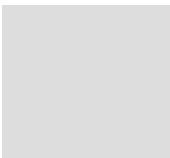


TRƯỜNG ĐẠI HỌC CÔNG NGHỆ THÔNG TIN
KHOA KHOA HỌC MÁY TÍNH

CS231.N2x. Nhập môn Thị giác máy tính

Bài 01 Giới thiệu môn học



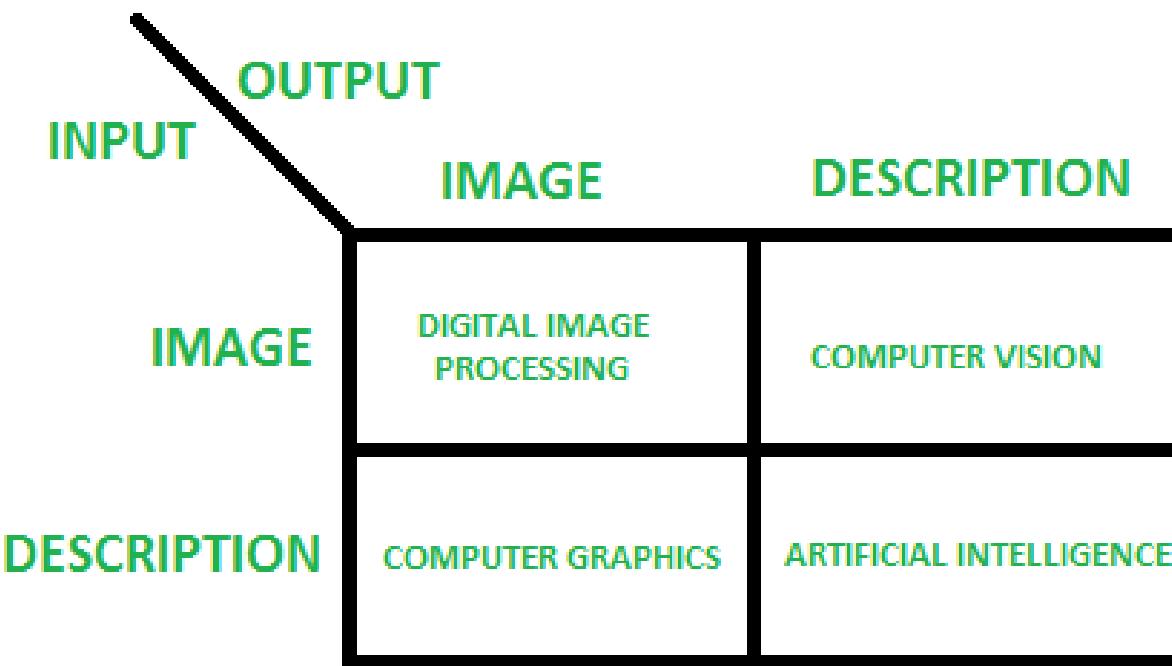
Mai Tiến Dũng

1. Thông tin chung

Tên môn học (tiếng Việt):	Nhập môn Thị giác Máy tính
Tên môn học (tiếng Anh):	Introduction to Computer Vision
Mã môn học:	CS231
Thuộc khối kiến thức:	Đại cương <input type="checkbox"/> ; Cơ sở nhóm ngành <input type="checkbox"/> ; Cơ sở ngành <input type="checkbox"/> ; Chuyên ngành <input checked="" type="checkbox"/> ; Tốt nghiệp <input type="checkbox"/>



2. Mô tả môn học



2. Mô tả môn học

- Môn học này giới thiệu các nội dung căn bản trong ngành Thị giác máy tính, bao gồm các chủ đề về:
 1. low-level computer vision: image → image





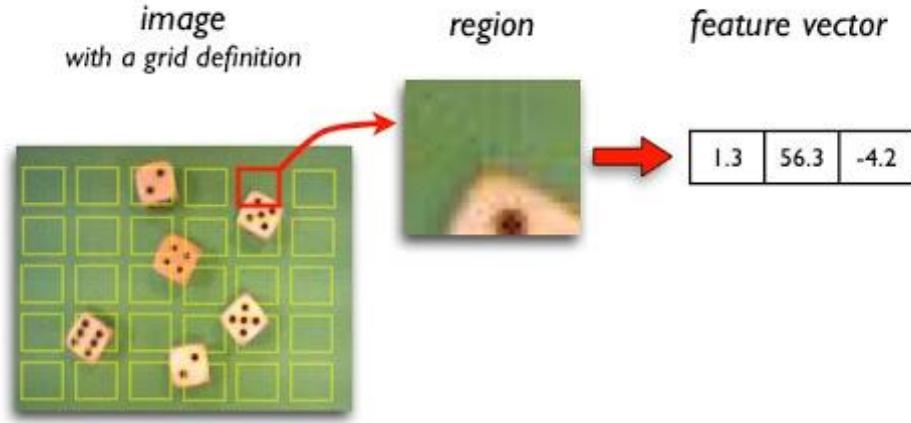
- Image Inpainting

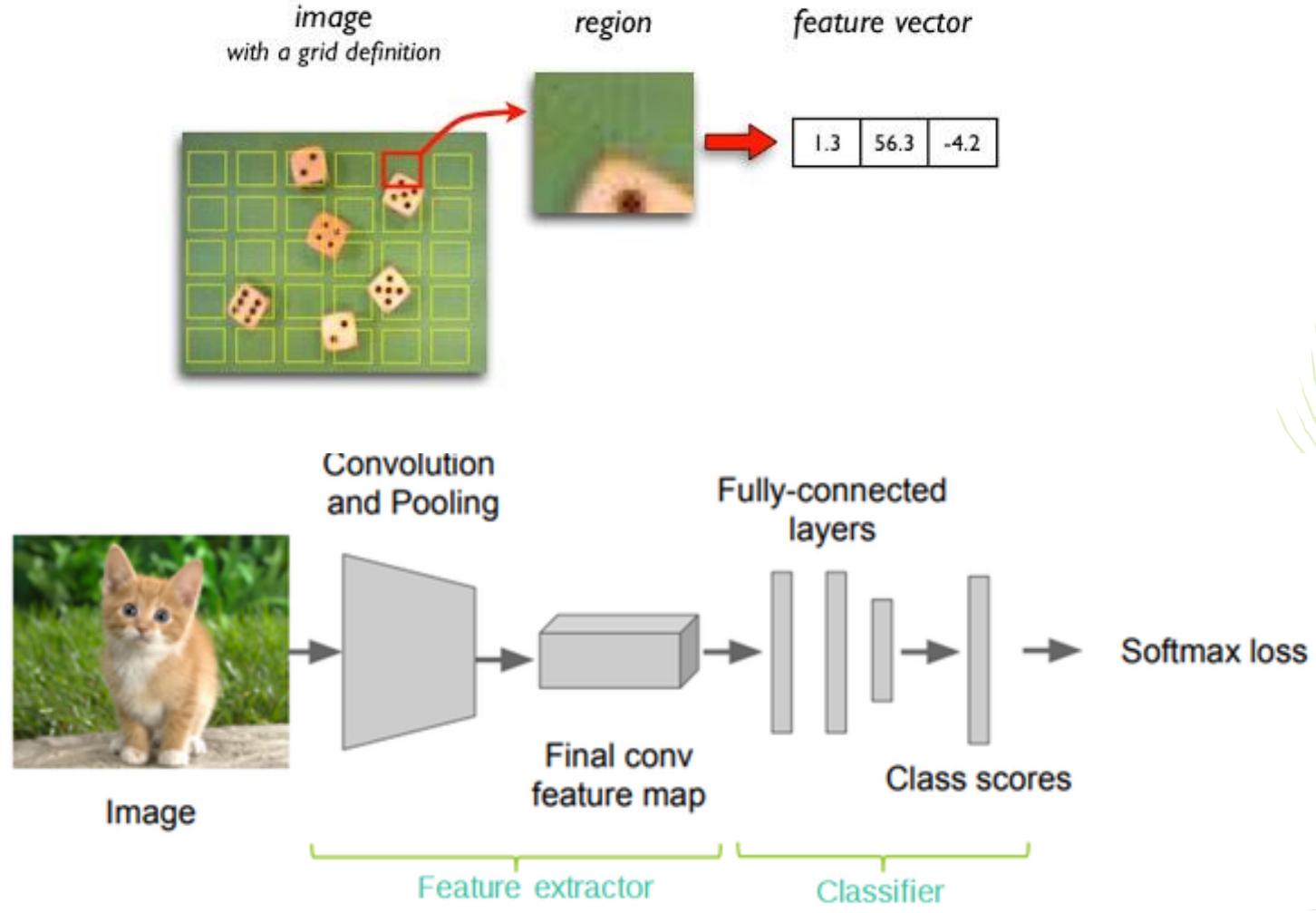


2. Mô tả môn học

- Môn học này giới thiệu các nội dung căn bản trong ngành Thị giác máy tính, bao gồm các chủ đề về:
 1. low-level computer vision: image → image
 2. mid-level computer vision: image → feature







2. Mô tả môn học

- Các chủ đề cụ thể gồm:
 - rút trích và khai thác thông tin trên ảnh,
 - các loại đặc trưng thị giác cấp thấp và phương pháp biểu diễn đặc trưng thị giác cấp thấp,
 - các kĩ thuật so khớp ảnh,
 - các kĩ thuật phân đoạn ảnh, phương pháp theo vết (tracking).



3. Mục tiêu môn học

1. Làm việc ở mức độ cá nhân và cộng tác nhóm để trình bày và giải quyết một số bài toán liên quan tới Thị giác máy tính.
2. Hiểu và giải thích được các khái niệm cơ bản, thuật ngữ liên quan tới Thị giác Máy tính



3. Mục tiêu môn học

3. Ứng dụng các kiến thức căn bản về Thị giác máy tính để ứng dụng vào các vấn đề đơn giản trong thực tế.
4. Ứng dụng các công cụ hỗ trợ, thư viện mở về Thị giác Máy tính.



4. Nội dung

Tuần 1	Giới thiệu về ảnh/video số
Tuần 2-4	<p>Khái niệm và các phương pháp rút trích đặc trưng cấp thấp trên ảnh</p> <ul style="list-style-type: none">• Biên, cạnh• Đặc trưng vân ảnh• Đặc trưng màu sắc• Đặc trưng hình dáng• Biểu diễn đặc trưng toàn cục, cục bộ



4. Nội dung

Tuần 5-7

Khái niệm và các phương pháp phân đoạn ảnh

- Phân đoạn ảnh dựa trên gom cụm (K-Means, MeanShift)
- Phân đoạn ảnh dựa trên đồ thị (GraphCut)



4. Nội dung

Tuần
8 - 12

Khái niệm và các phương pháp so khớp ảnh

- Phát hiện điểm nổi bật (Keypoint / Interest Points / Blobs)
- Rút trích và biểu diễn đặc trưng cục bộ (SIFT, SURF)
- So khớp ảnh
- RANSAC



4. Nội dung

Tuần 13 –15

Khái niệm và các phương
pháp theo vết (tracking)

- Optical Flow

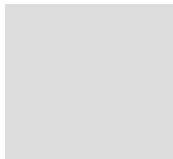


5. Đánh giá

A4. Cuối kỳ - LT cuối kỳ - Đồ án cuối kỳ		70 %
A3. Thực hành		30 %



What is computer vision ?



What is vision ?

- Human Vision

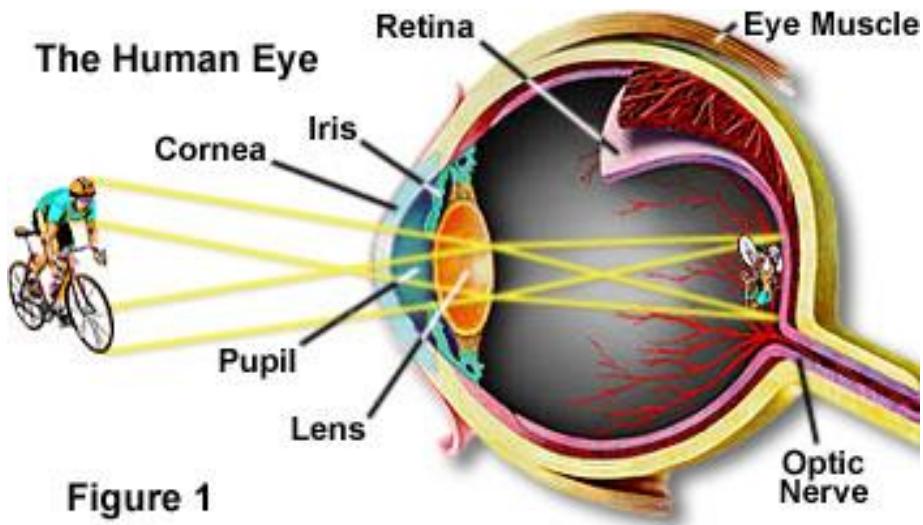


Figure 1

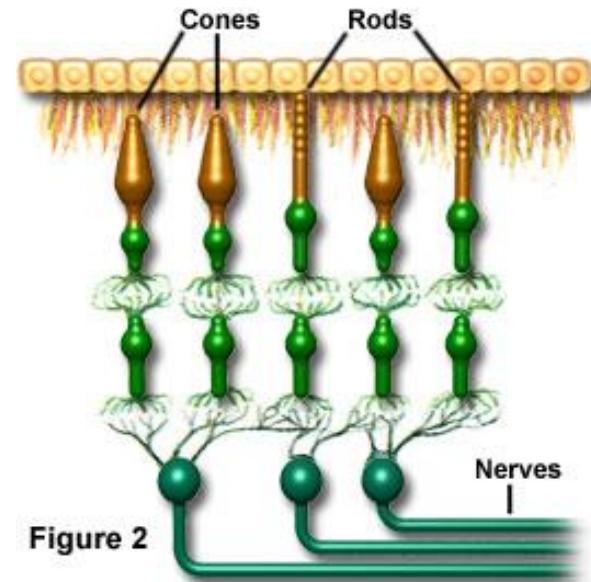
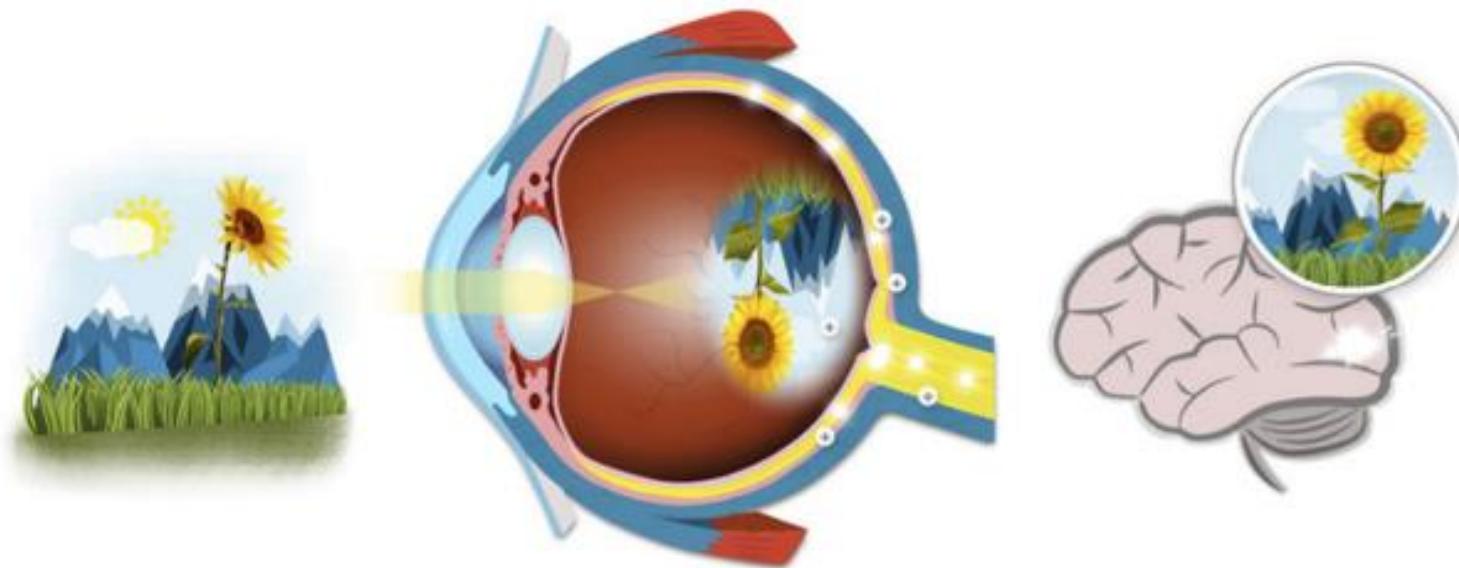


Figure 2

<https://micro.magnet.fsu.edu/optics/lightandcolor/vision.html>

What is vision ?

