Image Database Retrieval
NTT: Visit
1/7/99

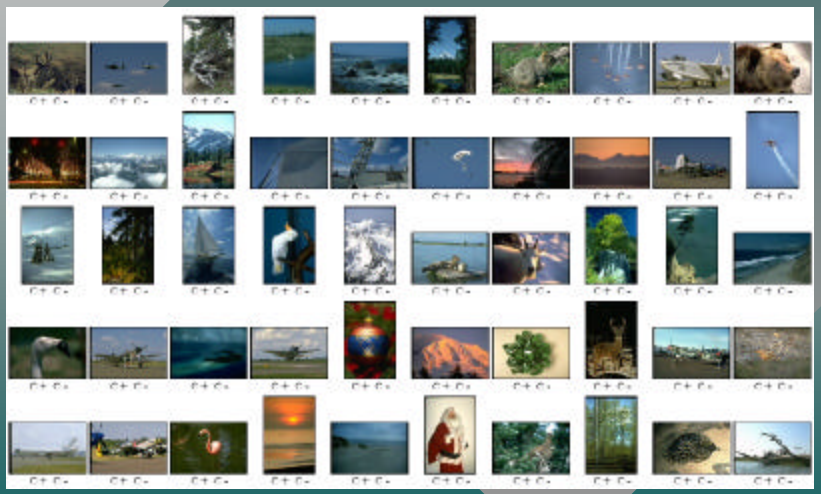
Overview of IDB Meeting

- Motivation from MIT …
- Discuss current and related work
  - Flexible Templates
  - Complex Features
  - Demonstrations
- Related NTT Efforts
- Discussion of collaboration
- Future work
- Dinner

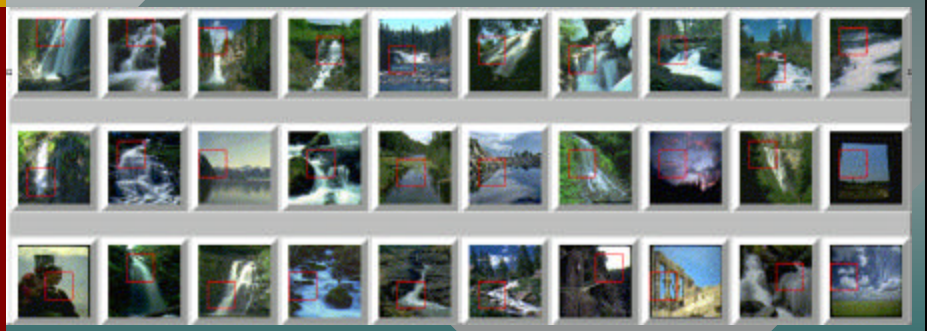
Motivating Scenario

- Image Databases are proliferating
  - The Web
  - Commercial Image Databases
  - Video Databases
  - Catalog Databases
    - "Find me a bag that looks like a Gucci."
  - Virtual Museums
    - "Find me impressionist portraits."
  - Travel Information
    - "Find me towns with Gothic architecture."
  - Real-estate
    - "Find me a home that is sunny and open."

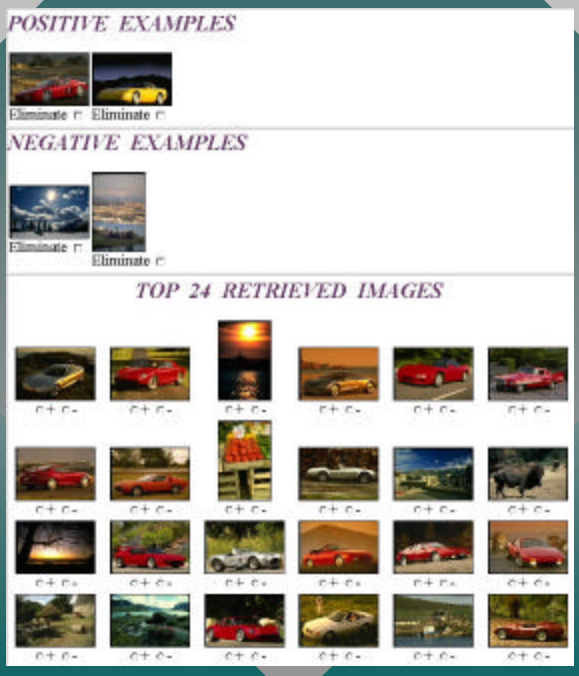
There is a very wide variety of images…



Search for images containing waterfalls?



