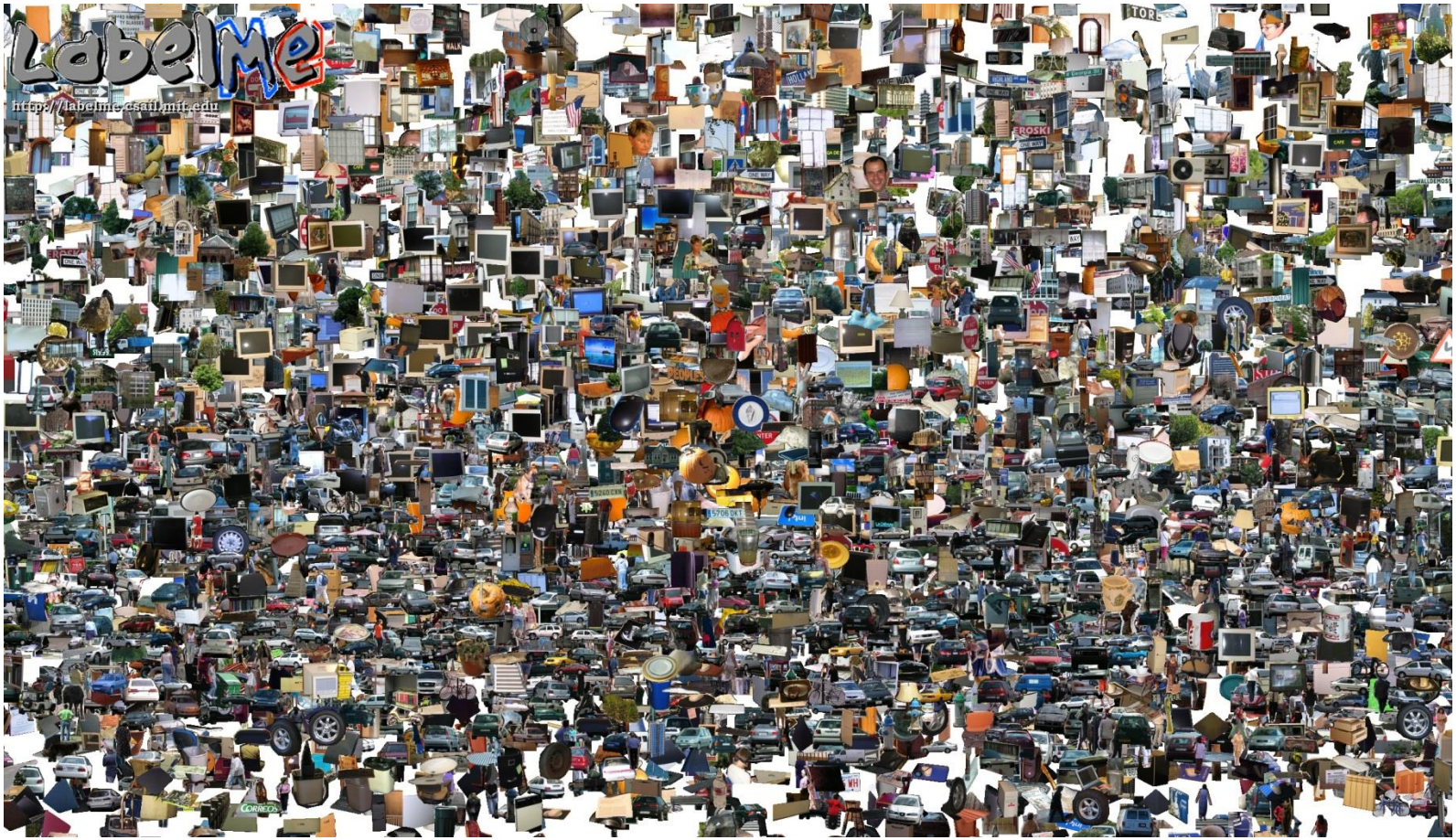
Opportunities of Scale, Part 2



Computer Vision

James Hays

Many slides from James Hays, Alyosha Efros, and Derek Hoiem

Graphic from Antonio Torralba

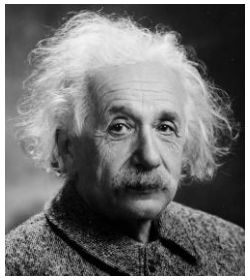
Recap

Opportunities of Scale: Data-driven methods

- Previous Lecture
  - The unreasonable effectiveness of data
  - Scene completion
- Today
  - Im2gps
  - Recognition via Tiny Images
- Project 5 Intro

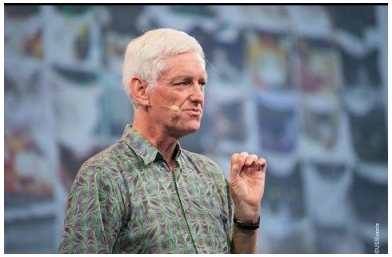
The Unreasonable Effectiveness of Math

- **“**The miracle of the appropriateness of the language of mathematics…” **Eugene Wigner**



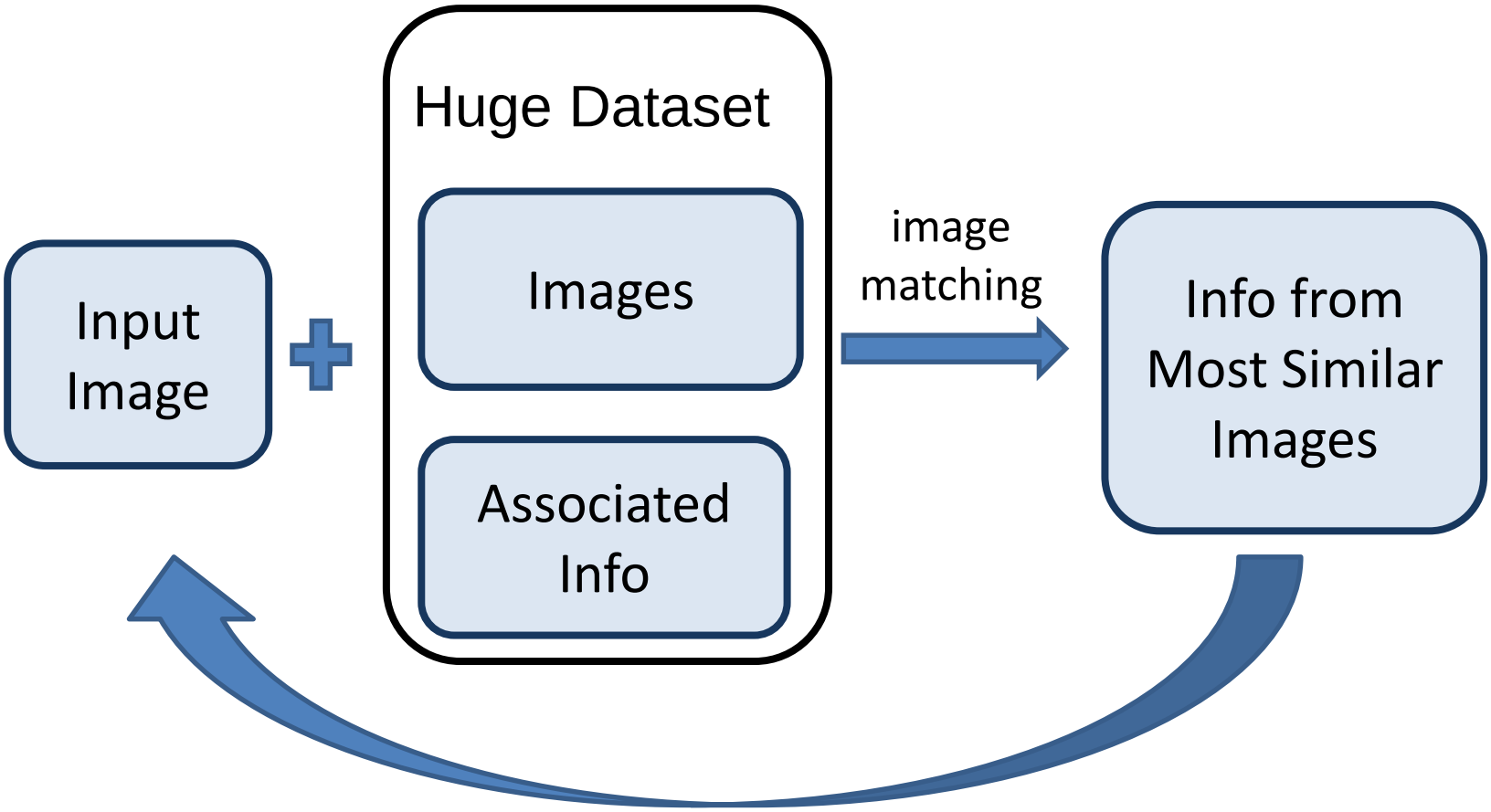
- “The most incomprehensible thing about the universe is that it is comprehensible.” **Albert Einstein**

