

Let's look at some lakefront property

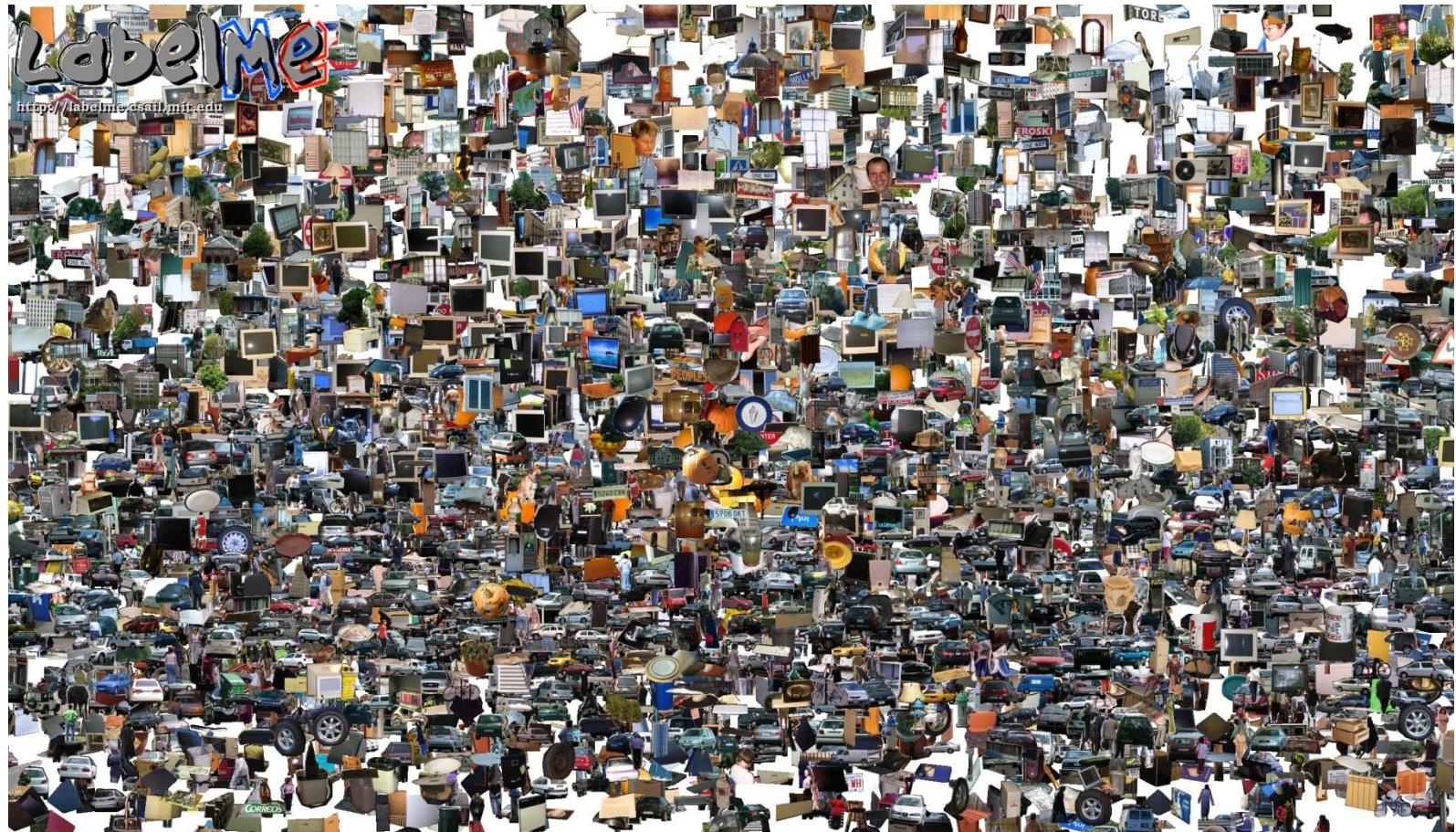


*actually fences / walls





Opportunities of Scale, Part 2



Computer Vision
James Hays

Recap

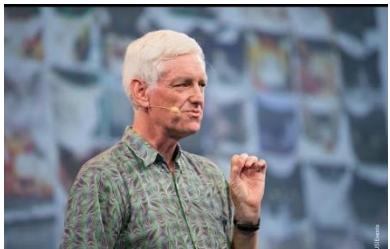
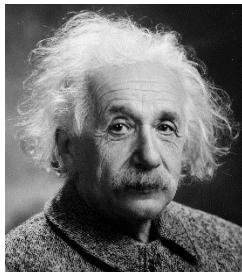
Opportunities of Scale: Data-driven methods