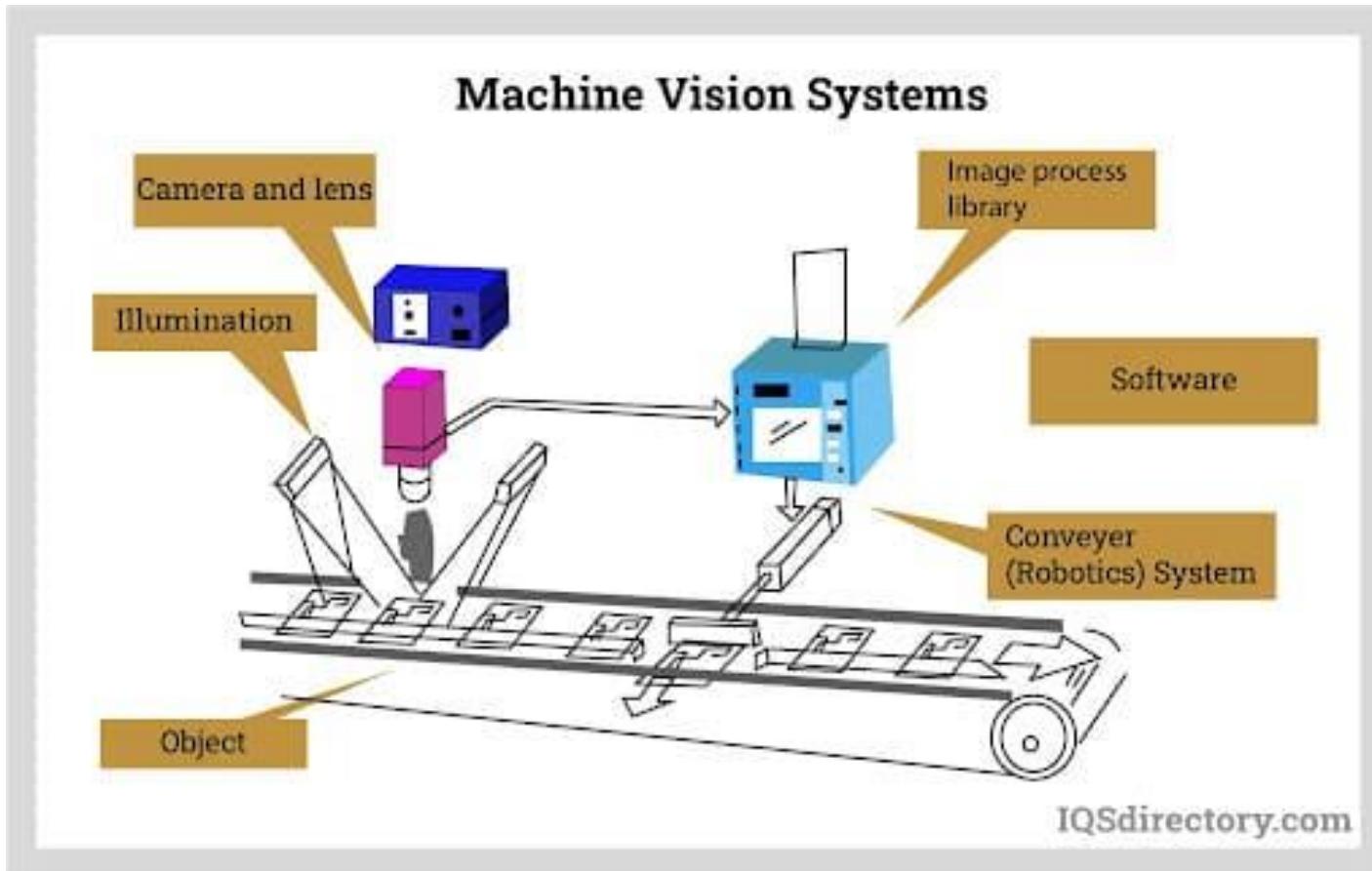
- Human Vision



<https://blog.tonkabi.com/blog/post/computer-vision-vs-human-vision>

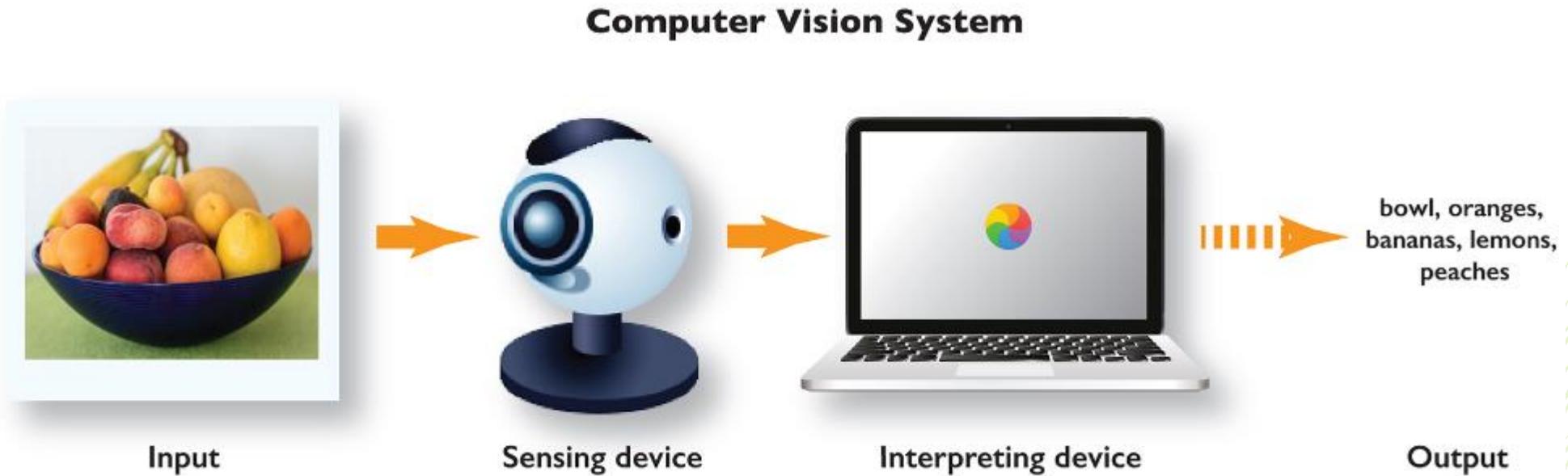
What is vision ?

- Machine Vision



What is vision ?

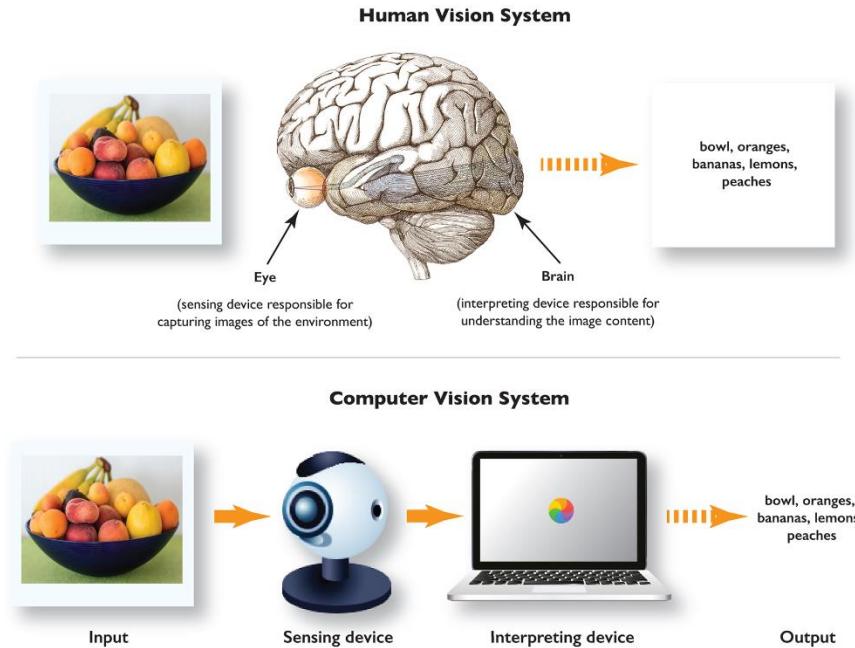
- Computer vision



<https://freecontent.manning.com/computer-vision-pipeline-part-1-the-big-picture/>

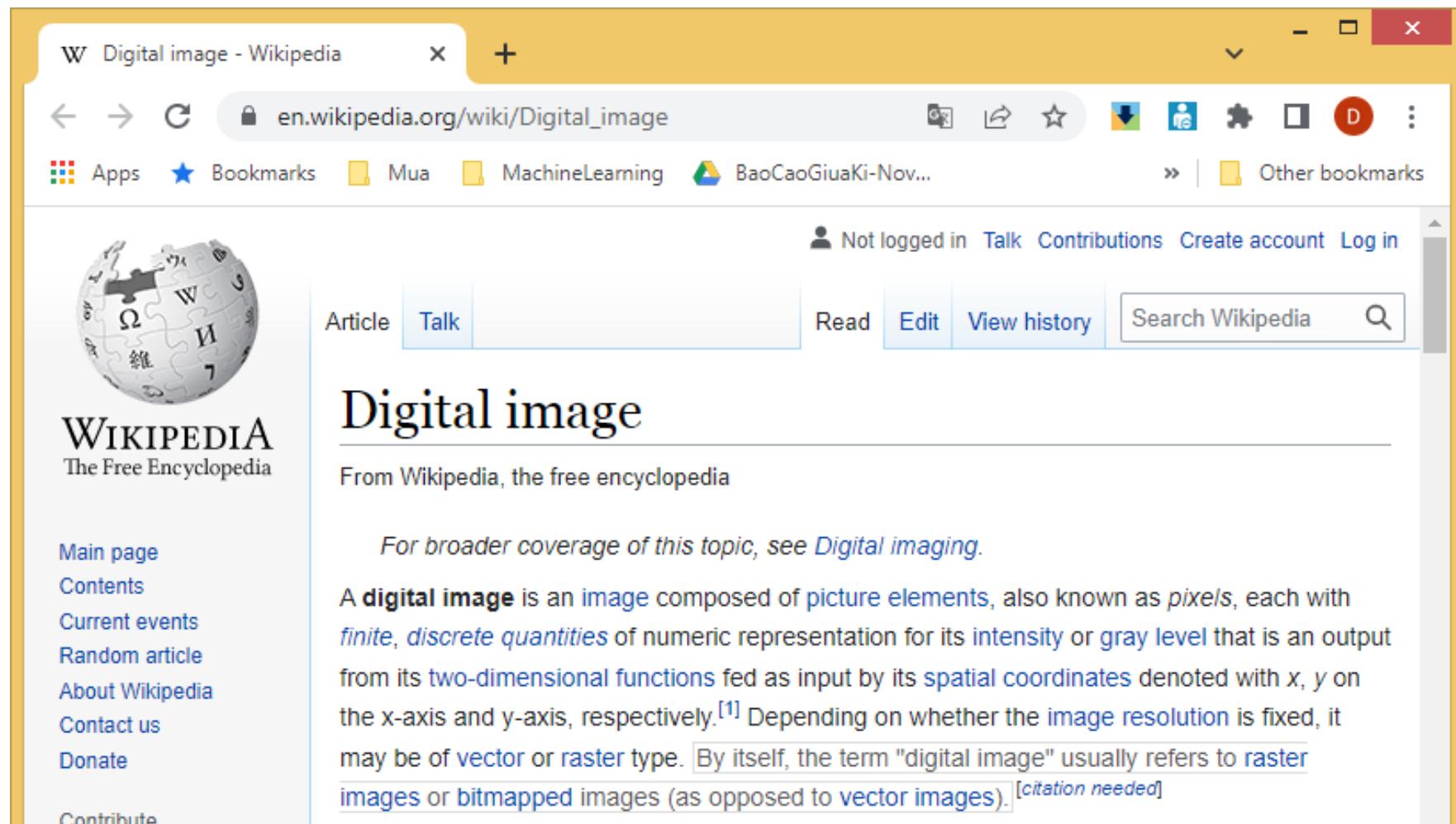
What is vision ?

- Human vs Computer vision



<https://freecontent.manning.com/mental-model-graphic-grokked-deep-learning-for-computer-vision/>

What is digital image ?

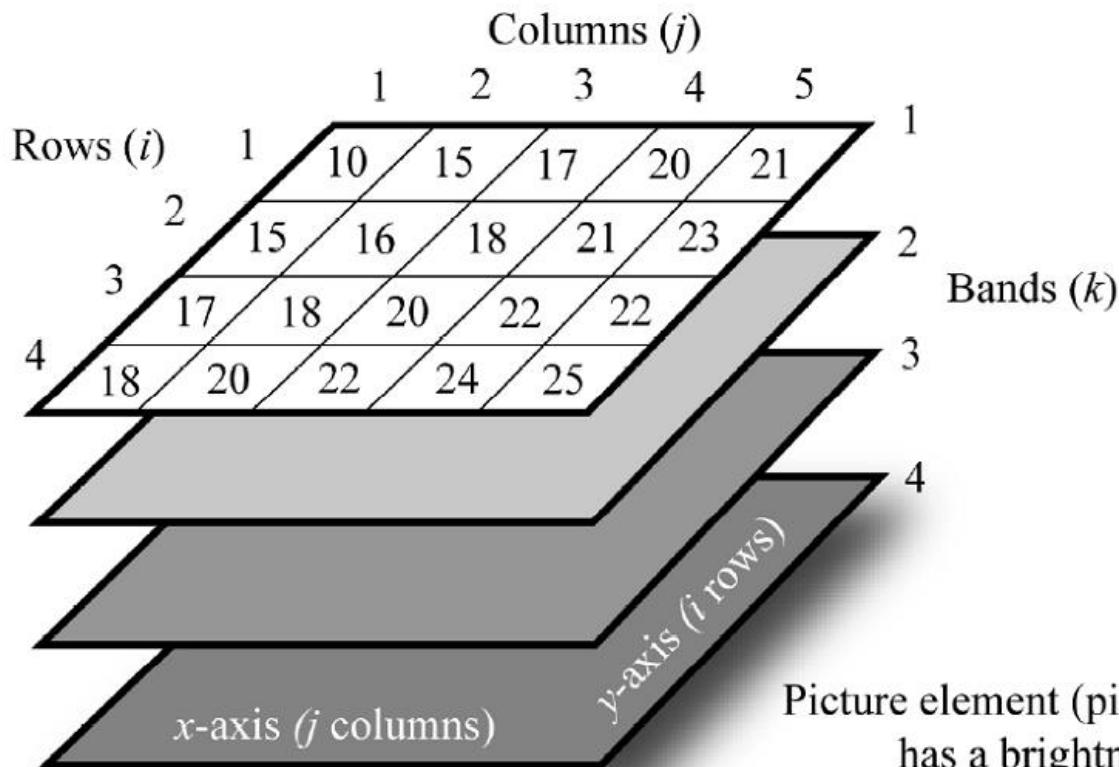


The screenshot shows a web browser window with the following details:

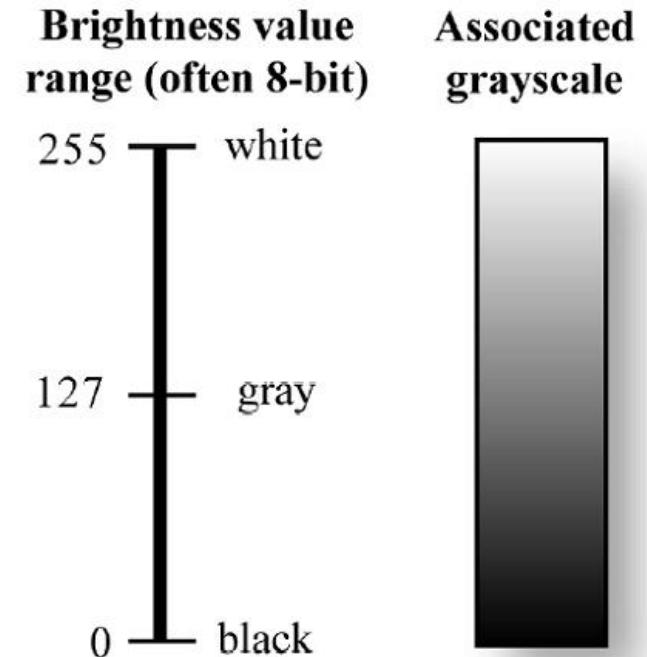
- Title Bar:** W Digital image - Wikipedia
- Address Bar:** en.wikipedia.org/wiki/Digital_image
- Toolbar:** Includes icons for refresh, back, forward, search, and other browser functions.
- Bookmark Bar:** Apps, Bookmarks, Mua, MachineLearning, BaoCaoGiuaki-Nov..., Other bookmarks
- User Account:** Not logged in, Talk, Contributions, Create account, Log in
- Page Navigation:** Article (selected), Talk, Read, Edit, View history
- Search Bar:** Search Wikipedia, magnifying glass icon
- Page Content:**
 - Section Header:** Digital image
 - Text:** From Wikipedia, the free encyclopedia
 - Text:** For broader coverage of this topic, see [Digital imaging](#).
 - Text:** A **digital image** is an image composed of picture elements, also known as **pixels**, each with **finite, discrete quantities** of numeric representation for its intensity or gray level that is an output from its two-dimensional functions fed as input by its spatial coordinates denoted with x , y on the x-axis and y-axis, respectively.^[1] Depending on whether the image resolution is fixed, it may be of **vector** or **raster** type. By itself, the term "digital image" usually refers to **raster images** or **bitmapped images** (as opposed to **vector images**). [citation needed]

What is digital image ?

