CS588:

Image Search

Sung-Eui Yoon
(윤성의)

Course URL:
http://sgvr.kaist.ac.kr/~sungeui/IR

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About the Instructor

- **Notable recognitions**
  - **Organized tutorial on image search at CVPR**
  - **Worked with Adobe, Naver, Hancom, etc.**
  - **Produced a professor on image search (SKKU)**
  - **Received next-generation scientist award (IT category) at 2019 from S-Oil and Korea Academy of Science**
- **Related materials**
  - **Paper and video: http://sgvr.kaist.ac.kr/publication**
  - **YouTube videos: http://www.youtube.com/user/sglabkaist**

Research Theme: Intelligent Ray Tracing, Image Search, Motion Planning

- **Designing *intelligent and scalable techniques* to efficiently handle massive models on commodity hardware or clouds**

Photo-realistic rendering

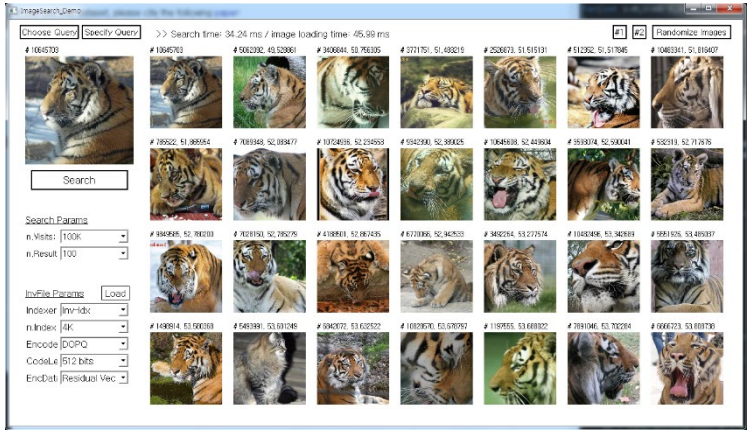

Image search

Motion planning

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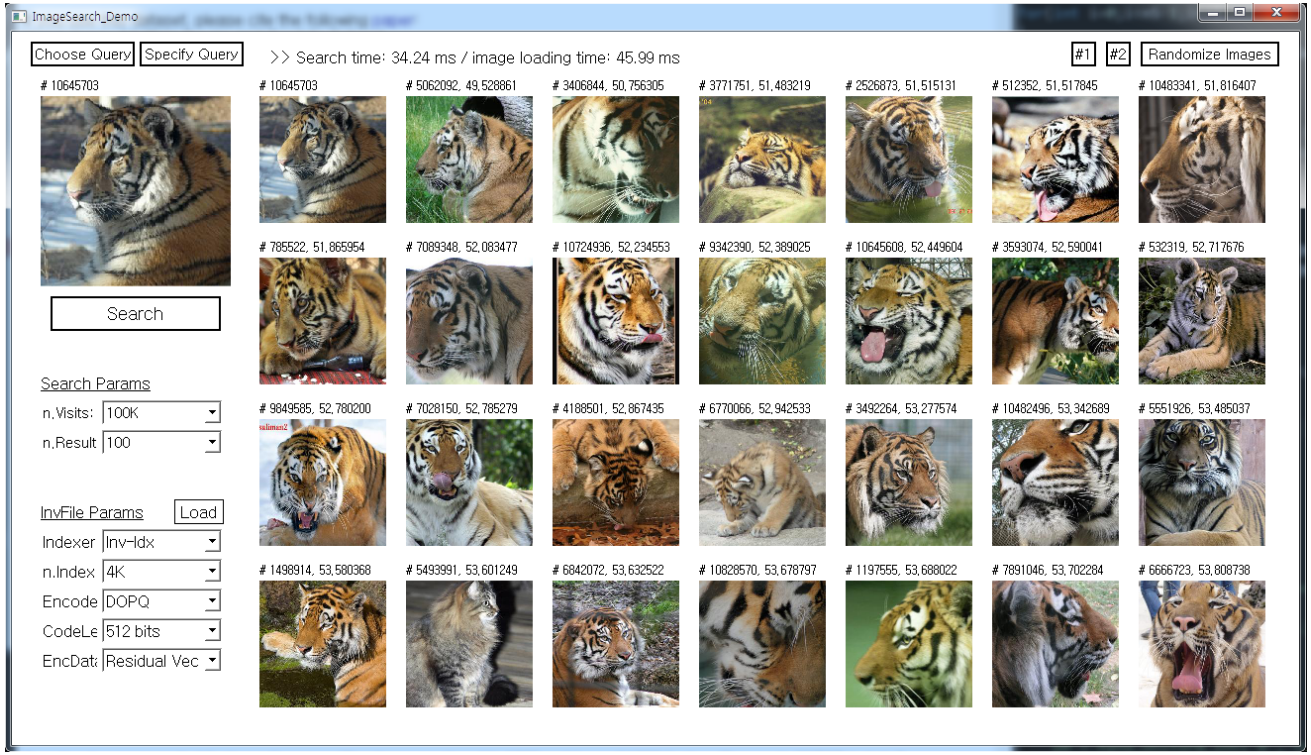
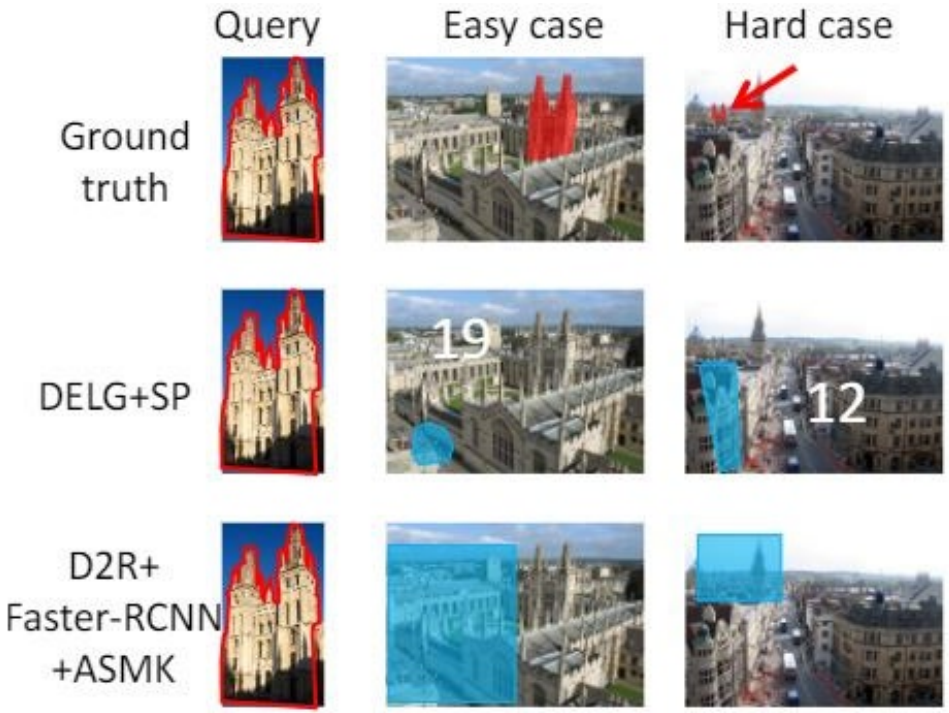
Results of Image Search

