Multi-perspective Panoramas

Slides from a talk by Lihi Zelnik-Manor
at ICCV'07 3DRR workshop

Pictures capture memories

Panoramas

Registration: Brown & Lowe,   ICCV'05
Blending: Burt & Adelson, Trans. Graphics,1983
Visualization: Kopf et al., SIGGRAPH, 2007
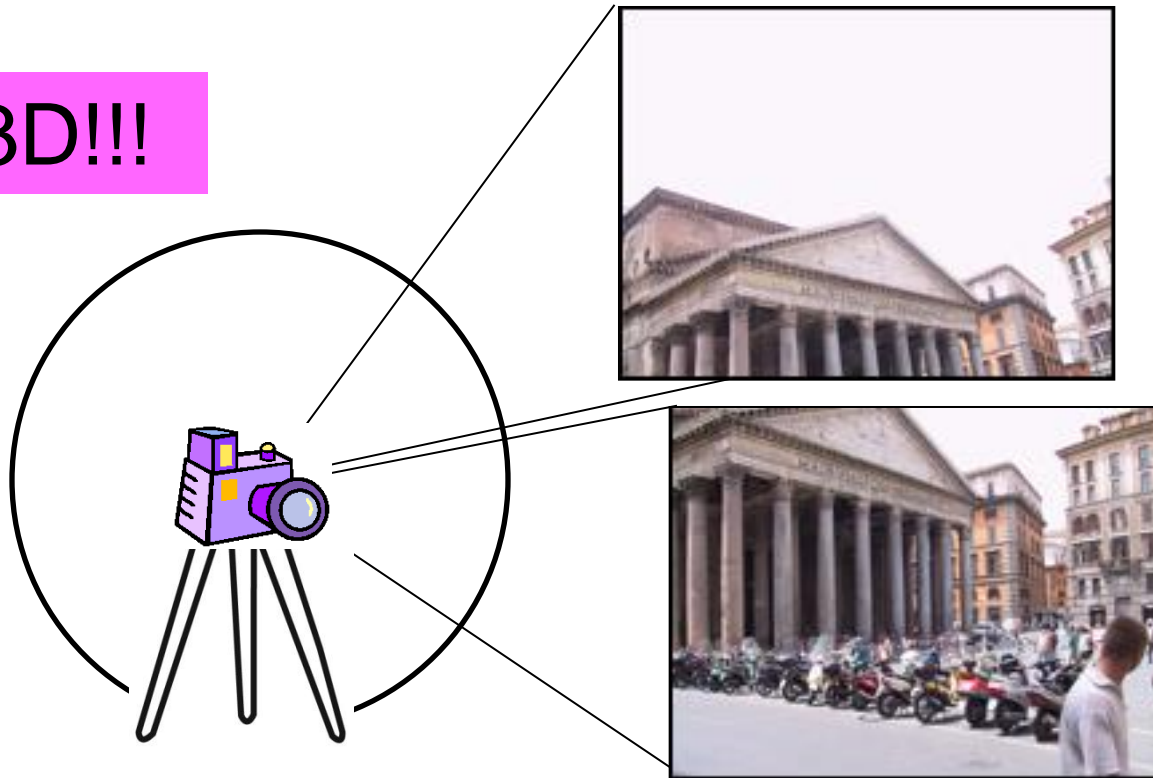
Bad panorama?

Output of Brown & Lowe software

No geometrically consistent solution

Scientists solution to panoramas:
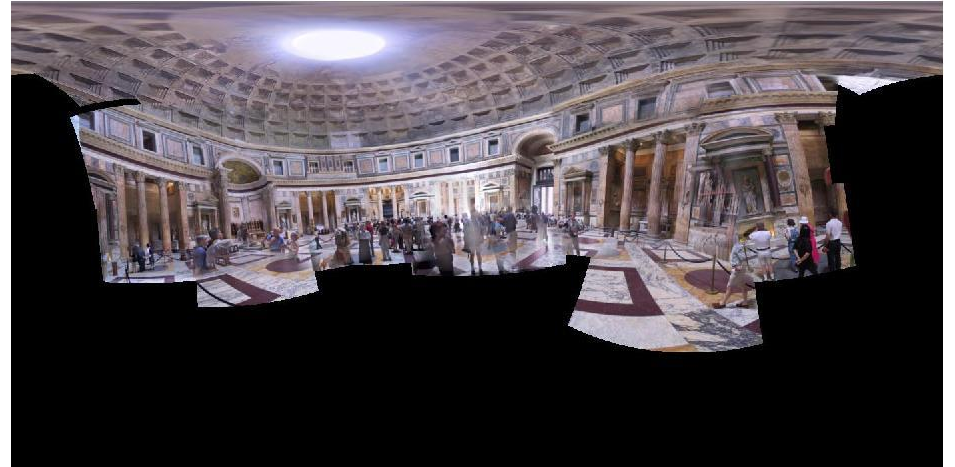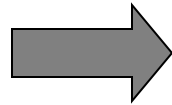# Single center of projection

No 3D!!!

Registration: Brown & Lowe, ICCV'05
Blending: Burt & Adelson, Trans. Graphics,1983
Visualization: Kopf et al., SIGGRAPH, 2007

From sphere to plane

Distortions are unavoidable

Distorted panoramas

Actual appearance

Output of Brown & Lowe software

Objectives

1. Better looking panoramas

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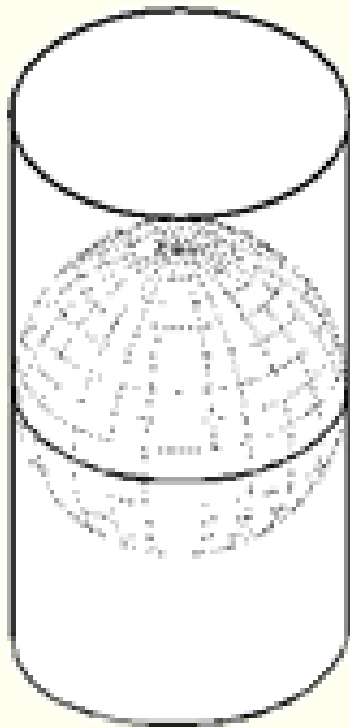   - Natural photographing

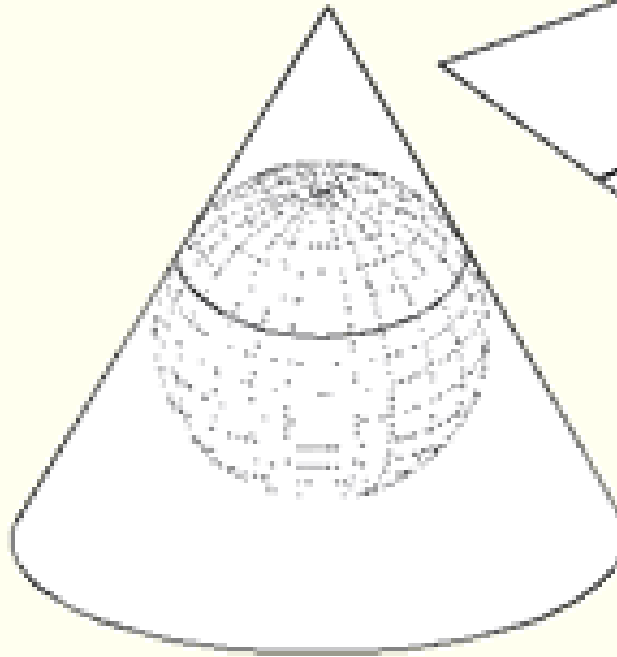# Stand on the shoulders of giants
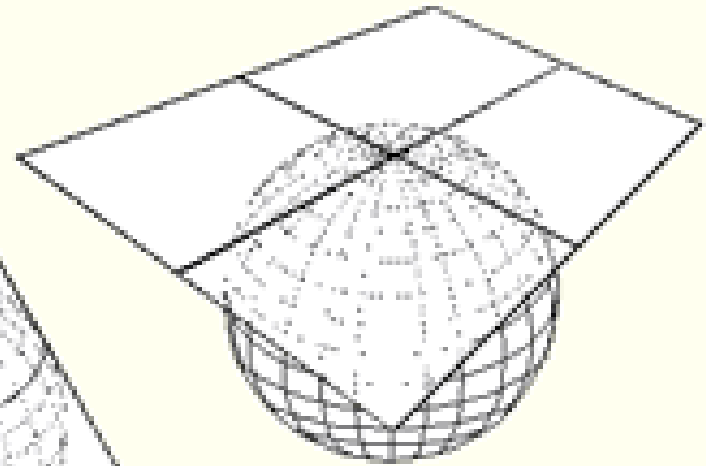
Cartographers

