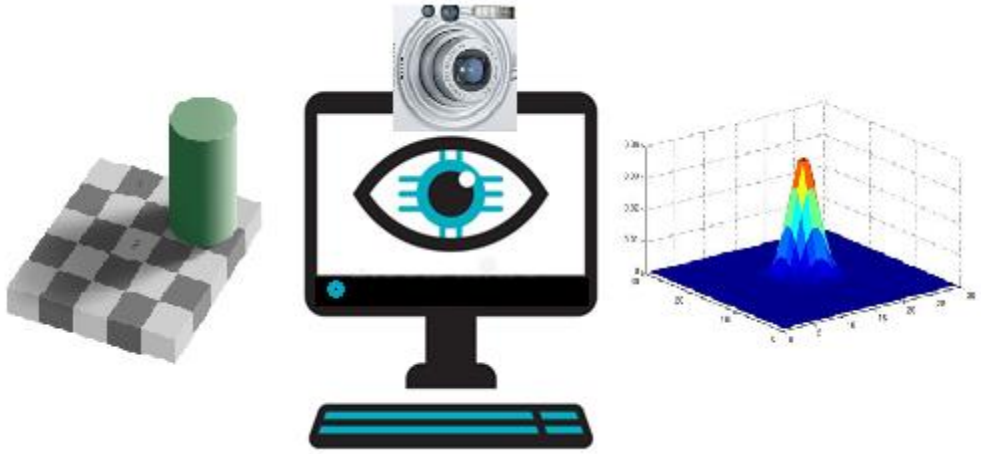
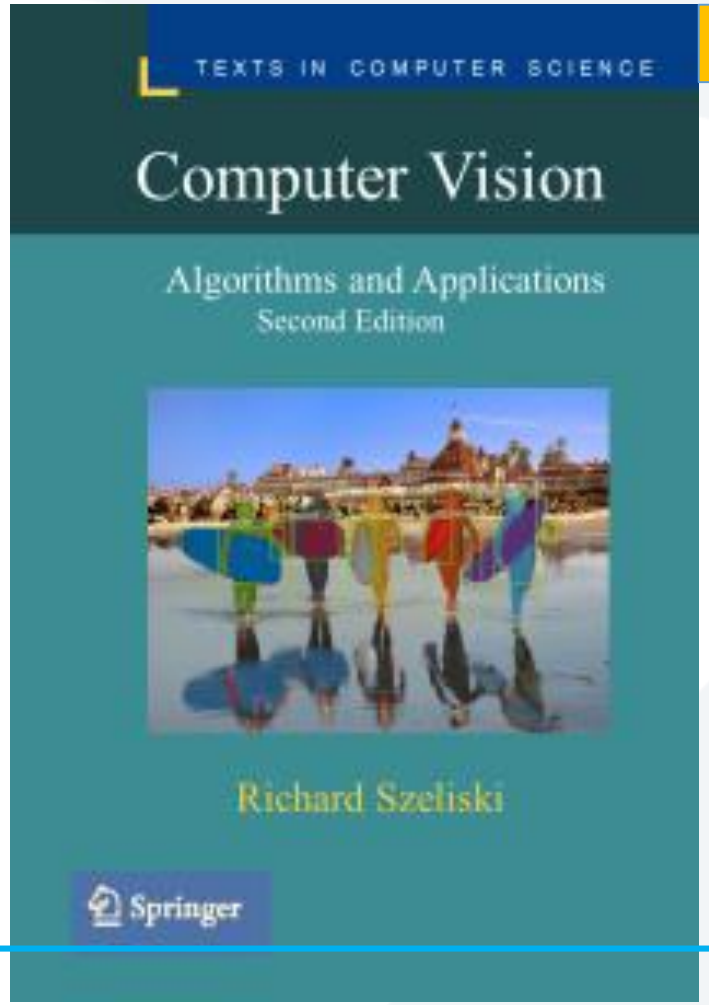


Computer Vision
Lecture1
Introduction to computer vision

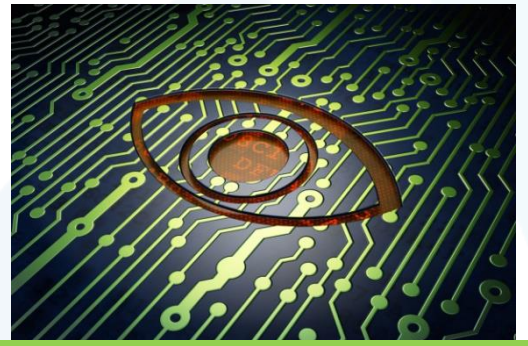
Dr. Ali Mahmoud Mayya
Computer Science Dept.
AL Manara University, Syria
2024

References Text Book and E-Cites

- Computer Vision: Algorithms and Applications, by Rick Szeliski



http://szeliski.org/Book/



CS 376: Texas University Computer Vision Spring 2018

http://vision.cs.utexas.edu/376-spring2018/

Syllabus المفردات

I. Features and filters: low-level vision

Linear filters
Edges and contours
Binary image analysis
Background subtraction
Texture
Motion and optical flow

II. Grouping and fitting: mid-level vision

Segmentation and clustering algorithms
Hough transform
Fitting lines and curves
Robust fitting, RANSAC
Deformable contours
Interactive segmentation

III. Multiple views

Local invariant feature detection and description
Image transformations and alignment
Planar homography
Epipolar geometry and stereo
Object instance recognition