Digital Image Terminology

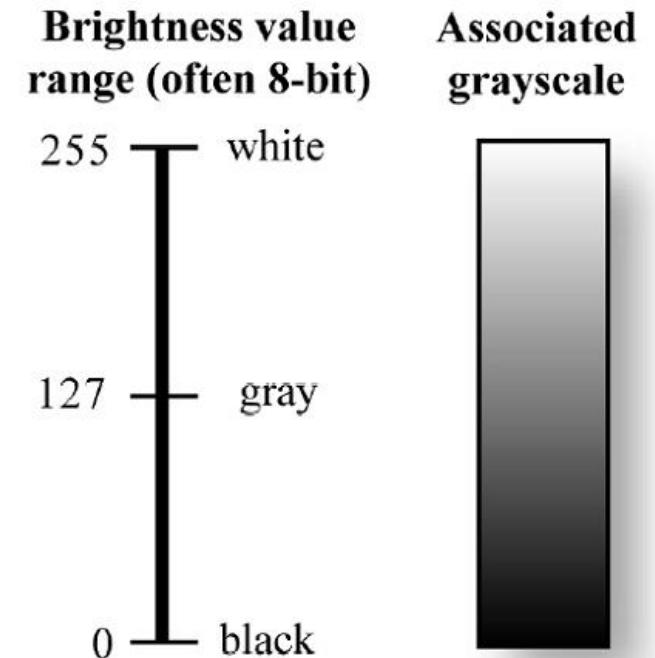
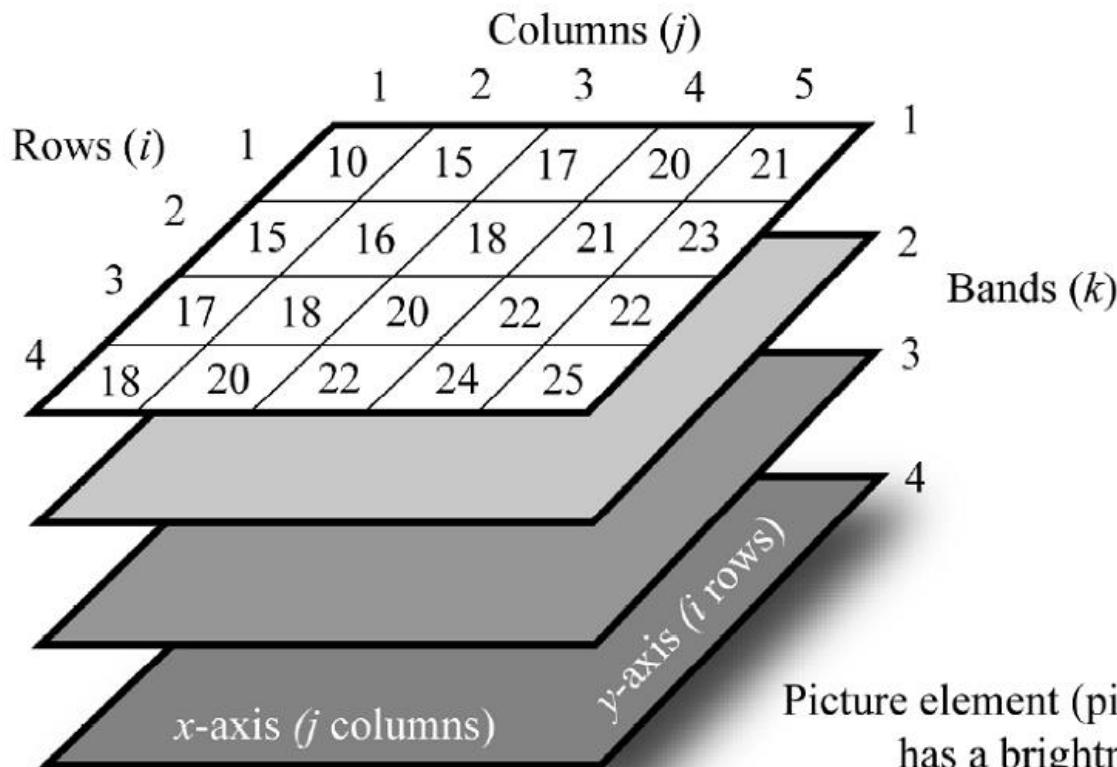


Picture element (pixel) at location row 4, column 4, band 1 has a brightness value of 24, i.e., $BV_{4,4,1} = 24$



What is digital image ?

Digital Image Terminology

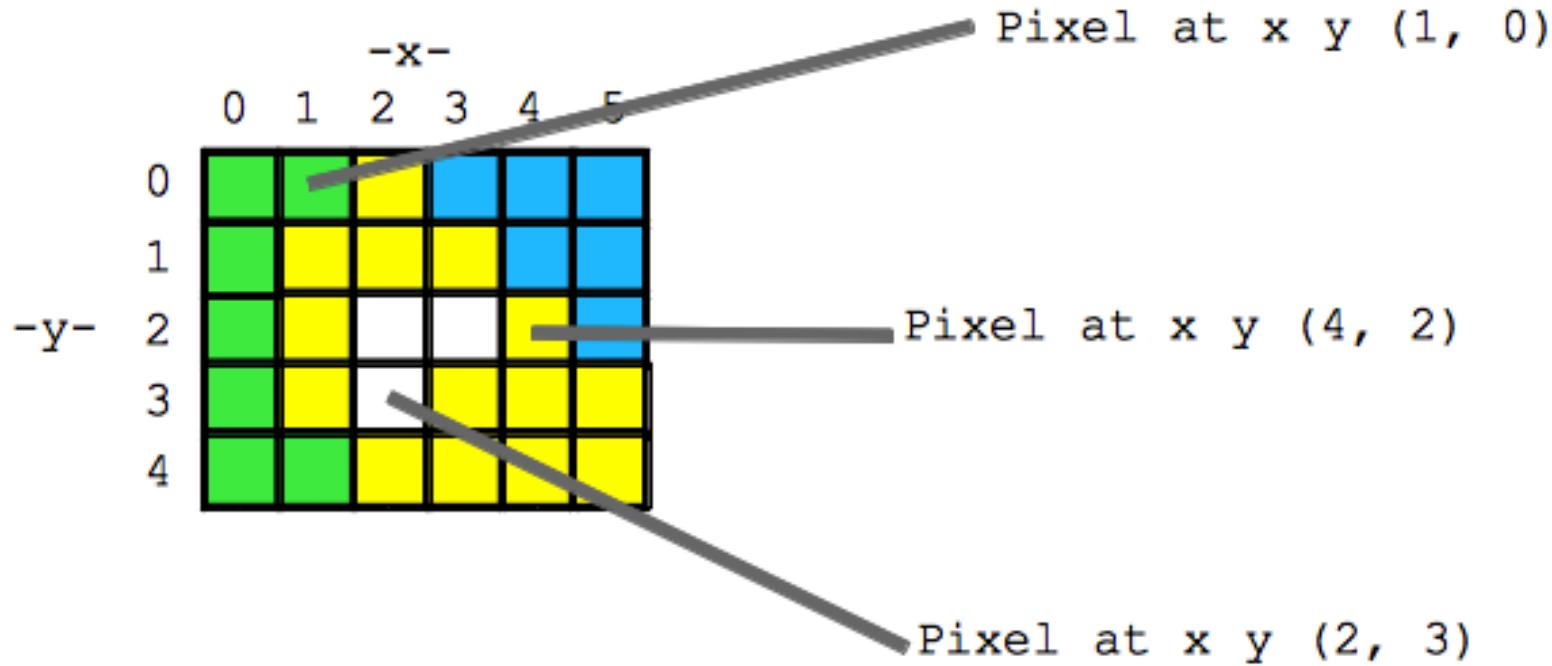


Picture element (pixel) at location row 4, column 4, band 1 has a brightness value of 24, i.e., $BV_{4,4,1} = 24$

Jensen



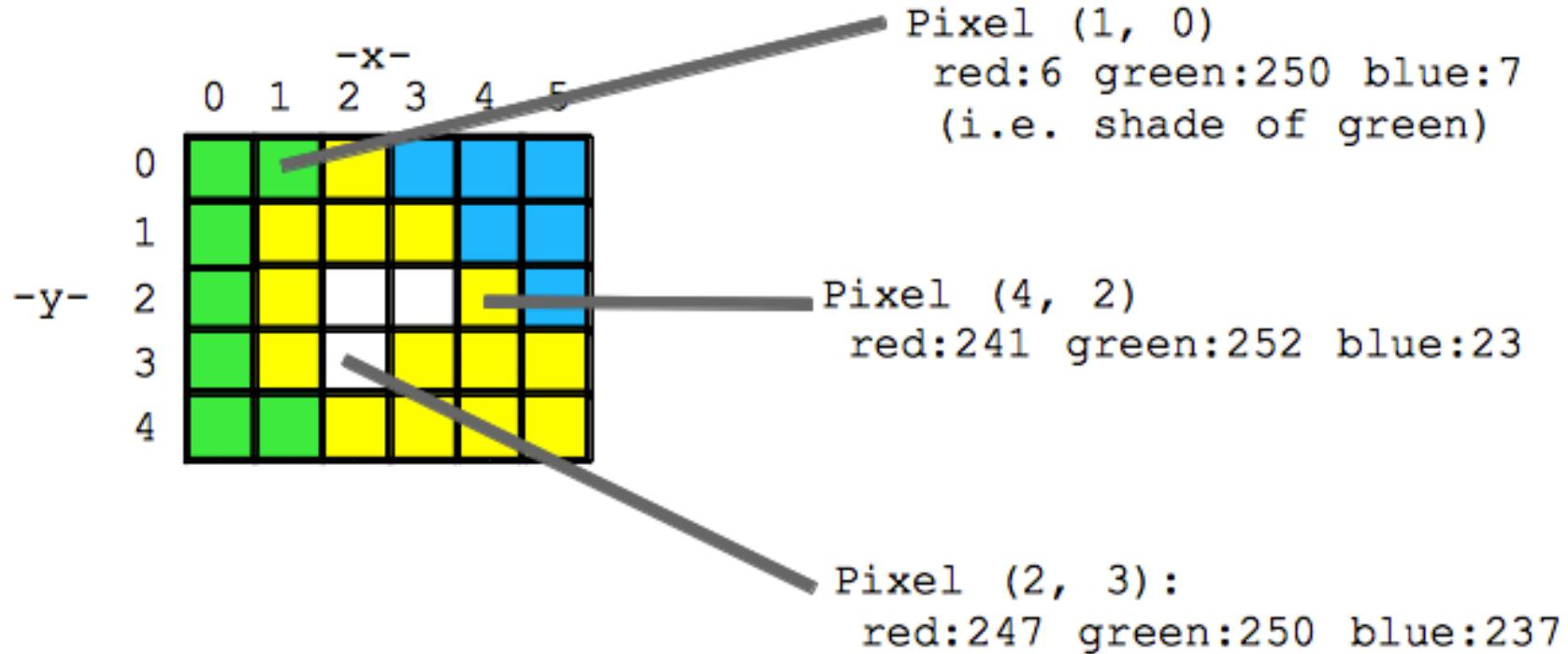
What is digital image ?



<https://web.stanford.edu/class/cs101/image-1-introduction.html>



What is digital image ?



<https://web.stanford.edu/class/cs101/image-1-introduction.html>



What is computer vision ?



Human



What is computer vision ?

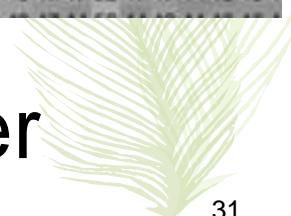


Human

62	62	63	64	65	66	67	67	69	70	71	72	72	73	73	73	72	72	71	70	69	67	66	66	65	63	62	61	60	6				
61	62	63	64	66	66	67	68	68	69	70	71	71	72	72	73	72	72	71	71	70	69	68	66	66	65	65	63	62	61	60	6		
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Human

Computer



What is computer vision ?

- <https://www.ibm.com/topics/computer-vision>
- <https://www.coursera.org/learn/introduction-computer-vision-watson-opencv>



What is computer vision ?

A screenshot of a web browser window displaying the IBM website at ibm.com/topics/computer-vision. The page title is "What is Computer Vision? | IBM". The main heading "What is computer vision?" is displayed prominently in large white text against a dark background featuring a glowing blue circuit board pattern. Below the heading, a subtext explains: "Use machine learning and neural networks to teach computers to see defects and issues before they affect operations". A blue call-to-action button at the bottom left reads "Explore Maximo Visual Inspection" with a right-pointing arrow.

What is computer vision ?

- Computer vision is a field of artificial intelligence (AI)



What is computer vision ?

- Computer vision is a field of artificial intelligence (AI) that enables computers and systems to **derive meaningful information from digital images, videos and other visual inputs**



What is computer vision ?

- Computer vision is a field of artificial intelligence (AI) that enables computers and systems to **derive meaningful information from digital images, videos and other visual inputs** — and **take actions or make recommendations** based on that information.



What is computer vision ?

- Computer vision is a field of artificial intelligence (AI) that enables computers and systems to **derive meaningful information from digital images, videos and other visual inputs** — and **take actions or make recommendations** based on that information. If **AI** enables **computers to think**, **computer vision** enables them to **see, observe and understand**.



What is computer vision ?

- Computer vision works much the same as human vision, except humans have a head start.



What is computer vision ?

- Computer vision works much the same as human vision, except humans have a head start. Human sight has the advantage of lifetimes of context to train how to tell objects apart, how far away they are, whether they are moving and whether there is something wrong in an image.



What is computer vision ?

- Computer vision trains machines to perform these functions, but it has to do it in much less time with cameras, data and algorithms rather than retinas, optic nerves and a visual cortex. Because a system trained to inspect products or watch a production asset can analyze thousands of products or processes a minute, noticing imperceptible defects or issues, it can quickly surpass human capabilities.

What is computer vision ?

- Computer vision is used in industries ranging from energy and utilities to manufacturing and automotive – and the market is continuing to grow. It is expected to reach USD **48.6** billion by 2022⁽¹⁾

1. <https://www.forbes.com/sites/bernardmarr/2019/04/08/7-amazing-examples-of-computer-and-machine-vision-in-practice/#3dbb3f751018>



Why use computer vision?

Like all technologies,

- Slower → Faster
- Expensive → Cheap
- Manual → Automated
- Difficult → Easy
- Inconvenient → Convenient
- Unscalable → Scalable



Computer vision applications

Industries

- Automotive
- Food & Beverage
- Manufacturing
- Pharmaceutical
- Supply chain
- Energy & Utilities
- Hospitality
- Life Sciences
- Human Resources
- Insurance



Computer vision examples

7 Amazing Examples Of Computer And Machine Vision In Practice



Bernard Marr Contributor ⓘ
Enterprise Tech

Follow

<https://www.forbes.com/sites/bernardmarr/2019/04/08/7-amazing-examples-of-computer-and-machine-vision-in-practice/?sh=2f5b2b8f1018>

Computer vision examples

1. Autonomous vehicles
2. Google Translate app
3. Facial recognition
4. Healthcare
5. Real-time sports tracking
6. Agriculture
7. Manufacturing



Computer vision examples

1. Autonomous vehicles

Computer vision is necessary to enable self-driving cars. Manufacturers such as Tesla, BMW, Volvo, and Audi use multiple cameras, lidar, radar, and ultrasonic sensors to acquire images from the environment so that their self-driving cars can detect objects, lane markings, signs and traffic signals to safely drive.



More images

Self-driving car



A self-driving car, also known as an autonomous vehicle, driverless car, or robo-car, is a vehicle that is capable of sensing its environment and moving safely with little or no human input. [Wikipedia](#)



Computer vision examples

1. Autonomous vehicles



<https://www.youtube.com/watch?v=tIThdr3O5Qo>

Computer vision examples

2. Google Translate app

All you need to do to read signs in a foreign language is to point your phone's camera at the words and let the Google Translate app tell you what it means in your preferred language almost instantly. By using optical character recognition to see the image and augmented reality to overlay an accurate translation, this is a convenient tool that uses computer vision.



Google Translate 4+
Translate 108 languages
Google LLC
#1 in Reference
★★★★★ 4.5 • 65.8K Ratings
Free



Google Translate

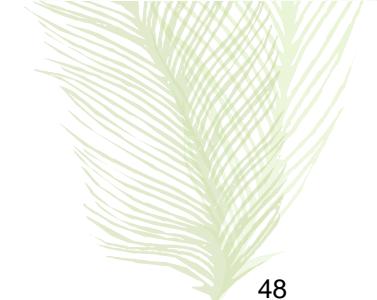
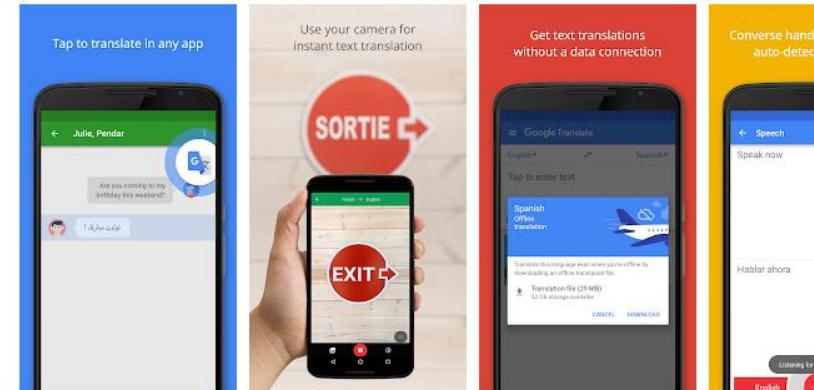
Google LLC Tools

★★★★★ 8,027,274

This app is available for your device

Add to Wishlist

Install



Computer vision examples

2. Google Translate app



<https://mashable.com/article/word-lens-japanese>



<https://www.hellotech.com/blog/the-5-best-free-translation-apps>

Computer vision examples

3. Facial recognition

China is definitely on the cutting edge of using [facial recognition technology](#), and they use it for police work, payment portals, security checkpoints at the airport and even to dispense toilet paper and prevent theft of the paper at Tiantan Park in Beijing, among many other applications.



