Life after 15-462…

15-465: Animation Art and Technology (spring 2008)

15-466: Game Programming (spring 2008)

16-421: Vision Sensors (spring 2008) NEW!!!

15-464 Technical Animation (spring 2008)

15-869 Physically Based Character Animation

15-463: Computational Photo (fall 2008)

15-385: Computer Vision

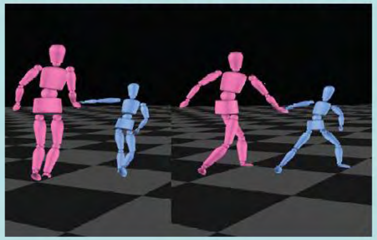
16-720: Grad. Computer Vision (fall 2008)

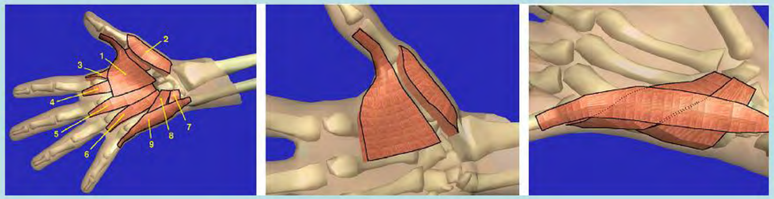
http://graphics.cs.cmu.edu/courses/

15-869
Physically Based Character Animation

classes start Sept 11

Simulation and optimization of character motion





Anatomy based modeling

... plus rigging, responsive characters, game physics, deformable objects, statistical techniques for character animation, and insights from biomechanics and neuroscience

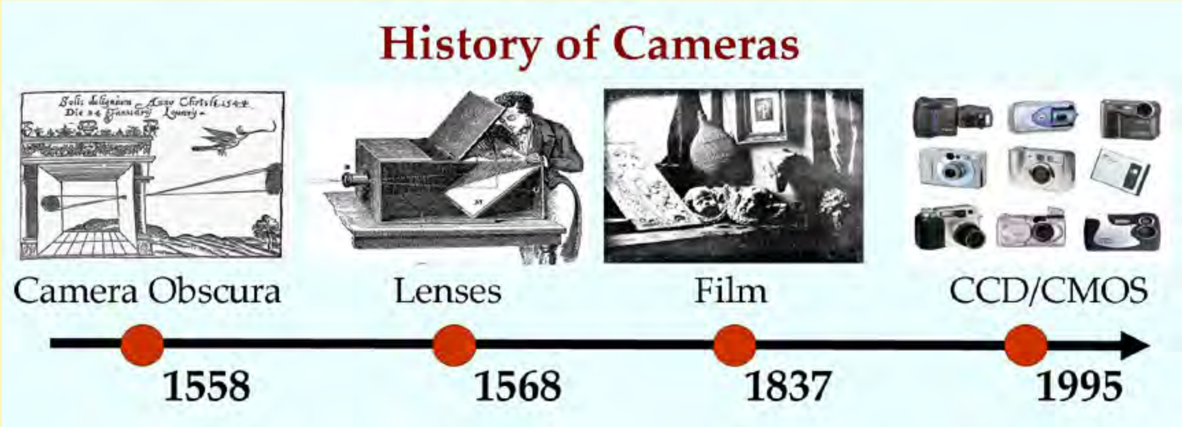
Webpage: graphics.cs.cmu.edu/nsp/course/15-869/ **Instructor: Nancy Pollard**

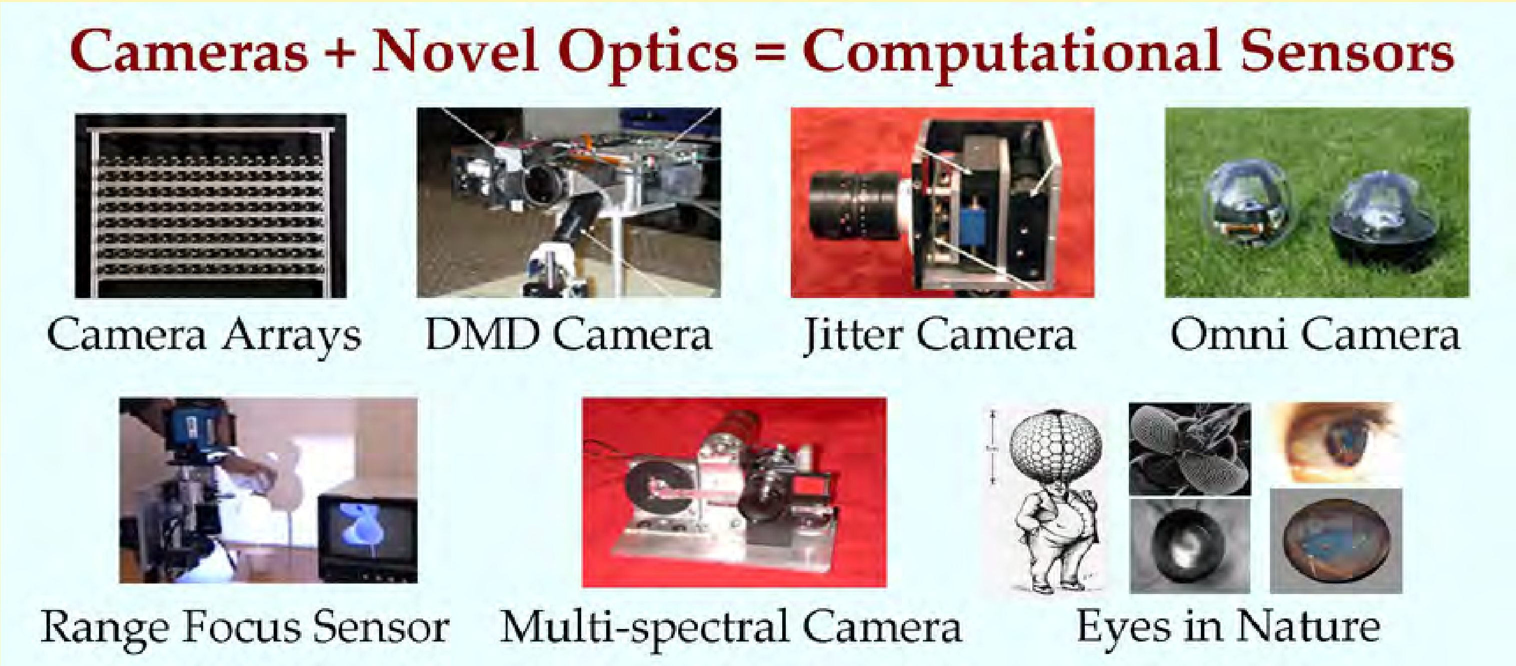
Animation Art and Technology: CFA and CSD
Prof. James Duesing and Prof. Jessica Hodgins

- Teams of students from art, design, CS, and ECE collaborate to create compelling animations with a technical component.

16-421: Vision Sensors, Spring 2008

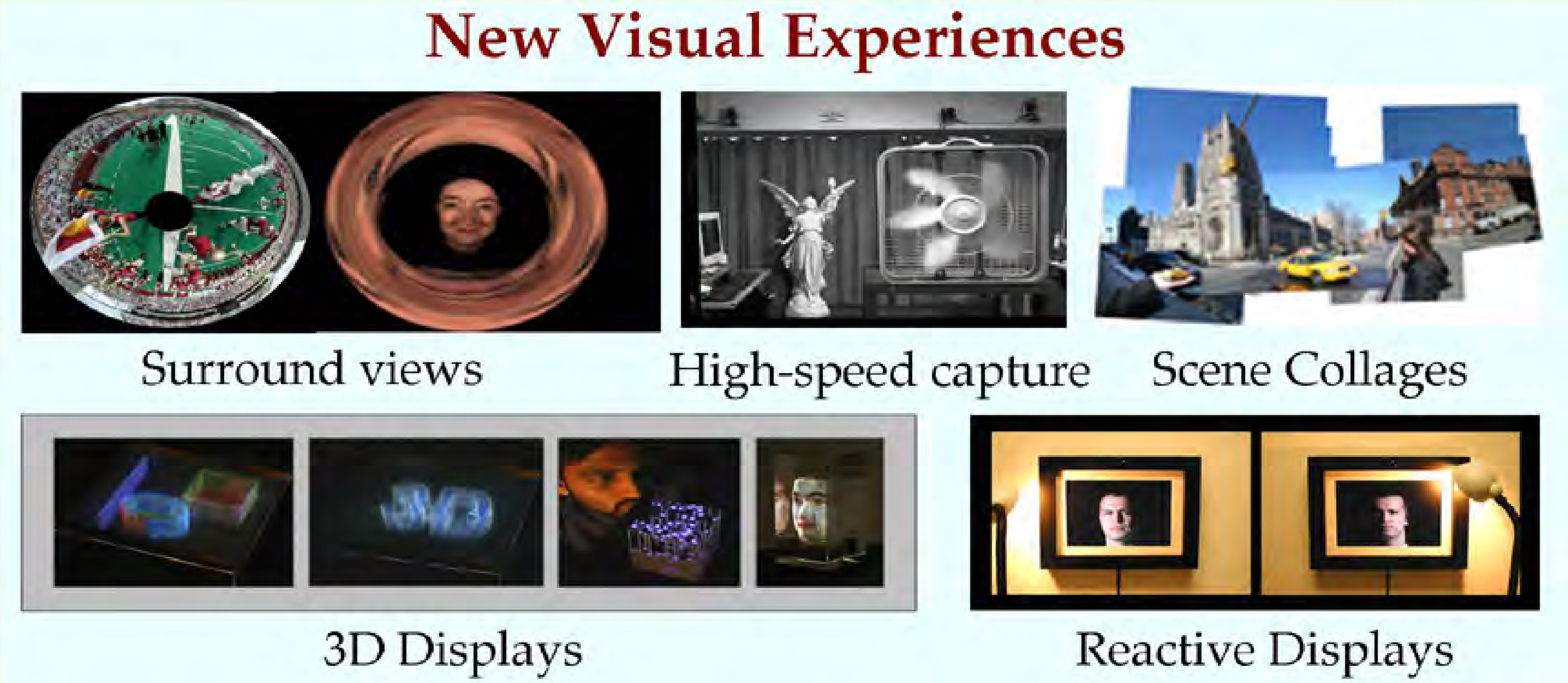
- http://www.cs.cmu.edu/~srinivas/vision-sensors/





16-421: Vision Sensors, Spring 2008

- http://www.cs.cmu.edu/~srinivas/vision-sensors/

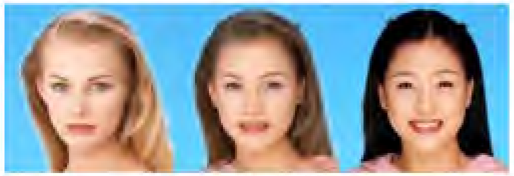


15-463 (15-862)
Computational Photography

(formerly: Rendering and Image Processing)

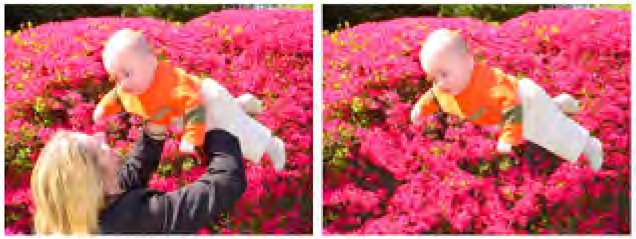
- Looking for a fun class this semester?
- Then get out your digital camera and take *Computational Photography*:
  - An emerging new field created by the convergence of computer graphics, computer vision, and digital photography!
- Learn how to acquire, represent, and render scenes using digitized photographs and video.
- Implement state-of-the-art algorithms such as:

Panoramic Mosaic Stitching



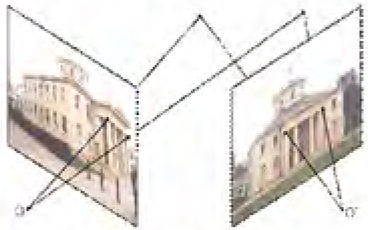
Face Morphing

Blending and Compositing



Texture Hole-Filling

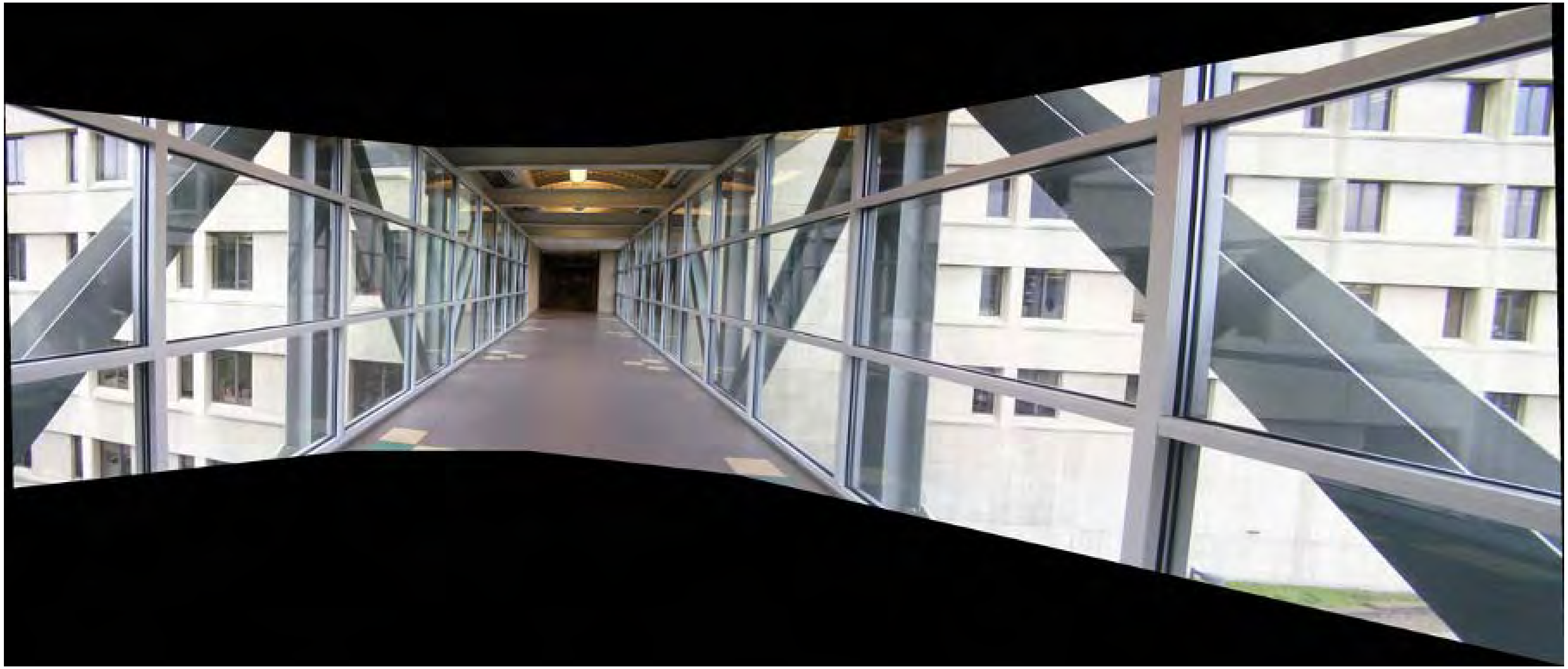
Single-view Geometry *(e.g. Tour into the Picture)*



Multi-view Geometry

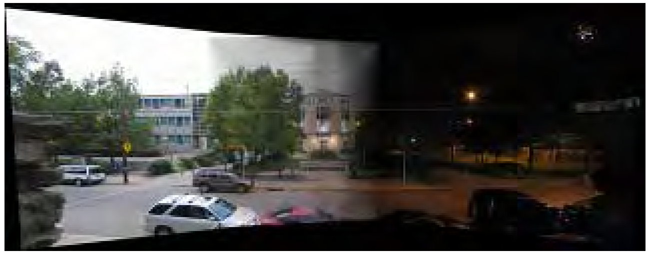
Webpage: graphics.cs.cmu.edu/courses/15-463/

