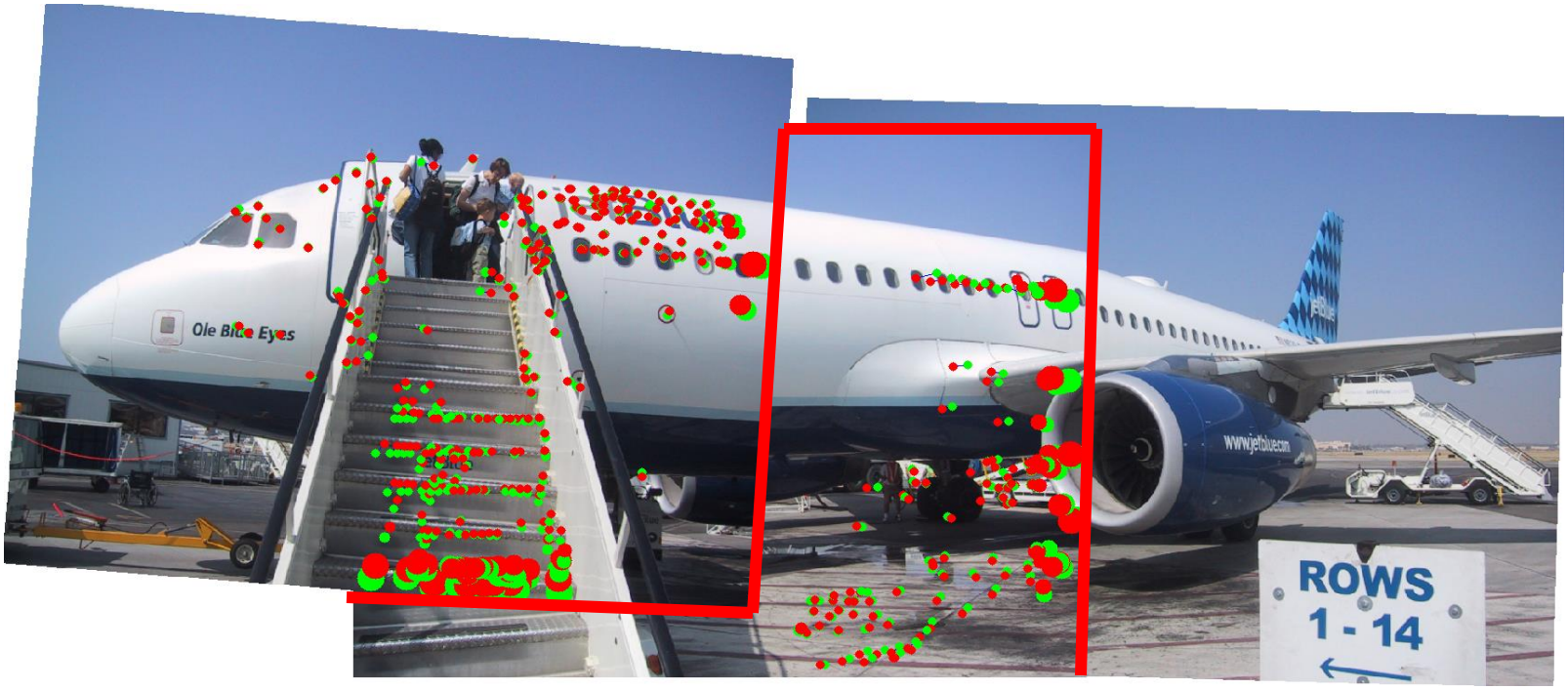
Approximate solution:

- Solve for each image independently
- Iterate over all images



Can we do better?