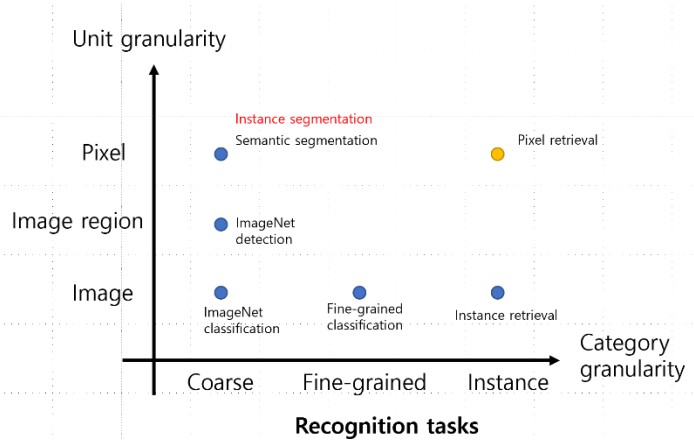
- **Collaborated with Adobe, NAVER, Hancom**
  - **11M images**
  - **Use deep neural nets for image representations**
  - **Spend only 35 ms for a single CPU thread**



New Image Search Benchmark

- **Image retrieval → Pixel retrieval**
  - **Towards Content-based Pixel Retrieval in Revisited Oxford and Paris, ICCV 23**
  - **https://sgvr.kaist.ac.kr/~guoyuan/Segment_retrieval**





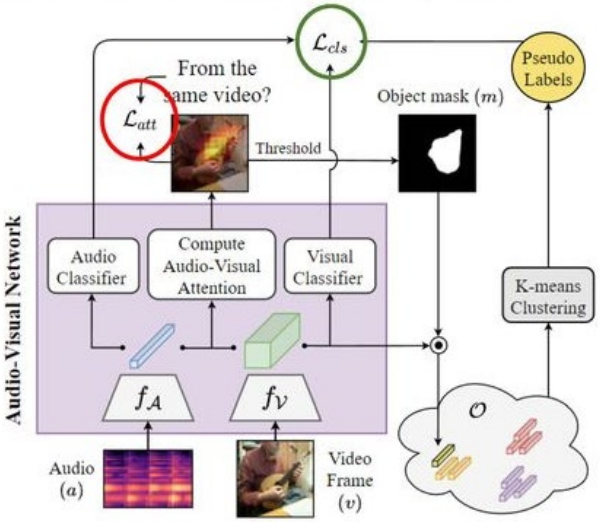
Other Related Works

Part-based Pseudo Label Refinement for Unsupervised Person Re-identification, CVPR 22

Unlabeled Dataset

Optical flow through matching, ECCV 22

Video inpainting through audio-visual self-supervision, ICASSP 22



About the Instructor

- **Contact info**
  - **Email: sungeui@kaist.edu**
  - **Office: 3432 at CS building (E3-1)**
  - **Homepage: http://sgvr.kaist.ac.kr/~sungeui**

Class Information

- **Class time**
  - **10:30am ~ 11:45pm on MW**
- **Office hours**
  - **Right after the class time**
  - **You can make arrangements by sending emails**

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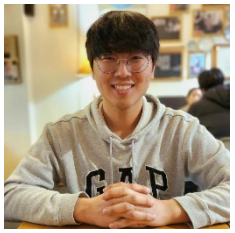
TA

- **Sebin Lee (이세빈)**
  - **Room: E3-1 #3443**

- **Woo Jae Kim (김우재)**
  - **Room: E3-1 #3446**



- **Use KLMS first for questions and discussions, instead of sending emails**

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About the Course

- **We will focus on the following things:**
  - **Broad understanding on image (and video) search techniques and related methods**
  - **In-depth knowledge on recent methods**
  - **Design better technologies as your final project**

- **Main theme:**
  - **Think about how matching and searching components can be utilized for various computer vision and other problems including even generation**

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Image Search or Content-Based Image Retrieval (CBIR)

- **Identify similar images given a user-specified image or other types of inputs**

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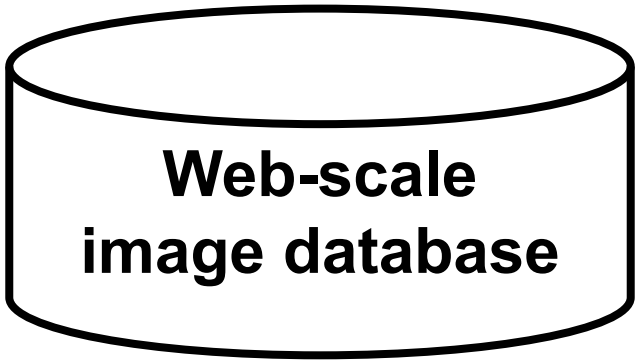
Image Search

- **Identify similar images given a user-specified image or other types of inputs**

Extract image descriptors (e.g., SIFT or CNNs)

Input



Output

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Gmail - Inbox - sungeui | Google Calendar | apple - Google Search

www.google.com/search?q=apple&hl=en&biw=1024&bih=600&prmd=ivnsu&source=lnms&tbm=isch&ei=zxpNTv7bN8_OrQeB9v

Web **Images** Videos Maps News Shopping Gmail more ▾ Sung-Eui Yoon

Google

apple

About 177,000,000 results (0.46 seconds)

Advanced search

SafeSearch moderate ▾

Everything
Images
Videos
News
Shopping
More

Sort by relevance
Sort by subject

Any size
Large
Medium
Icon
Larger than...
Exactly...

