

# Multi-View Image Compositions

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# Pictures capture memories



Stephen Johnson:  
*"pictures depict a memory of a place"*

# Extended memories



Stephen Johnson:

*"pictures depict a memory of a place"*

*"memories are acquired over time in many moments"*

*"photography is often a concatenated experience"*

# Organized memories





# Panoramas



# Why panoramas?

Regular photo



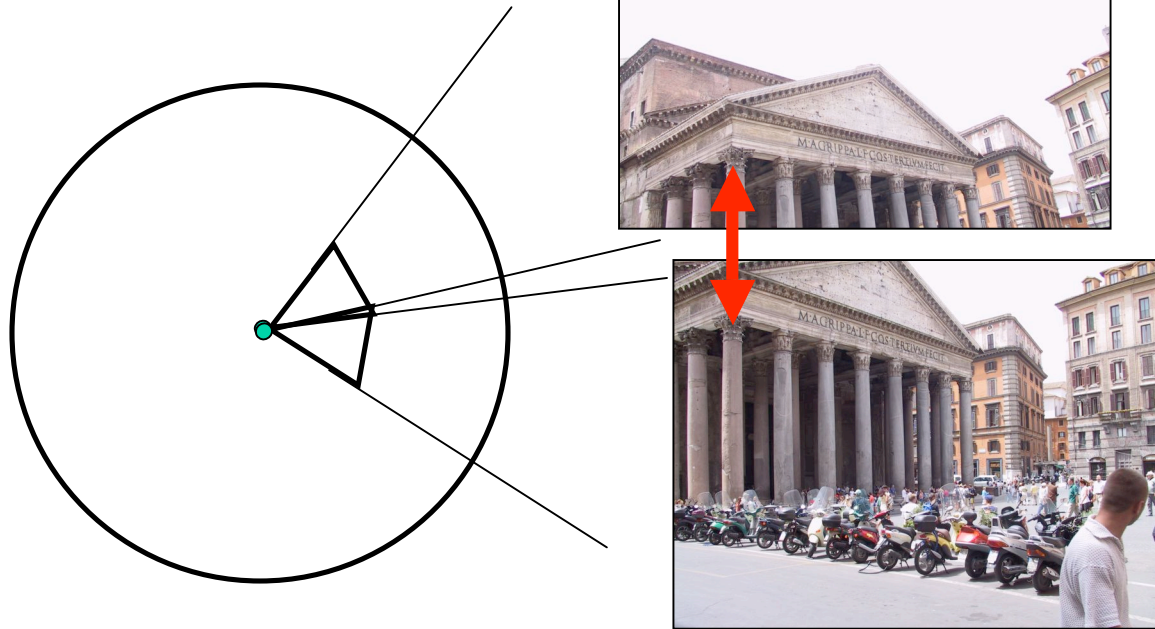
Fish-eye



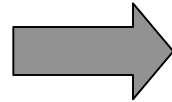
A lot better



# Scientists solution = Single center of projection



# From sphere to plane

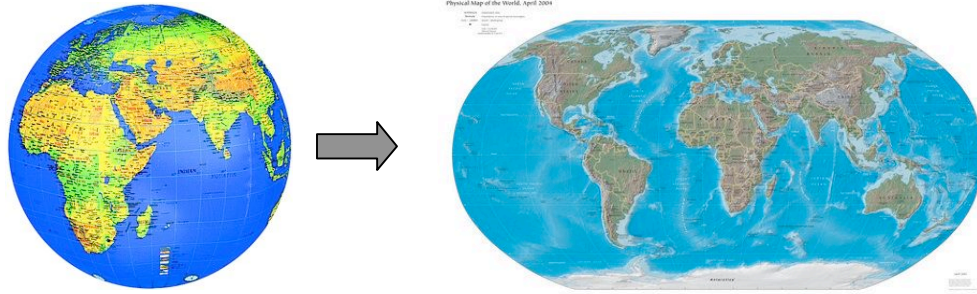


How can we flatten the sphere to obtain a flat image?



# An already solved problem?

Cartographers

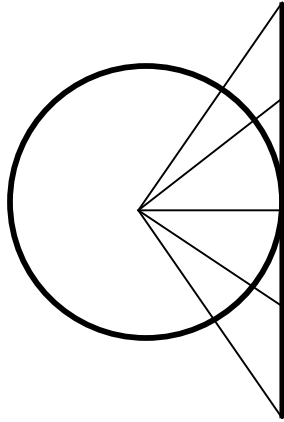


Artists

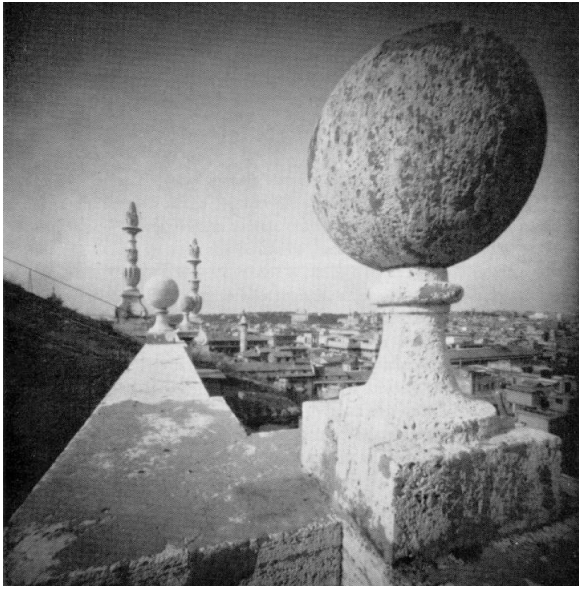




# Perspective Projection



- Cannot handle wide fields of view
- Distorts foreground objects



[Pirenne, 1970]



[Zelnik & Perona, 2005]

# Perspective Distortion



TIME

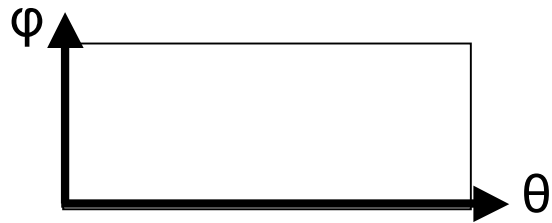
# Perspective Works If...

- You stand at the center of projection

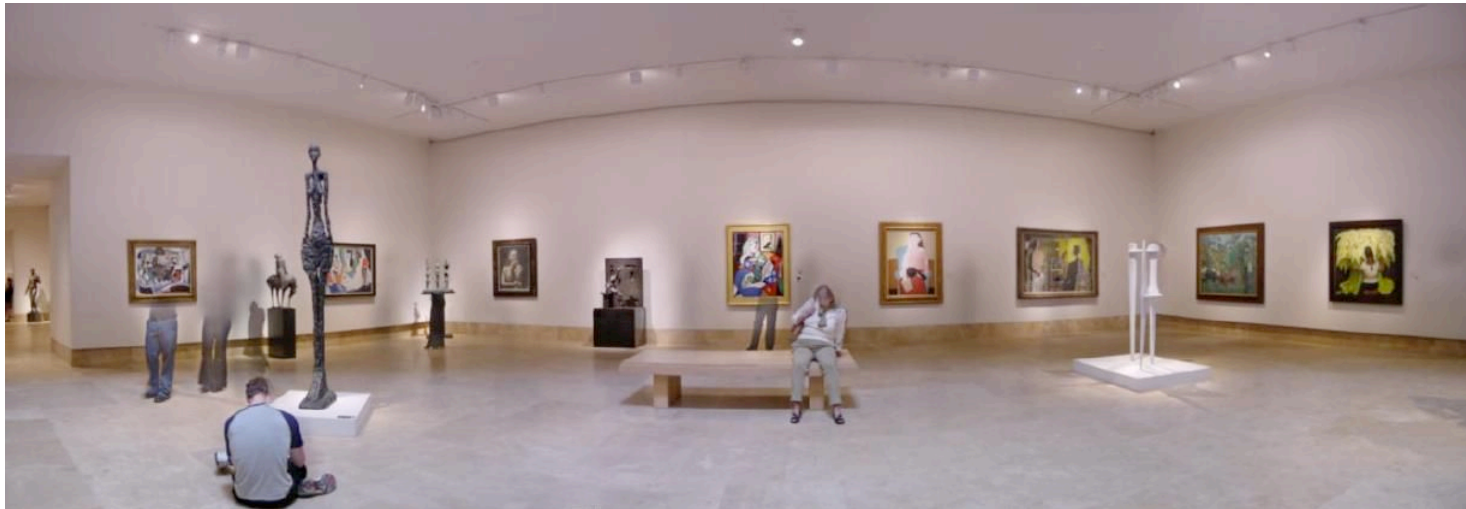
But...