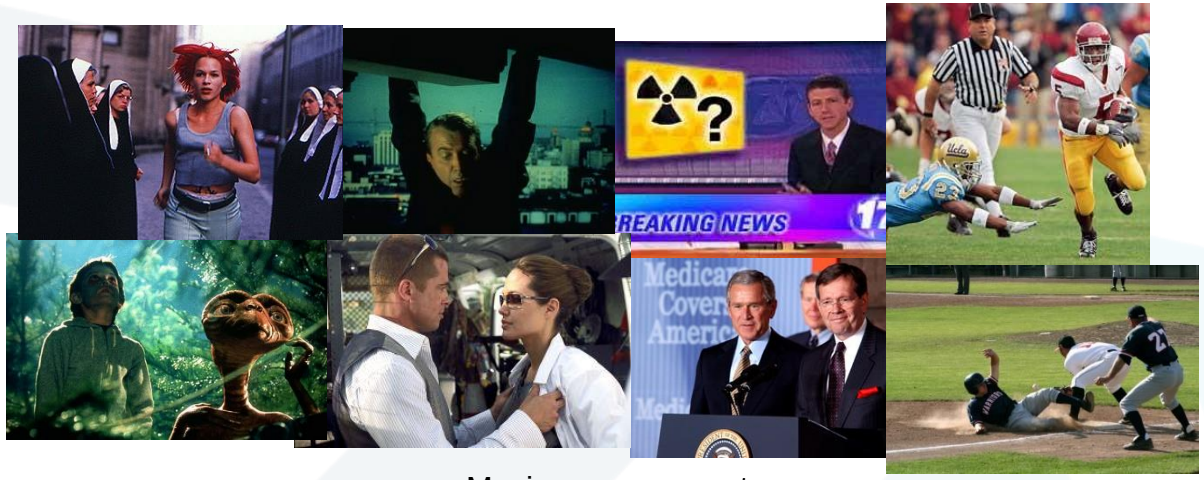
IV. Recognition: high-level vision

Object/scene/activity categorization
Object detection
Supervised classification algorithms
Probabilistic models for sequence data
Visual attributes
Active learning
Dimensionality reduction
Non-parametric methods and big data
Deep learning, convolutional neural networks
Other advanced topics as time permits

Why is the study of computer vision?