Any color
Full color
Black and white

Related searches: apple **iphone 5** apple **logo** apple **wallpaper** **red** apple apple **background** apple **mac**

콜로퀴엄_2011_08_…,doc 콜로퀴엄_2011_08_…,doc 다운로드 항목 모두 표

Gmail - Inbox - sungeui | Google Calendar | Google Search

www.google.com/search?tbs=sbi:AMhZZiuyKQN8VbdVKrlWLNXXzF8NwQ3U6nZjHoGicvPiP_1LltJ1Ts9EF9aMliLZ52wdbl9cGW

Web **Images** Videos Maps News Shopping Gmail more Sung-Eui Yoon

Google

sungeui.jpg describe image here

About 4 results (0.29 seconds) Advanced search

- Everything
- Images
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Image size:
200 × 272

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Pages that include matching images

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Sungeui Yoon (성의,윤성의)
sglab.kaist.ac.kr/~sungeui/ - Cached
Sung-Eui Yoon (윤 성의) Assistant professor. Scalable Graphics/Geometric Algorithm Lab. Dept. of Computer Science · KAIST ...

120 × 140

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이름Cha, Meeyoung (차미영) 조교수; 연구분야Social Computing, Data-Driven Social Science; 학위PhD, KAIST, 2008; 전화번호+82-42-350-2922; 이 메일meeyoungcha ...

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2010.09.13 - KGC 2011 - [Translate this page]
www.kgconf.com/kor/html/conference_c_view.html?cate3... - Cached
Kristian Segerstrale Playfish, 소셜게임의 미래 현재 소셜게임의 현주소와 빠르게 성장하는 소셜게임의 미래를 예리한 견식으로 소개 ...

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Applications of Matching

- Search
- Image stitching
- Object/scene/location recognitions
- Robot localization and mapping (SLAM)
- Copyright detection
- Optical flow
- Neural radiance field

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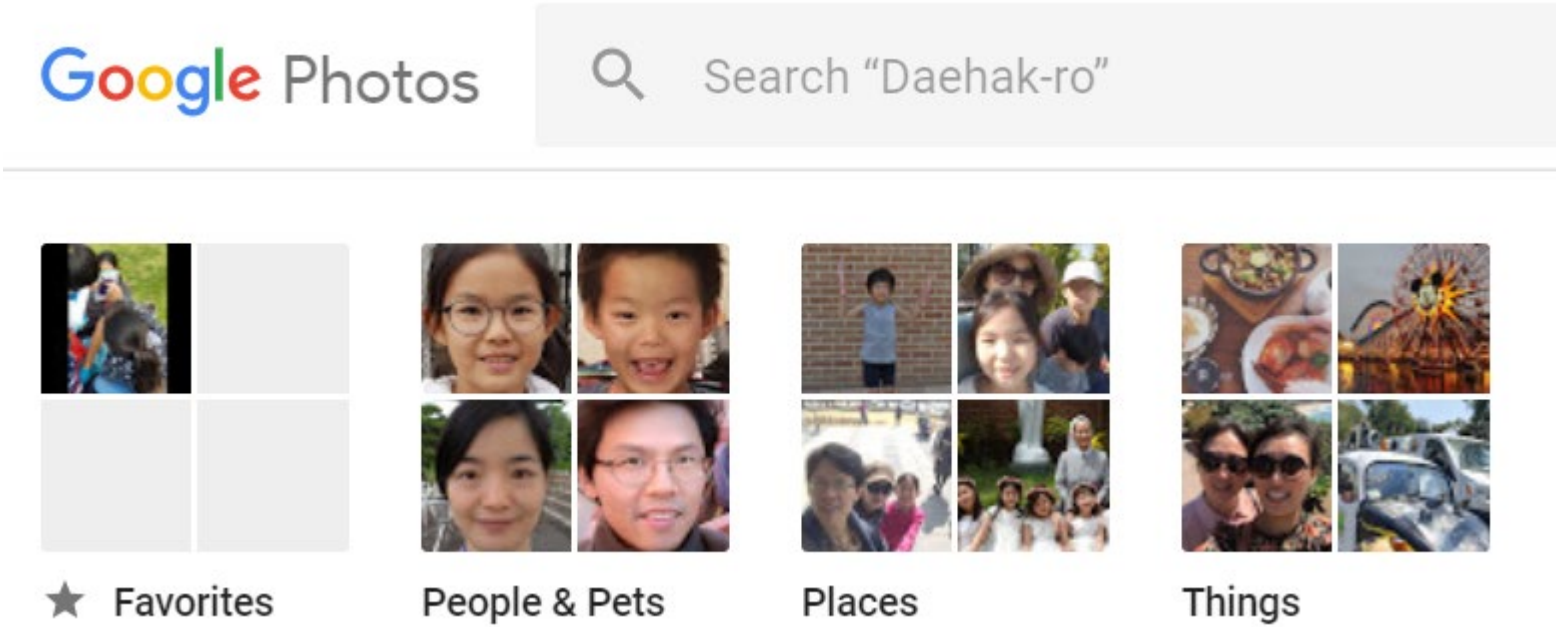
Google Photos and Many Search Functionality