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

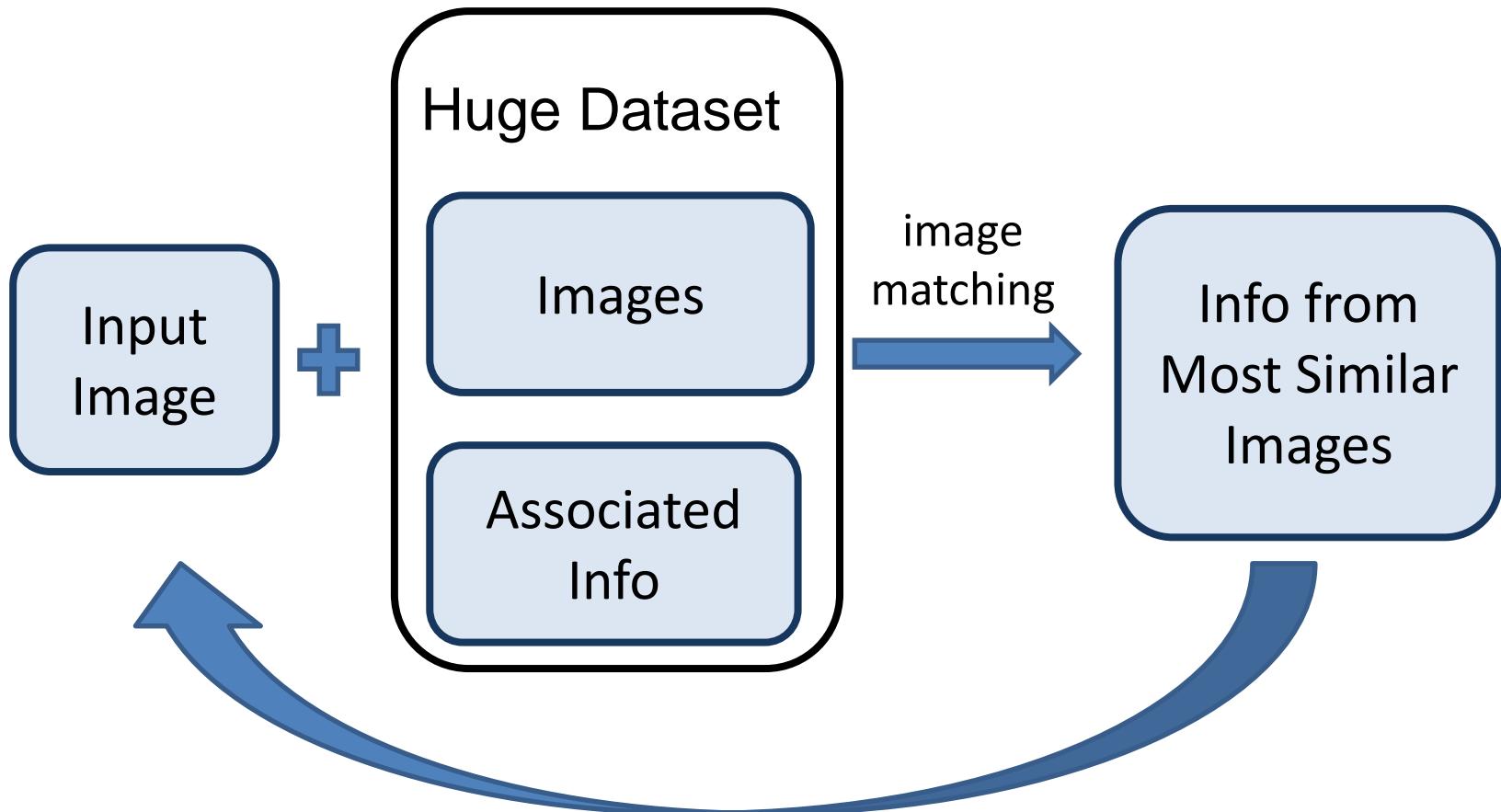
The Unreasonable Effectiveness of Math



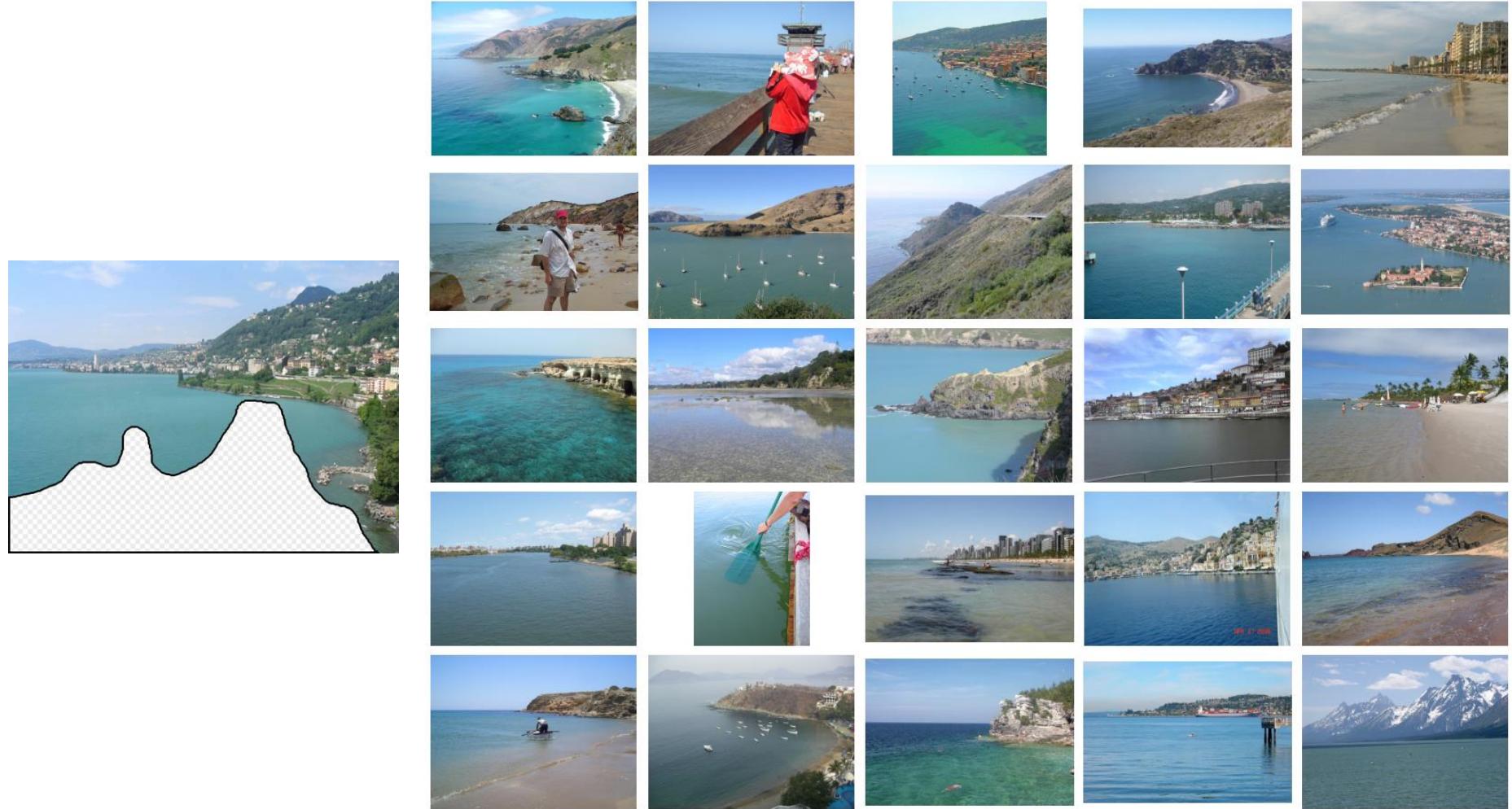
- “The miracle of the appropriateness of the language of mathematics...” **Eugene Wigner**
- “The most incomprehensible thing about the universe is that it is comprehensible.” **Albert Einstein**
- “There is only one thing which is more unreasonable than the unreasonable effectiveness of mathematics 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



Rome



Paris



Pari



Pari



Part



Polar



Part



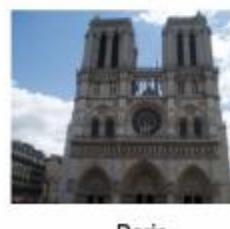
Par



Paris



Madrid



Paris

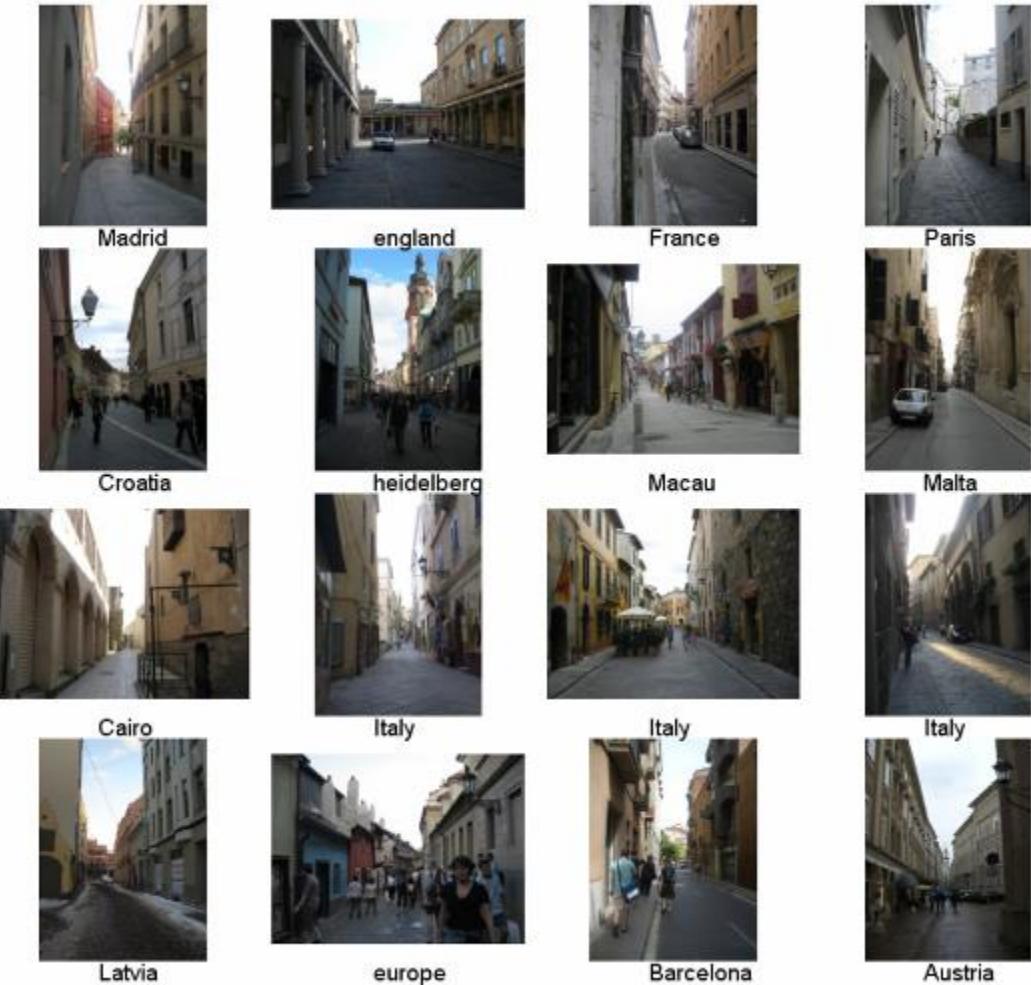
Nearest Neighbors according to gist + bag of SIFT + color histogram + a few others



