

Multi-perspective Panoramas



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

Panoramas



Registration: Brown & Lowe, ICCV'05

Blending: Burt & Adelson, Trans. Graphics, 1983

Visualization: Kopf et al., SIGGRAPH, 2007

Bad panorama?



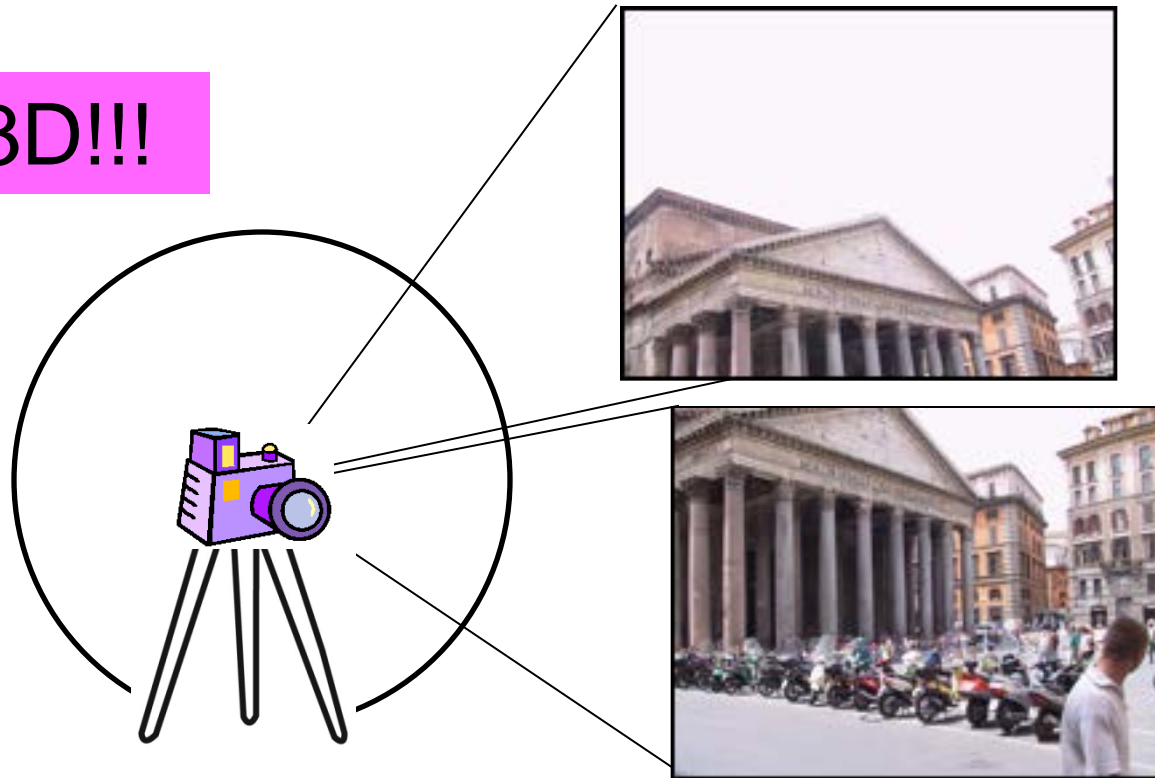
Output of Brown & Lowe software

No geometrically consistent solution



Scientists solution to panoramas: Single center of projection

No 3D!!!

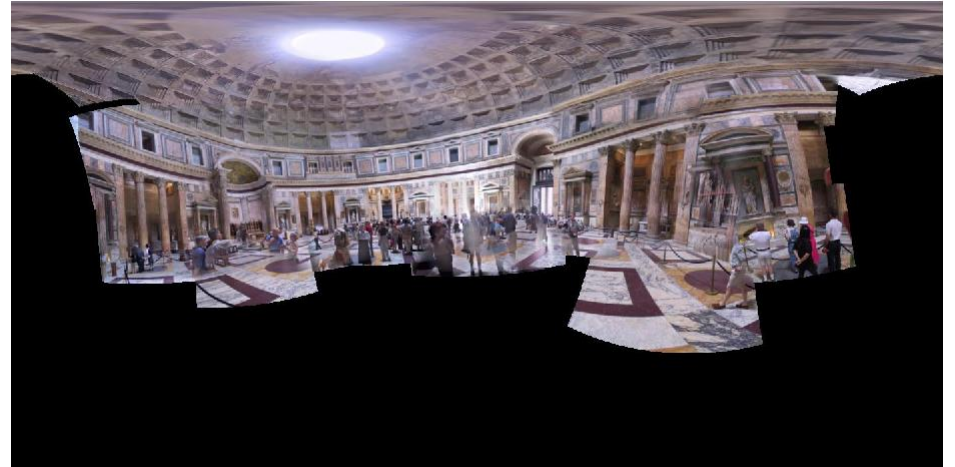
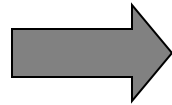