Step 4: Improve alignment



Iterate Align-Order-Importance

Iterative refinement

Initial

Final

Iterative refinement

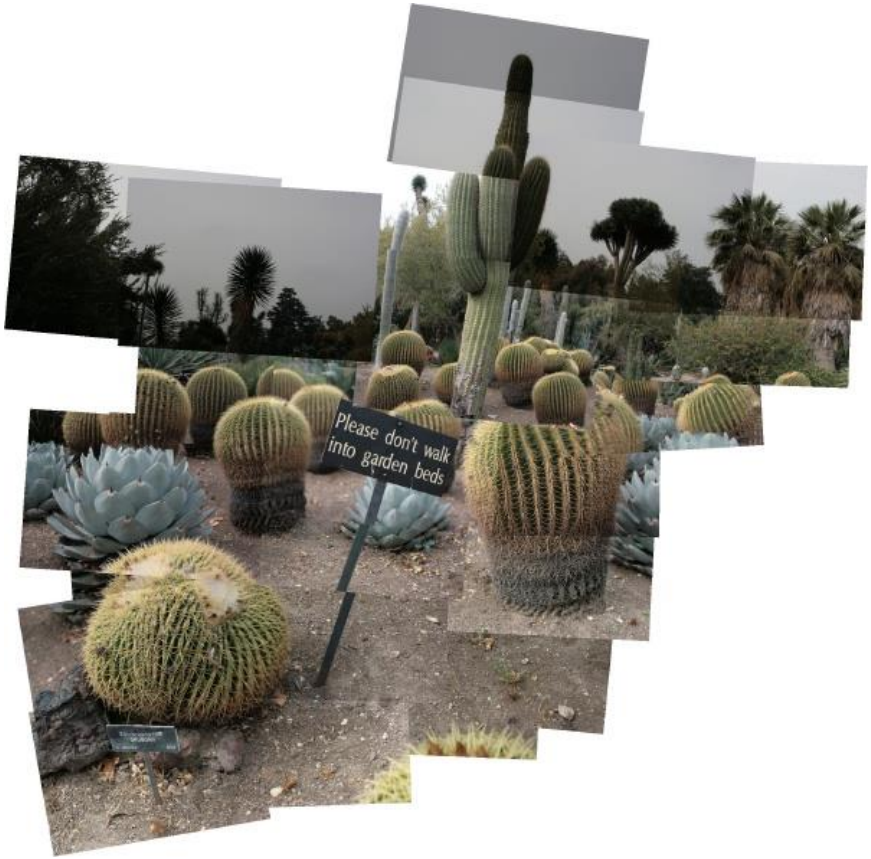
Initial

Final

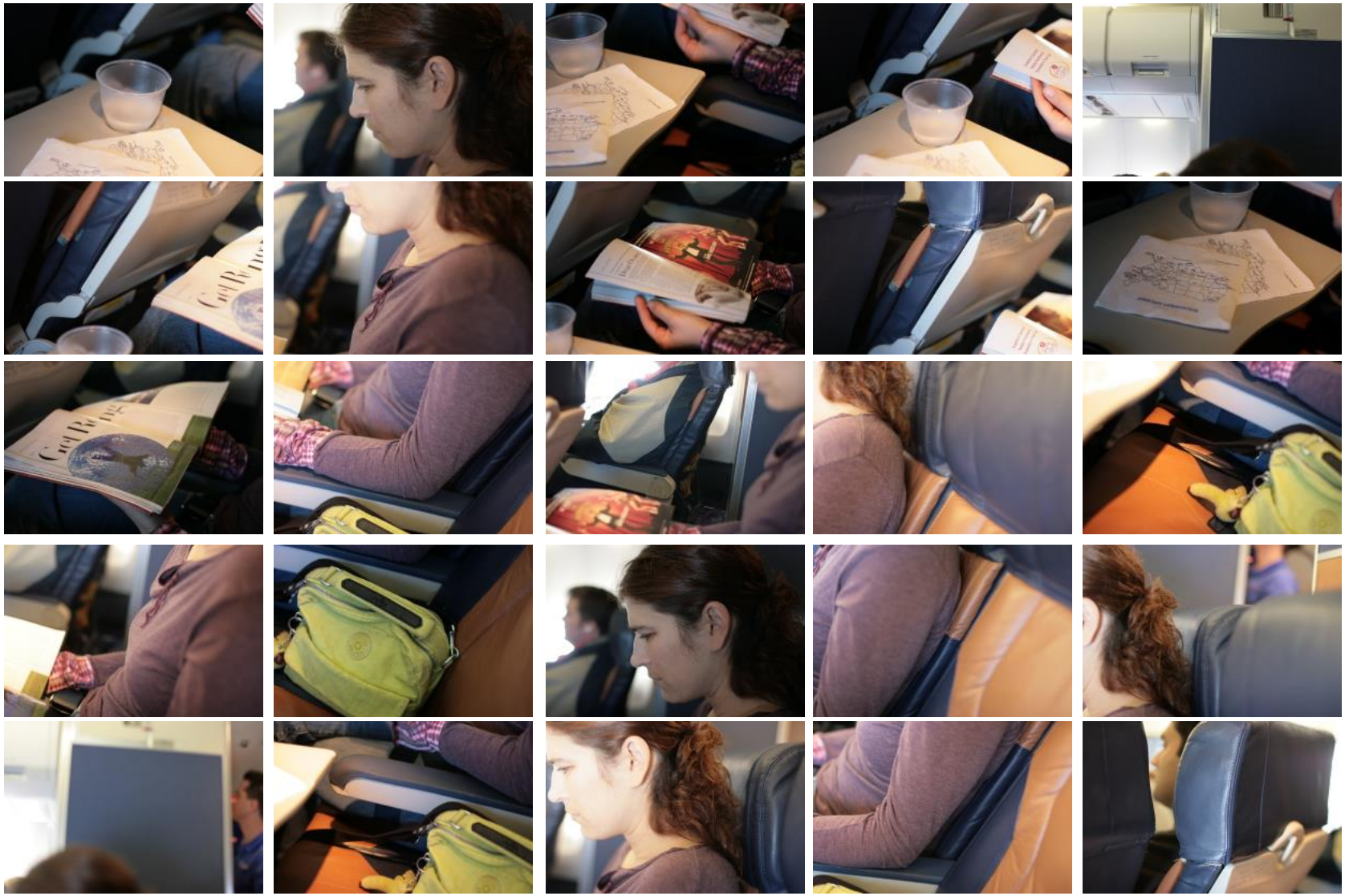