- People move the picture or around the picture, when they look at it

# Cylindrical Projection

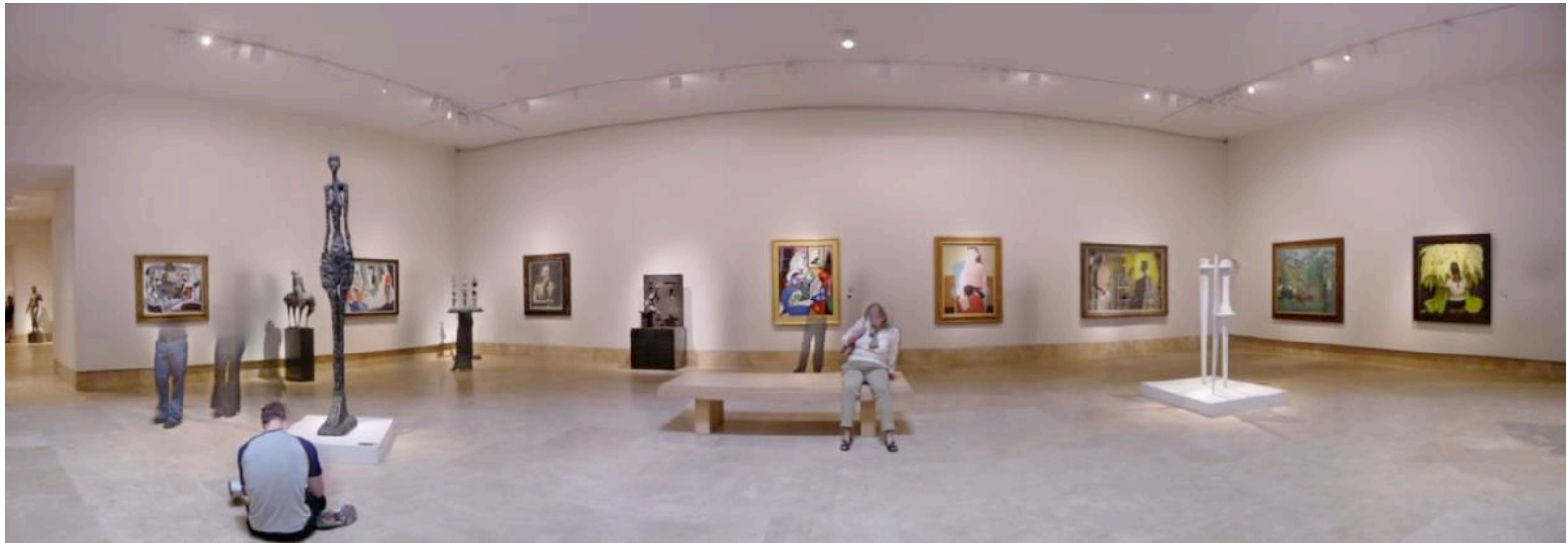
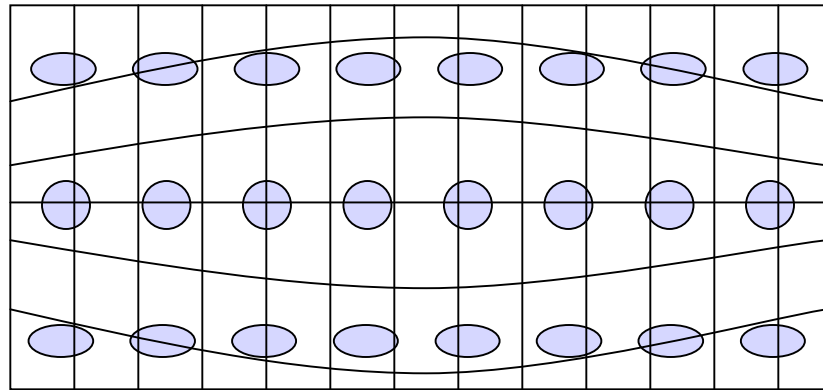


- Can handle full sphere
- Bends horizontal lines



# Equidistant; Rectangular; Cylindrical

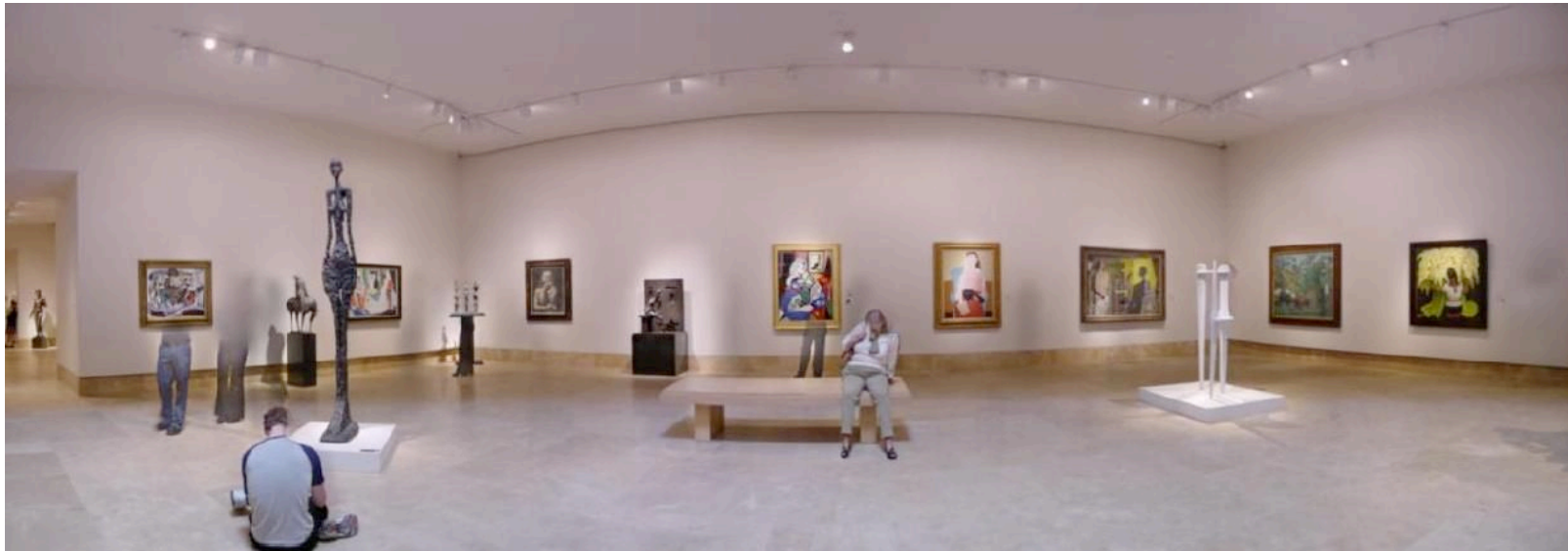
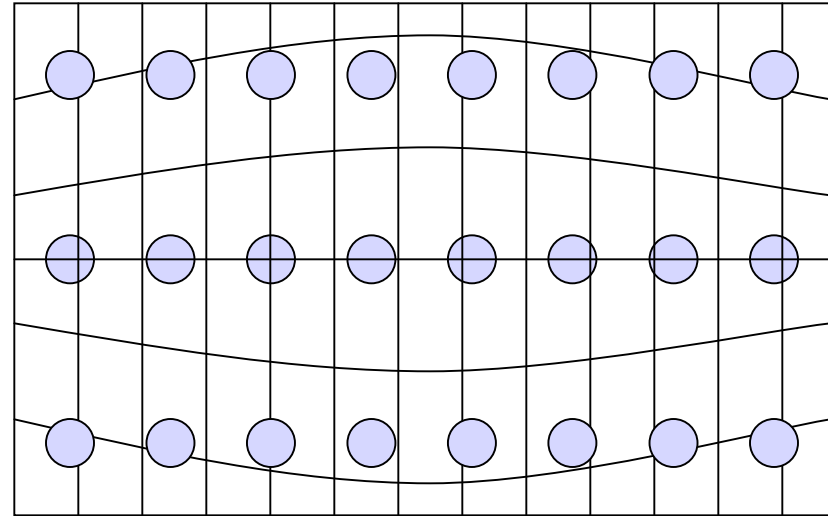
- Bends horizontal lines
- Distorts proportions