Registration: Brown & Lowe, ICCV'05

Blending: Burt & Adelson, Trans. Graphics, 1983

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From sphere to plane



Distortions are unavoidable

Distorted panoramas

Actual appearance



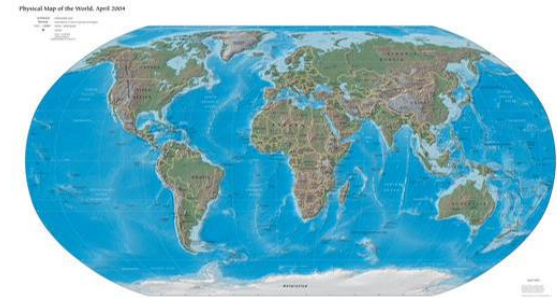
Output of Brown & Lowe software

Objectives

1. Better looking panoramas
2. Let the camera move:
 - Any view
 - Natural photographing

Stand on the shoulders of giants

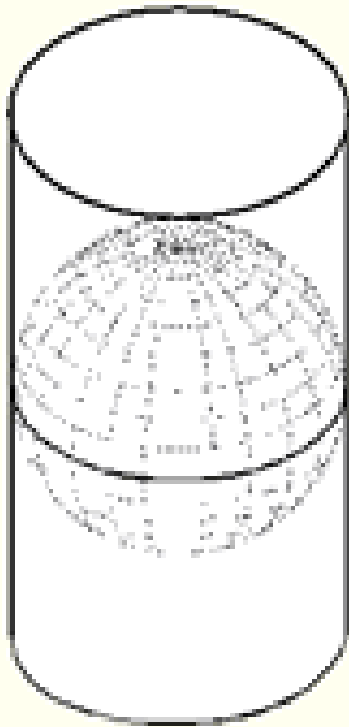
Cartographers



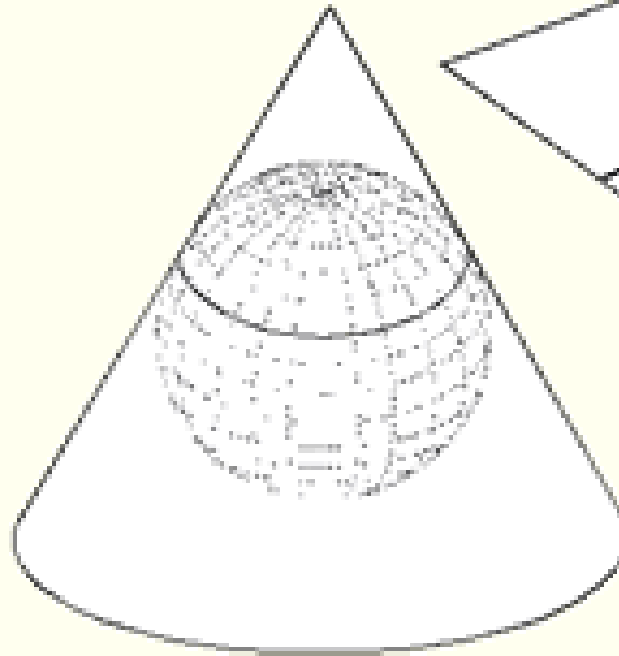
Artists



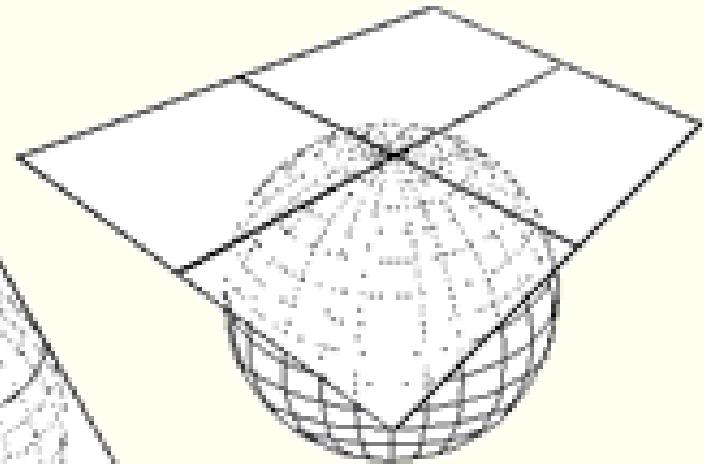
