Introduction to Media Computing

Lecture 1: Introduction

Lecturer: Zechao Li (李泽超)

Outline

- **Objectives and Expected Outcome**
- **Course Arrangements**
- **History of Media Search Engines**
- **Applications of Media on the Web**
- **Summary**

Why?

- ## Multimedia is cool
  - Media -> Multimedia
  - Everywhere
  - Requires broad knowledge in mathematics, signal processing, communications, networking, software, hardware, ……
  - You are paid to watch movies in your office !

- ## Job opportunities
  - Multimedia is a booming industry
    - in the metro Vancouver area
  - Tons of opportunities created by next-generation standards and emerging applications:
    - JPEG/JPEG 2000
    - MPEG-1/2/4 H.264/265/HEVC 4K UHD 3D/freeview
    - 3G/4G/5G mobile communications
    - Multimedia-enabled smartphone, tablets
    - Social media, Cloud media, Crowd media
    - Online gaming

Aims and Objectives:

- This module introduces students to the concepts, issues, design, implementation, standards and applications of multimedia technologies:

  with special emphasis on media representation, standards, content analysis and search

- The module is divided into 2 parts:
  1) Fundamentals and Standards of Digital Media
  2) Text, Image and Audio Search

# Fundamentals & Standards of Digital Media:

- Most important development in media processing is the standardization of audio, image and video standards, in terms of MP3, JPEG and MPEG
  - They are used everywhere, and promoted the wide spread use of audios/images/videos on the Web
  - Students must have fundamental understanding of the compression schemes, and their strengths and limitations

- This module will cover:
  - Fundamentals of digital media
  - Compression techniques
  - Audio standards
  - JPEG, MPEG (for movies) and H26x (for video conferencing)

Text, Audio and Image Search:

- Search is a fundamental tool for information access and management, be it on the Web or on local file system

- Search, esp. media search, is becoming active (both commercial and in research) because of the exponential growth of social media contents

- Issues to be discussed:
  - Representation of text, audio and image content
  - Similarity match between a query and the database items
  - Bridging of semantic and user intention-gaps in retrieval
  - Backend architecture
  - Search engine design and implementation

Examples of Media Search -1

- Goolge/ Bing/ Baidu Search Engines: Support text and image search etc.
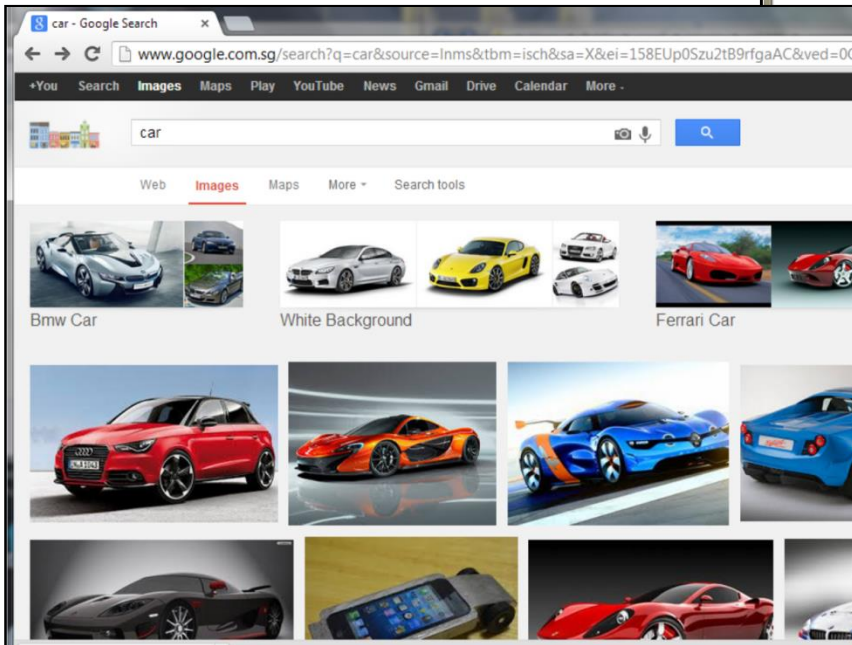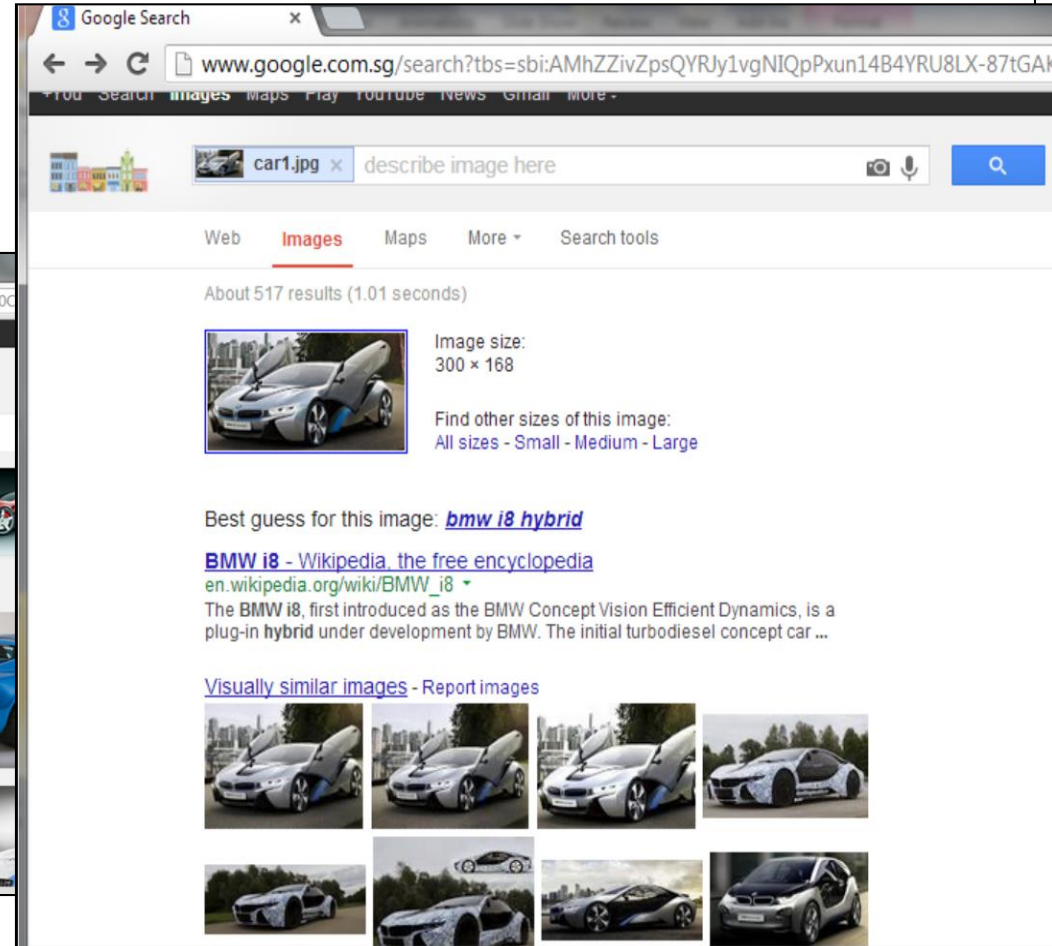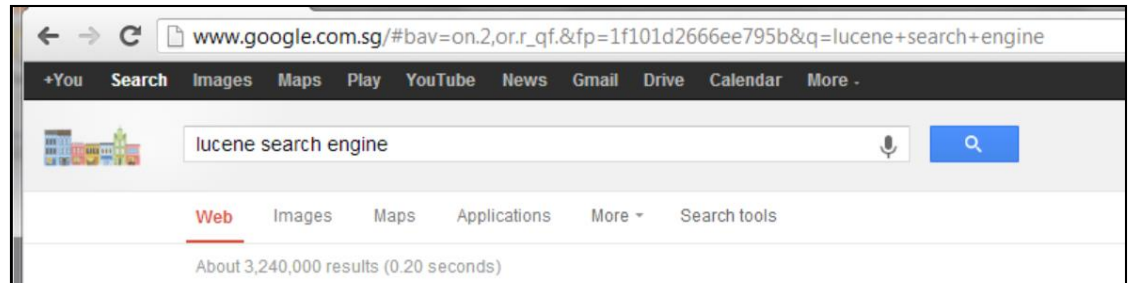
Examples of Media Search -2

- Search engines developed at NUS:
  - www.nextcenter.org

Examples of Media Search -3

- Search engines developed at NUS:
  - www.visenze.com (An example of vertical domain visual search)

What are the Technologies Behind these Search Engines?