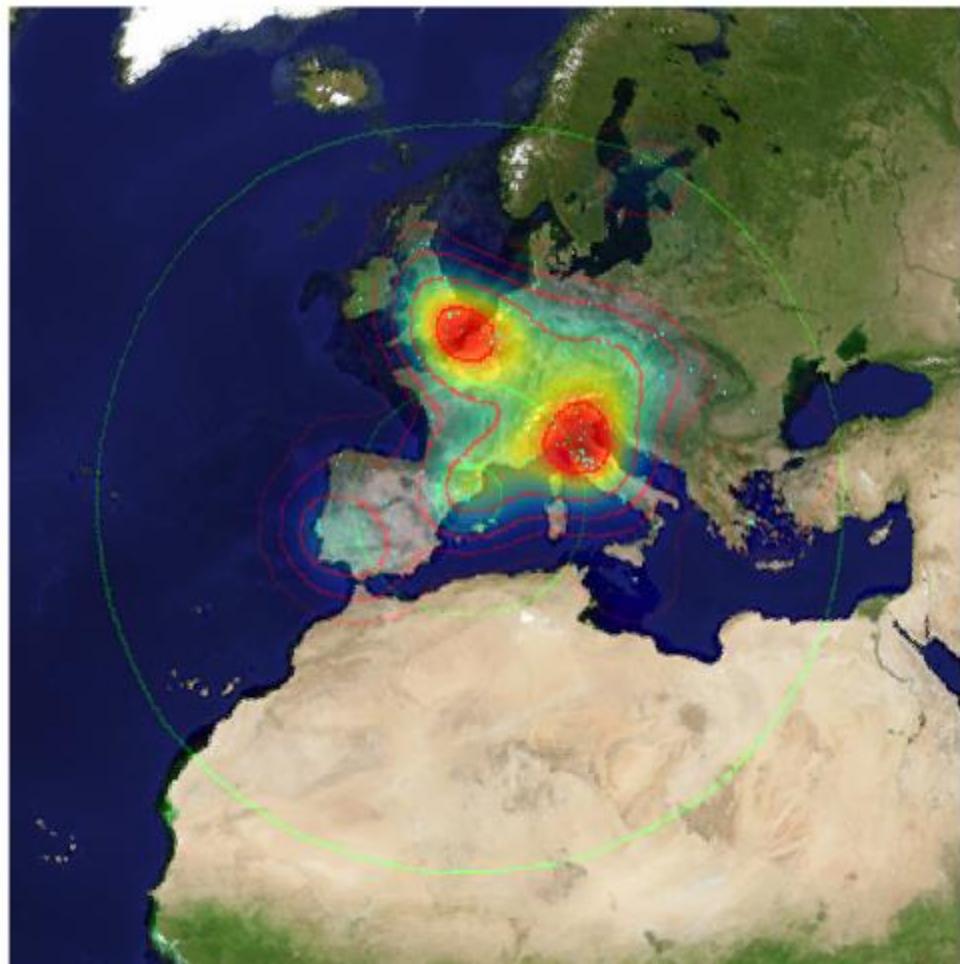
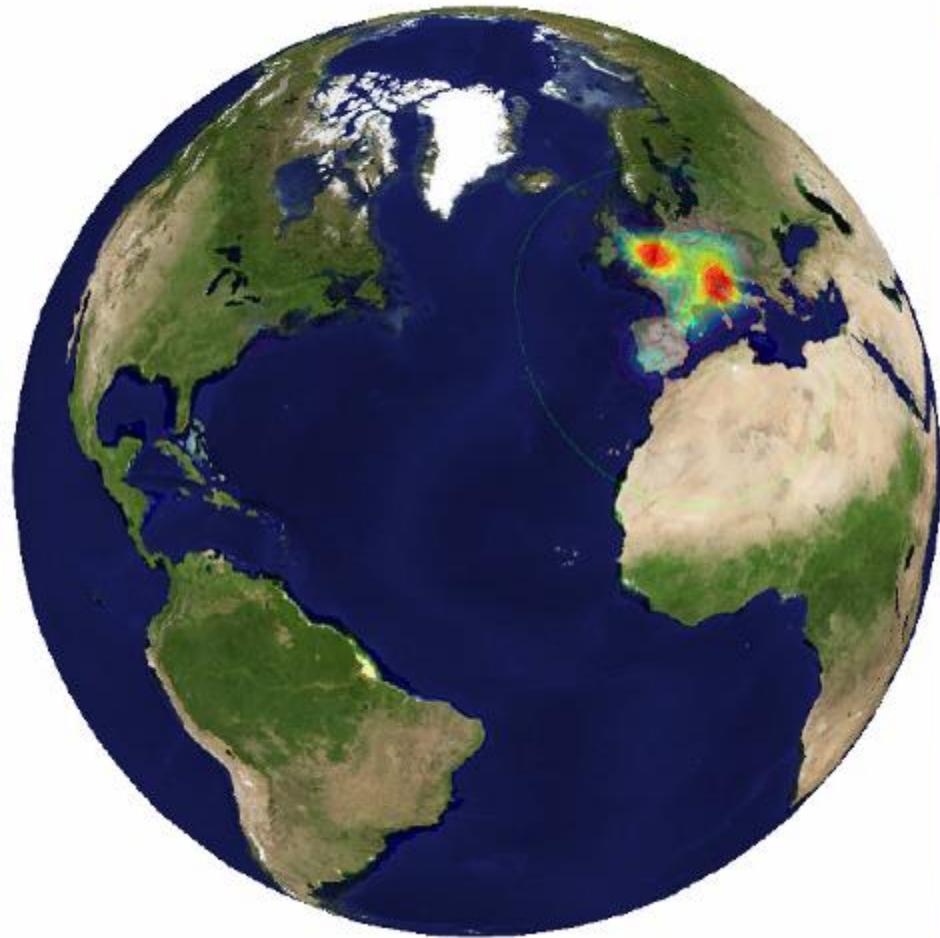
Im2gps