Facial recognition system Share

A facial recognition system is a technology capable of matching a human face from a digital image or a video frame against a database of faces, typically employed to authenticate users through ID verification services, works by pinpointing and measuring facial features from a given image. [Wikipedia](#)

Computer vision examples

3. Facial recognition

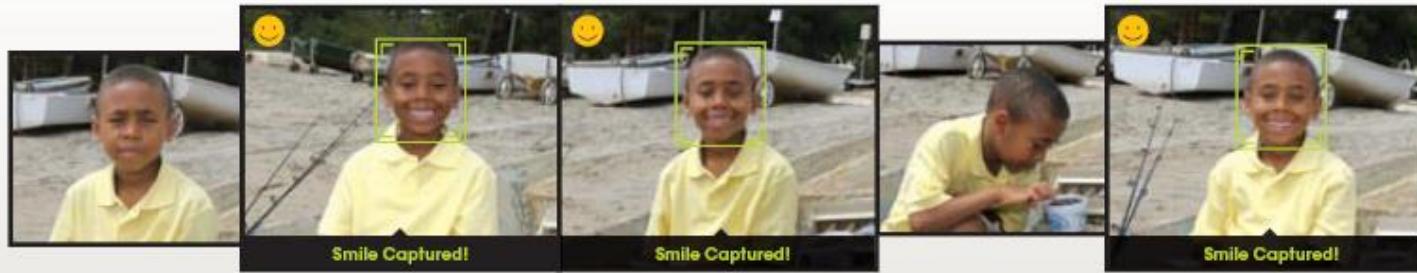


- Many new digital cameras now detect faces
 - Canon, Sony, Fuji, ...

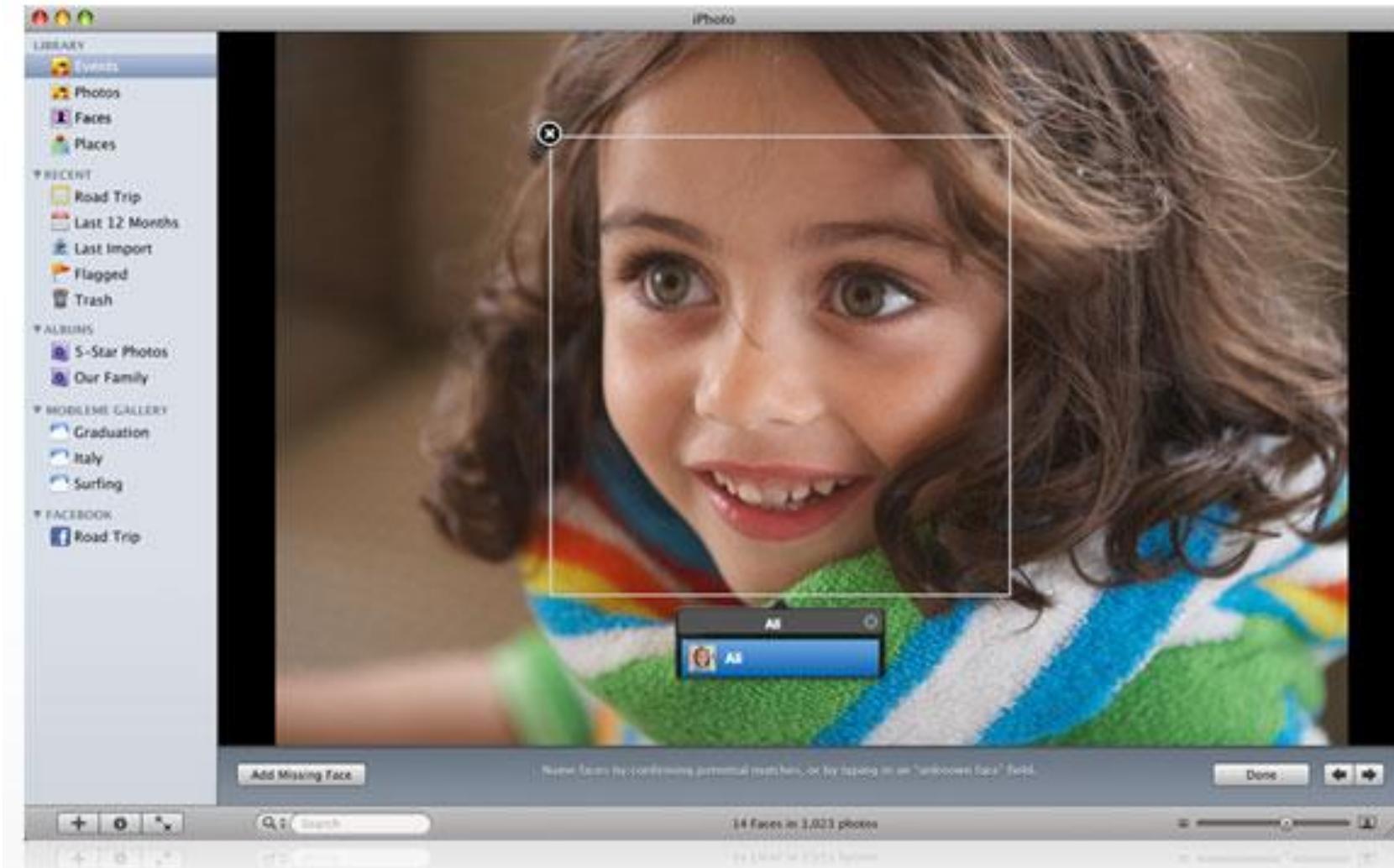
Smile detection

The Smile Shutter flow

Imagine a camera smart enough to catch every smile! In Smile Shutter Mode, your Cyber-shot® camera can automatically trip the shutter at just the right instant to catch the perfect expression.



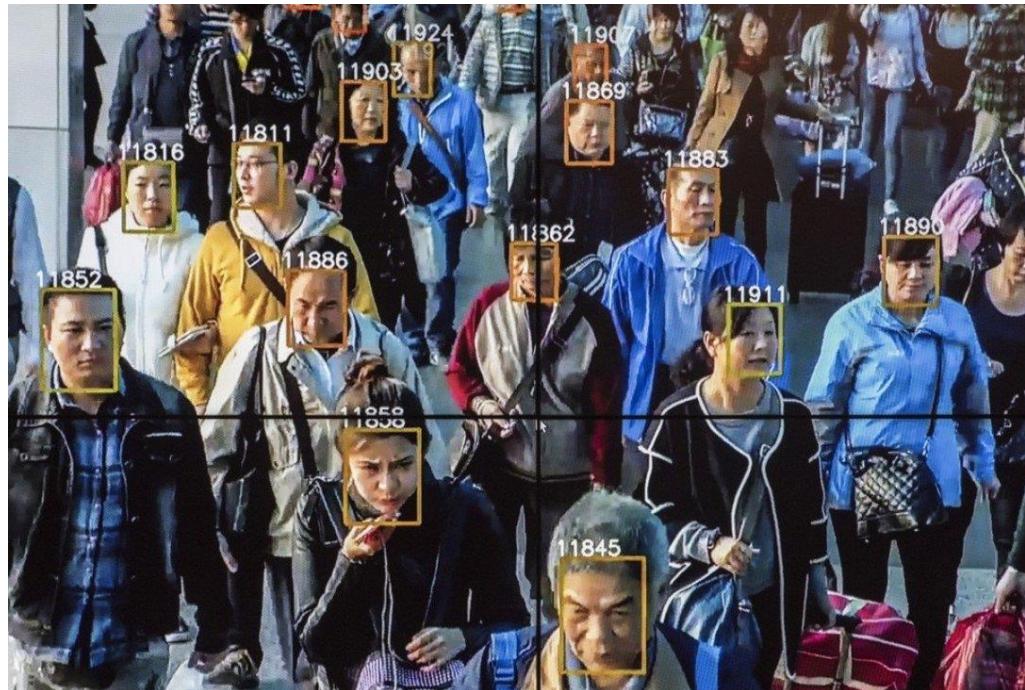
Face recognition: Apple iPhoto, Facebook, Google, etc



Computer vision examples

3. Facial recognition

Shanghai airport first to launch automated clearance system using facial recognition technology



https://www.scmp.com/tech/enterprises/article/2168681/shanghai-airport-first-launch-automated-clearance-system-using?module=perpetual_scroll&pgtype=article&campaign=2168681

Computer vision examples

3. Facial recognition

Alibaba launches ‘smile to pay’ facial recognition system at KFC in China



An Alibaba employee demonstrates 'Smile to Pay', an automatic payment system that authorize payment via facial recognition

Alex Wong / Staff / Getty Images



Computer vision examples

4. Healthcare

Since 90 percent of all medical data is image based there is a plethora of uses for computer vision in medicine. From enabling new medical diagnostic methods to analyze X-rays, mammography and other scans to monitoring patients to identify problems earlier and assist with surgery, expect that our medical institutions and professionals and patients will benefit from computer vision today and even more in the future as its rolled out in healthcare.



Computer vision examples

4. Healthcare



assisted living, patient monitoring
[Lan et al, PAMI 2012]



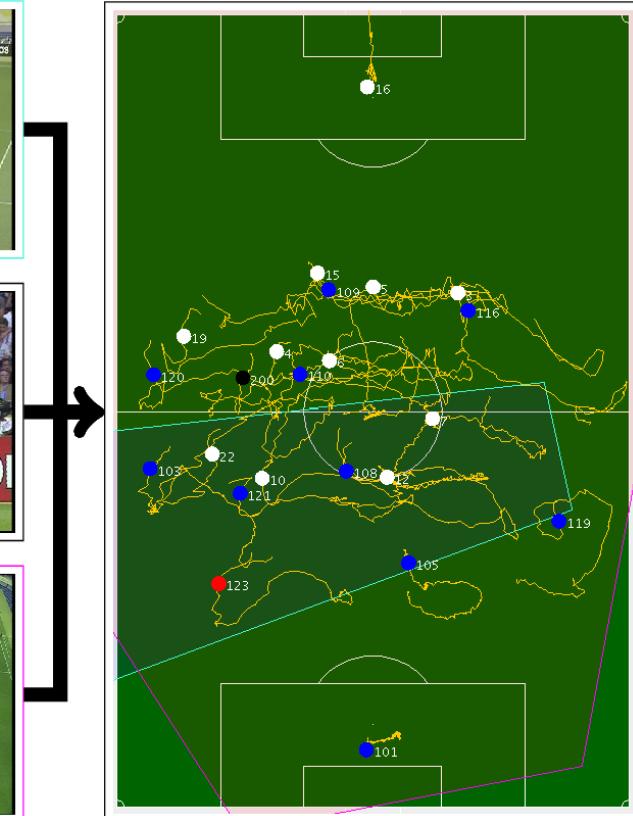
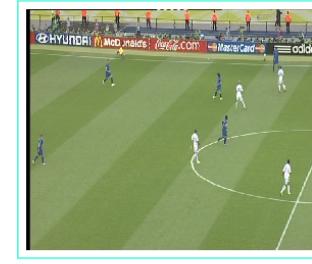
autism screening (sàng lọc tự kỷ)

<http://www.gatech.edu/newsroom/release.html?nid=60509>

Computer vision examples

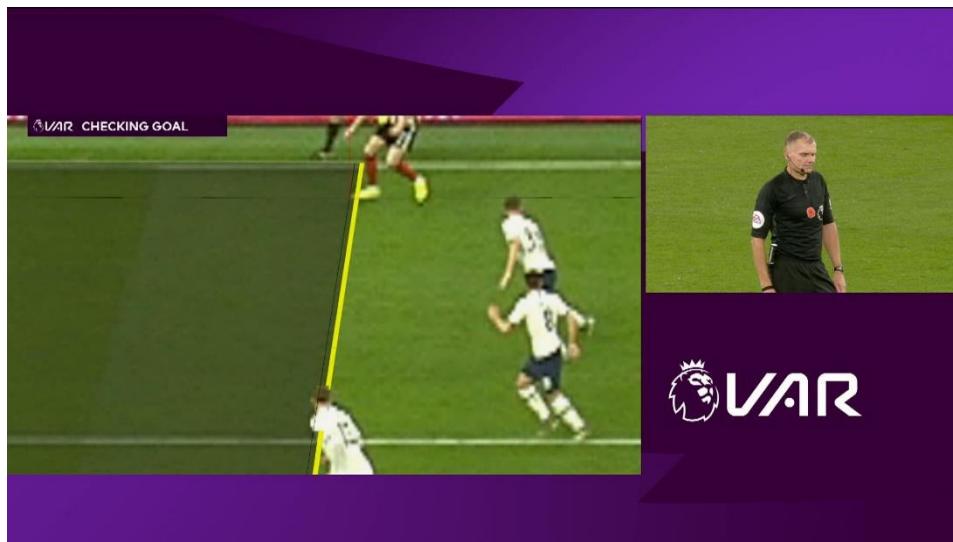
5. Real-time sports tracking

Ball and puck tracking on televised sports has been common for a while now, but computer vision is also helping play and strategy analysis, player performance and ratings, as well as to track the brand sponsorship visibility in [sports broadcasts](#).



Computer vision examples

5. Real-time sports tracking



<https://www.skysports.com/football/news/11095/11928910/var-premier-league-clubs-call-for-change-in-marginal-offside-calls>

Computer vision examples

6. Agriculture

At [CES 2019](#), John Deere featured a semi-autonomous combine harvester that uses artificial intelligence and computer vision to analyze grain quality as it gets harvested and to find the optimal route through the crops.

There's also great potential for computer vision to identify weeds so that herbicides can be sprayed directly on them instead of on the crops. This is expected to [reduce the amount of herbicides needed by 90 percent](#).



Computer vision examples

6. Agriculture

computer vision in agriculture

X |

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The agricultural industry has witnessed several contributions of computer vision-artificial intelligence (AI) models in areas such as **planting, harvesting**, advanced analysis of weather conditions, weeding and plant health detection and monitoring. Jan 31, 2021



Computer vision examples

computer vision in agriculture - C x +

google.com/search?q=computer+vision+in+agriculture&source=lnms&tbs=isch&sa=X&ved=2ahUKEwjv6-6ewOnyAhXFZSsKHFwDvMQ_AUoAXoECAEQAw&bi...

computer vision in agriculture

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Computer Vision In Agriculture. Humans ...
sushanjha8.medium.com

Croptracker - Computer Vision in Agtech
croptracker.com

Machine Vision Saving Agriculture: One ...
automate.org

Application of Computer Vision in ...
medium.com

5 Top Computer Vision Startups in Agriculture
startus INSIGHTS

Global Startup Heat Map Inside >>

Application of Computer Vision in ...

Driving Agriculture into the Future ...

Machine Vision Applications in ...

62

Computer vision examples

7. Manufacturing

Computer vision is helping manufacturers run more safely, intelligently and effectively in a variety of ways. Predictive maintenance is just one example where equipment is monitored with computer vision to intervene before a breakdown would cause expensive downtime. Packaging and product quality are monitored, and defective products are also reduced with computer vision.

<https://www.devteam.space/blog/10-examples-of-using-machine-vision-in-manufacturing/>

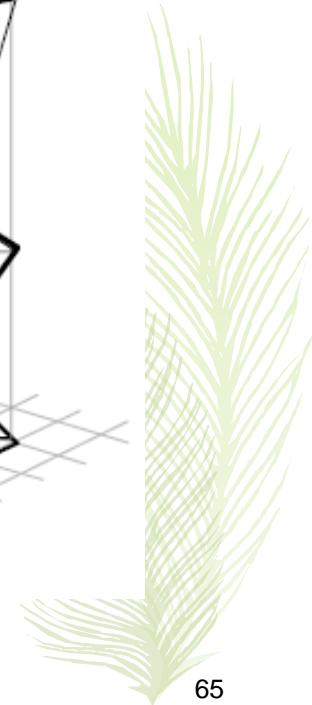
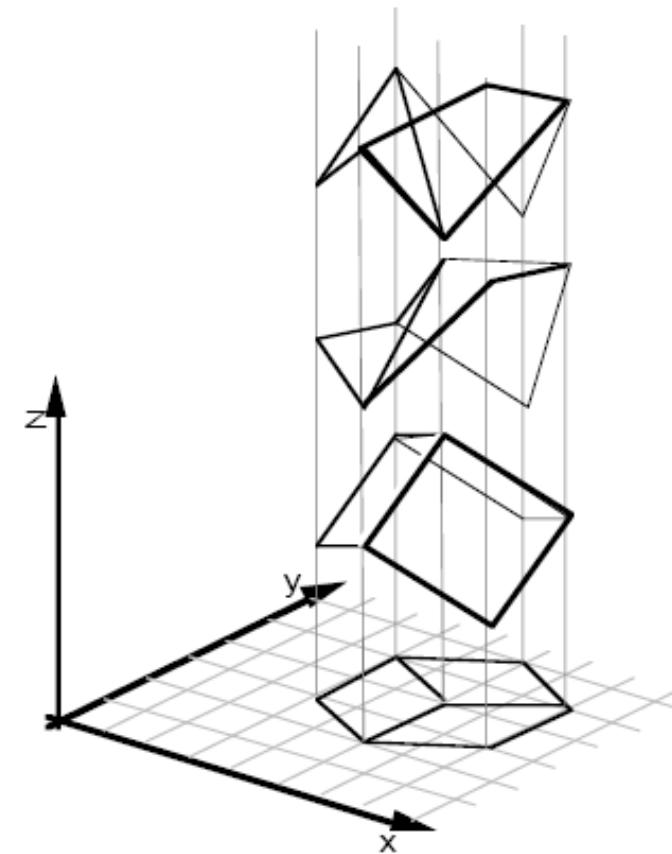


Why vision is so hard?



Why is vision so hard?