- Text representation and matching

At the end of this module, the students should have the expertise and competence to design, implement and deploy multimedia search systems

1x end; 1x module;
1x student; 1x expertise;
1x competence;
1x design; 1x implement;
1x deploy; 1x multimedia
1x search; 1x systems

Query:
Text

Results

- Image representation and matching

0.1 0.2 0.4 0.1 0.2
Color compositions

Critical Point Representation

Query:
An image

Results
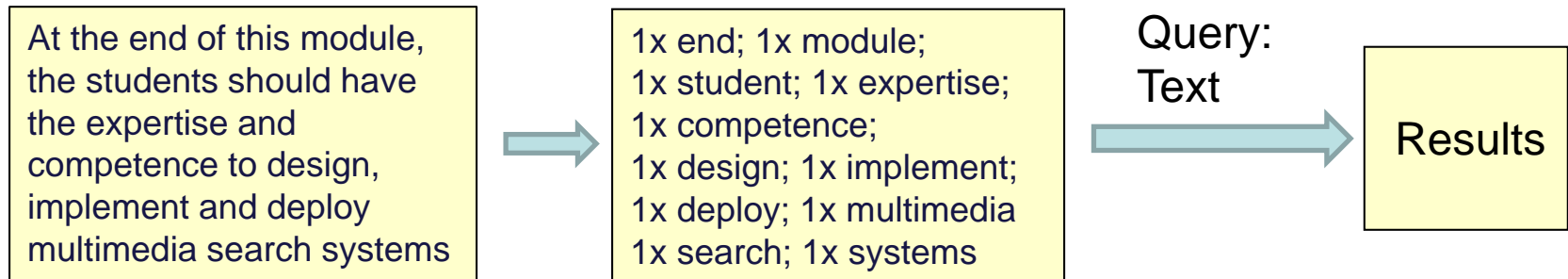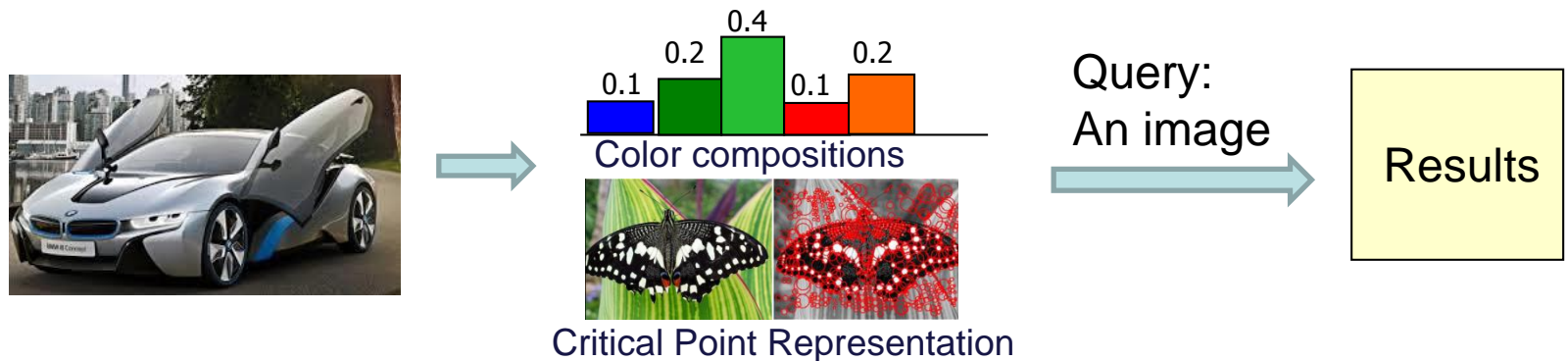
- Extract object-level representation (for vertical domain)
- Indexing for efficient matching and retrieval

Teaching Outcome:

At the end of this module, the students should have the expertise and competence to design, implement and deploy multimedia search systems, with a good understanding of the architecture of modern search engines

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Course Schedule (1)

Lecture/Tutorial Topics
L1: Introduction to MM Systems
L2: Brief Into to Text Retrieval (+RF)
L3: Image Content Analysis (Feature Extraction & Similarity Measures)
L4: Concept-based Image Retrieval
L5: Indexing and Search Architecture
L6: Basic Concepts in Digital Multimedia
L7: Intro to Audio Processing
L8: Image Transformation and Filters

Course Schedule (2)

Lecture/Tutorial Topics
L8: Image Transformation and Filters
L9: Compression Algorithms [7,8]
L10: Introduction to JPEG [4,9]
L11: Color Model and Color JPEG
L12: MPEG Model [10,11]
L13: : H261 [10,12] & Future Trends

References:

- **MainText** (on media standards):
  - Z.N. Li and M.S. Drew (2004). Fundamentals of Multimedia. Prentice Hall

- **Reference Text:**
- Jennifer Burg. The Science of Digital Media. Pearson Prentice-Hall, 2009
- Alberta Del Bimbo. Visual Information Retrieval. Morgan Kaufmann Publishers, 1999
- Yuhang Zhang. Content-based Image Retrieval. LAP Lambert Acad Publisher, 2010.
- Price R., Chua Tat-Seng, Al-Hawamdeh S. (1992). Applying Relevance Feedback to a Photo Archival System. Journal of Information Science, 18: 203-215.
- Brin S & Page L (1998). The anatomy of a large-scale hypertextual web search engine. 19 pages

References:

- ## MainText:

  - Zechao Li. **Understanding-Oriented Multimedia Content Analysis.** Springer 2017

  - https://link.springer.com/content
  /pdf/10.1007%2F978-981-10-3689-7.pdf
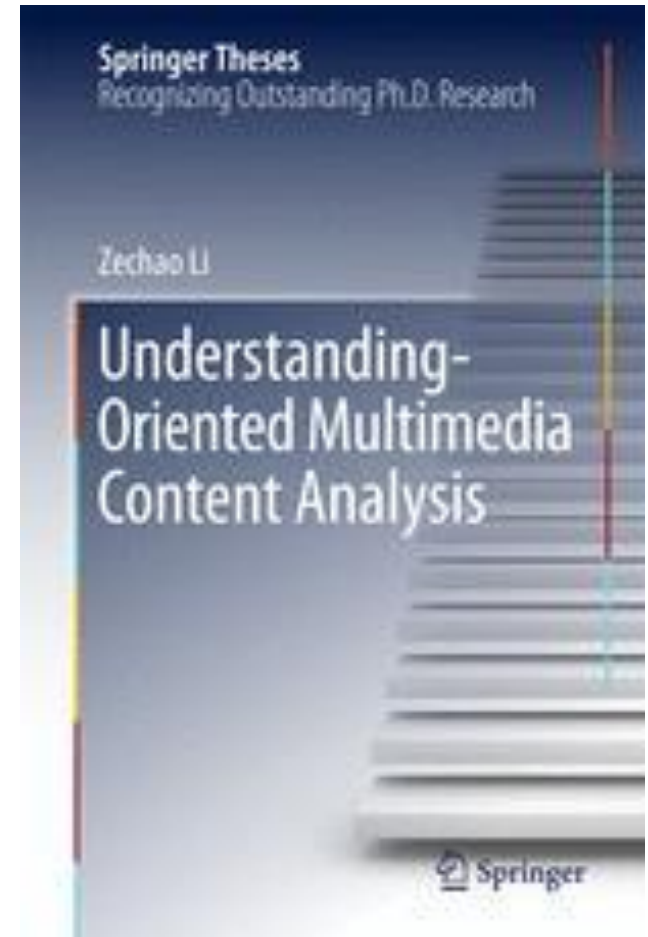
About Myself

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  - Professor

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  - Education
  - 2004-2008, University of Science and Technology of China
  - 2008-2013, Institute of Automation, Chinese Academy of Sciences
  - 2013-Date, Nanjing University of Science and Technology

  - 智能媒体分析实验室 http://imag.njust.edu.cn/

Any Questions Before We Proceed??