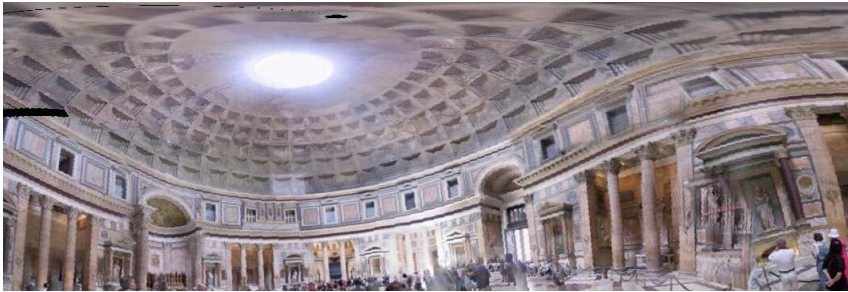
# Mercator

- Bends horizontal lines
- Preserves proportions



# Preserving Proportions

Rectangular

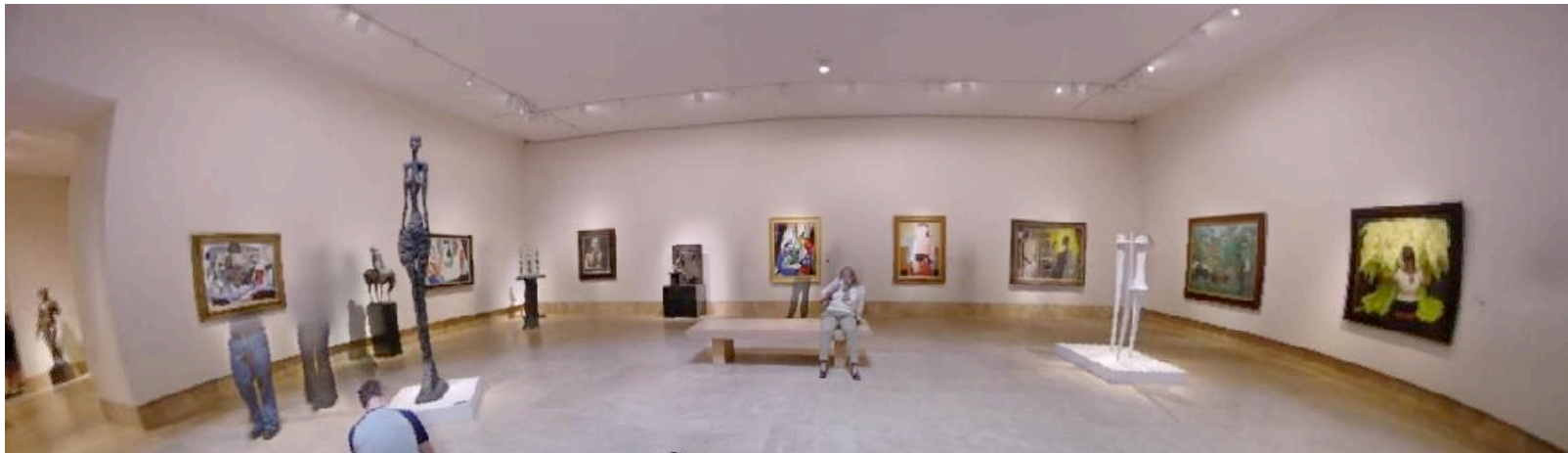
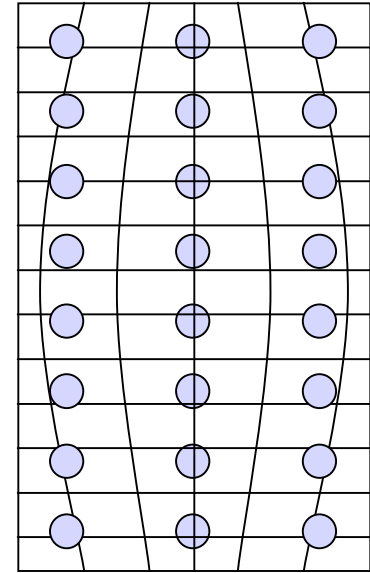