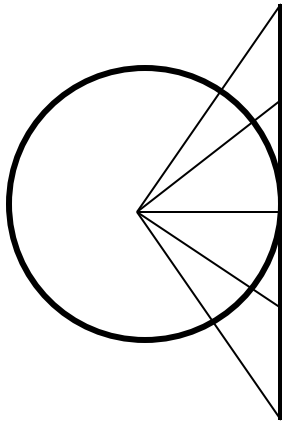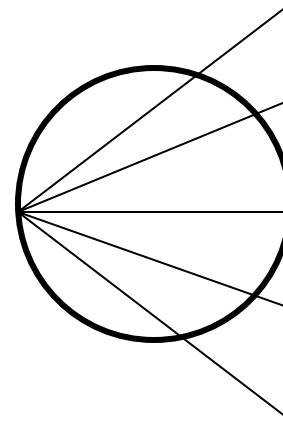Artists

Cartographic projections

Cylindrical
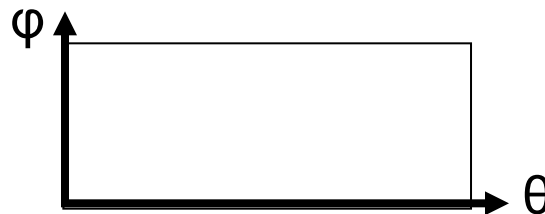
Conical

Azimuthal

Common panorama projections

Perspective

Stereographic

Cylindircal

φ

θ

Global Projections

Perspective

Stereographic

Cylindircal

Learn from the artists

Multiple view points

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