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The web is really large

- 100 B pages

- Lots of dynamically generated content

- New pages get added all the time

- The size of the blogosphere doubles every 6 months
  - o Technorati has 50M+ blogs

- Yahoo deals with 12TB of data per day (according to Ron Brachman)

- The biggest addition of info is the social network sites
  - o Every day, Facebook users share 2.3 billion pieces of content and upload 250 million photos
  - o Twitter users post 190 million tweets
  - o Many tweets have images (1/3 in Weibo)

Examples of search engines

- Conventional (library catalog).
  Search by keyword, title, author, etc.

- Text-based (Lexis-Nexis, Google, Yahoo!, Bing, Baidu).
  Search by keywords. Limited search using queries in natural language.

- Multimedia (QBIC, WebSeek, SaFe, Major Search Engines)
  Search by visual appearance (shapes, colors,…).

- Question answering systems (Ask, NSIR, Answerbus)
  Search in (restricted) natural language

- Clustering (Lesystems (Vivísimo, Clusty)

- Many research systems

- Social media search: Twitter/Weibo search interfaces..
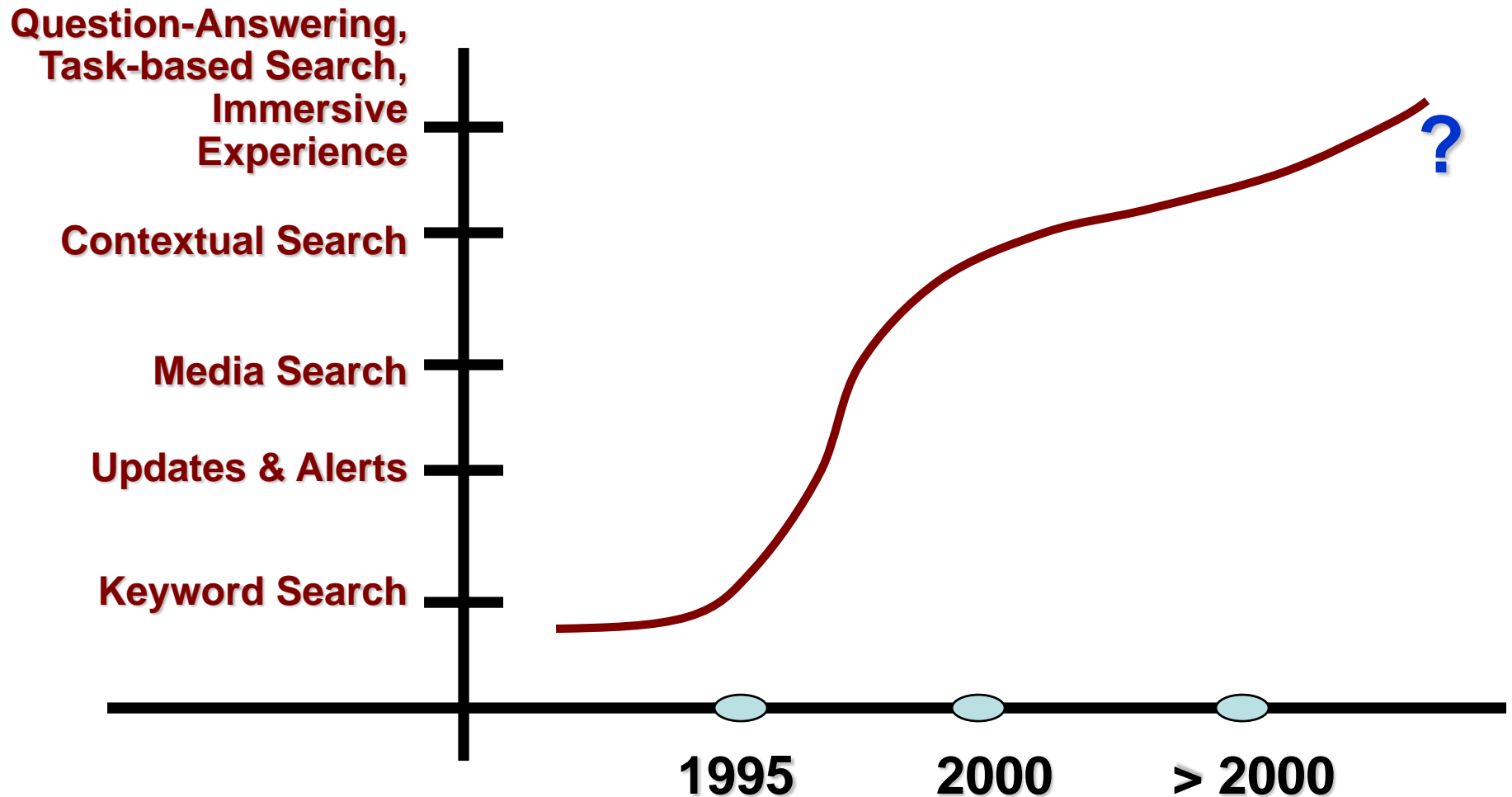 Problem in indexing live postings – not all live posts are indexed

What does it take to build a search engine?

- Decide what to index

- Decide what features to index

- Gather data

- Index it (efficiently)

- Keep the index up to date

- Provide user-friendly query facilities

What else?

- Understand the structure of the web for efficient crawling

- Understand user information needs

- Preprocess text and other unstructured data

- Cluster data

- Classify data

- Evaluate performance

Development of Web Search

Question-Answering, Task-based Search, Immersive Experience

Contextual Search

Media Search

Updates & Alerts

Keyword Search

?

1995 **2000** **> 2000**

- Current Web is text-based and document-oriented
- Future is going to be multimedia and information oriented

Text-Based Media Search

- Most commercial image search systems allow user to issue query as a list of keywords - Query by keywords

  - Search is performed on basis of textual tags annotated by users, which tend to be incomplete and ambiguous
  - Moreover, most users cannot express the search intention clearly

Early Media Search Systems

- Use of media contents in search evolved in early 90s

- QBIC of IBM is an early example (Flickner et al '95)
  - First complete commercial CBIR System that supports Query by Image Content
  - Uses color, texture, shape features
 - Support search by colors, shapes, sketch and text - primitive
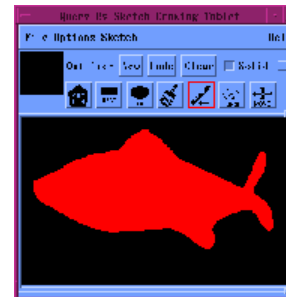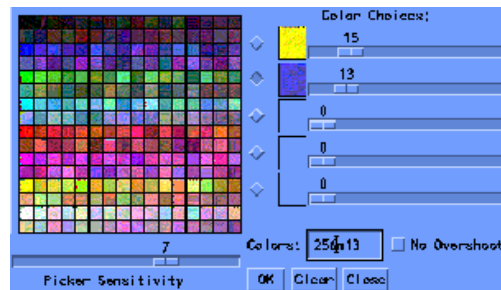
CBIR in
Main Stream Search Engines -1