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Cross Domain Image Search

- **Visual similarity across image domains**

Shrivastava et al., SIGA

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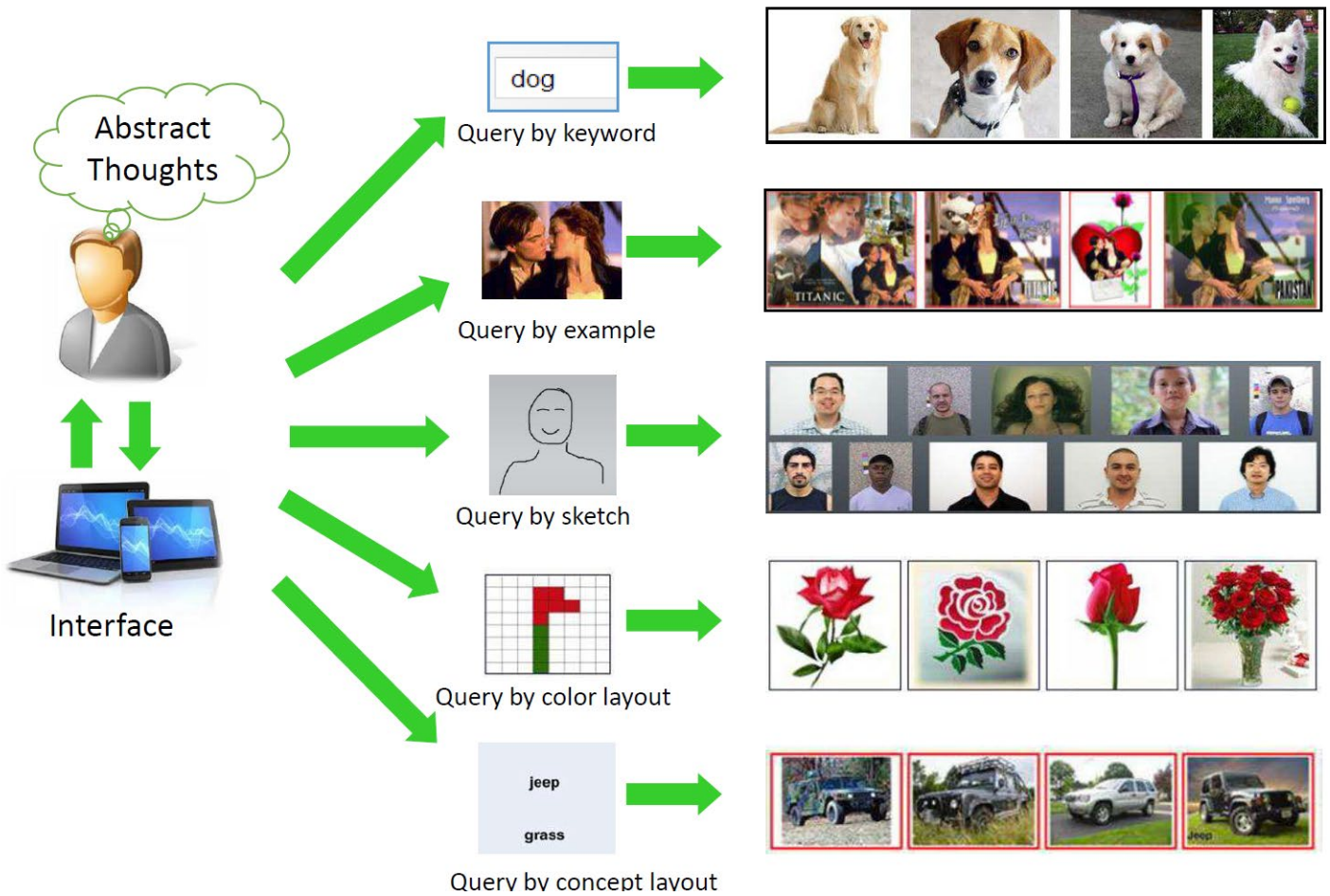
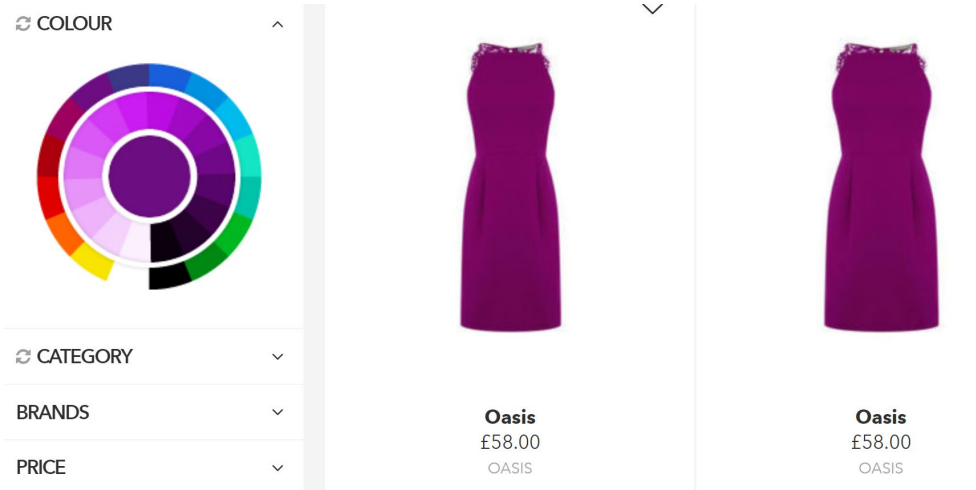
Different Search Scenario



Zhou et al., arxiv

Some Image Search Companies

Based on near duplicate image search



Snap fashion

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Some Startups

- 학생 창업
  - 클디, **2011**년 창업

클디 팀원들, 왼쪽부터 김효은 연구원, 백승욱 CEO, 이정인 CTO

기술기반 스타트업으로서 좋은 모범 사례를 남기고 싶다

Product Image Recognition

[X. Shen et al., ECCV 2012]