- “There is only one thing which is more unreasonable than the unreasonable effectiveness of mathematics in physics, and this is the unreasonable ineffectiveness of mathematics in biology.” **Israel Gelfand**

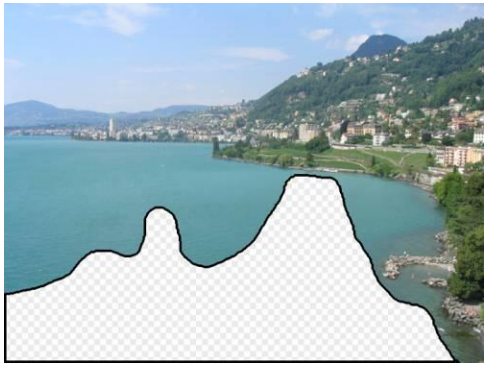


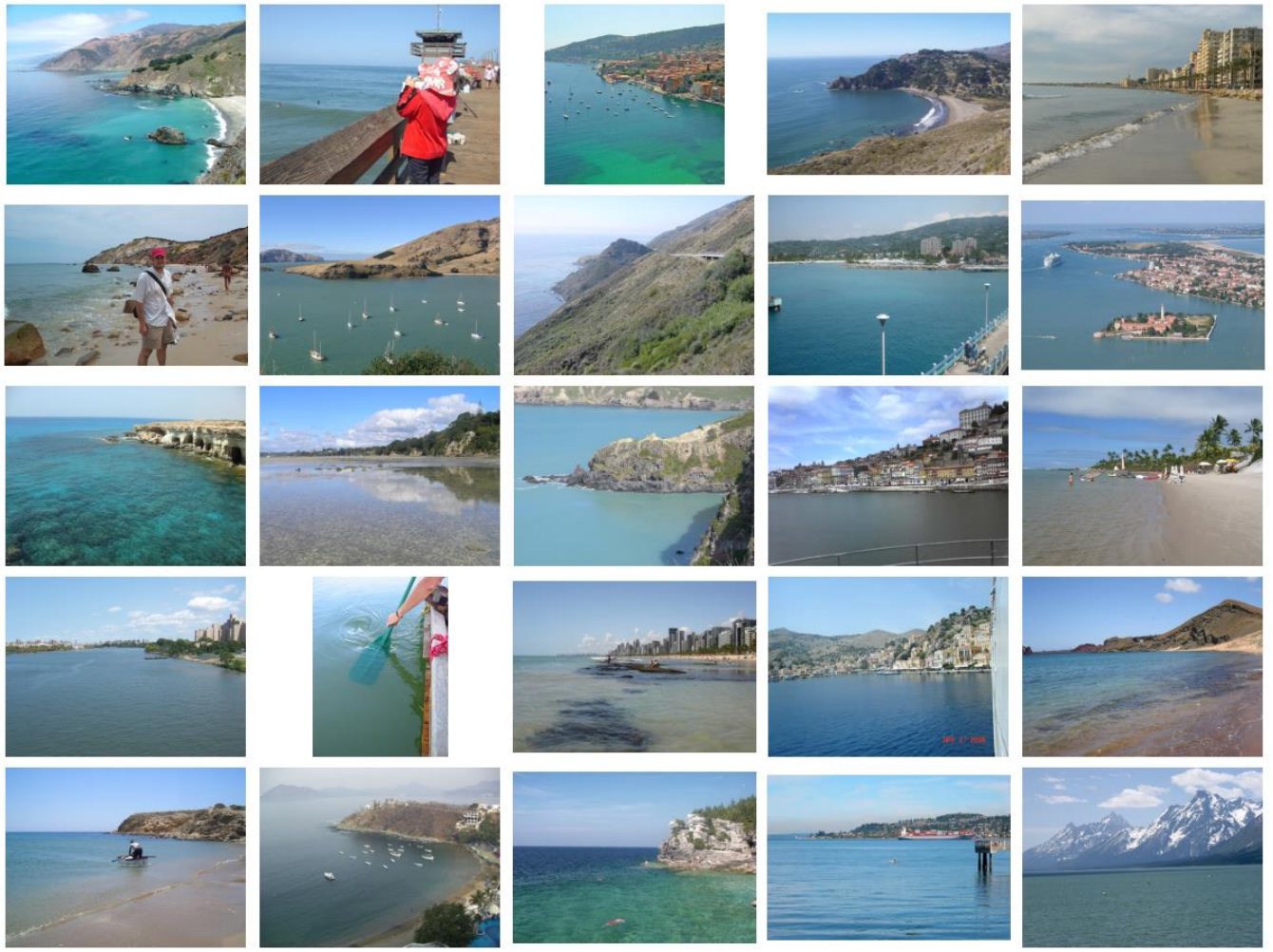
- “We should stop acting as if our goal is to author extremely elegant theories, and instead embrace complexity and make use of the best ally we have: the unreasonable effectiveness of data.” **Peter Norvig**

General Principal



Hopefully, If you have enough images, the dataset will contain very similar images that you can find with simple matching methods.





… 200 total


Graph cut + Poisson blending

im2gps (Hays & Efros, CVPR 2008)

6 million geo-tagged Flickr images

http://graphics.cs.cmu.edu/projects/im2gps/

How much can an image tell about its geographic location?


