

EE 6882



Statistical Methods for Video Indexing and Analysis

Instructors:
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Fall 2007, Lecture 1
Course web site: <http://www.ee.columbia.edu/~sfchang/course/svia>

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EE E6882 SVIA Lecture #1

- Introduction, Course Syllabus
- Readings (available on course site)
 - Rui et al, Content-Based Image Retrieval Review paper
 - A. Jain et al, "Statistical Pattern Recognition: A Review," IEEE Tran. on Pattern Analysis and Machine Intelligence, vol 22, No 1, Jan. 2000.
 - Gonzalez and Woods, Digital Image Processing, 2nd edition, Prentice Hall, 2001 (Chapter 12, Object recognition)
- Next Week:
 - Sept. 17th 2007 (Prof. Xie)
 - Topic: Content Based Image Retrieval

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Topics: Image/Video Search

- Explosive growth of online image/video data, personal media, broadcast news videos, etc.
- 5 billion images on the Web, 31 million hours of TV programs each year
- Successful services like Youtube and Flickr
 - Others: blinkx.com, like.com, etc
- Image/video search exciting opportunity



Different Visual Search Models

- Browsing and Grouping
 - Subject listing (e.g., WebSeek, <http://www.ee.columbia.edu/webseek>)
 - Animation summary (e.g., <http://www.blinkx.com>)
- Keyword Search
- Content-Based Search
 - E.g., VisualSeek, like.com

User Expectation in Practice

“...type in a few words at most, then expect the engine to bring back the perfect results. More than 95 percent of us never use the advanced search features most engines include, ...” – *The Search*, J. Battelle, 2003

- Keyword search is the primary search method.



Google Zeitgeist publishes top keywords monthly

Google Image Queries: April 2007

Newsmakers

1. virginia tech
2. knut
3. yuri gagarin
4. shaha riza
5. kurt vonnegut

Getaways

1. hawaii
2. dubai
3. mexico
4. chelsea
5. london

At the cineplex

1. ghost rider
2. shrek
3. borat
4. 300 movie
5. spiderman 3

Global consciousness

1. global warming
2. world map
3. earth day
4. southern cross
5. iceberg

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Examples of Keyword Image Search

query: "sunset"

1st page

2nd page



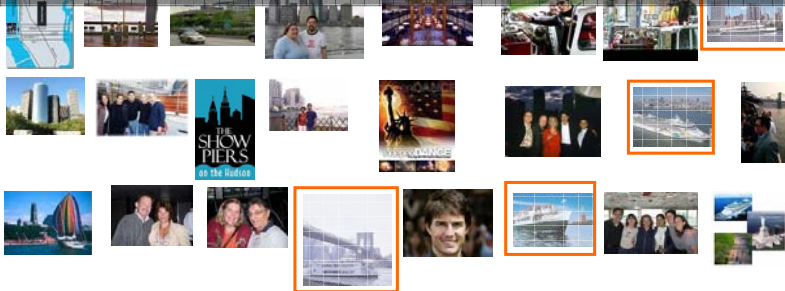
- Reasonable Keyword Search Results
- Content Analysis May Help Correct Mistakes...

Example Search

- Text Query on Google: "Manhattan Cruise"



- Image content analysis may help refine results



How about Social-Net Tagging?

- Yahoo-flickr millions of users,

Social tags may be subjective and incomplete.

flickr

✓ We found 2,225 photos about **manhattan** and **cruise**.

View: Most relevant • Most recent • Most interesting

Uploaded by gdanny
Tags: outdoor, nyc, bridges, water, boat, cruise
Camera: Canon PowerShot SD 400
Date: Sept. 17 2006



From nosilla_g



From nosilla_g



From anandstein



From Eins Fotos



From nosilla_g



From wenzdav01



From cvreeland86



From nosilla_g



From nosilla_g



From Eins Fotos



From nosilla_g



From nosilla_g



From nosilla_g

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Insufficient Precision of Social Tags

- Test New York City landmark labels

	precision
Bronx-Whitestone Br.	1.00
Brooklyn Br.	0.38
Chrysler Building	0.65
Columbia University	0.30
Empire State Building	0.18
Flatiron Building	0.70
George Washington Br.	0.48
Grand Central	0.37

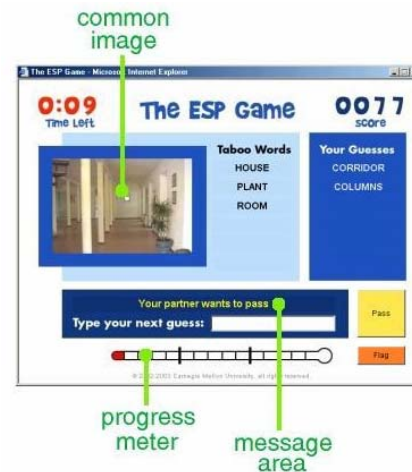
Many tags from social networks are of low precision (due to batch uploading?)