Examples of product images in the database

Examples of query images taken by mobile phones

Landmark or Location Detection

query

City-scale image DB

Chen et al. KAIST

3D Reconstruction

- **Conducted by feature matching among many images**

Photo tourism

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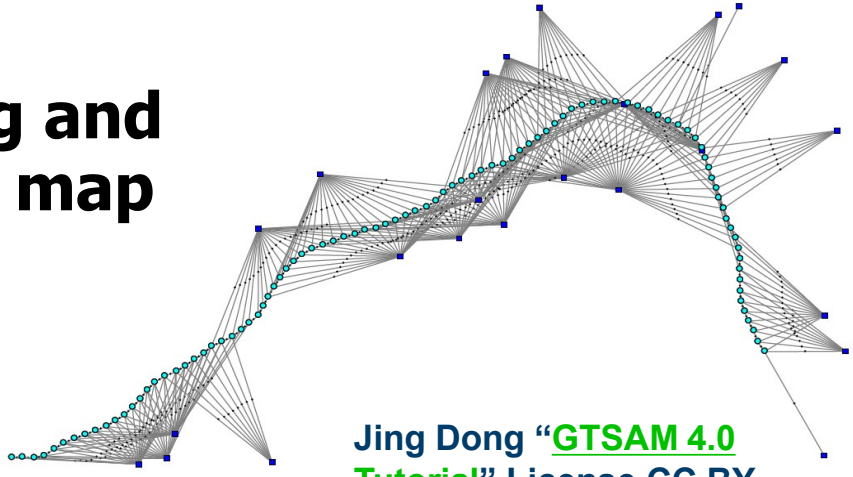
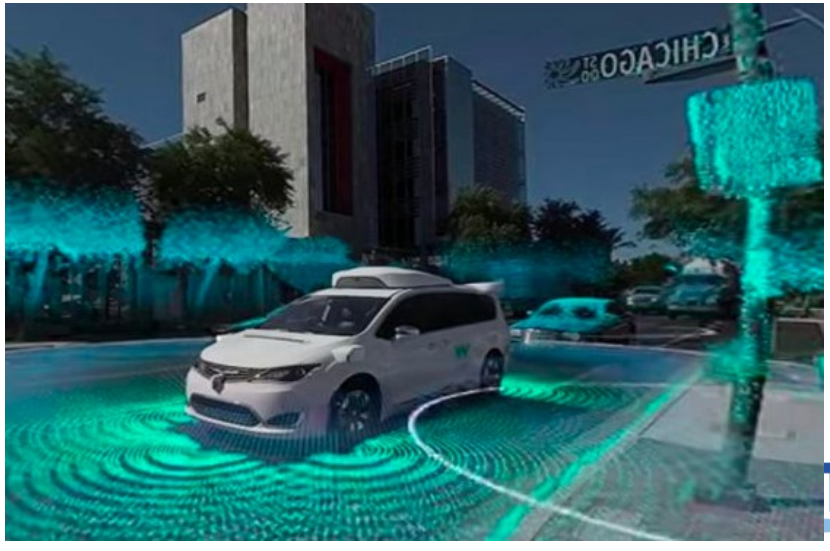
Simultaneous localization and mapping (SLAM)

- **Mapping**
  - **Continuously expanding and optimizing a consistent map while exploring the environment**
- **Localization**
  - **Localization within the map**

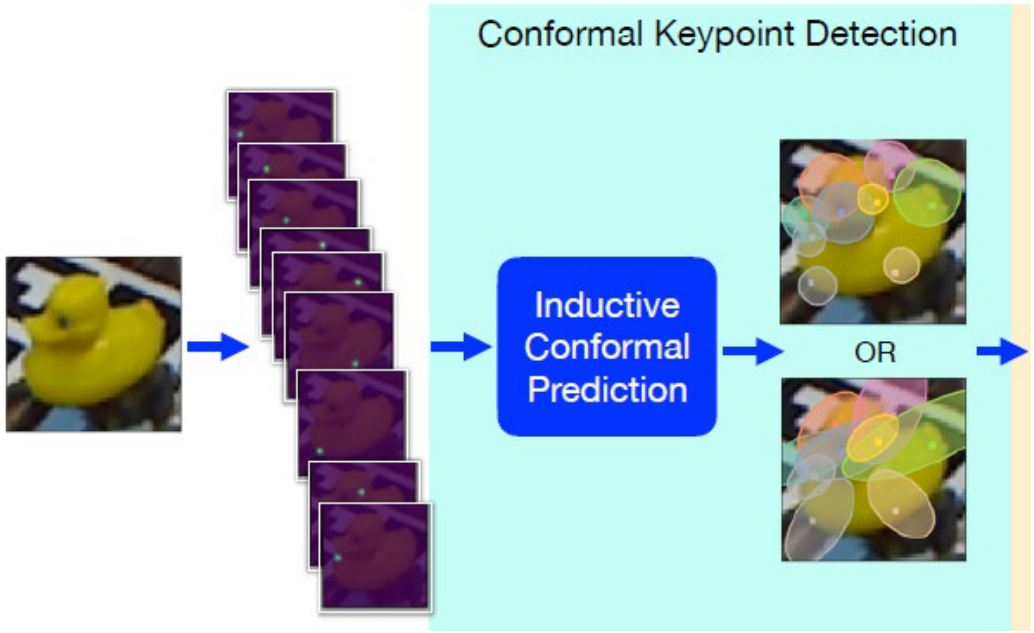


Jing Dong "GTSAM 4.0 Tutorial" License CC BY-NC-SA 3.0



Object Pose Estimation with Statistical Guarantees, CVPR 23

- **Object Pose Estimation with Statistical Guarantees: Conformal Keypoint Detection and Geometric Uncertainty Propagation**



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Example: Transfiguring Portraits [SIG. 16]

Time-Lapse Photography and Edit Transfer [Shen et al.]