Instructor: Alexei Efros



Ken Chu, 2004

From Last Year's class



Ben Hollis, 2004

Ben Hollis, 2004

Eunjeong Ryu (E.J), 2004

Matt Pucevich , 2004

Programming Project 2

Image Resizing by Scene Carving

Project #3 Showcase

cmcamero

Project #3 Showcase

slim

nvyas

Project #3 Showcase

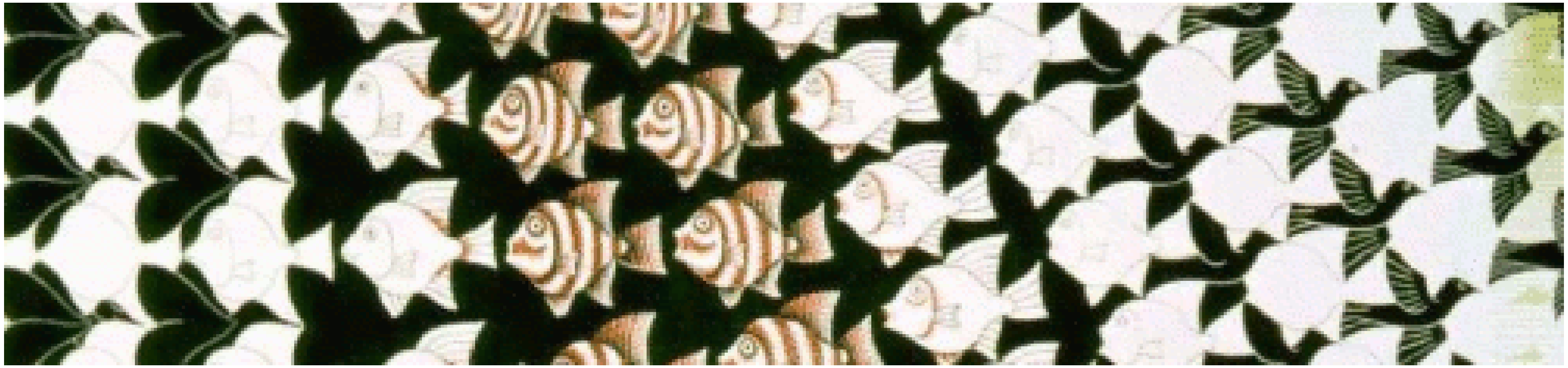
cmcamero

bhon

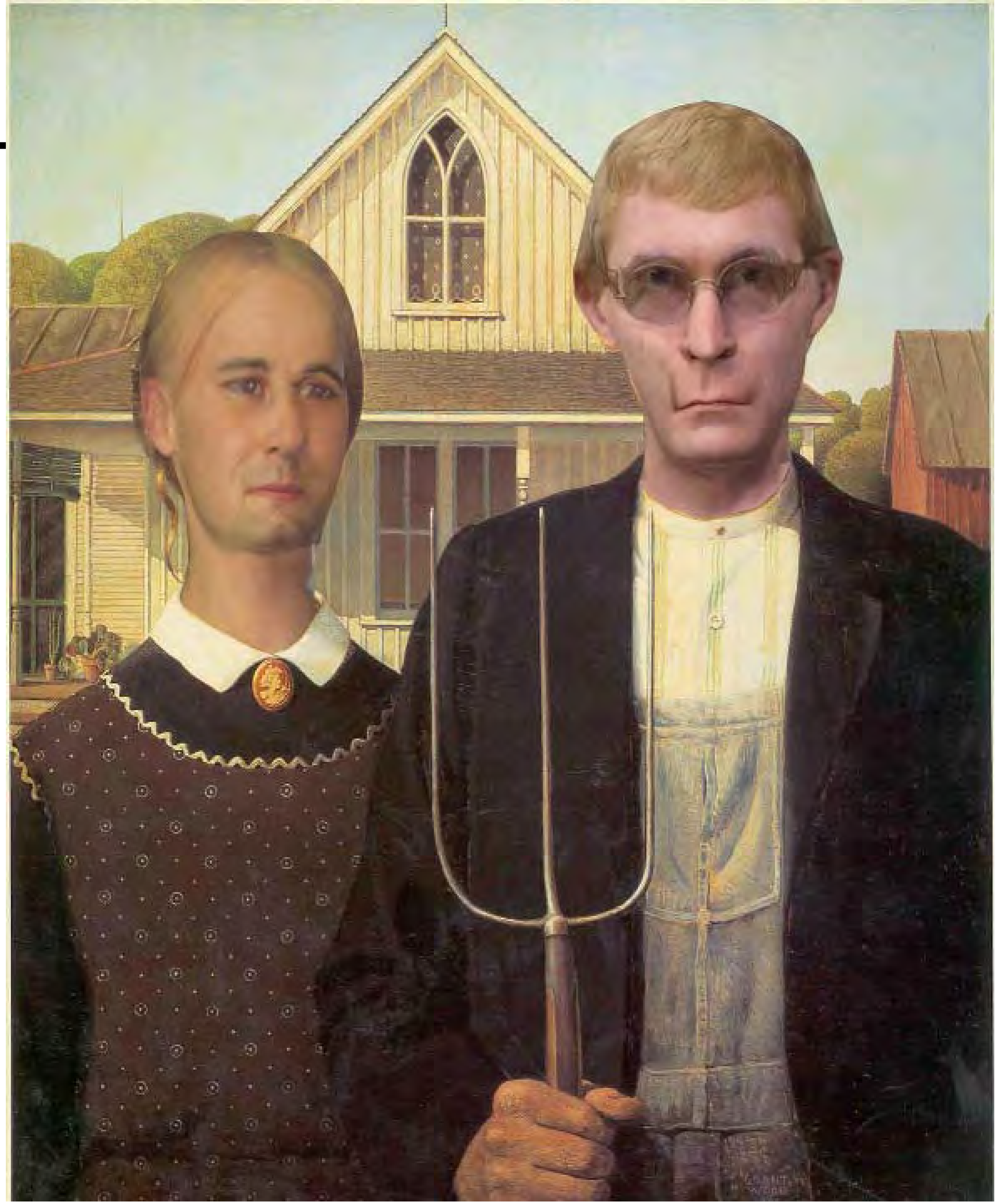
Project #3 Showcase

chenyuwu

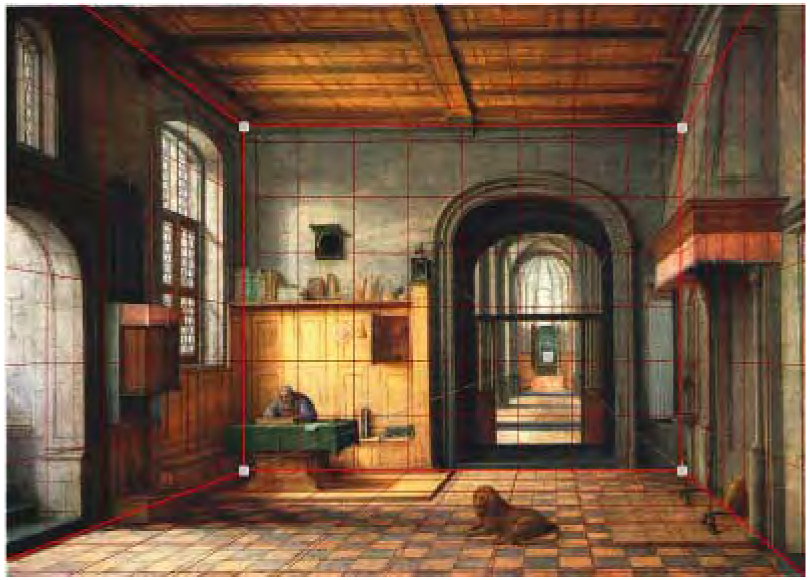
Morphing & Caricatures

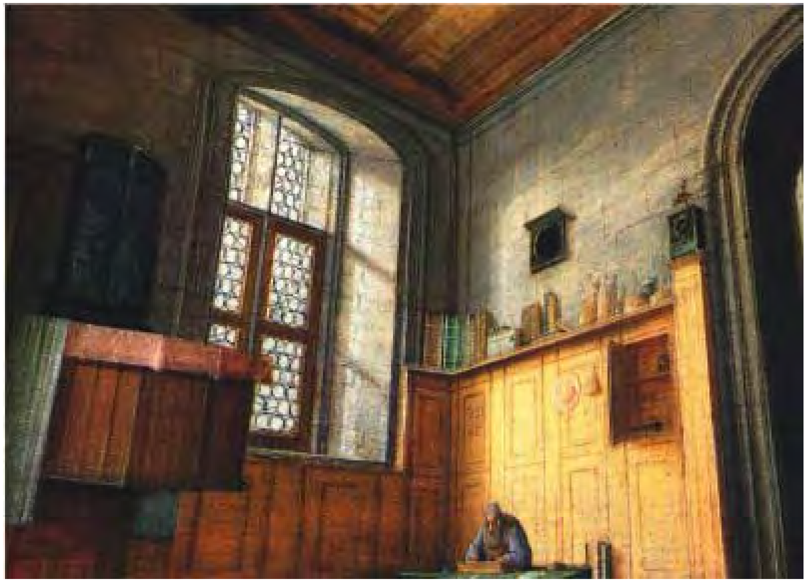


http://graphics.cs.cmu.edu/courses/15-463/2007_fall/morph_mpeg4.avi



Foreground DEMO (and video)



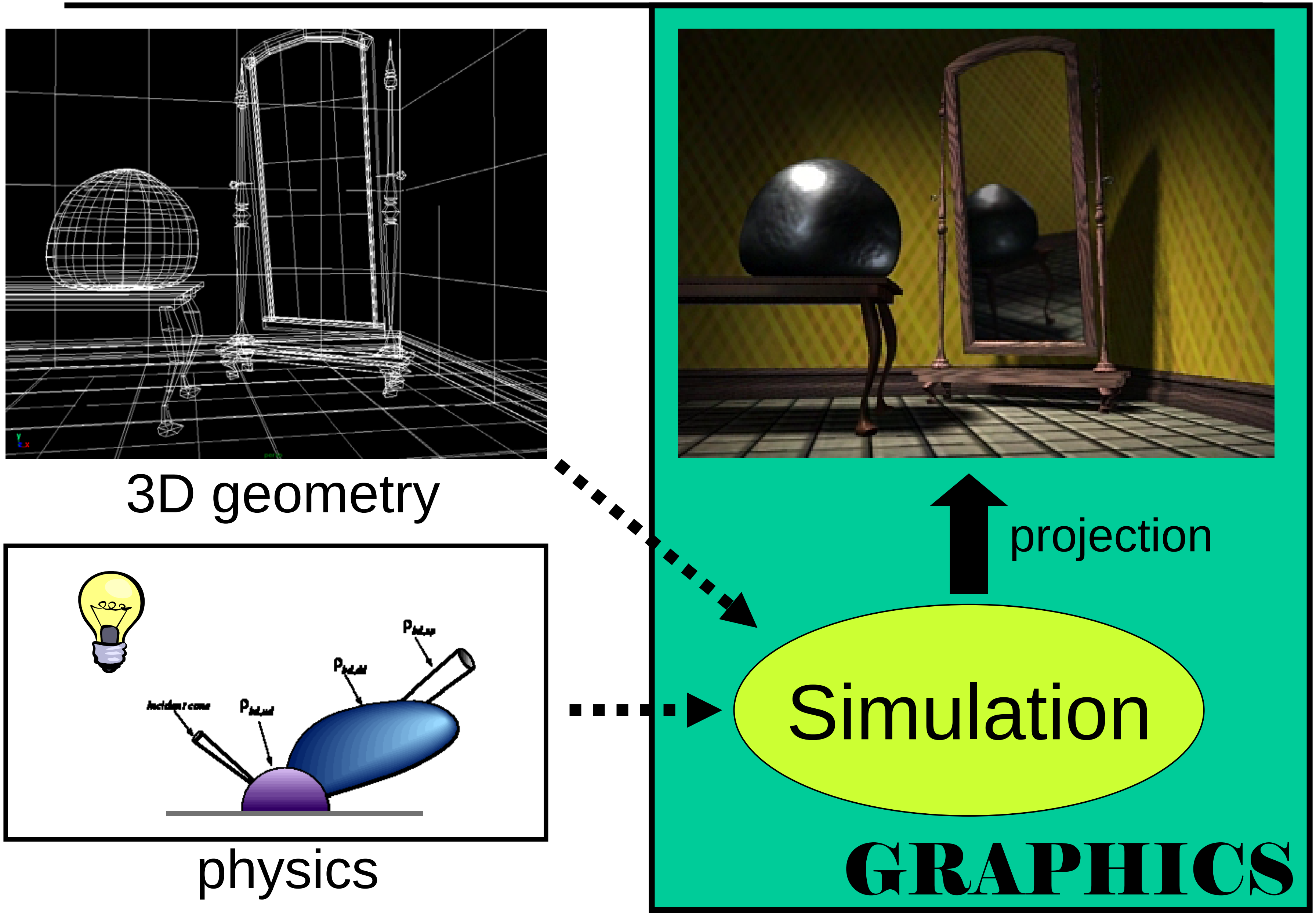







Data-Driven Graphics

Traditional Computer Graphics



State of the Art

- Amazingly real
- But so sterile, lifeless, *futuristic (why?)*

The richness of our everyday world

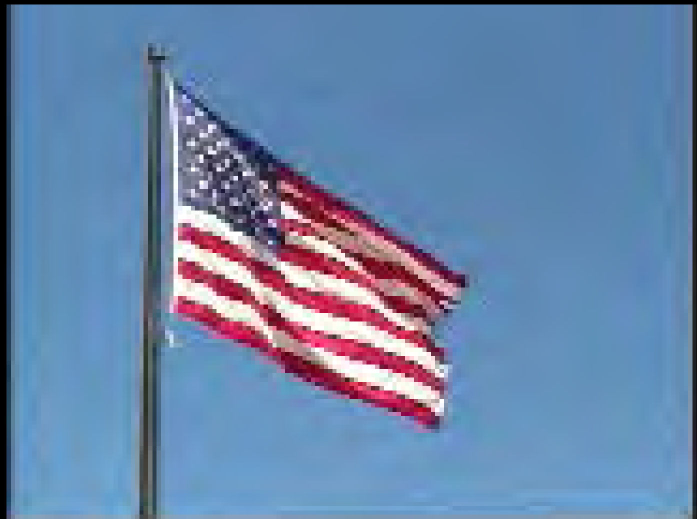
Photo by Svetlana Lazebnik

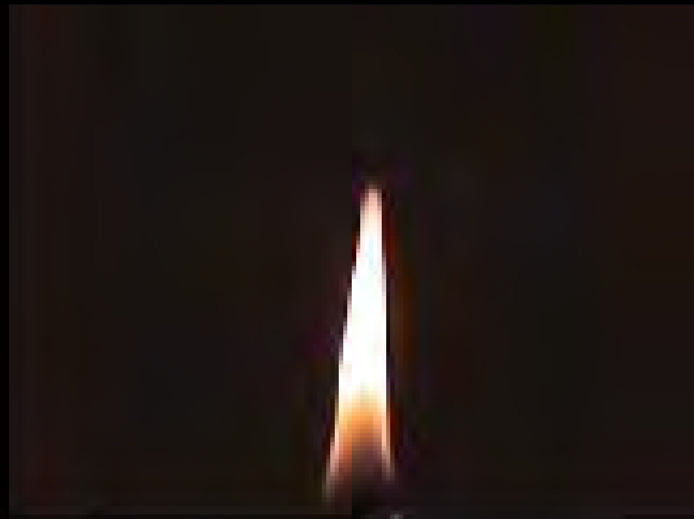
Video Textures

Arno Schödl
Richard Szeliski
David Salesin
Irfan Essa

Microsoft Research, Georgia Tech

Still photos





Video clips

Video textures

Problem statement

video clip

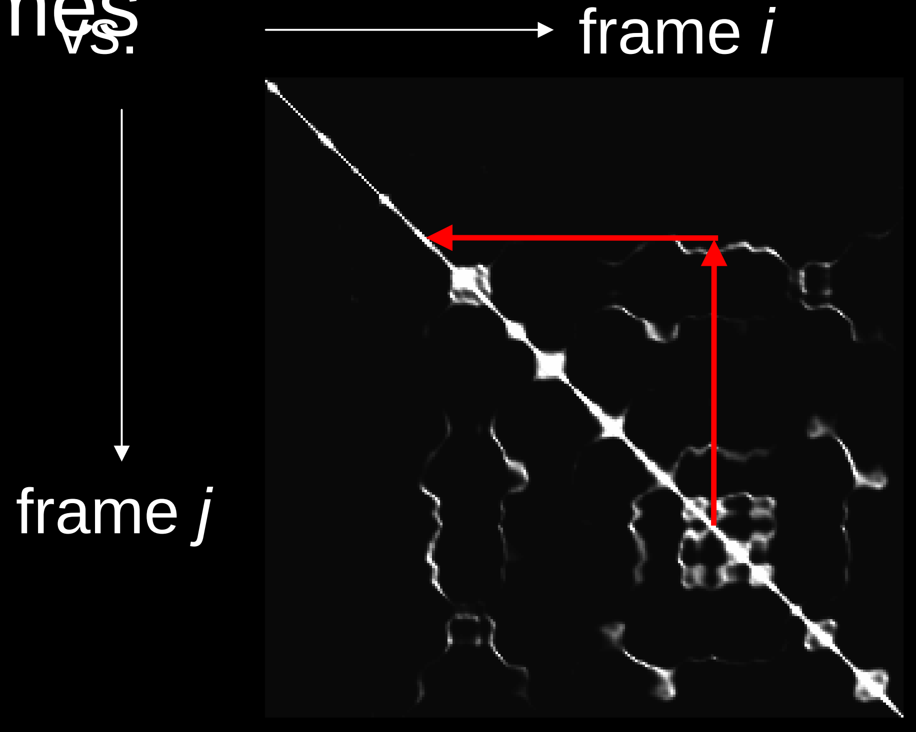
video texture

Our approach

- How do we find good transitions?

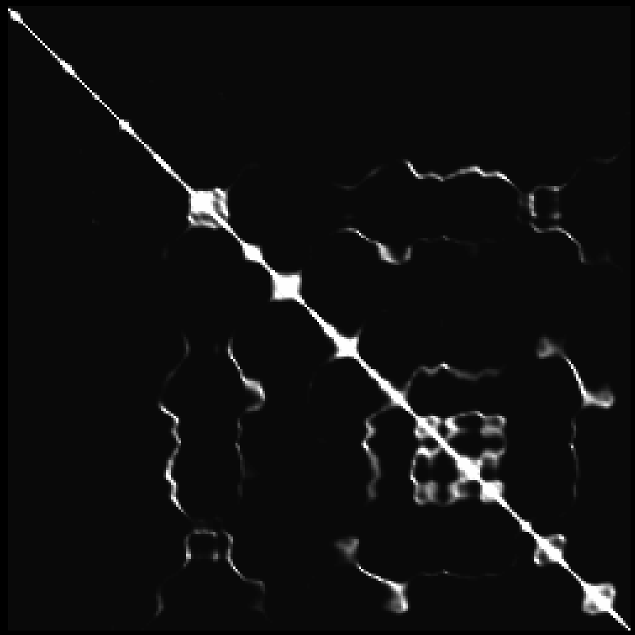
Finding good transitions

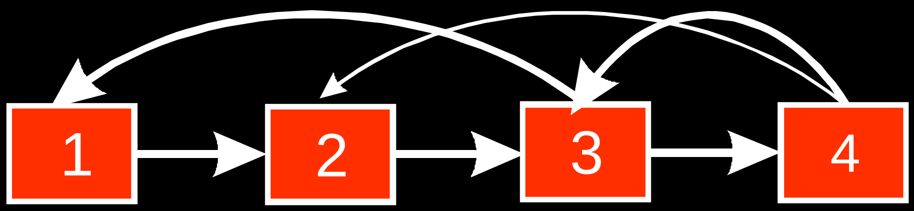
- Compute L_2 distance $D_{i,\,j}$ between all frames



Similar frames make good transitions

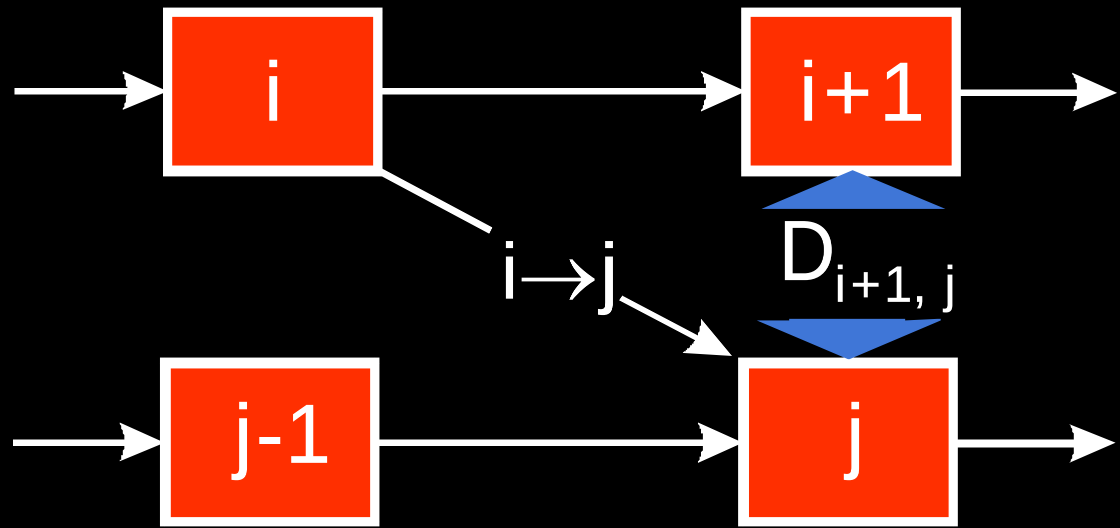
Markov chain representation





Similar frames make good transitions

Transition costs

- Transition from i to j if successor of i is similar to j
    - Cost function: $C_{i \to j} = D_{i+1, j}$
- 