- More recently, content-based media search has been integrated into main stream search engines
  - Uses a combination text and content-based media search functions
  - Media contents used include: color, texture and visual keywords based on local features such as SIFT
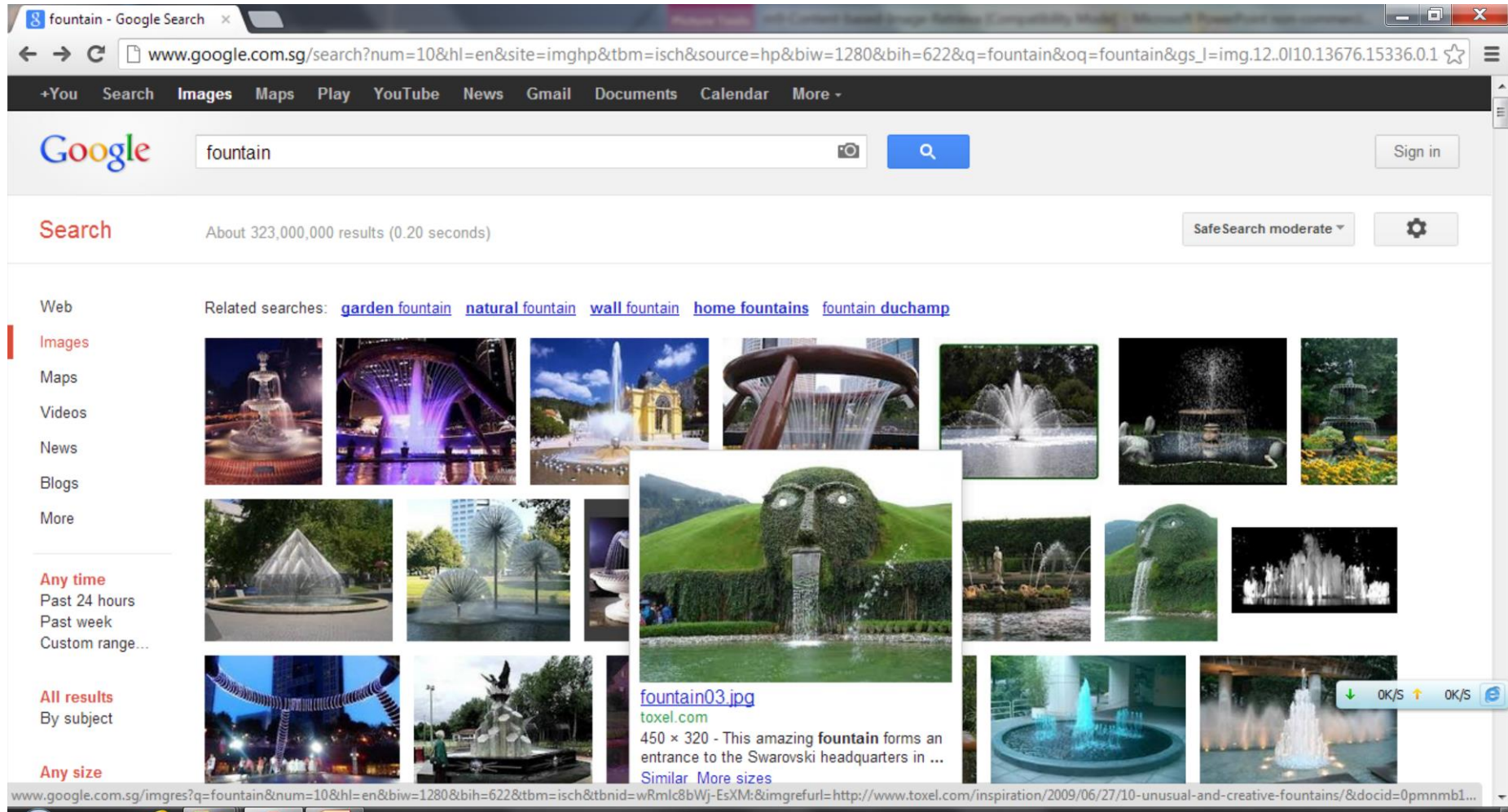 - Media analysis is secondary to text in retrieval

Google Image Search -1
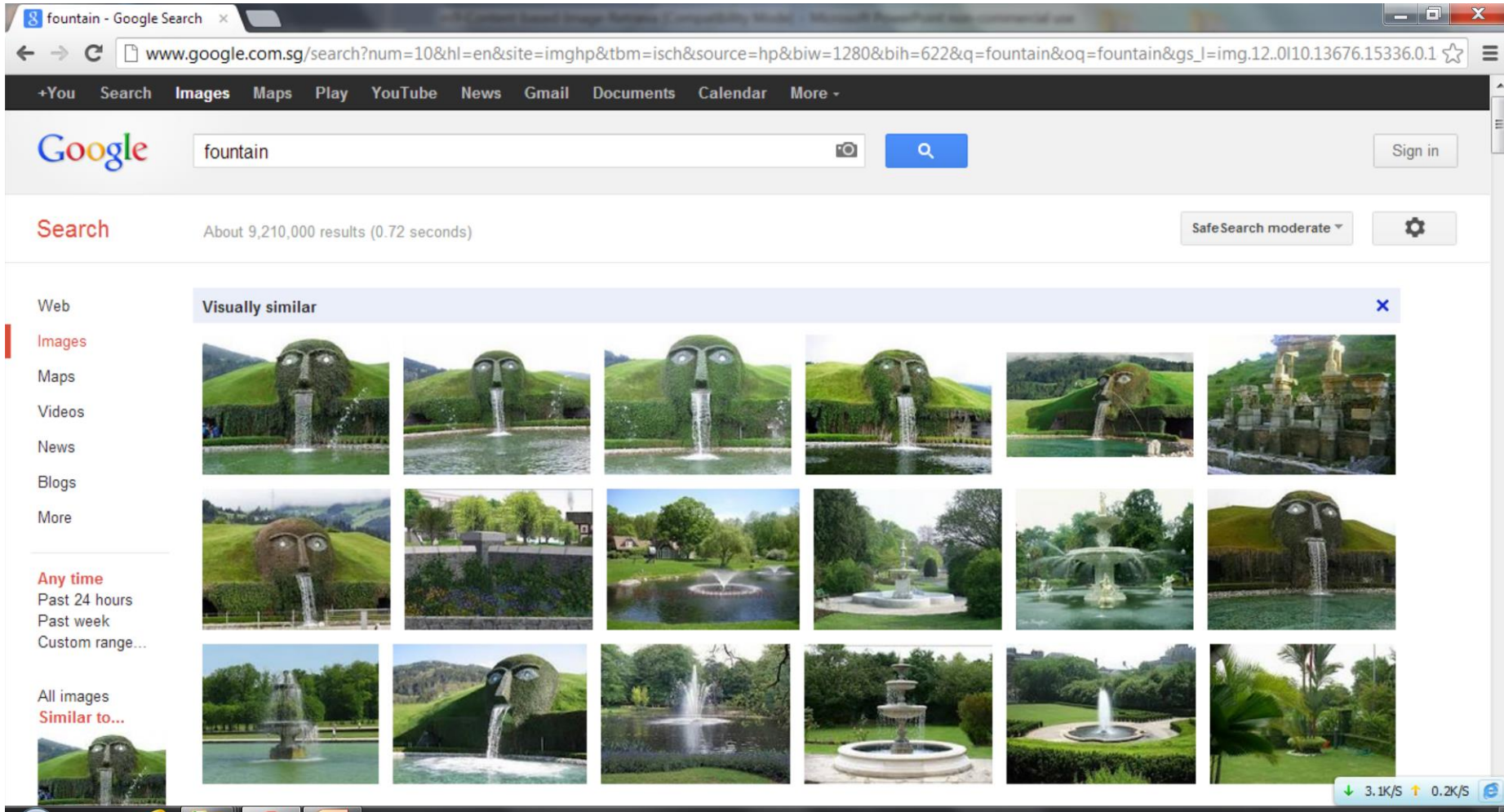
- Google has integrated Content-based Media Search
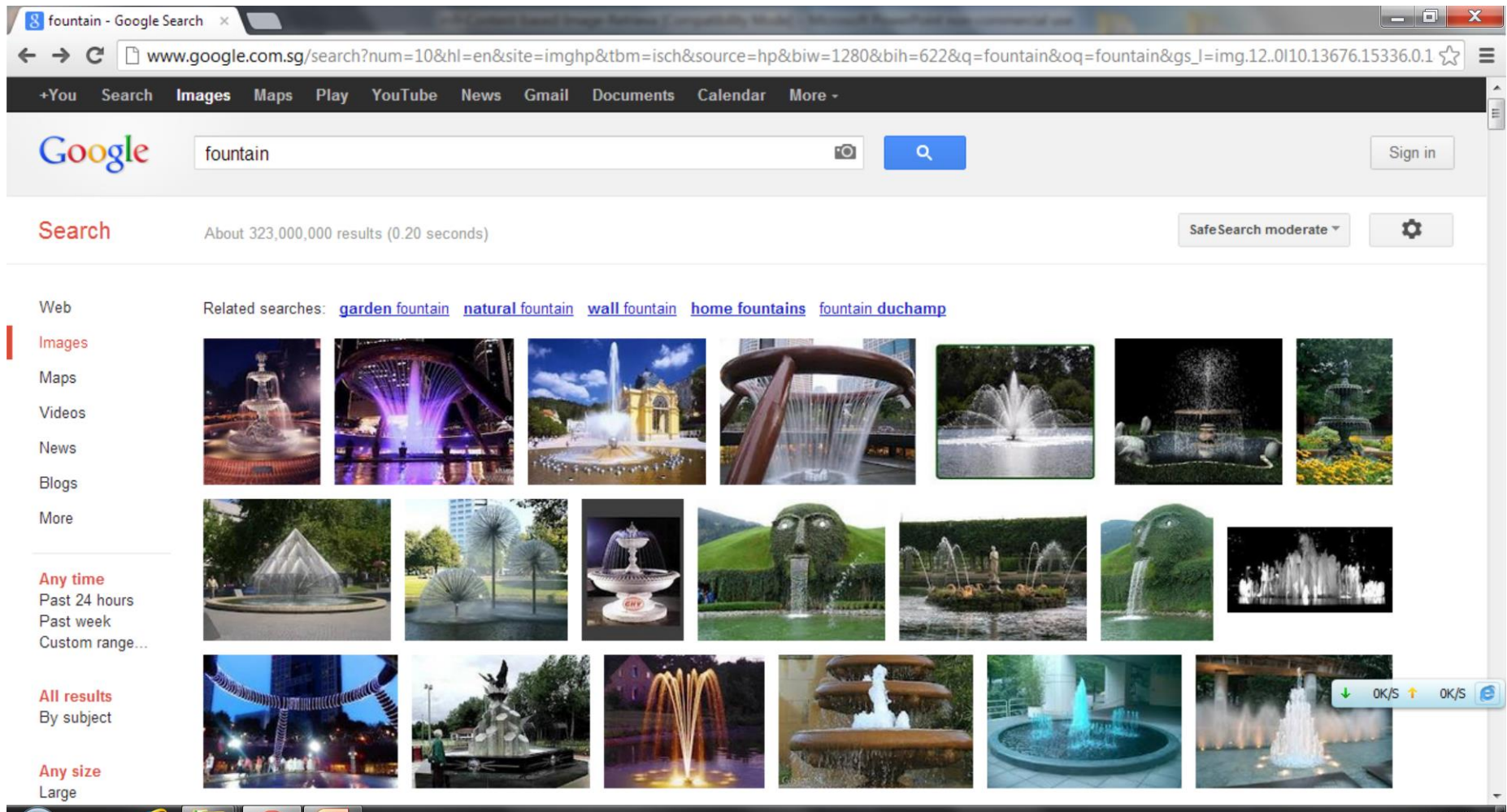
Google Image Search -2