- Images and videos are every where !الصور والفيديو في كل مكان

Personal photos

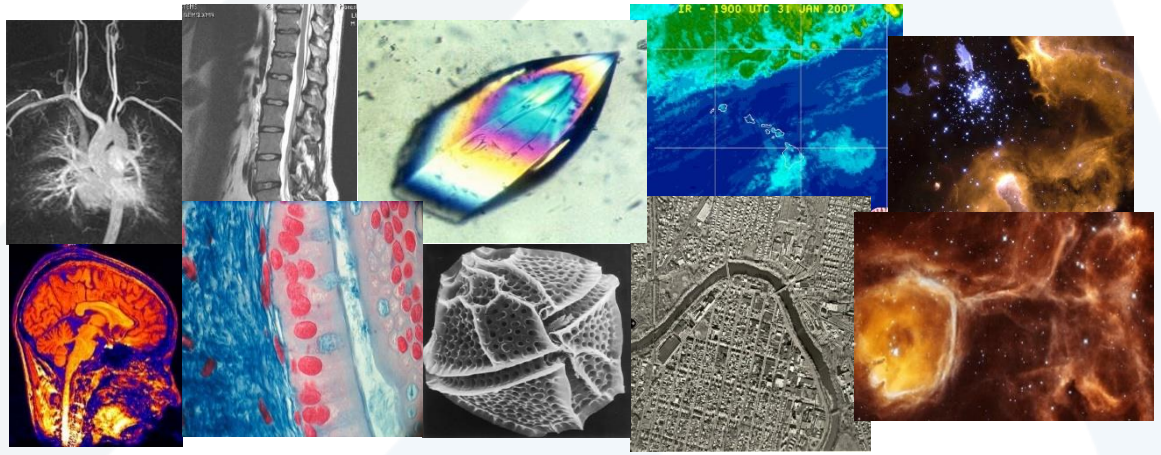


Movies, news, sports

Google Image Search

flickr

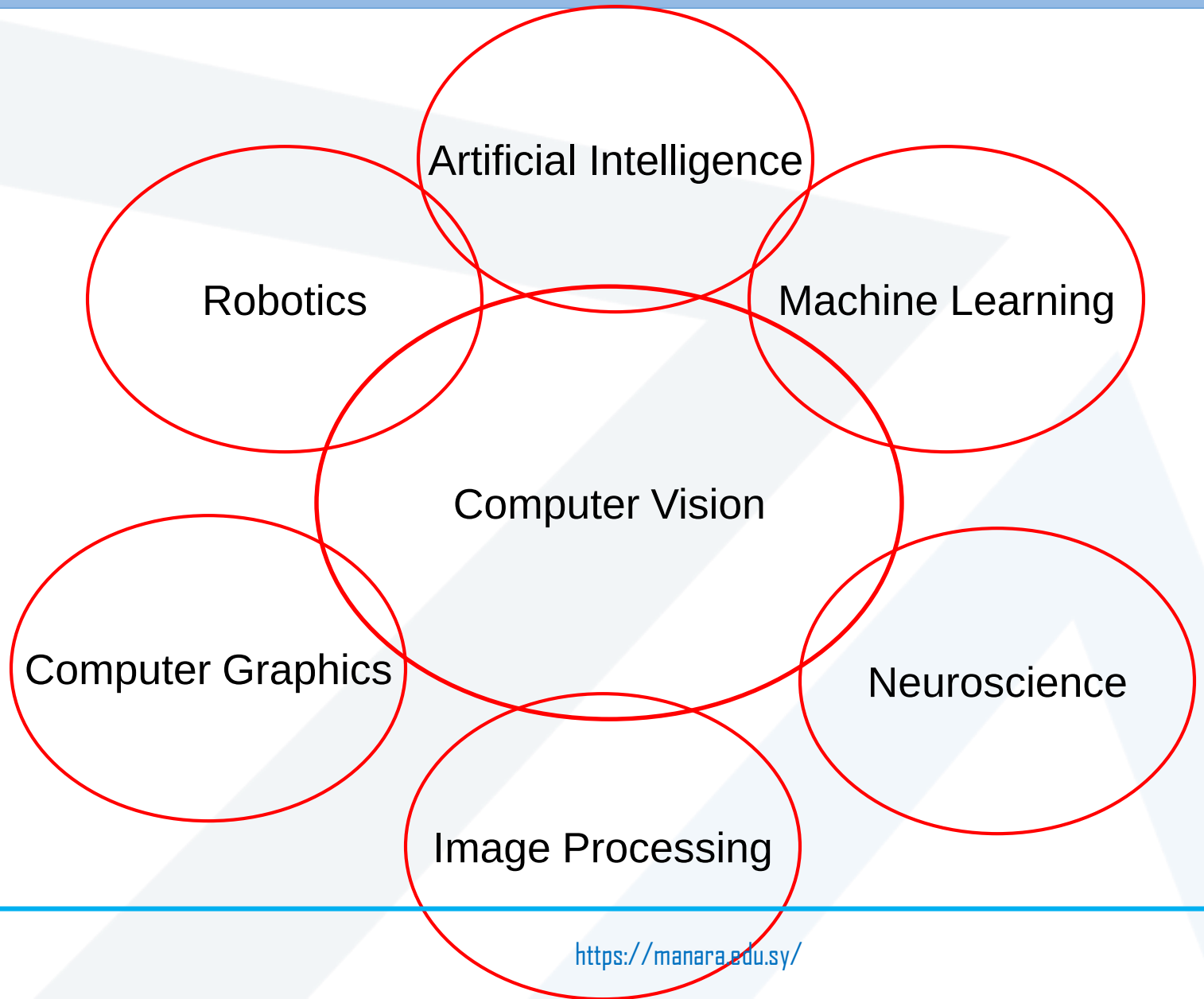
Surveillance and security



Medical and scientific images

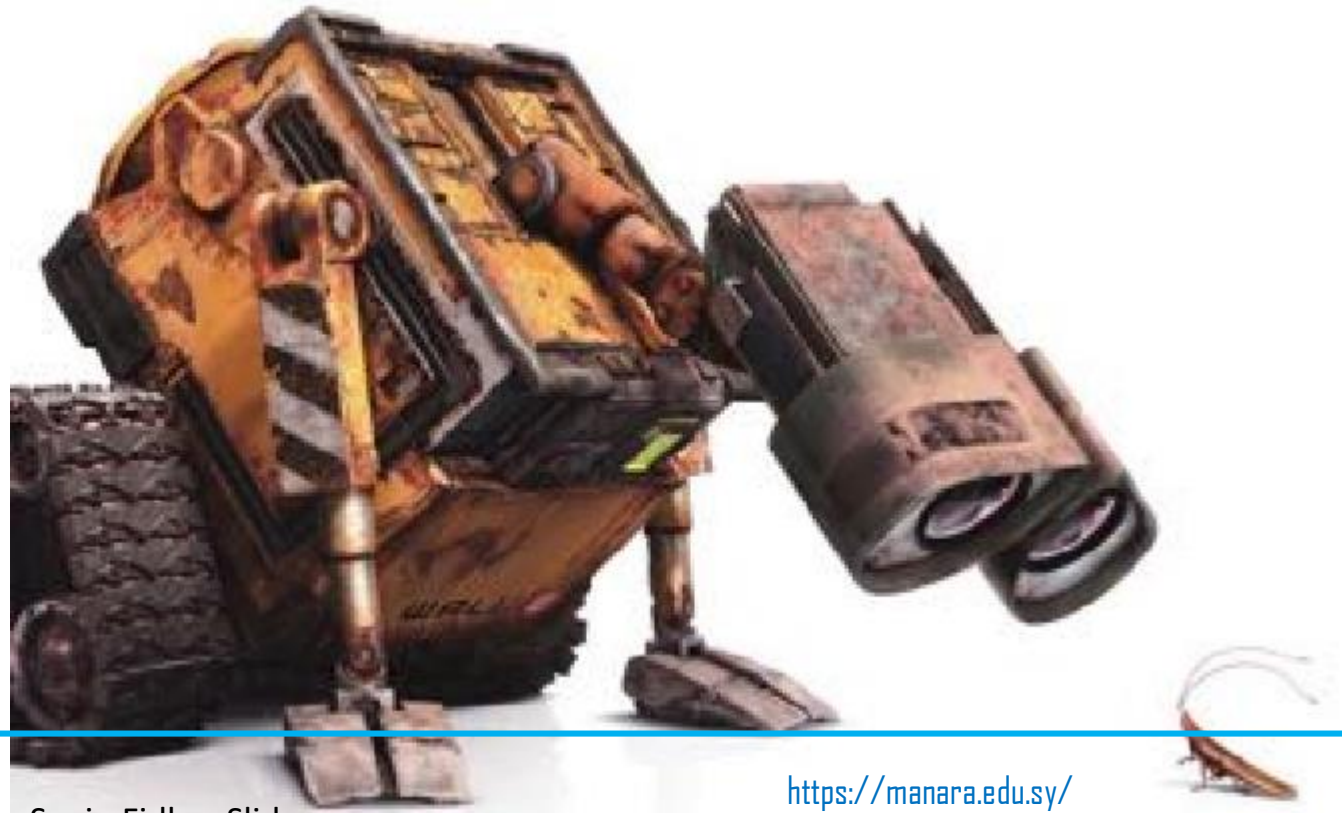
YouTube Broadcast Yourself™

Connection to other fields



What is computer vision?

- A field trying to develop automatic algorithms that would “see”
  - حقل من حقول الذكاء الصنعي يحاول تطوير خوارزميات آلية تساعد الآلة لكي ترى وتفهم



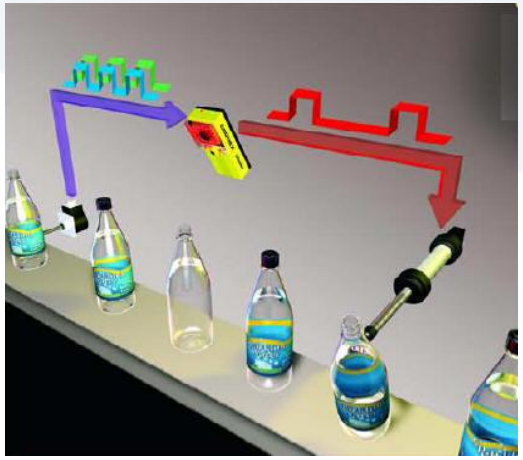
Sanja Fidler Slides

What is computer vision?

- Understand the scene in order to take actions: perception, planning, reasoning
- فهم المشهد من أجل اتخاذ القرار: الإدراك والتخطيط والاستنتاج

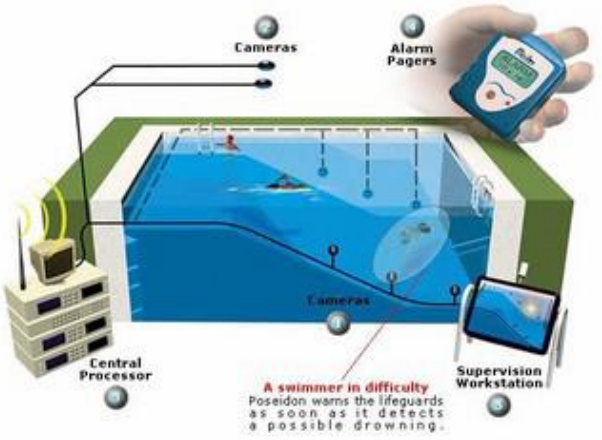
How do I prepare dinner in this household?