Cartographic projections



Cylindrical



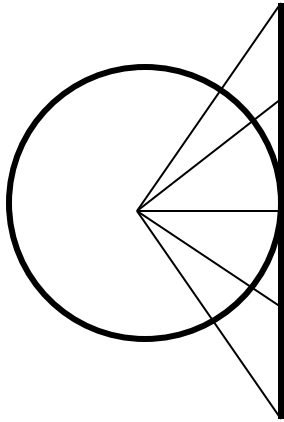
Conical



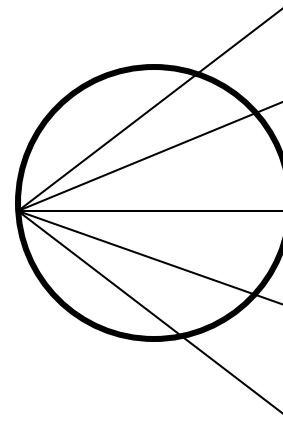
Azimuthal

Common panorama projections

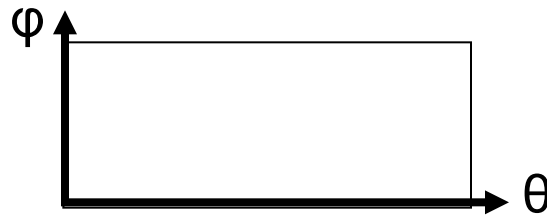
Perspective



Stereographic



Cylindrical



Global Projections

Perspective



Stereographic



Cylindrical

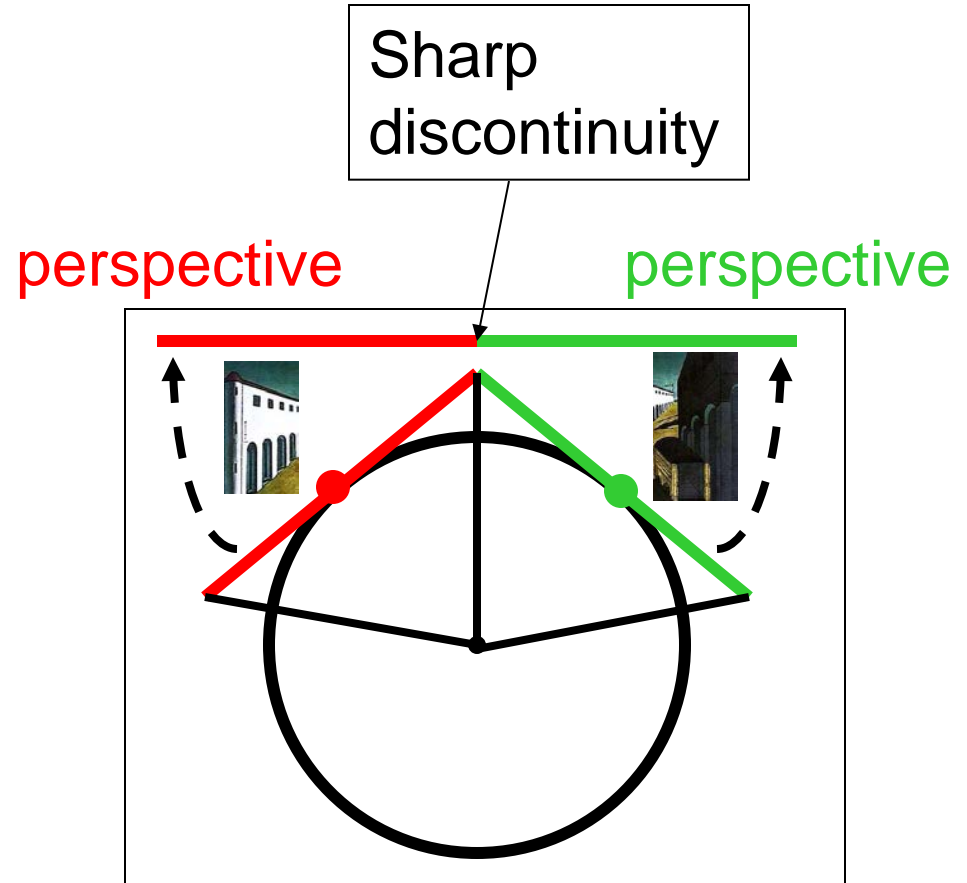


Learn from the artists

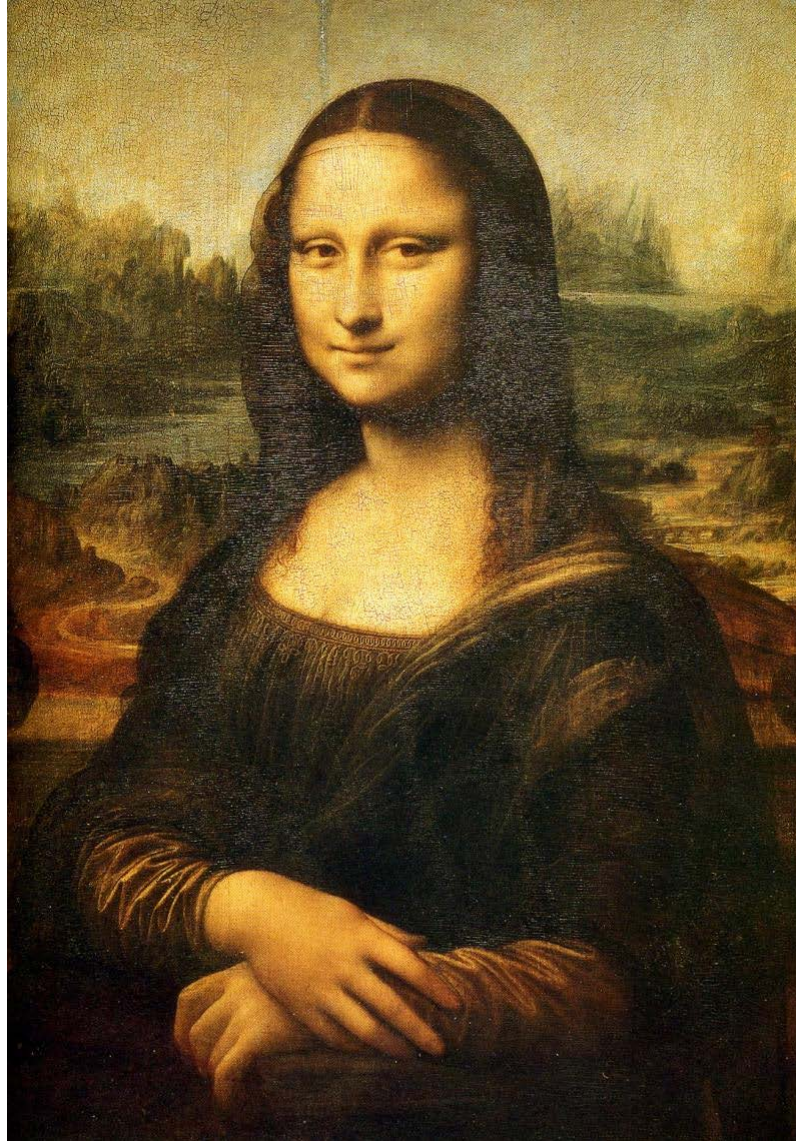
Multiple view points



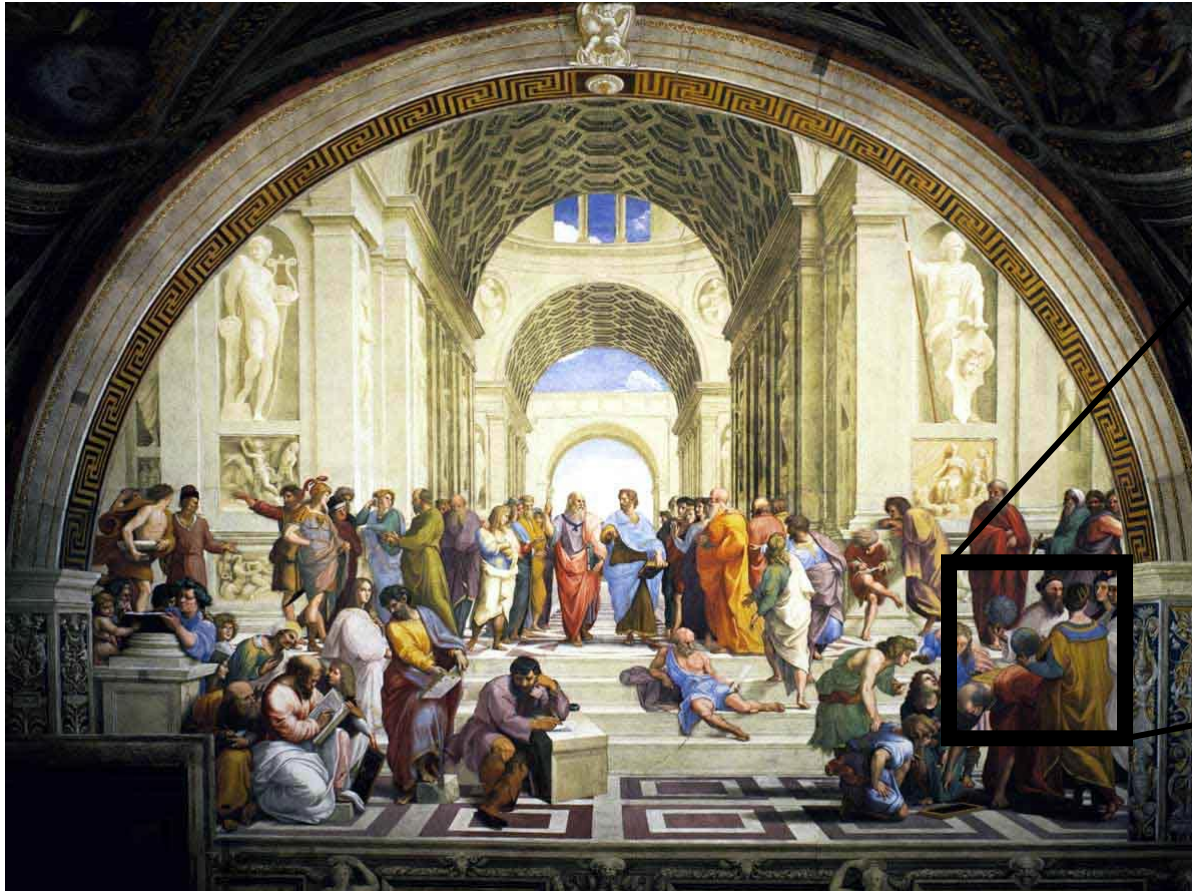
De Chirico "Mystery and Melancholy of a Street", 1914



Two horizons!