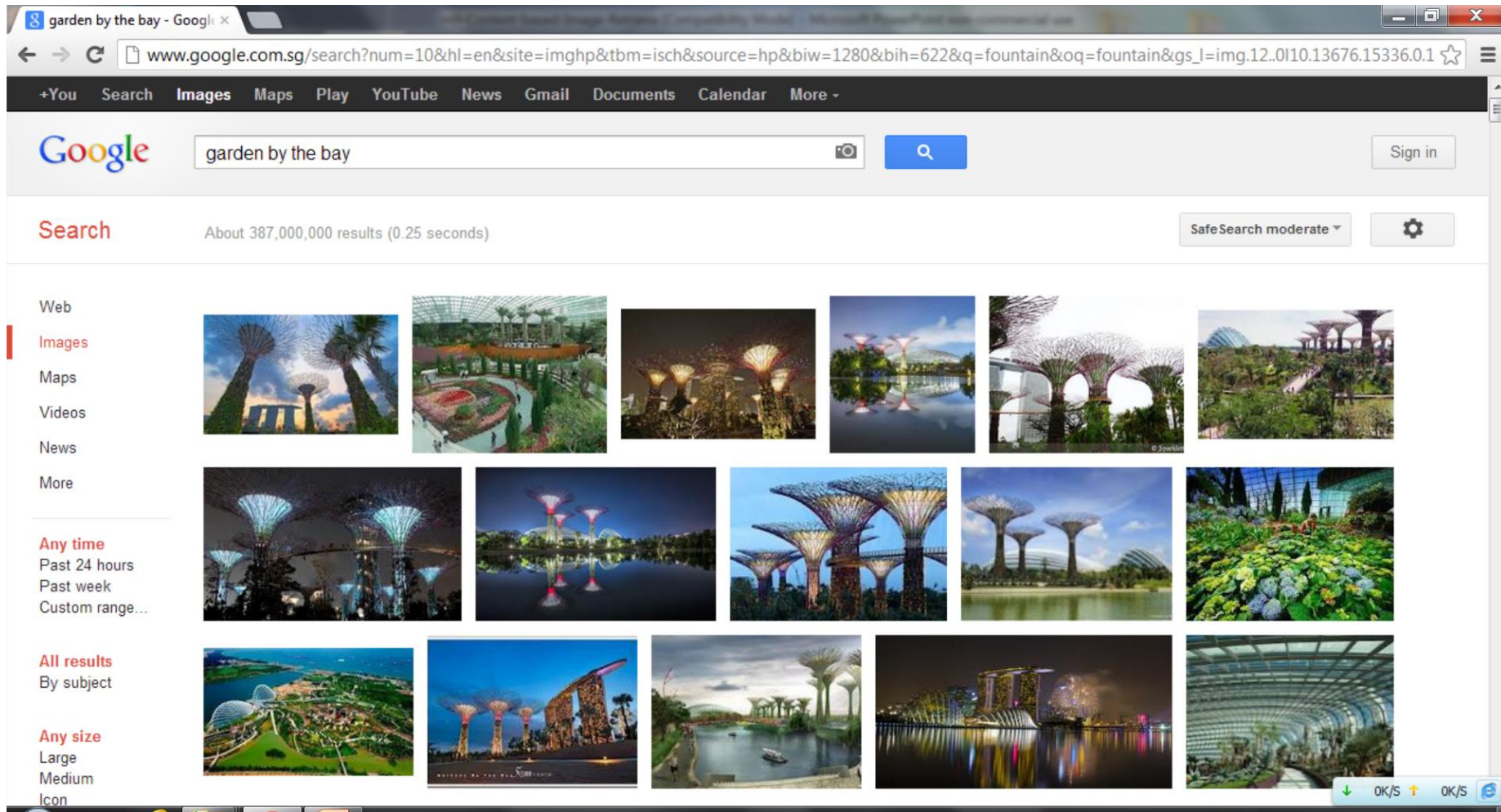- Google has integrated Content-based Media Search