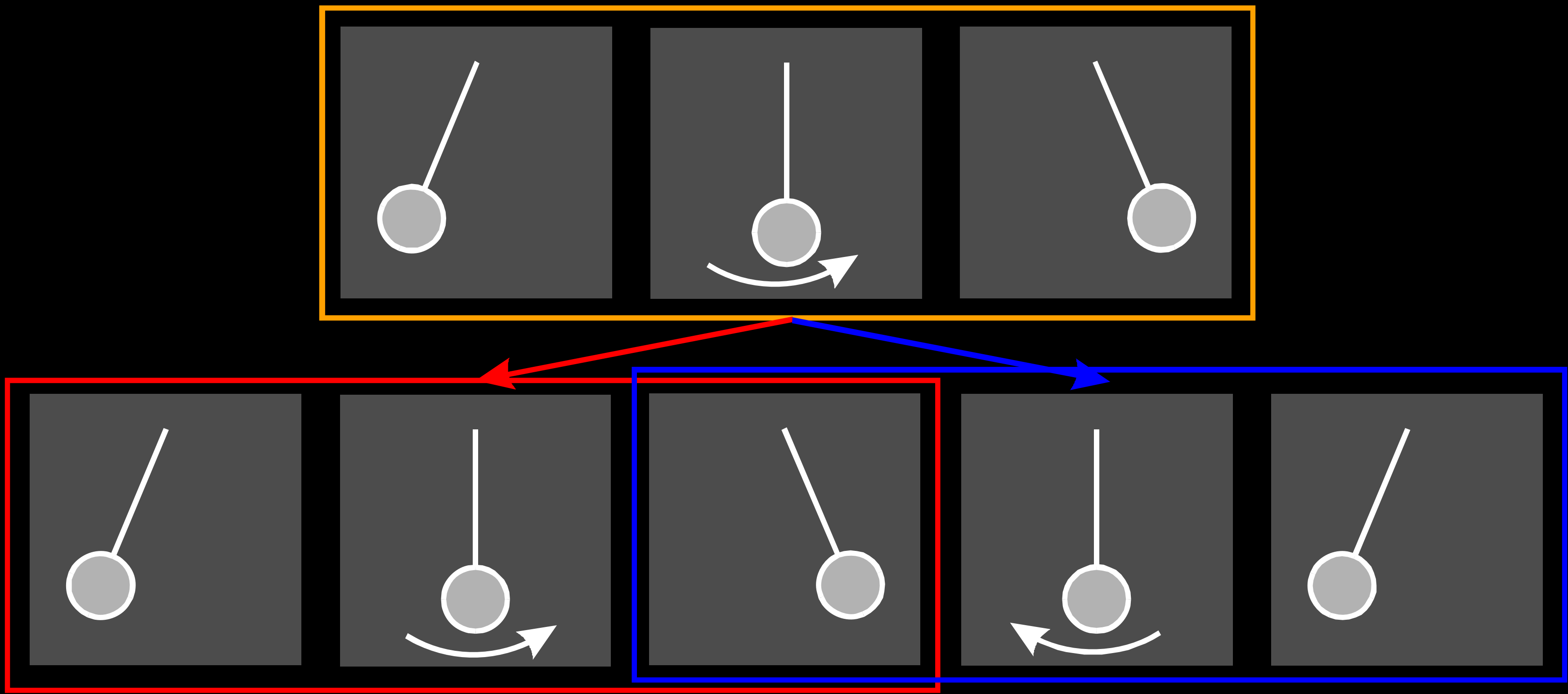
Transition probabilities

- Probability for transition $P_{i \to j}$ inversely related to cost:
  - $P_{i \to j} \sim \exp\left(- C_{i \to j} / \sigma^2 \right)$

high σ low σ

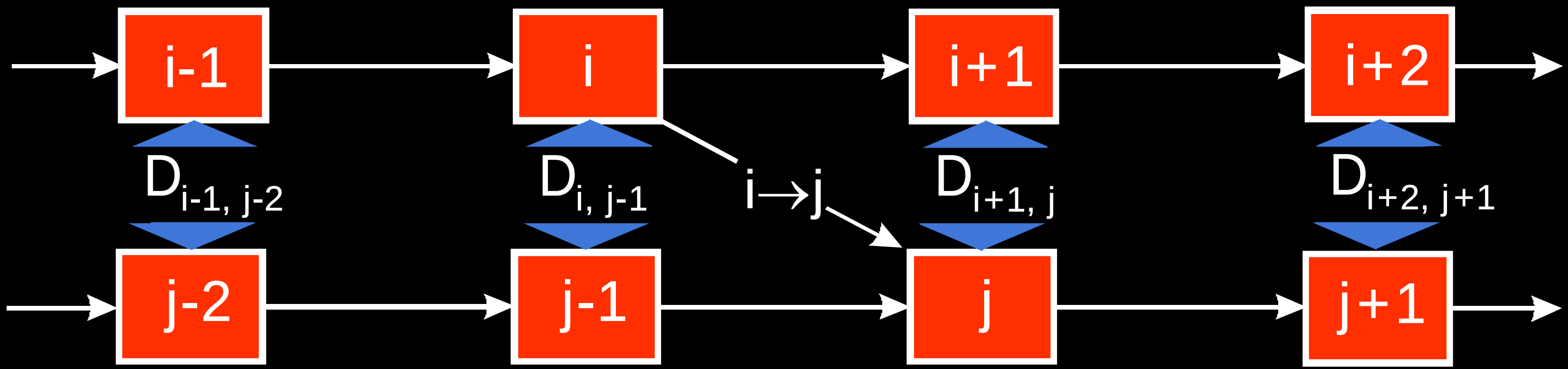
Preserving dynamics

Preserving dynamics



Preserving dynamics

- Cost for transition $i \rightarrow j$
  - $$C_{i \rightarrow j} = \sum_{k=-N}^{N-1} w_k \, D_{i+k+1,\, j+k}$$



Preserving dynamics – effect

- Cost for transition $i \to j$
  - $$C_{i \to j} = \sum_{k=-N}^{N-1} w_k D_{i+k+1,\, j+k}$$

Finding good loops

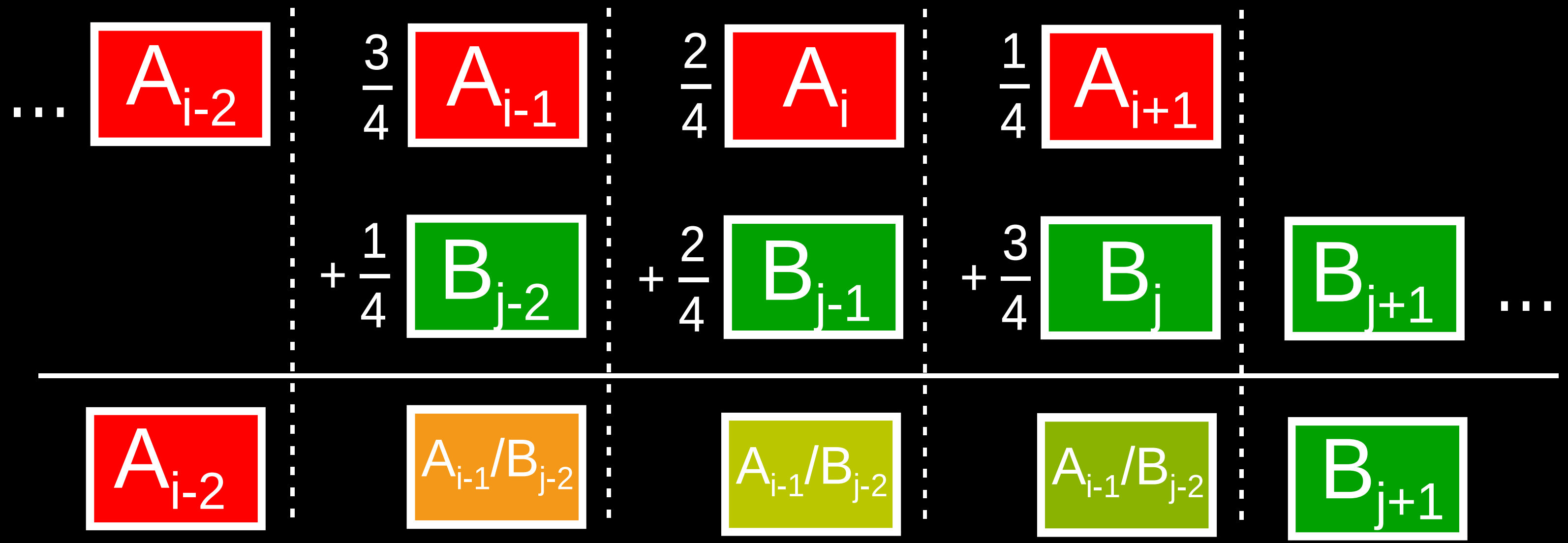
- Alternative to random transitions
- Precompute set of loops up front

Visual discontinuities

- Problem: Visible “Jumps”

Crossfading

- Solution: Crossfade from one sequence to the other.



Morphing

- Interpolation task:

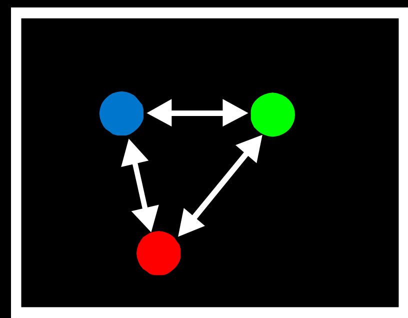
$$\frac{2}{5}\,\boxed{A} + \frac{2}{5}\,\boxed{B} + \frac{1}{5}\,\boxed{C}$$

Morphing

- Interpolation task:

$$\frac{2}{5}A + \frac{2}{5}B + \frac{1}{5}C$$

- Compute correspondence between pixels of all frames

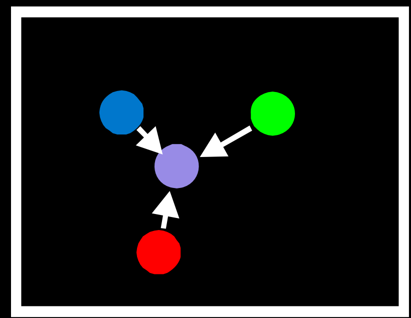


Morphing

- Interpolation task:

$$\frac{2}{5}\,\boxed{A} + \frac{2}{5}\,\boxed{B} + \frac{1}{5}\,\boxed{C}$$

- Compute correspondence between pixels of all frames



- Interpolate pixel position and color in morphed frame
- based on [Shum 2000]

Results – crossfading/morphing

Results – crossfading/morphing

Jump Cut　　Crossfade　　Morph

Crossfading

Frequent jump & crossfading

Video portrait

- Useful for web pages

Region-based analysis

- Divide video up into regions

- Generate a video texture for each region

User-controlled video textures

slow variable fast

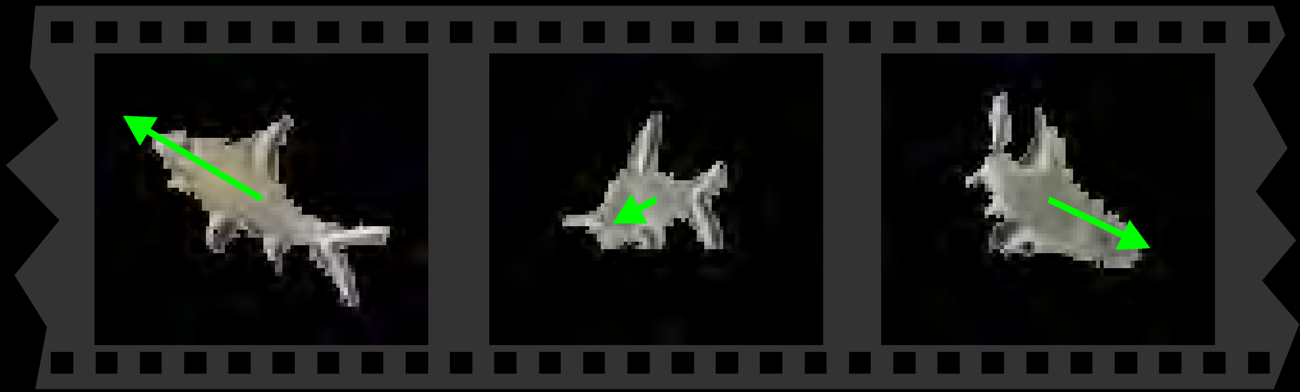
User selects target frame range

Video-based animation

- Like sprites computer games
- Extract sprites from real video
- Interactively control desired motion

Video sprite extraction

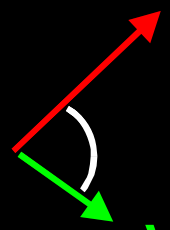
blue screen matting
and velocity estimation



Video sprite control

- Augmented transition cost:

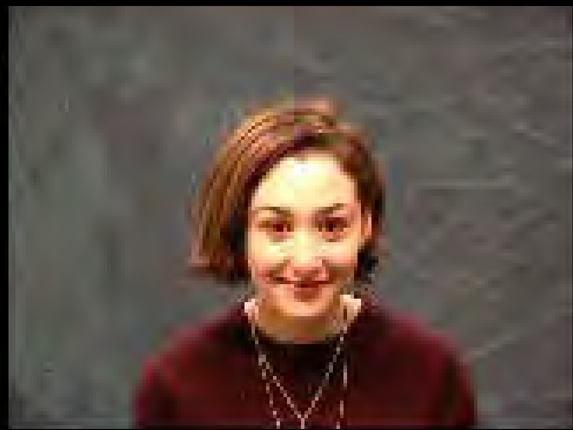
$$C^{\text{Animation}}_{i\to j} = \underbrace{\alpha\, C_{i\to j}}_{\text{Similarity term}} + \underbrace{\beta\, \text{angle}}_{\text{Control term}}$$



Interactive fish

Discussion

- Some things are relatively easy



Discussion

- Some are hard

A final example

Human Motion Synthesis

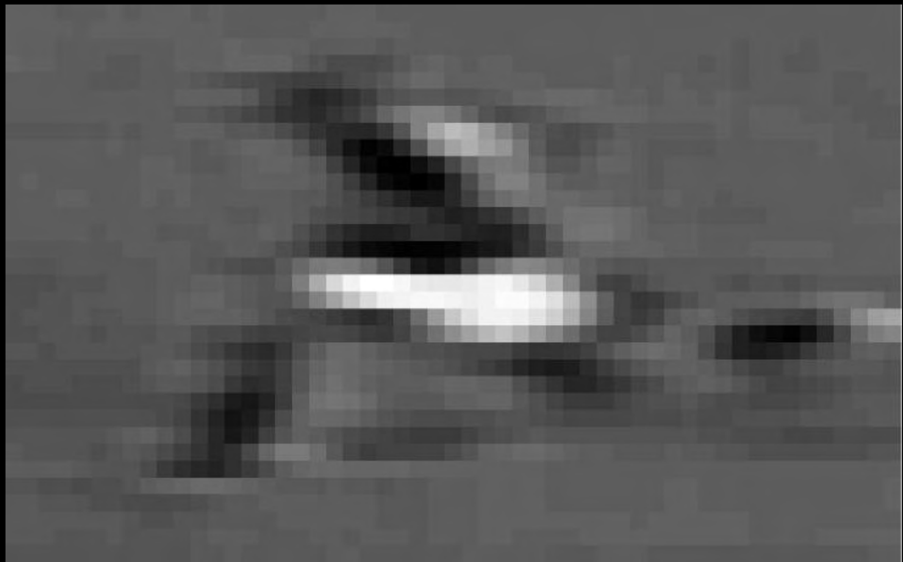
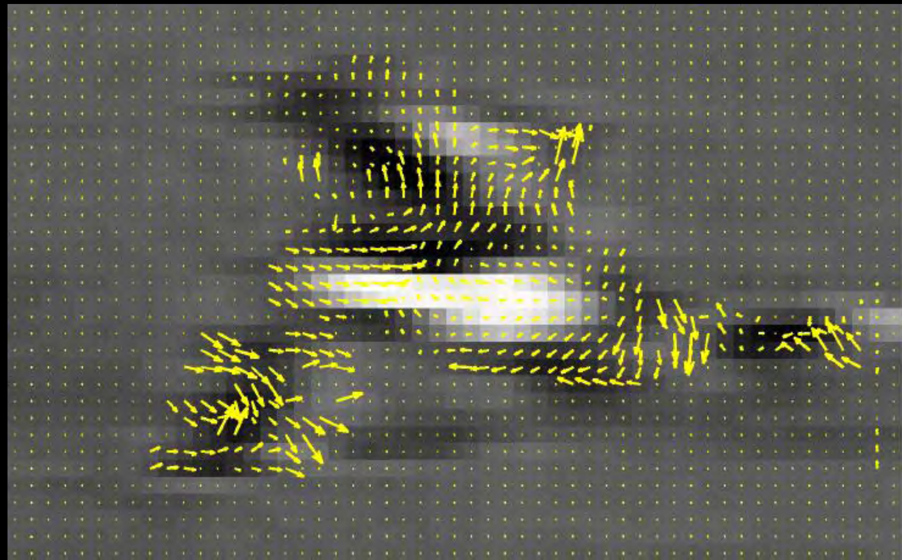
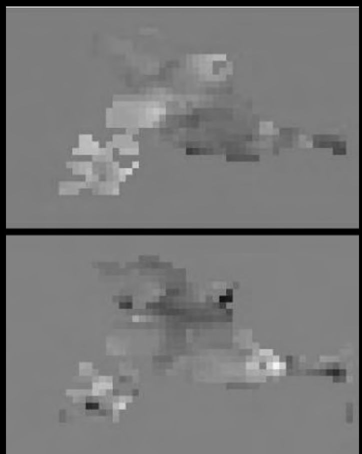