Sharp discontinuity

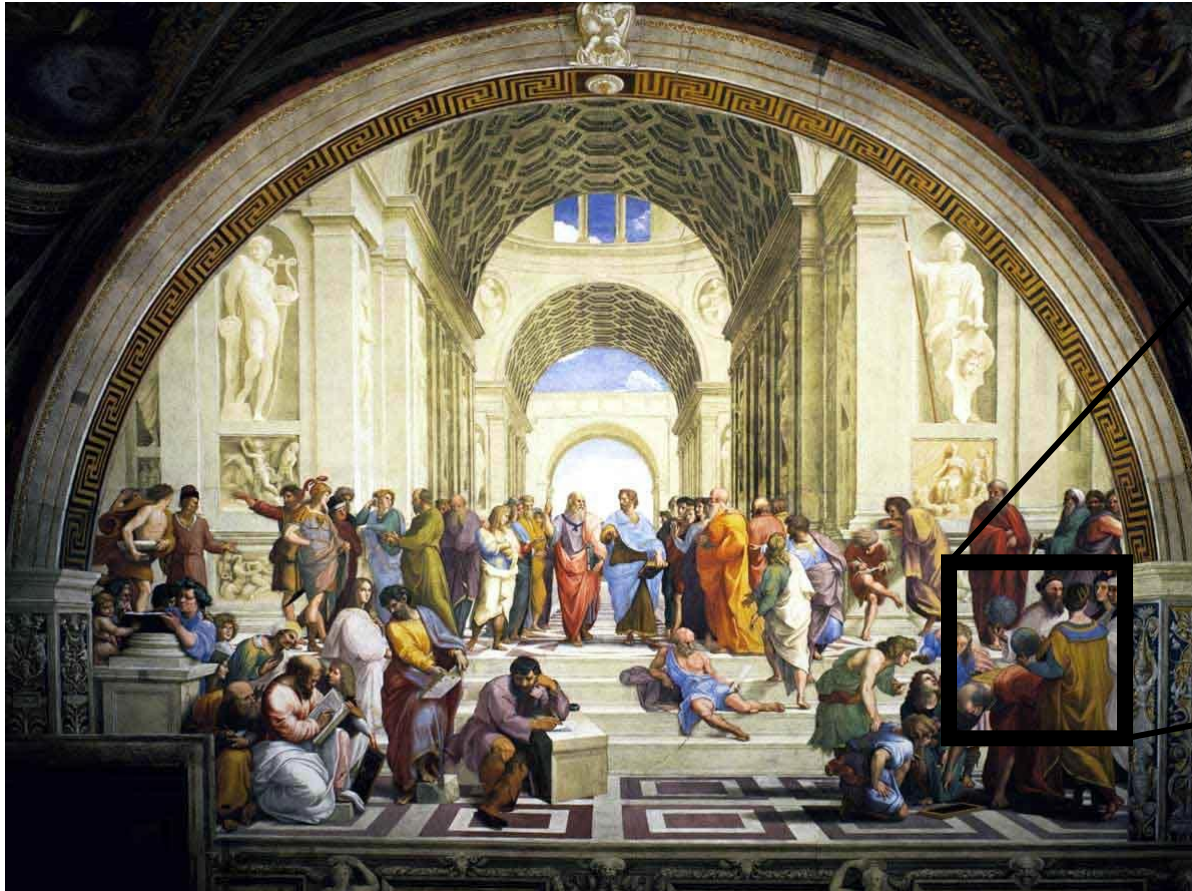perspective   perspective
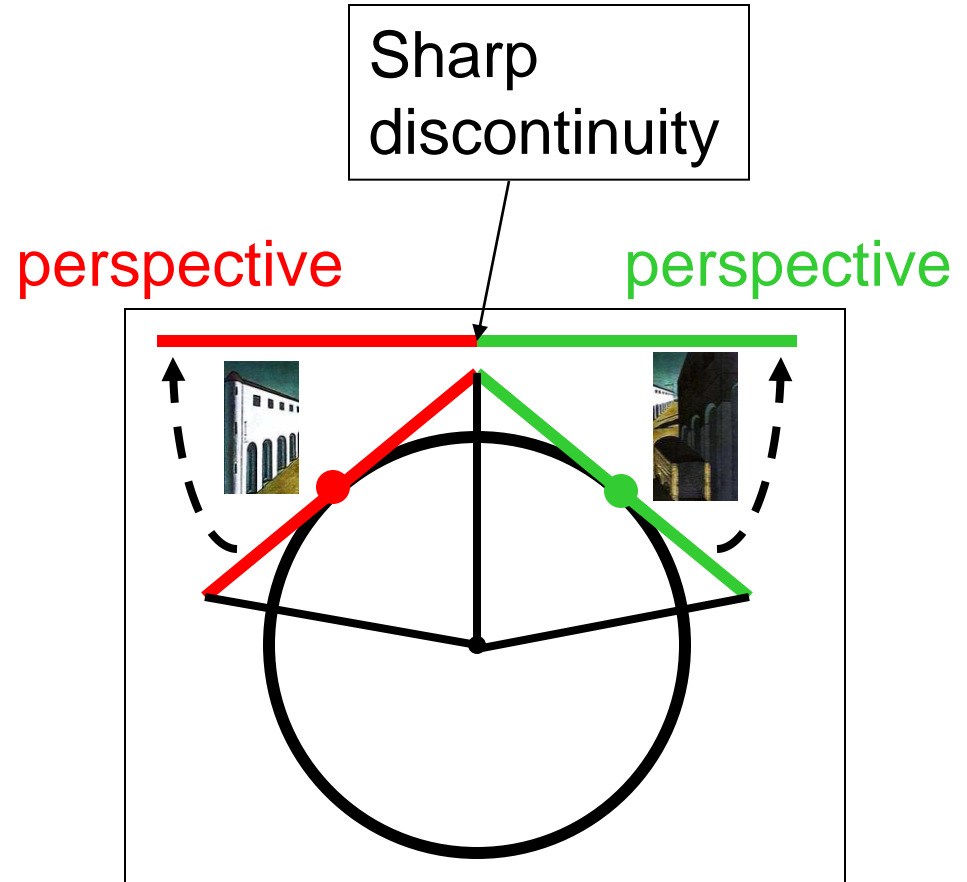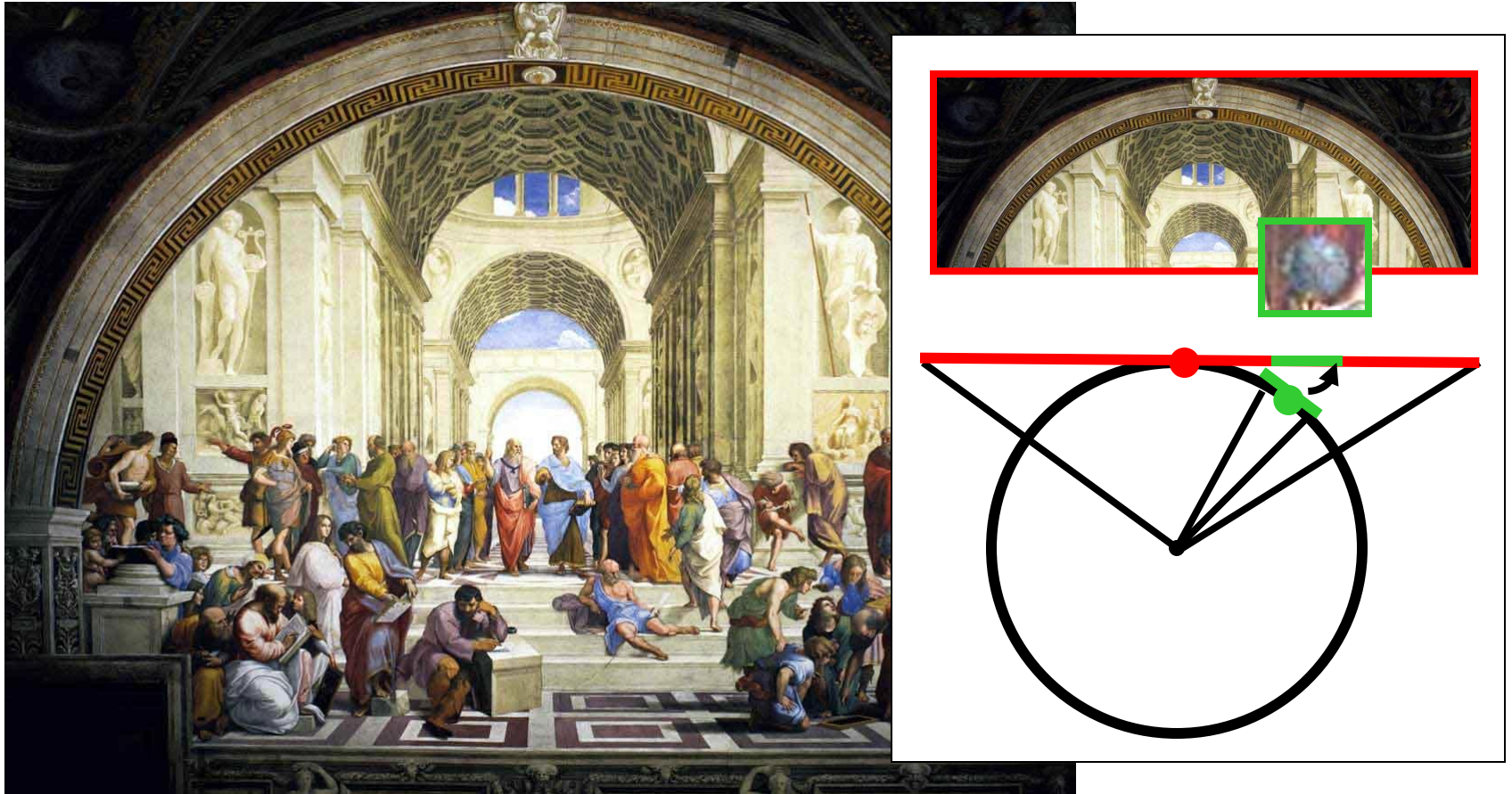
Two horizons!
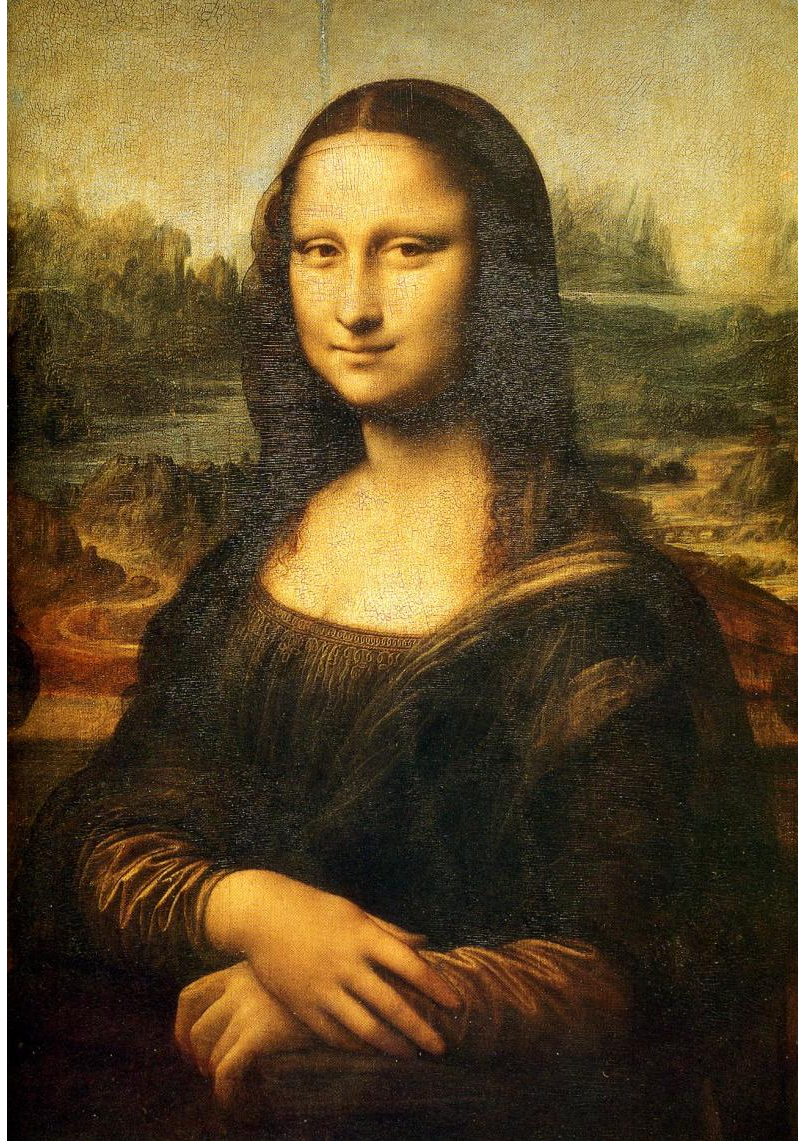
Renaissance painters solution

"School of Athens", Raffaello Sanzio ~1510

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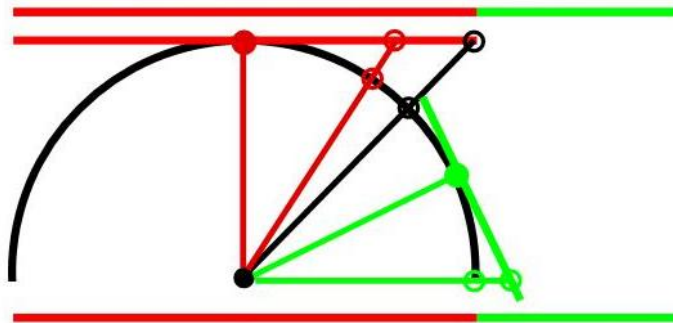
Personalized projections