Search for cars?



What makes IDB hard?

- Finding the right features
  - Insensitive to movement of components
  - Sensitive to critical properties
- Focussing attention
  - Not everything matters

- Generalization based on class
  - Given two images
    - Small black dog & Large white dog
    - (Don't have much in common…)
  - Return other dogs

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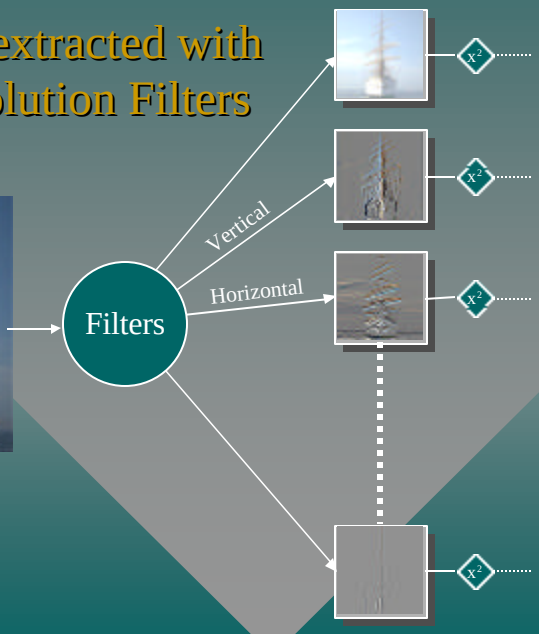
Complex Feature Representation

- Motivated by the Human brain...
  - Infero-temporal cortex computes many thousand selective features
  - Features are selective yet insensitive to unimportant variations
  - Every object/image has some but not all of these features
- Retrieval involves matching the most salient features

Features are extracted with many Convolution Filters



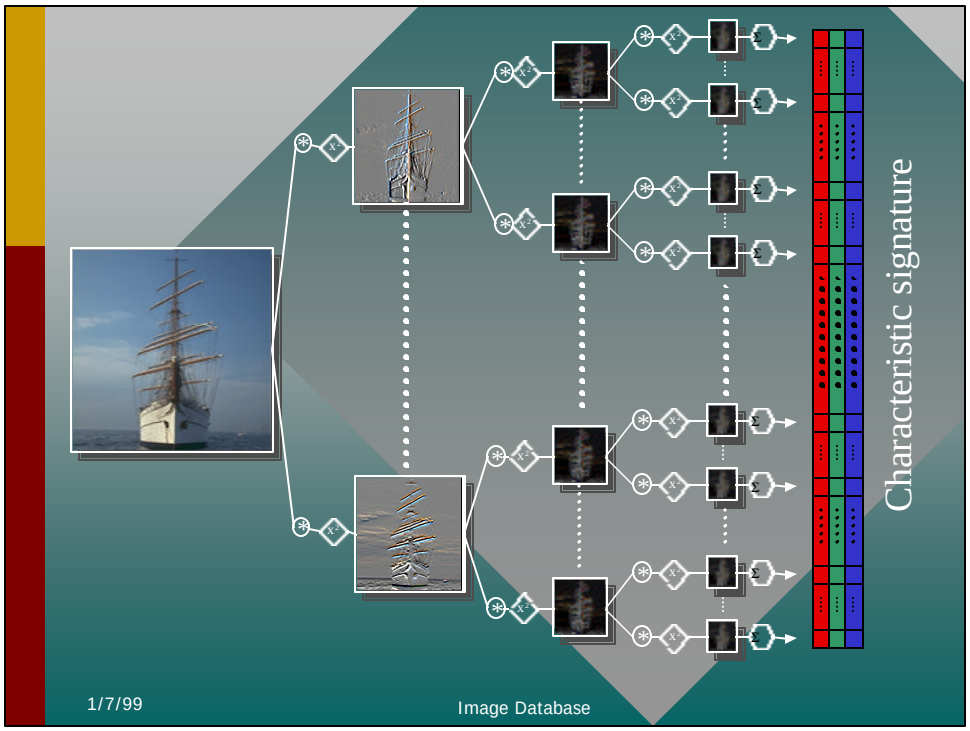

Characteristic signature
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Image Database