Mercator



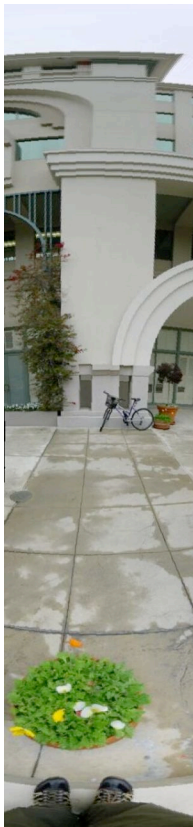
# Transverse Mercator

- Bends vertical lines
- Preserves proportions

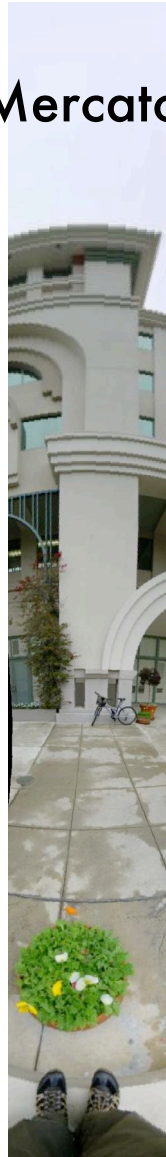


# Thin and Tall

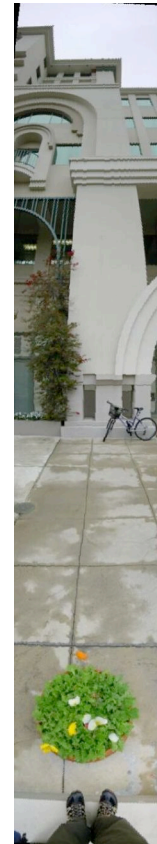
Rectangular



Mercator



Transverse  
Mercator





# Global Projections

Postel



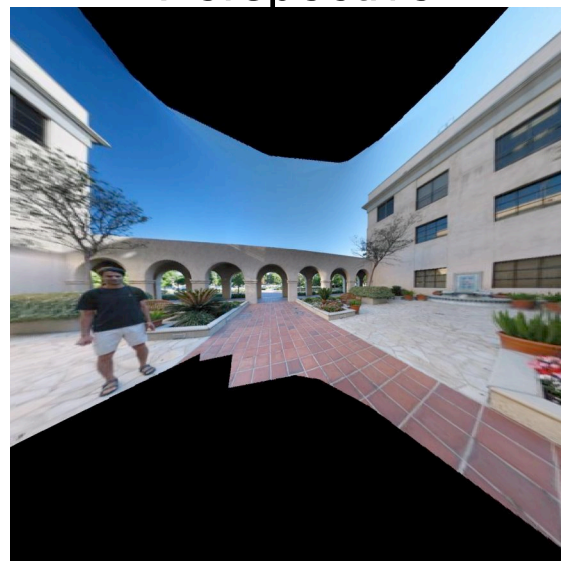
Stereographic



Mercator



Perspective





# Observations

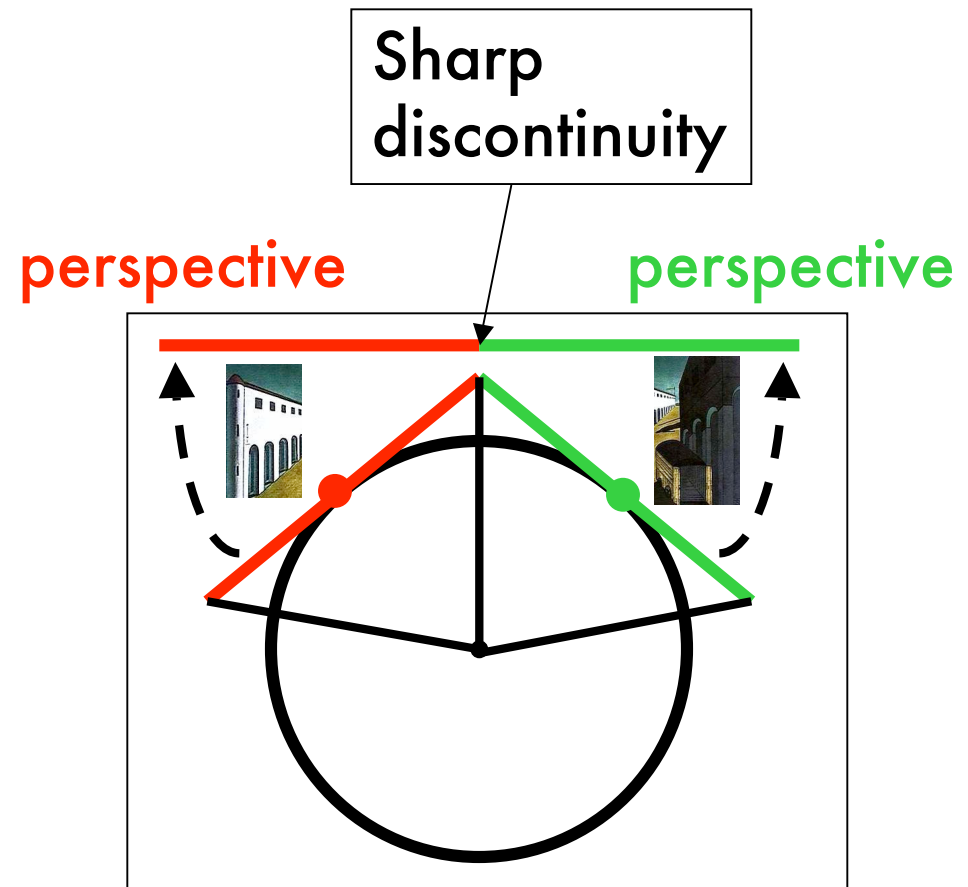
- *“We want the best of cylindrical and perspective”*
- *“Perspective is better for narrow fields of view, cylindrical for wide”*

# Learn from the artists

## Multiple view points

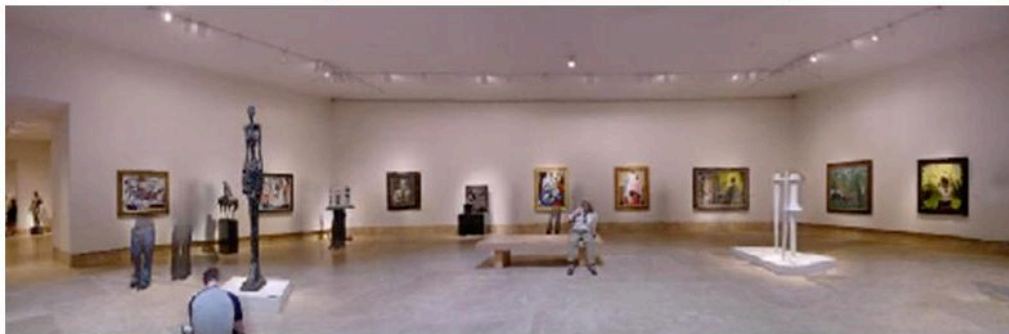
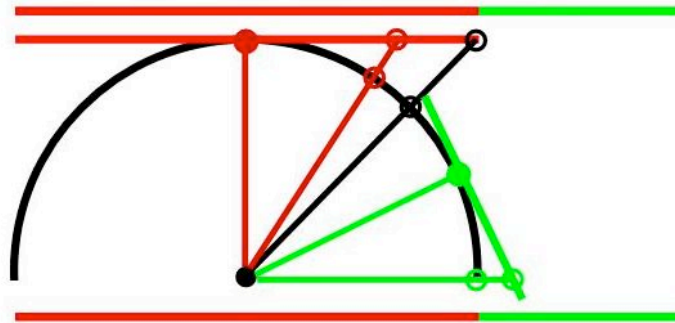
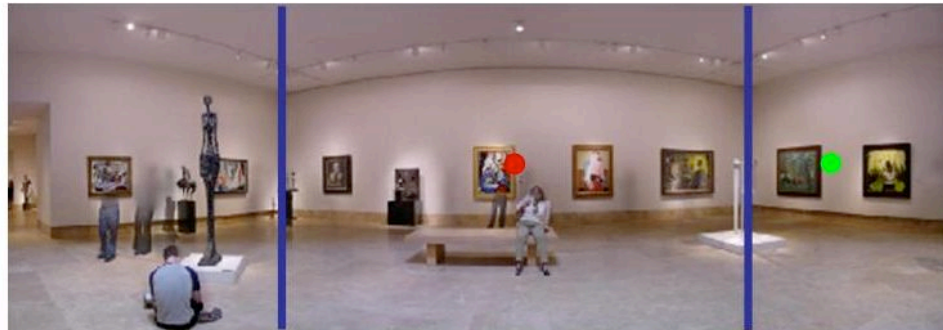


De Chirico "Mystery and Melancholy of a Street", 1914



# Multiple planes of projection

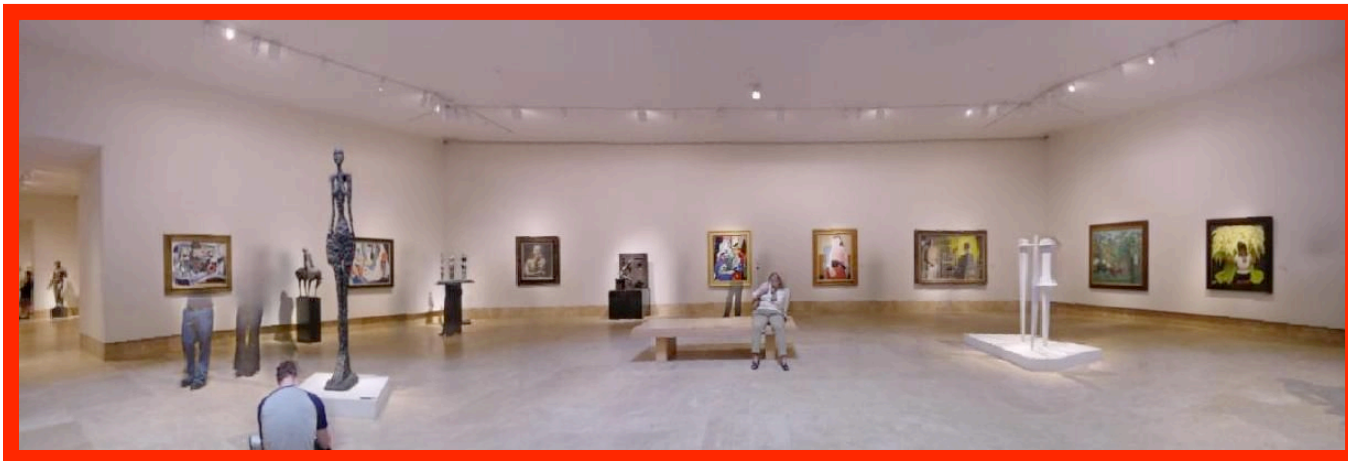
Sharp discontinuities can often be well hidden