Times Square	0.56
Verrazano Narrows Br.	0.66
World Trade Center	0.13

An Interesting Paradigm: Image Tagging via Game Playing

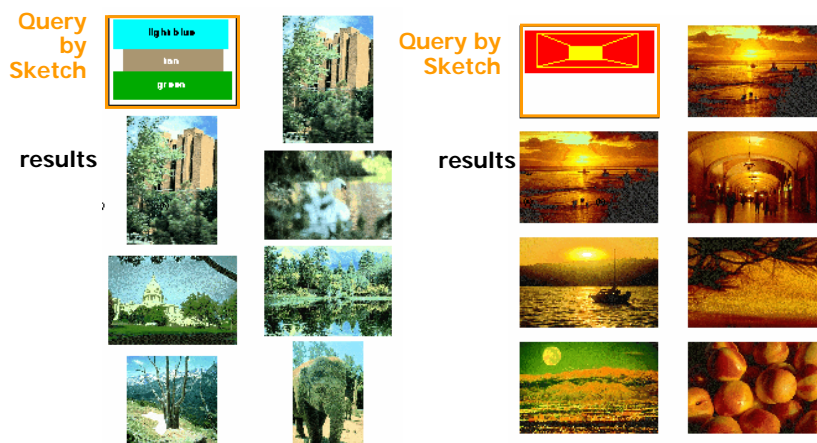
(Von Ahn & Dabbish, CHI 04)

- Used in *Goggle Image Labeler* (<http://images.google.com/imagelabeler/>)
- Use competitive games to motivate users
- Has attracted many participants for free!
 - Some users spent hours in a day
- Claim the potential of annotating the whole Web in just few months!
 - 5 Billion images



Seeking the image search tools -- Content-Based Image Retrieval (CBIR)

IBM QBIC '95, Columbia VisualSEEK '96



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Issues

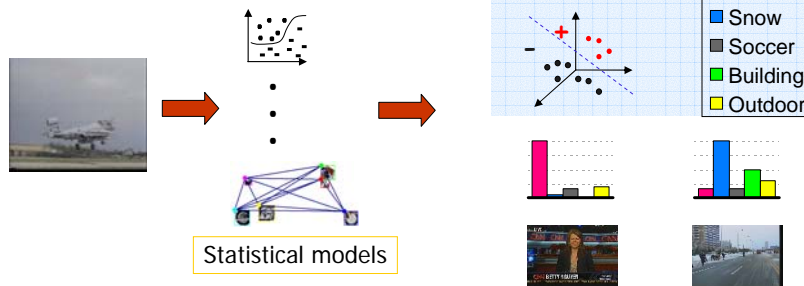
- What image features to extract?
- How to match images and videos?
- How to make it fast?

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Opportunity for Content Analysis: Large-Scale Auto. Image Tagging Framework

- Audio-visual features
 - Surrounding text
 - SVM or graph models
 - Context fusion
- Rich semantic description based on content analysis



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Large-Scale Concept Detectors from Research Community

- Columbia374
 - 374 baseline detectors for LSCOM multimedia ontology
- MediaMill
 - 491 concept detectors for LSCOM and MediaMill
101 Lexicons
- IBM MARVEL Search System
 - Trials with BBC, CNN
 - Real-time standalone detectors from IBM AlphaWorks
- Others ...

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What Concept to Detect?

- One effort: Large Scale Concept Ontology for Multimedia (LSCOM)
 - Joint effort by news/intelligence analysts, librarians, researchers
 - Broadcast News Domain
 - Selection Criteria
 - useful, detectable, observable
 - 834 concepts defined, 449 concepts annotated
 - Labeled over 61,000 shots of TRECVID 2005 data set
 - 33 Million judgments collected, 100 person-month labor
 - Download by 170+ groups so far
 - <http://www.ee.columbia.edu/dvmm/lscom/>

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LSCOM Concepts (449)

- Event/Activity (56 - 13%)
 - Airplane taking off, car crash, explosion, etc
- People (113 - 25%)
 - Person, male/female, firefighter, etc
- Location (89 - 20%)
 - Cityscape, hospital, airfield, etc
- Object (135 - 30%)
 - Vehicle, map, tank, power plant, etc
- Scene (49 - 10%)
 - Vegetation, urban, interview, etc
- Program (7 - 2%)
 - Entertainment, weather, finance, etc