Applications of computer vision



Factory inspection

Reading license plates, checks, ZIP codes



Monitoring for safety (Poseidon)

Surveillance

Autonomous driving, robot navigation

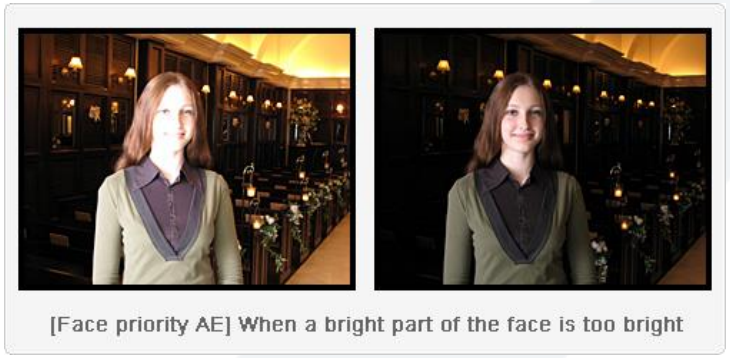
Driver assistance (collision warning, lane departure warning, rear object detection)

Applications of computer vision

Assistive technologies

Entertainment
(Sony EyeToy)

Movie special effects



Digital cameras (face detection for setting focus, exposure)

Visual search
(MSR Lincoln)

Applications of computer vision

https://www.youtube.com/watch?v=gy5g33S0Gzo

Fold laundry

تجميع الملابس

Amnon Shashua's Mobileye autonomous driving system

https://www.youtube.com/watch?v=4fxFDypHZLs

القيادة الآلية

Applications of computer vision

Fancy visualization and game analysis

Fancy visualization and special effects in movies

Applications of computer vision

Play with Faces

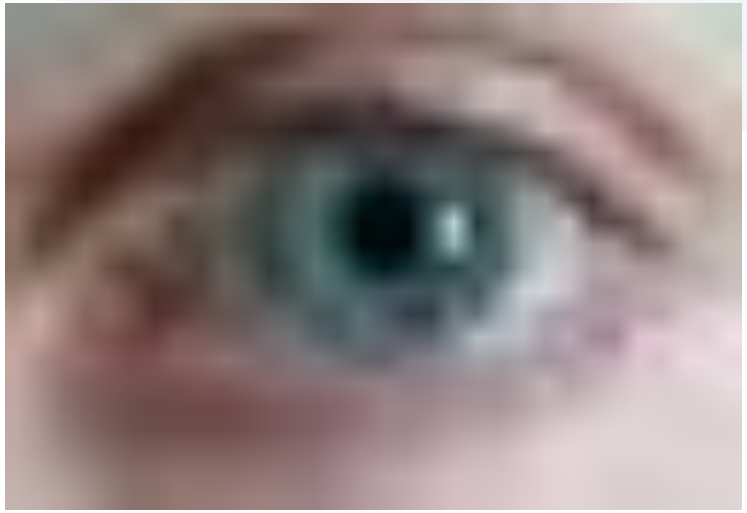
Applications of computer vision

Generate Image Captioning

توليد مسميات توضيحية للصور (وصف الصور)

The goal of computer vision

- To perceive the “world behind the picture”



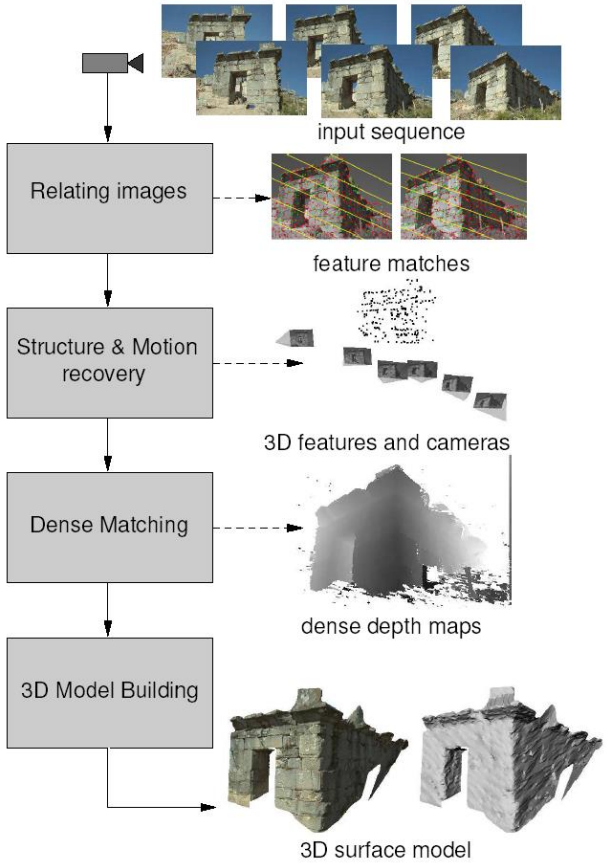
- What exactly does this mean?
  - Vision as a source of metric 3D information معلومات قياس
  - Vision as a source of semantic information معلومات معنوية

The goal of computer vision

Vision as measurement device
الرؤية كجهاز قياس

Real-time stereo

Structure from motion



Vision as a source of semantic information
الرؤية كمصدر للمعلومات المعنوية

Scene and context categorization

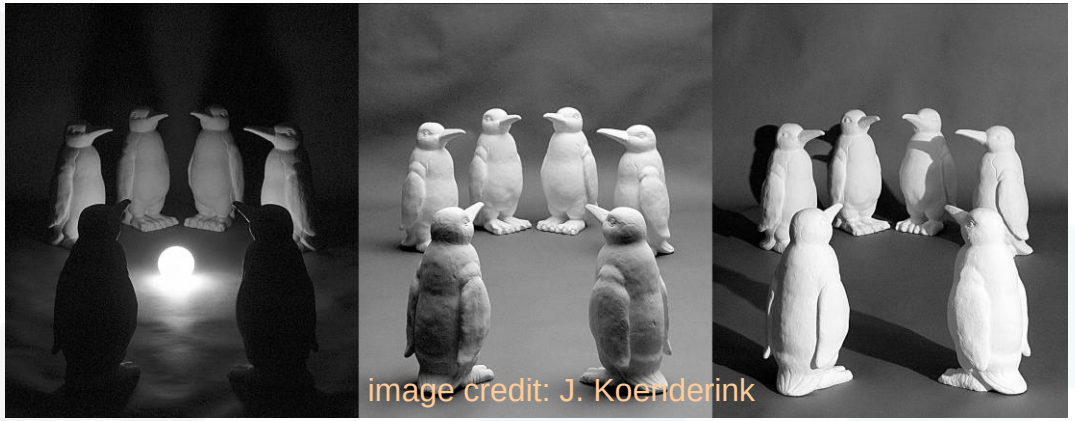
- outdoor
- city
- traffic
- ...