- Ill-posed problem



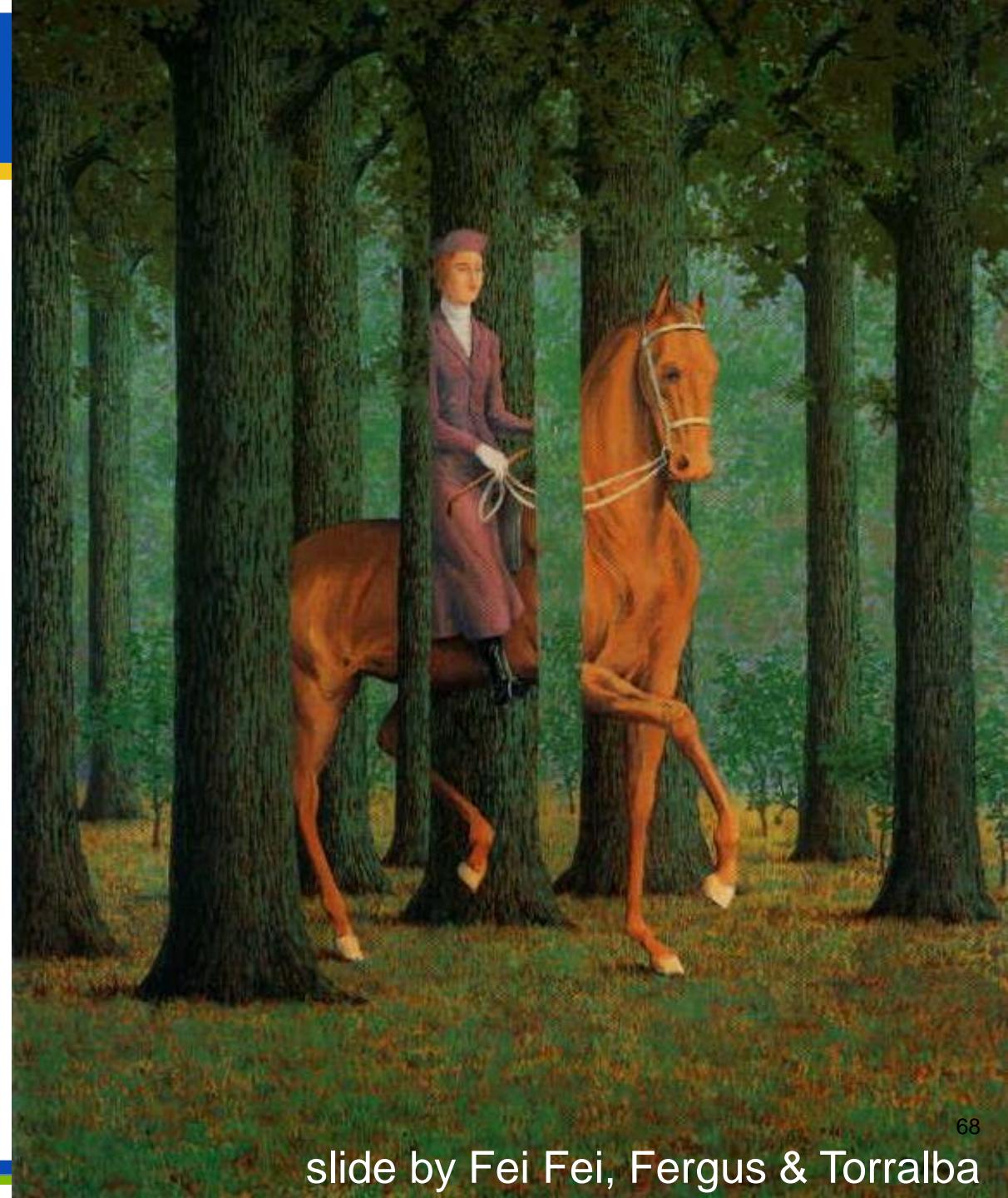
Challenges 1: view point variation



Challenges 2: illumination



Challenges 3: occlusion



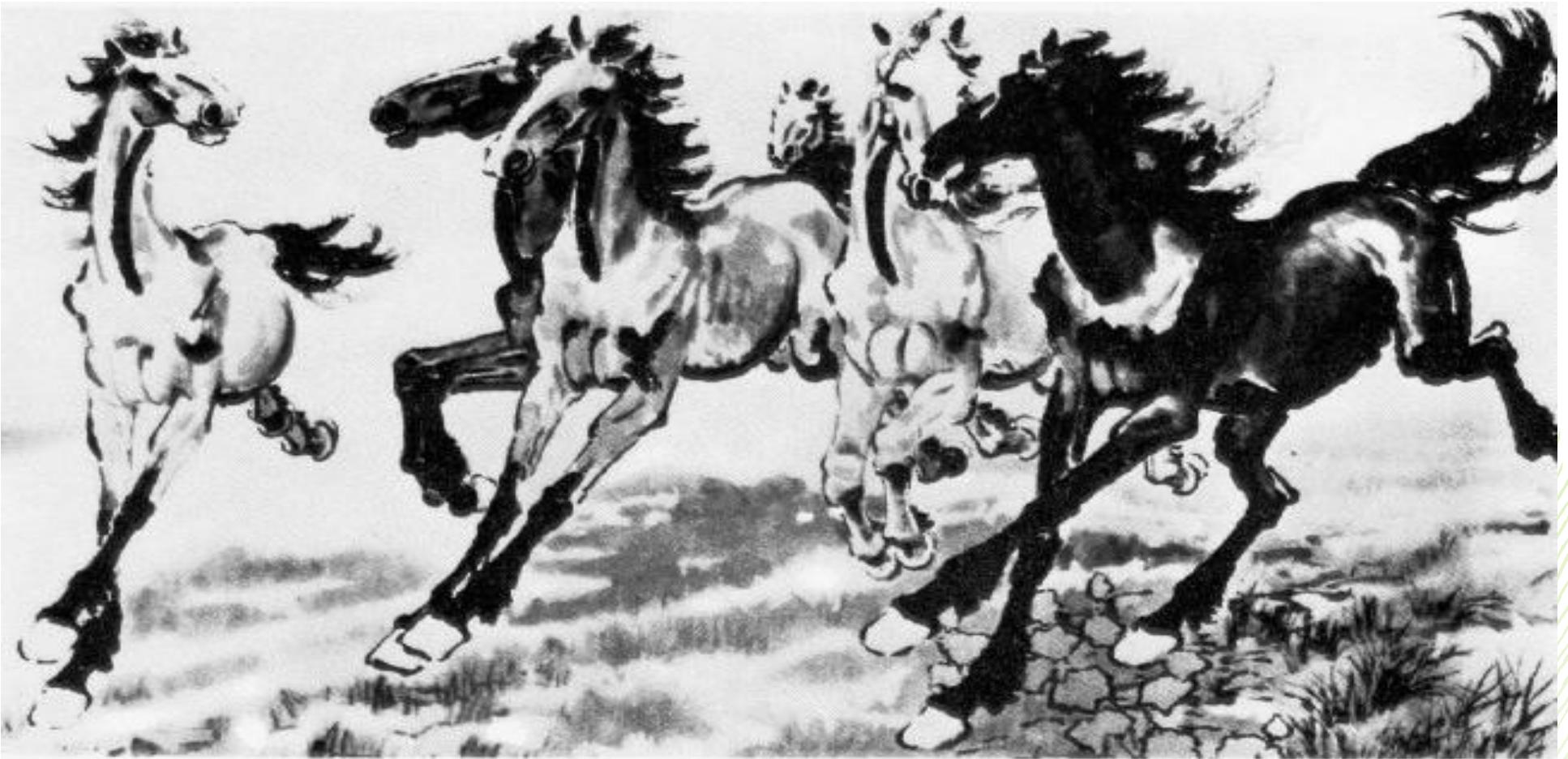
Magritte, 1957

slide by Fei Fei, Fergus & Torralba

Challenges 4: scale

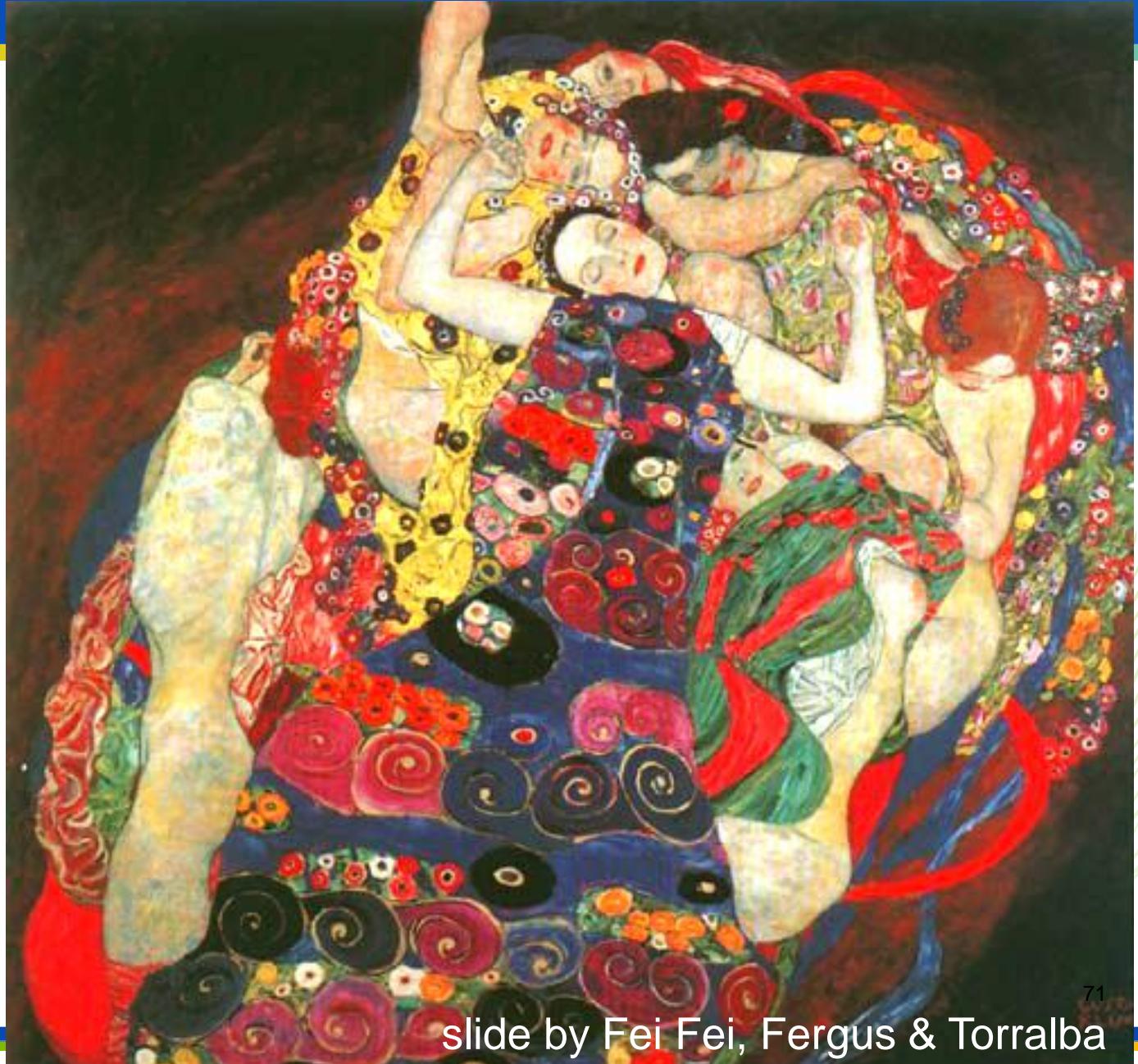


Challenges 5: deformation



70

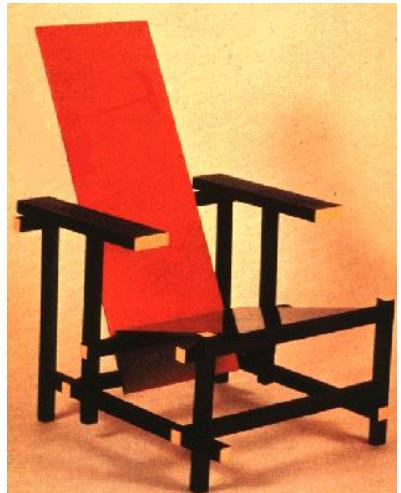
Challenges 6: background clutter



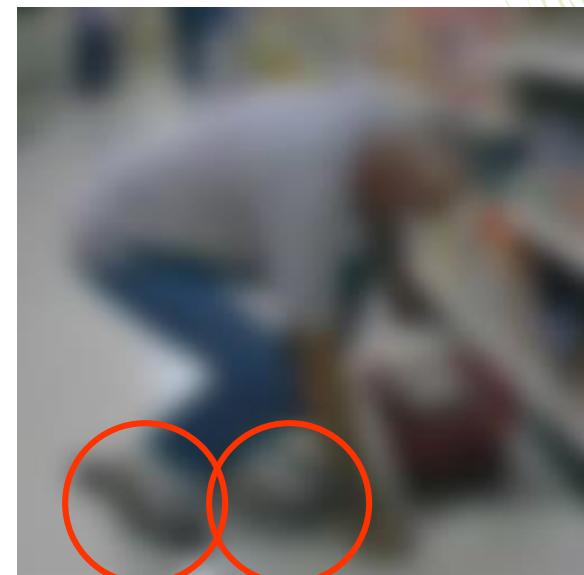
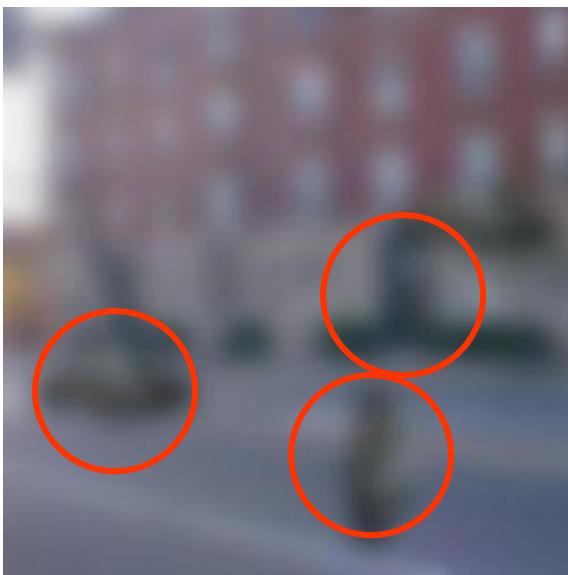
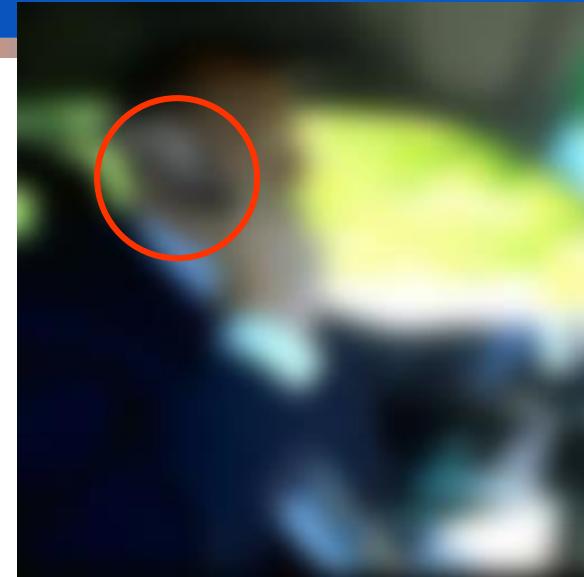
Klimt, 1913

slide by Fei Fei, Fergus & Torralba

Challenges 7: object intra-class variation



Challenges 8: local ambiguity

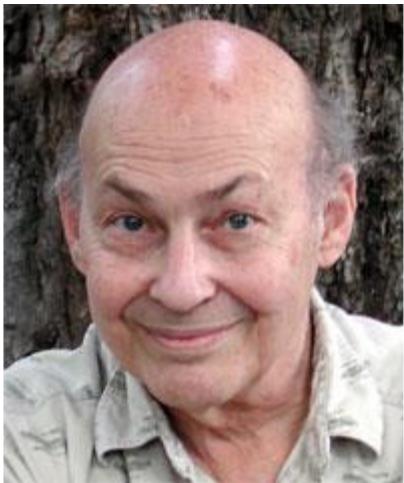


Challenges 9: the world behind the image



How hard is computer vision?





Marvin Minsky, MIT
Turing award, 1969

“In 1966, Minsky hired a first-year undergraduate student and assigned him a problem to solve over the summer: connect a television camera to a computer and get the machine to describe what it sees.”

Crevier 1993, pg. 88



MASSACHUSETTS INSTITUTE OF TECHNOLOGY
PROJECT MAC

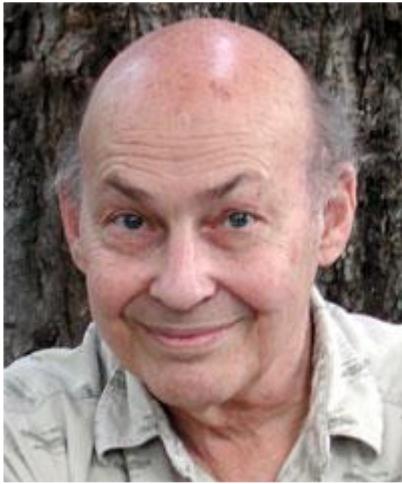
Artificial Intelligence Group
Vision Memo. No. 100.

July 7, 1966

THE SUMMER VISION PROJECT

Seymour Papert

The summer vision project is an attempt to use our summer workers effectively in the construction of a significant part of a visual system. The particular task was chosen partly because it can be segmented into sub-problems which will allow individuals to work independently and yet participate in the construction of a system complex enough to be a real landmark in the development of "pattern recognition".