Iterative refinement

Initial

Final



What is this?



That’s me reading

Anza-Borrego

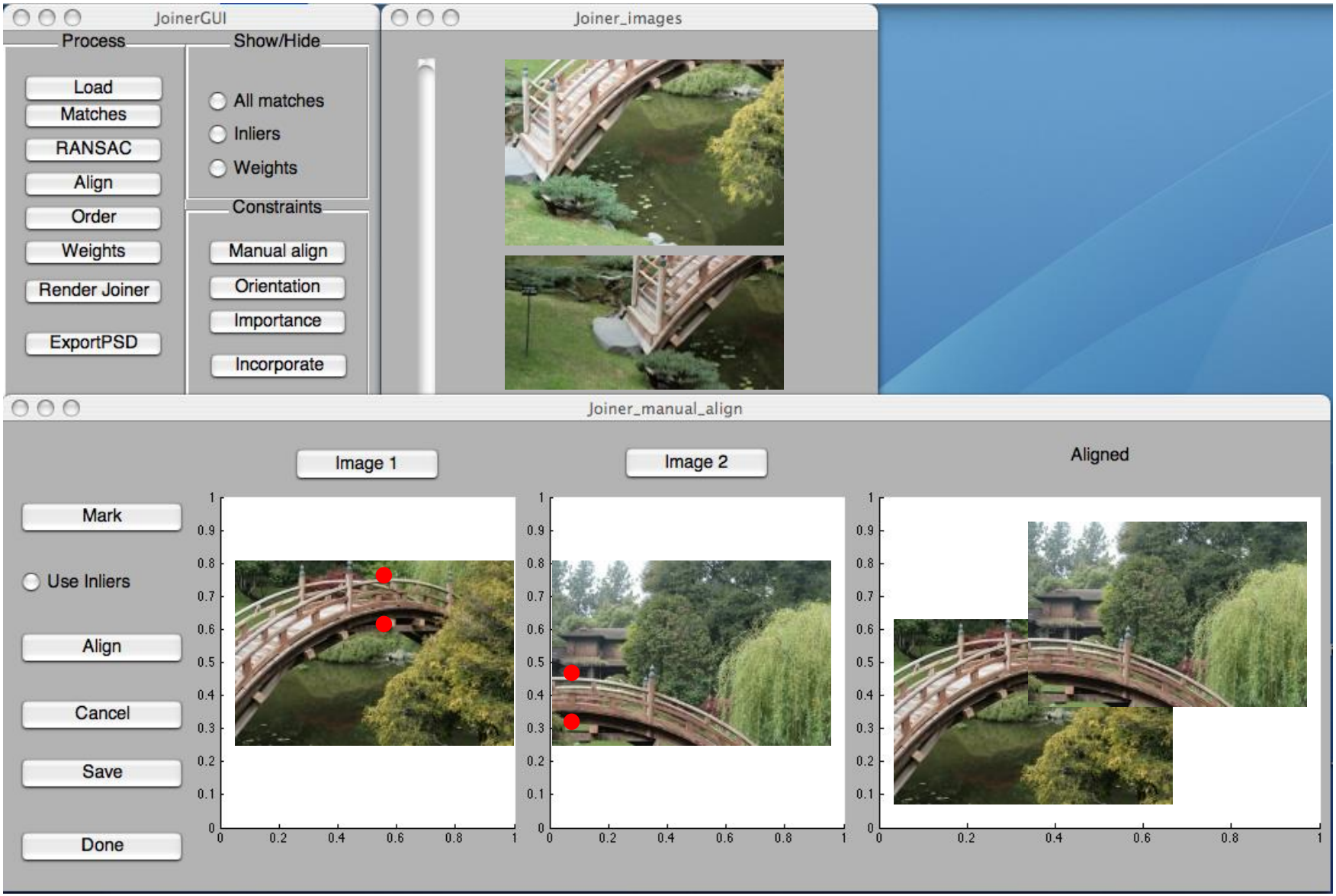
Tractor

Manual by Photographer

Our automatic result

Failure?

