Lab1 graded.

Requesting changes to the grades, please write to me in an email with descriptions.

Move my office hours to the morning. 11am - 12:30pm Thursdays
Internet-scale texture synthesis

With slides from James Hays, Antonio Torralba, Frederic Heger and Deepak Pathak

Cassandra Jones: https://youtu.be/5H7WrIBrDRg?t=161

Face movie: https://www.youtube.com/watch?v=fLQtssJDMMc
13 billion images uploaded daily

300 million images uploaded daily

1.5 million images uploaded daily

300 hours uploaded every minute

4.7 trillion photographs

90% of net traffic will be visual!
Big issues

• What is out there on the Internet? How do we get it? What can we do with it?
• How do we compute distances between images?
Subject-specific Data

Photos of Coliseum

Portraits of Bill Clinton
Much of Captured World is “generic”
Generic Data

street scenes

Food plates

faces

pedestrians
The Internet as a Data Source

- Social Networking Sites (e.g. Facebook)
- Image Search Engines (e.g. Google, Bing)
- Photo Sharing Sites (e.g. Instagram, Flickr, Picasa, Panoramio, photo.net)
- Computer Vision Databases (e.g. CalTech 256, PASCAL VOC, LabelMe, Tiny Images, image-net.org, Places365, LSUN, etc.)
Is Generic Data useful?

A motivating example...
[Hays and Efros. Scene Completion Using Millions of Photographs. SIGGRAPH 2007 and CACM October 2008.]
Scene Matching for Image Completion
The Algorithm
Scene Descriptor

[Diagram and image of a scene with a landscape and a graph showing frequency and edge orientation with color-coded energy levels.]
Scene Descriptor

Scene Gist Descriptor

(Oliva and Torralba 2001)
Scene Descriptor

Scene Gist Descriptor
(Oliva and Torralba 2001)
2 Million Flickr Images
... 200 total
Context Matching
Graph cut + Poisson blending
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
... 200 scene matches
Why does it work?
Nearest neighbors from a collection of 20 thousand images
Nearest neighbors from a collection of 2 million images
“Unreasonable Effectiveness of Data”

[Halevy, Norvig, Pereira 2009]

• Parts of our world can be explained by elegant mathematics
  – physics, chemistry, astronomy, etc.
• But much cannot
  – psychology, economics, genetics, etc.
• Enter The Data!
  – Great advances in several fields:
    • e.g. speech recognition, machine translation
    • Case study: Google
A.I. for the postmodern world:
  - all questions have already been answered... many times, in many ways
  - Google is dumb, the "intelligence" is in the data
How about **visual** data?

- **text is simple:**
  - clean, segmented, compact, 1D
- **Visual data is much harder:**
  - Noisy, unsegmented, high entropy, 2D/3D

**Quick Overview**

Comparing Images
Uses of Visual Data
Deep Learning with Big Visual Data
The Dangers of Data
Distance Metrics

- Euclidian distance of 5 units
- Grayvalue distance of 50 values
- ?
SSD says these are not similar
Gist of a scene

• Need a full image descriptor, to capture the context

• But still want it to be not too high-dimensional (else nothing will look similar)
Make them tiny!
Tiny Images

Tiny Images pack a punch!

4x4  
8x8  
16x16  
32x32  
64x64
c) Segmentation of 32x32 images
Image Segmentation (by humans)
Human Scene Recognition

![Graph showing correct recognition rate versus image resolution for color and grayscale images.](image)
Tiny Images Project Page

http://groups.csail.mit.edu/vision/TinyImages/
Powers of 10

Number of images on my hard drive: $10^4$

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

Number of images seen by all humanity:
106,456,367,669 humans * 60 years * 3 images/second * 60 * 60 * 16 * 365 = $10^{20}$

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

Number of all 32x32 images:
$256^{32^3^3} \approx 10^{7373}$
Scenes are unique
But not all scenes are so original
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