Marvin Minsky, MIT
Turing award, 1969

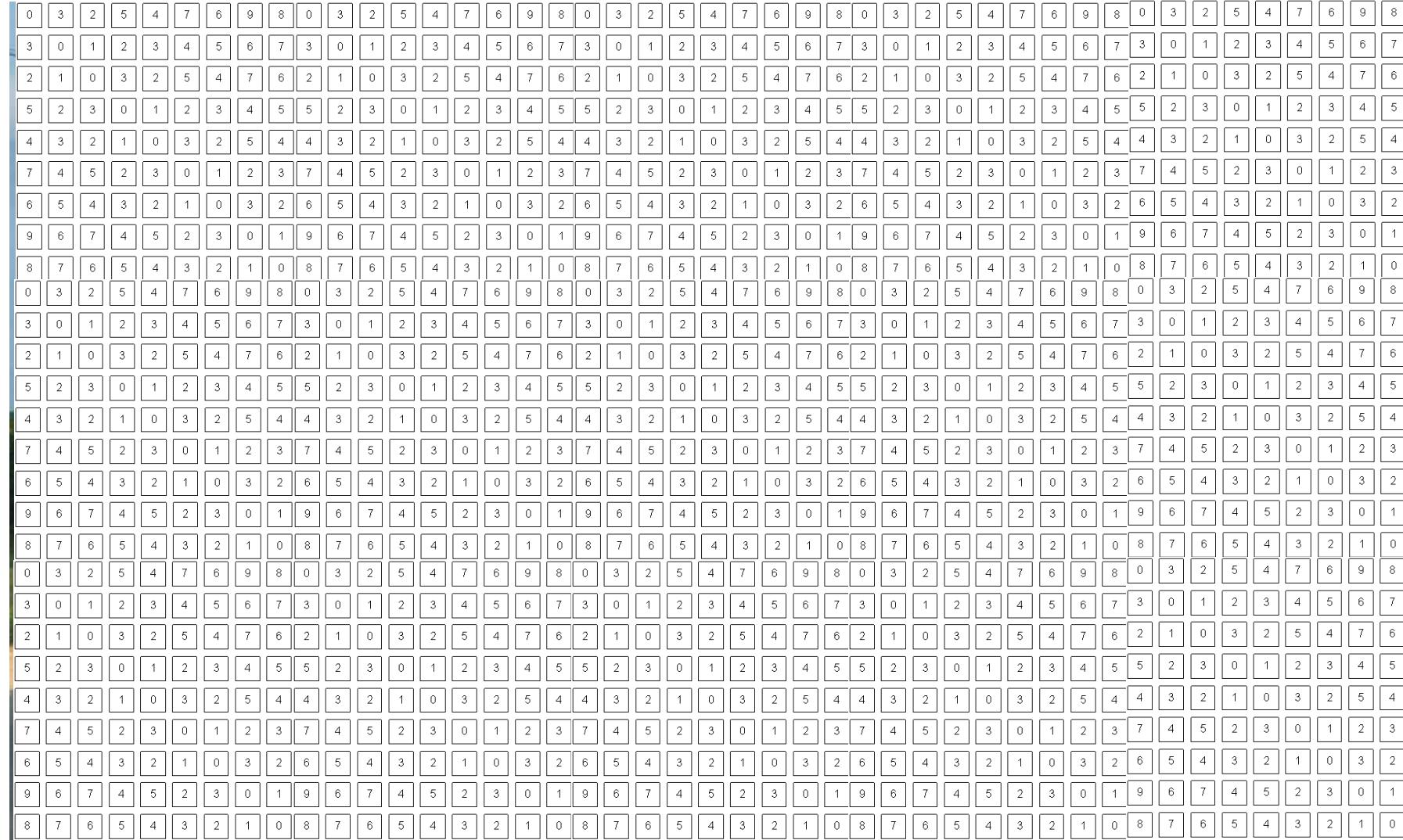


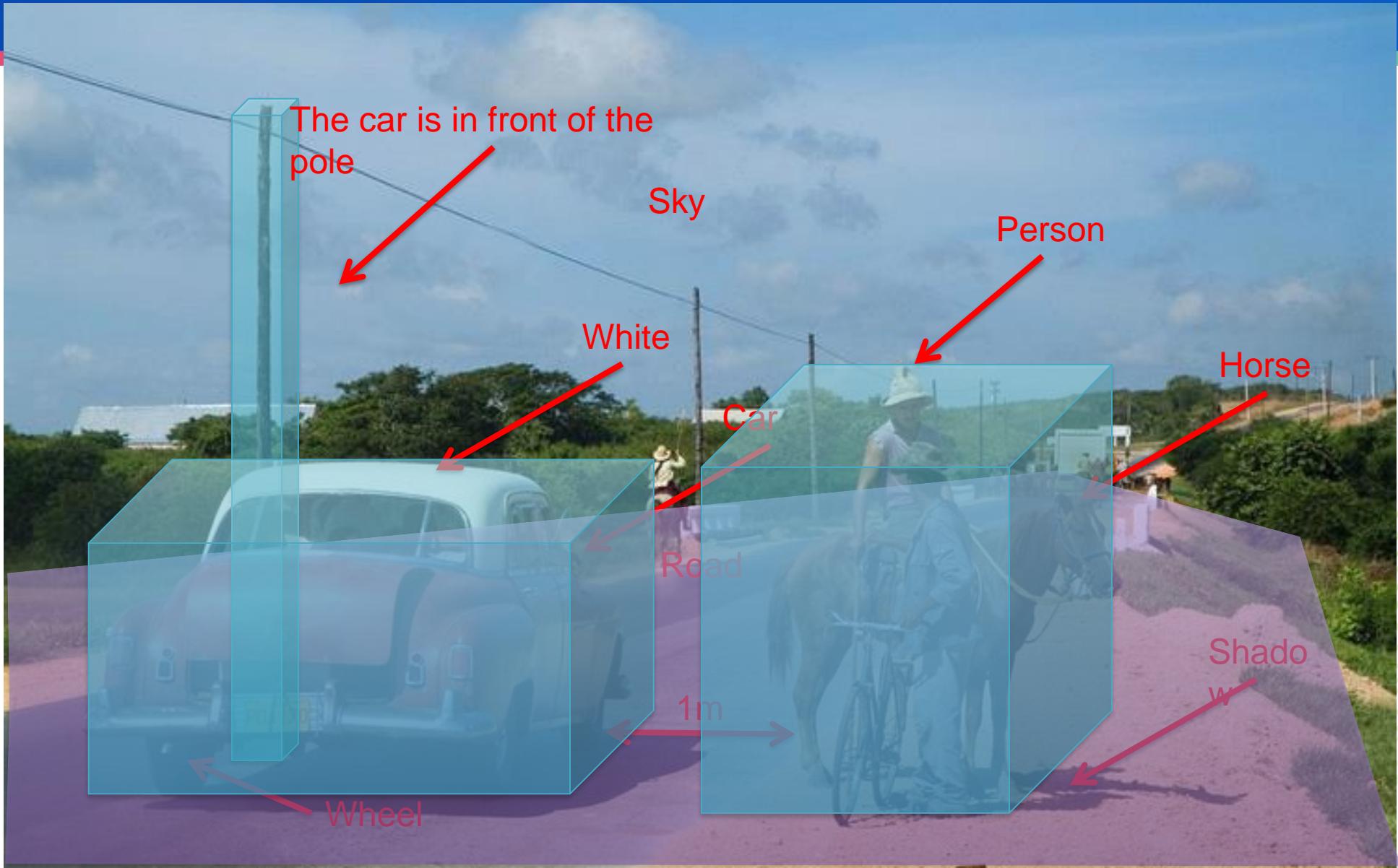
Gerald Sussman, MIT
(the undergraduate)

“You’ll notice that Sussman never worked
in vision again!” – Berthold Horn



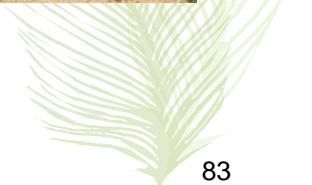






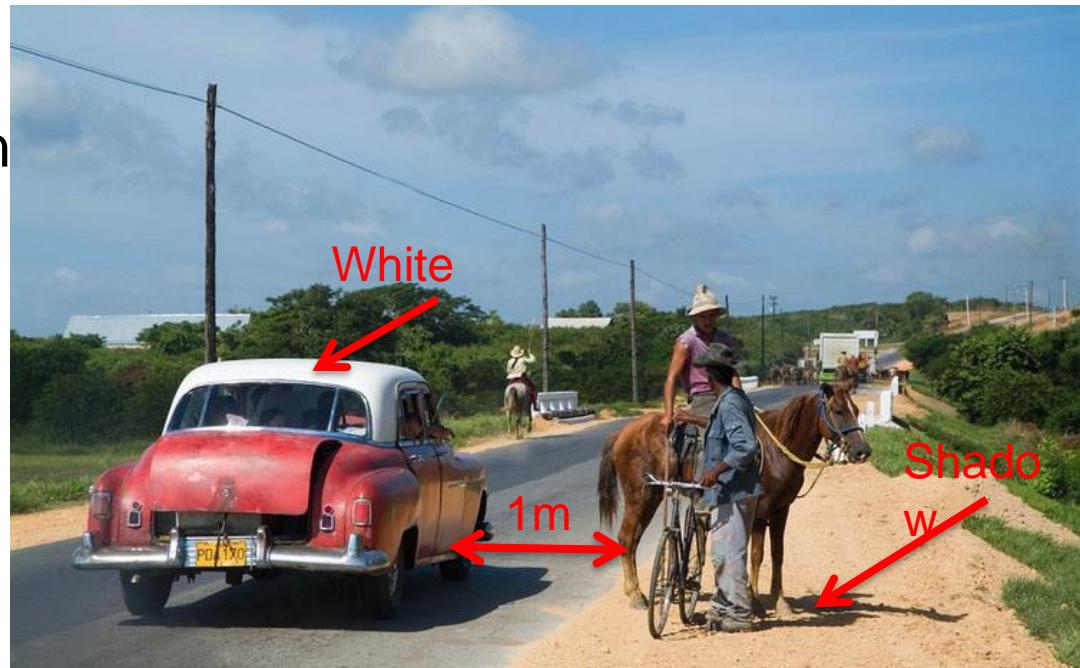
Computer Vision

- Low Level Vision
 - Measurements
 - Enhancements
 - Region segmentation
 - Features
- Mid Level Vision
 - Reconstruction
 - Depth
 - Motion Estimation
- High Level Vision
 - Category detection
 - Activity recognition
 - Deep understandings

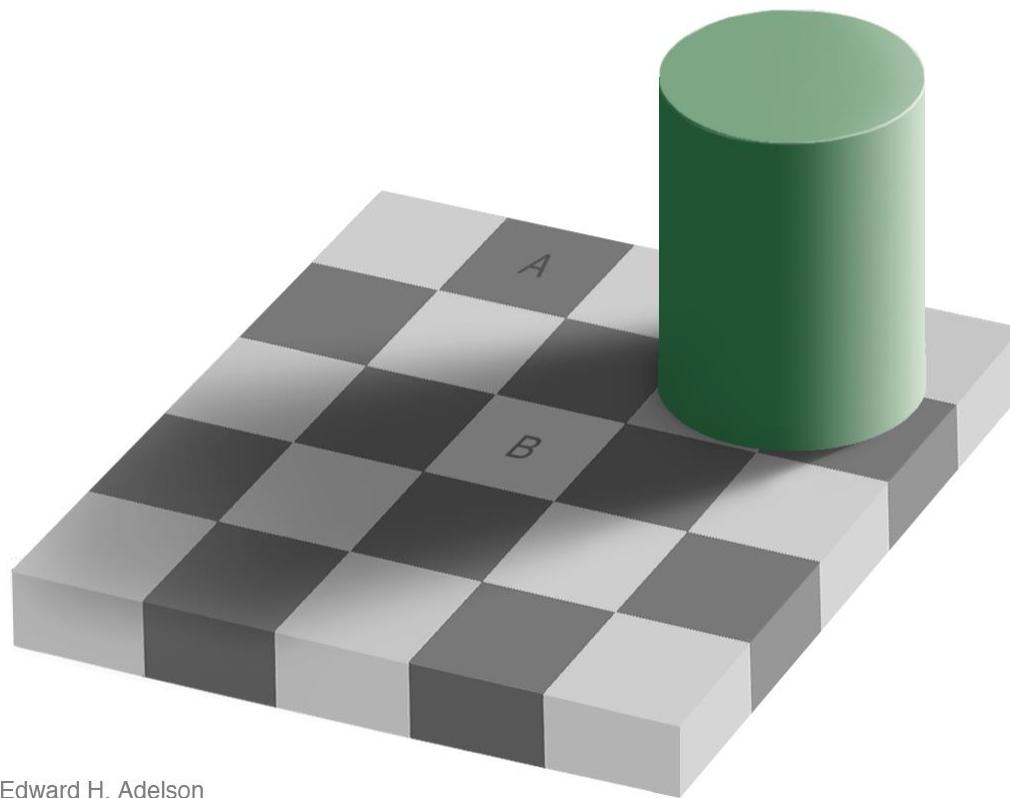


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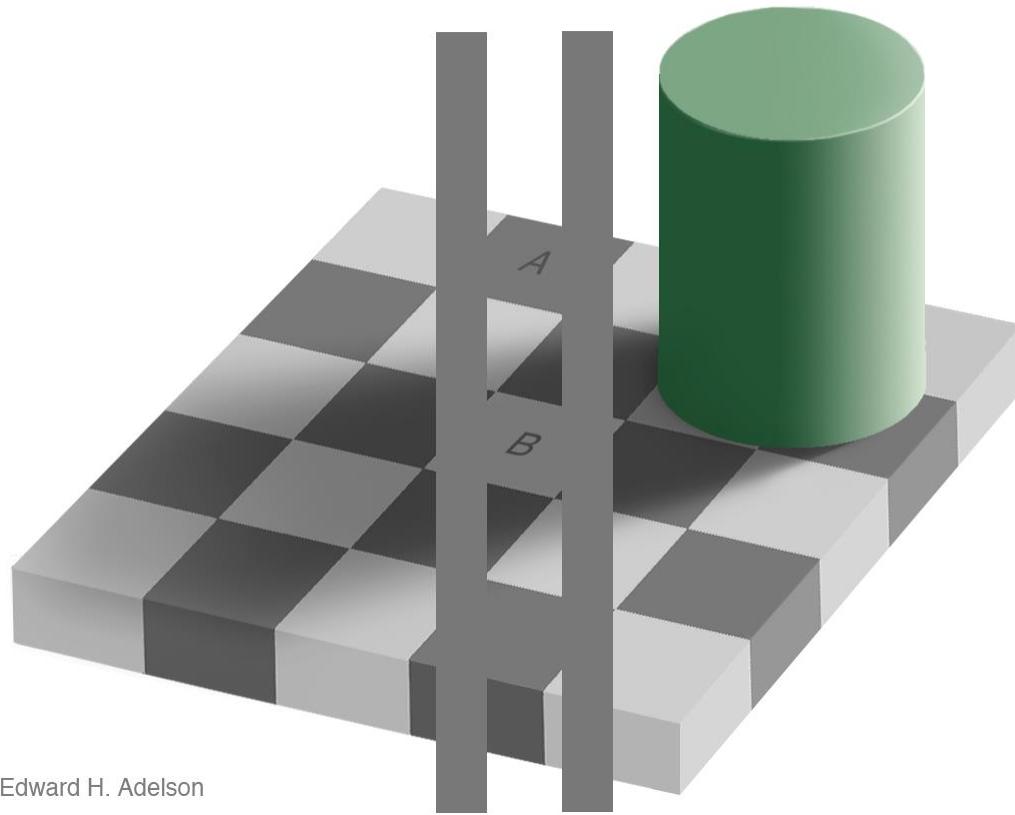
Measurement



Edward H. Adelson



Measurement



Measurement

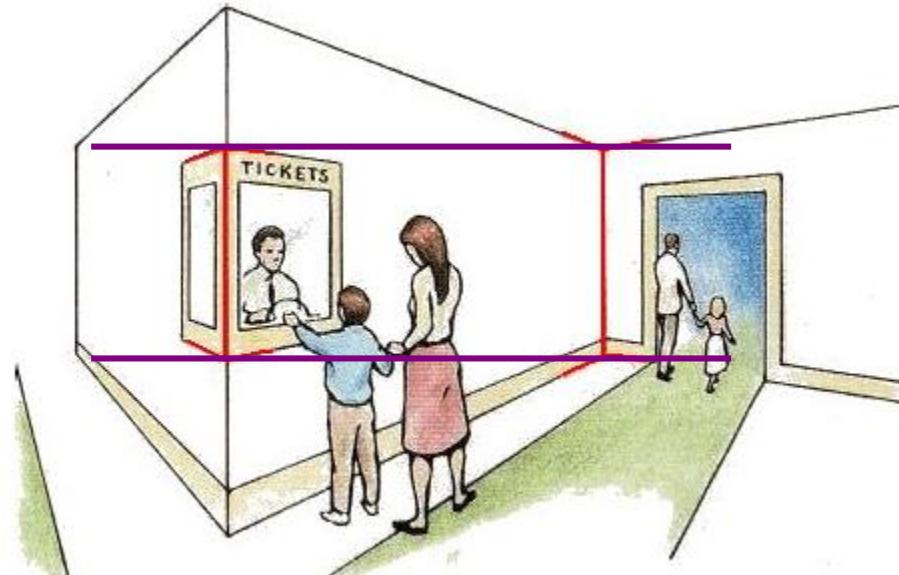


Image Enhancement



<http://www.iua.upf.es/~mbertalmio//restoration.html>



Image Enhancement



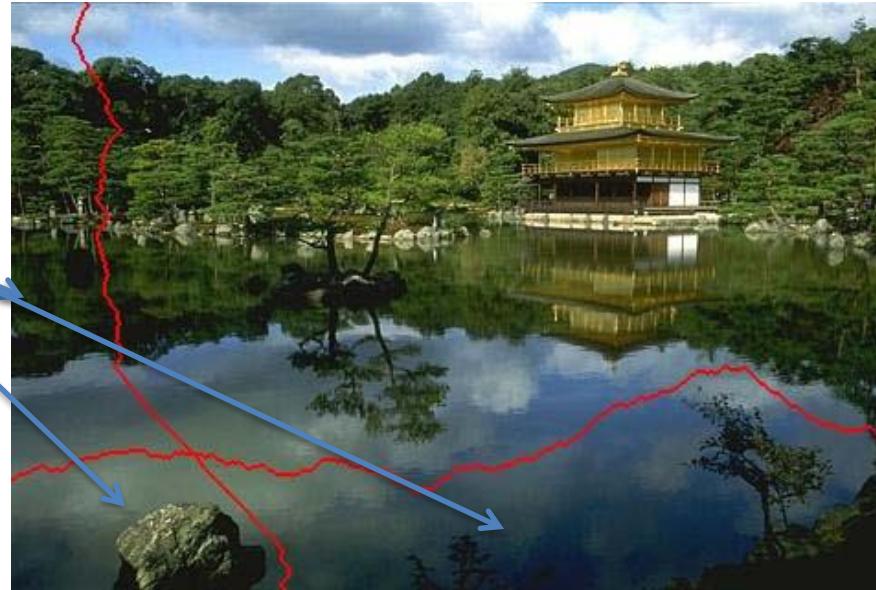
<http://www.iua.upf.es/~mbertalmio//restoration.html>