Paris


Paris


Paris


Paris


Paris


Paris


Paris


Madrid


Rome


Paris


Cuba


Paris

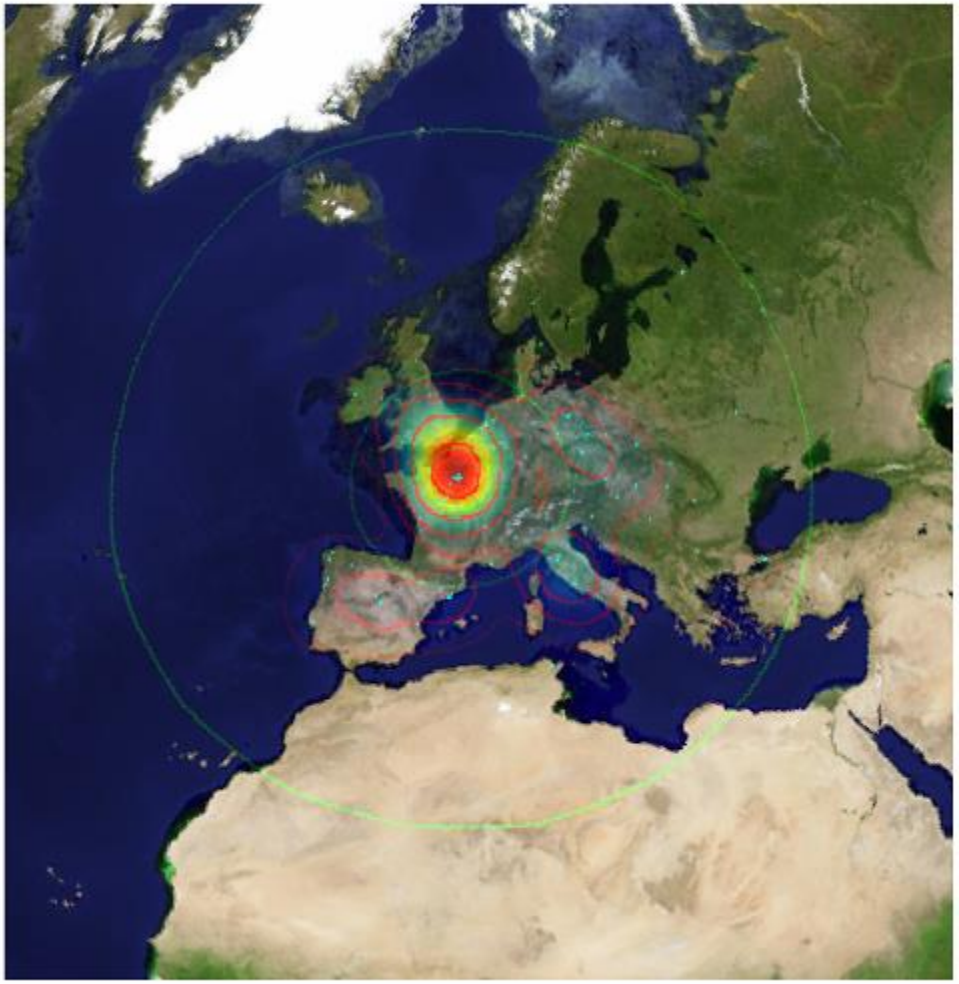

Paris


Poland


Paris


Paris

Nearest Neighbors according to gist + bag of SIFT + color histogram + a few others