Resolution is reduced at each step...
Σ
pixels
Feature Value

Not every feature is useful for a query

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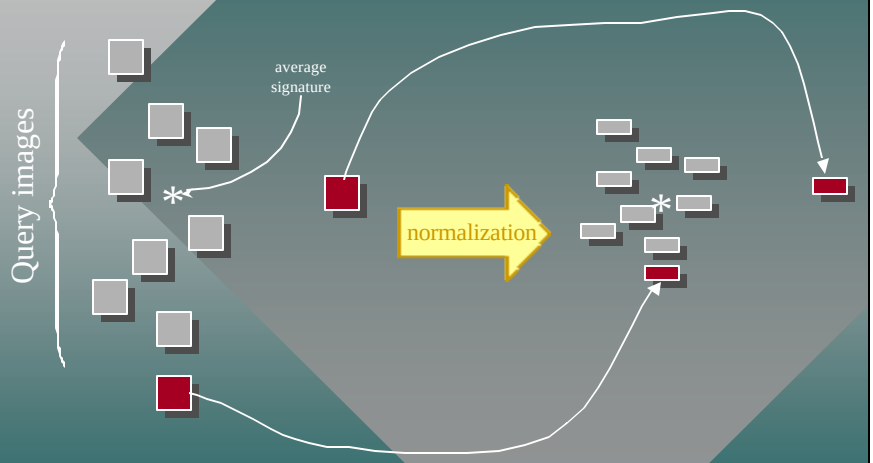
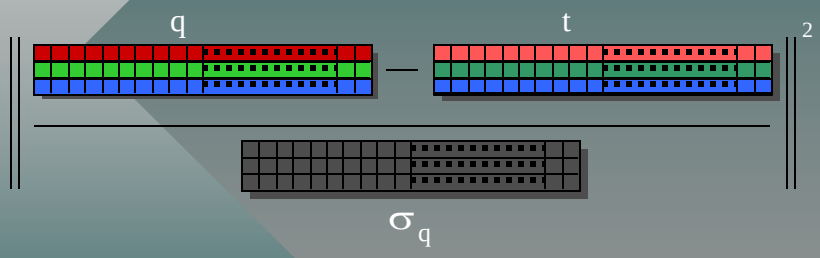
Image Database

Normalization of Signature Space



- Normalization brings some image closer to the mean

Distance/Similarity Measure



$$\sum_{e=0}^{25^3} \sum_{c=\{r,g,b\}} \left(\frac{\overline{q_{e,c}} - t_{e,c}}{\sigma_{q_{e,c}}} \right)^2$$

Diagonal Mahalanobis Distance

Incorporating Negative Examples

- Diagonal approx. of Fisher's Linear Discr.
  - Weight features highly if:
    - Variance of pos and neg is greater than
    - Variance of pos alone

$$Dist(t) = \sum_{e=0}^{25^3} \sum_{c=\{r,g,b\}} \left(\frac{\sigma_{q_{e,c}}^{PN}}{\sigma_{q_{e,c}}^{P}} \right)^2 \left(\frac{\overline{q_{e,c}} - t_{e,c}}{\sigma_{q_{e,c}}} \right)^2$$

Interesting Pattern Recognition Properties

- The statistics of the data is non-gaussian
- Data is 45,000 dim. but highly redundant.
  - PCA can be used to reduce dimension
  - But, retrieval performance deteriorates (??)
  - ** Non-gaussian data!
- Retain only those features which are kurtotic
  - 45,000 down to 5,000
  - ** Performance improves!
- Kurtotic features are those which are unusual
  - Distinct, interesting.
  - Kurtotic features require fewer bits