GUI


JoinerGUI
Process
Load
Matches
RANSAC
Align
Order
Weights
Render Joiner
ExportPSD
Show/Hide
All matches
Inliers
Weights
Constraints
Manual align
Orientation
Importance
Incorporate
Joiner_images
Joiner_manual_align
Image 1
Image 2
Aligned
Mark
Use Inliers
Align
Cancel
Save
Done

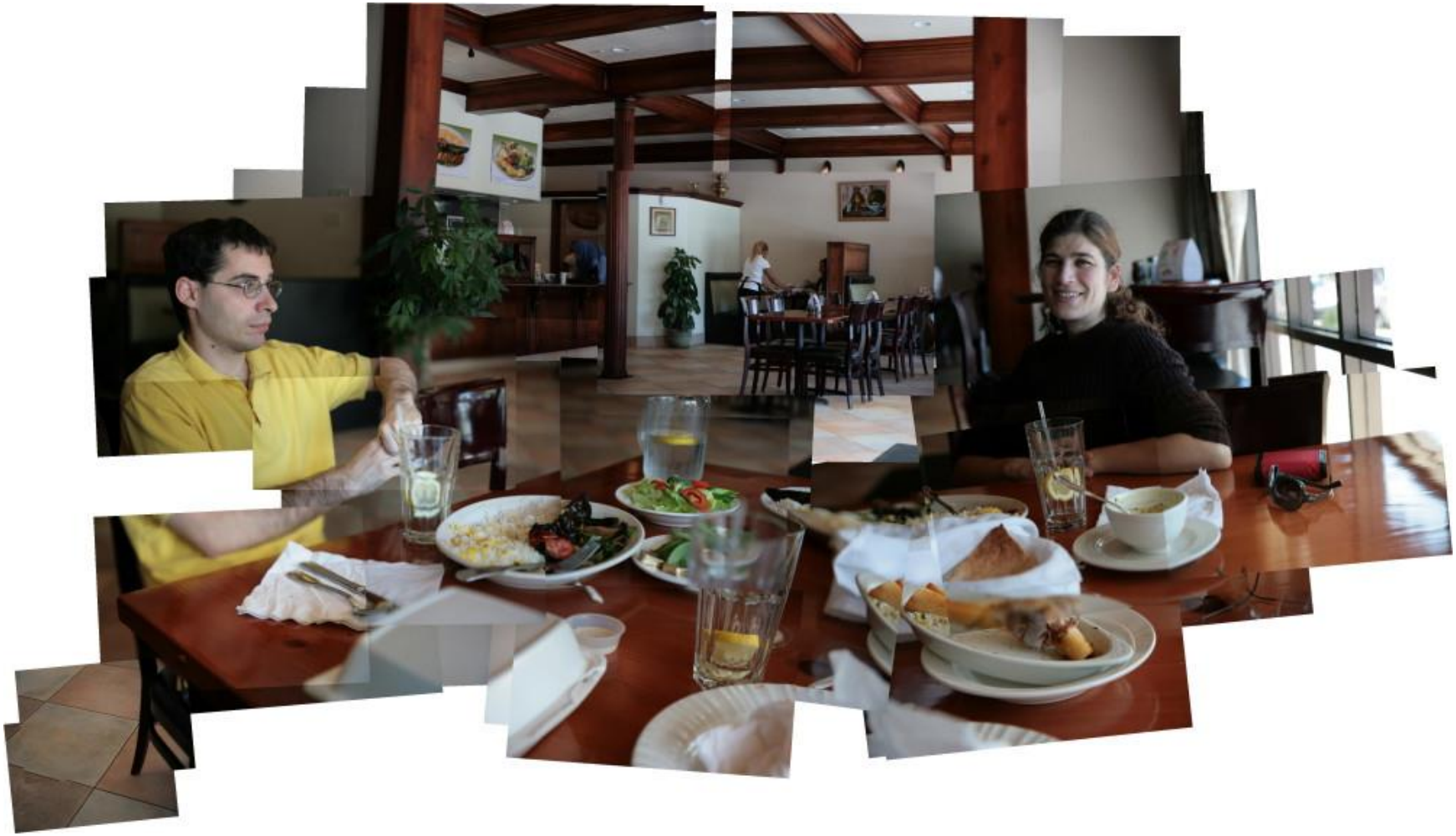
The Impossible Bridge

Homage to David Hockney

Take home

- Incorrect geometries are possible and fun!
- Geometry is not enough, we need scene analysis

- A highly related work:
  "Scene Collages and Flexible Camera Arrays,"
  Y. Nomura, L. Zhang and S.K. Nayar,
  Eurographics Symposium on Rendering, Jun, 2007.



This Class Project from 2007

http://www.cs.cmu.edu/afs/andrew/scs/cs/5-463/f07/proj_final/www/echuangs/