Image Enhancement



<http://www.iua.upf.es/~mbertalmio//restoration.html>

Seam Carving





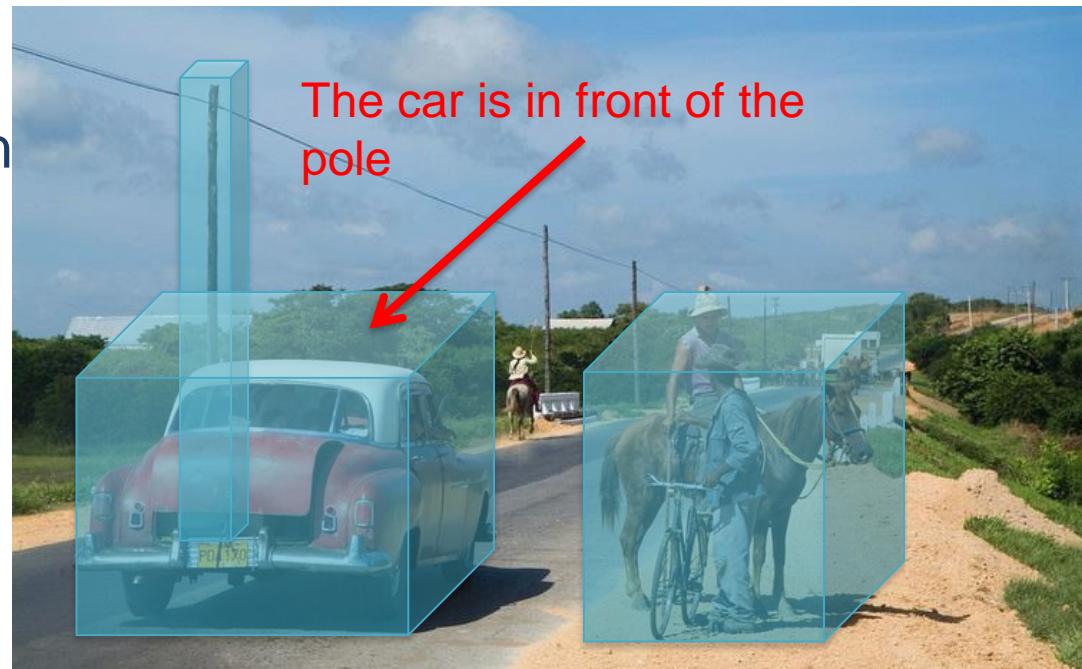
Traditional resizing uses and stretches the whole image.



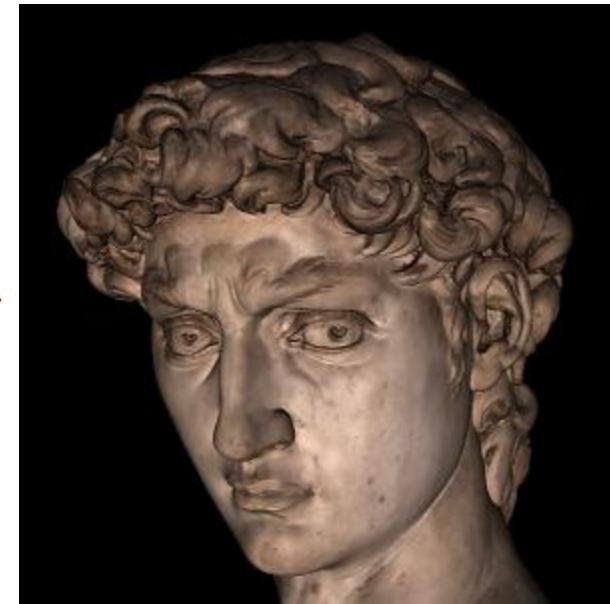
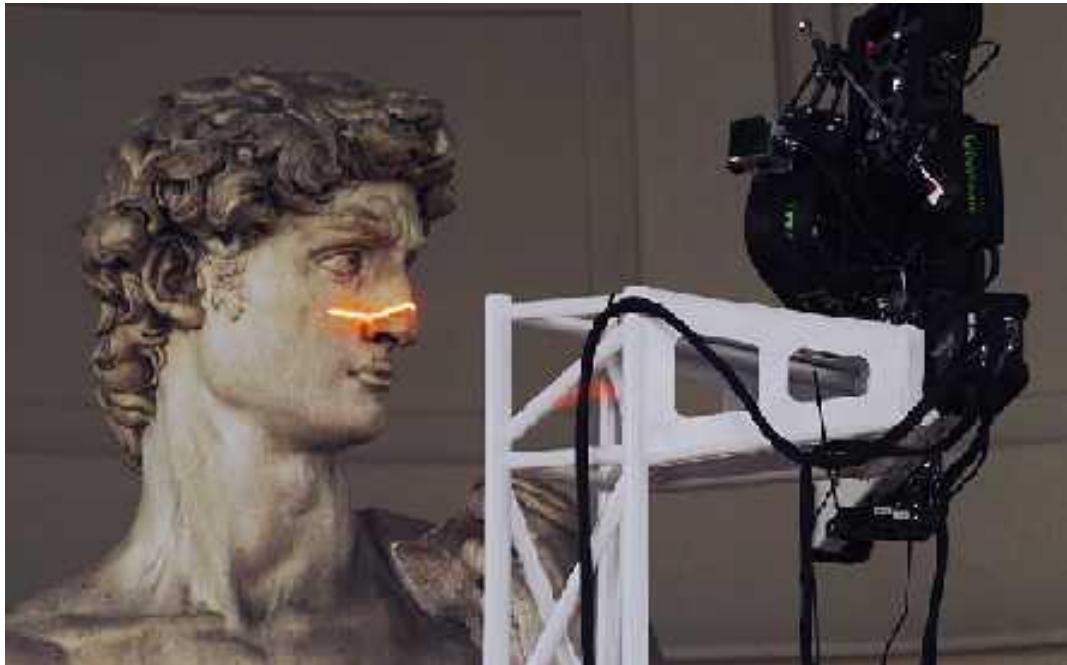
**Content-aware resizing uses important areas.
Extends in horizontal direction and reduces in
vertical.**

Computer Vision

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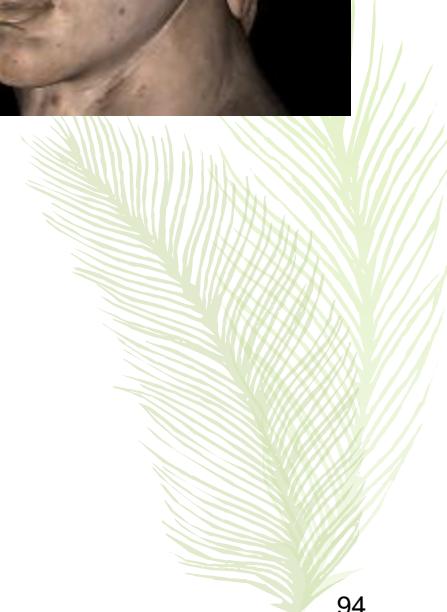


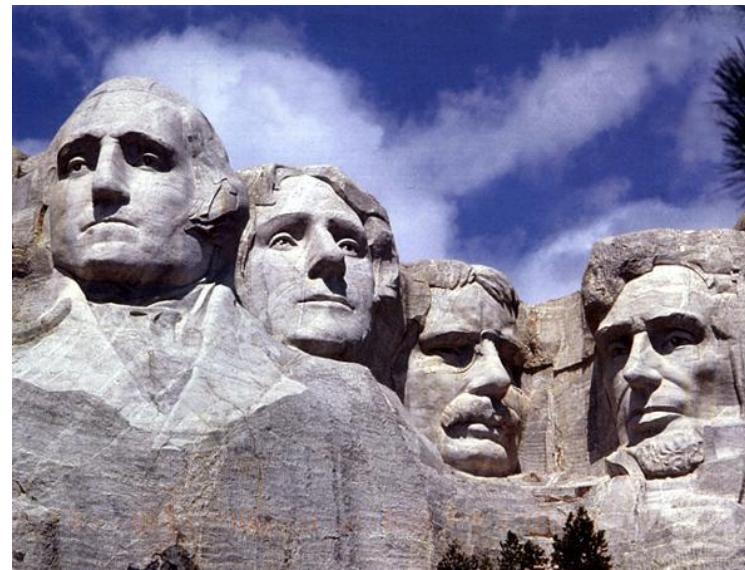
Applications: 3D Scanning



The Digital Michelangelo Project

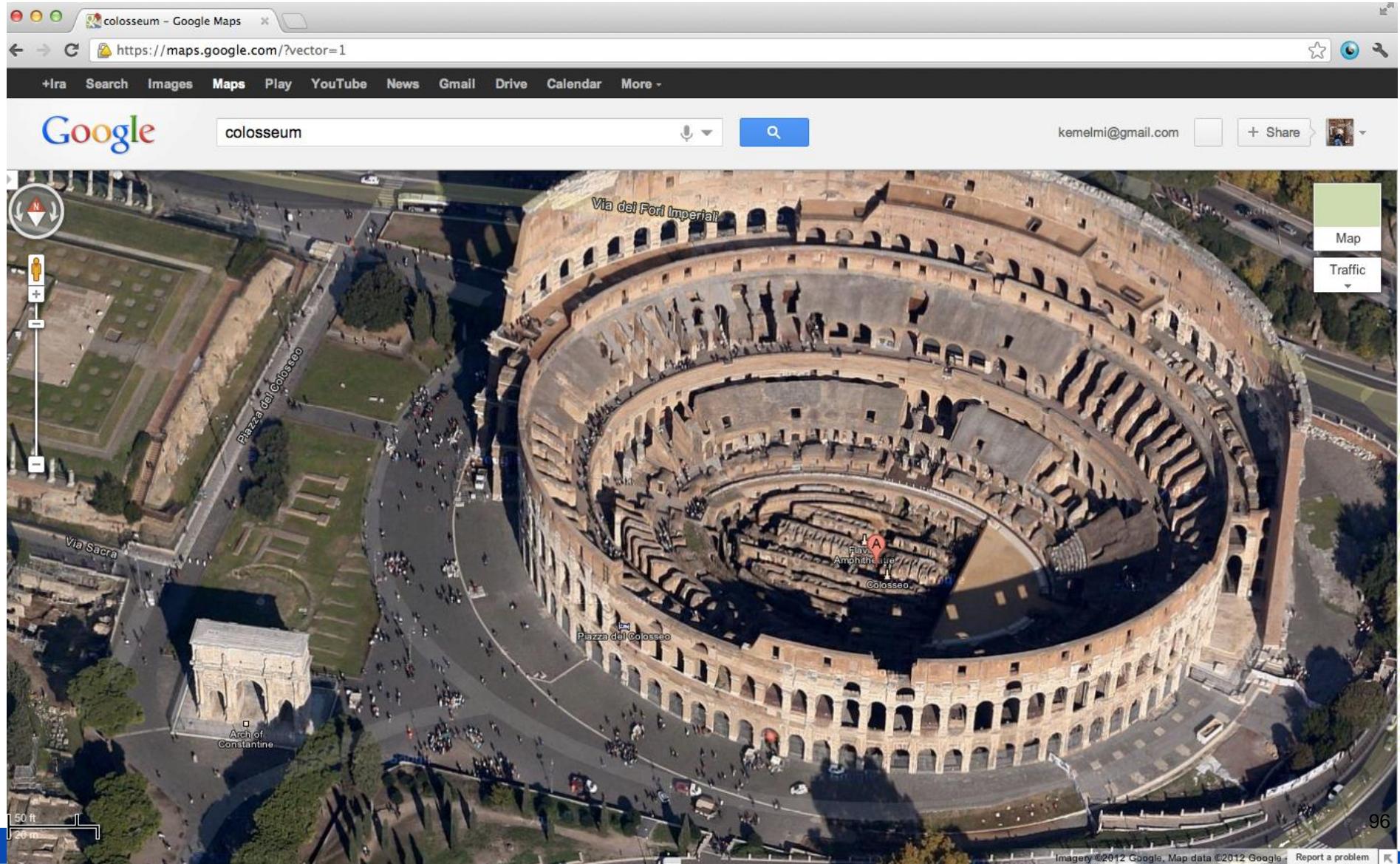
Brian Curless





Google's 3D Maps

Structure estimation from tourist photos



Apple's 3D maps

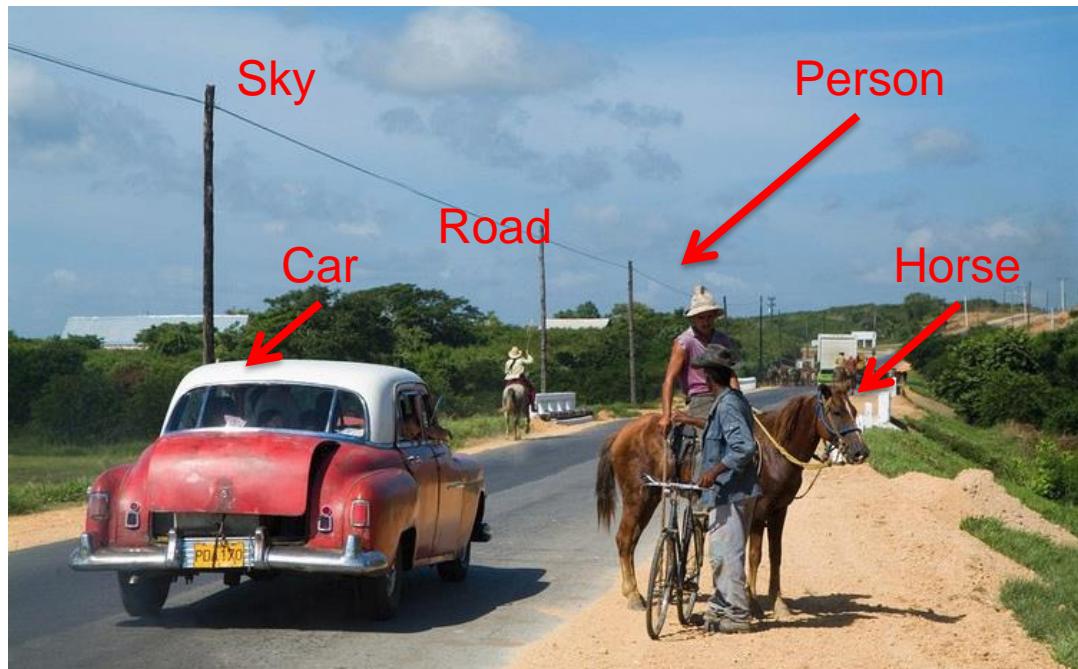


www.youtube.com/watch?v=InIVv-LsgZE



Computer Vision

- Low Level Vision
 - Measurements
 - Enhancements
 - Region segmentation
 - Features
- Mid Level Vision
 - Reconstruction
 - Depth
 - Motion Estimation
- High Level Vision
 - Category detection
 - Activity recognition
 - Deep understandings
 - Pose estimation



Computer vision in other scientific fields

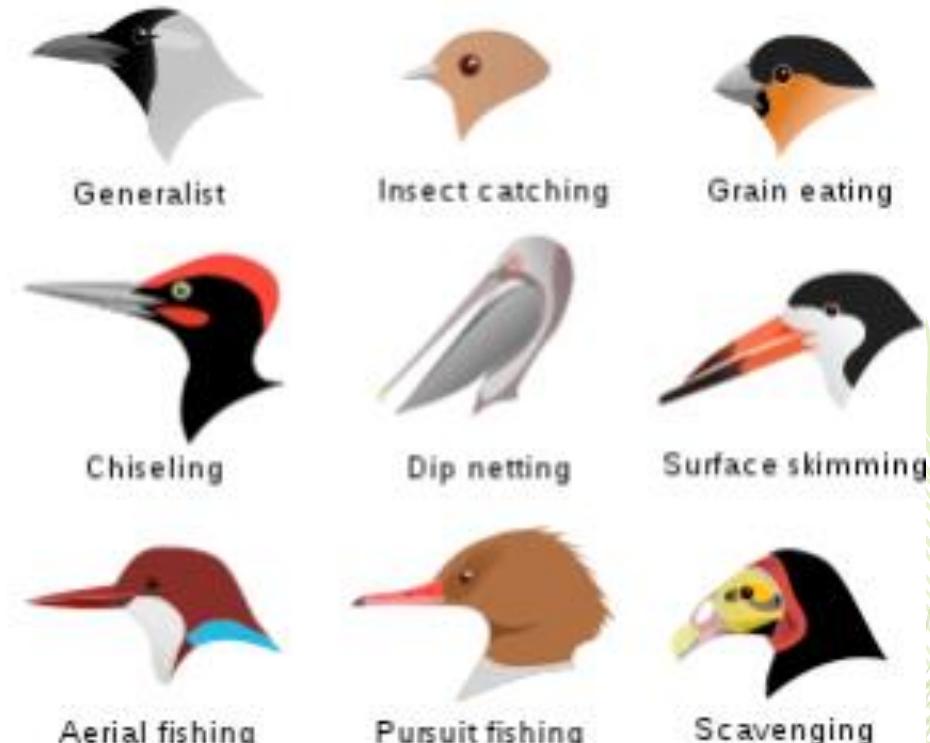


Computer vision research in biology

The screenshot shows a mobile application interface for identifying plants. At the top, there are buttons for 'First', 'Last', and 'Scientific'. Below that is a large letter 'A'. The list contains four entries:

- American Holly (*Ilex opaca*)
- American Linden (*Tilia americana*)
- American Sycamore (*Platanus occidentalis*)
- Amur Corktree (*Phellodendron amurense*)

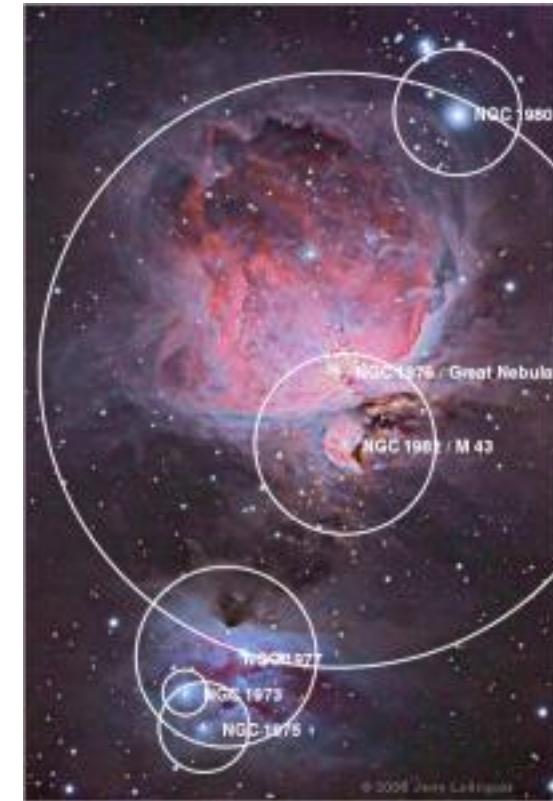
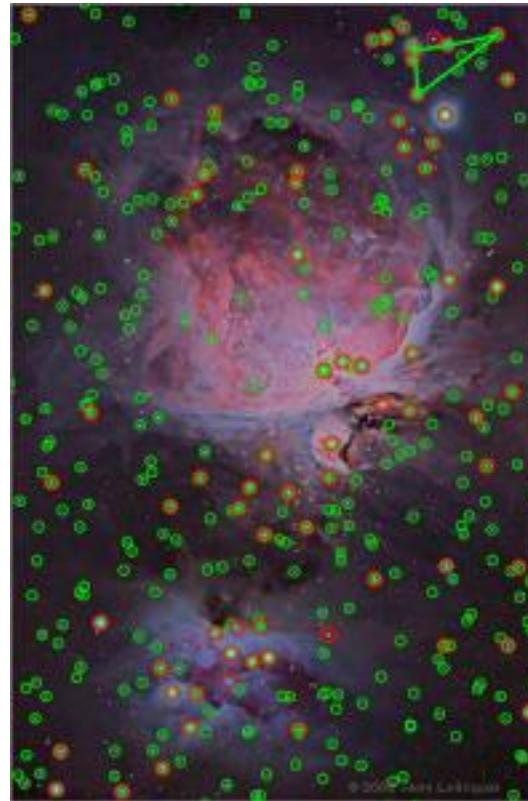
At the bottom are navigation icons for 'Home', 'Browse', 'Collection', 'Options', and 'Snap It!'. A vertical scroll bar is visible on the right side of the list.



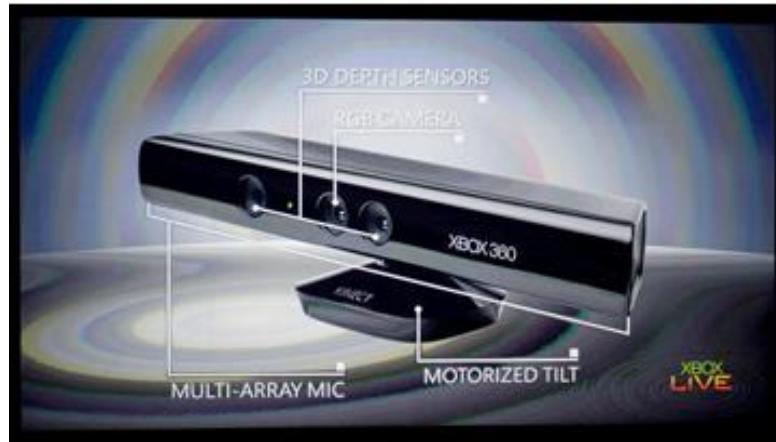
<http://leafsnap.com/>

<http://www.vision.caltech.edu/visipedia/>

Computer vision in cosmology



Vision-based interaction: Xbox Kinect



Mobile visual search: Google Goggles

Google Goggles in Action

Click the icons below to see the different ways Google Goggles can be used.



Object recognition (in supermarkets)



[LaneHawk by EvolutionRobotics](#)



Safety

BBC
NEWS

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Last Updated: Wednesday, 31 August 2005, 05:44 GMT 06:44 UK

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Computer alert for drowning girl

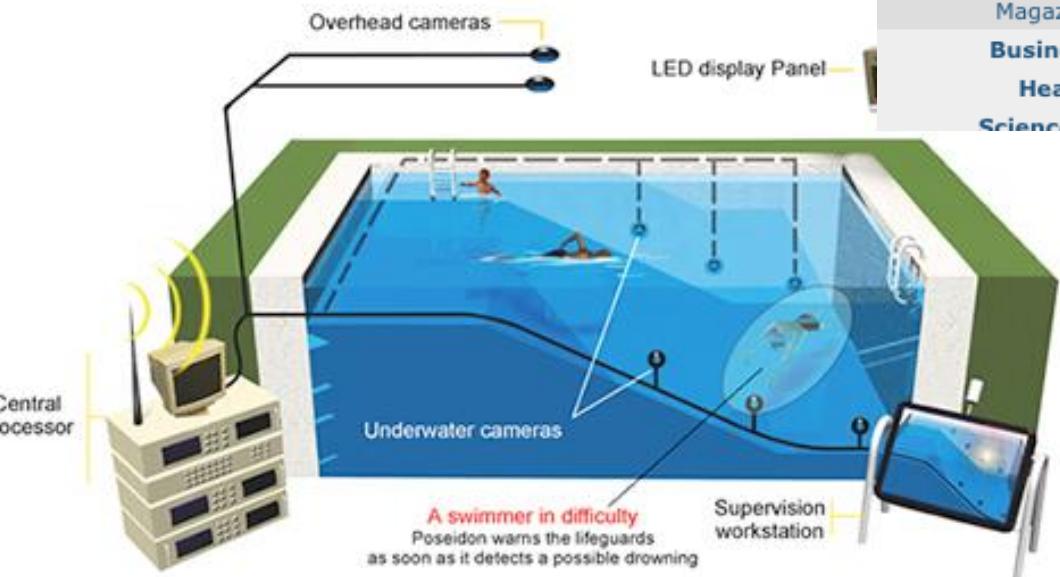
A 10-year-old girl has been saved from drowning by a computer system designed to raise the alarm when swimmers get into difficulties.



[VIDEO Watch the rescue](#)

The girl, from Rochdale, was at the deep end of the pool in Bangor, north Wales, when she sank to the bottom.

The £65,000 system, called Poseidon, detected her on the pool floor and sounded the alarm. A lifeguard pulled her out and she recovered in hospital.



Security

Local 

Cameras help confirm Scott suicide ruling

Friday, December 04, 2009



Block...

MICHAEL SCOTT

5:04 26°

abc 7

00:00 / 00:00

EMBED

TAGS: local, paul meincke

Comment Now Email Print Report a typo      



December 4, 2009 (CHICAGO) (WLS) -- Chicago police have closed the case in the death of Chicago School Board President Michael Scott.

Police Supt. Jody Weis says investigators used police cameras in the city to trace Scott's last steps in the hours before his body was found in November.

Scott's death has been ruled a suicide. The medical examiner's office concluded --not long after Scott's body was found -- that he had committed suicide. Police did not dispute the finding but wanted to pursue all the investigative leads they could. They say they have done that and have now reached the same conclusion.

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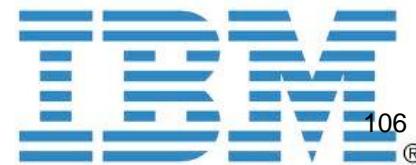
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News Headlines Video

- 2 suspects arrested in volleyball star's murder 47 min ago
- BP Gas Recall: BP finds, fixes source of bad gas
- Teachers union, board resume negotiating
- Back to School
- 5 injured in South Side shooting 49 min ago
- Pastor: Stacy Peterson said she lied for Drew



Automotive safety

The screenshot shows the Mobileye website interface. At the top, there are navigation links for "manufacturer products" and "consumer products". Below this, a main heading reads "Our Vision. Your Safety." with a subtext "A leader in advanced driver assistance systems". A central image shows a car from above with three camera systems highlighted: "rear looking camera", "forward looking camera", and "side looking camera". Below this, there are three product cards:

- EyeQ Vision on a Chip**: Shows a close-up of a chip labeled "EyeQ".
- Vision Applications**: Shows a person walking across a crosswalk with a bounding box around them, with the text "Road, Vehicle, Pedestrian Protection and more".
- AWS Advance Warning System**: Shows a circular display screen with a car icon and the number "0.8".

On the right side, there are two columns: "News" and "Events". The "News" column lists articles like "Mobileye Advanced Technologies Power Volvo Cars World First Collision Warning With Auto Brake System" and "Volvo: New Collision Warning with Auto Brake Helps Prevent Rear-end". The "Events" column lists "Mobileye at Equip Auto, Paris, France" and "Mobileye at SEMA, Las Vegas, NV".

- Mobileye: Vision systems in high-end BMW, GM, Volvo models
 - Pedestrian collision warning
 - Forward collision warning
 - Lane departure warning
 - Headway monitoring and warning

Google cars

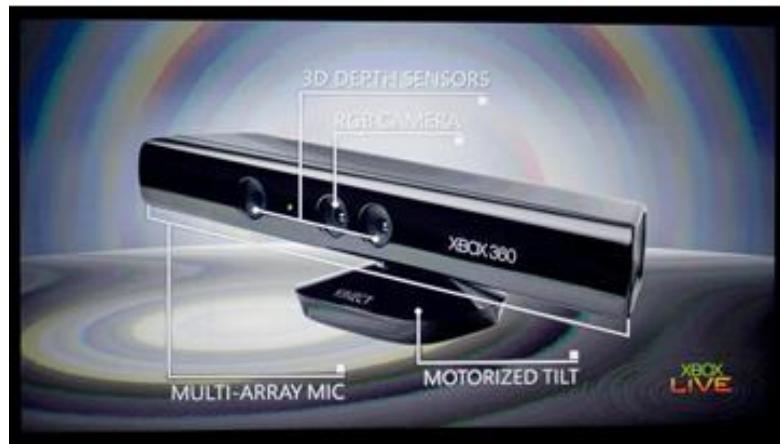


"Google Cars Drive Themselves, in Traffic" *The New York Times* John

"Nevada state law paves the way for driverless cars" *Financial Post*

"Human error blamed after Google's driverless car sparks five-vehicle crash". *The Star*

Vision-based interaction: Xbox Kinect

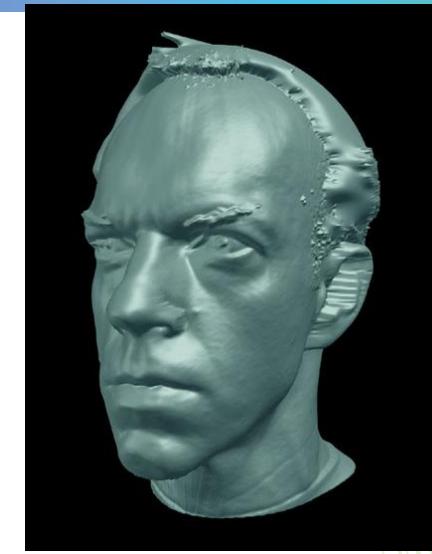


Augmented reality, consumer products



110

Special effects: shape and motion capture

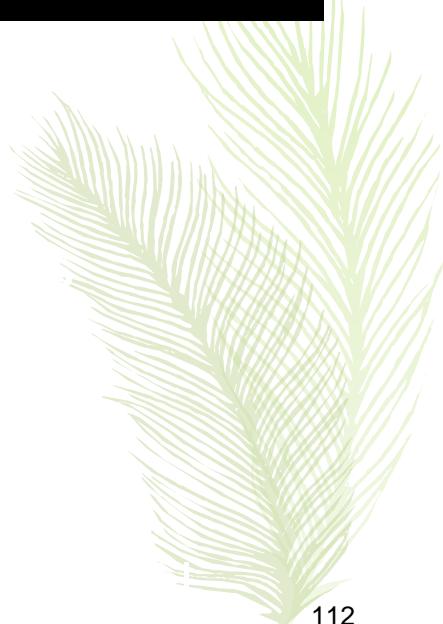


Vision for robotics, space exploration



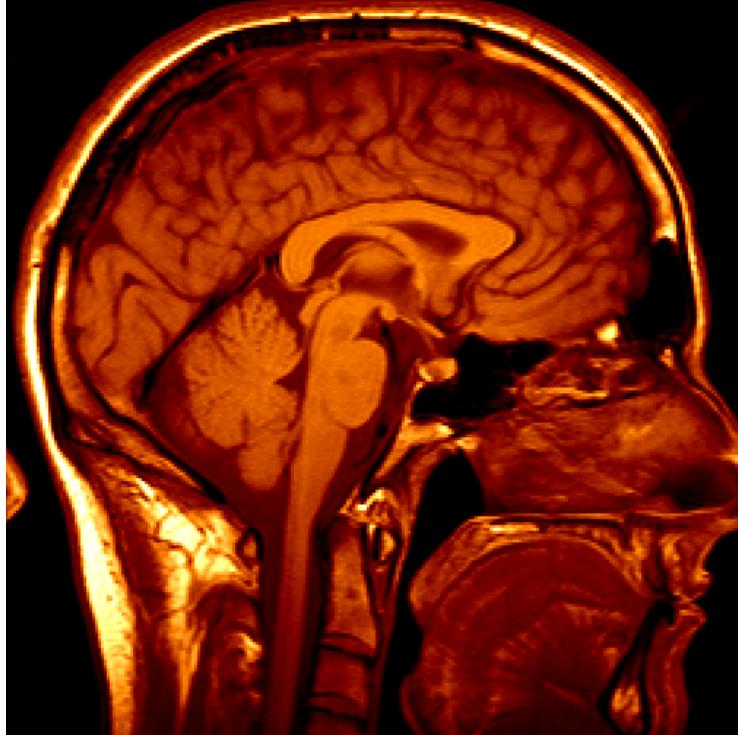
NASA'S Mars Exploration Rover Spirit

Computer Vision on Mars



112

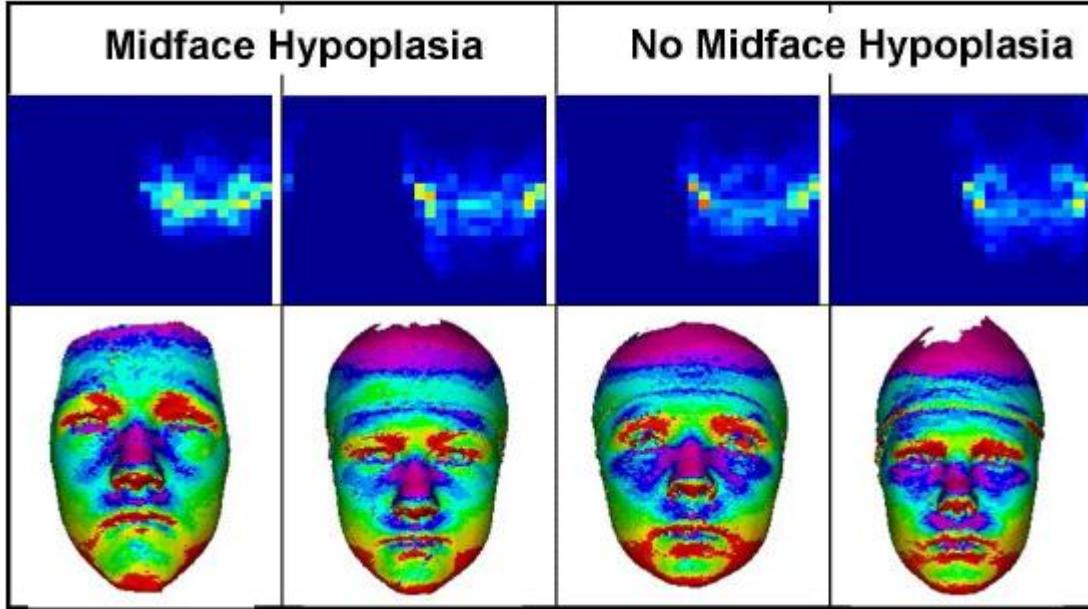
Medical imaging



[Grimson et al., MIT](#)



Classification of 22q11.2DS



- Treat 2D azimuth-elevation angle histogram as feature vector



	8×8	16×16	24×24	32 × 32	Experts' median
Whole 2D hist	0.651	0.569	0.79	0.684	0.68