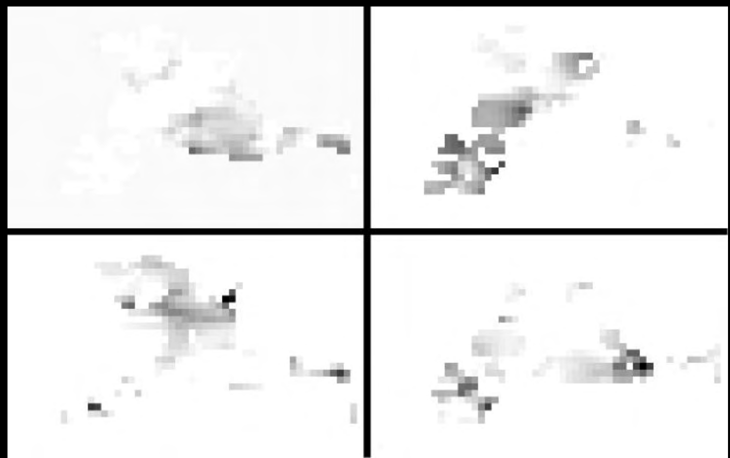
Image frame



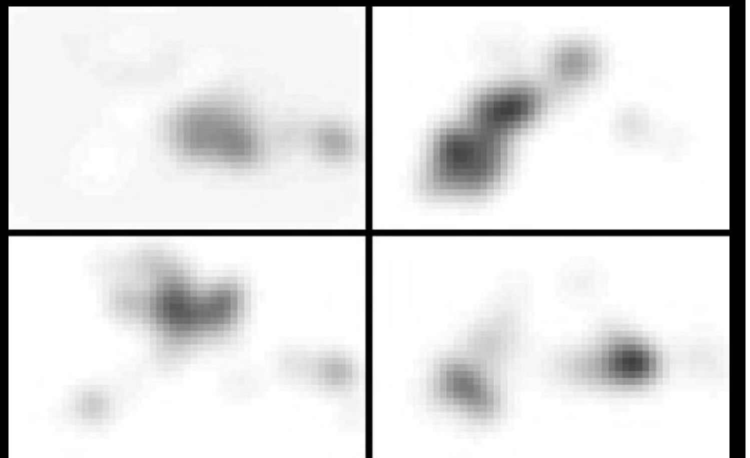
Optical flow $F_{x,y}$



F_x, F_y

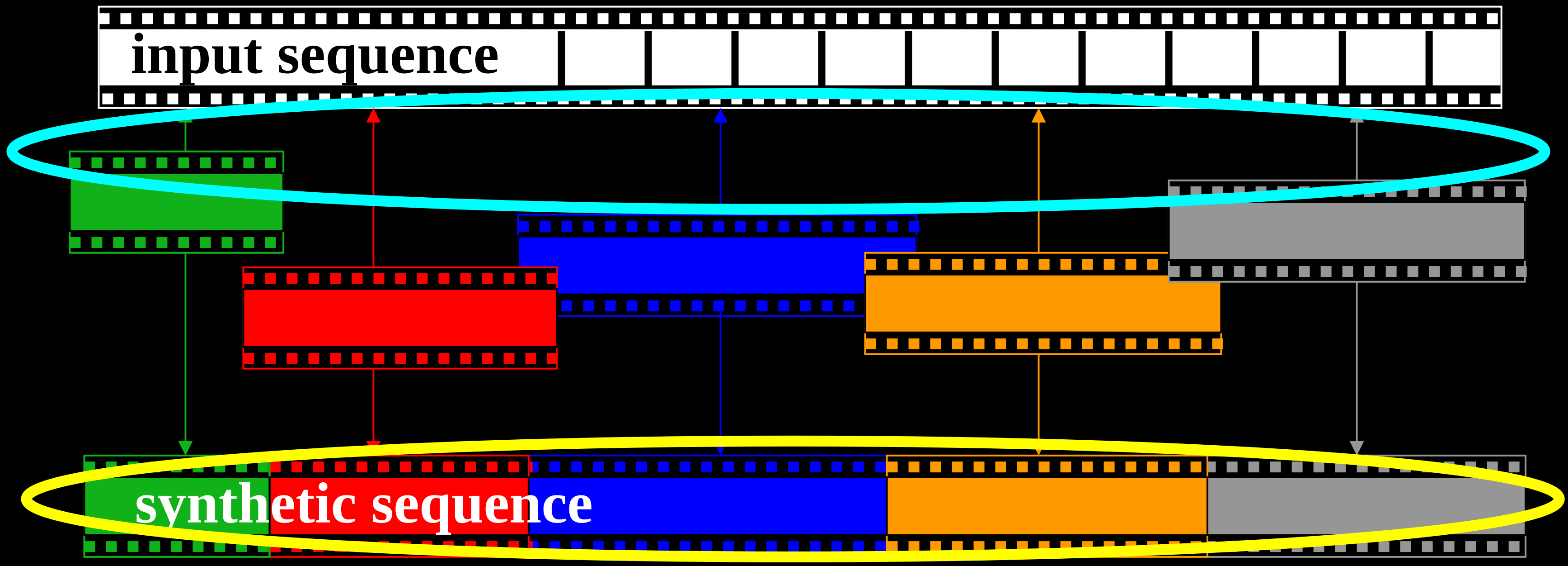


$F_x^-, F_x^+, F_y^-, F_y^+$



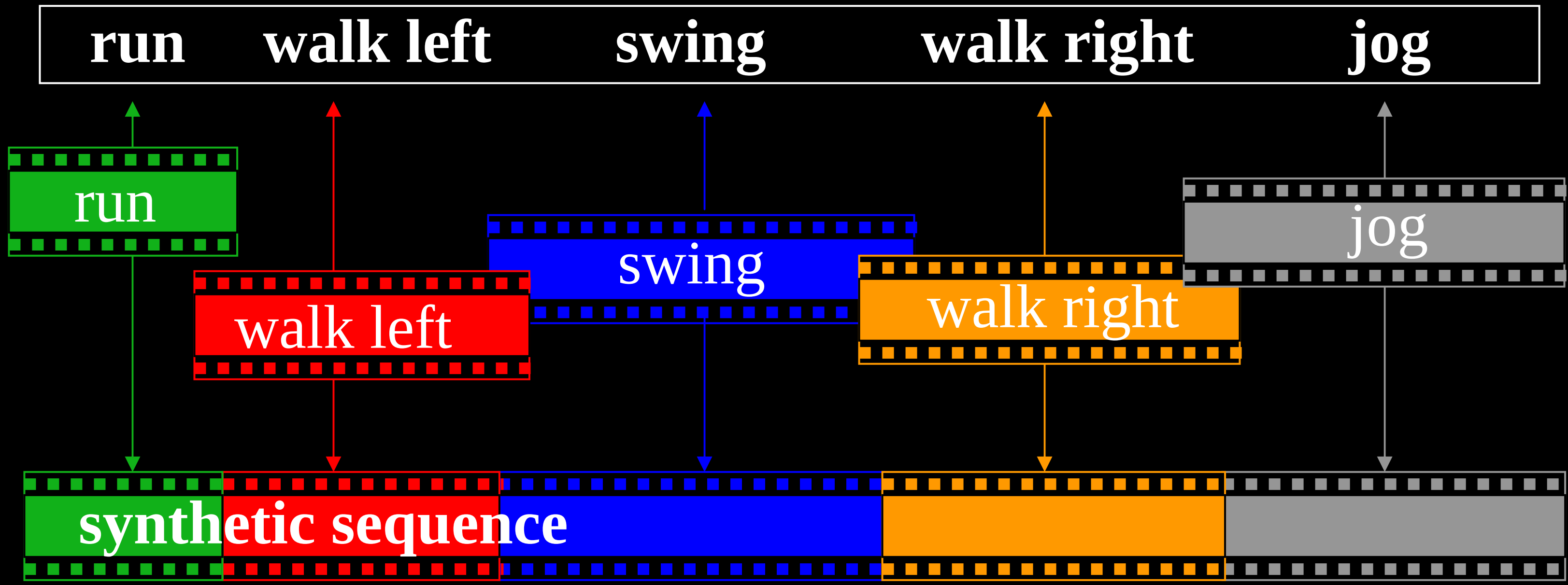
blurred $F_x^-, F_x^+, F_y^-, F_y^+$

“Do as I Do” Motion Synthesis



- Matching two things:
  - Motion similarity across sequences
  - Appearance similarity within sequence
- Dynamic Programming

“Do as I Say” Synthesis



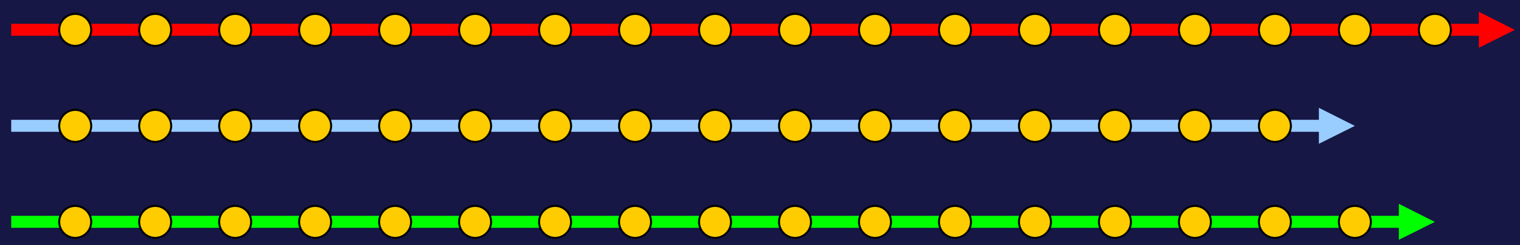
- Synthesize given action labels
  - – e.g. video game control

Actor Replacement

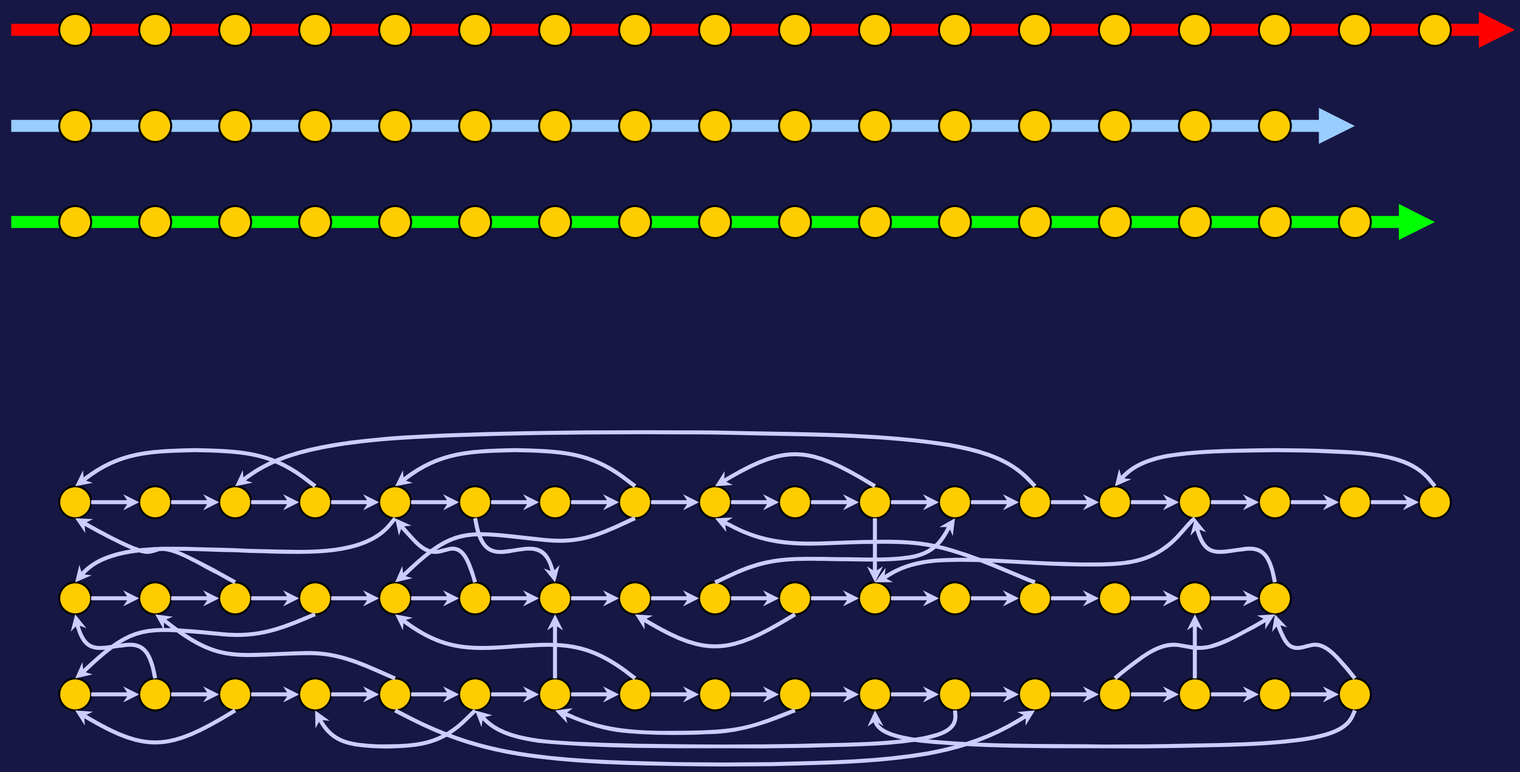
SHOW VIDEO

Sketch Interface

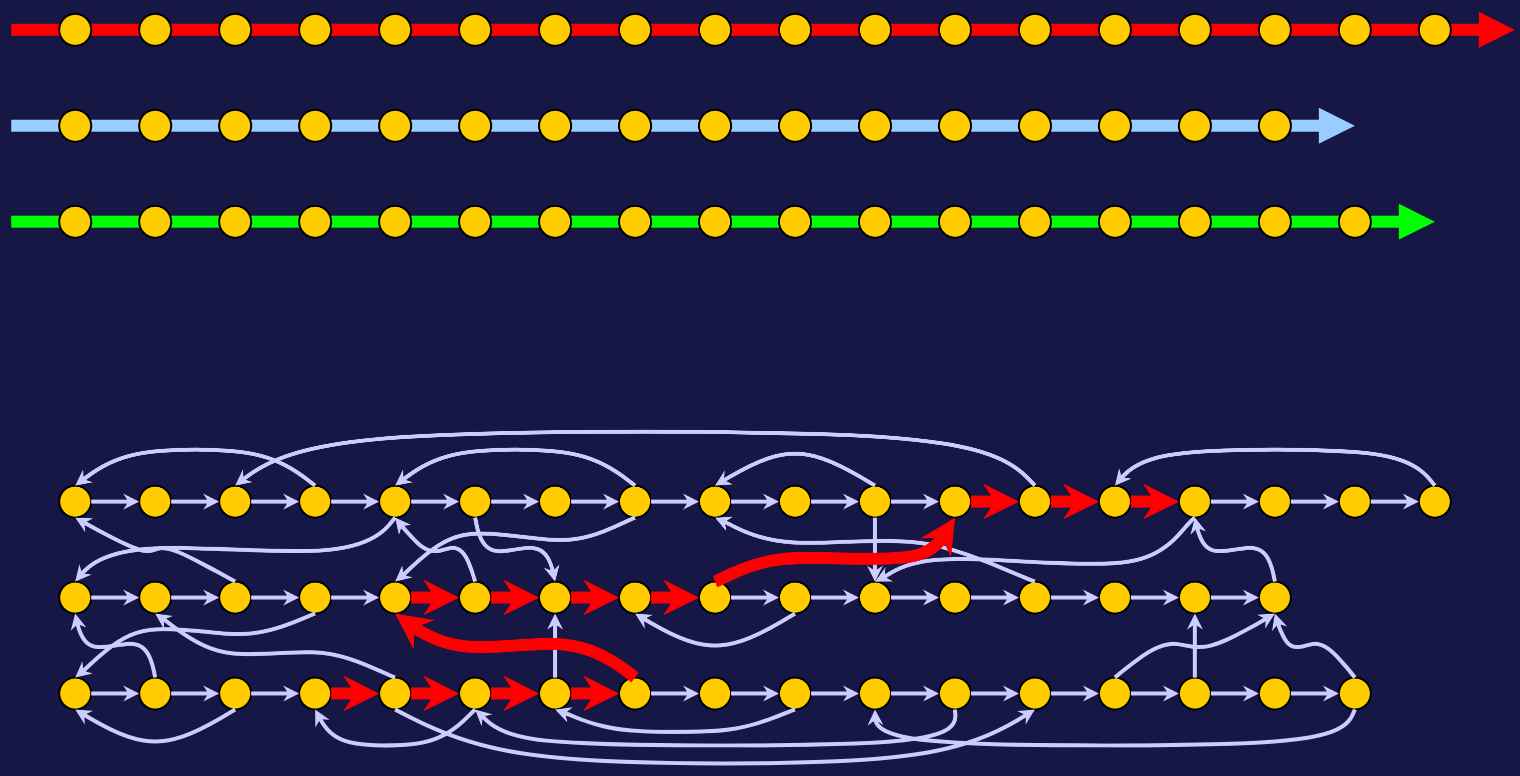
Unstructured Input Data



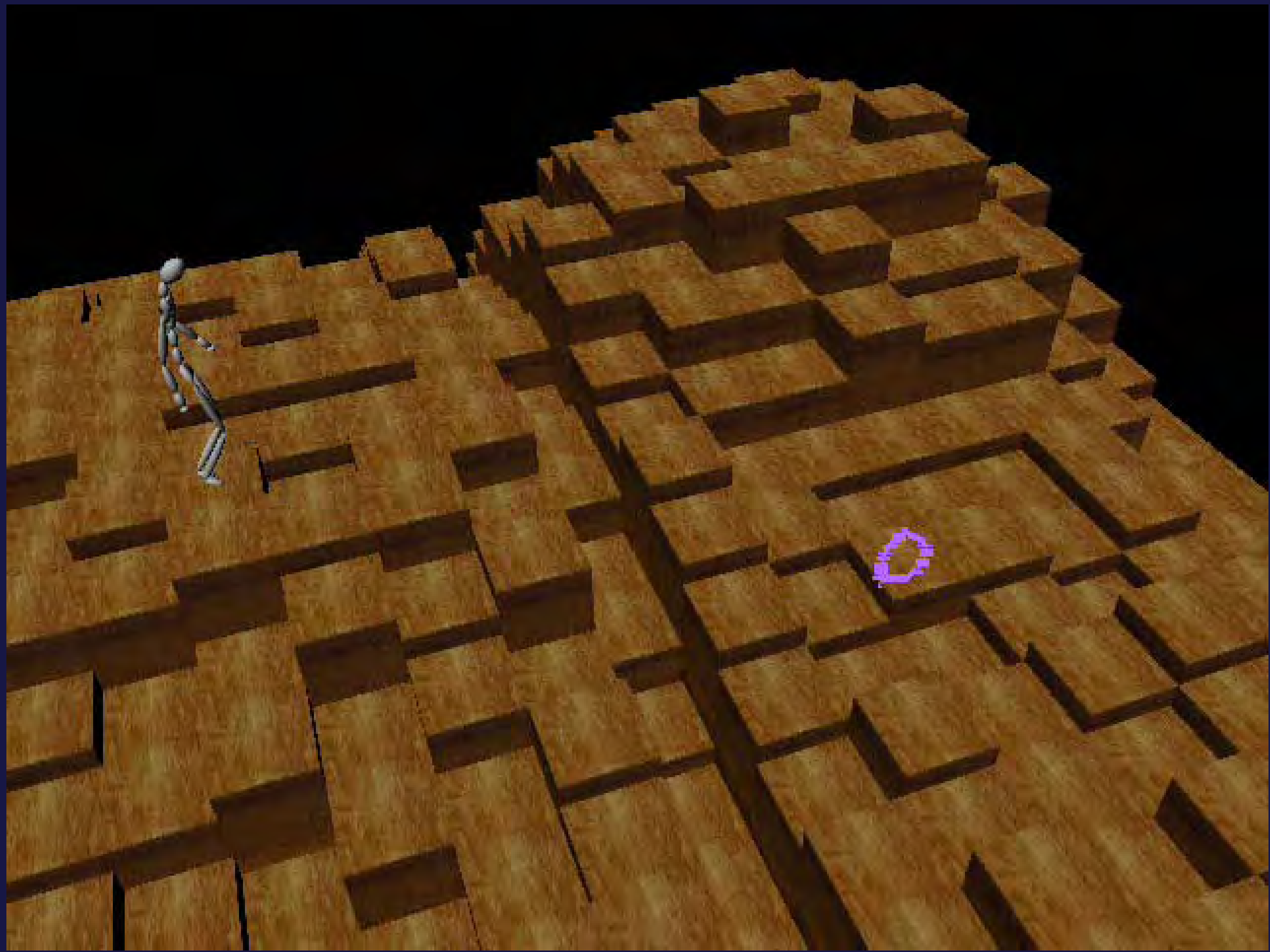
Connecting Transitions



Search to Find Path



Rough Terrain



Modeling the World from Photos on the Internet

Steve Seitz
University of Washington

Noah Snavely, Ian Simon, Brian Curless
University of Washington

Michael Goesele
TU Darmstadt

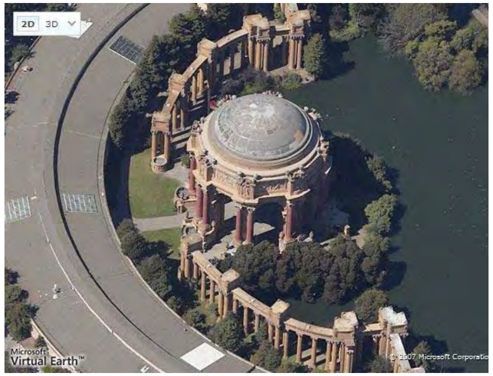
Hugues Hoppe, Rick Szeliski
Microsoft Research, Redmond