Example Scene Matches

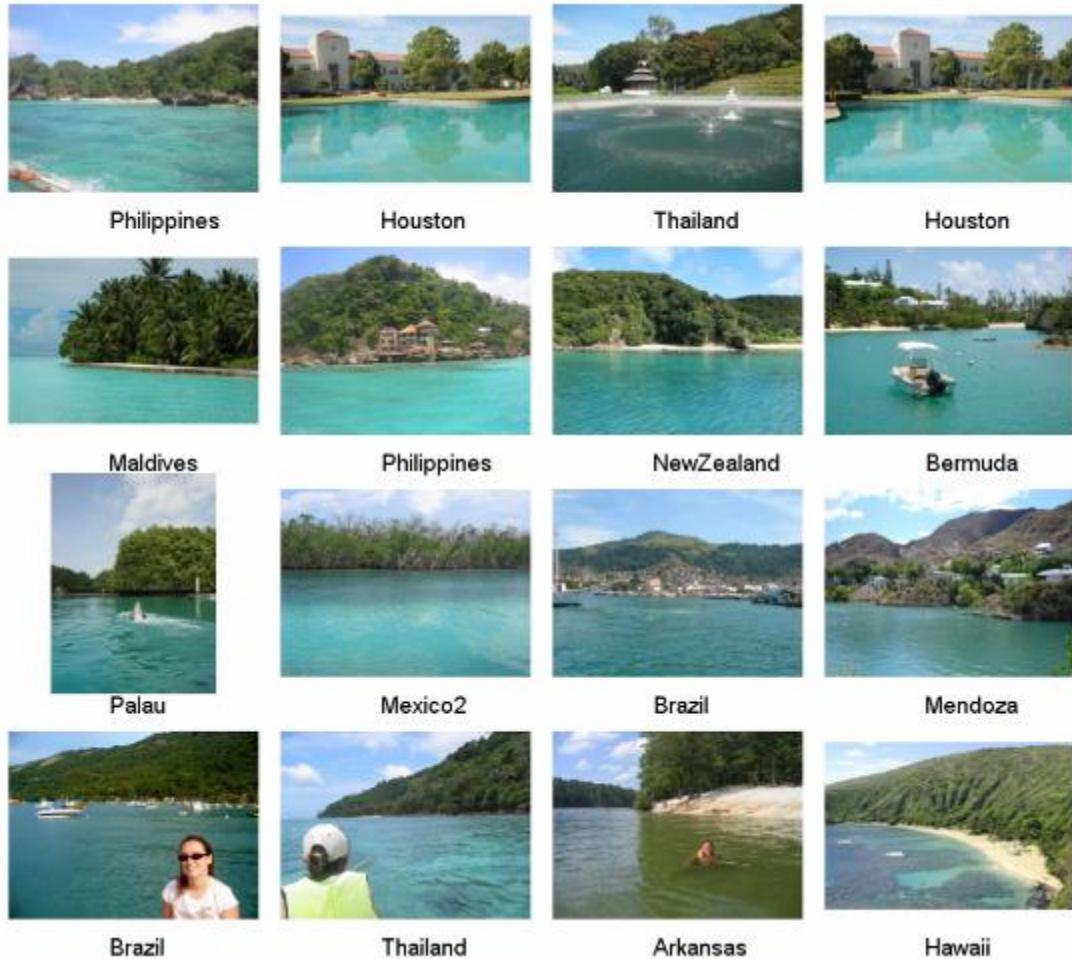


Voting Scheme



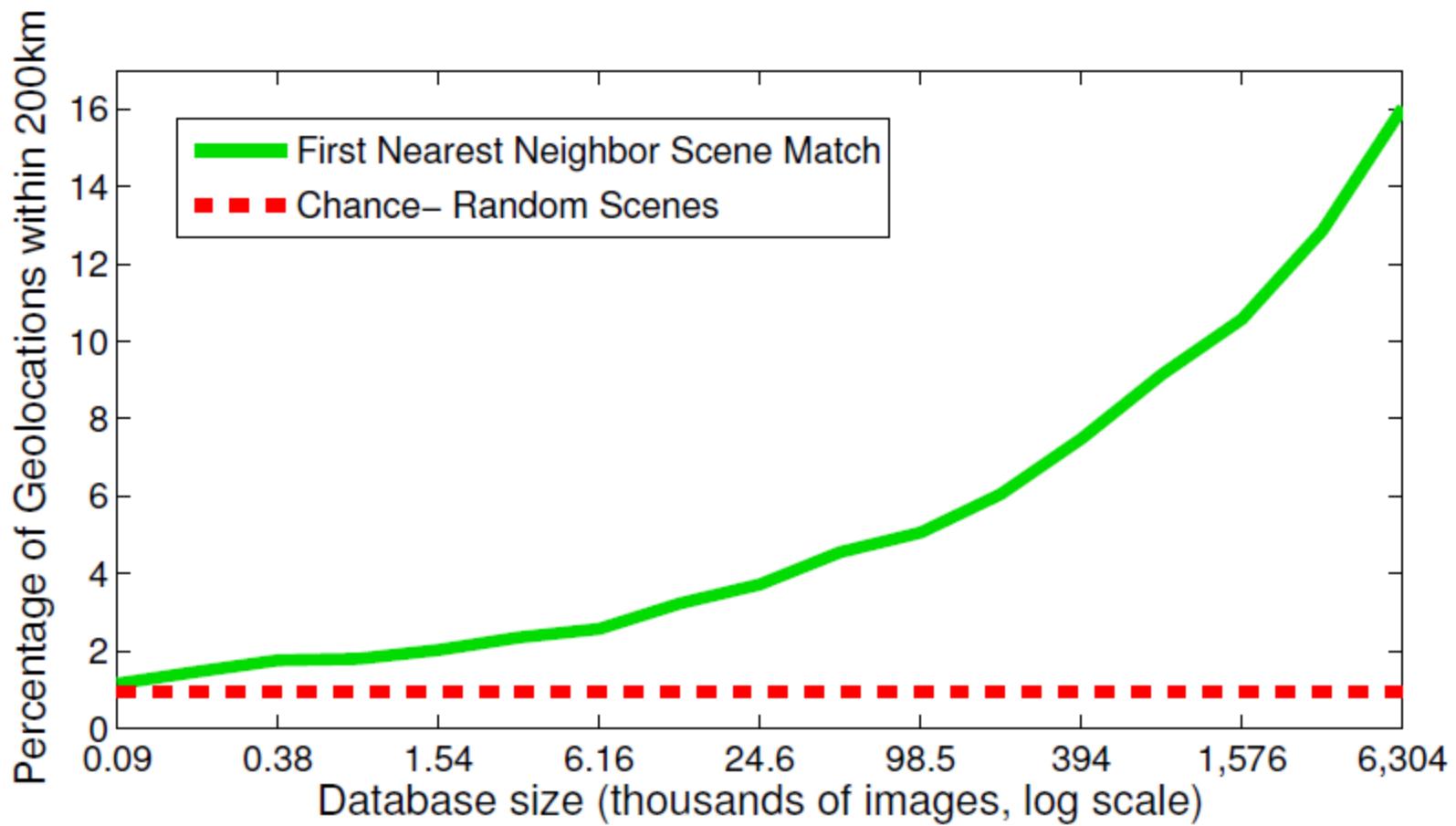
im2gps







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



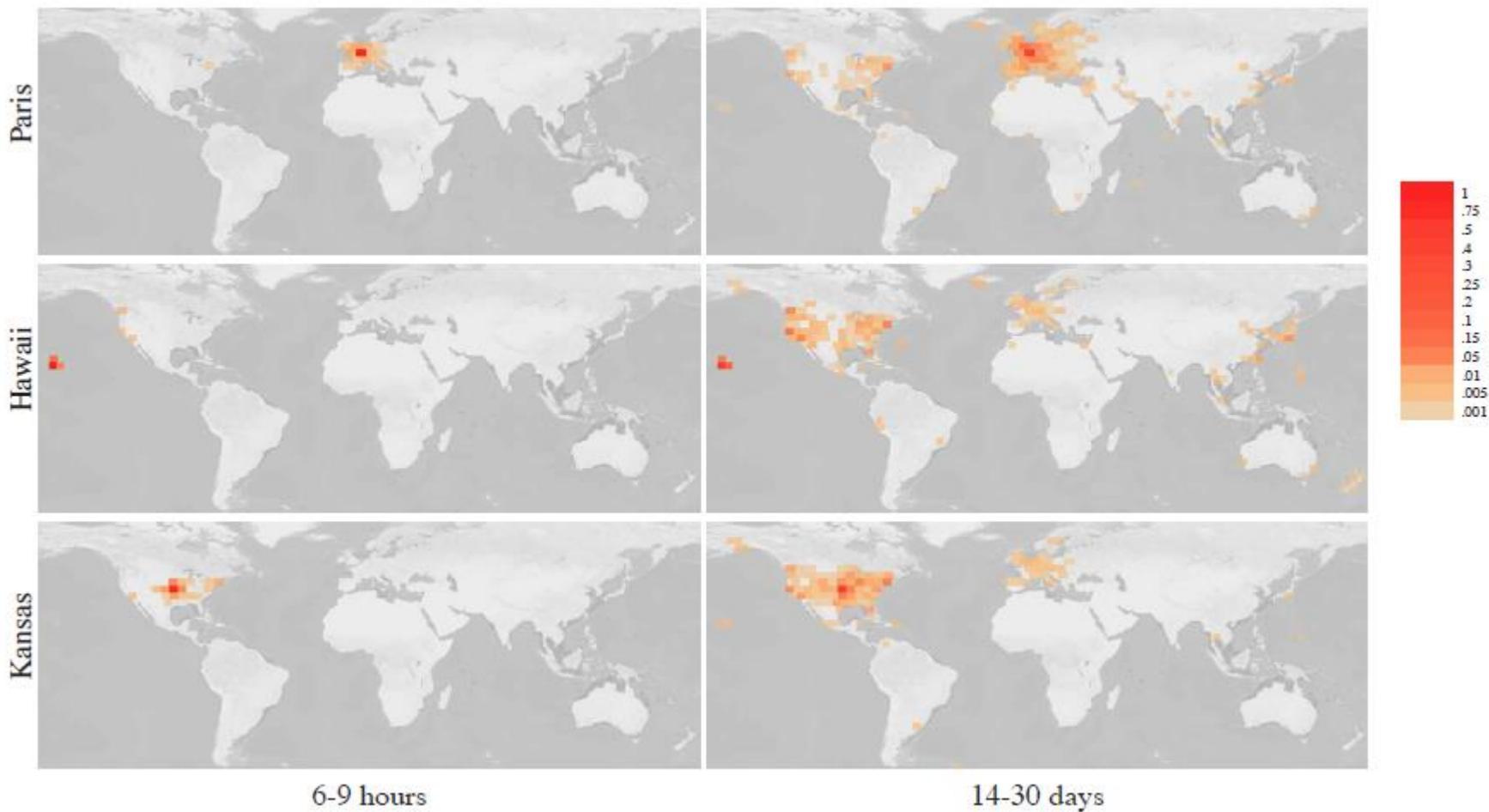
16:31,
June 18th, 2006



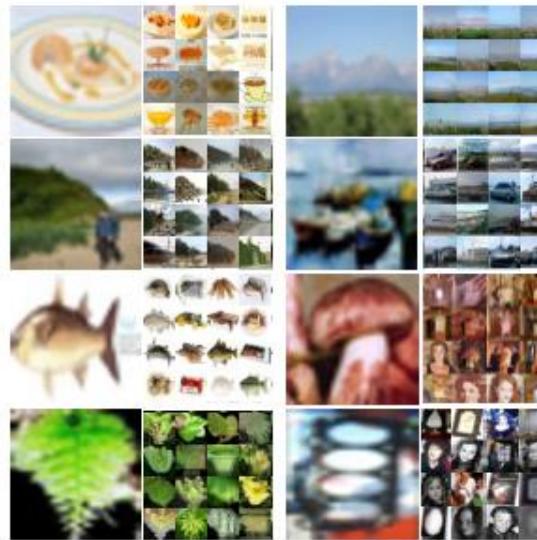
17:24,
June 19th, 2006

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



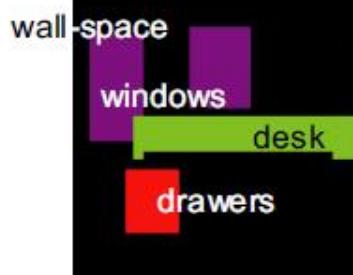
256x256