## Cylindrical



## Multi-Plane



Cylindrical



Multi-Plane





Cylindrical



Multi-Plane



Cylindrical



Multi-Plane



Cylindrical

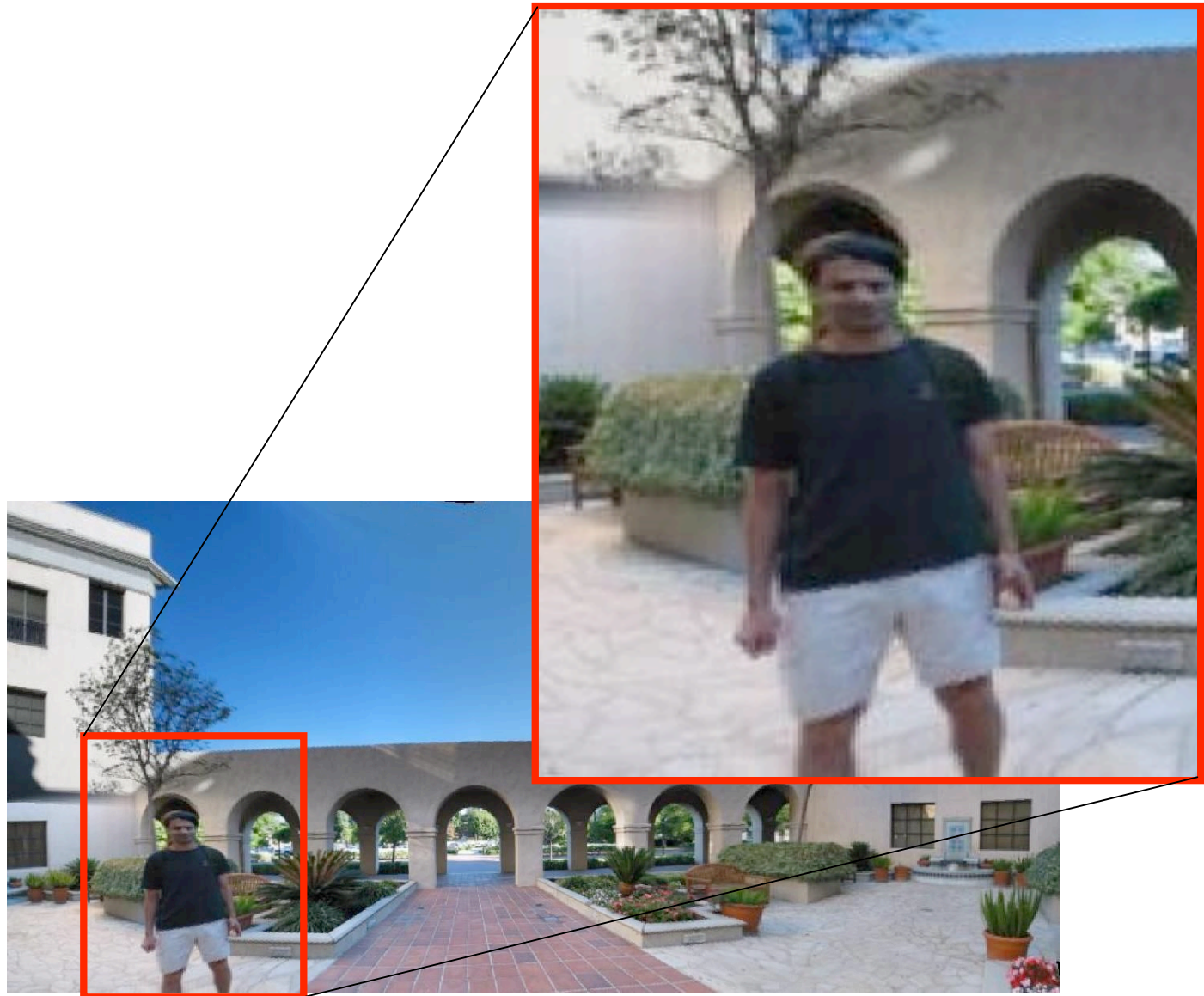


Multi-Plane





Foreground objects are still distorted!