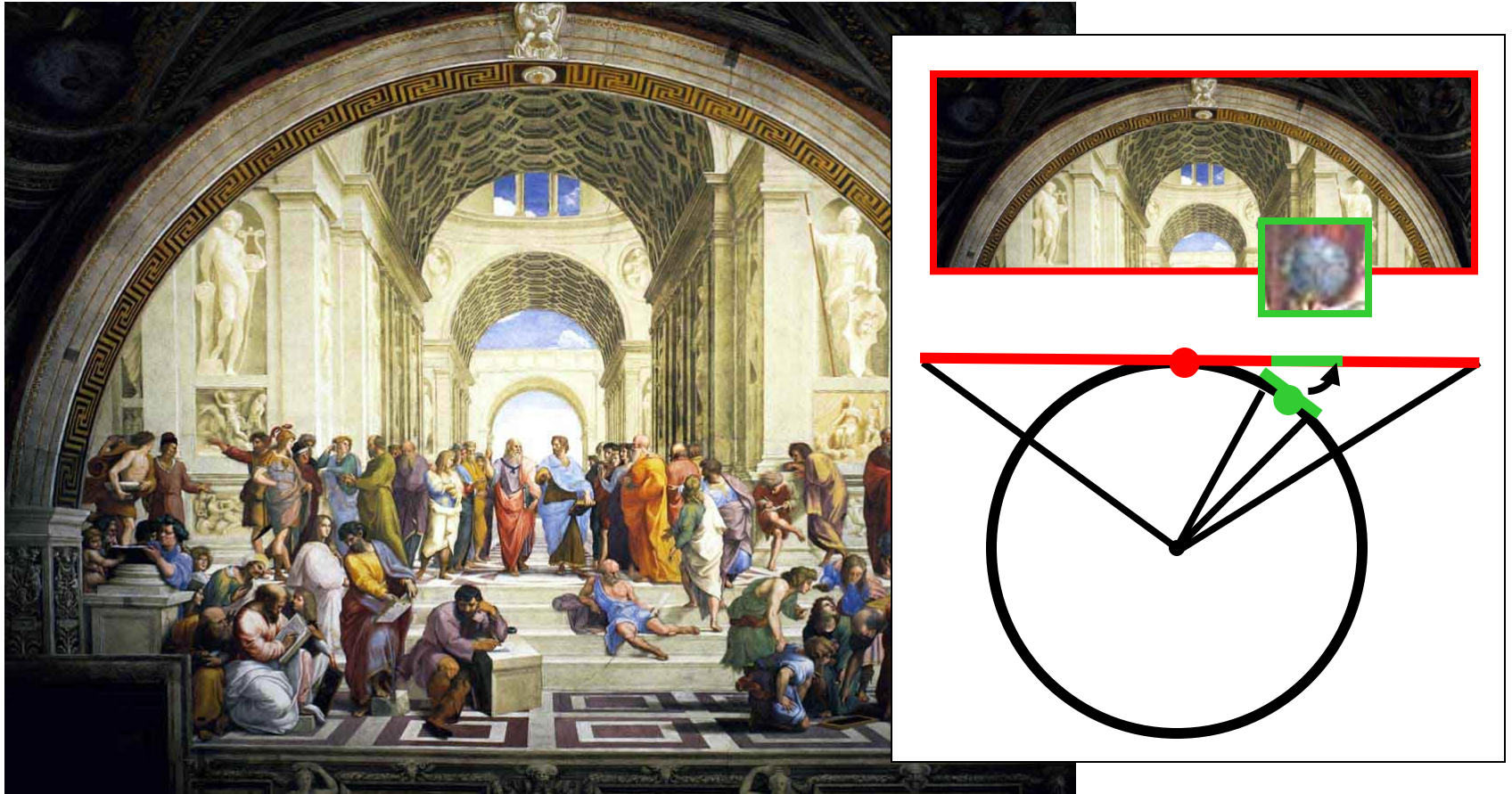
Renaissance painters solution



“School of Athens”, Raffaello Sanzio ~1510

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

Personalized projections

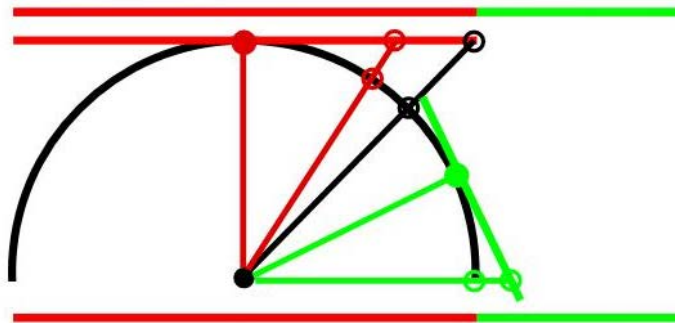


“School of Athens”, Raffaello Sanzio ~1510

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

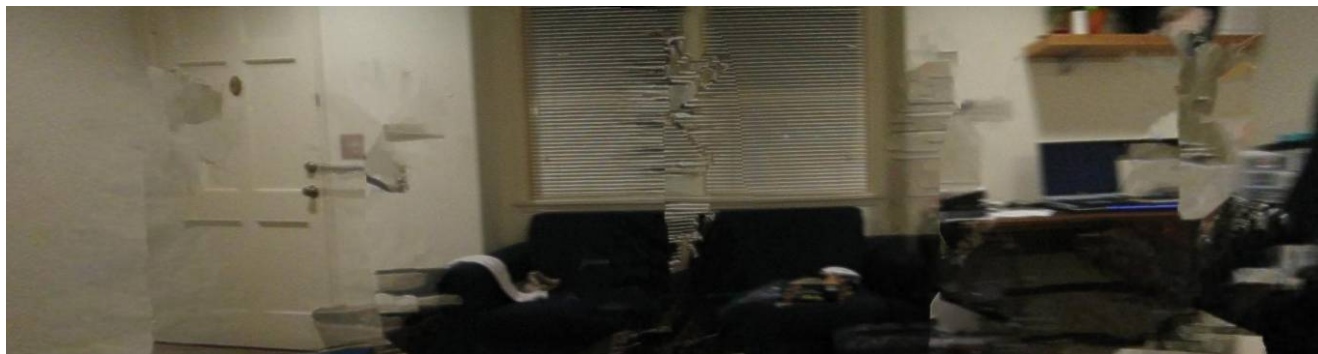
Input images



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



David Hockney,
Place Furstenberg, 1985

Single viewpoint



Melissa Slomin,
Place Furstenberg, 2003

Multi-view panoramas

Single view



Multiview



Zomet et al. (PAMI'03)

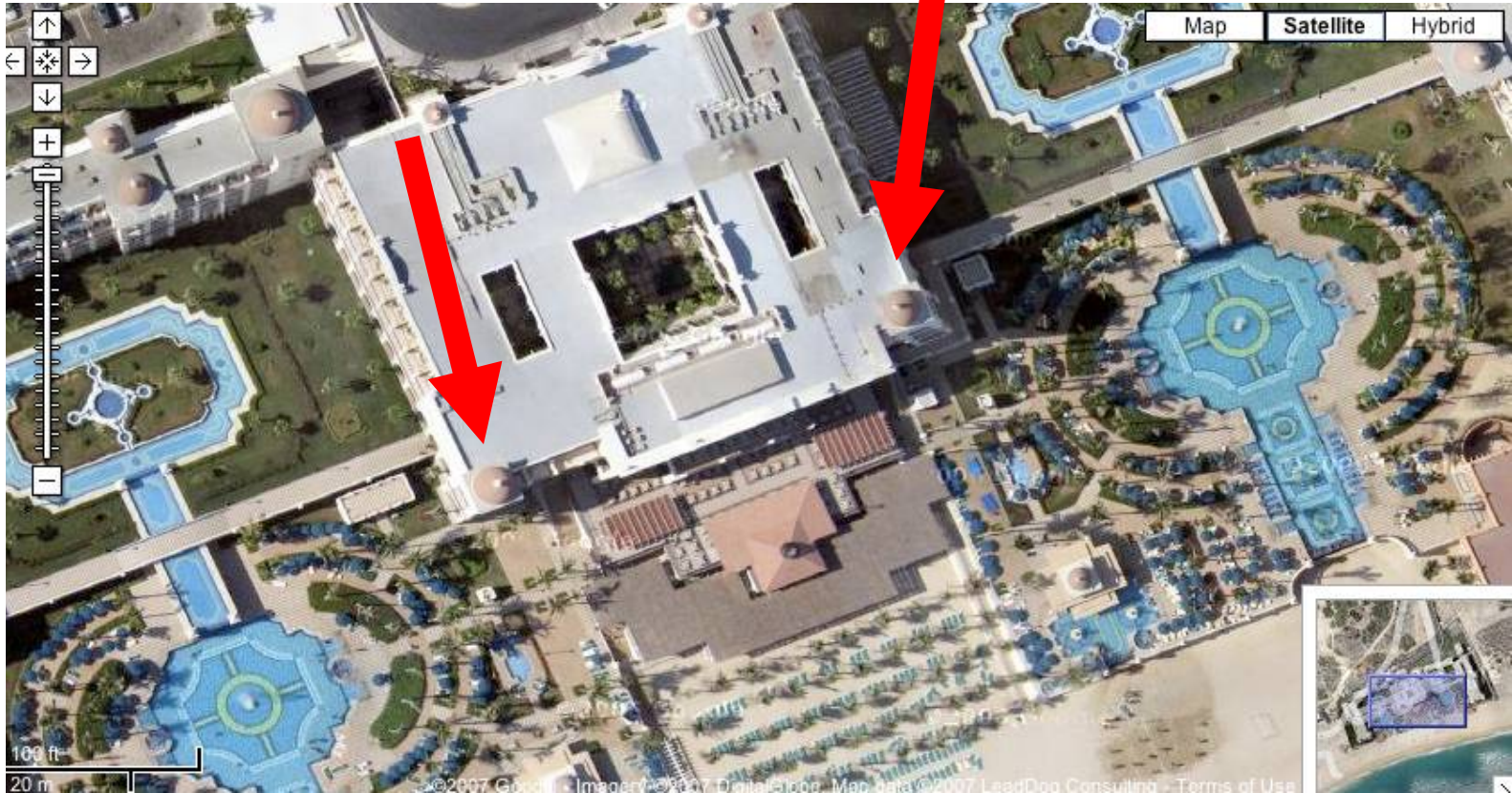
Requires video input

Long Imaging



Agarwala et al. (SIGGRAPH 2006)

Smooth Multi-View



Google maps

What's wrong in the picture?