Im2gps

Example Scene Matches


Madrid


england


France


Paris


Croatia


heidelberg


Macau


Malta


Cairo


Italy


Italy


Italy

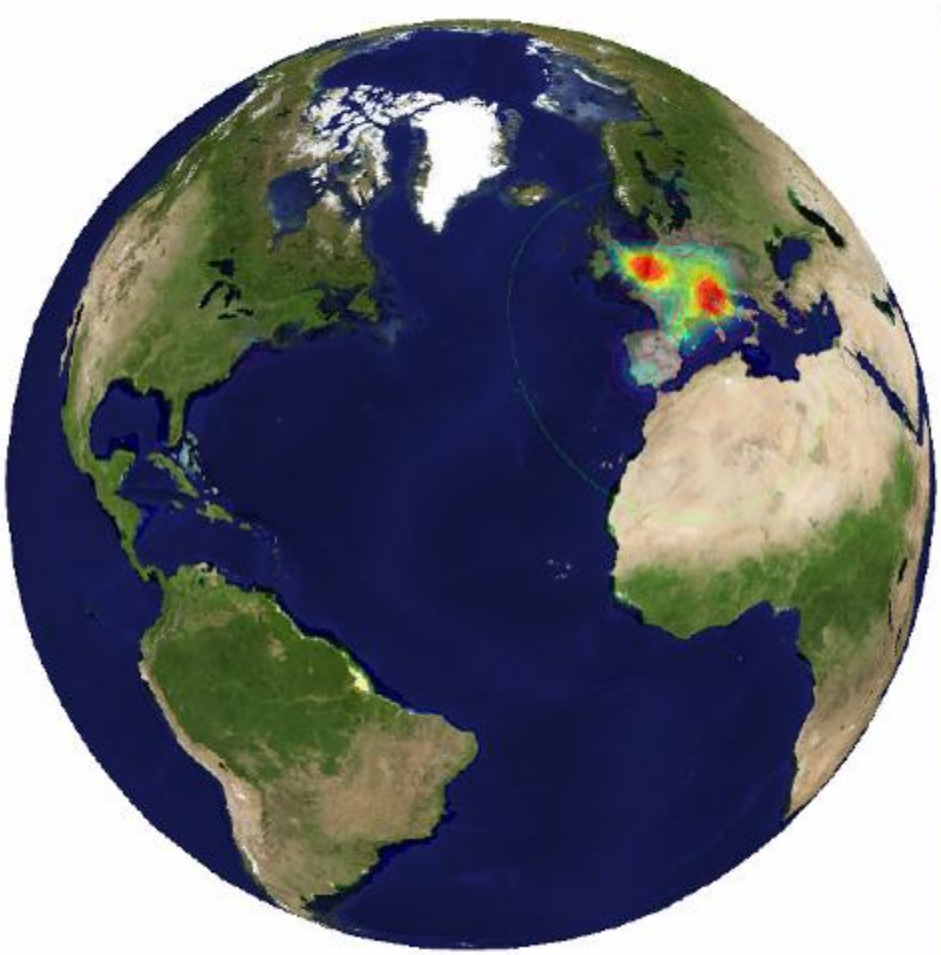

Latvia

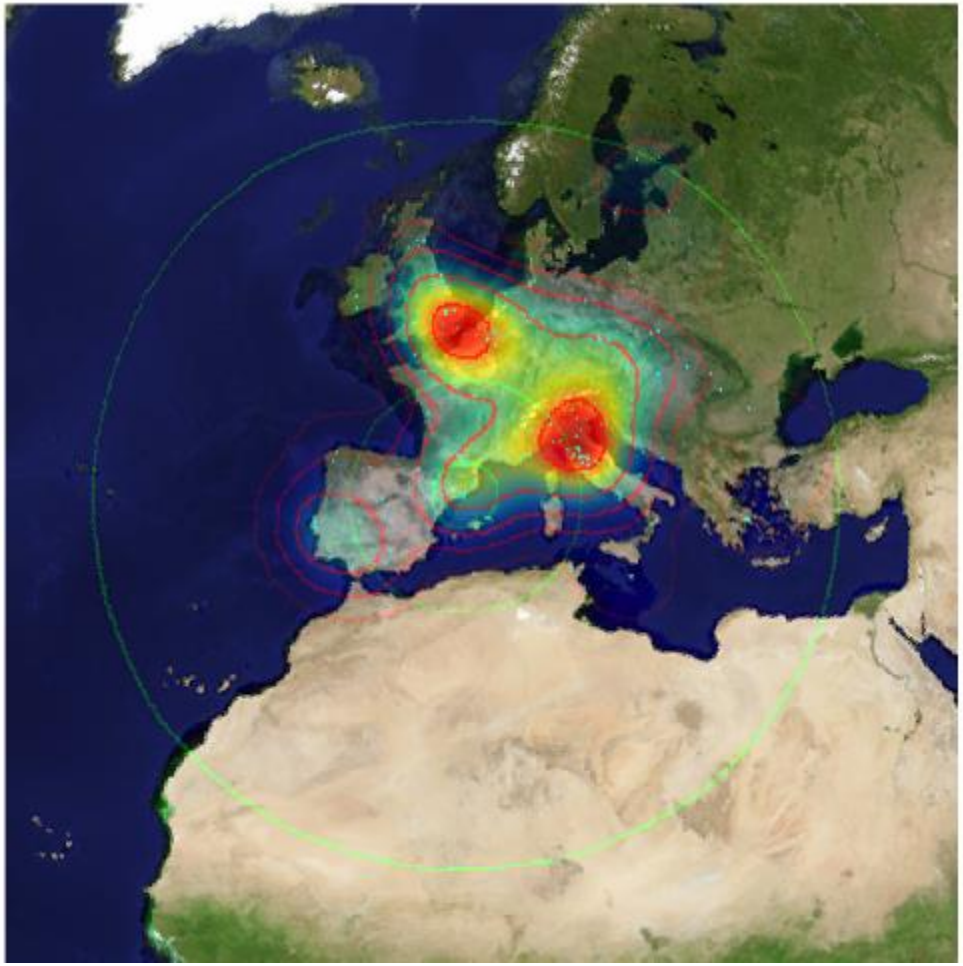

europe


Barcelona


Austria

Voting Scheme





im2gps

Philippines

Houston

Thailand

Houston

Maldives

Philippines

NewZealand

Bermuda

Palau

Mexico2

Brazil

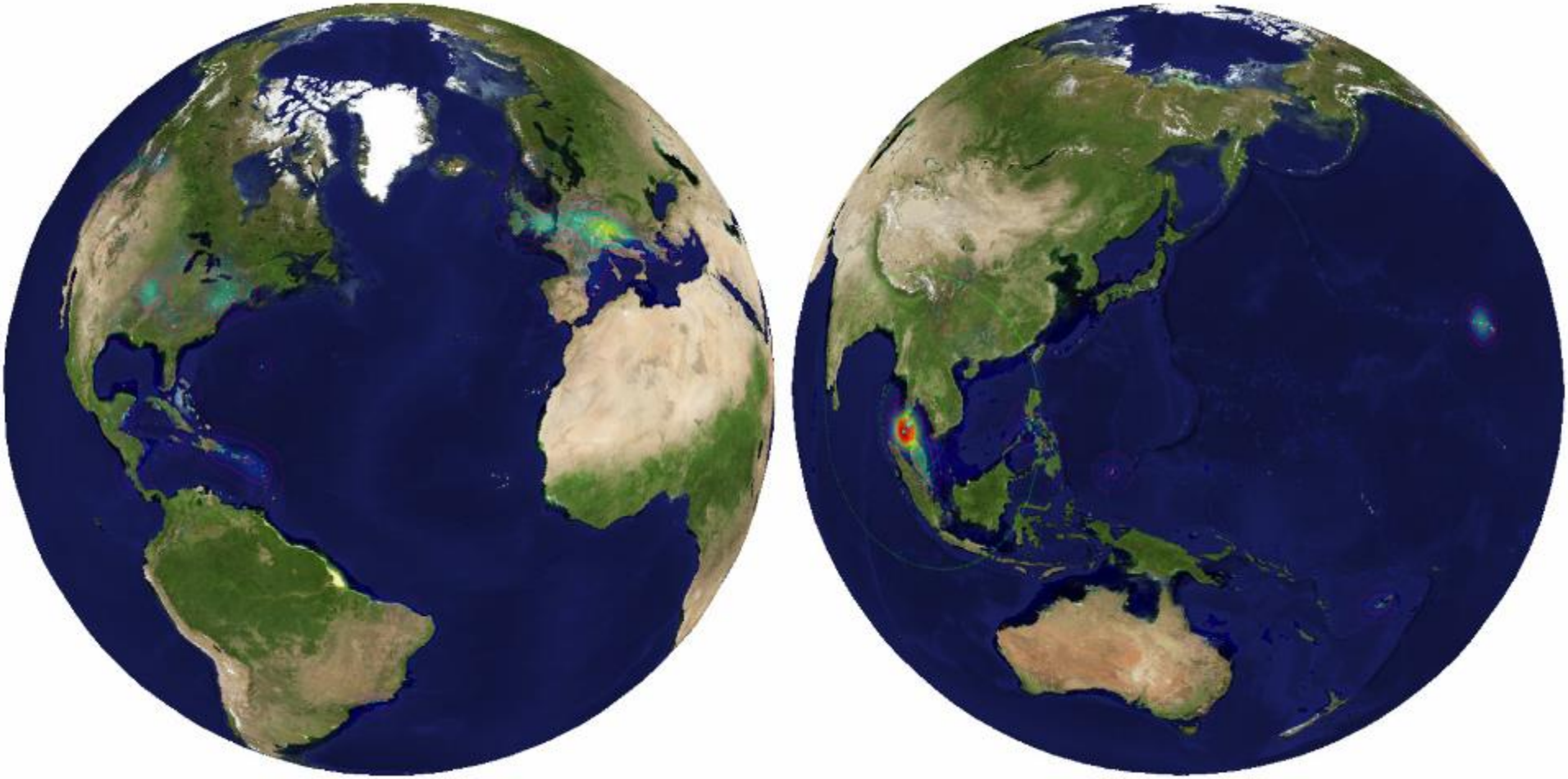
Mendoza