Google Image Search -3

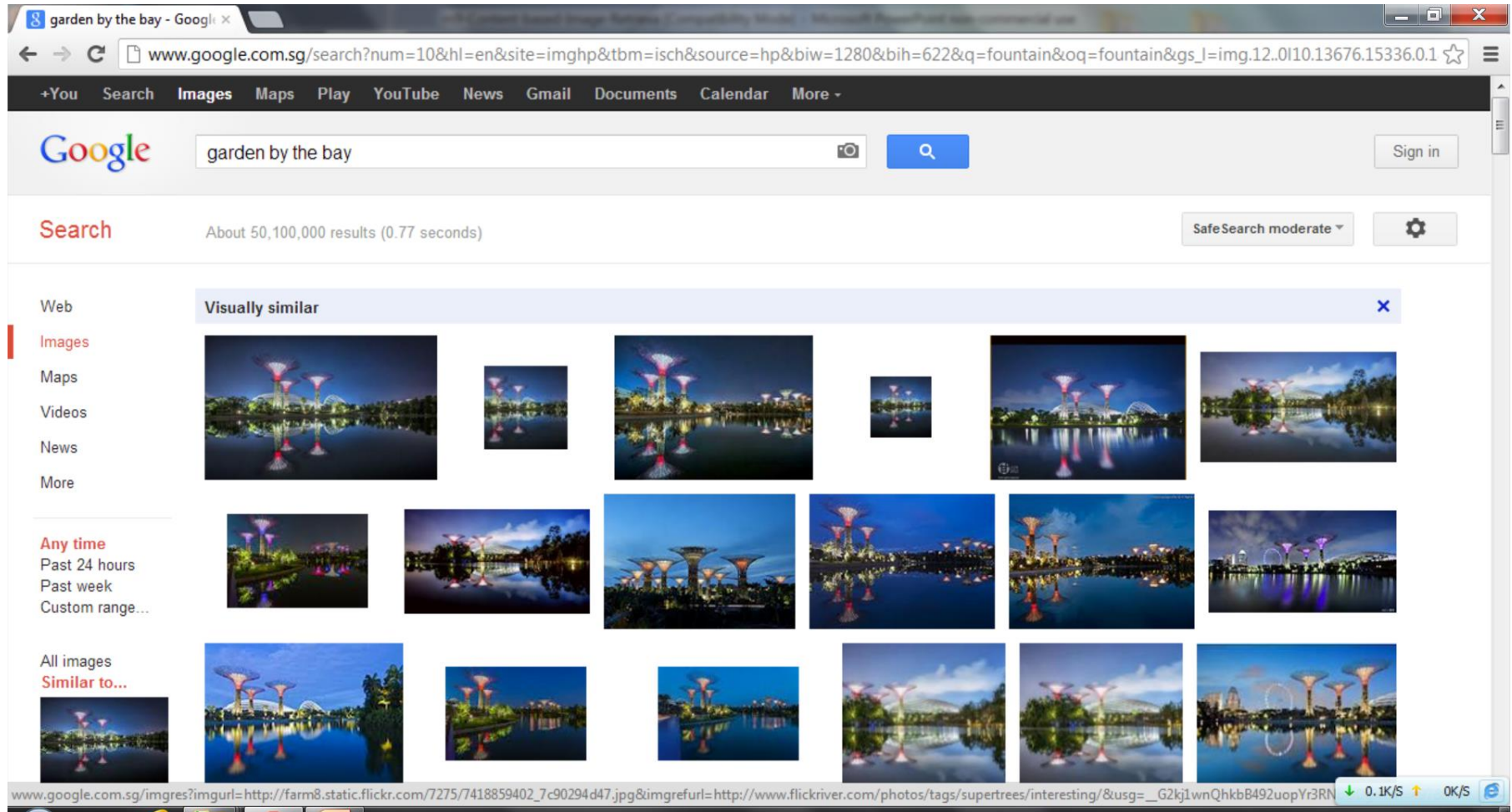- Google has integrated Content-based Media Search

Google Image Search -4

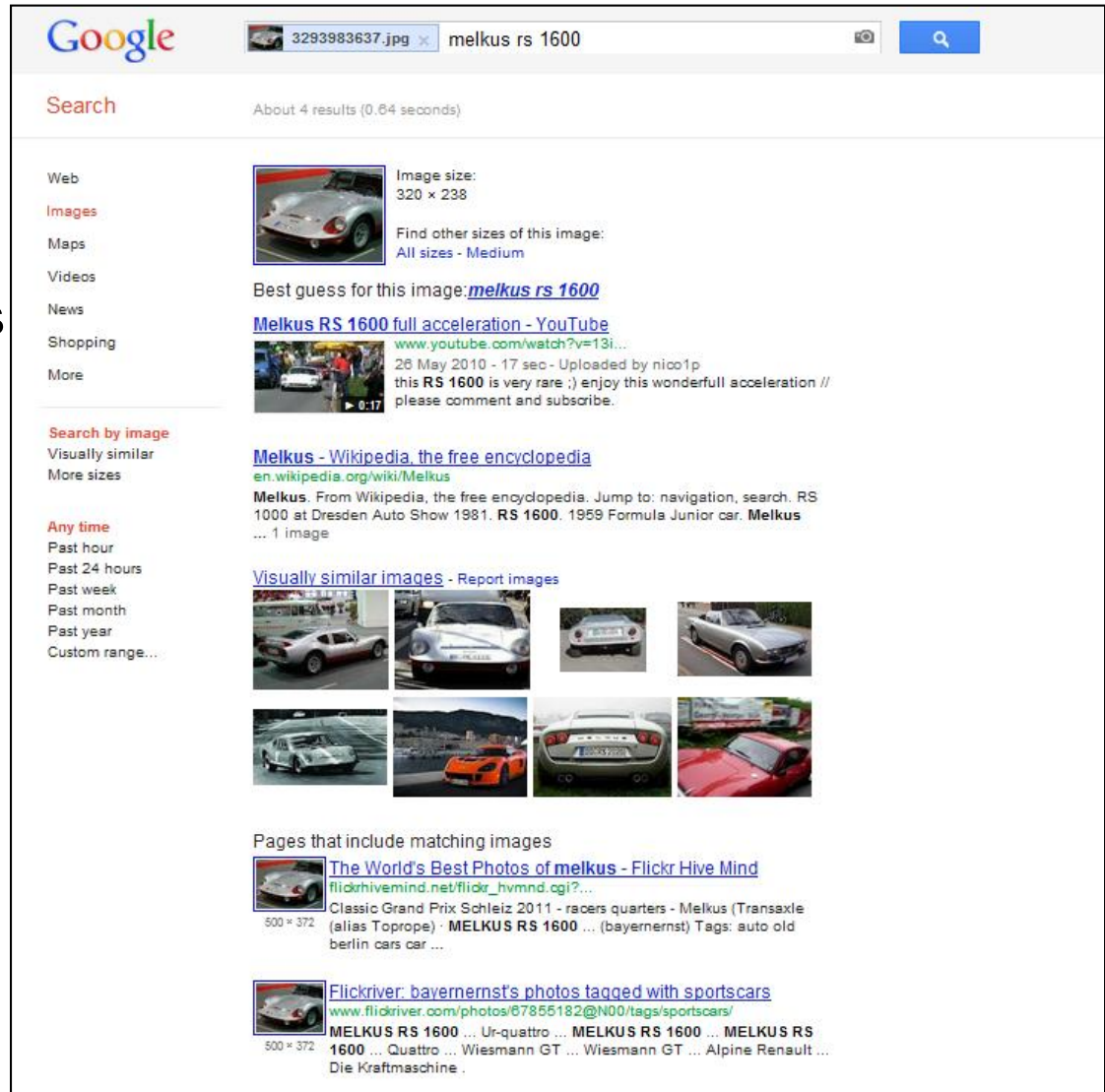- Google has integrated Content-based Media Search

Google Image Search -5

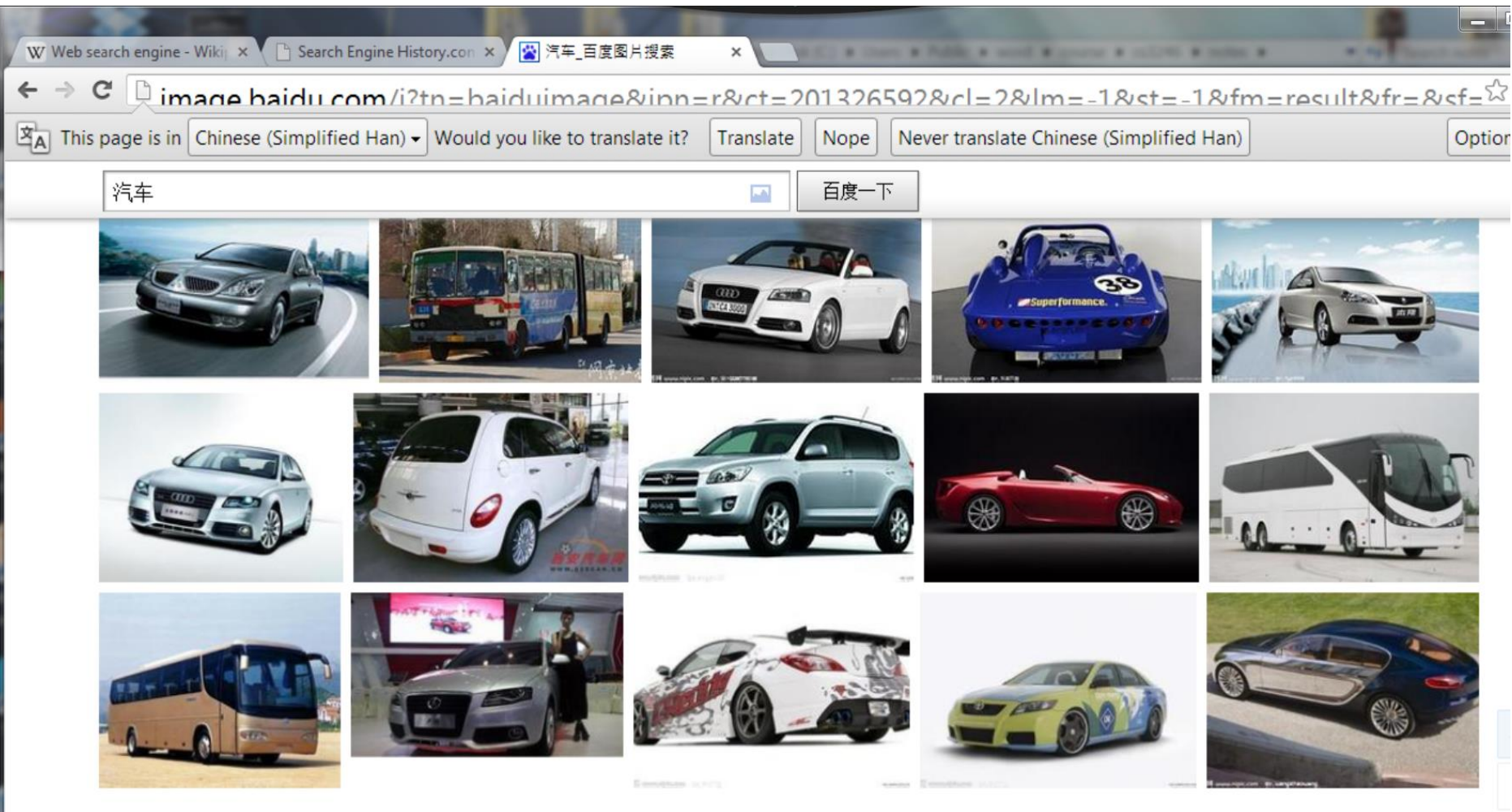- Google has integrated Content-based Media Search