Figure 1: *Our regional foremost matching for Internet images estimates accurate regional correspondence and enables several applications.*

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Person Search or Re-ID

query

positive images(2)

negative images(98)

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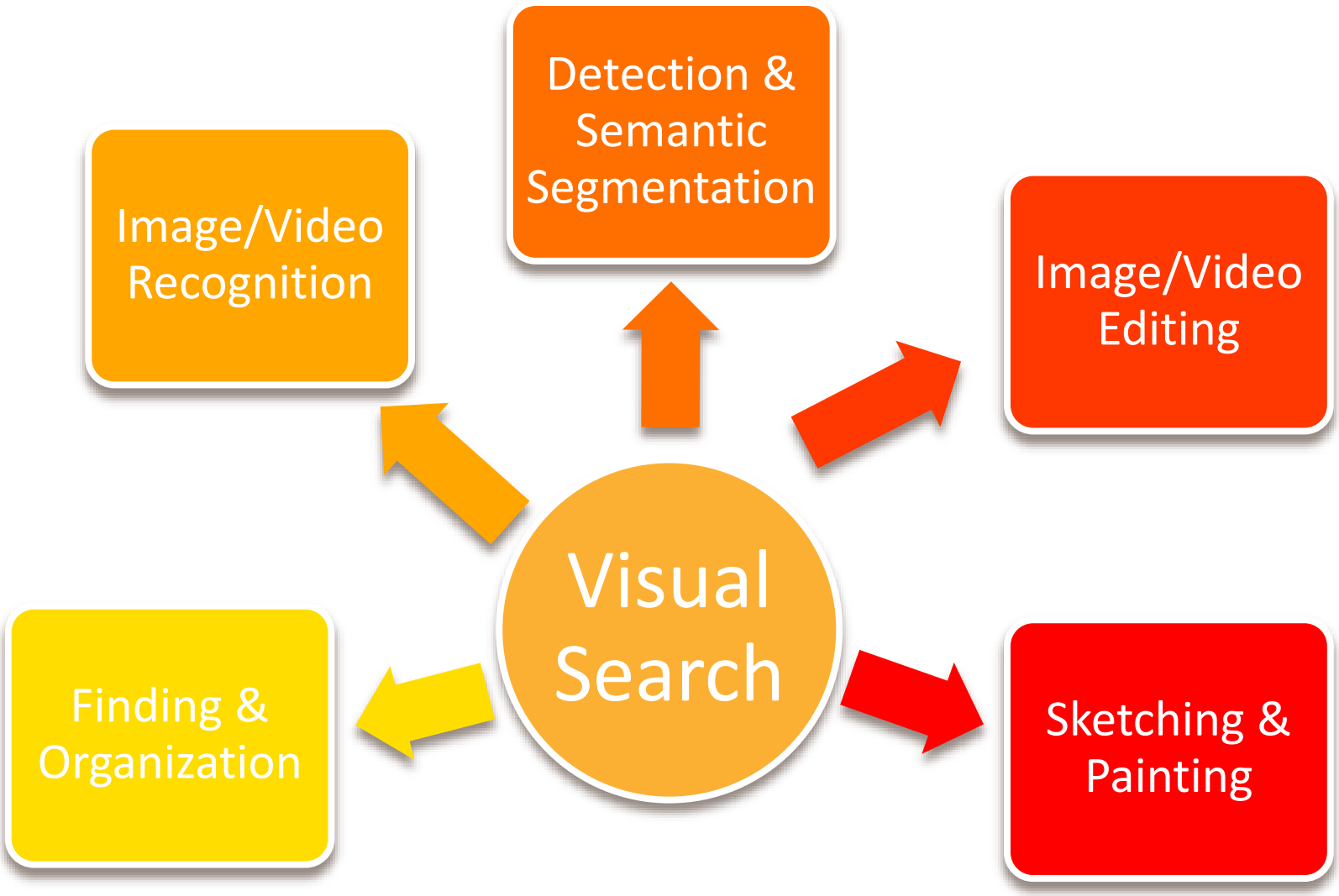
Possible Application Domains



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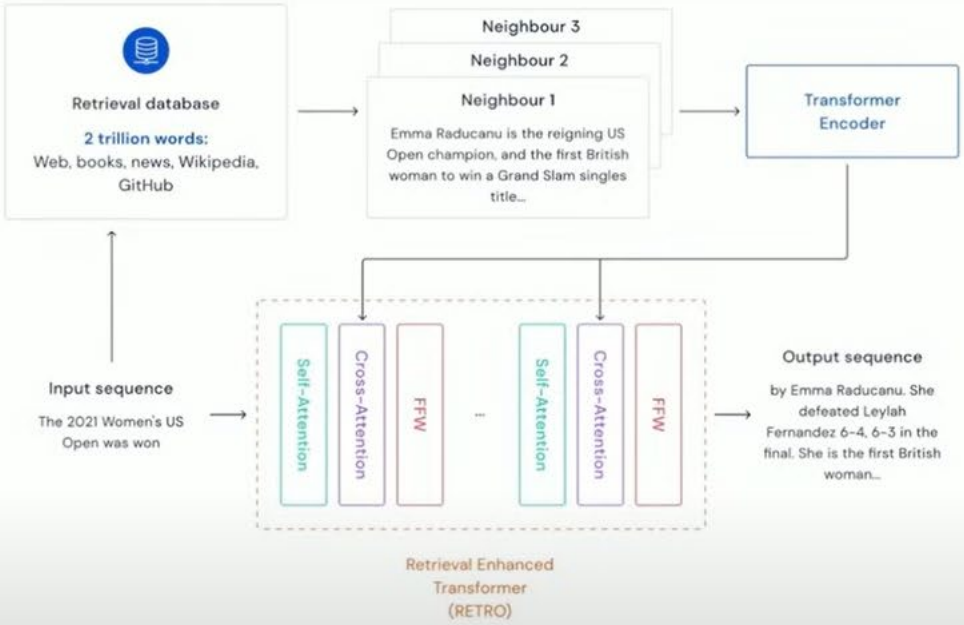
Adobe

Retrieval-Augmented Generation

Current Efforts to Address Problems: Retrieval-Augmented LMs

- Retrieval-Augmented Language Models
  - Use input sequence to search external document collections or knowledge graphs
  - Fuse results with the query to generate the answer
  - Bing probably implements this
- Benefits
  - Network can be 10x smaller (RETRO)
  - External documents can be updated without retraining
  - Reduces hallucination
  - Answer can be attributed to source documents
- Issues
  - Implicit world knowledge (in LLM) can interfere with knowledge from retrieved documents to cause hallucinations
  - Evaluations (Bing, NeevaAI, perplexity.ai, YouChat) show 48.5% of generated sentences are not fully supported by retrieved documents and 25.5% of cited documents are irrelevant (Liu, et al. 2023)
  - Vulnerable to poisoning of external knowledge sources



RETRO: Borgeaud, et al. 2021; 2022

Ack. Dietterich

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www.google.com/search?tbs=sbi:AMhZZiuyKQN8VbdVKrlWLNXXzF8NwQ3U6nZjHoGicvPiP_1LltJ1Ts9EF9aMliLZ52wdbl9cGWI

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이름Cha, Meeyoung (차미영) 조교수; 연구분야Social Computing, Data-Driven Social Science; 학위PhD, KAIST, 2008; 전화번호+82-42-350-2922; 이 메일meeyoungcha ...

