#### Image Searches and Invariance

36-350: Data Mining6 September 2006

- Finding illustrations
- Medical: x-rays, brain imaging, histology ("are these cells cancerous?")
- Satellite imagery
- Fingerprints



### Searching for Images by Searching for Text

- Assume there's text accompanying the images ("annotation")
- Search those text records with the query phrase
- Take images which appear close to the query phrase on highly-ranked records
- This how Google does it



Pittsburgh's Cathedral of

Open "http://images.google.com/imgres?imgurl=http://www.netspace.org...%26safe%3Doff%26client%3Dsafari%26rls%3Den%26sa%3DG" in a new window

The Cathedral of Learning

Jen Hartman at Cathedral of ... Cathedral of Learning, U. of



Sometimes this works...



Wallpaper Musik Atomic-Kitten 1024 x 768 pixels - 99k - jpg www.new-dream.de

![](_page_4_Picture_2.jpeg)

kitten information, cat and ... 189 x 226 pixels - 9k - jpg www.kitten-stork.com More results from www.kitten-

![](_page_4_Picture_4.jpeg)

sometimes it doesn't; depends on the text!

![](_page_4_Picture_6.jpeg)

Kitten Anonymous 12th century Album ... 440 x 440 pixels - 36k - jpg www.asianart.com

![](_page_4_Picture_8.jpeg)

kitten Diler Maaw 450 x 556 pixels - 41k - jpg maaw.net

![](_page_4_Picture_10.jpeg)

![](_page_4_Picture_11.jpeg)

![](_page_4_Picture_12.jpeg)

![](_page_4_Picture_13.jpeg)

# Searching for images by representing images

- For text, we only cared about *features*, and only operated on *feature vectors*
- Define features for images and everything carries over (abstraction)
- Key is finding good features

![](_page_6_Picture_0.jpeg)

![](_page_6_Picture_1.jpeg)

![](_page_6_Picture_2.jpeg)

flower2

![](_page_6_Picture_4.jpeg)

flower3

![](_page_6_Picture_6.jpeg)

tigerl

![](_page_6_Picture_8.jpeg)

oceanl

![](_page_6_Picture_10.jpeg)

tiger2

![](_page_6_Picture_12.jpeg)

ocean2

![](_page_6_Picture_14.jpeg)

tiger3

![](_page_6_Picture_16.jpeg)

![](_page_6_Picture_17.jpeg)

## Euclidean Distance of Images

- Image is MxN pixels, each with 3 color components, so a 3MN vector
- Euclidean distance possible, and OK for some kinds of noise-removal
- but hopeless even at grouping flower1 with flower2
- or slight changes in perspective...

### Bag of Colors

- "If it works, try it some more"
- For each possible color, count how many pixels there are of that color
- Use Euclidean distance on color-count vectors
- Too many colors, so quantize them down to a manageable number (like stemming, or combining synonyms)

![](_page_9_Figure_0.jpeg)

![](_page_9_Figure_1.jpeg)

#### Distances between images

MDS plot of images

#### Representation and Invariance

- Invariances of a representation = how can we change the underlying object without changing the representation?
- What differences does the representation ignore?

#### Invariants of bags of words

- Punctuation and word order ("Why do you love me?" vs. "Why, you do love me!")
- Universal words (exact count of "the"), if using inverse document frequency
- Grammar, context, ...

## Invariants of bags of colors

- Small changes in orientation, pose, over-all rotations
- Small amounts of color noise or weird colors
- Texture

![](_page_13_Figure_0.jpeg)

#### Same color counts, different textures

#### Non-invariants

- Lighting, shadows
- Occlusion, 3D effects
- Blurring
  - There are good ways to deal with blur (from astronomy)
  - but full vision is very, very hard

- Breaking an invariance is easy
  - e.g., add features for textures
  - or sub-divide the image and do colorcounts on each part
- Adding invariances is hard
  - often need to go back to scratch