# The Distortions of Perspective

Input images

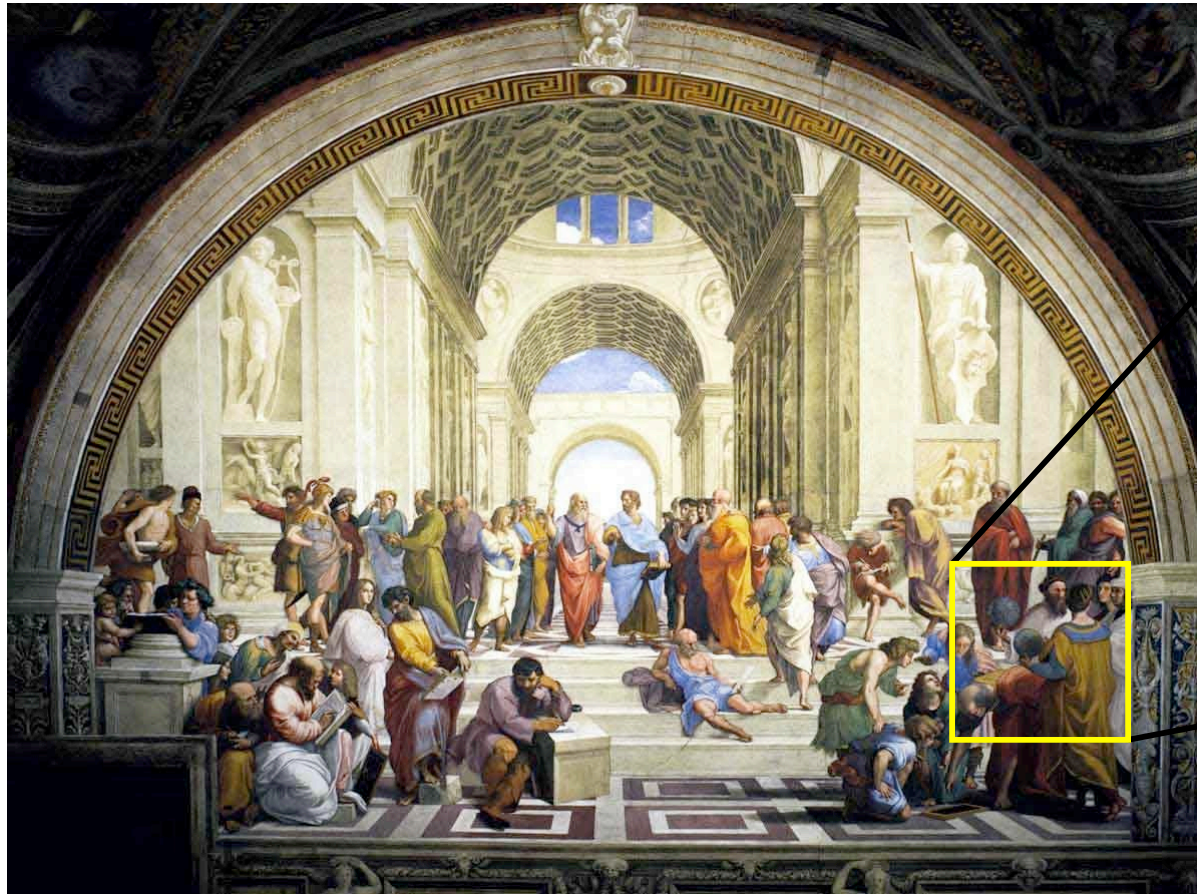


Single-View Perspective





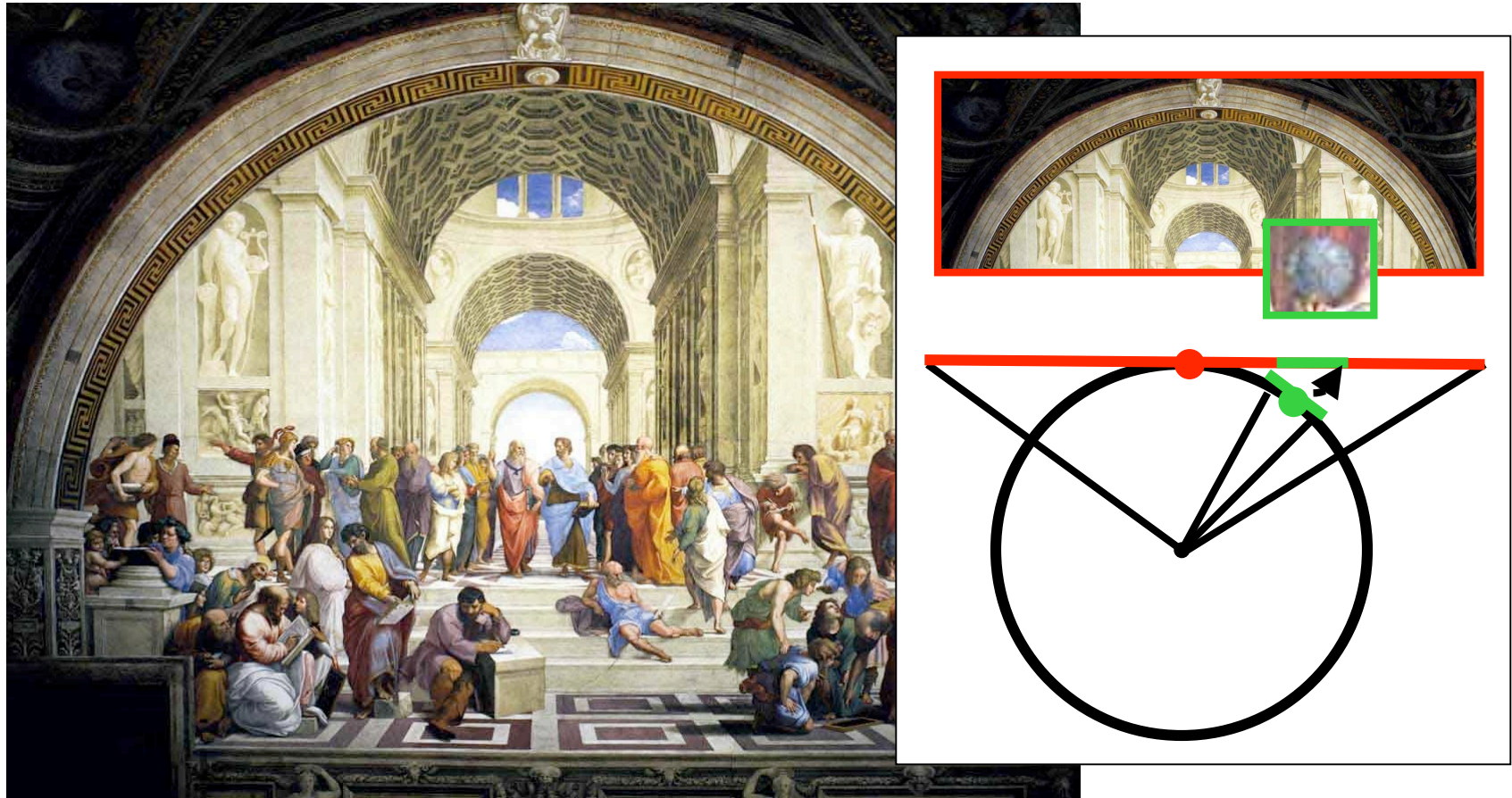
# Renaissance painters solution



“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!!

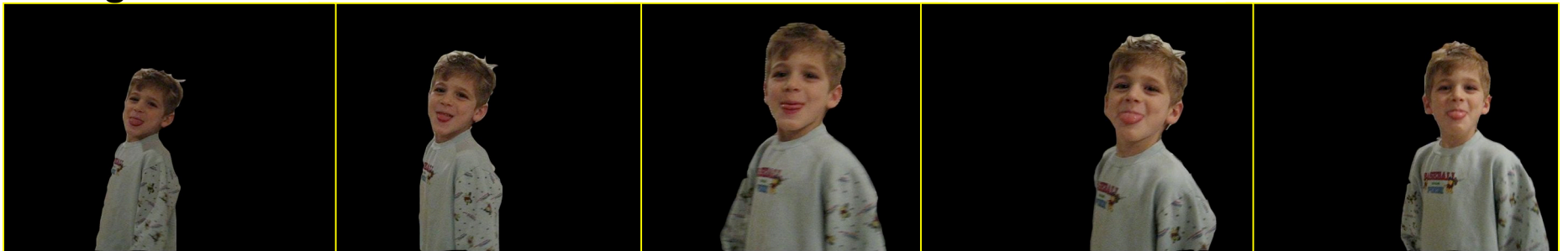


# Applying personalized projections

Input images



Foreground



Filled background [Efros & Leung 99]