"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

Our multi-view result

Single view

Our multi-view result

Single view

Our multi-view result

Applying personalized projections
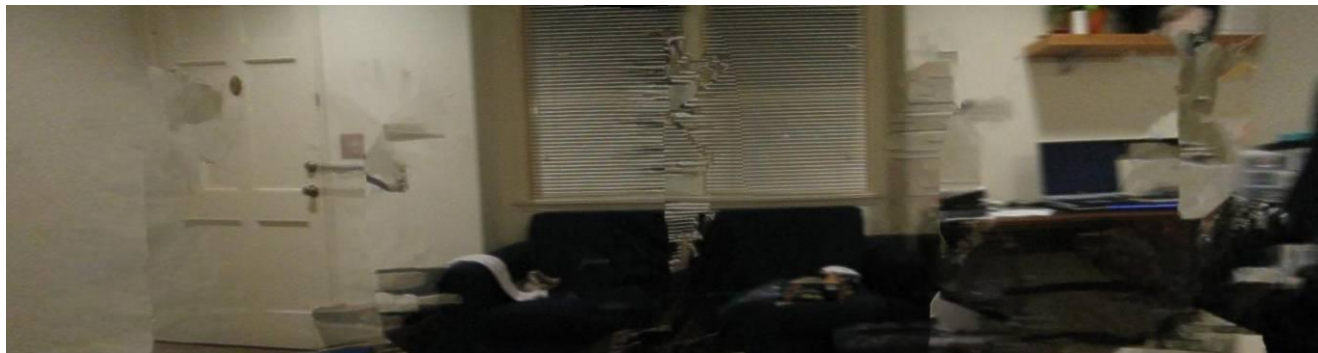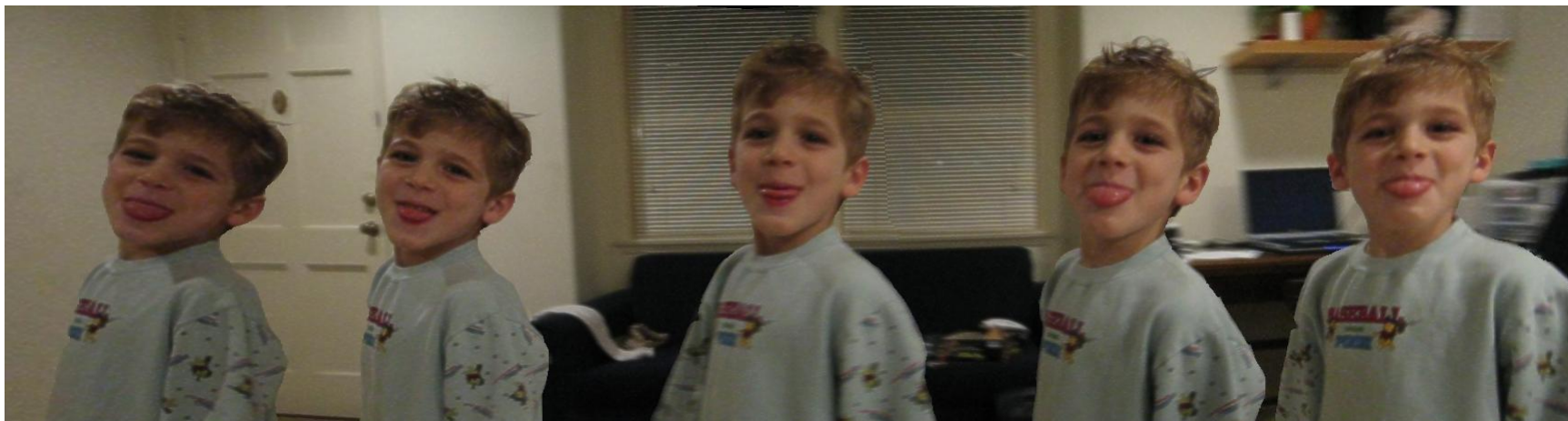
Input images

Foreground

Background panorama

Single view

Our multi-view result
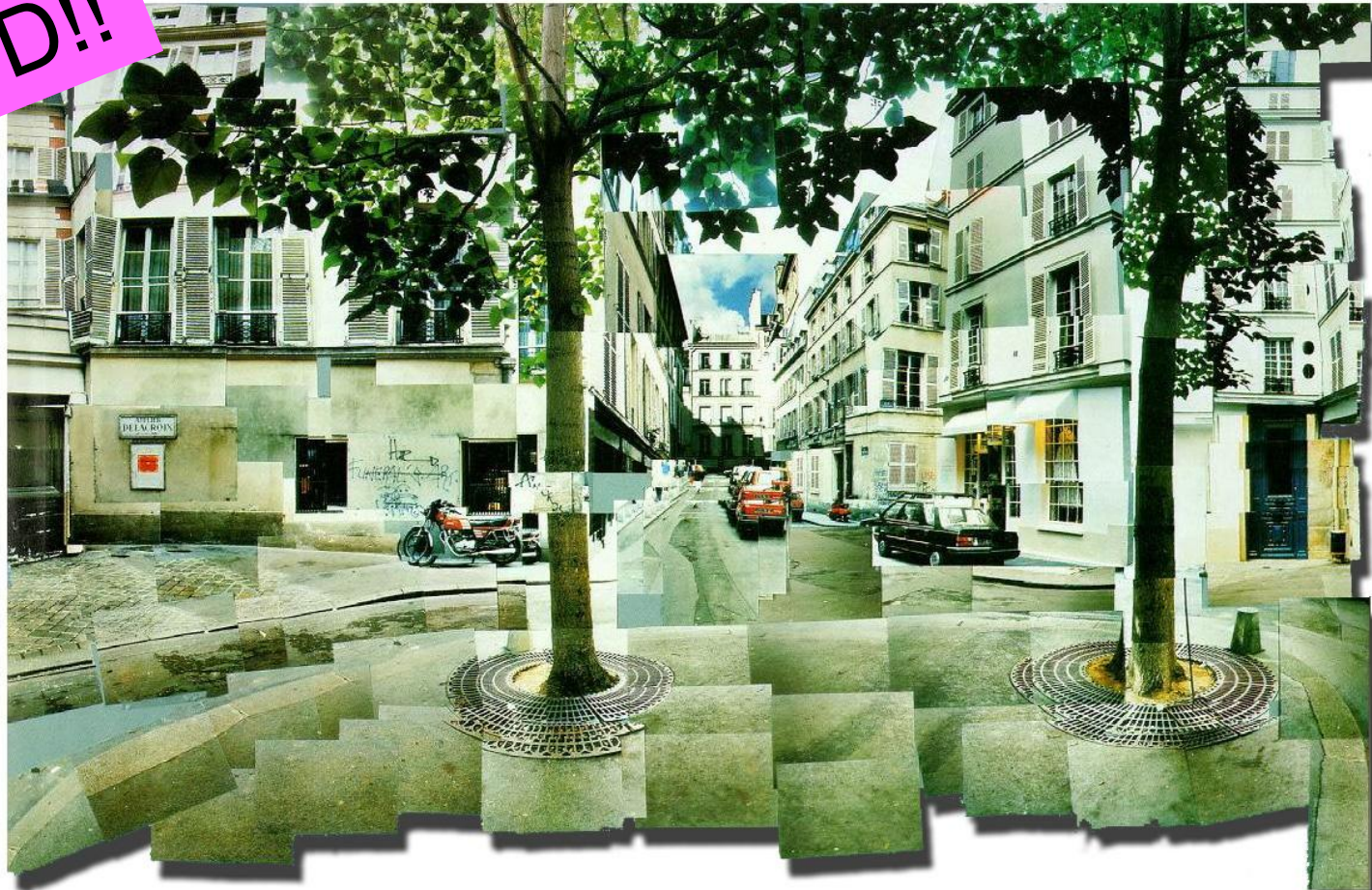
Single view

Our 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

Single viewpoint

David Hockney,
Place Furstenberg, 1985

Melissa Slomin,
Place Furstenberg, 2003

Multi-view panoramas

Single view

Multiview

Zomet et al. (PAMI'03)