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Consumer Video Ontology

(Kodak-Columbia, 2007)

- Activity (6)
- Occasion (16)
- Scene (15)
- Object (25)
- People (11)
- Sound (14)
- Camera Motion (5)
- Object Motion (3)
- Social (4)

Activity:
Occasion :
Scene:
Object:
People:
Sound:
Camera Motion:
Object Motion:
Social: friend, family, classmate, colleague

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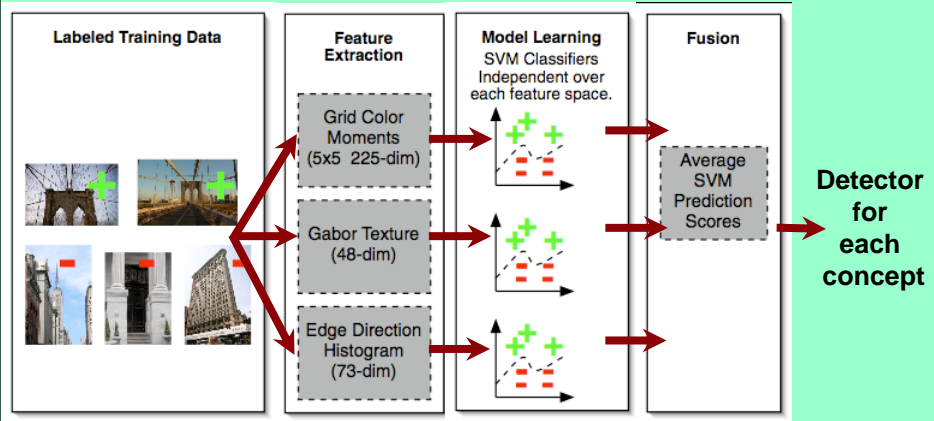
Research Issues

- How to develop automatic tagging tools?
 - Train automatic recognition models
 - What image features?
 - What statistical models?
 - Explore surrounding information
 - Time, location (e.g., Yahoo! Zonetag, <http://zonetag.research.yahoo.com/>)
 - Text and metadata

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Building Image Classifiers – Basic



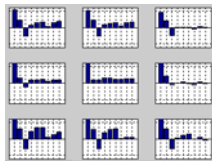
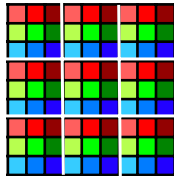
- General for all concepts, easy to implement
- 374 baseline detectors (*Columbia 374*) released

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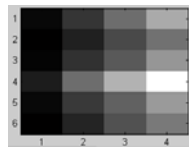
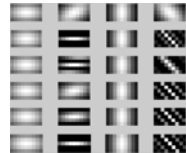
Examples of Basic Image Features

grid layout + color moment



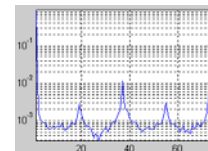
225 dimensions

Gabor texture



48 dimensions

edge direction histogram



73 dimensions

Text search vs. visual classification

Displaying results 1 - 40 of 1000 from 1000 documents. [\[All By Time\]](#) [\[All Duplicate Shots\]](#) [\[Results By Story\]](#) 1 2 5 9 14 18 22 24 25 26 Next >>

Displaying results 1 - 40 of 1000 from 1000 documents. [\[All By Time\]](#) [\[All Duplicate Shots\]](#) [\[Results By Story\]](#) 1 2 5 9 14 18 22 24 25 26 Next >>

Automatic classification – “boat”

(images from TRECVID)

Text search vs. visual classification

Displaying results 1 - 40 of 1000 from 1000 documents. [All By Time | All Duplicate Shots | Results By Story] 1 2 5 9 14 18 22 24 25 26 Next >>

Displaying results 1 - 40 of 1000 from 1000 documents. [All By Time | All Duplicate Shots | Results By Story] 1 2 5 9 14 18 22 24 25 26 Next >>

Automatic classification – “car”

The screenshot shows a grid of video thumbnails. The first column contains three thumbnails with labels: [1] shot224_217_RKF, [6] shot224_222_RKF, and [11] shot224_227_DVF. The second column contains thumbnails labeled [1] shot167_238_NRKF_4, [6] shot167_309_NRKF_1, and [11] shot269_209_NDVF_2. The third column contains [2] shot257_229_NRKF_1, [7] shot226_51_NRKF_1, and [12] shot264_106_NDVF_4. The fourth column contains [3] shot257_234_NRKF_1, [8] shot264_106_NRKF_2, and [13] shot189_106_NDVF_3. The fifth column contains [4] shot167_229_NRKF_1, [9] shot269_273_NRKF_3, and [14] shot189_266_NDVF_3. The sixth column contains [5] shot221_225_NRKF_2, [10] shot175_34_RKF, and [15] shot221_224_NDVF_4. Each thumbnail includes a magnifying glass icon and a green checkmark.