Computer Vision: Challenges التحديات

1. viewpoint variation
تغير المنظور

slide credit: Fei-Fei, Fergus & Torralba

2. Illumination variation
تغير الإضاءة



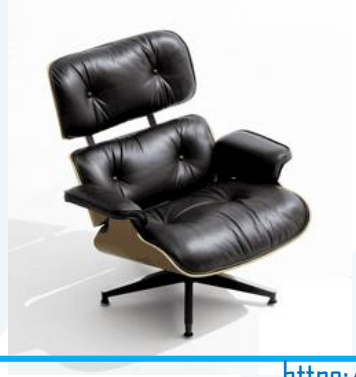
3. Scale variation
تغير الحجم

Computer Vision: Challenges التحديات

4. Occlusion
التغطية

5. background clutter
تشويش الخلفية

3. object intra-class variation
تغير شكل الصنف نفسه بين مشاهد مختلفة (مثال الكرسي)



Computer Vision: Challenges التحديات

- Images are confusing, but
- they also reveal the structure of the world through numerous cues
- Our job is to **interpret the cues!**

- الصور محيرة وخادعة لكنها تكشف بنية العالم من خلال عدة أدلة.
- مهمتنا الأساسية تفسير هذه الأدلة الموجودة في الصور!

Depth Cues: Information about the 3rd dimension of the image (Depth)

Depth Cue: Linear Perspective
دليل العمق (المنظور الخطي)

- Parallel lines converge by depth
- Deals with the organization of shapes in space

- الخطوط المتوازية تتقارب لتبدو متقاطعة مع زيادة العمق.

Depth Cue: Linear Perspective
دليل العمق (المنظور الخطي)

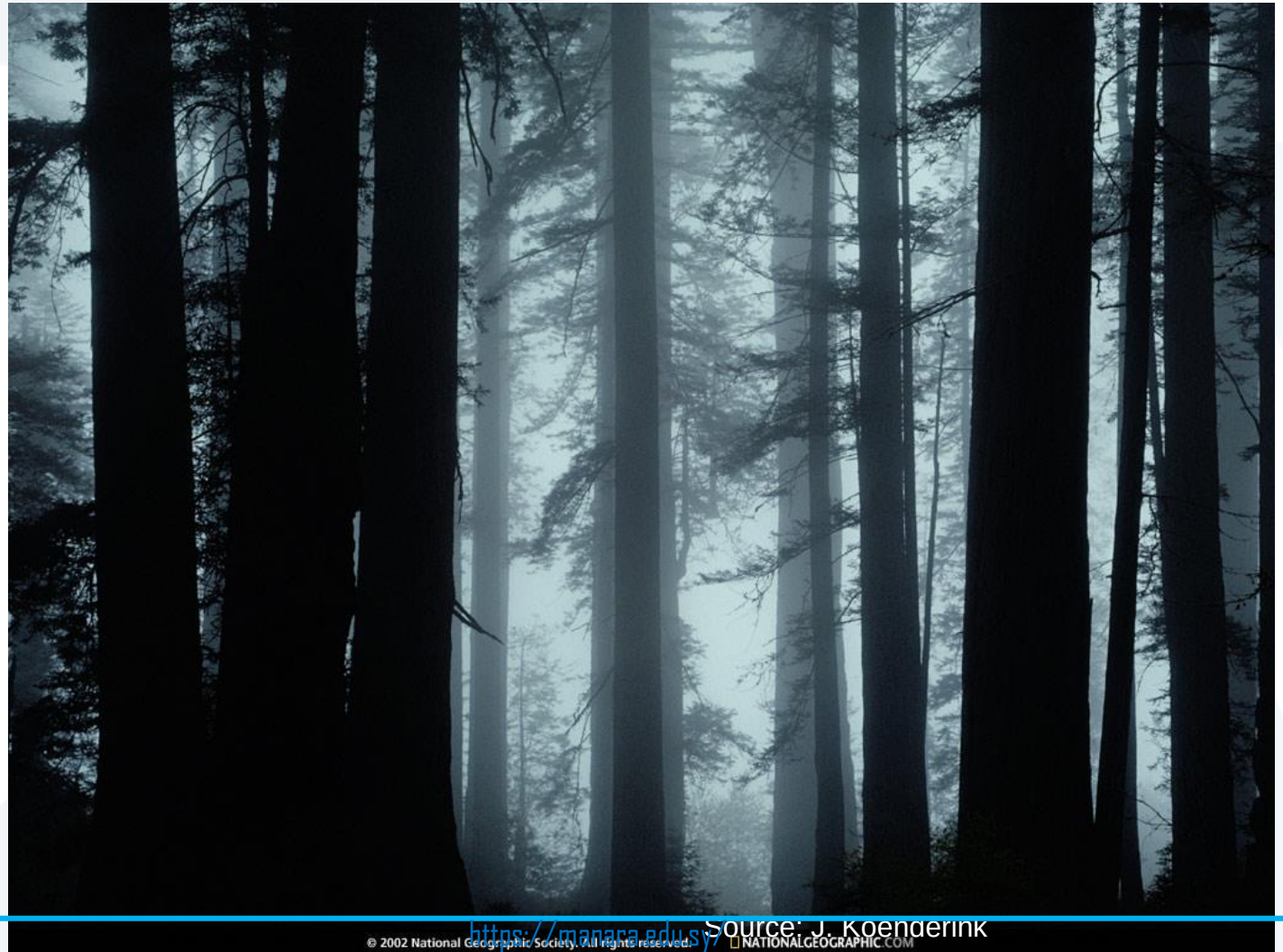
Which red line is longer?