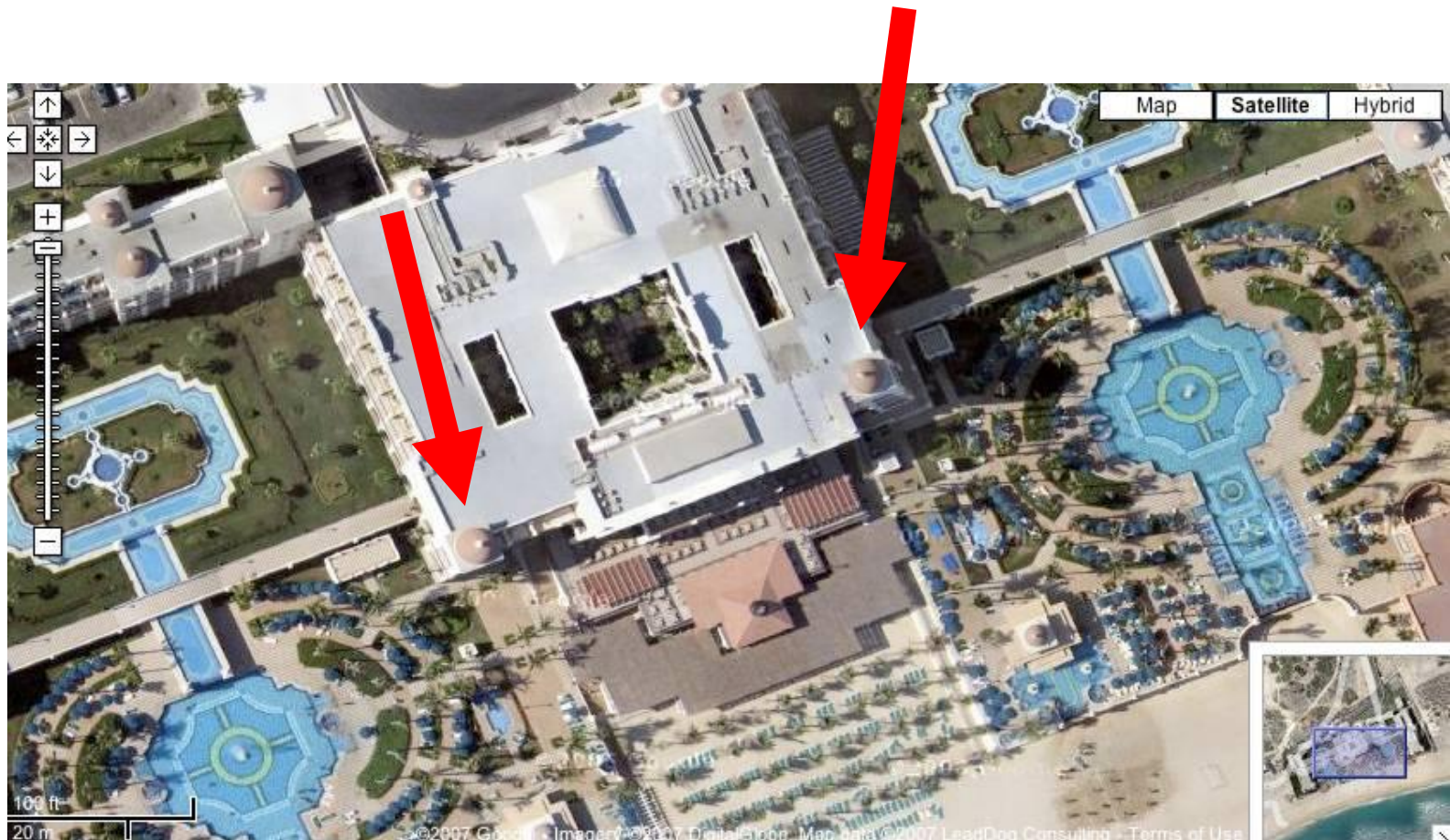Requires video input

Long Imaging

Agarwala et al. (SIGGRAPH 2006)

Smooth Multi-View

Google maps

What's wrong in the picture?
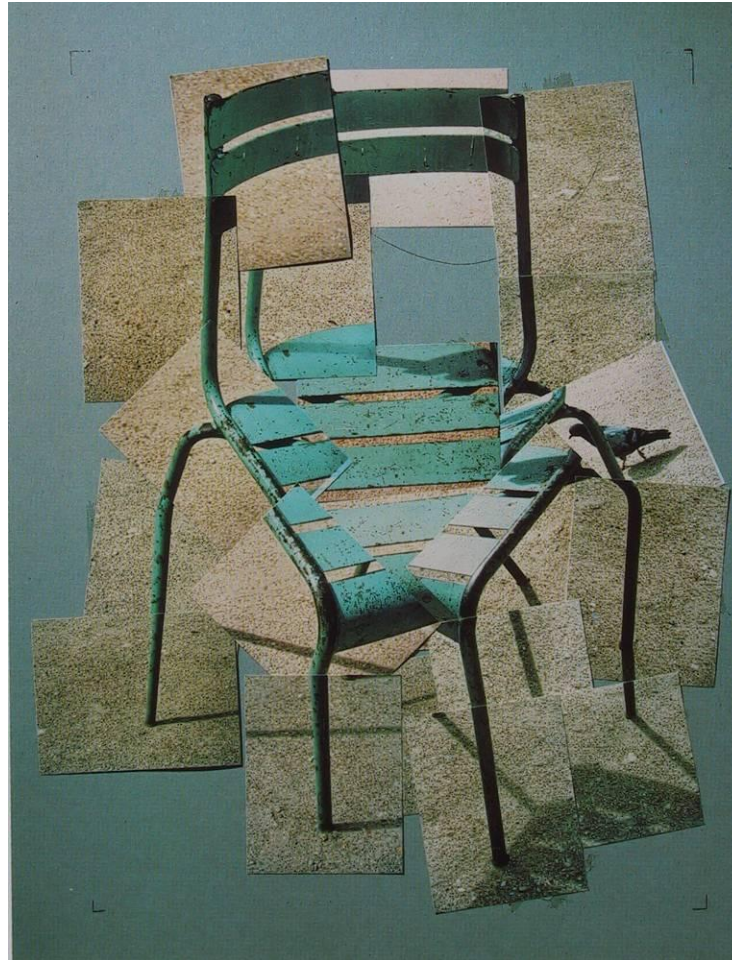

Google maps

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:

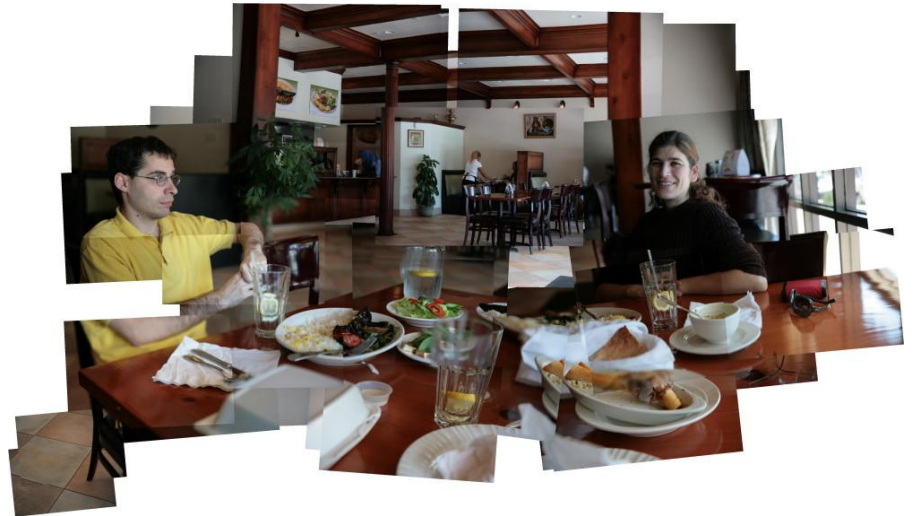## Automate joiners

Generalize panoramas to general image collections

Objectives

- For Artists:
  Reduce manual labor
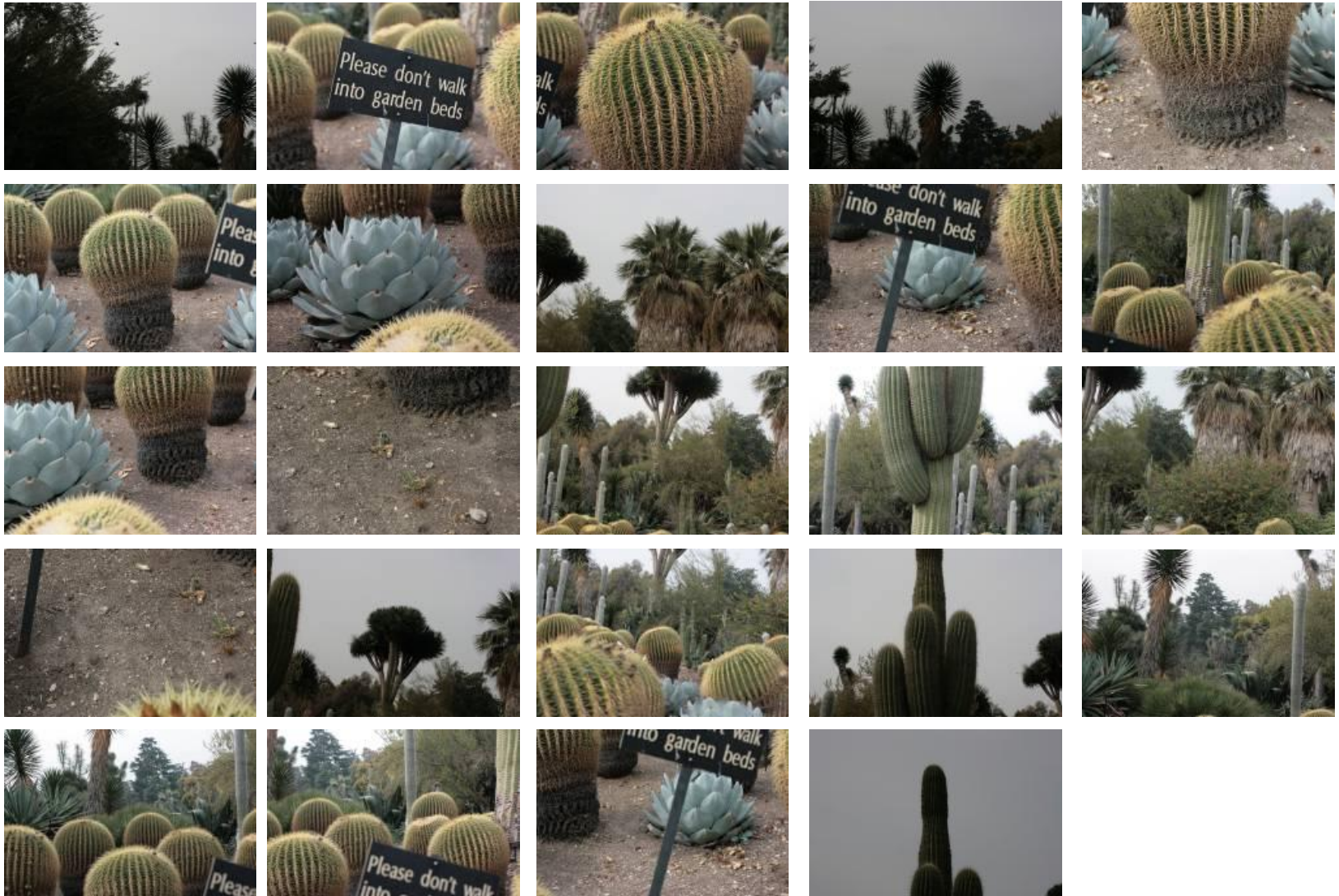

Manual: ~40min.

Fully automatic

Objectives

- For Artists:
  Reduce manual labor

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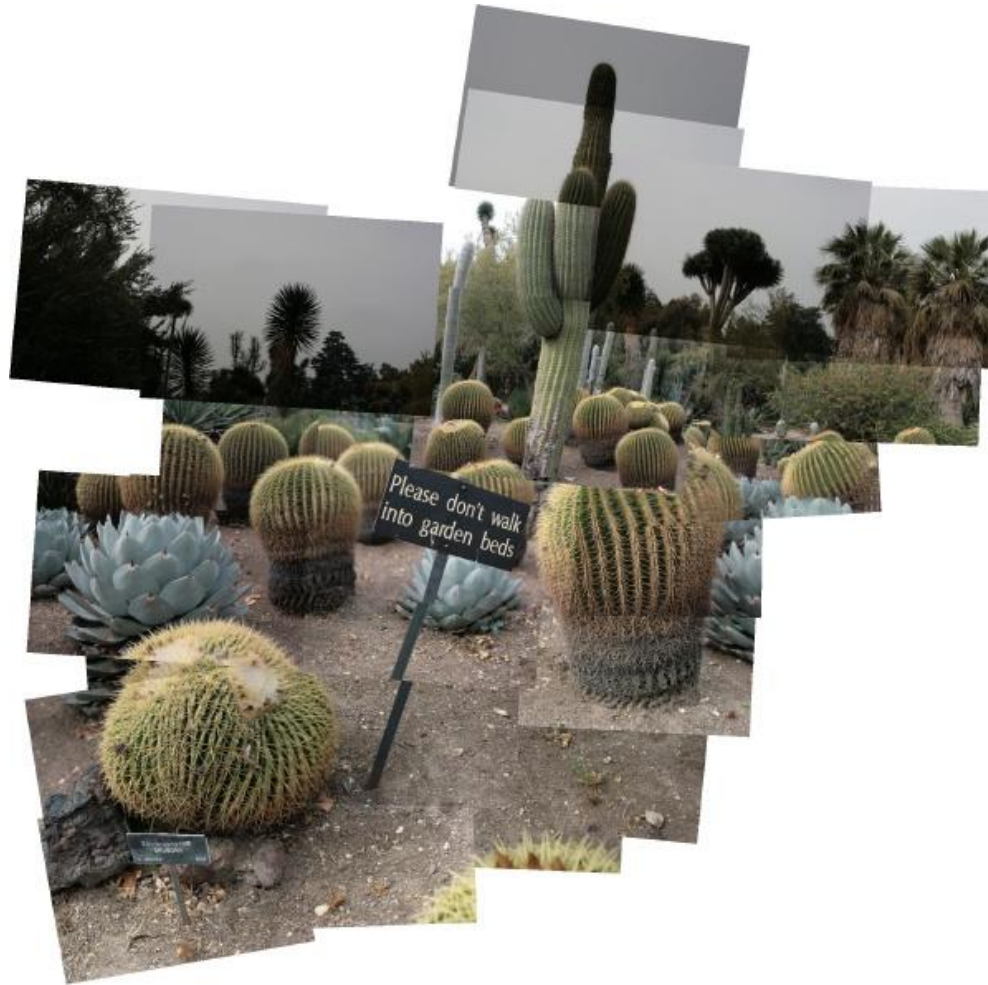 Generate pleasing-to-the-eye joiners

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
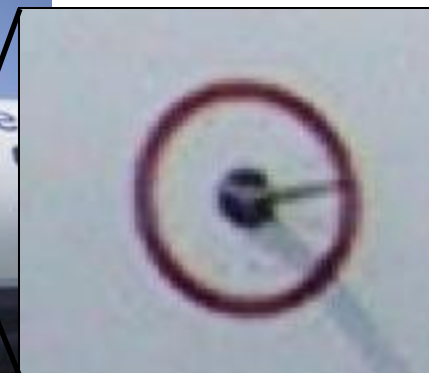

Bad

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

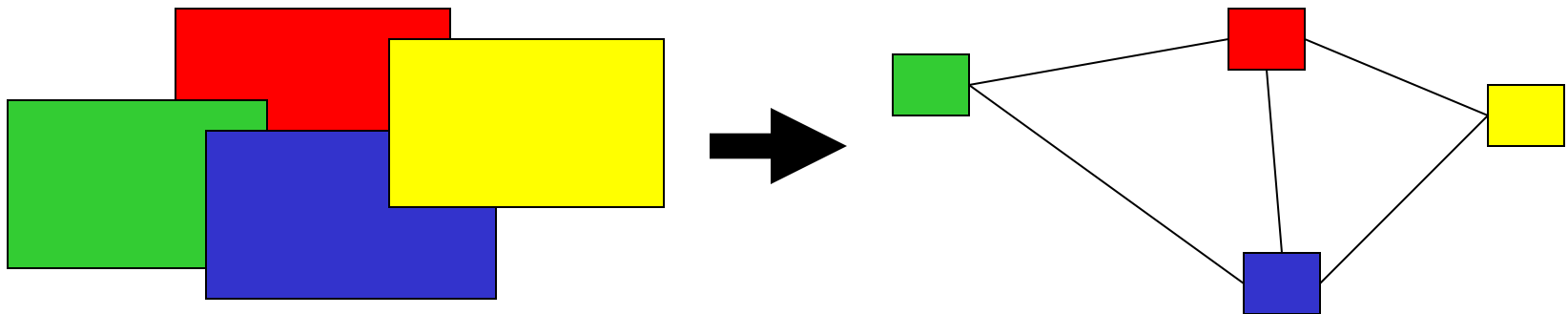Try all orders: only for small datasets

Ordering images

Try all orders: only for small datasets

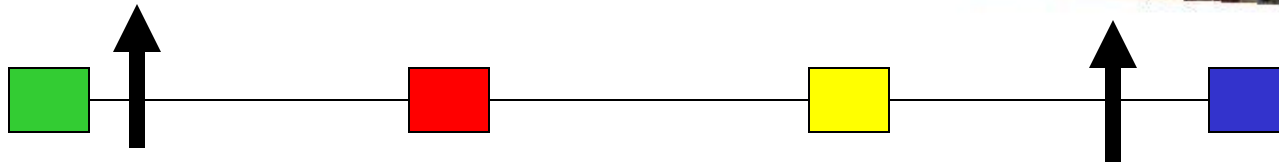complexity: (m+n)α
   m = # images
   n = # overlaps
   α = # acyclic orders
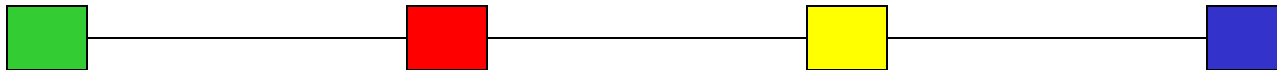
Ordering images