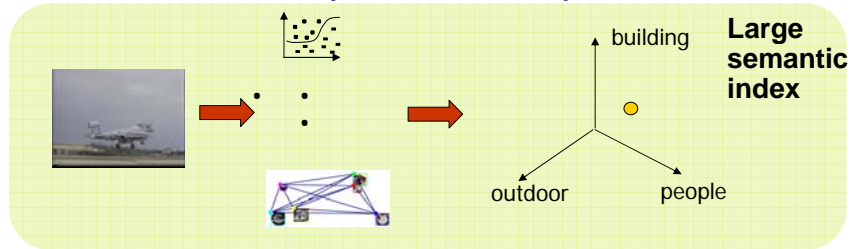
Example: good detectors for LSCOM concept

waterfront bridge crowd explosion fire US flag Military personnel

Search Results: Search Results: Search Results: Search Results: Search Results:

The screenshot displays a grid of 20 video thumbnails, each with a magnifying glass icon and a green checkmark. The thumbnails show various scenes of military personnel in different environments, including urban settings, military vehicles, and soldiers in uniform. The search results are organized into four rows of five thumbnails each.

Power of Concept-based Representation



New applications:
Search, Filtering, Pattern Mining



Mapping search topics to concepts

TRECVID search topics

Find shots with one or more **emergency vehicles** in **motion** (e.g., ambulance, police car, fire truck, etc.)

Matched Concepts:
Emergency_Room, Vehicle

Find shots with a view of one or more tall **buildings** (more than 4 stories) and the top **story** visible.

Matched Concepts: Building

Find shots with **vehicles** or entering a **vehicle**

Matched Concepts: Person, Vehicle

Research issue:
what concept to use?
How to fuse multiple concepts?

Find shots with **vehicles** or entering a **vehicle** are **soldiers**, **police**, **prisoner**.

Matched Concepts:
Guard, Police_Security, Prisoner, Soldier



Concept Search Demo

- Interactive demos available at <http://apollo.ee.columbia.edu/vace/newSearch/>
- Concept search case 1 ([link](#))
- Concept search case 2 ([link](#))
- Multimodal search ([link](#))

Demos prepared by Eric Zavesky

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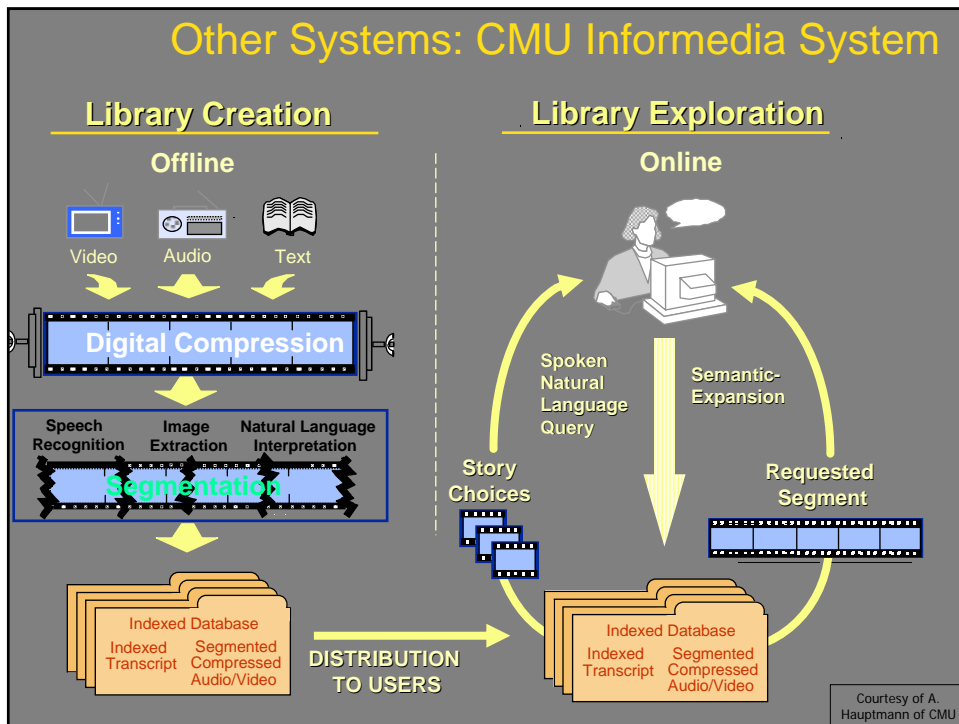
CuVid: Columbia Video Search System