Google Image Search -6

- In fact, Google appears to be even more intelligent!!

- Approach:
  - Looks for near-duplicates
  - Use their text features to describe input image
  - Works because they have large number of samples

- Bing & Baidu have also introduced content-based search with improved quality

Baidu Image Search -1

Baidu Image Search -2
Upload image Query

Equivalent Results from
Google Image Search

CBIR in
Main Stream Search Engines -2

- More recently, content-based media search has been integrated into main stream search engines
    - o Uses a combination text and content-based media search functions
    - o Media contents used include: color, texture and visual keywords based on local features such as SIFT
    - o Media analysis is secondary to text in retrieval

- Why after almost 20 years since QBIC?
    - Local visual features is sufficiently robust
    - Large amount of social annotations available
    - Advances in indexing strategy and storage permit large visual index to be searched efficiently

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Towards Object-based Search in a Vertical Domain: ViSenze -1

- Start-up from NUS (www.visenze.com)
- Specialized in visual fashion search (snap-search-browse)
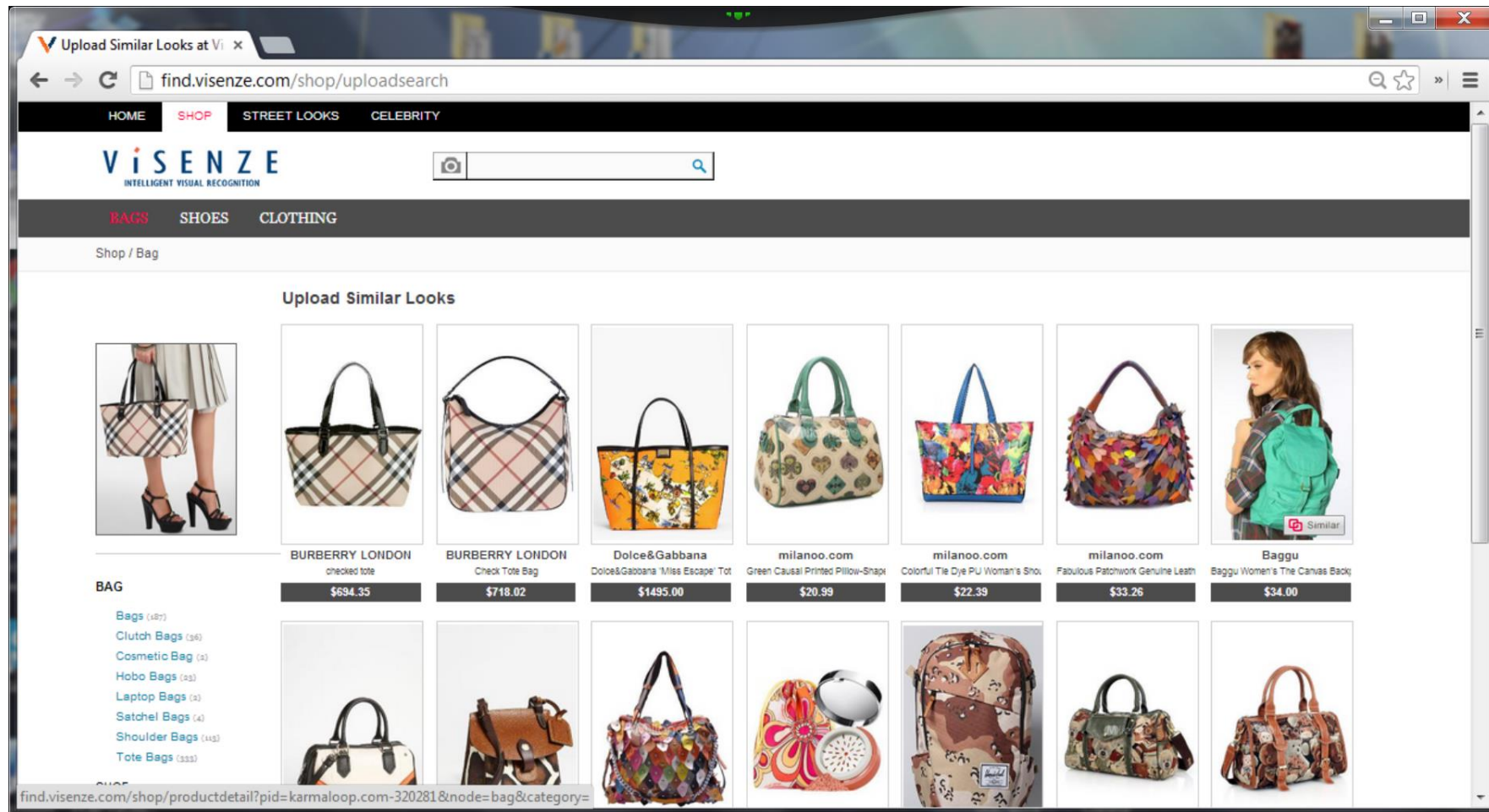
Towards Object-based Search in a Vertical Domain: ViSenze -2