أي الخطين الحمر هو الأطول؟

هل نستطيع بالعين المجردة تحديد ذلك؟ لا

Depth cues: Aerial perspective
دليل العمق (المنظور الهوائي)

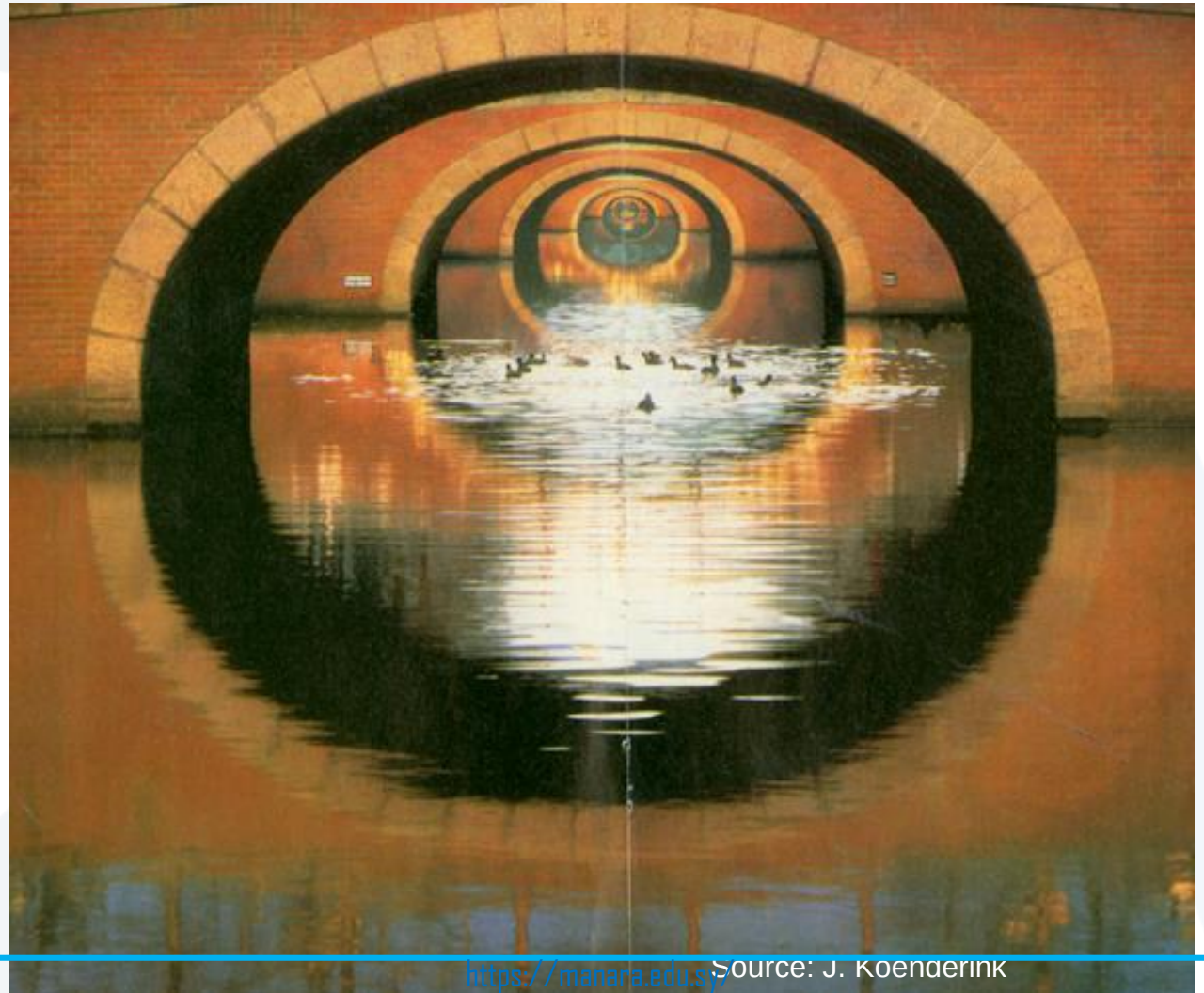
- تتعامل مع التأثيرات الهوائية لدرجات الضوء واللون- تتناقص الألوان ودرجات الضوء مع زيادة العمق!
- **Deals with atmospheric effects on tones and colors.**



Source: J. Koenderink

Depth ordering cues: Occlusion
دليل ترتيب العمق (التغطية)