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https://www.google.com/search?tbs=sbi:AMhZZiuIDxGKnZ9_1wT8VBeRZu5kWShzIORX4tI

Google JPG × eiffel tower

All Images Maps Shopping More Search tools

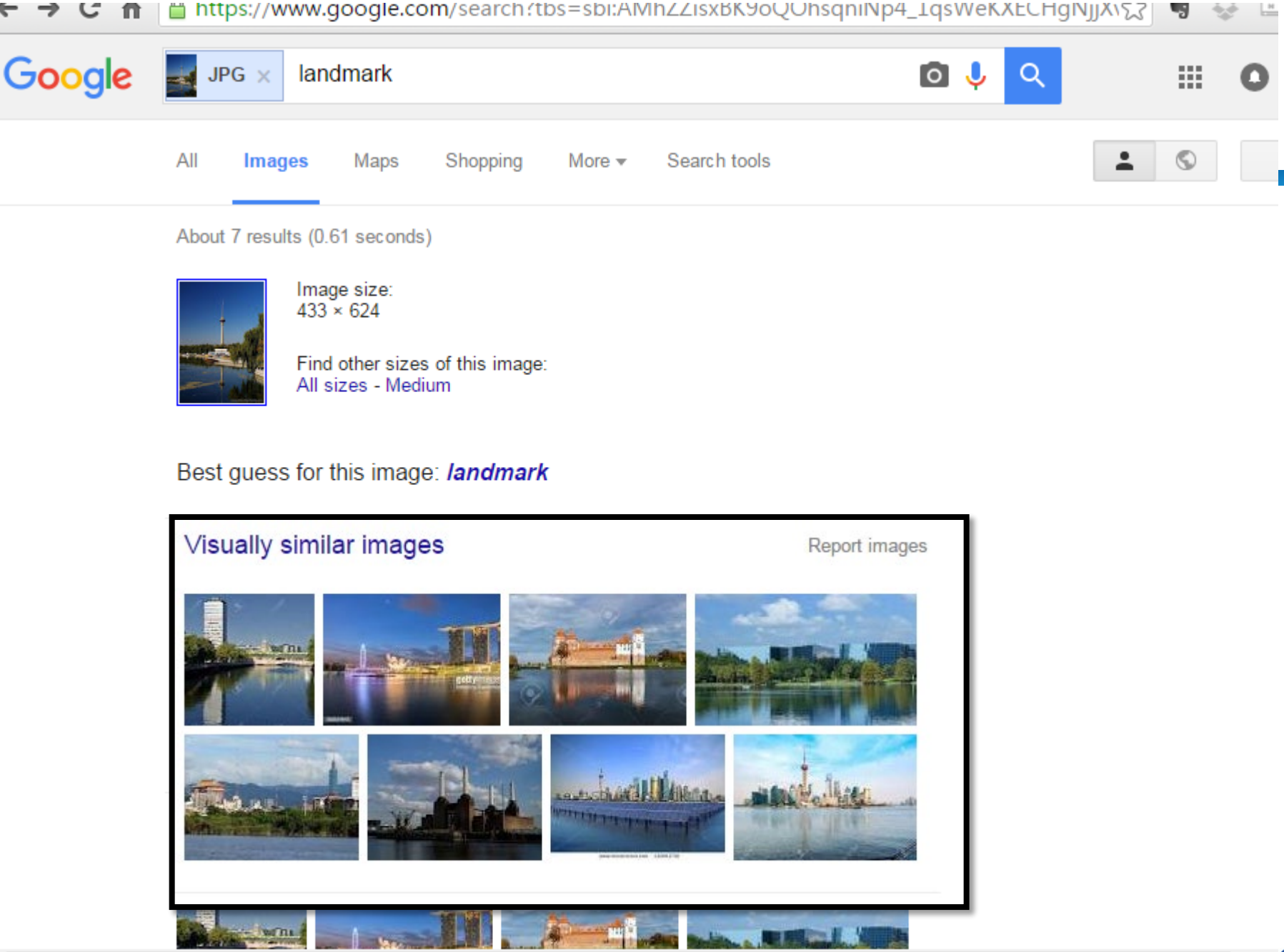
About 453 results (0.64 seconds)

Image size:
240 × 400

Find other sizes of this image:
All sizes - Small - Medium - Large

Best guess for this image: ***eiffel tower***

Visually similar images Report images


https://www.google.com/search?tbs=sbi:AMhZZisxBK9oQOhsqhiNp4_1qsWeKXECHgNjjX\
Google
JPG
landmark
All
Images
Maps
Shopping
More
Search tools
About 7 results (0.61 seconds)
Image size:
433 × 624
Find other sizes of this image:
All sizes - Medium
Best guess for this image: landmark
Visually similar images
Report images

Some of Topic Lists

- Feature detectors
- Descriptors
- Nearest neighbor search
- Bag-of-Word
- Recognition
- Convolutional neural network
- Feature aggregation
- Hashing techniques
- Large-scale retrieval indexing techniques
- Video related techniques
- Various applications
- Image generation for cross domain
- Attention

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Prerequisites

- **Basic knowledge of linear algebra and data structures**
- **Basic knowledge on machine learning (e.g., regression) and deep learning**
  - **Assume you to know deep learning and modify it for your application**
- **Some prior experiences on programming**

- **If you are not sure, please consult the instructor at the end of the course**

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Course Overview

- **Half of lectures and other half of student presentations**
  - **This is a research-oriented course**