- Extraction of fashion contents and matching to products from street photos

- Piloting with big e-commerce and affiliate marketing sites
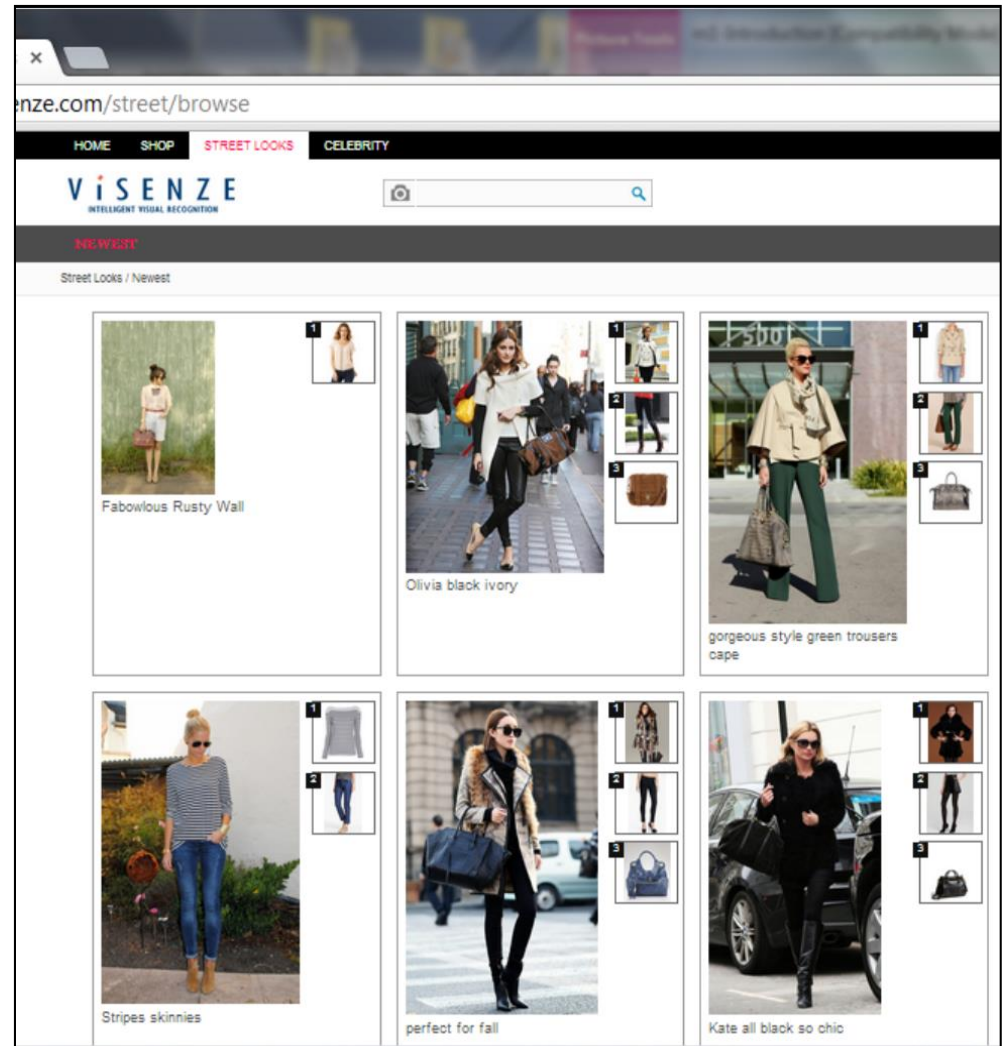
Reverse Search Engine

- Goolge, Baidu & ViSenze are examples of reverse search
- TinEye: A Reverse Image Search Engine
  - It finds out where an image came from, how it is being used
  - Based on copy and near duplicate detection technology
  - Purely content-based search on database of over 3 billion images

TinEye

Google Goggles
Use pictures to search the web.

- **List of objects searchable via Goggle**
  - Snap pictures and get answers

New! Menu Crêpes-8 œufs-7 Text	Landmarks	Books	Contact Info	Artwork	Places	Wine	Logos
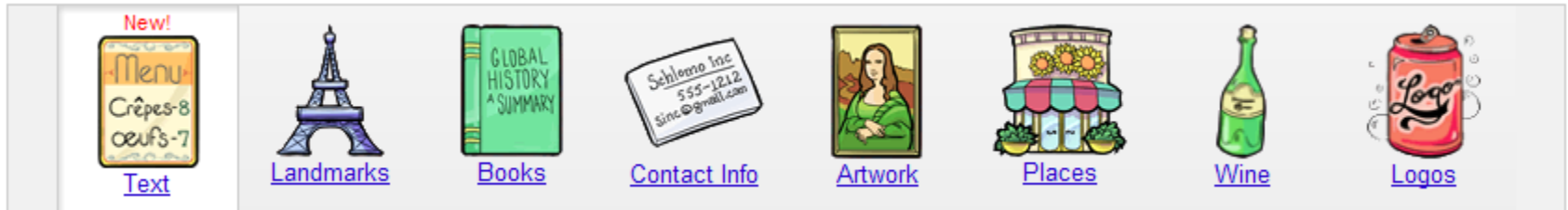
- More details of this Landmarks

- Give me the English translation of this menu?
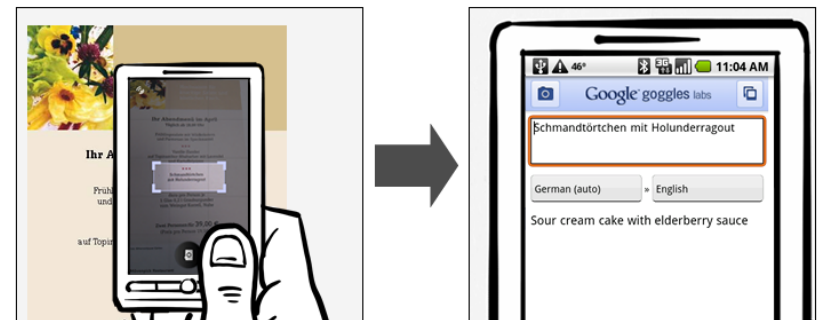
- **Key technologies: OCR, logo detection, image matching…**

kooaba

point - snap - find

Many other similar systems in the market !!
- LTU
- IQ Engines
- etc

- Match object in database on millions of objects in Amazon's EC2 Cloud Computing Services

Amazon Firefly

- Specializes in logo recognition

- Perform recognition & matching in real-time
  - Match to logo, covers etc in Amazon database
  - Did very well in limited domain
  - Try download a mobile version to try

With the debut of the Amazon Fire Phone this afternoon, the company introduced a new feature called Firefly, which is largely designed to let you identify — and then, of course, buy — things you see out in the real world. Firefly takes advantage of the smartphone's camera to let you identify things like phone numbers, movies, books, games, CDs, food and more just by pointing your camera at them.

The feature is a key part of the new phone, in fact, as it even has a dedicated button on the side – a perfect example of how much this new hardware is about bringing customers into Amazon's ecosystem and turning them into regular online shoppers.

A Firefly button is sort of like "instant gratification" built into your device.

Social Network Sites

- How do you see the big picture involving FaceBook and Twitter?
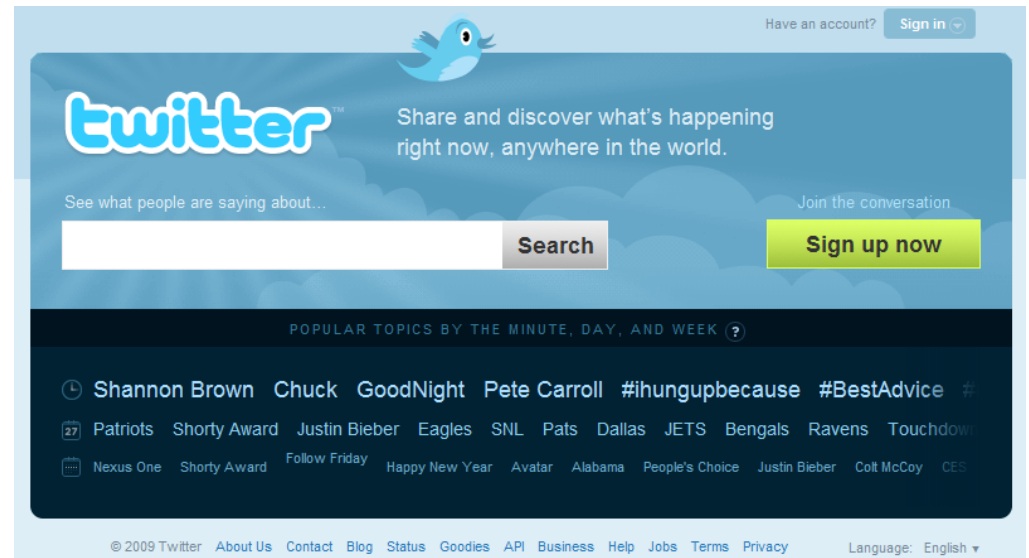
- Facebook has been the most popular site, overtaking Google 3 years ago in terms of user traffic

- They are also the largest photo sharing sites, with more than 250 million uploads each month

Photo Sharing: on Instagram

- Fun app: give users capability to transform picture to professional looking ones
- Simple technology, innovative implementation & good timing
- Bought by Facebook for US$1 Billion

Trends

- Leveraging on huge amount of images on social media
  - Example, 1/3 of Weibo have images, and 60% of these images do not have text annotation

- Fun and Utility social app based on photos
  - Such as Instagram, Path

- Increasingly requires content-based matching capability

- Real-time, social and Location!!!

- Business Models:
  - B2C or Consumer in the past
  - More recently towards enterprise (B2B model)

Recap: Aims and Objectives

- This module introduces students to the concepts, issues, design, implementation, standards and applications of multimedia technologies:

  with special emphasis on media representation, standards, content analysis and search

- The module is divided into 2 parts:
  1) Fundamentals and Standards of Digital Media
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Next Lesson

- **Introduction to Concepts**