VRML Workshop, October 14, 2007

Billions of photos online

In situ
flickr.com

Street side
Google StreetView



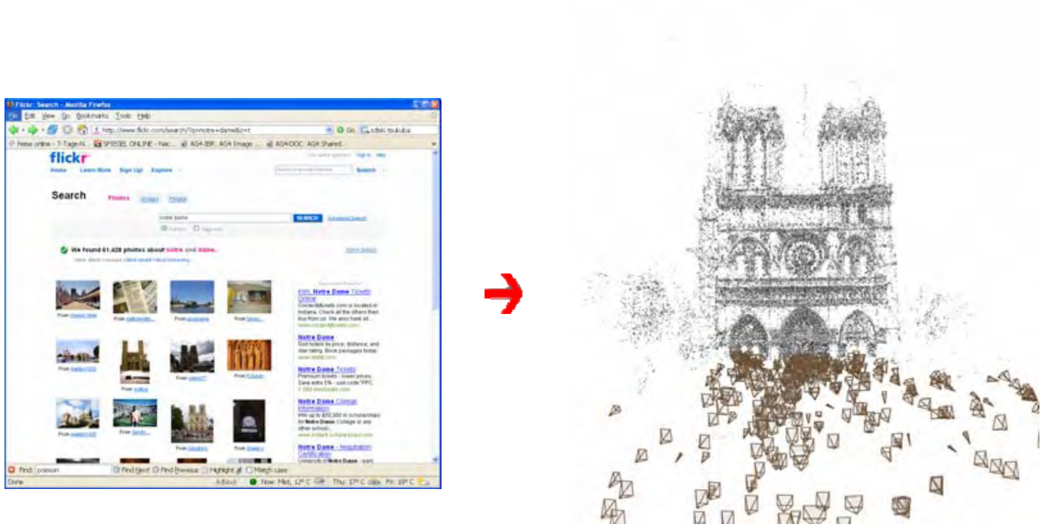
Oblique
local.live.com

Satellite
google.com

- Entire cities captured from ground and air

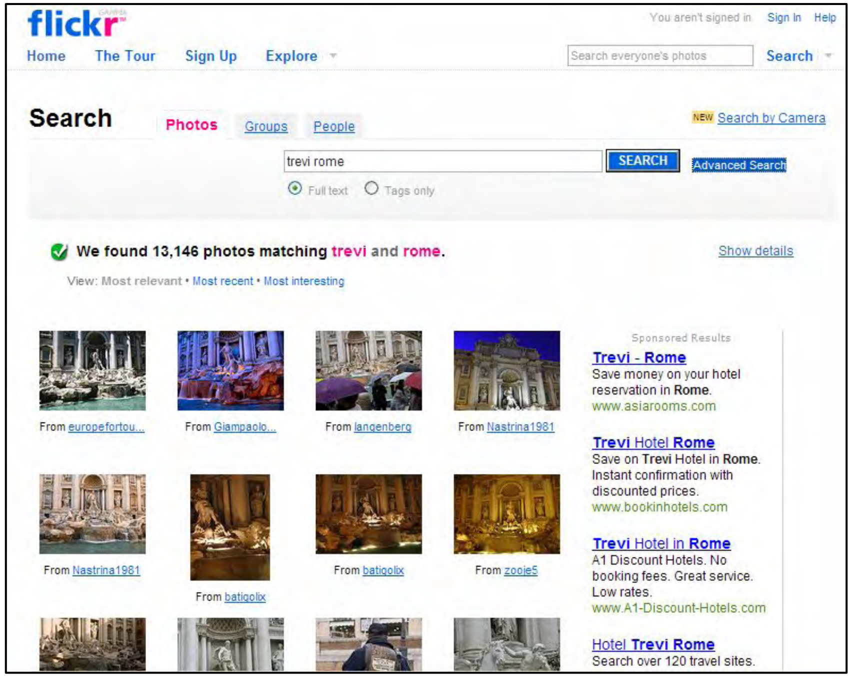
Billions of photos online

- We’re figuring out how to “calibrate” them
  - (more work remains to be done of course!)



- This will completely transform our field

Photo Tourism [with Noah Snavely, Rick Szeliski]

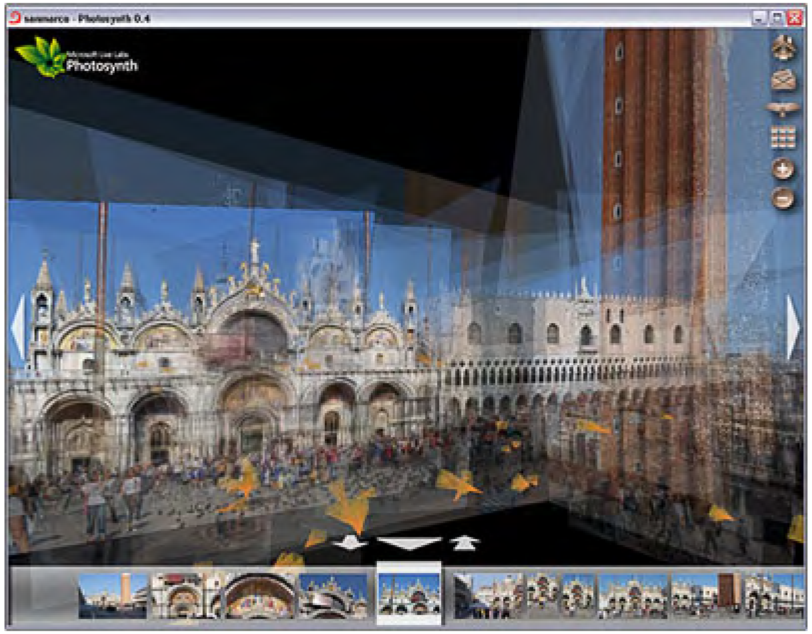


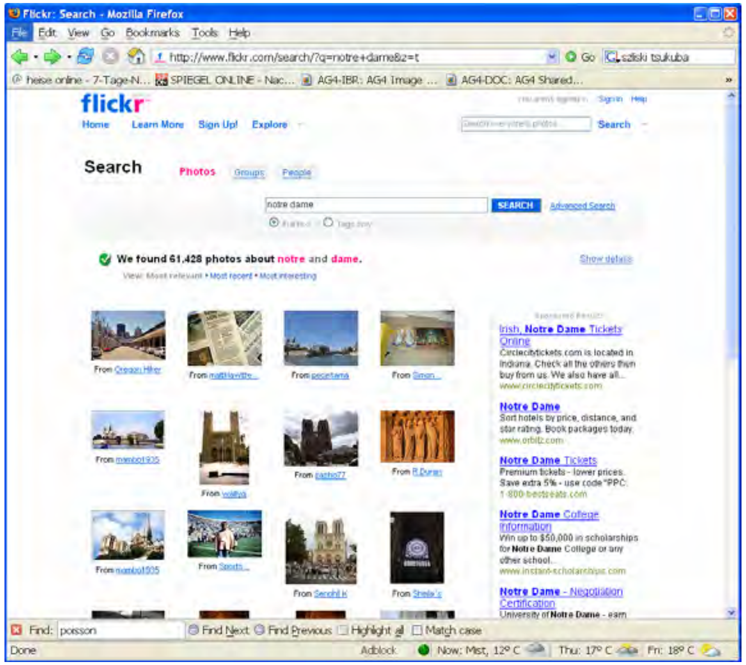
Images on the Internet

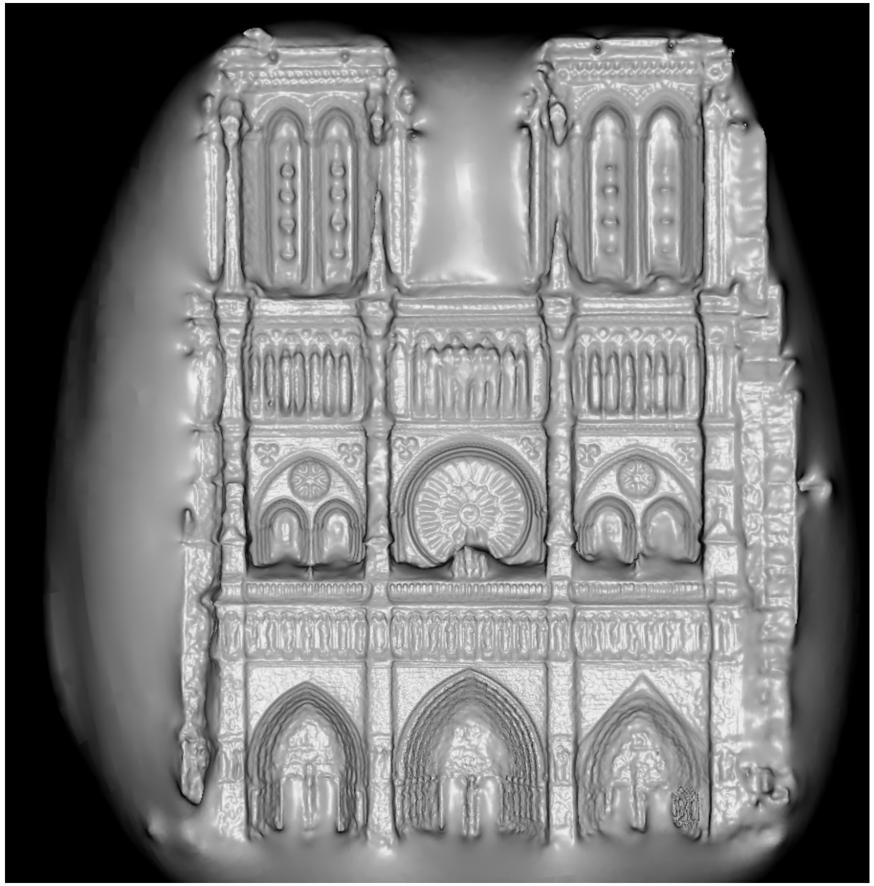
Computed 3D structure

Microsoft Live Labs Photosynth

- Photo Tourism licensed to Microsoft
- Microsoft *Live Labs* released **Photosynth** in 2006
  - image streaming architecture (SeaDragon)
  - scale to *all* of the world's photos
  - http://labs.live.com/photosynth




Flickr: Search - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://www.flickr.com/search/?q=notre+dame&z=t
flickr
Home Learn More Sign Up! Explore
Search
Search
Photos Groups People
notre dame
SEARCH
Advanced Search
We found 61,428 photos about notre and dame.
Show details
Irish, Notre Dame Tickets Online
Notre Dame
Sort hotels by price, distance, and star rating. Book packages today.
Notre Dame Tickets
Premium tickets - lower prices.
Notre Dame College Information
Win up to $50,000 in scholarships for Notre Dame College or any other school.
Notre Dame - Negotiation Certification
Find: poisson
Find Next Find Previous Highlight all Match case
Done



Challenges

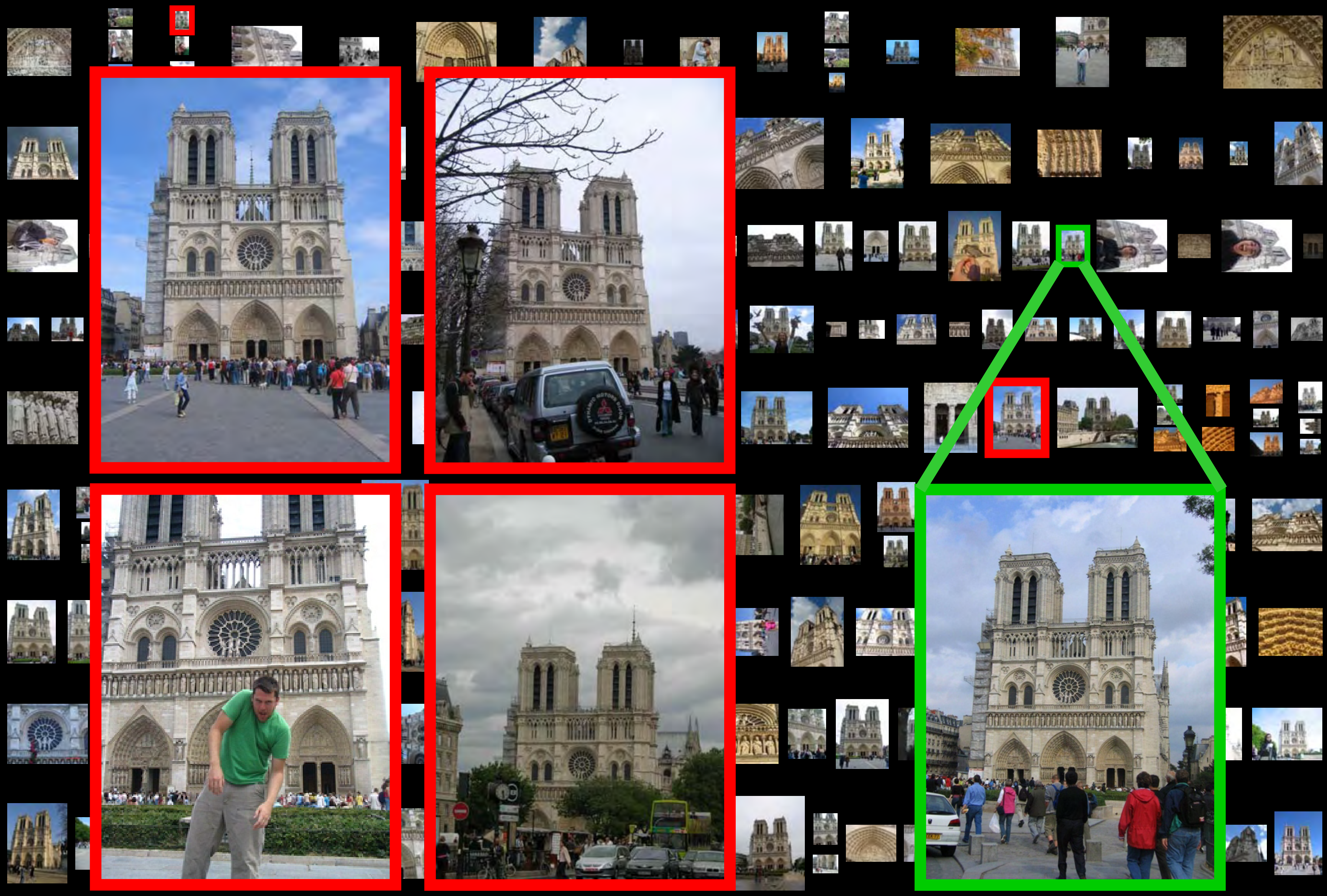
- appearance variation

- resolution

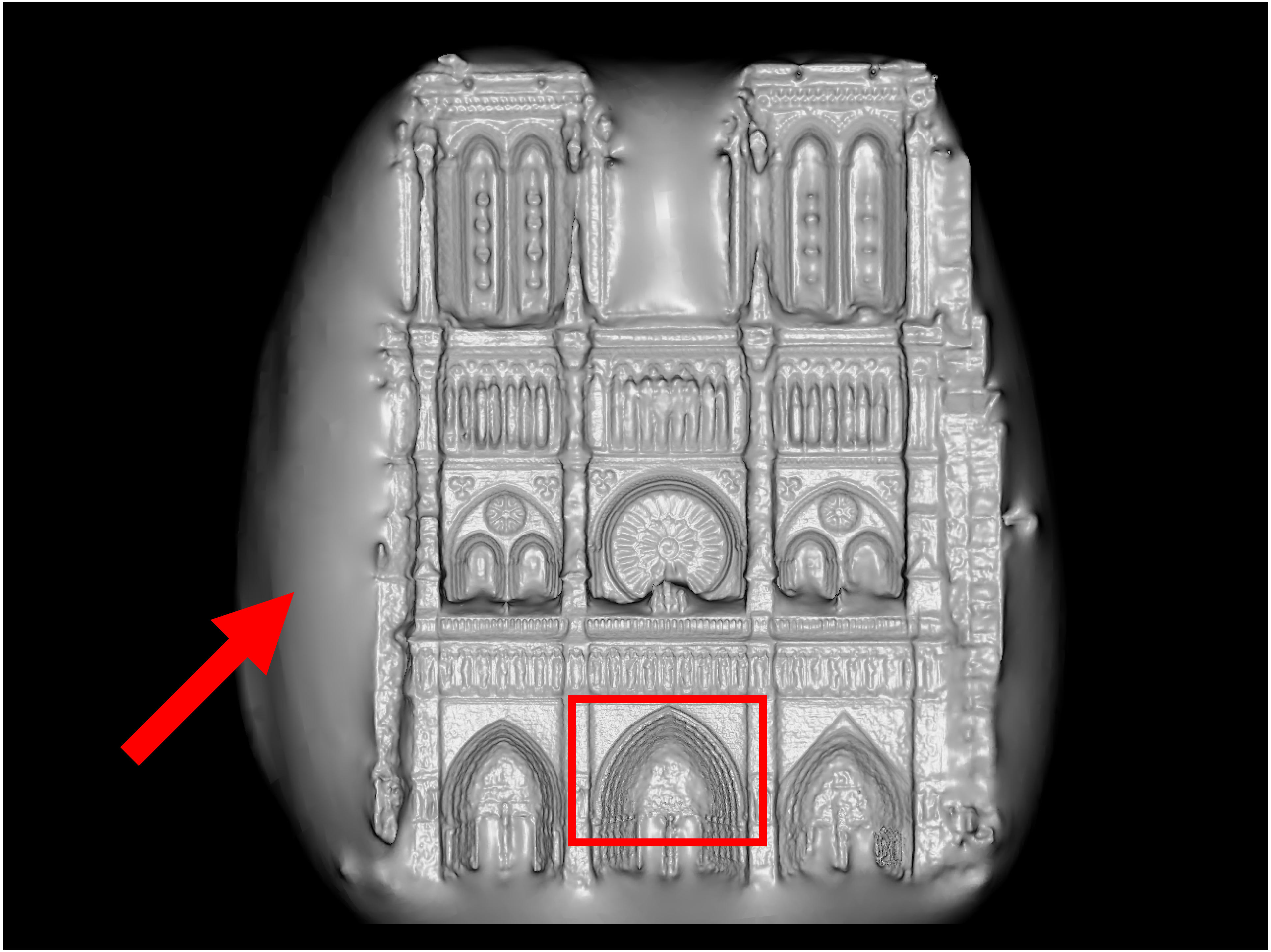
- massive collections

82,754 results for photos matching **notre** and **dame** and **paris**.