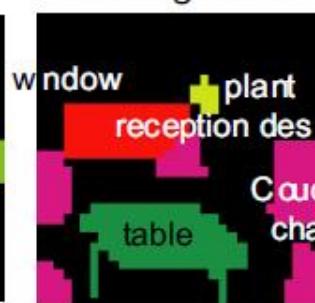
32x32



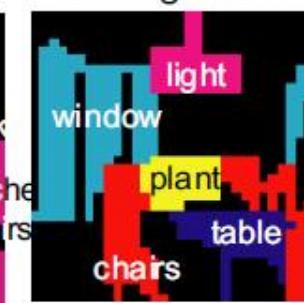
office



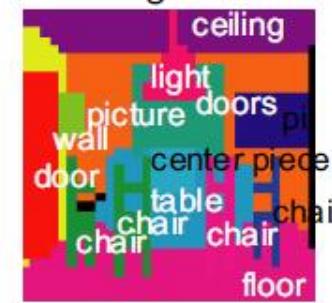
waiting area



dining room



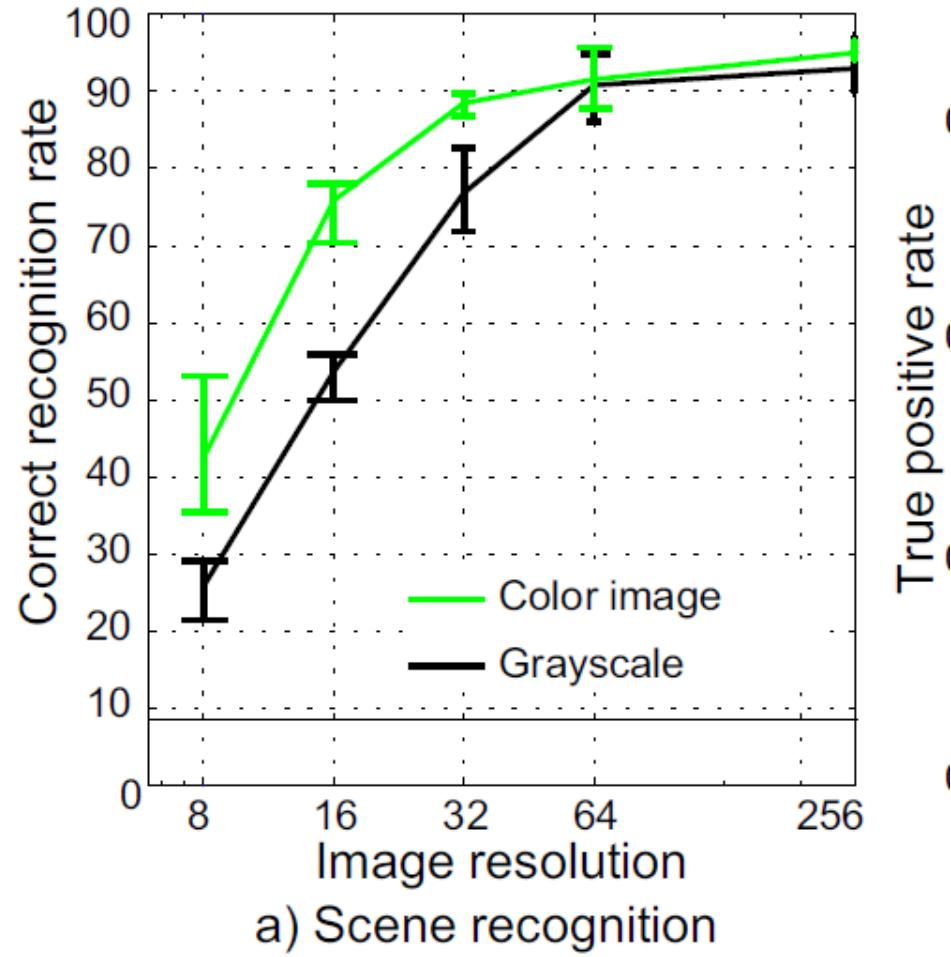
dining room



c) Segmentation of 32x32 images



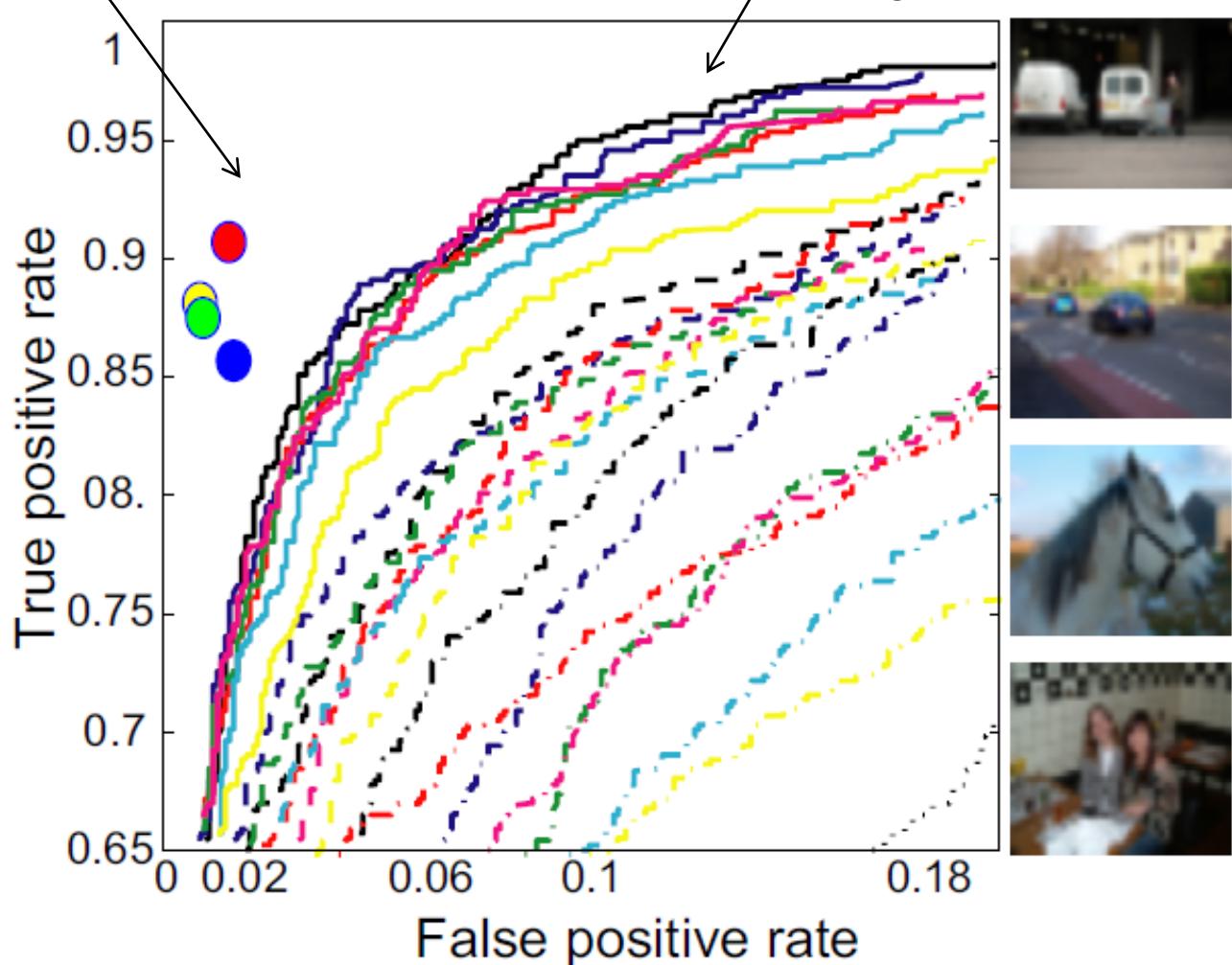
Human Scene Recognition



Humans vs. Computers: Car-Image Classification

Humans for 32 pixel tall images

Various computer vision
algorithms for full resolution
images



Powers of 10

Number of images on my hard drive: 10^4



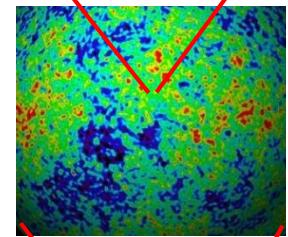
Number of images seen during my first 10 years: 10^8
(3 images/second * 60 * 60 * 16 * 365 * 10 = 630720000)



Number of images seen by all humanity: 10^{20}
106,456,367,669 humans¹ * 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}
 $256^{32 \times 32 \times 3} \sim 10^{7373}$