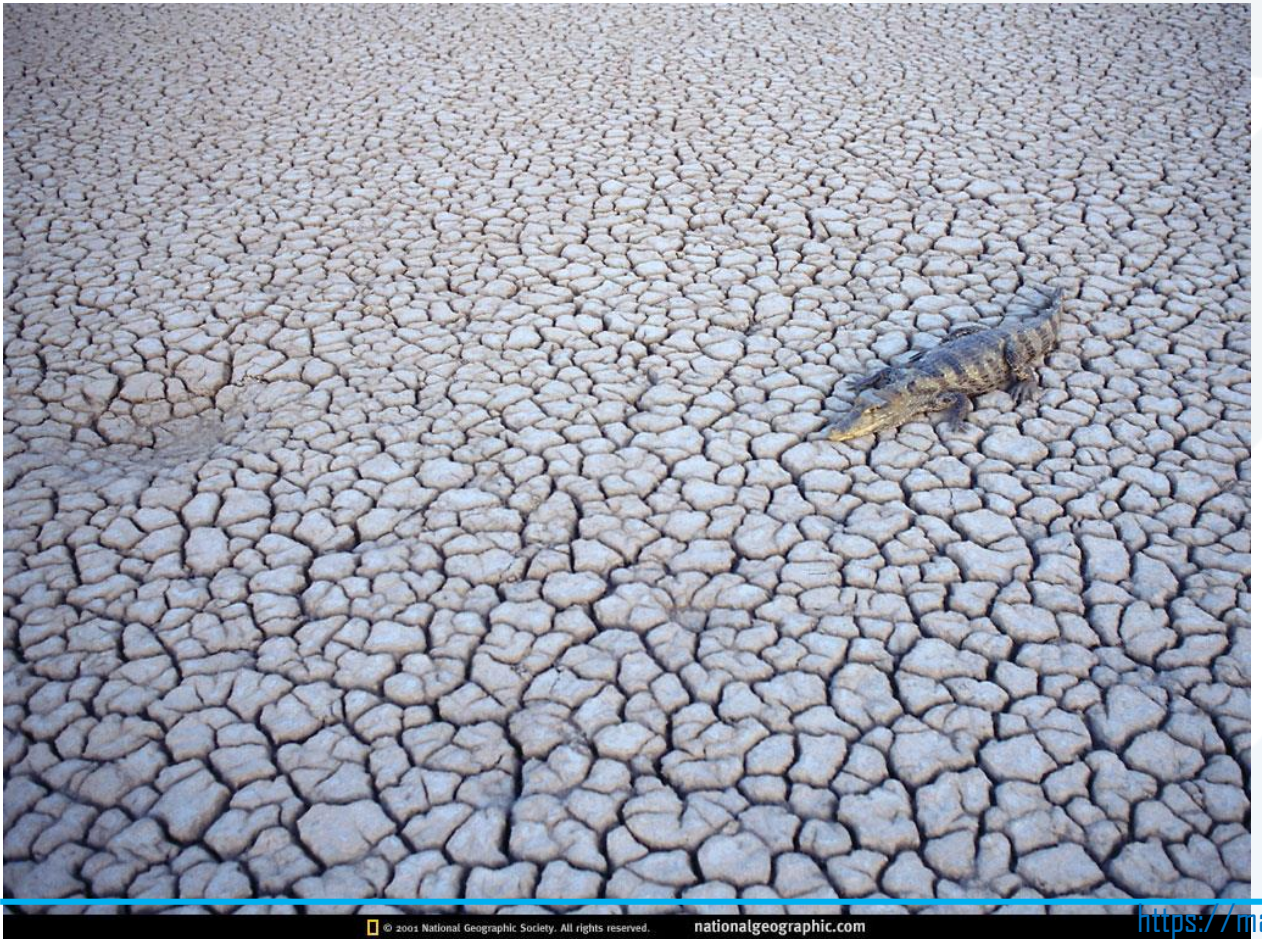
- إشارة إلى ترتيب العمق النسبي حيث يمكن لكائن ما في صورة أن يغطى جزئياً من قبل كائن آخر.
- **Occlusion: is a cue to relative depth order in which one object partially occluded by another one.**



Source: J. Koenderink

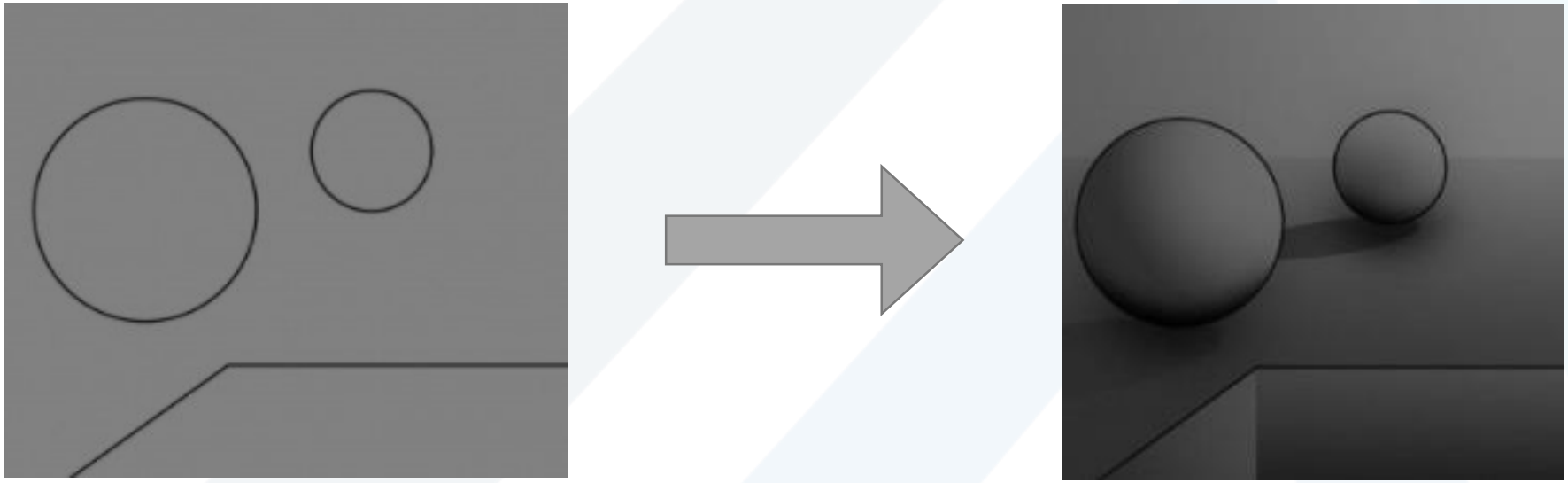
Shape cues: Texture gradient
دليل الشكل (تدرج النسيج)

- تغير (تشوه) الحجم بين الأجسام الأقرب والأبعد – مع زيادة العمق (البعد) تزداد الكثافة ويقل الحجم.
- **Texture Gradient is the distortion in size which closer objects have compared to objects appearing denser as they move farther away.**