- **What you will do:**
  - **Choose papers and present them**
  - **Propose ideas that can improve the state-of-the-art techniques**
  - **Quiz, mid-term, final-term exams, and**
  - **Have fun!**

Course Overview

- **Grade policy**
  - **Quiz, assignment, and exams: 30%**
  - **Class attendance and presentations: 30%**
  - **Final project: 40%**
  - **Class presentation and projects are the most important activities in this class**
- **Instructor and students will evaluate presentations and projects**
  - **Instructor: 50% weights**
  - **Students: 50% weights**

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Presentations

- **Choose and present papers that are related to the course theme**
  - **Two talks for each student**
  - **Present a paper in each talk**

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Final Project

- **Propose ideas to address problems identified from your presentation papers**
  - **Show benefits of your ideas and how your ideas can improve the state-of-the-art techniques in a logical manner**
  - **Implementation of your ideas is not required, but is recommended**
- **Team project is allowed**
  - **Role of each student should be very clear**

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Course Awards

- **Best speaker and best project awards**
  - **Lunch or dinner for awardees with me and TAs**
- **A high grade will be given to members of the best project**

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Programming HWs and Exams

- **Two programming assignments**
  - **Implement basic image search components**
- **Late policy**
  - **No score for late submissions**
  - **Submit your work before the deadline!**
- **Two exams**
  - **Mid-term exam covers class materials**
  - **Final-term exam covers presentation materials of students**

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Question HWs for Every Class

- **Come up with one question in the class and submit at the end of the class**
  - **1 for typical questions (that were answered in the class)**
  - **2 for questions with thoughts or that surprised me**

- **Submit questions three times before the mid-term exam**

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Homework for Every Week

- Go over recent papers on image search
  - Those should be high quality and recent ones
  - Find two papers, and submit your summary before every beginning of the Mon. class
  - Online submission is possible
- Think about possible team members
- Too late if you think them later..

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Honor Code

- **Collaboration encouraged, but *assignments must be your own work***
- **Cite any other's work if you use their code**

- **Classroom etiquette: help you and your peer to focus on the class**
  - **Turn off cell phones**
  - **Arrive to the class on time**
  - **Avoid private conversations**
  - **Be attentive in class**

Class Attendance Rule

- Late two times → count as one absence
- Every two absences →lower your grade (e.g., A- → B+)
- To check attendance, I'll call your names
- If you are in situations where you should be late, notify earlier

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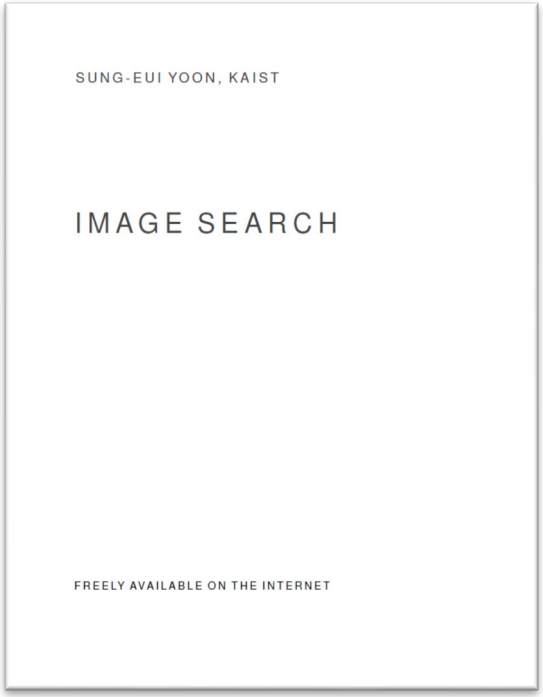
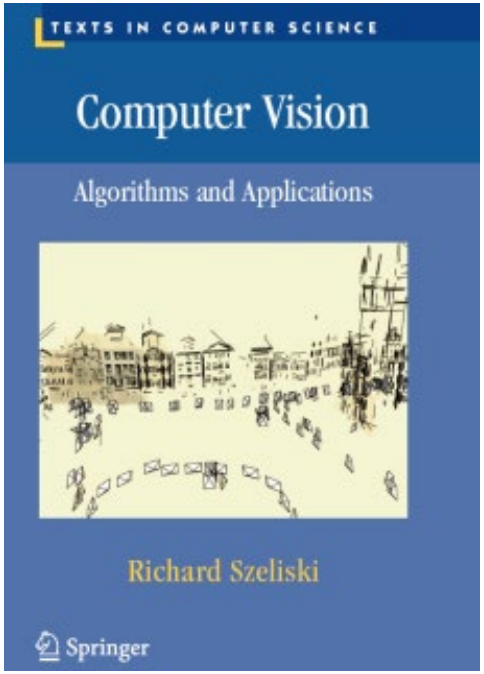
Resource

- **My ongoing draft on image search**
  - **pdf file is available at the webpage**
- **Reference**
  - **Computer vision: algorithms and applications**
    - **Its file is available (http://szeliski.org/Book/)**





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Other Resources

- Technical papers
  - CVPR, ICCV, ICLR, NeurIPS, ICMR, ACM MM, SIGGRAPH, etc.
  - Youtube (technical talks)
  - Computer vision resource (http://www.cvpapers.com/)
  - Multimedia information retrieval (http://www.mirsociety.org/mweb/)
- Course homepages
- Google or Google scholar

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Schedule

- **Please refer the course homepage:**
  - **http://sgvr.kaist.ac.kr/~sungeui/IR**

Official Language in Class

- English
  - I'll give lectures in English
  - I may explain again in Korean if materials are unclear to you
  - You are no required to use English, but are recommended
- To non-native Korean speakers
  - Many Korean students prefer to use Korean for deeper discussions
  - In these cases, we will use Korean, but I will summarize main points in English

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My Wish for You

- **Follow up lecture materials and do various class activities/HWs**

- **Hopefully, they will:**
  - **Lead to your next publication, or**
  - **Lead to your next start-up**

About You

- Name
- Your (non hanmail.net) email address

- What is your major?
- Previous experience on image search and computer vision
- Credit/audit

- Online submission: https://forms.gle/gRcHfvfdP9DnQBjj8

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Next Time

- **Feature detectors**

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