## Background panorama



## Multi-View panorama





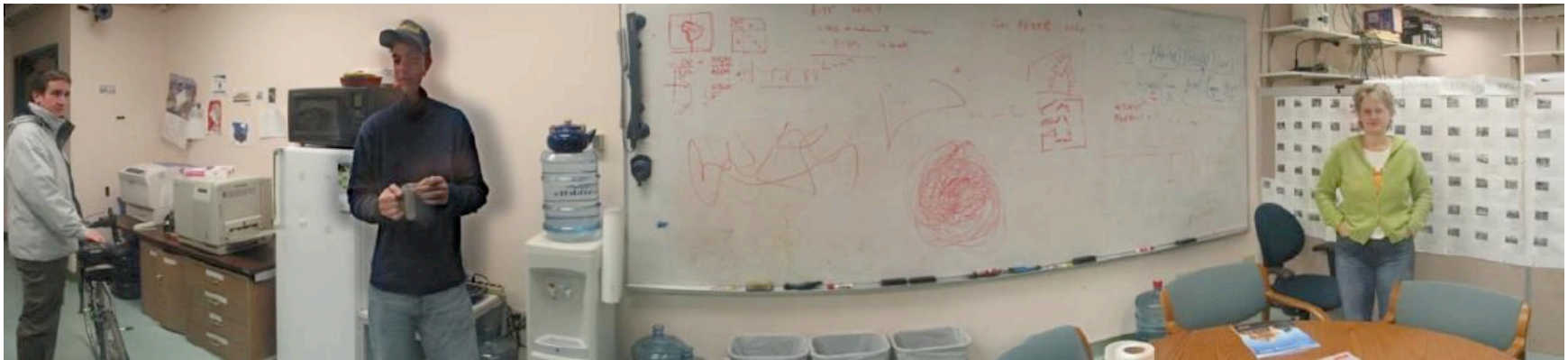
## Multi-View panorama



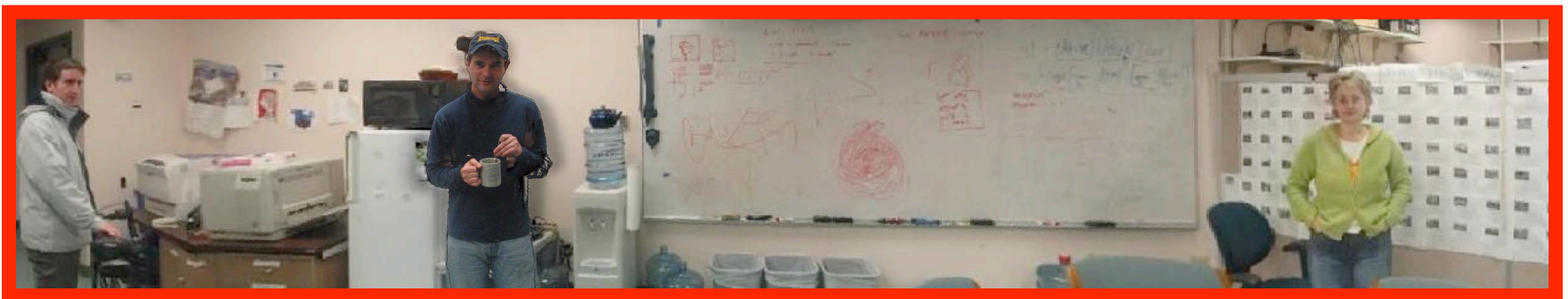
## Single-View Perspective



## Cylindrical



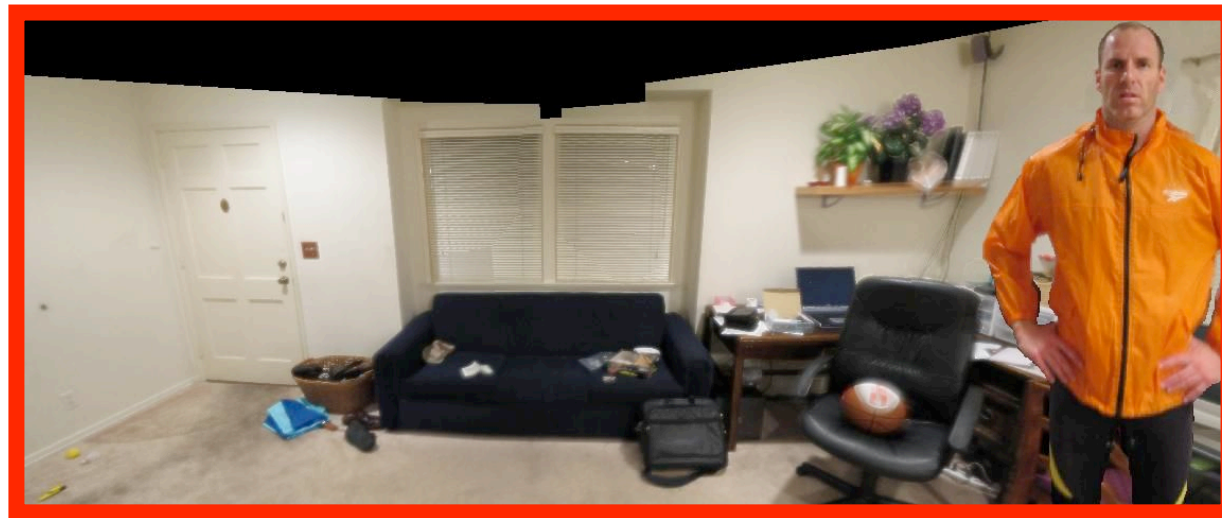
## Multi-View



## Perspective



## Multi-View panorama

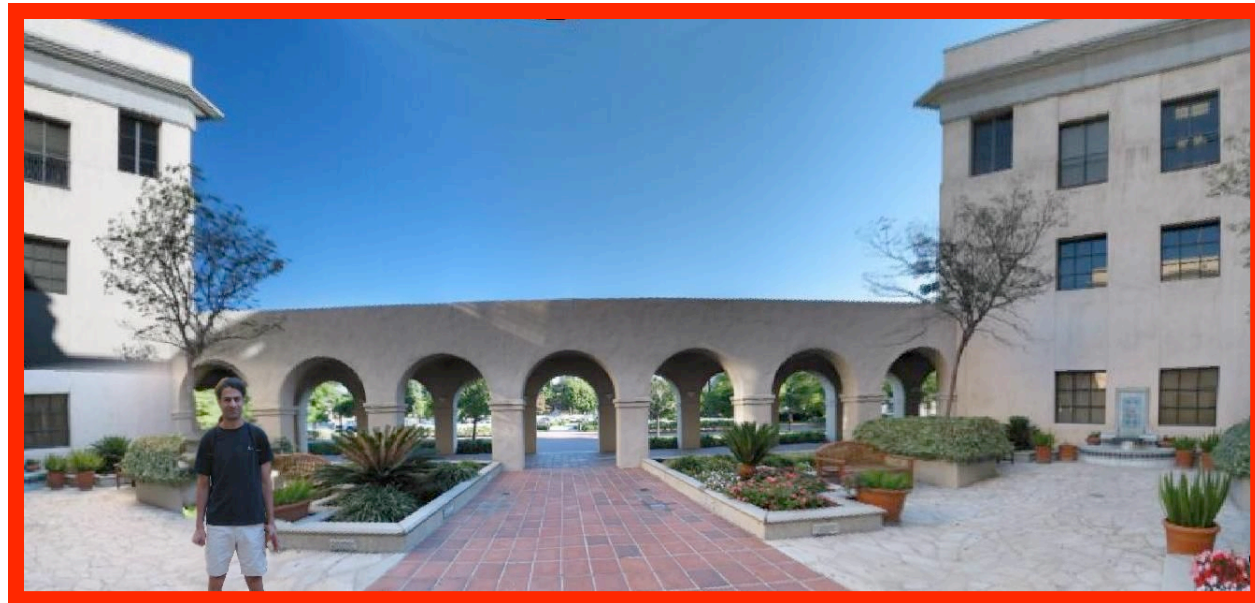




Cylindrical



Multi-Plane  
Multi-View



# Some observations

Stephen Johnson:

- *"memories are acquired over time in many moments"*
- *"photography is often a concatenated experience"*

Multiple views can live happily together on the same canvas



# Let the camera move

Avoid  
obstacles



See more of  
the scene



# Long Imaging



Michael Koller

- *"The Seamless City Scenes are absolutely NOT stitched panorama photos!"*
- *"Each segment is made from many, many photos shot from all kinds of angles that are then edited and composited in Photoshop to create the illusion of a seamless single image."*

# Moving Camera Problem

No geometrically consistent solution





# Non-smooth compositions



David Hockney

# Non-smooth compositions



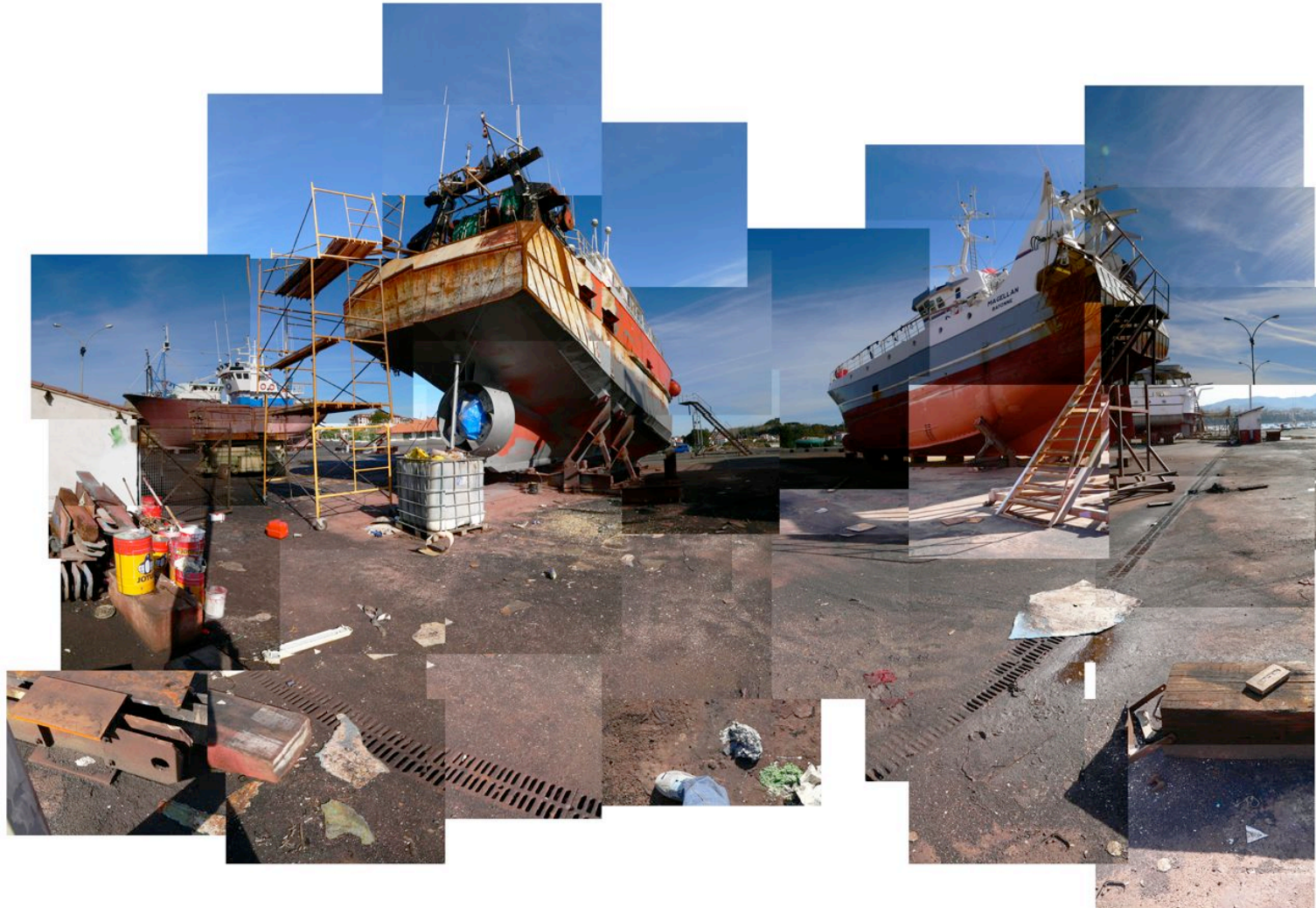
James Balog



# Flickr.com



# Flickr.com



# Key ideas (1)

- Align images on the composition plane
- Consider only translation, rotation and scale

Align + blend



Alignment imperfect => Blur



## Key ideas (2)

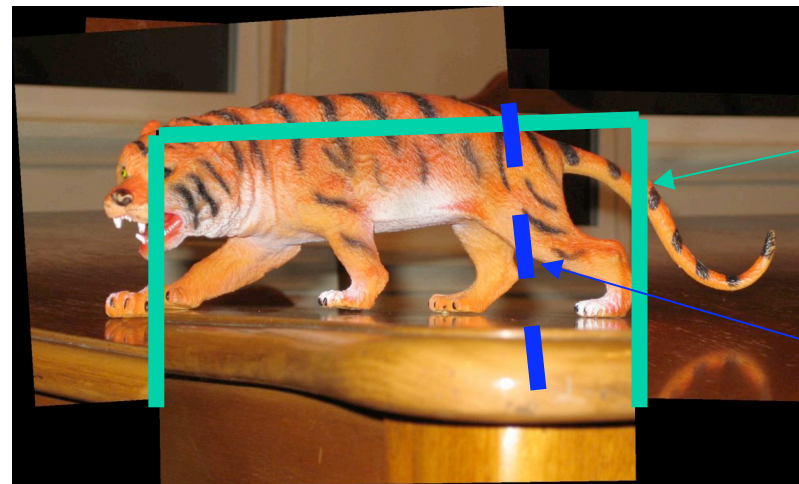
- Align images on the composition plane
- Consider only translation, rotation and scale
- Layer the images (rather than blend)