Brazil

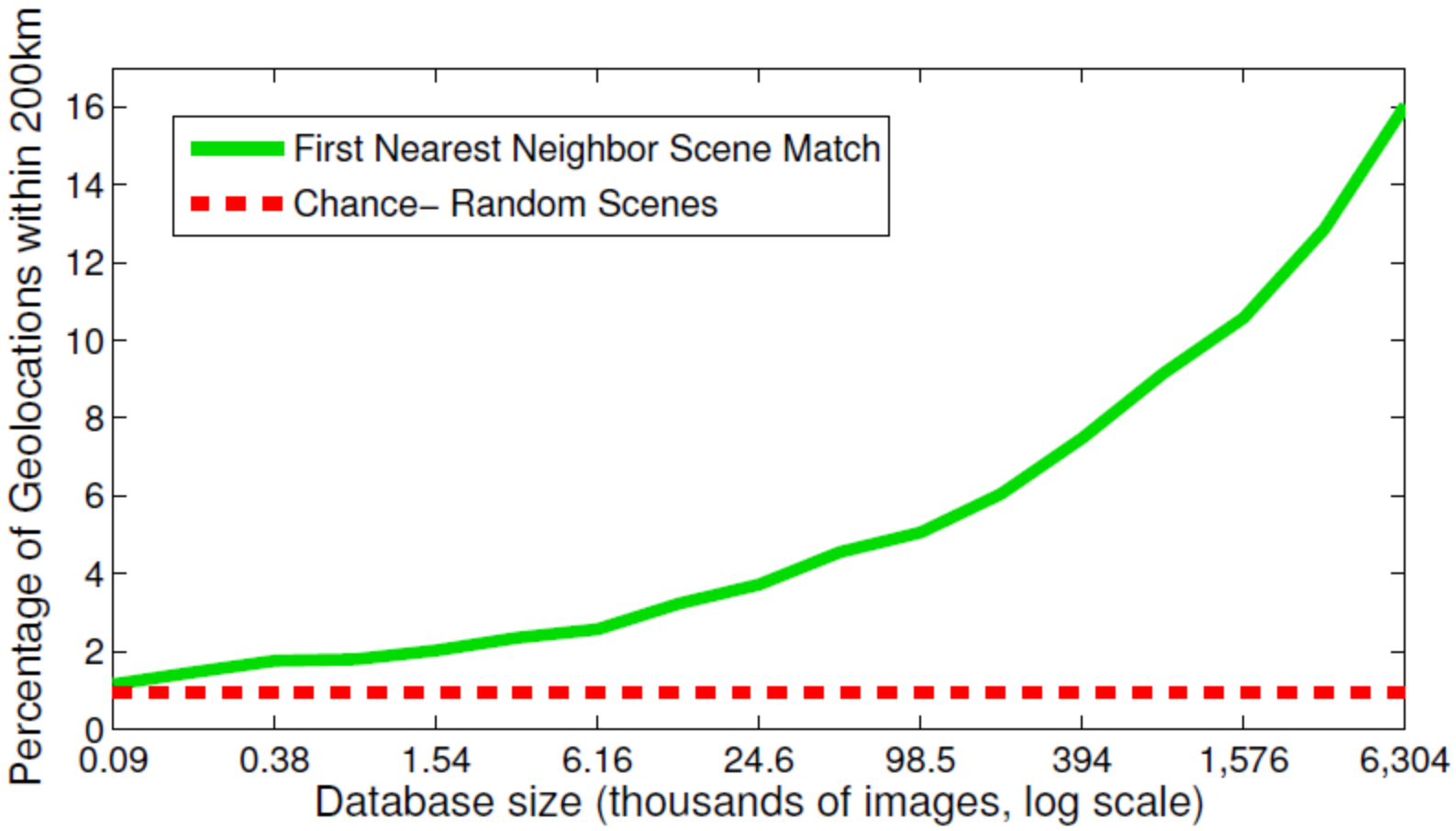
Thailand

Arkansas

Hawaii

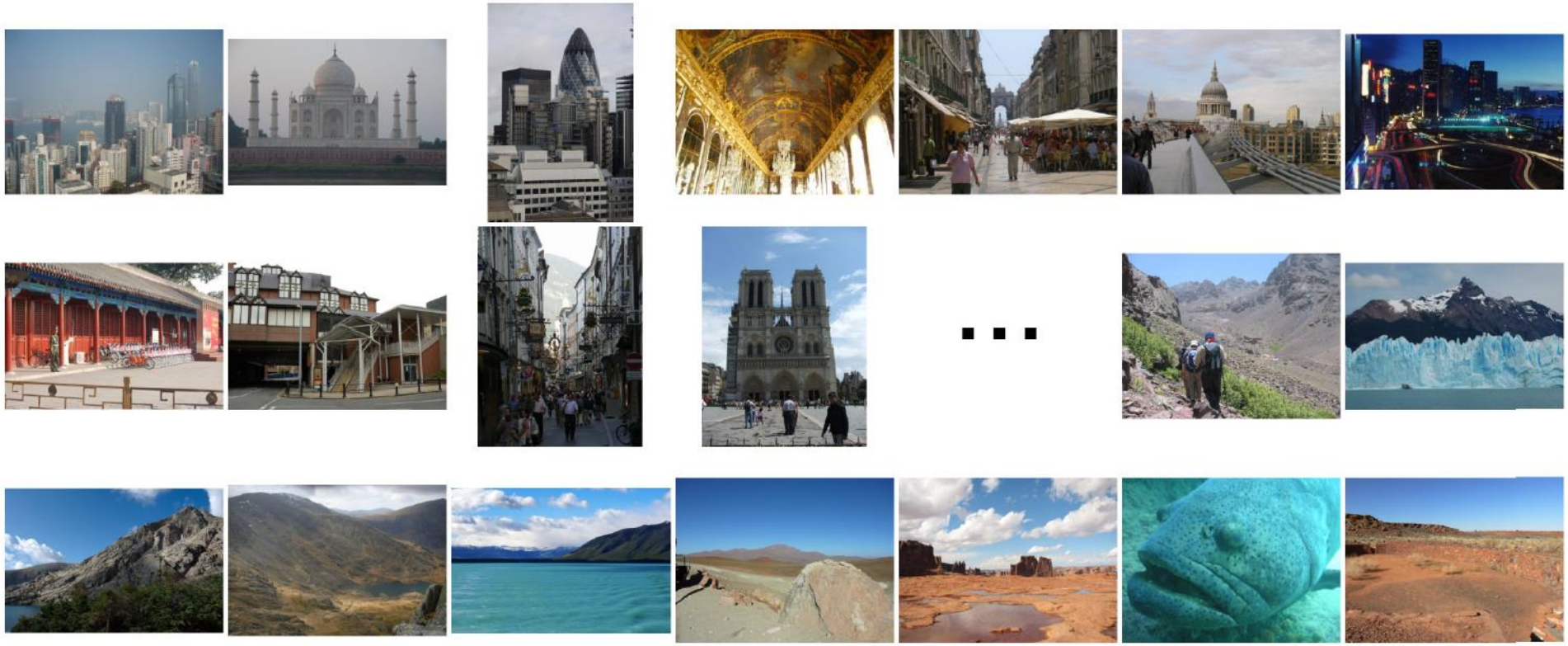


Effect of Dataset Size



Population density ranking

High Predicted Density



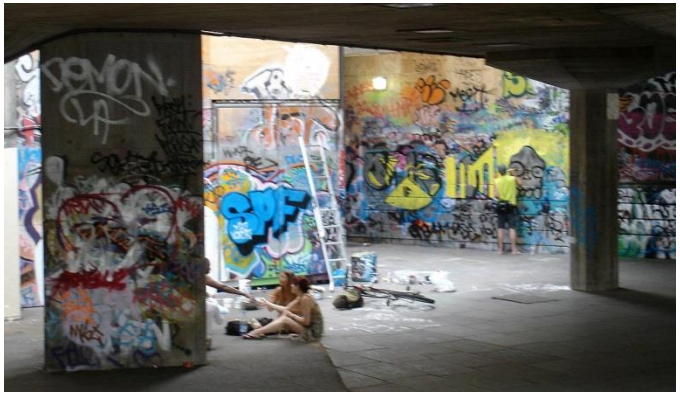
Low Predicted Density

Where is This?

[Olga Vesselova, Vangelis Kalogerakis, Aaron Hertzmann, James Hays, Alexei A. Efros. Image Sequence Geolocation. ICCV'09]

Where is This?

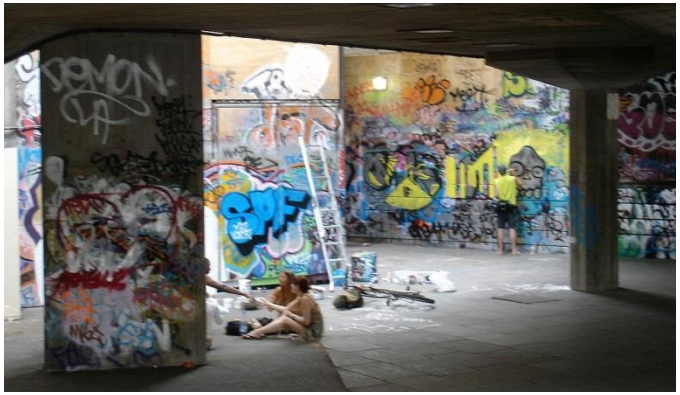