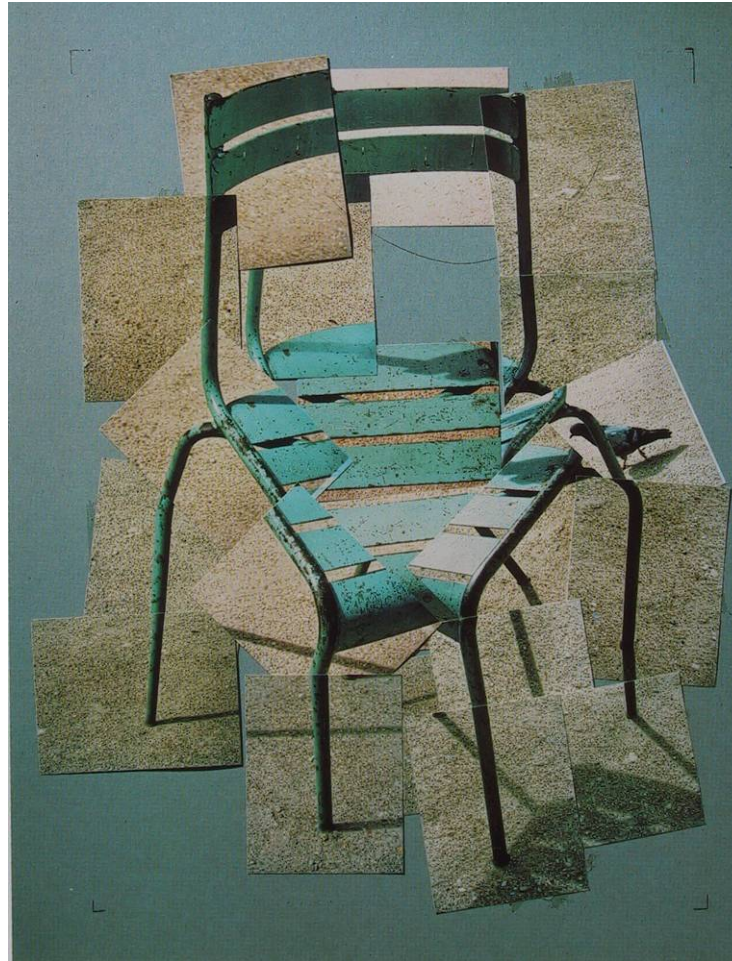
Google maps

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

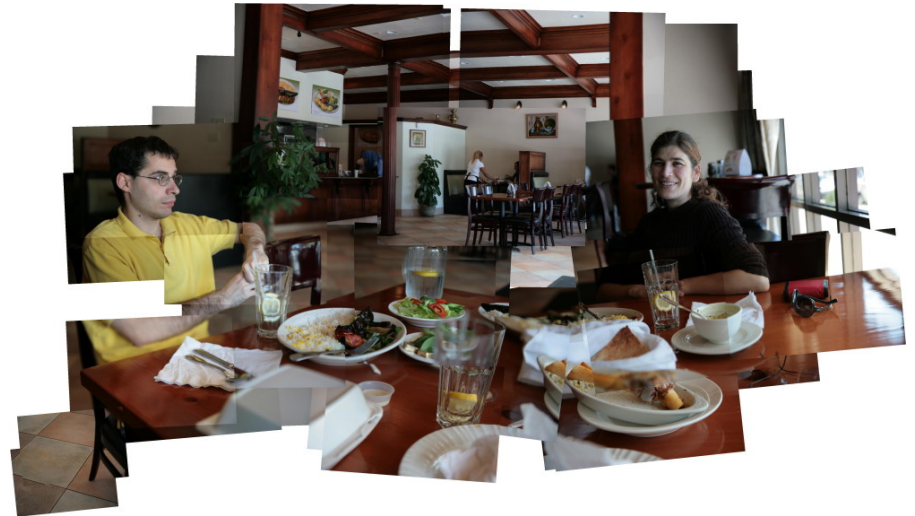
Generalize panoramas to general
image collections

Objectives

- For Artists:
Reduce manual labor



Manual: ~40min.