<http://www.ee.columbia.edu/cuvidsearch>

The screenshot displays the CuVid search interface with several key features highlighted by callouts:

- Customizable Multi-modal Search Tool Suite:** Located at the top left, it includes a query input field, search options, and various filters.
- Automatic Query Expansions:** Located at the top right, it shows suggestions and NLP keywords generated from the search query.
- Beyond keywords: search by example image:** Located on the left side, it shows a search result card with a video thumbnail and associated text.
- Automatically Detected Story Segments:** Located in the center, it highlights video segments within a search result.
- Search Result Folder:** Located on the right side, it shows a list of saved search results.

Prototype includes 160 hours, 3 languages (English, Arabic, Chinese), 6 channels



Problems Studied in this Course

- Content Based Image Retrieval
 - Feature extraction
 - Image/Video matching methods
 - Efficient indexing: search millions or billions of images
- Image/Video Copy Detection Methods
- Image Annotation Strategies
 - Make image annotation more attractive
- Automatic Classification and Tagging
 - Statistical models
 - Contextual information
- Multimodal Search Using Text, Image, and Others
- Strategies for Searching Media on Social Networks

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About the course

- Objectives:
 - Learn how to formulate and solve problems in this field
 - Get insights and experience of recent pattern recognition/machine learning techniques
 - Hands on experiments with image/video classification/indexing problems
- Intended Audience
 - Beginning graduate students or professionals
 - familiar with signal/image processing
 - comfortable with probability, statistics, linear algebra, and some machine learning

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Course Format

- Overview Lectures + student presentations + final projects
- We will give several overview lectures at the beginning.
- 1 hands-on homework on image search (assigned in week 2)
- Student paper presentation (starting week 5)
 - One paper assigned to each student
 - assignments determined 2-3 weeks in advance
- Everyone writes comments before class on the web site
- One final term project (1-2 people per team)
- Grading
 - Paper presentation/demo 30%
 - Class participation/homework 30%
 - Final Project 40%

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Paper review and presentation

- Each student discusses paper and experiments with us 3 weeks before class
 - Week 1: review and research
 - Week 2: simulate a toy problem using available data set and tools
 - Week 3: prepare presentation
- Other students post comments and questions before class
- Presentation
 - 30 mins each paper (including demo if available)

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Paper Review and Demo (2)

- Review
 - Background review and examples
 - Problem addressed and main ideas
 - Insights about why it works
 - Limitation, generality, and repeatability
 - Alternatives and comparisons
- Experiments
 - Check software and data available and repeatable
 - Reconstruct the method and try on toy data sets
 - Analyze results (not just accuracy numbers, offer explanations and verifiable theories about observations)
 - Demo code archived on class site and shared with others

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Resources and Matlab

- Links on the class web site
 - Tutorials on paper writing, Matlab, etc
- Software links on web site to Matlab, Neural Network, HMM, Netlab, SVM
- SVIA EE6882 Class Dataset
 - Benchmark data set, a few thousands of images from broadcast news and stock photos
 - Extracted features and labels
 - Available through TA
- Matlab is often used for programming, C/Java welcome
 - Accessible on university computers
 - Very brief introduction next week

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Paper Review last year

(www.ee.columbia.edu/~sfchang/course/svia-F04)

- Feature Selection for SVM
- Fast multiresolution image querying
- Relevance Feedback in Image Retrieval
- MPEG-7 Color and Texture Features
- SVM Image Classification
- SVM Active Learning
- Maximum Entropy for Story Segmentation
- HMM for Video Parsing
- Relevance Model for Image Retrieval
- Video Fingerprinting

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Final Projects last time (2004)

- Many students extend topics chosen for paper review/experiments
 - SVM feature selection for news story segmentation
 - Wavelet multiresolution image retrieval
 - Comparison of relevant feedback methods for image retrieval
 - Object Search over 3D VR object database
 - Michael and Graham
Relevance Feedback for music retrieval
 - SVM image classification
 - HMM for news story segmentation
 - Motion based object segmentation and classification
 - MPEG-7 CSS Shape feature evaluation



Other information

- Student presentations and codes from last year will be available
- Office Hours
 - Instructors: Mondays 3-4, Mudd 1300
 - TA: Eric Zavesky, emz2101@columbia.edu, Wed. 3:30-5pm, CEPSR 708