Where are These?



15:14,
June 18th, 2006

16:31,
June 18th, 2006

Where are These?



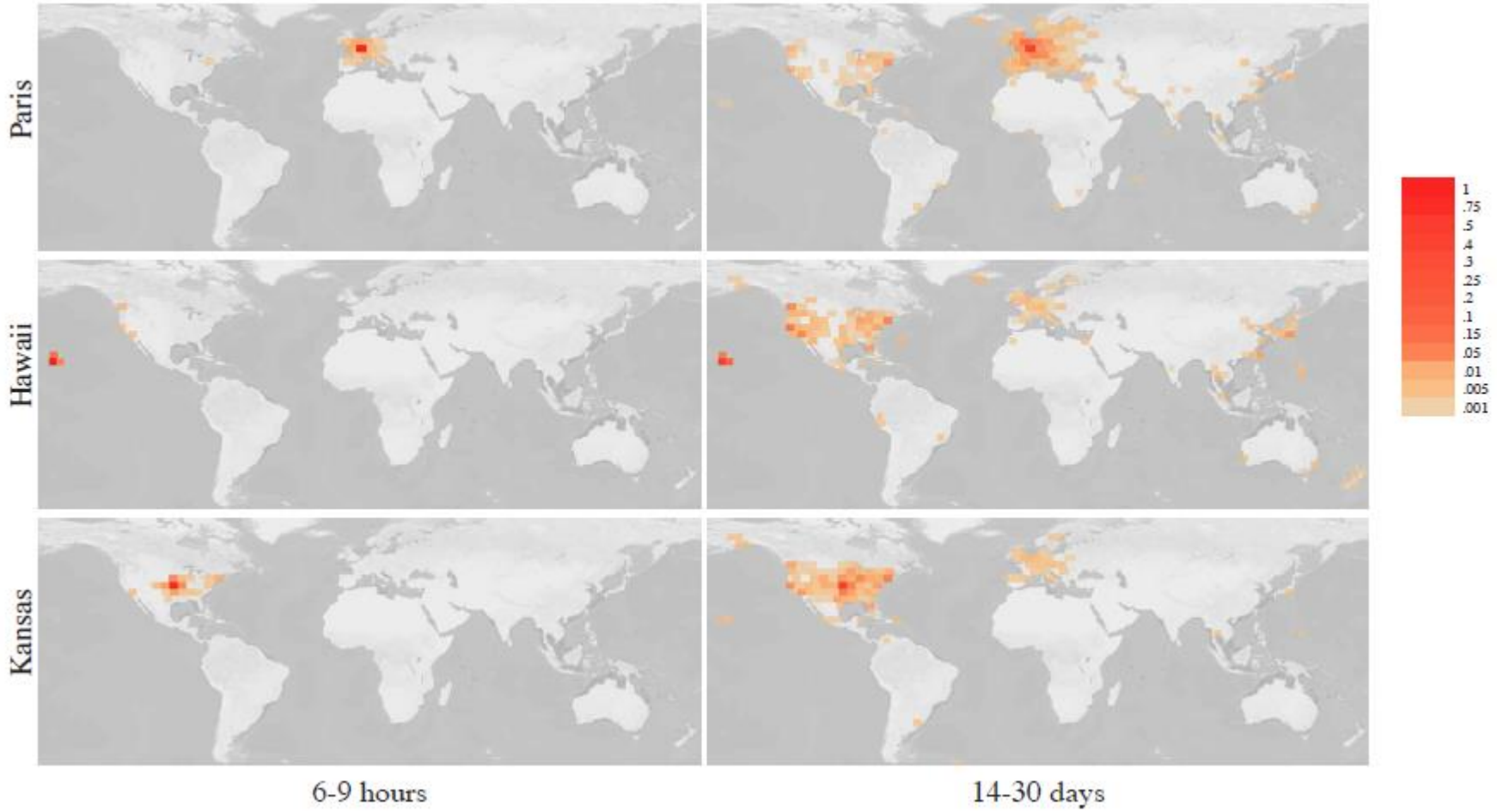
15:14,
June 18th, 2006

16:31,
June 18th, 2006

17:24,
June 19th, 2006

Results

- im2gps – 10% (geo-loc within 400 km)
- temporal im2gps – 56%



Tiny Images

80 million tiny images: a large dataset for non-parametric object and scene recognition Antonio Torralba, Rob Fergus and William T. Freeman. PAMI 2008.