# Key ideas (3)

- Align images on the composition plane
- Consider only translation, rotation and scale
- Layer the images (rather than blend)
- Optimize mostly visible discontinuities

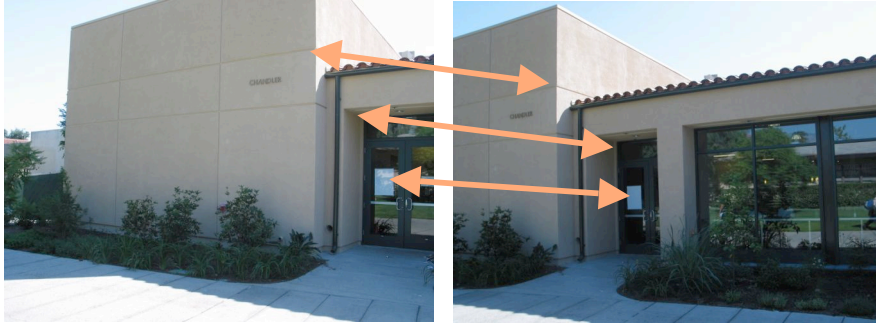


Visible

Not visible

# System Overview

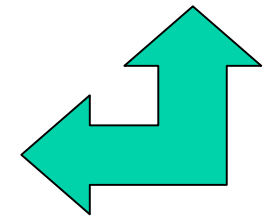
Match features



Align



Order the layers + prioritize matches

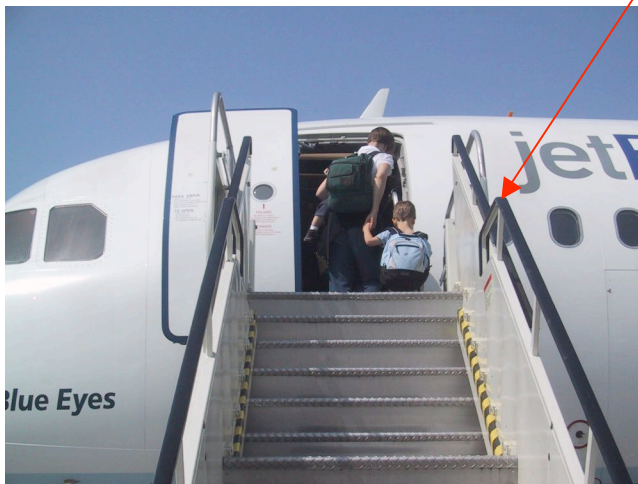
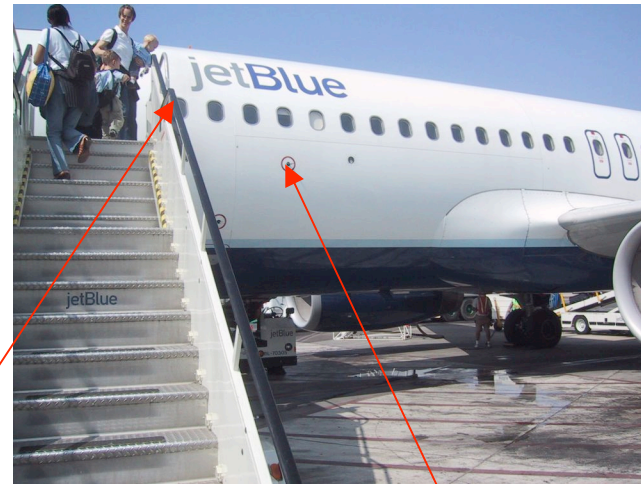


Iterate

Important

# Joiners - step 1

## Feature matching





# Joiners - step 2

## Align





# Joiners - step 3

## Order



# Joiners - step 4

## Important features



# Joiners - step 5

## Iterate Align-Order-Importance



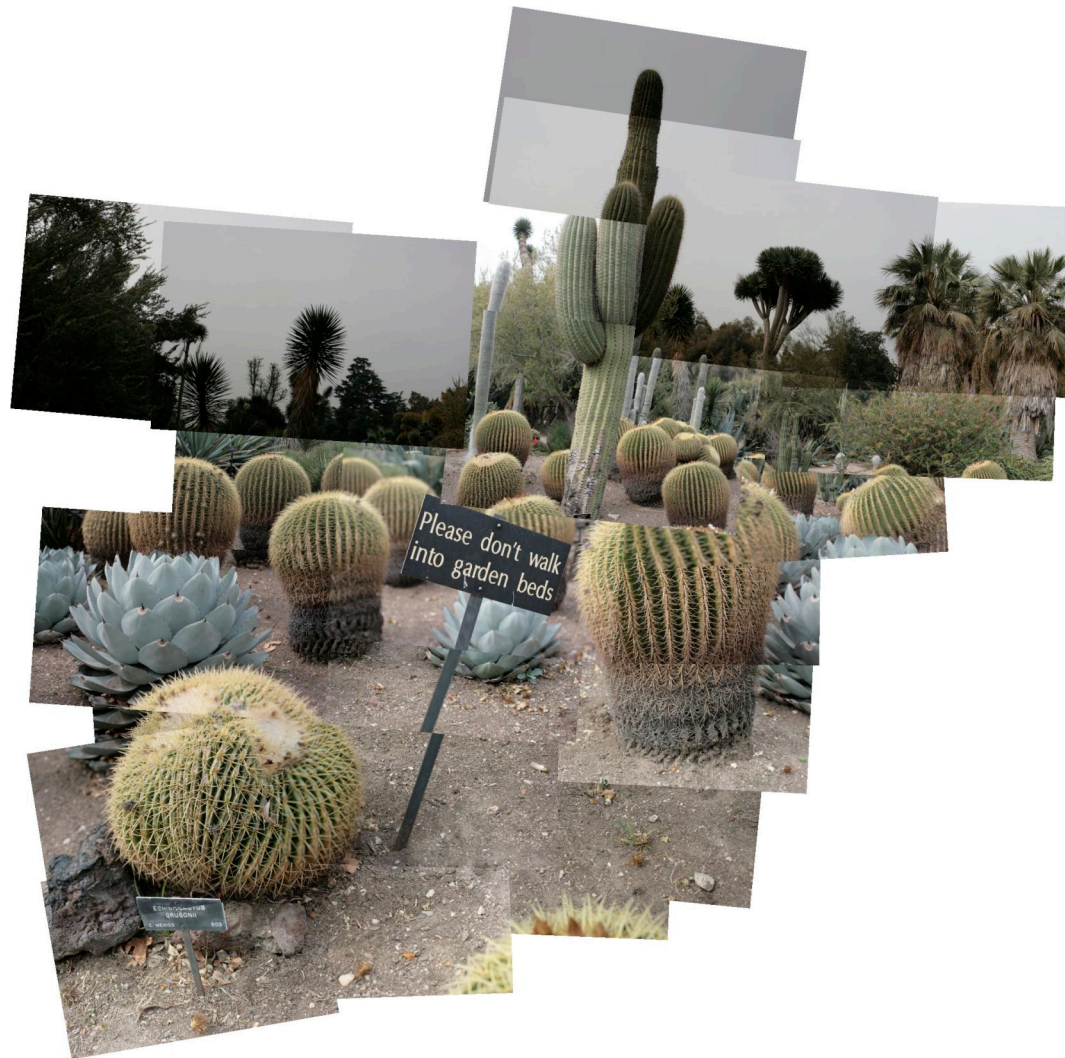


# Long Beach





# Cacti



# Anza-Borrego





# Truck



# Tractor





# Semi Automatic





# Japanese Bridge





# Art Reproduction



Paolo Uccello, 1436



Zelnik & Perona, 2006

# From Flickr





# Manual by Photographer



# Homage to David Hockney





# Organized Memories



# Take home

- Mosaic construction is not a pure geometrical problem.
- Incorrect geometries should not be banned.



**Thank You**