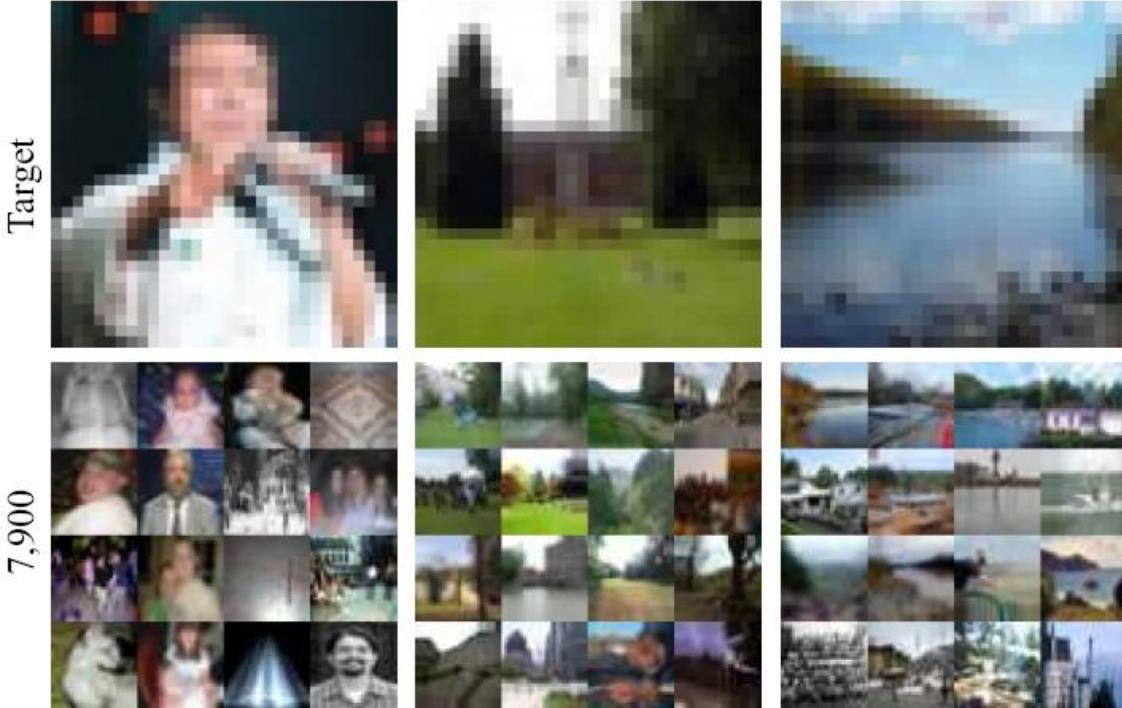
Scenes are unique



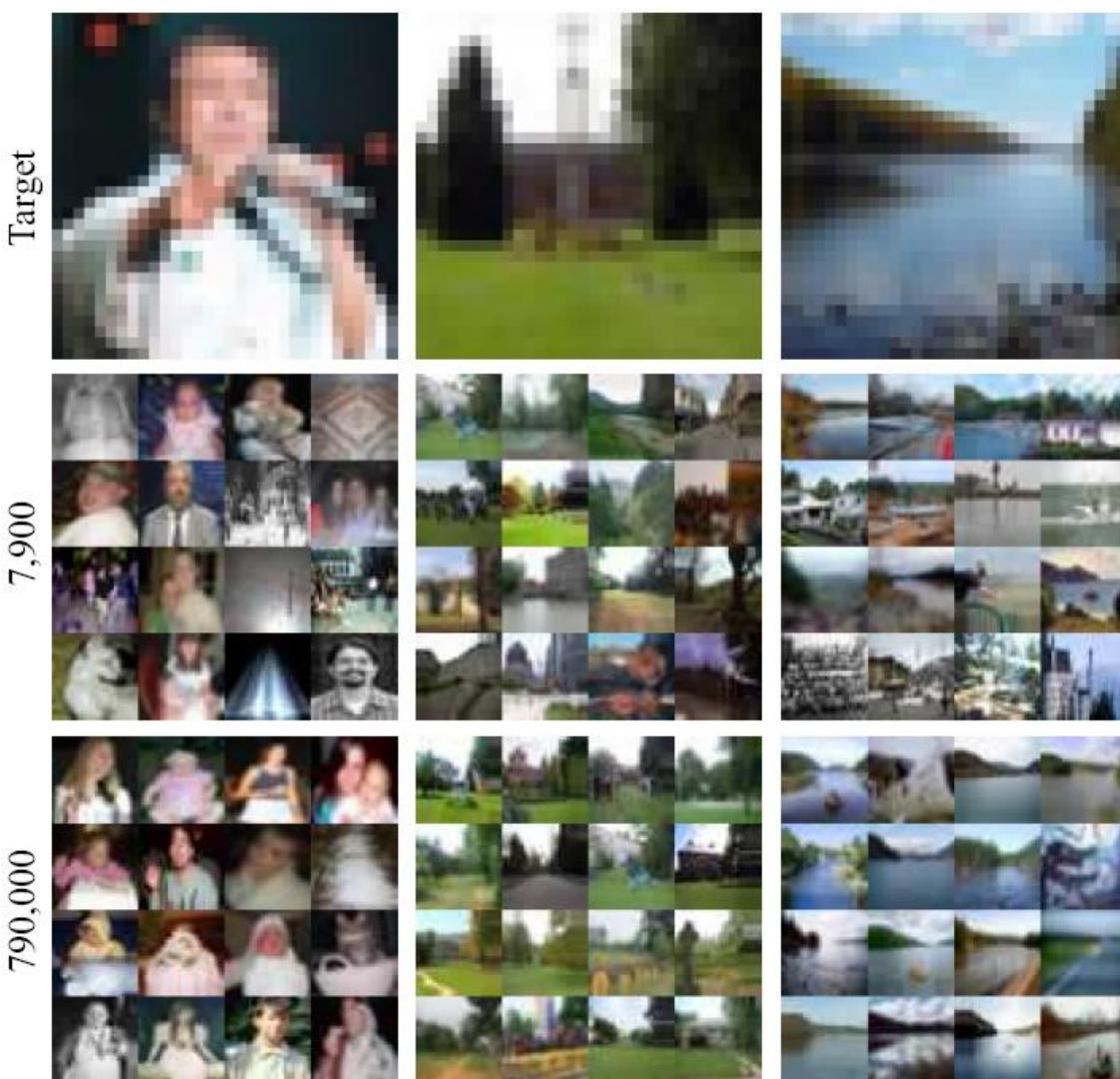
But not all scenes are so original



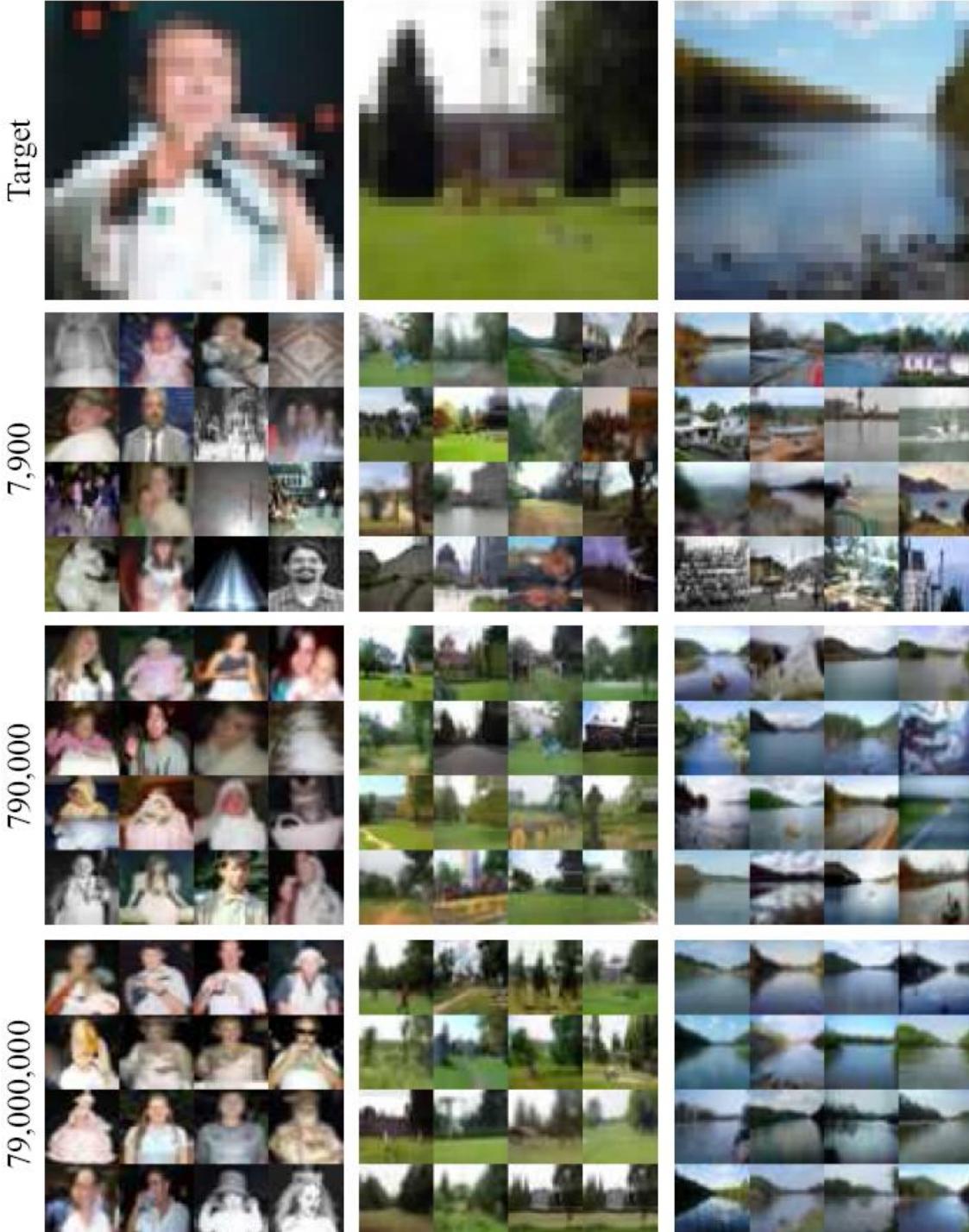
Lots Of Images



Lots Of Images



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)

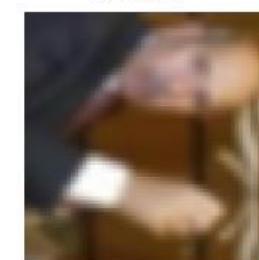
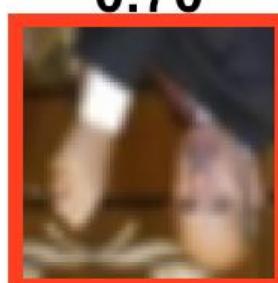
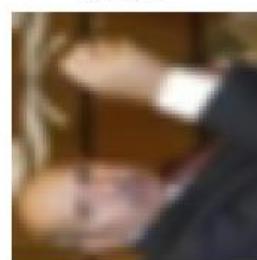
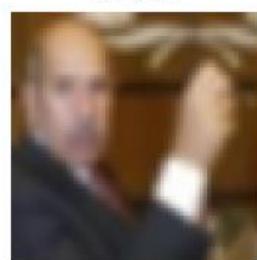


Matches (w/ color)



Avg Color of Match