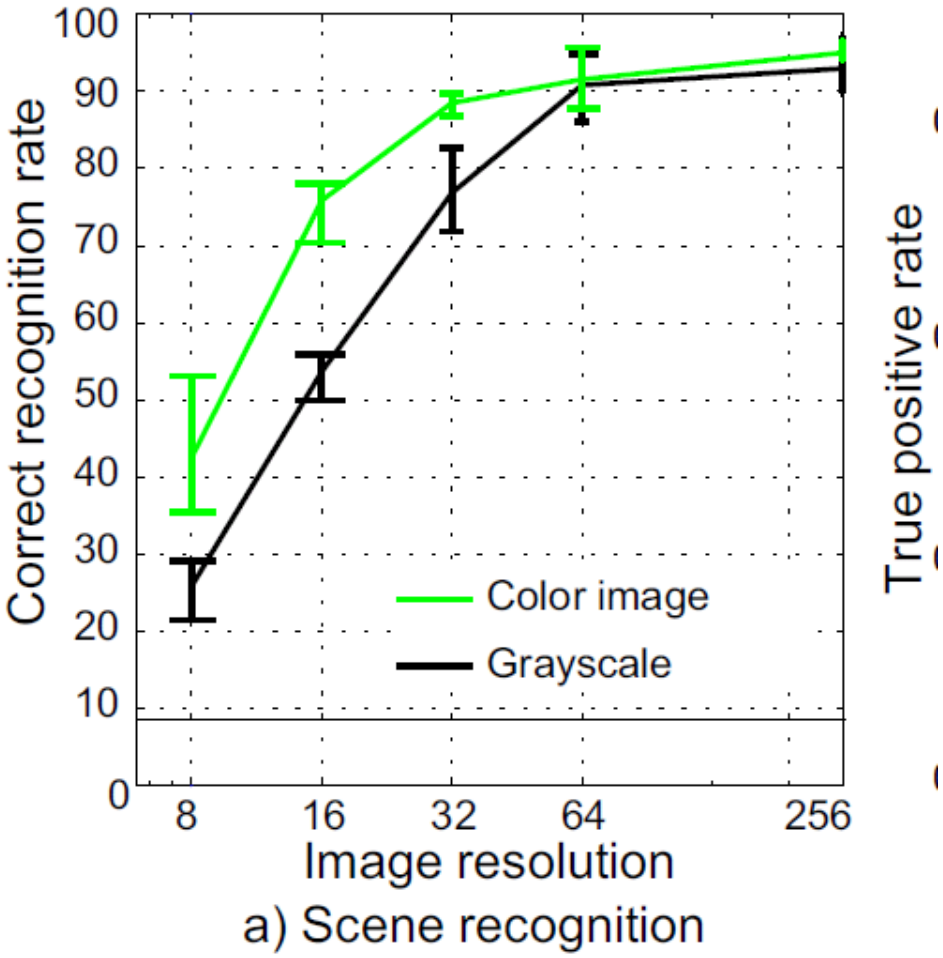
http://groups.csail.mit.edu/vision/TinyImages/

256x256



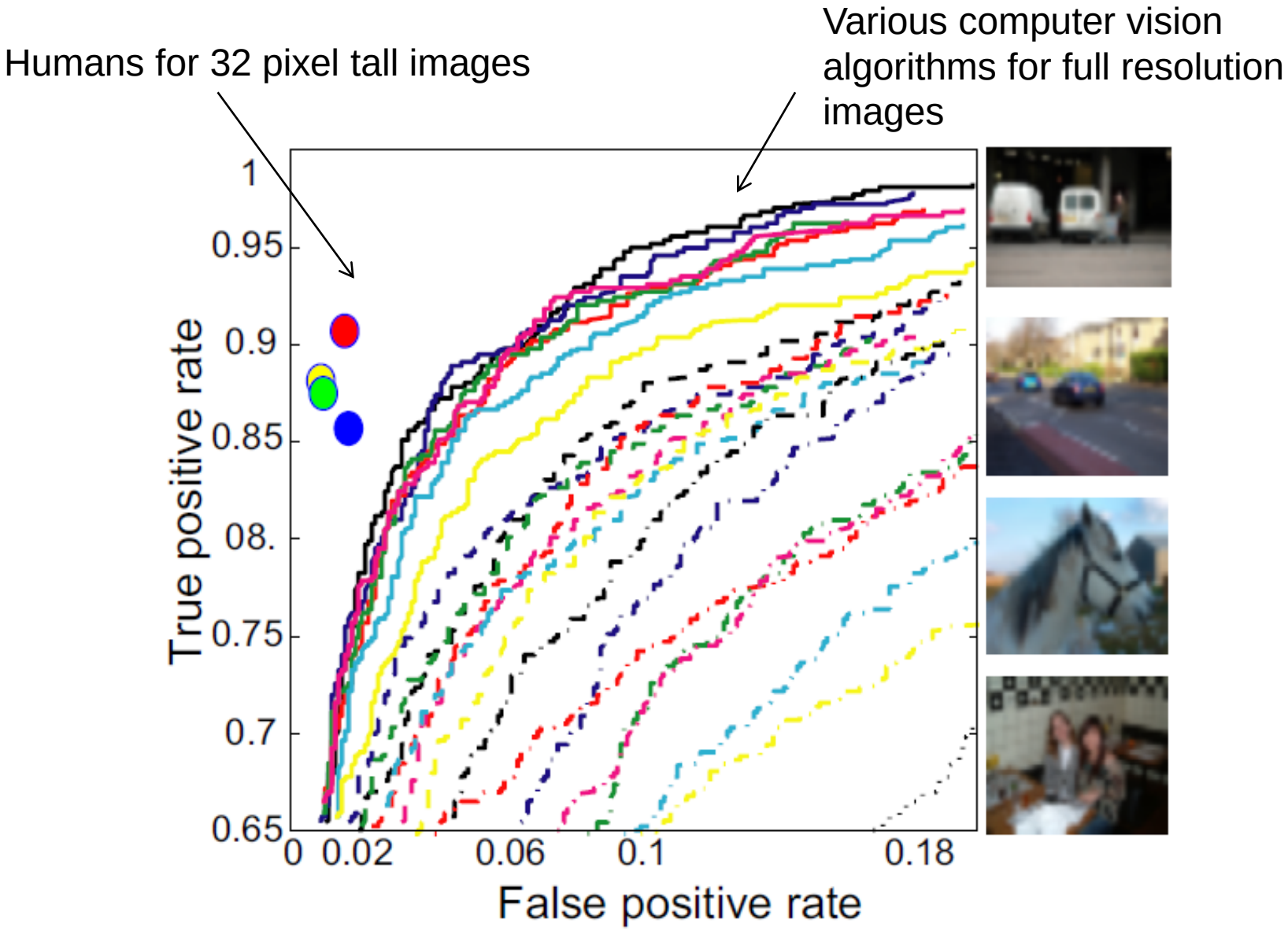

c) Segmentation of 32x32 images

Human Scene Recognition



a) Scene recognition

Humans vs. Computers: Car-Image Classification



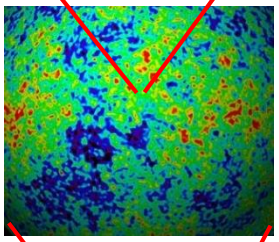
Powers of 10

Number of images on my hard drive: 10^4

Number of images seen during my first 10 years: 10^8
(3 images/second * 60 * 60 * 16 * 365 * 10 = 630720000)