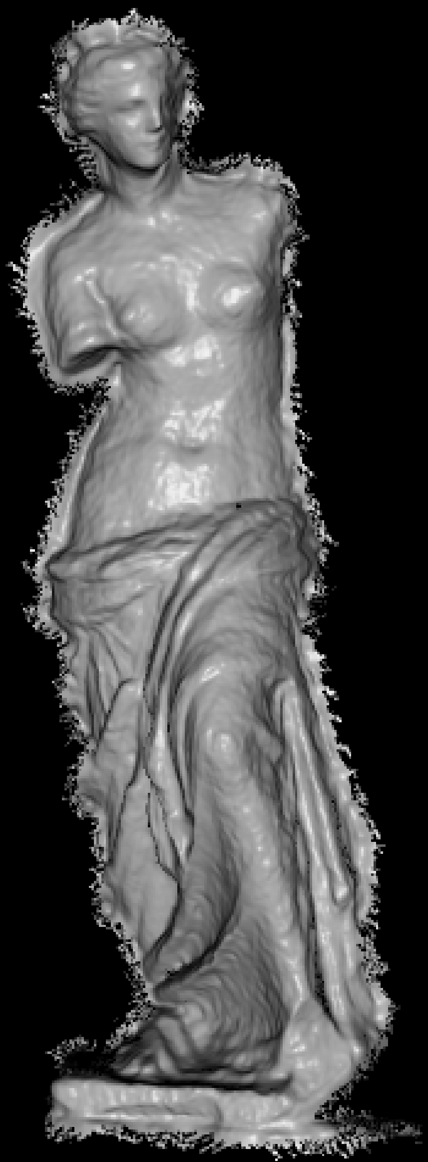
Law of Large Image Collections



206 *Flickr* images taken by 92 photographers

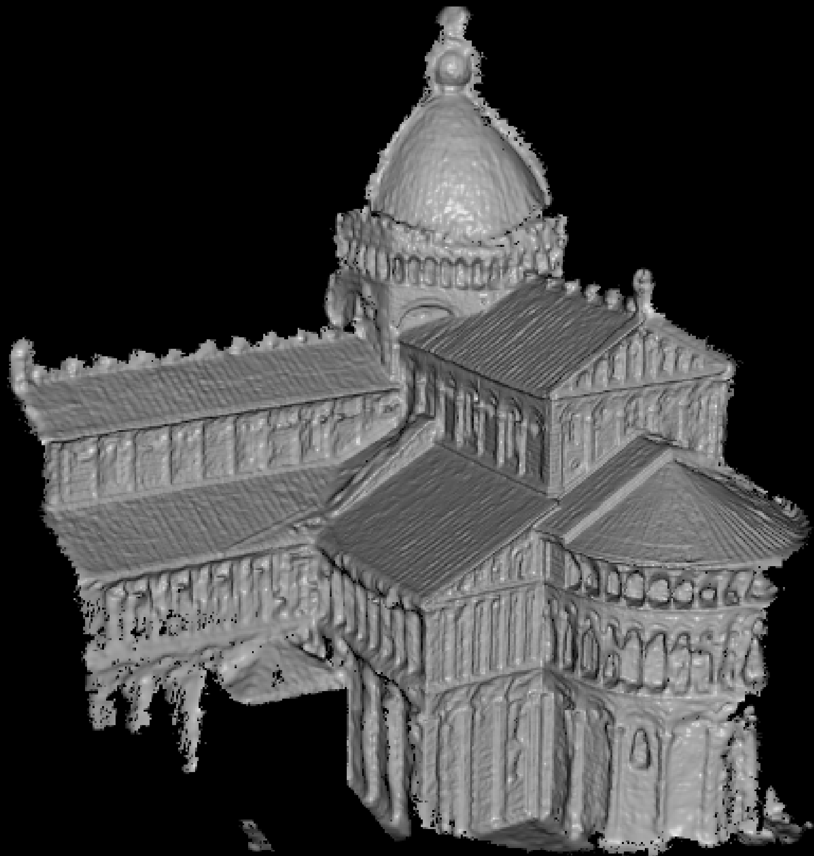


129 *Flickr* images taken by 98 photographers

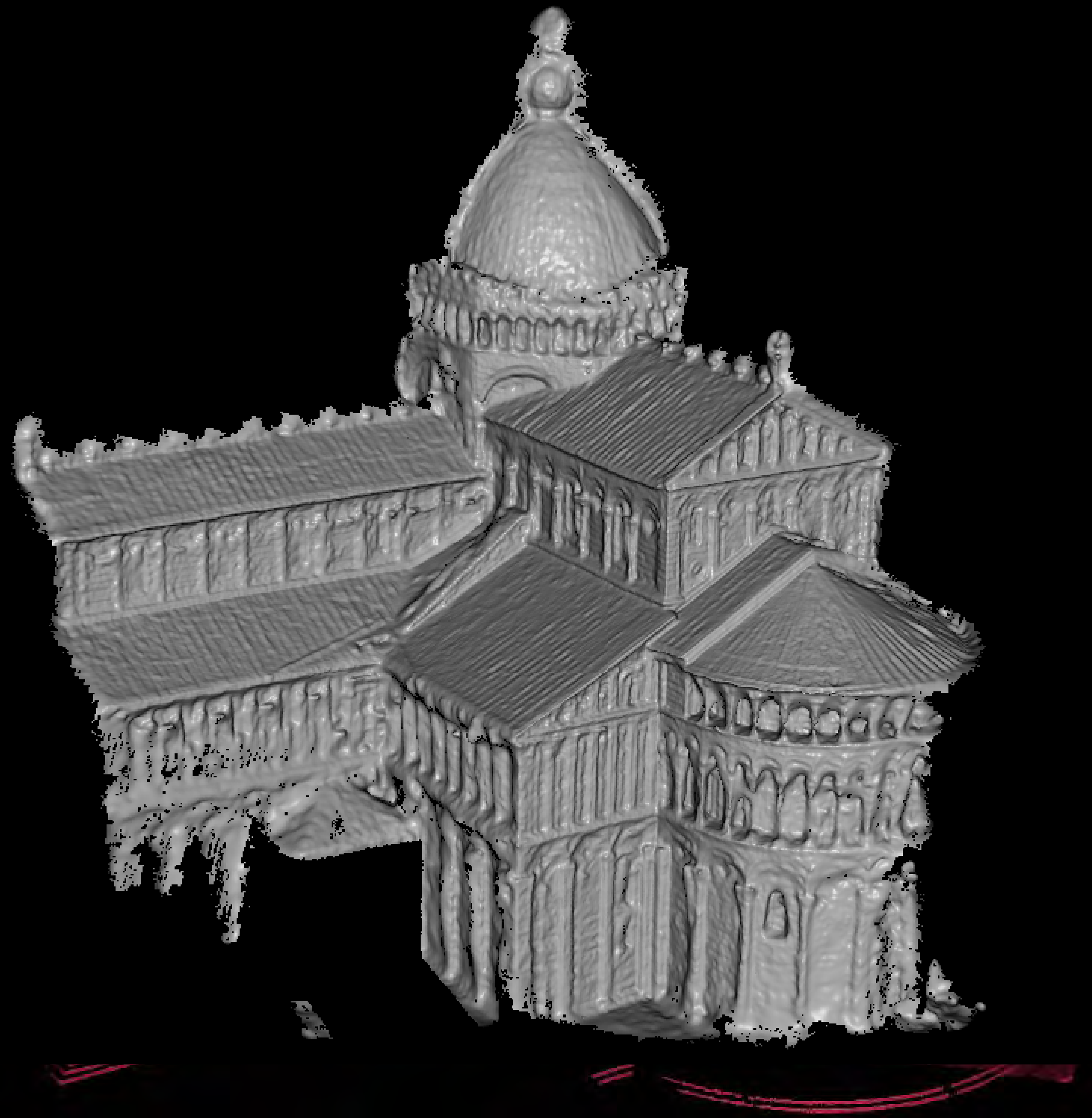


(preliminary) merged model of Venus de Milo

56 *Flickr* images taken by 8 photographers



merged model of Pisa Cathedral



Accuracy compared to laser scanned model:
90% of points within *0.25%* of ground truth

Scene Completion Using Millions of Photographs

James Hays and Alexei A. Efros

Carnegie Mellon University

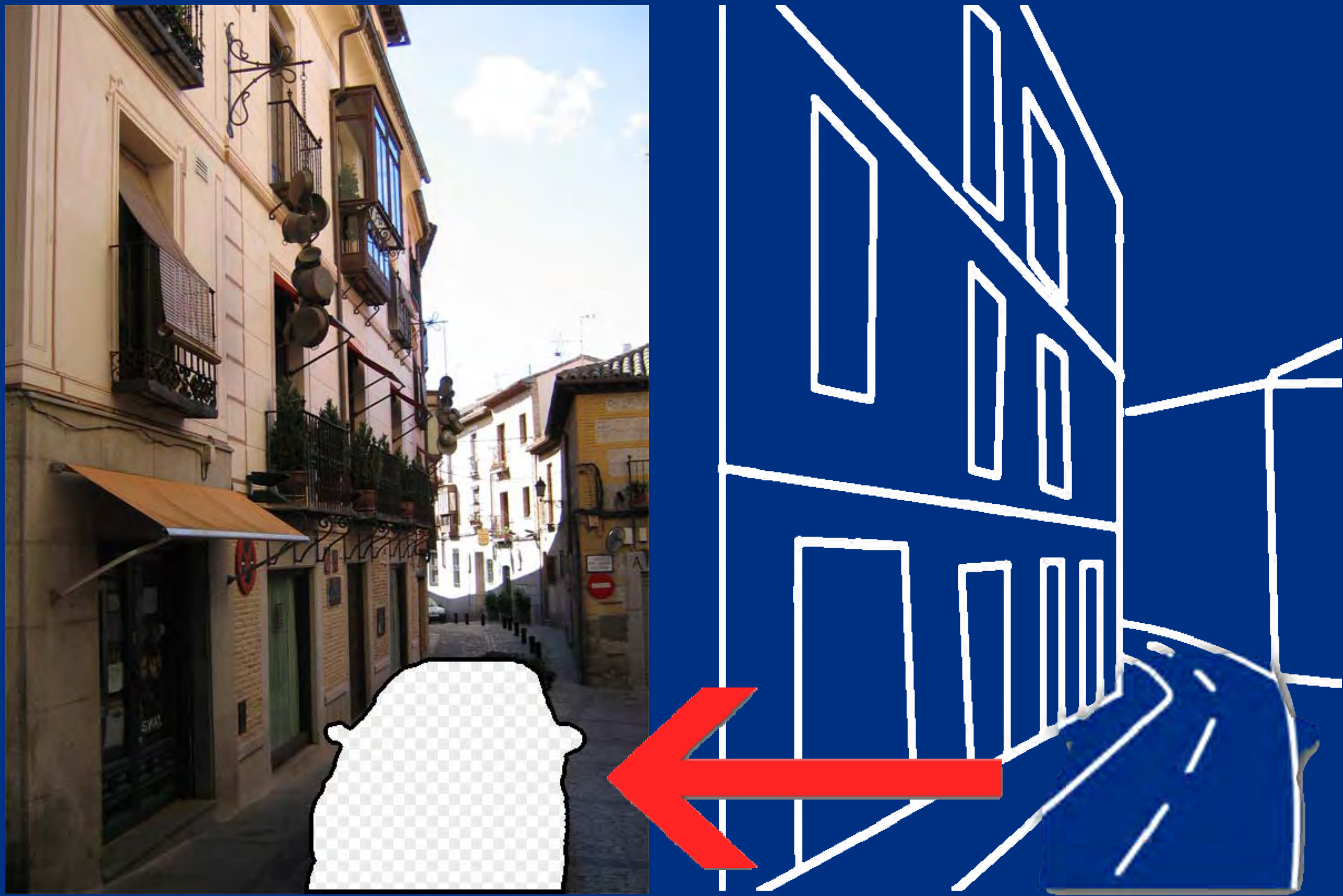

5407 BWL

Efros and Leung result

Criminisi et al. result

Criminisi et al. result

Scene Matching for Image Completion



alley

Search Images | Search the Web

Advanced Image Search
Preferences

Strict SafeSearch is on

Images Showing: All image sizes

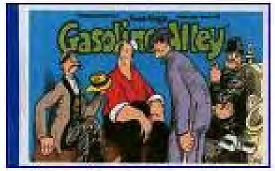
Results **1** - **20** of about **908,000** for **alley** [definition] with **Safesearch on**. (**0.07** seconds)

Change **Alley** Aerial Plaza with its ...
300 x 400 - 21k
en.wikipedia.org

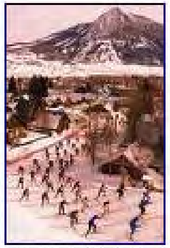
The Printer's **Alley** sign looking **...**
679 x 450 - 469k - jpg
franklin.thefuntimesguide.com

Looking west past Printers **Alley**.
679 x 450 - 464k - jpg
franklin.thefuntimesguide.com

More Bubble Gum **Alley** photos can be **...**
764 x 591 - 33k - gif
www.locallinks.com



Gasoline **Alley** gang
692 x 430 - 177k - jpg
newcritics.com



2007 **Alley** Loop Sponsors
300 x 453 - 51k - jpg
www.cbnordic.org

Change **Alley** : interior
550 x 413 - 98k
infopedia.nlb.gov.sg

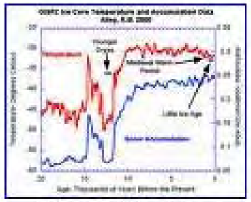
Earl G. **Alley ...**
321 x 383 - 19k - jpg
www.msstate.edu

Gun **Alley** 8.5x11 Full Color Ink Wash **...**
390 x 301 - 14k - jpg
www.rorschachentertainment.com

Grace Court **Alley**
732 x 549 - 98k - jpg
www.bridgeandtunnelclub.com

Grace Court **Alley**
732 x 549 - 80k - jpg
www.bridgeandtunnelclub.com

panoramic photo of Alligator **Alley**
4902 x 460 - 1048k - jpg
sflwww.er.usgs.gov



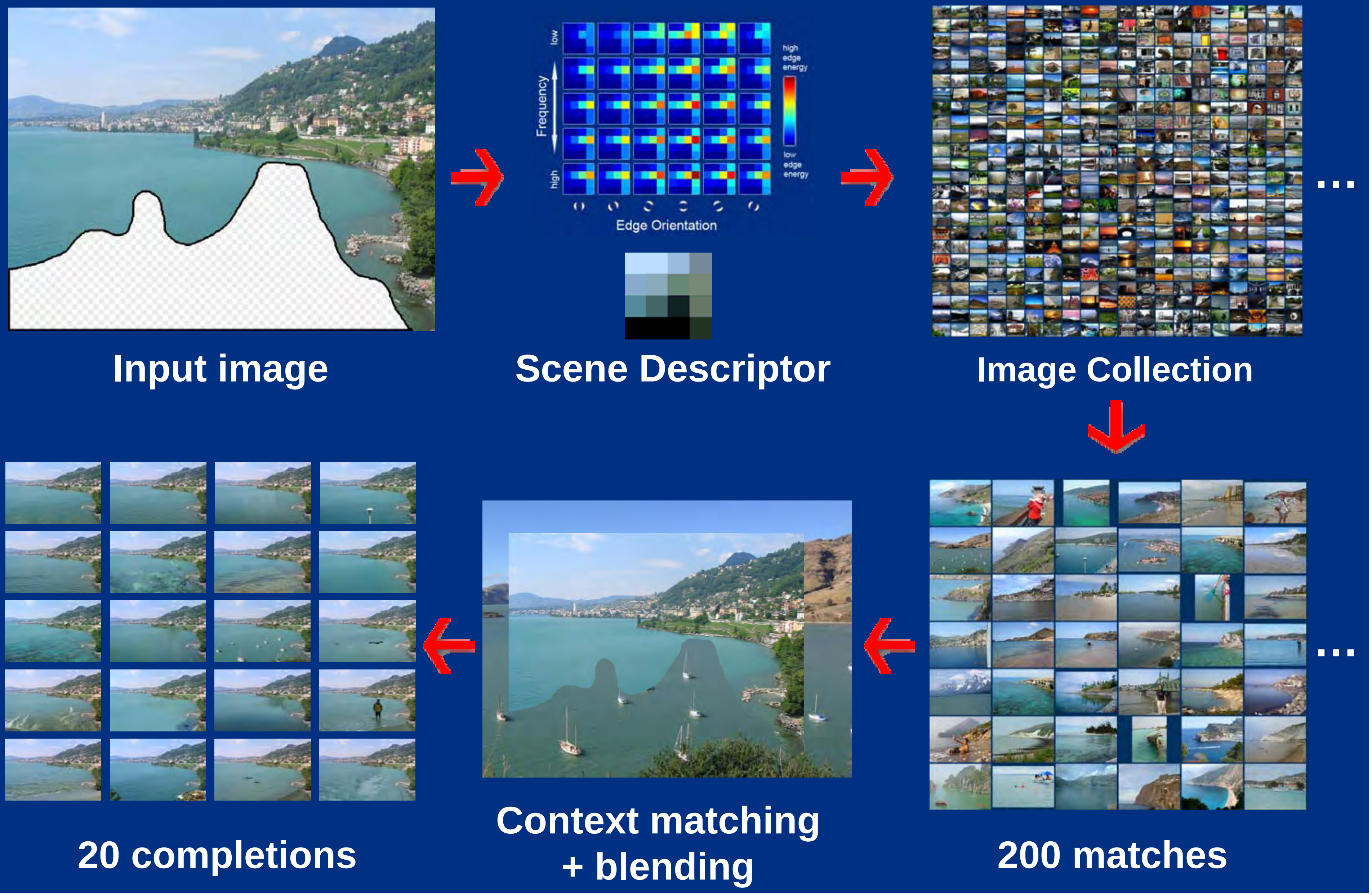
Richard B. **Alley**
450 x 361 - 29k - gif
www.ncdc.noaa.gov

Also, Chicken **Alley** is reported to **...**
450 x 337 - 82k
phidoux.typepad.com