Fully automatic

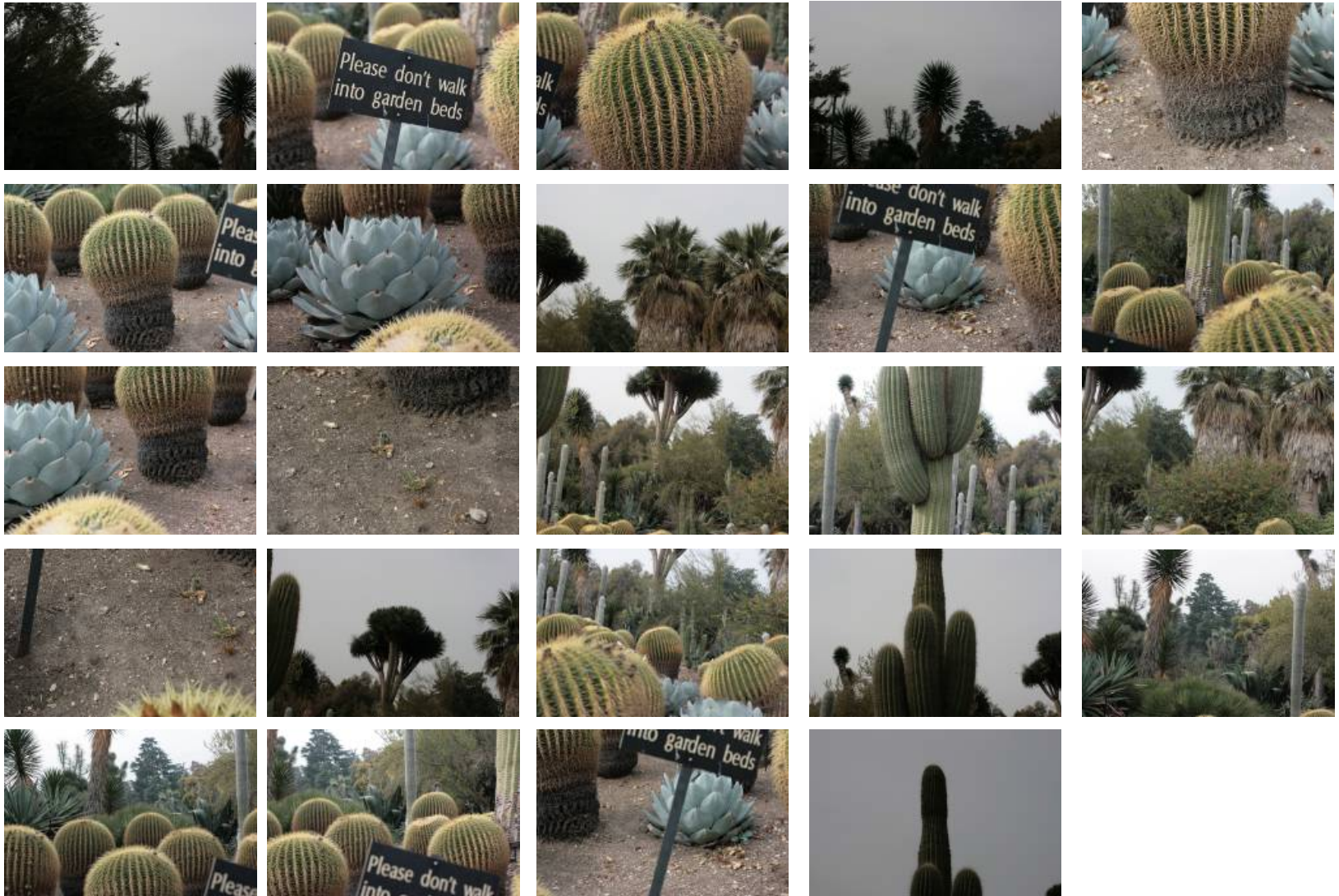
Objectives

- For Artists:
Reduce manual labor
- For non-artists:
Generate pleasing-to-the-eye joiners

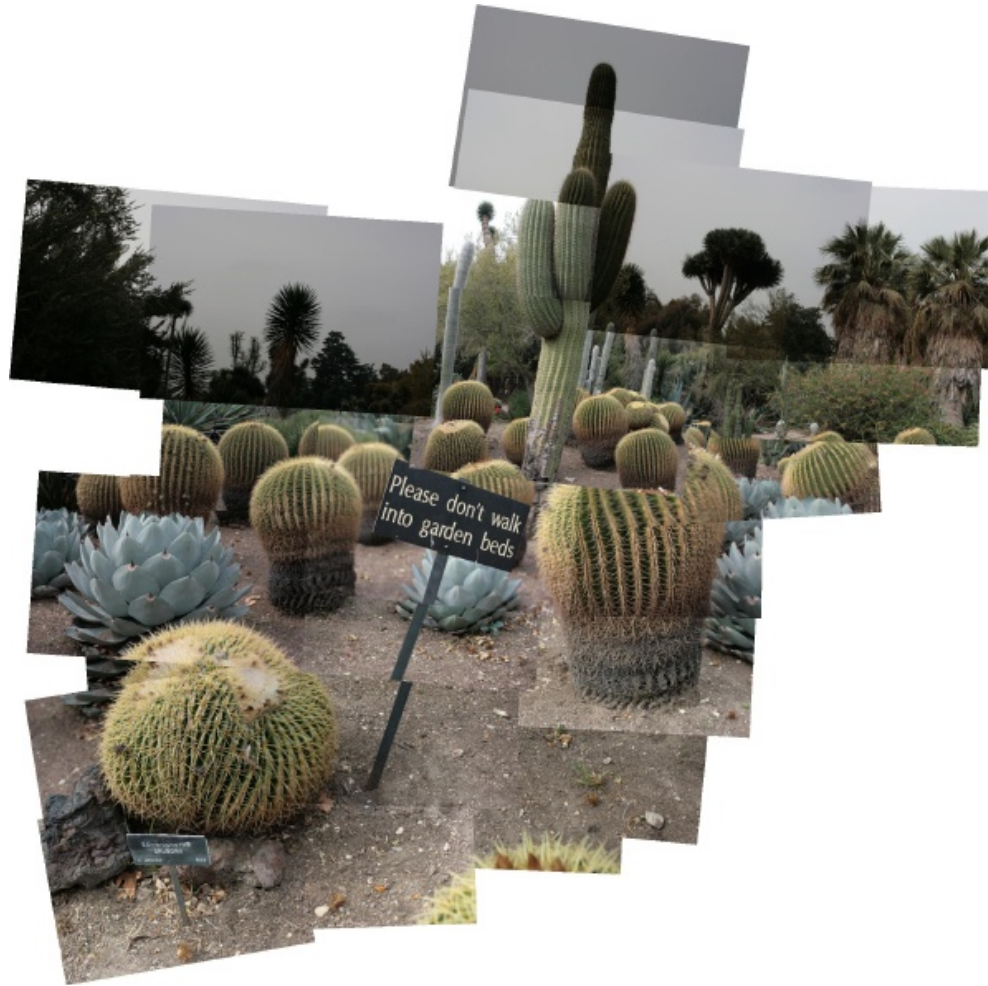
Objectives

- 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



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



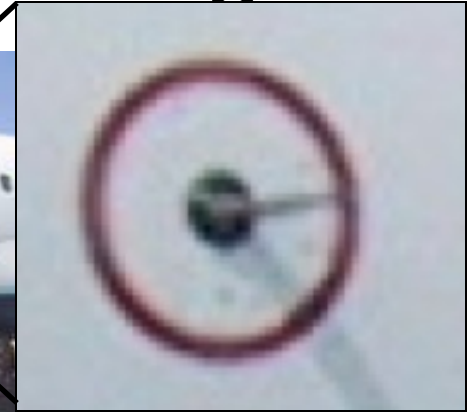
Bad



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

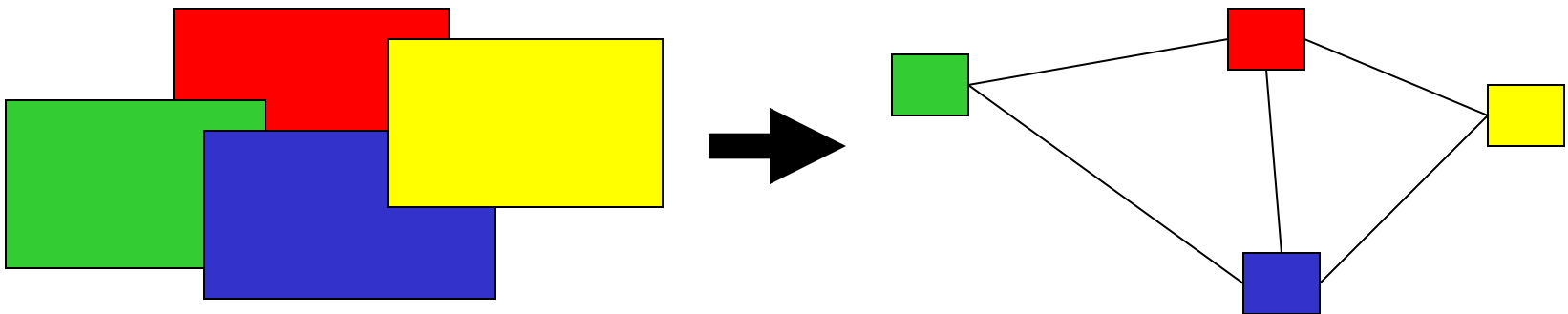
Try all orders: only for small datasets

complexity: $(m+n)\alpha$

$m = \#$ images

$n = \#$ overlaps

$\alpha = \#$ acyclic orders



Ordering images

Observations:

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



Ordering images

Approximate solution:

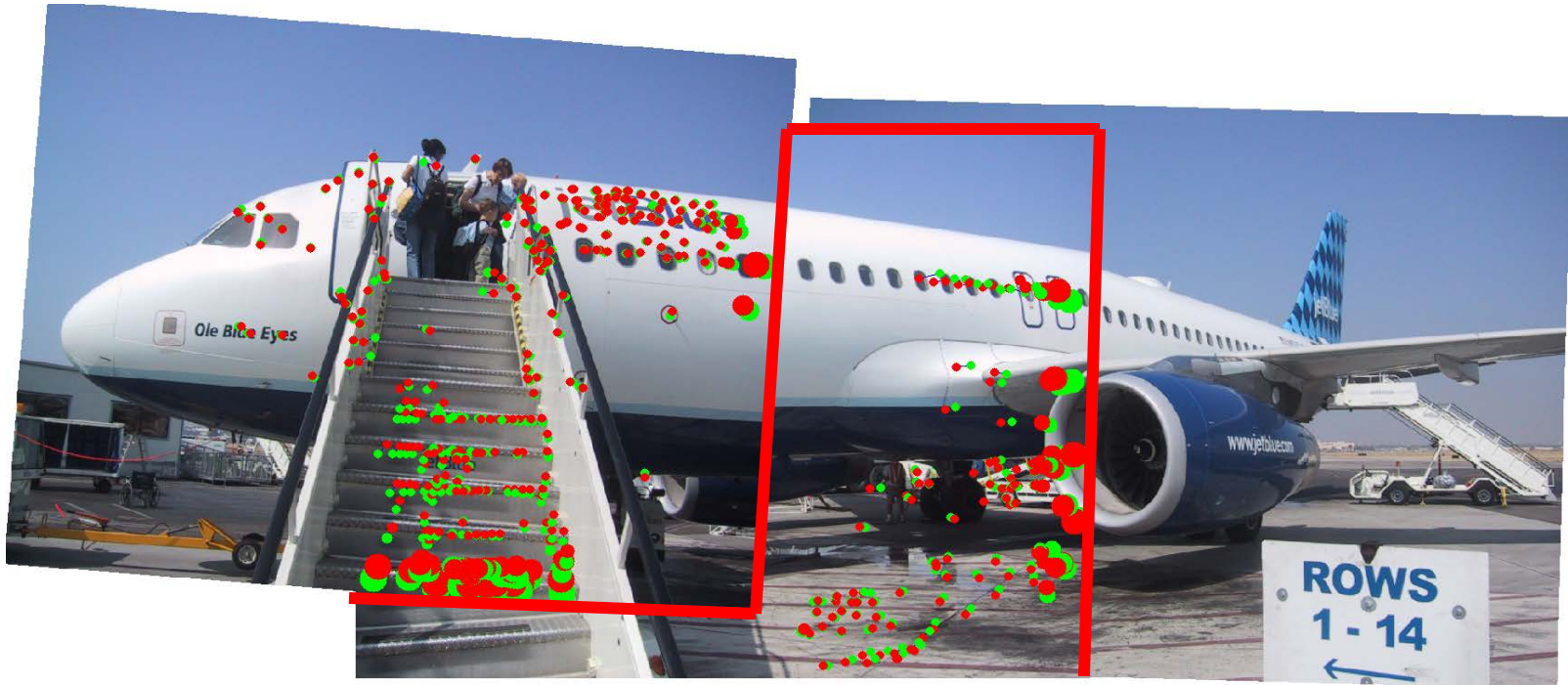
- Solve for each image independently
- Iterate over all images



Can we do better?