Number of images seen by all humanity: 10^{20}
106,456,367,669 humans[1] * 60 years * 3 images/second * 60 * 60 * 16 * 365 =
1 from http://www.prb.org/Articles/2002/HowManyPeopleHaveEverLivedonEarth.aspx

Number of photons in the universe: 10^{88}



Number of all 32x32 images: 10^{7373}
$256^{32*32*3} \sim 10^{7373}$

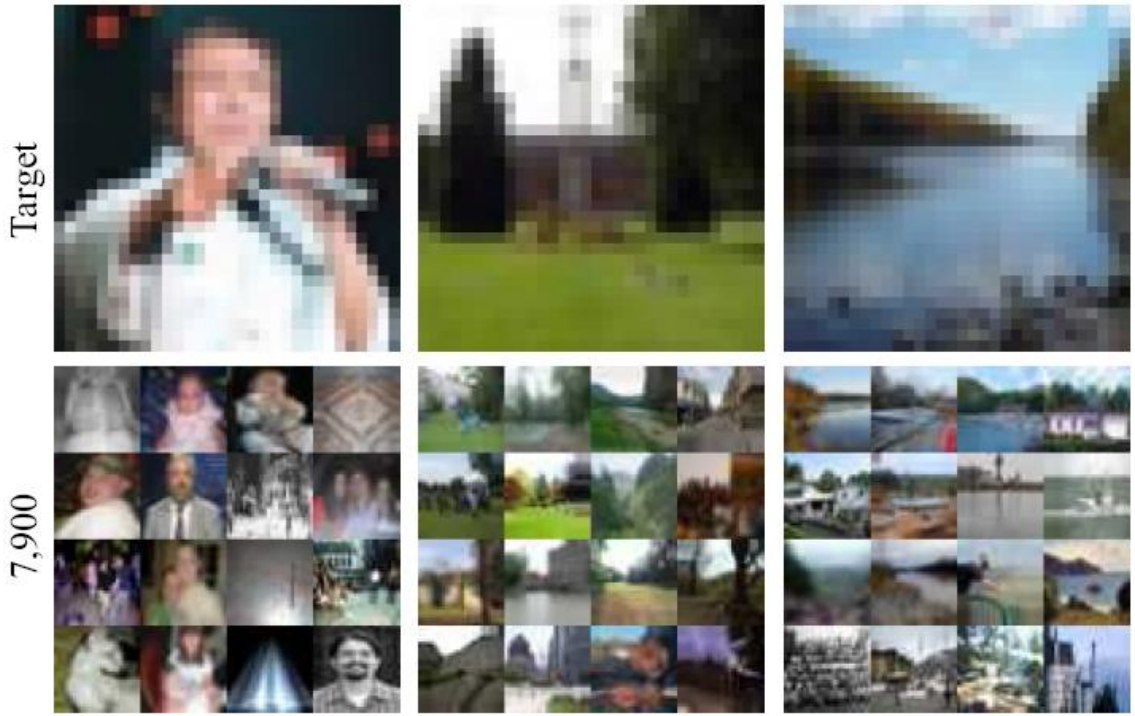
Scenes are unique

But not all scenes are so original

Lots

Of

Images

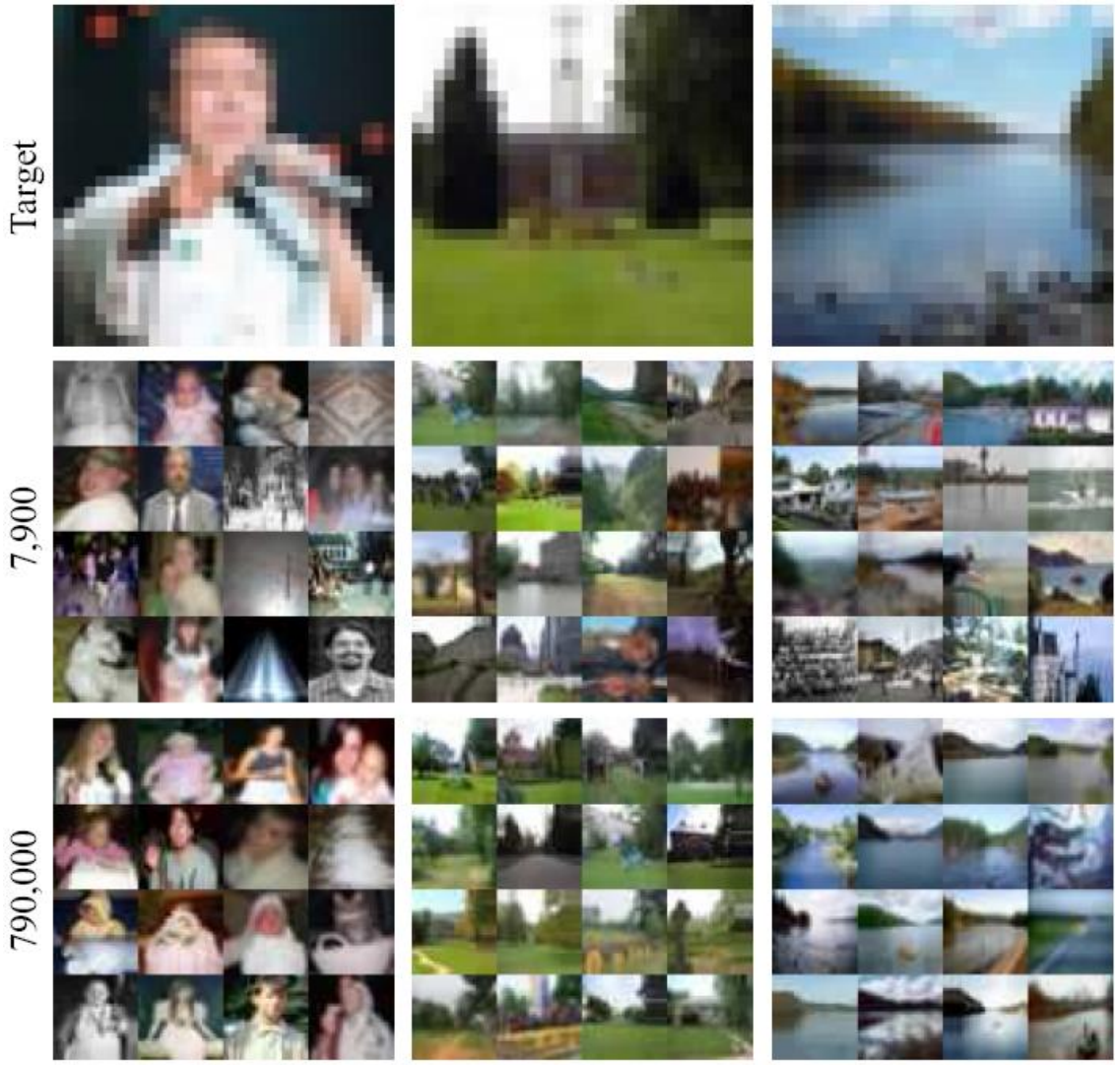


A. Torralba, R. Fergus, W.T.Freeman. PAMI 2008

Lots

Of

Images

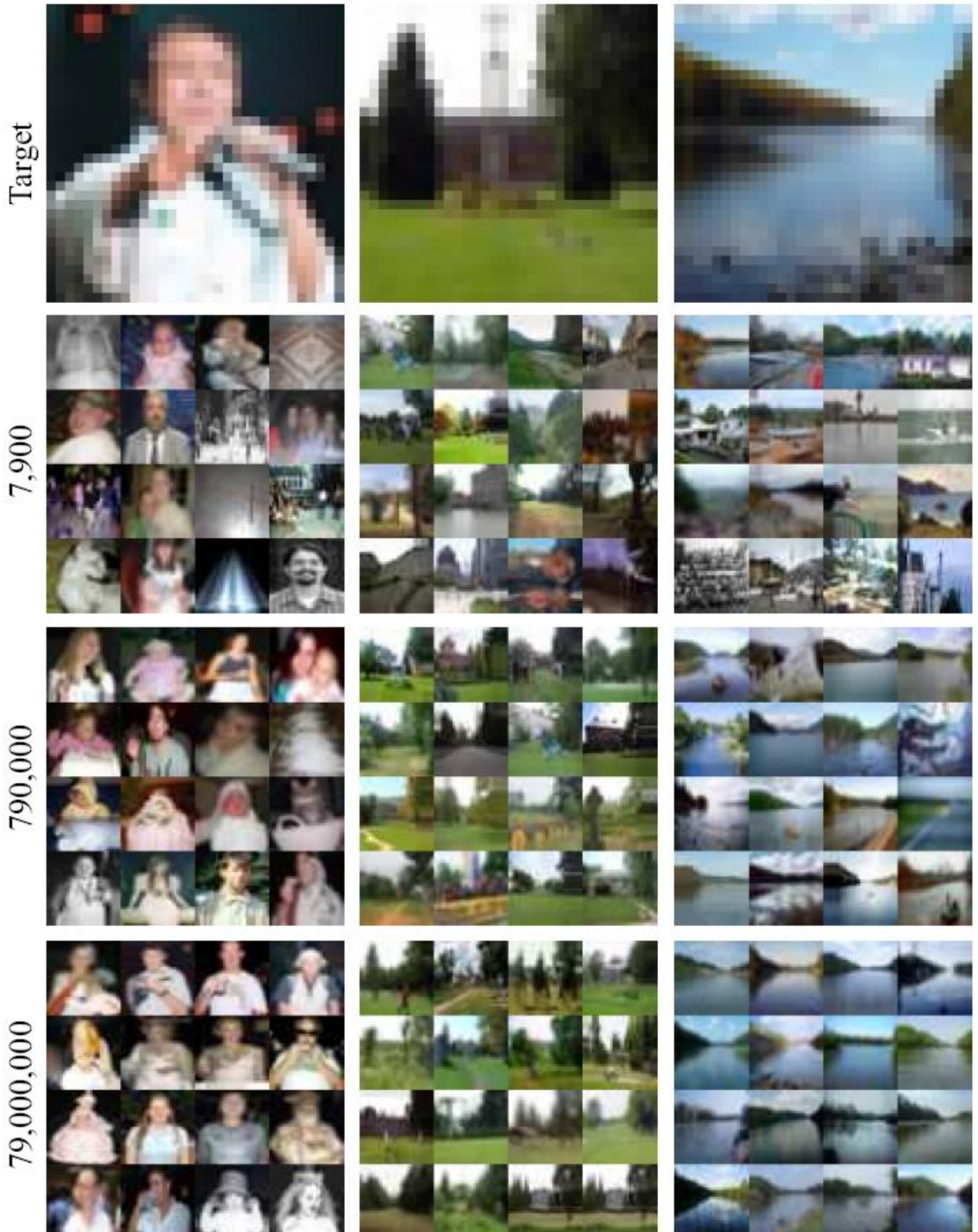


A. Torralba, R. Fergus, W.T.Freeman. PAMI 2008

Lots

Of

Images



Application: Automatic Colorization

Input

Color Transfer

Color Transfer

Matches (gray)

Matches (w/ color)

Avg Color of Match

Application: Automatic Colorization

Input

Color Transfer

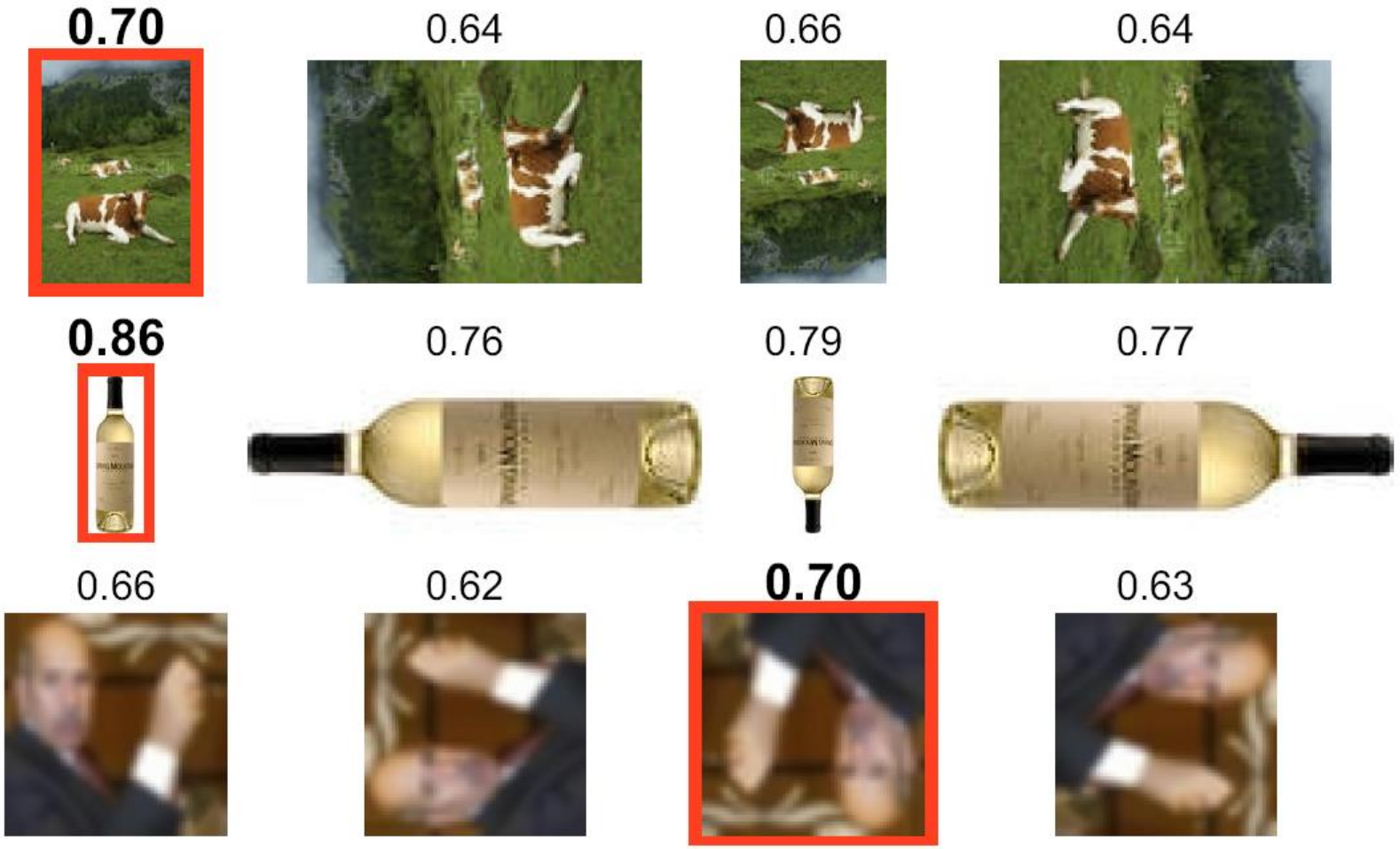
Color Transfer

Matches (gray)

Matches (w/ color)

Avg Color of Match

Automatic Orientation Examples



A. Torralba, R. Fergus, W.T.Freeman. 2008

Summary

- With billions of images on the web, it's often possible to find a close nearest neighbor

- In such cases, we can shortcut hard problems by "looking up" the answer, stealing the labels from our nearest neighbor

- For example, simple (or learned) associations can be used to synthesize background regions, colorize, or recognize objects

Project 5

- http://www.cc.gatech.edu/~hays/compvision/proj5/