Ego **Alley**
500 x 375 - 48k - jpg
dc.about.com

Scene Completion Result

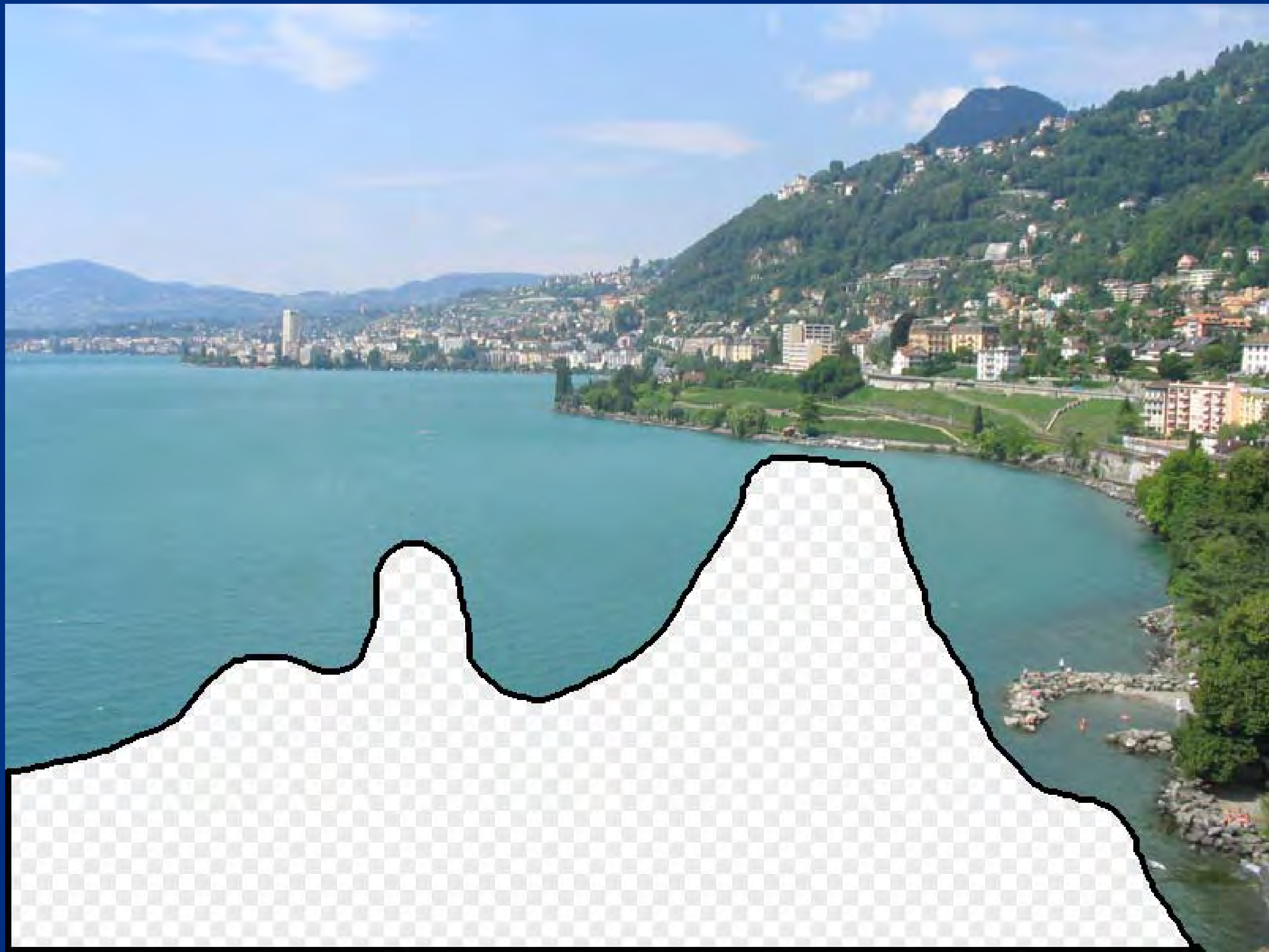
The Algorithm



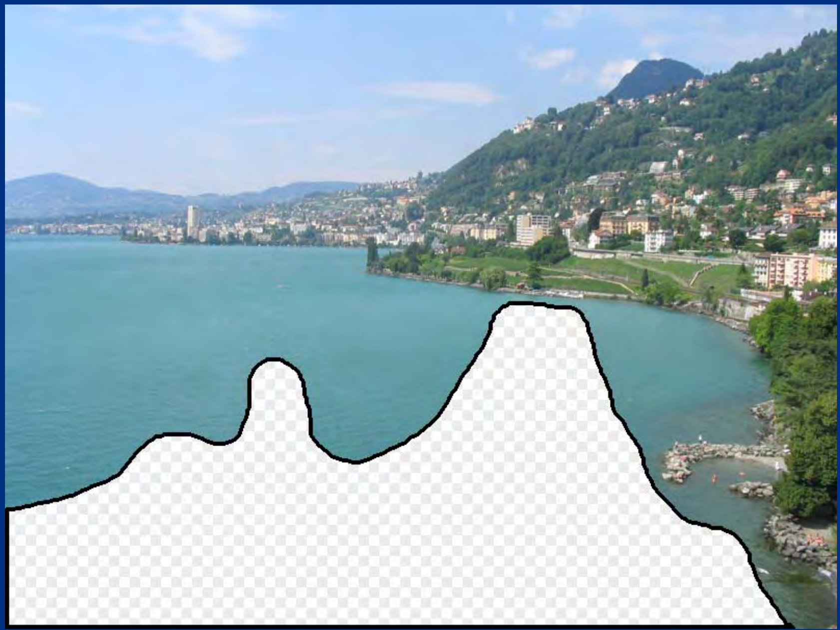
Data

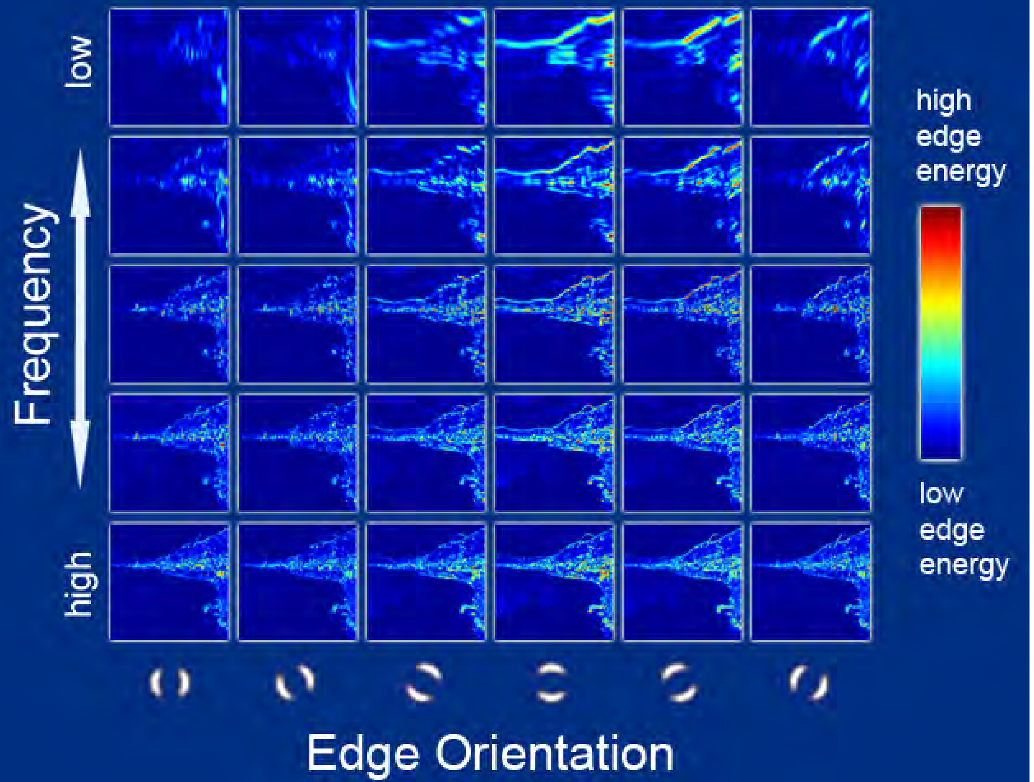
We downloaded **2.3 Million** unique images from Flickr groups and keyword searches.

Scene Matching

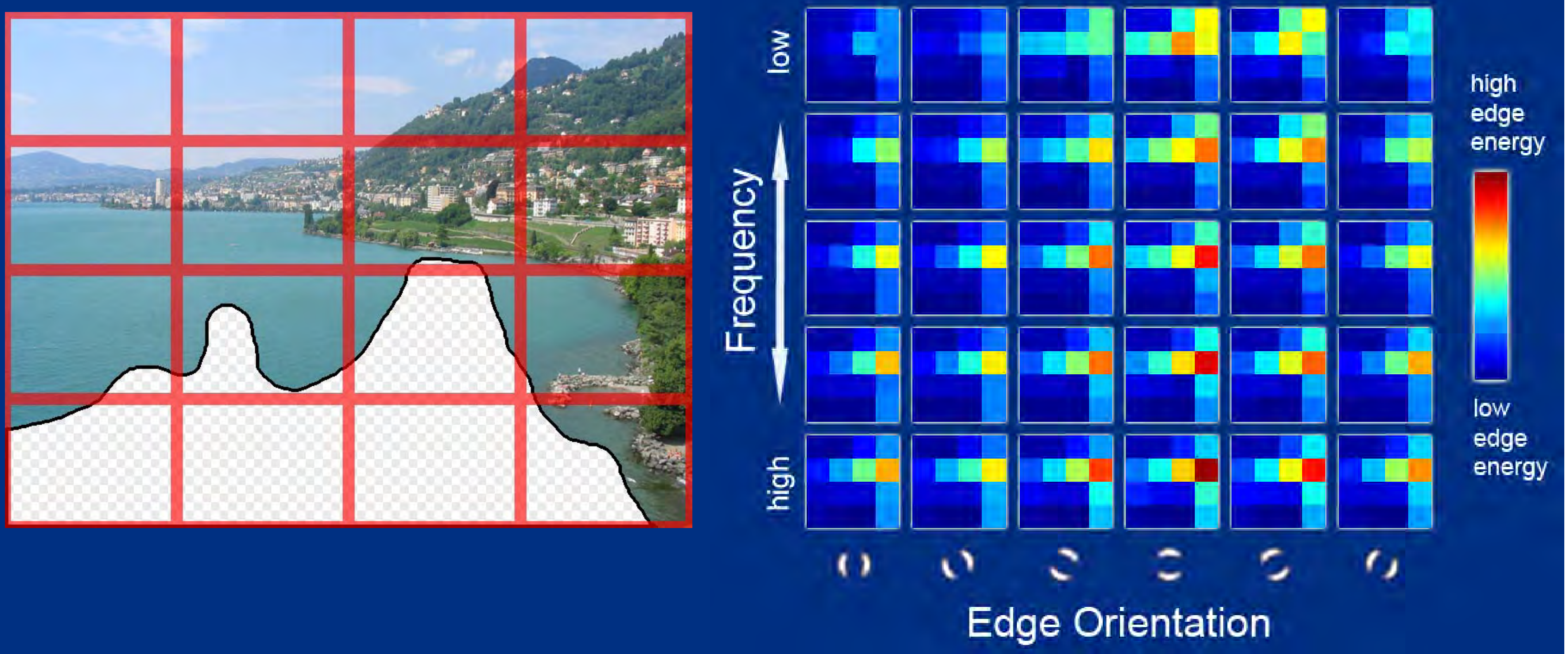


Scene Descriptor

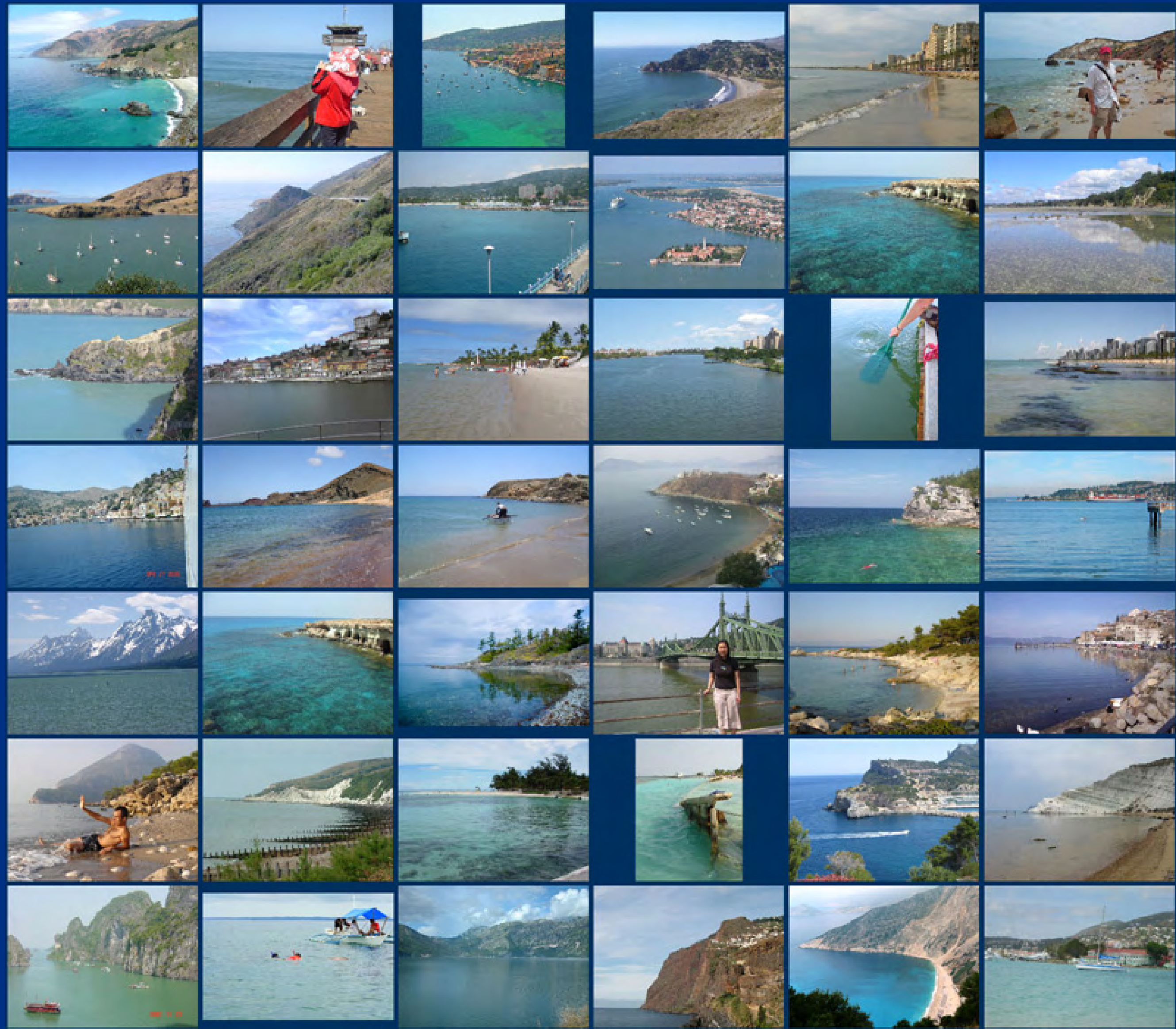




Scene Descriptor

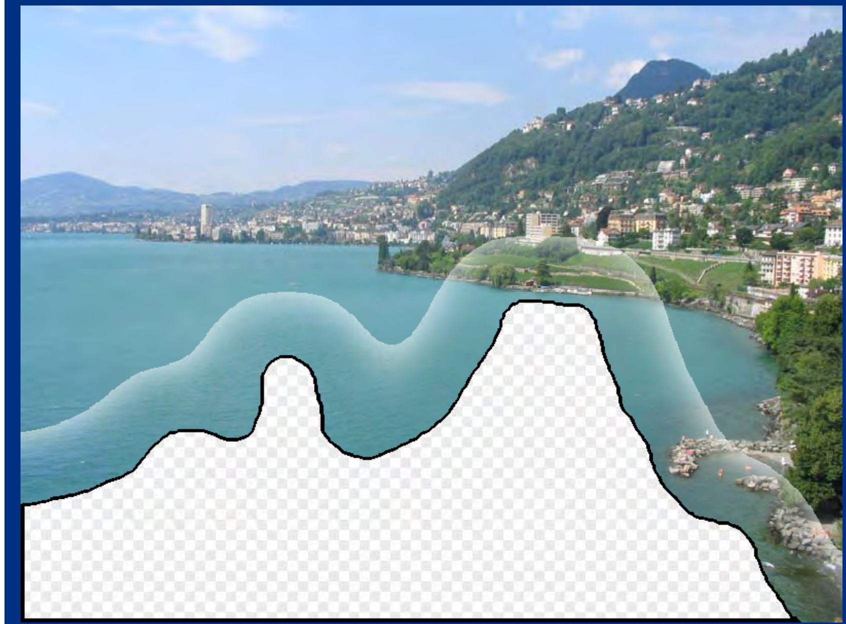


Gist scene descriptor
(Oliva and Torralba 2001)



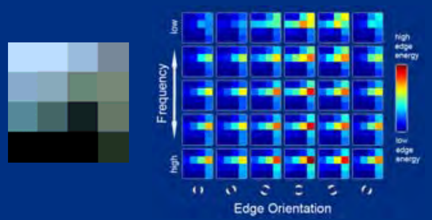
… 200 total

Context Matching



Result Ranking

We assign each of the 200 results a score which is the sum of:



The scene matching distance

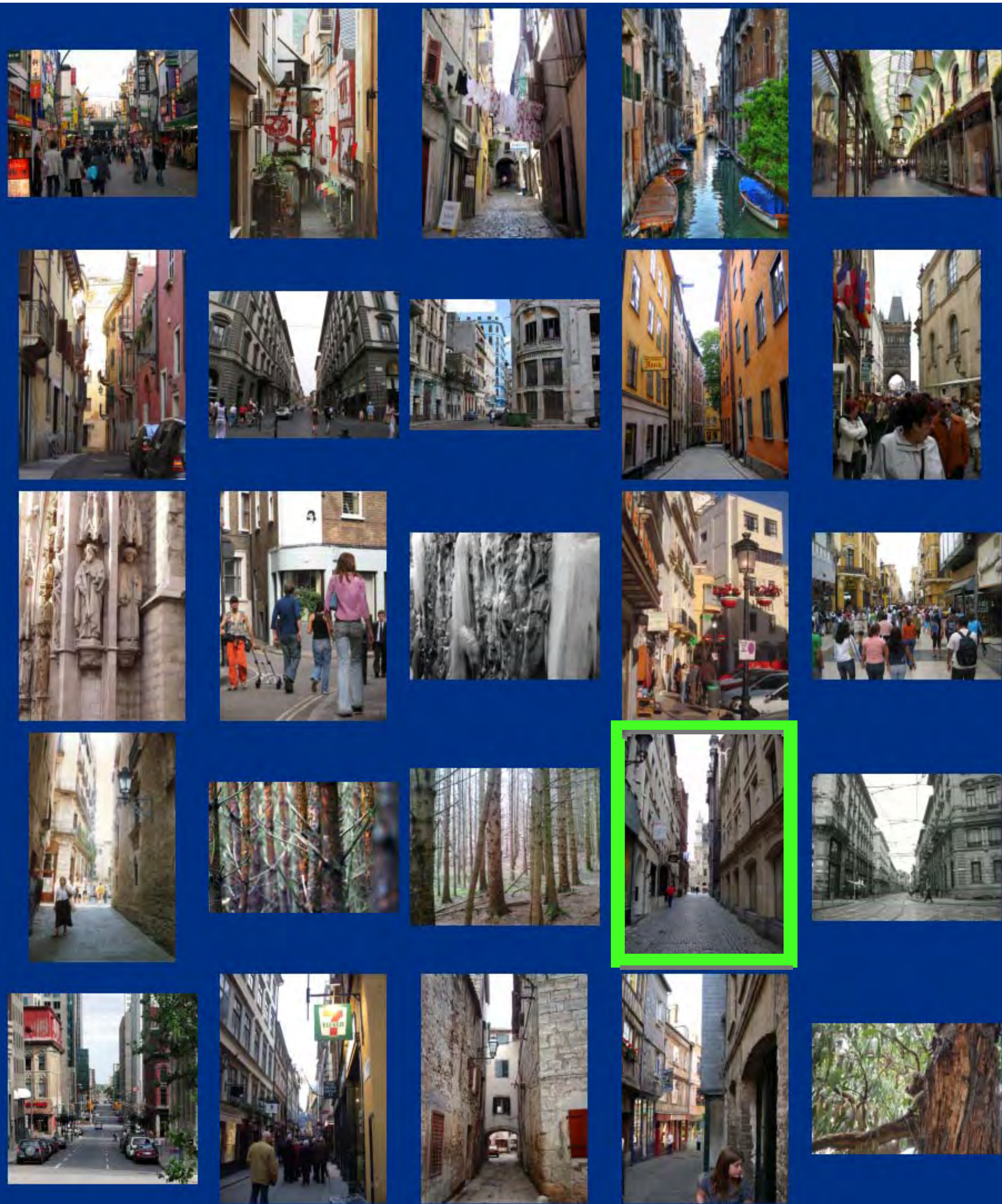
The context matching distance
(color + texture)