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
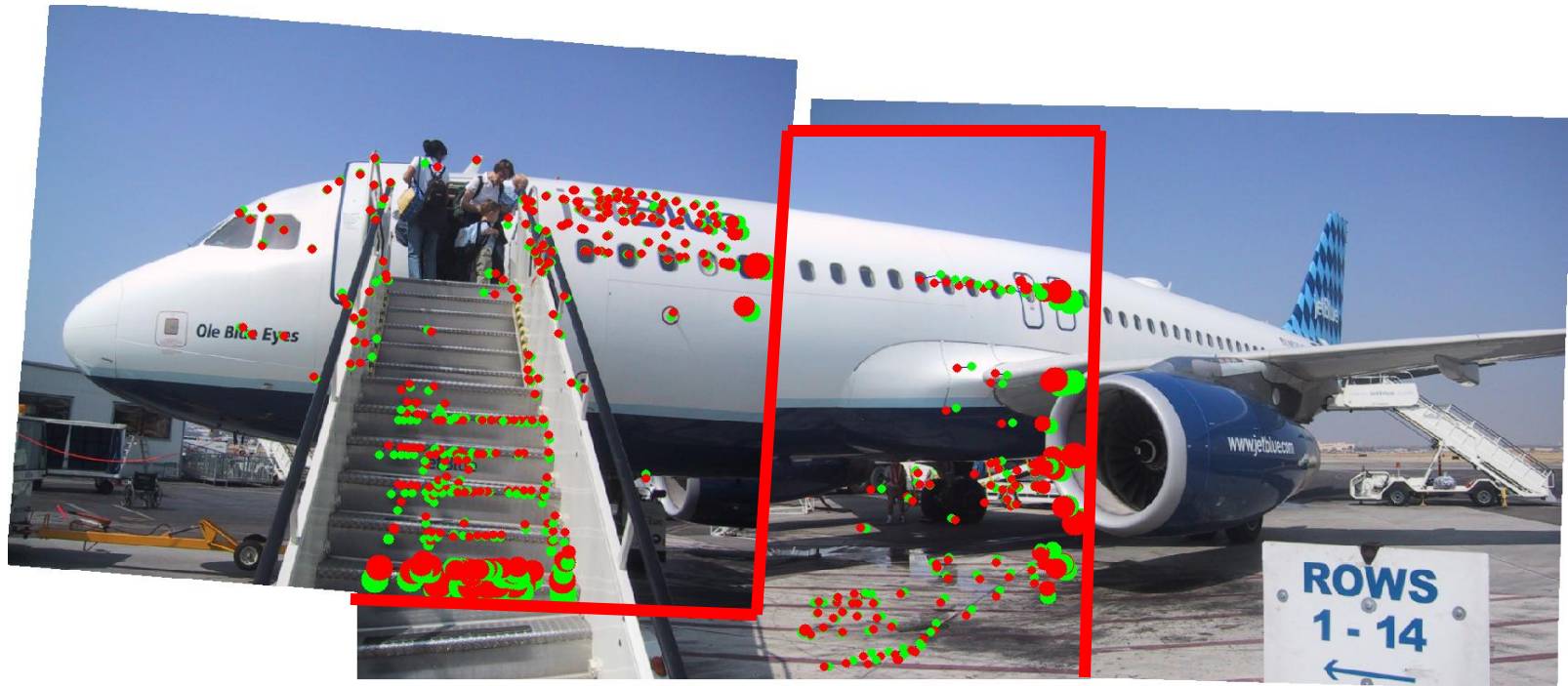
    – Iterate over all images

Can we do better?

Step 4: Improve alignment

Iterate Align-Order-Importance

Iterative refinement

Initial

Final

Iterative refinement
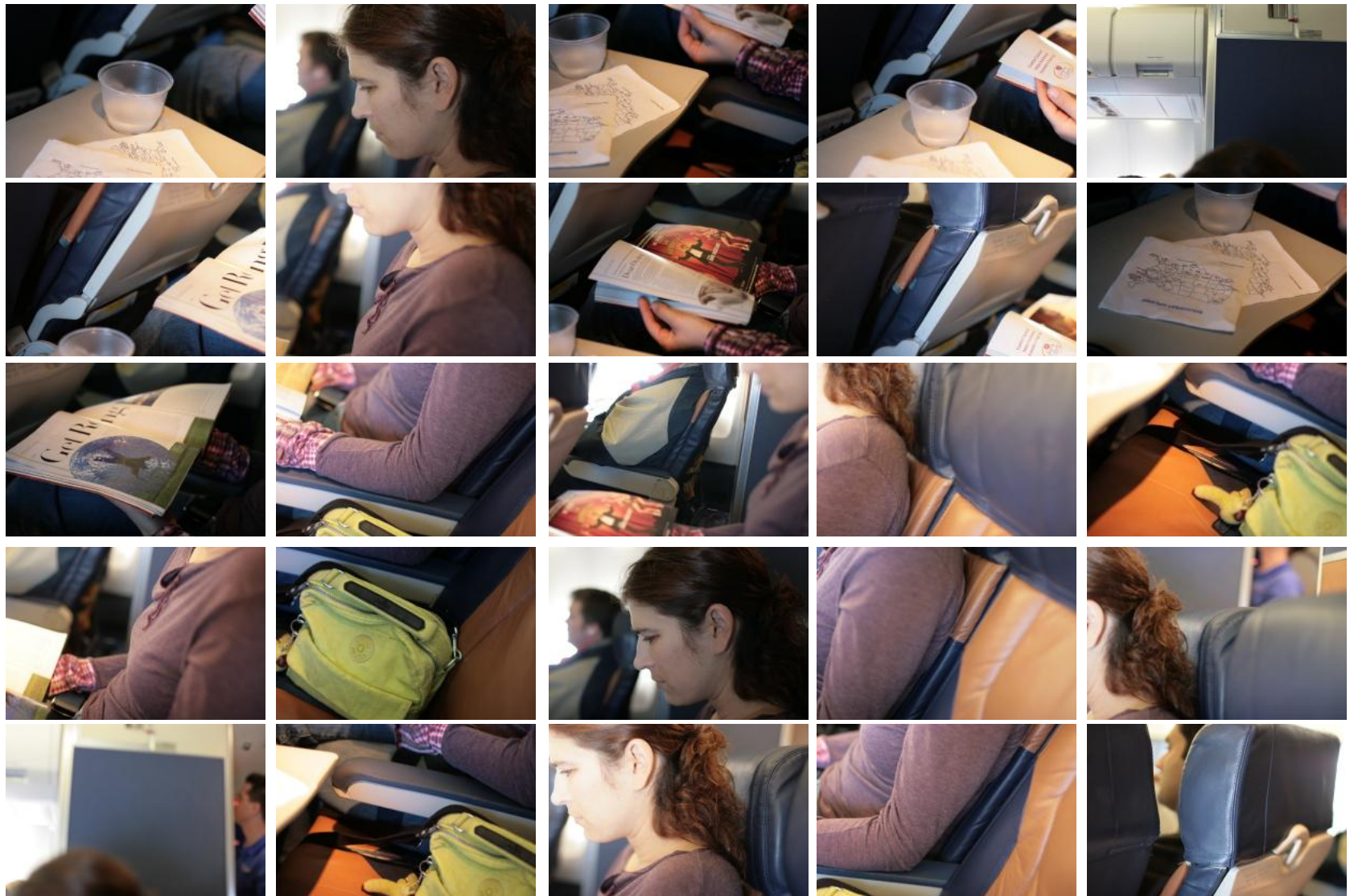
Initial

Final

Iterative refinement

Initial

Final

What is this?