Step 4: Improve alignment



Iterate Align-Order-Importance



Iterative refinement

Initial



Final



Iterative refinement

Initial



Final



Iterative refinement

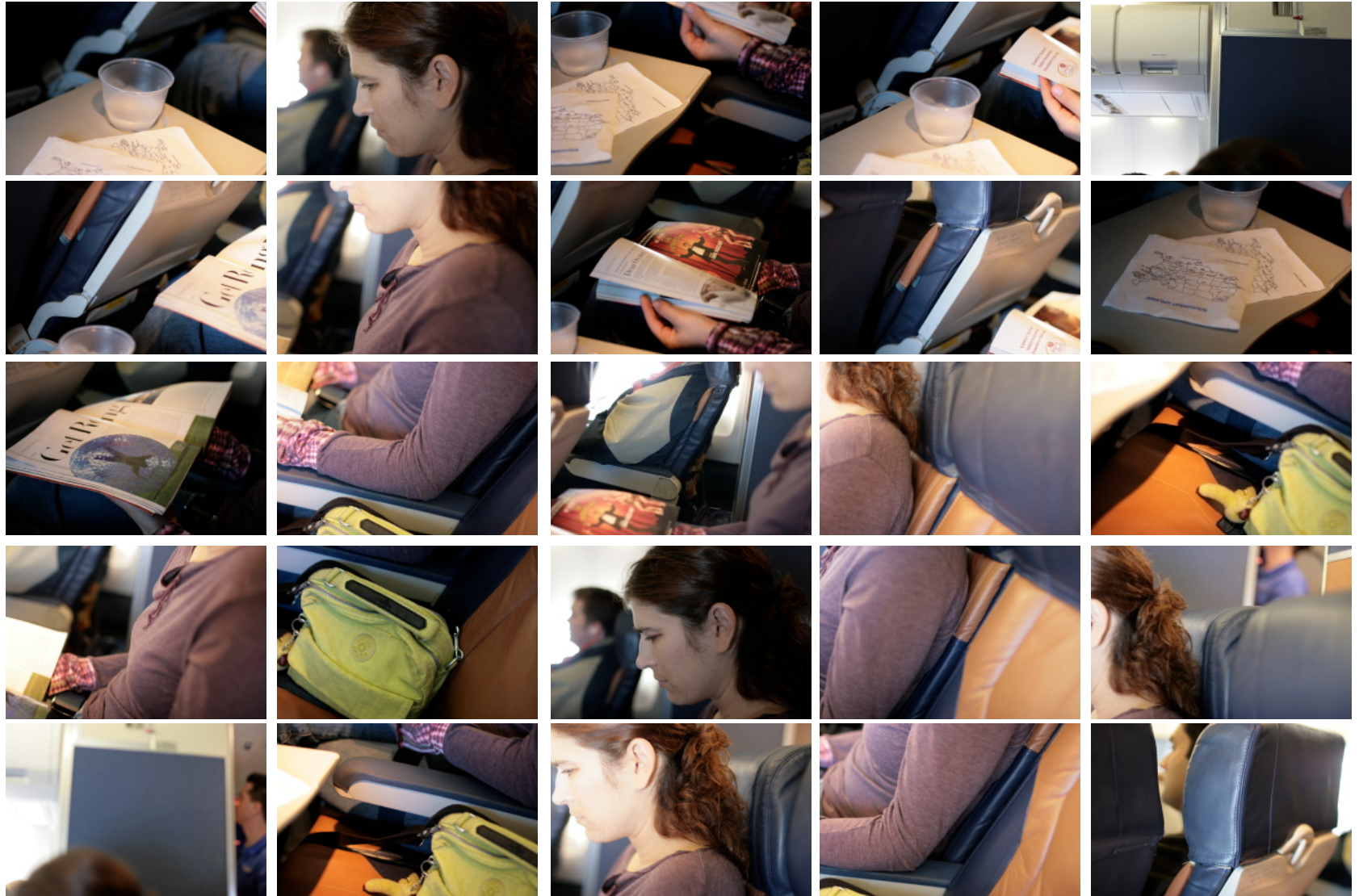
Initial



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



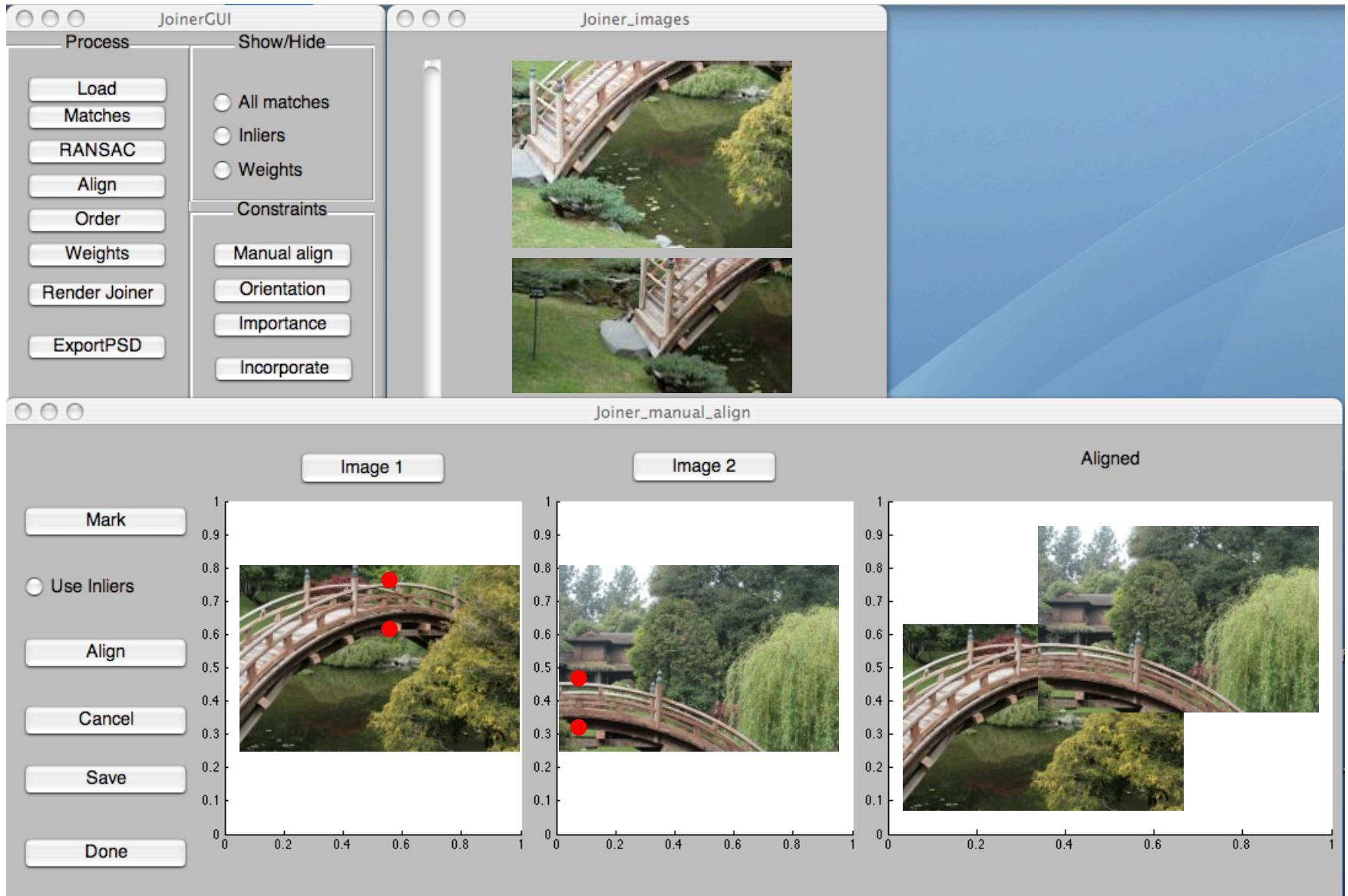
Our automatic result



Failure?



GUI



The Impossible Bridge



Homage to David Hockney

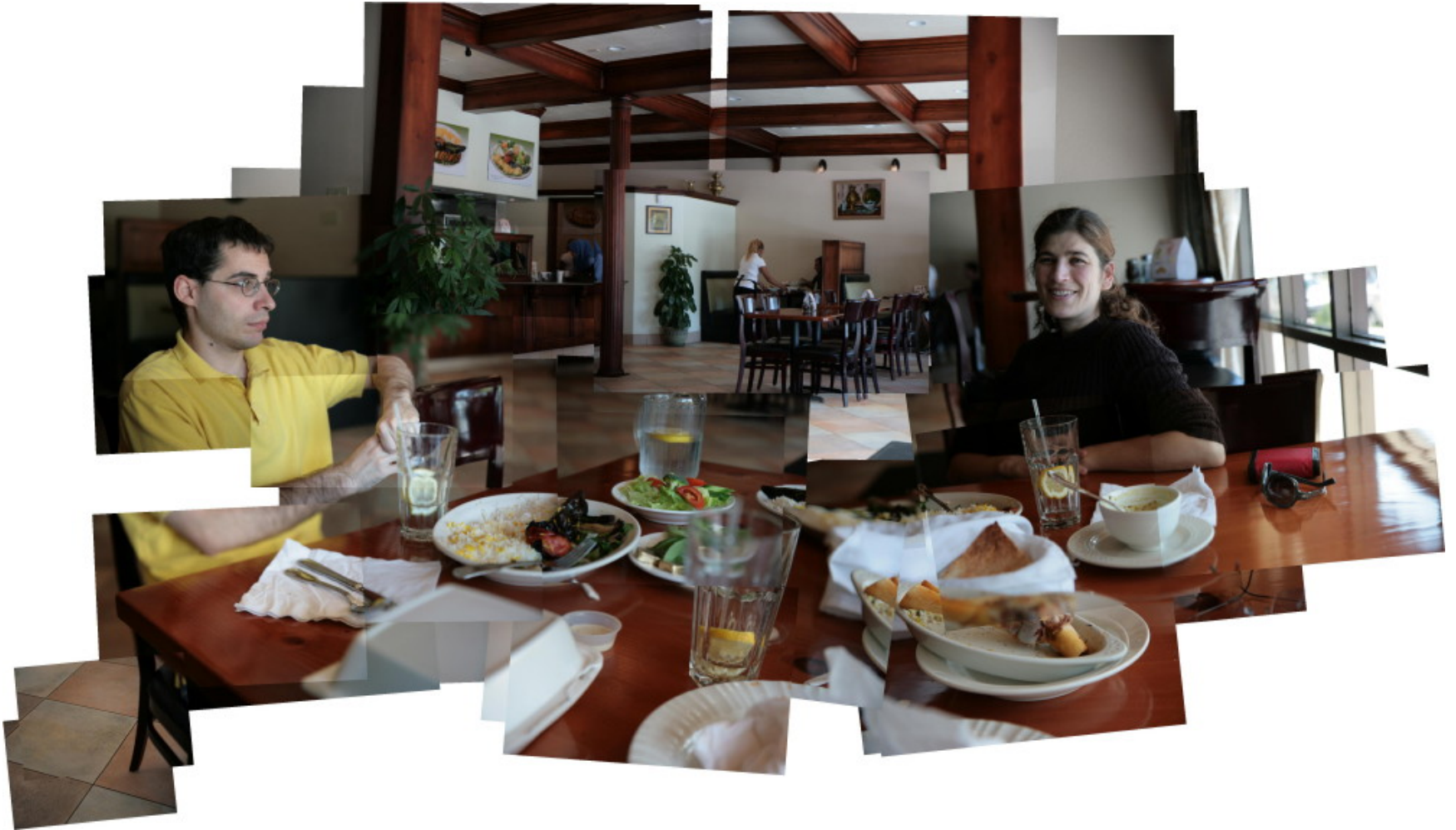


Take home



- 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/