The graph cut cost

Top 20 Results


OCT 30 2003

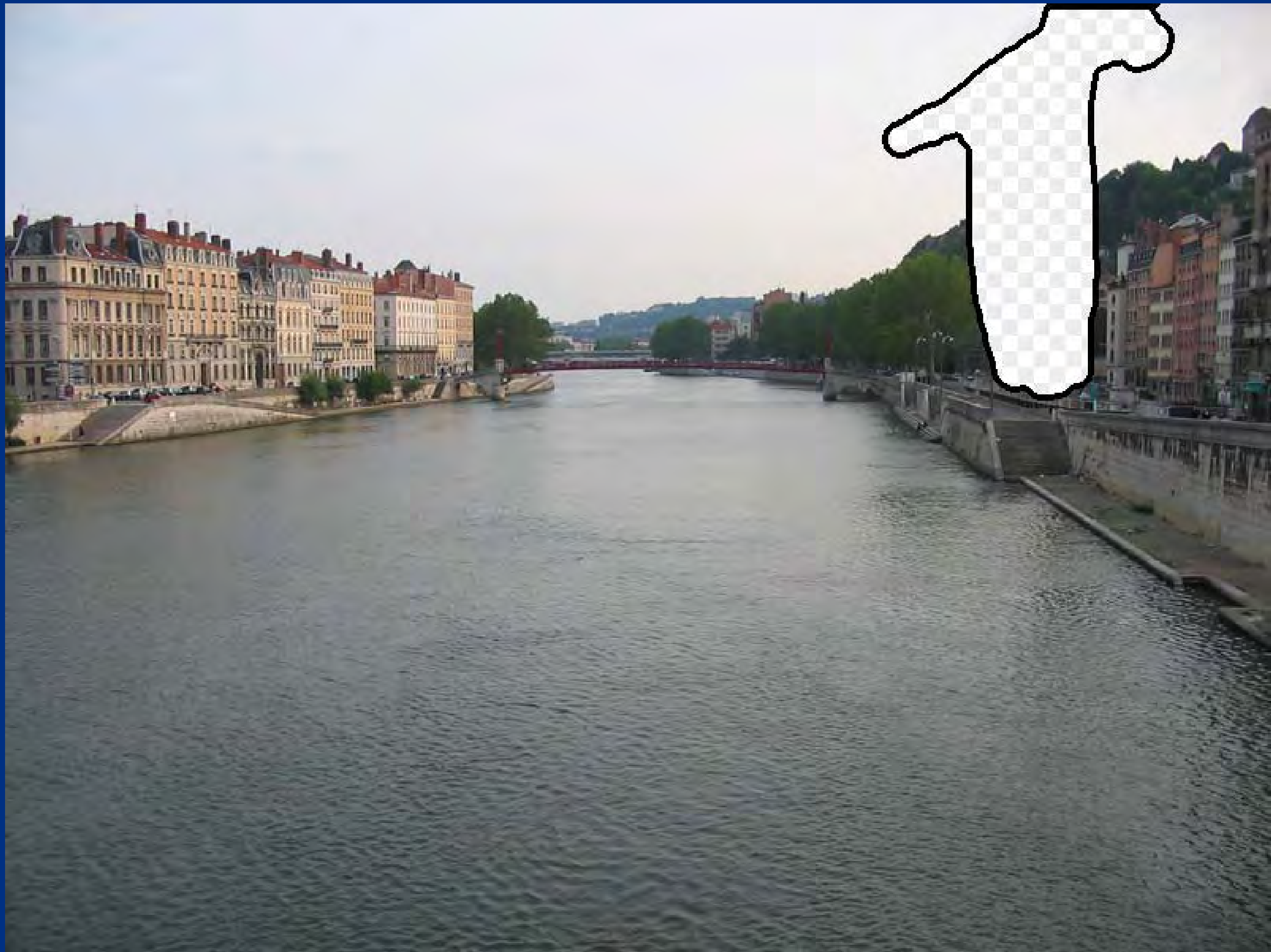
… 200 scene matches

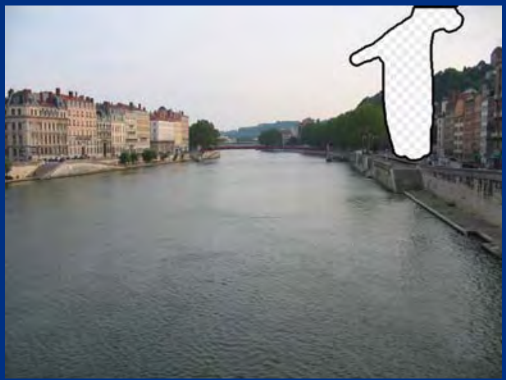


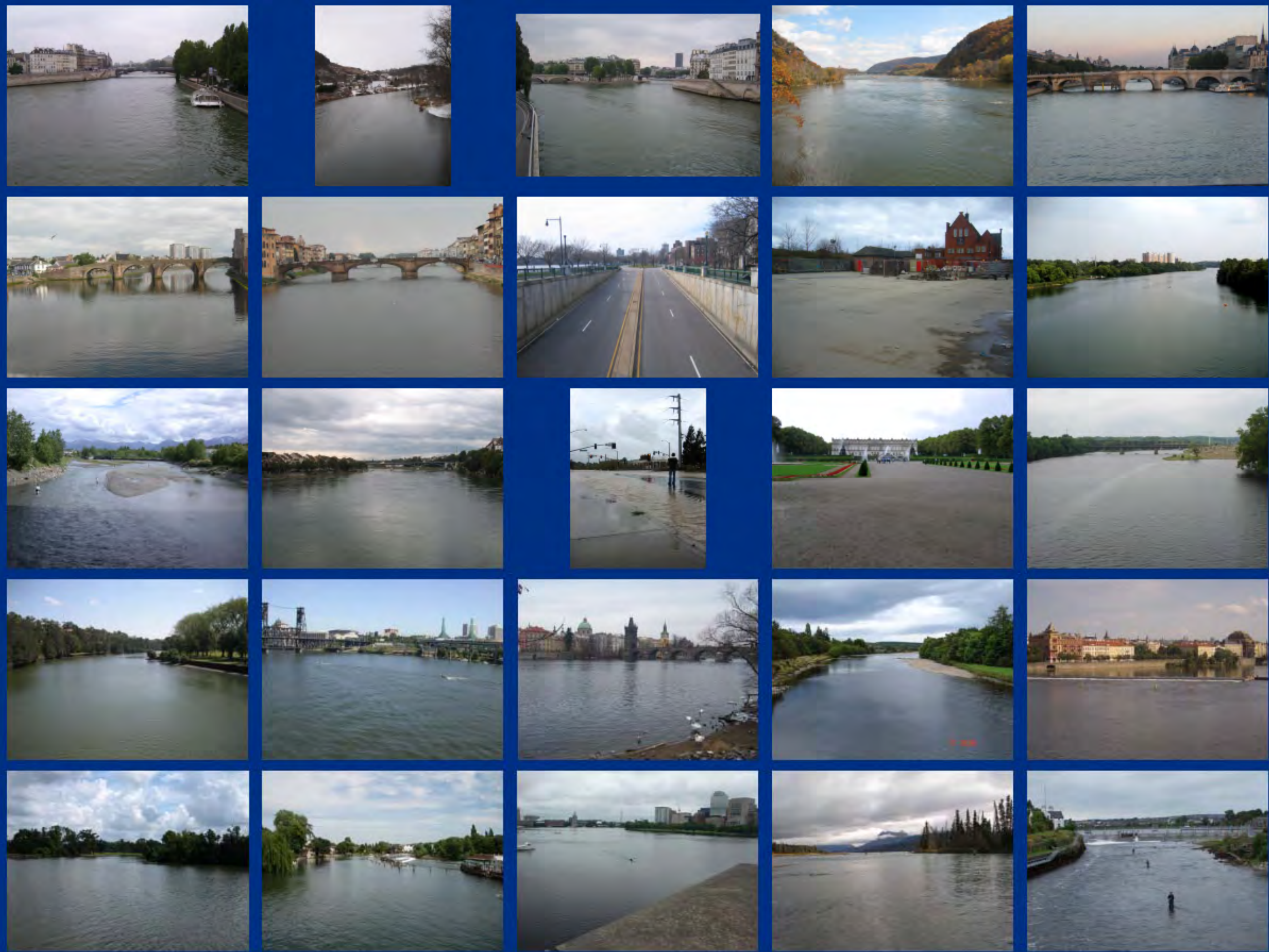
… 200 scene matches



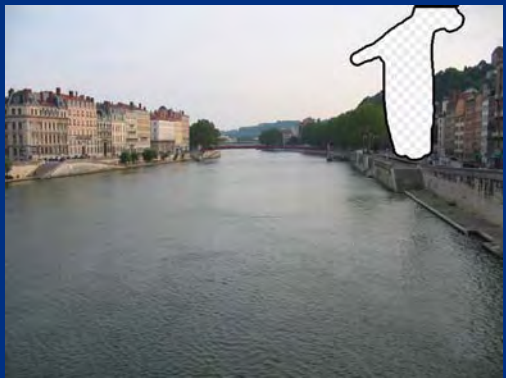
HOTEL
Jupiter





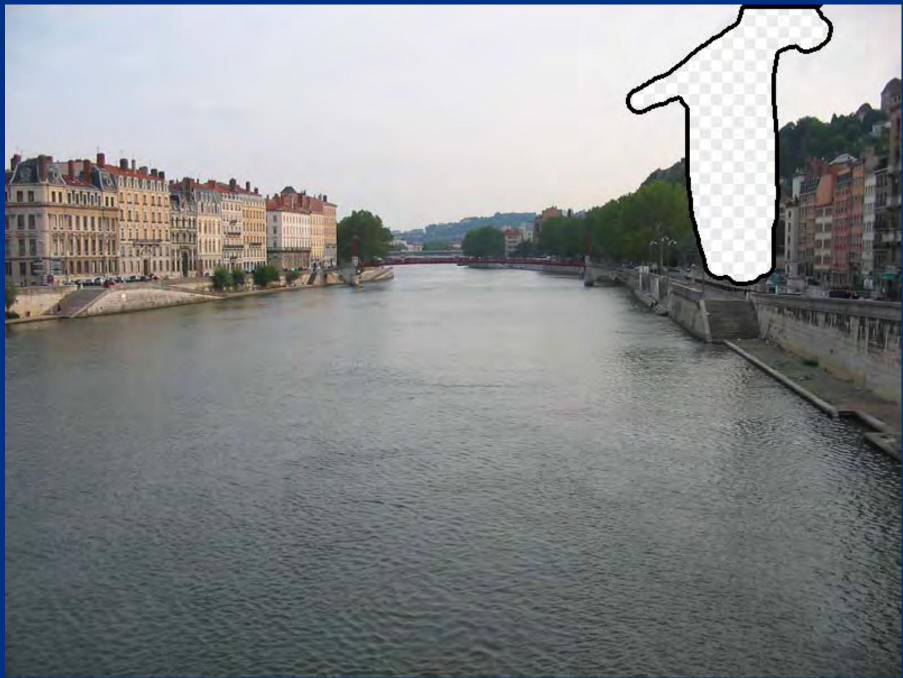


… 200 scene matches

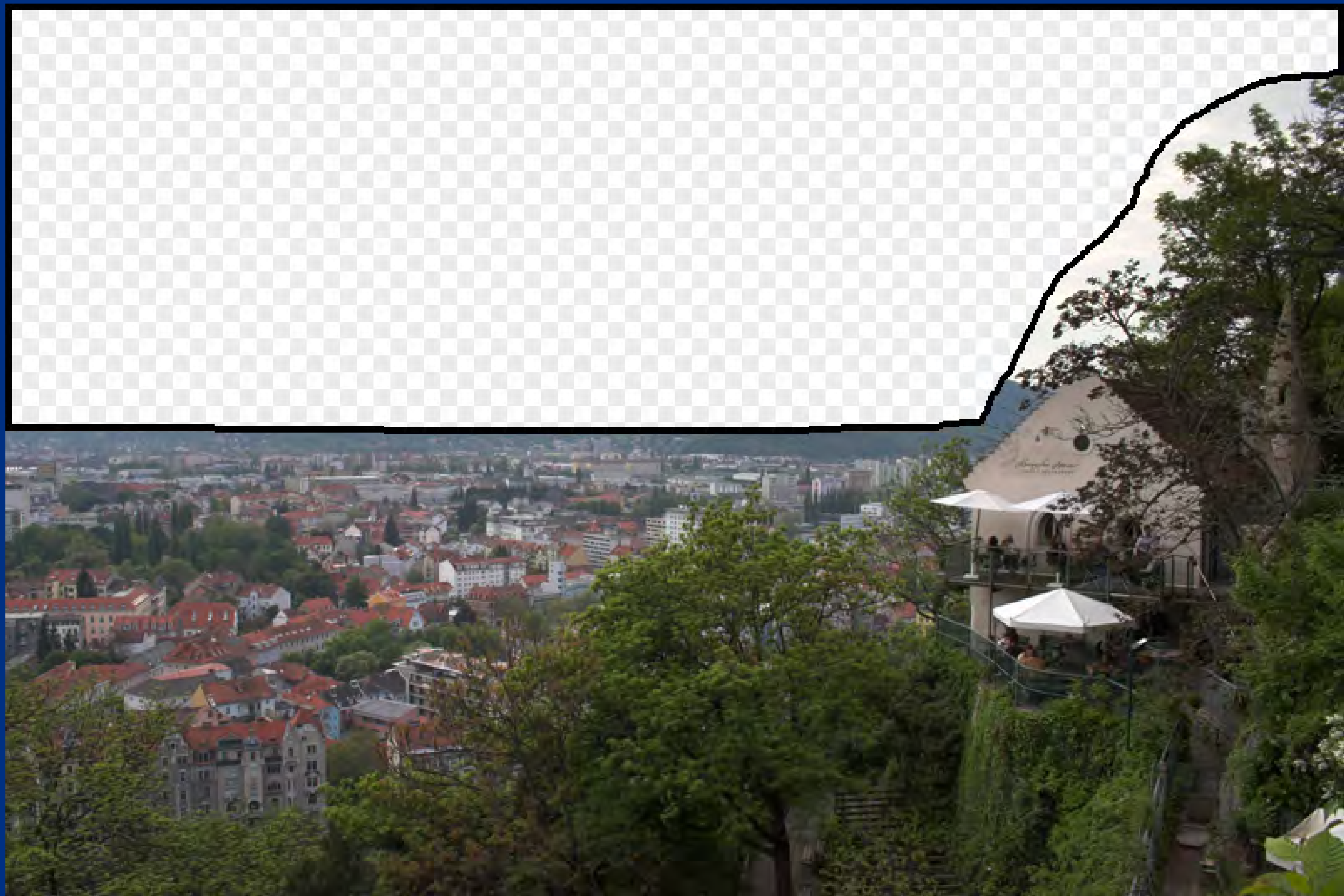


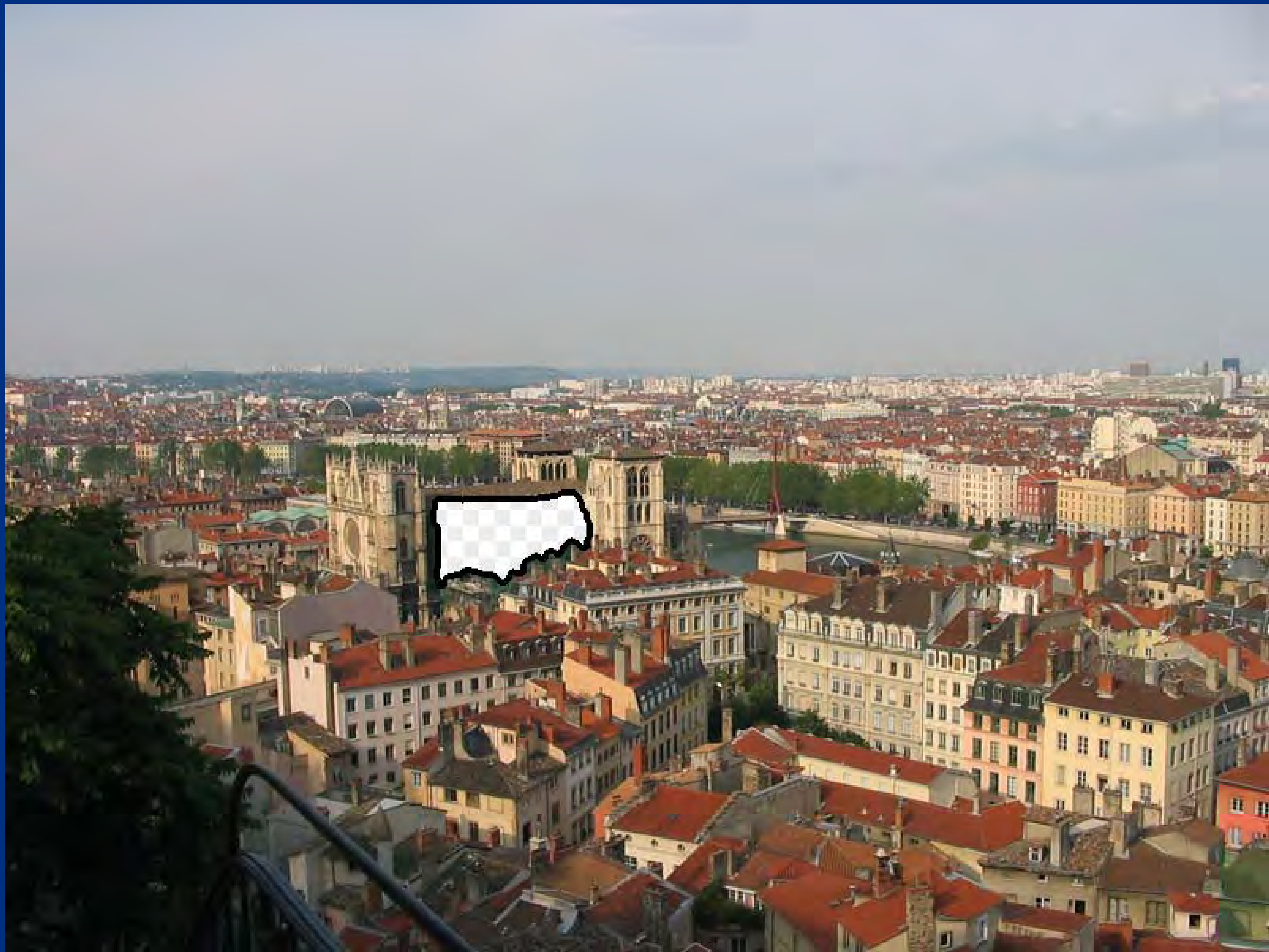
… 200 scene matches

… 200 scene matches




七五三詣り





… 200 scene matches

… 200 scene matches