That's me reading

Anza-Borrego

Tractor

Art reproduction

Paolo Uccello, 1436

Art reproduction

Paolo Uccello, 1436

Zelnik & Perona, 2006

Art reproduction

Single view-point   Zelnik & Perona, 2006
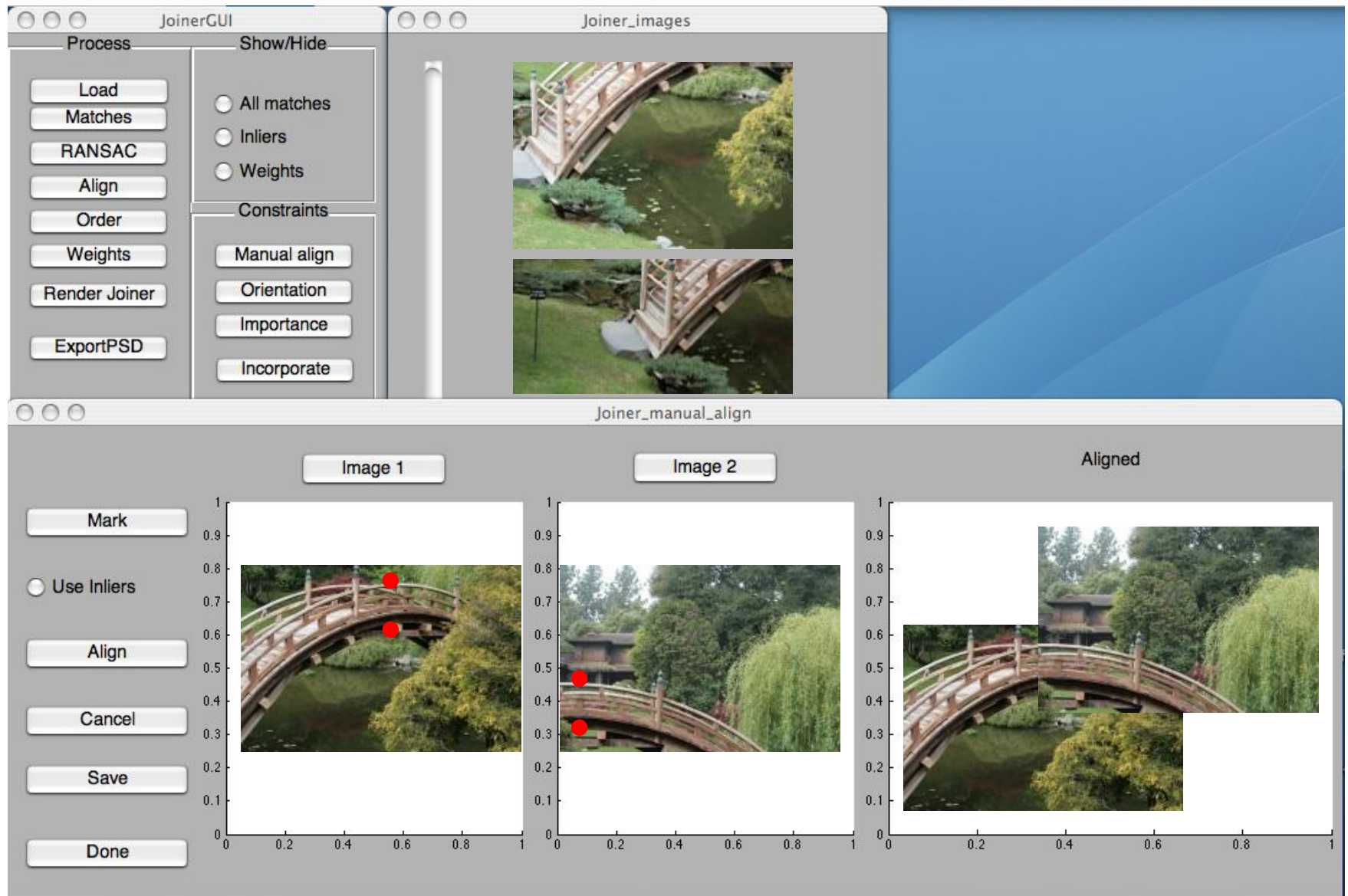
Manual by Photographer

Our automatic result

Failure?

GUI

The Impossible Bridge
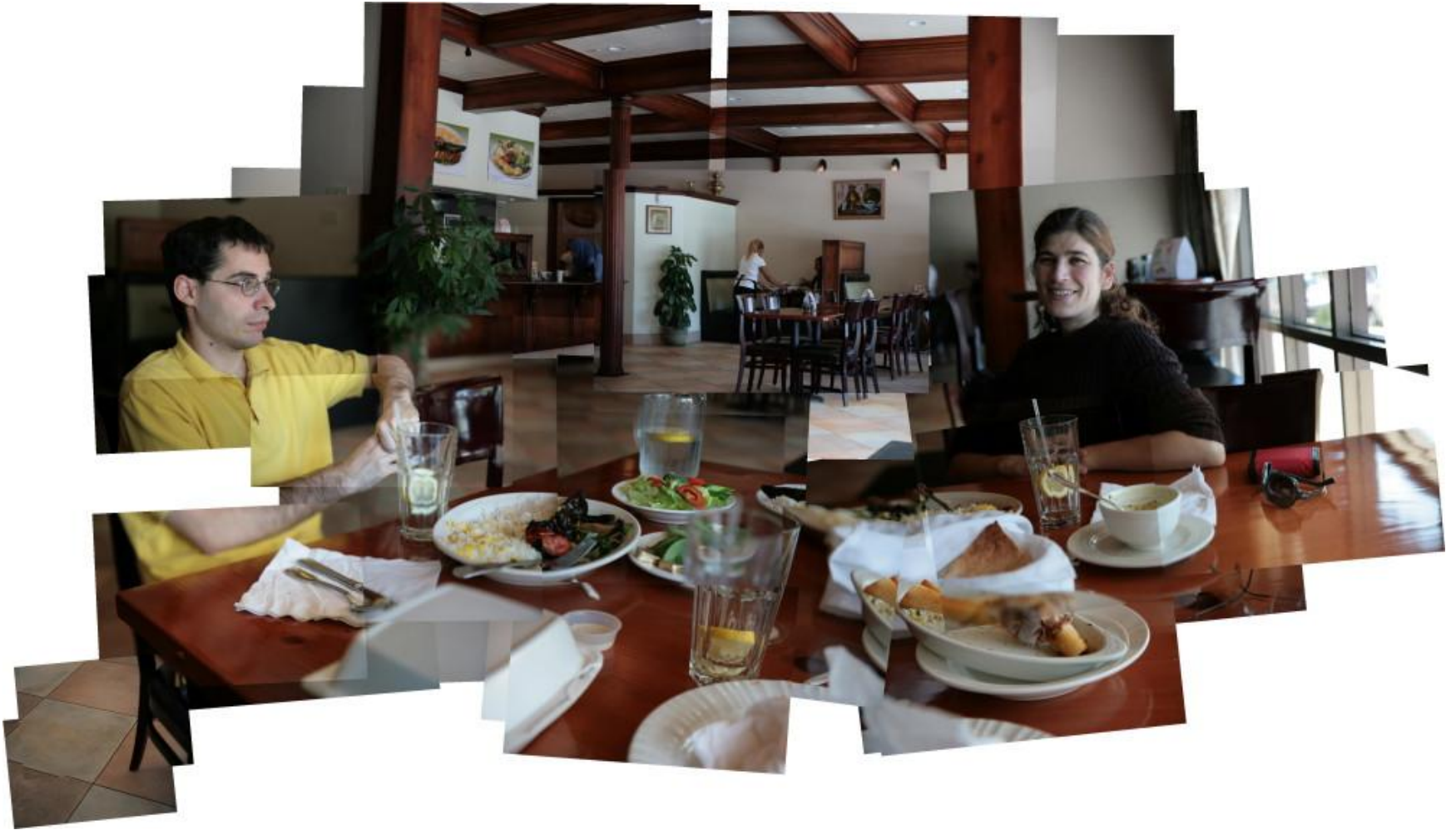
Homage to David Hockney

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.

Thank You

15-463 Class Project from 2007

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