Automatic Orientation Examples



Summary

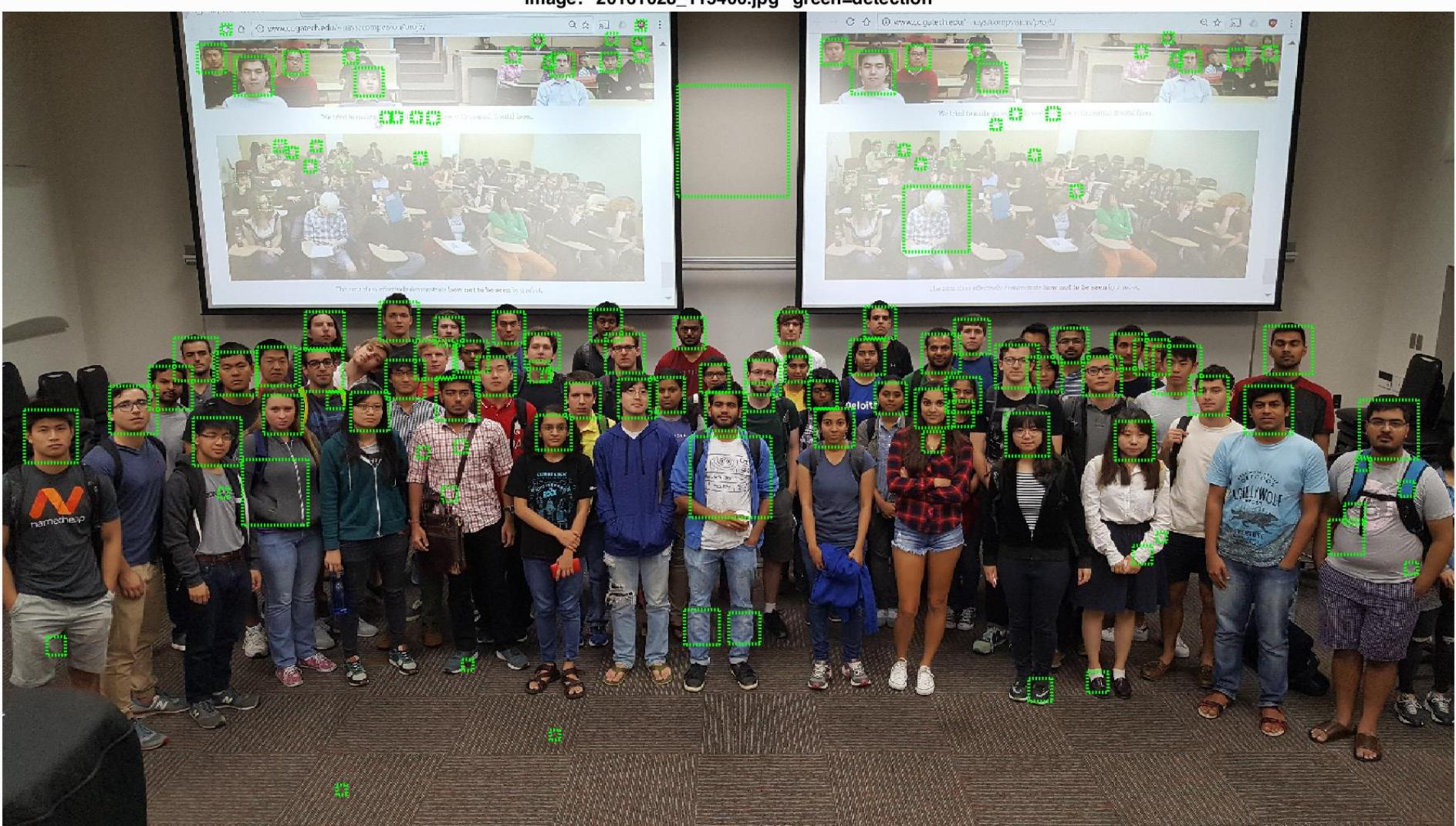
- With billions of images on the web, it's often possible to find a close nearest neighbor
- In such cases, we can shortcut hard problems by “looking up” the answer, stealing the labels from our nearest neighbor
- For example, simple (or learned) associations can be used to synthesize background regions, colorize, or recognize objects



Project 5

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





Wenqi Xian