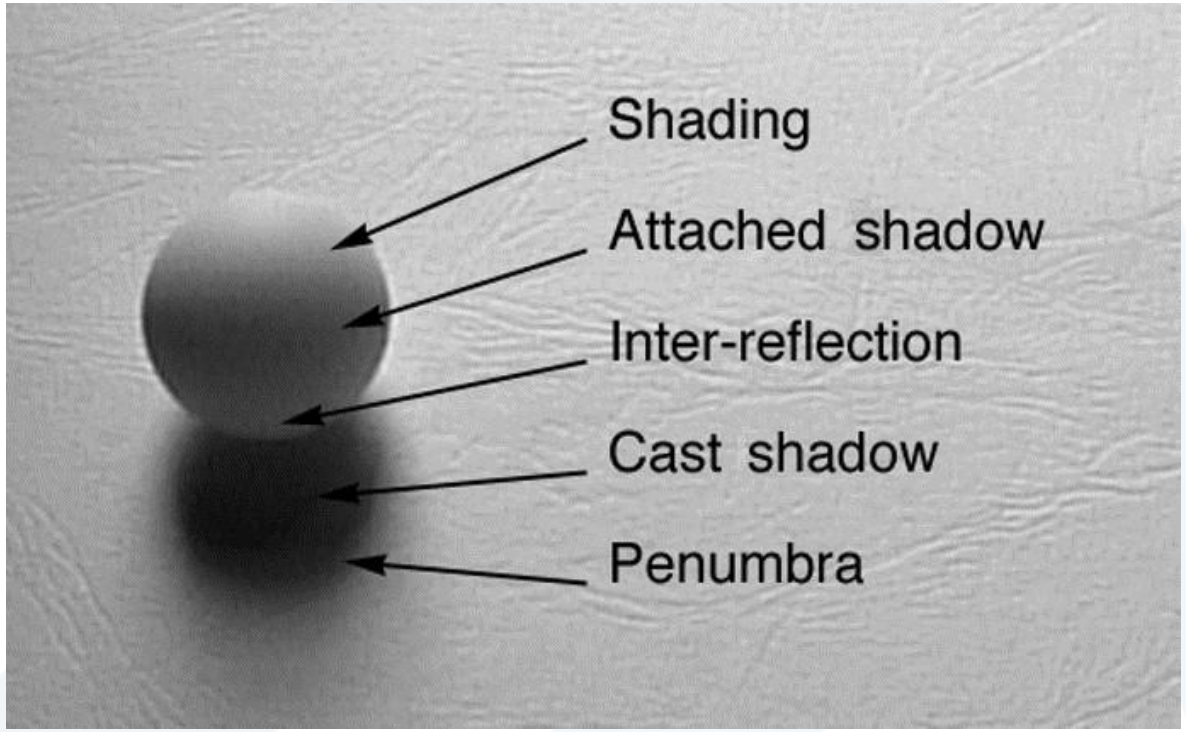
Shape and lighting cues: Shading
دليل الإضاءة والشكل: الظلال

- تغيير لون الجسم (ظلاله) في الفضاء ثلاثي الأبعاد بالاعتماد على أشياء مثل **زاوية سطح الجسم بالنسبة للضوء** و **المسافة عن المنبع الضوئي والزاوية عن الكاميرا وبعض خصائص المادة** مثل (الانعكاس)
- **The process of altering the color of an object/surface/polygon in the 3D scene, based on things like (but not limited to) the surface's angle to lights, its distance from lights, its angle to the camera and material properties**
- **Result: Object gets its 3D shape from shading.**



Position and lighting cues: Cast shadows
دليل الضوء والموقع: إلقاء الظِّل

- يتشكل إلقاء الظل عندما يغطي سطح ما سطحاً آخراً حاجباً عنه جزءاً من ضوء المنبع فينشأ الظل.
- **Cast shadows are formed when one surface occludes another surface from the light source.**

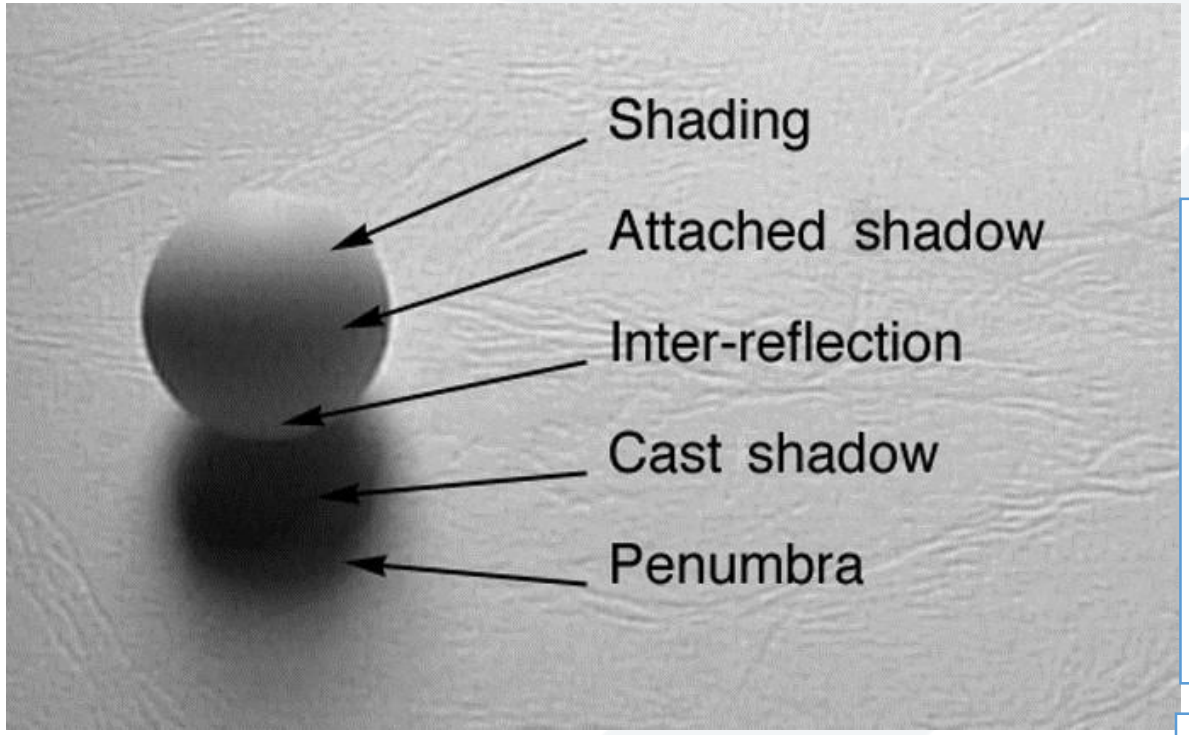


Mamassian et al. –Perception of shadows, Trends in Cognitive Sciences –Vol .2 , No .8 ,August 1998

Position and lighting cues: Cast shadows
دليل الضوء والموقع: إلقاء الظِّل

Shading is the variation of reflected light on a surface patch which faces directly the light source .

الظل: التغير في الضوء المنعكس من السطح والمواجه مباشرة للمنبع الضوئي



Shadows are regions occluded from the light source and come in two types.

الظلال مناطق **مغطاة أو محجوبة** عن المنبع الضوئي ولها نوعان

cast shadows are formed on remote surfaces.

ظلال تتشكل على السطح البعيد عن المنبع

For extended light sources, penumbras surround the cast shadows .

شبه الظل Penumbra ظلال تحيط بظلال Cast Shadow

attached shadows are formed on the very surface which is occluding the light

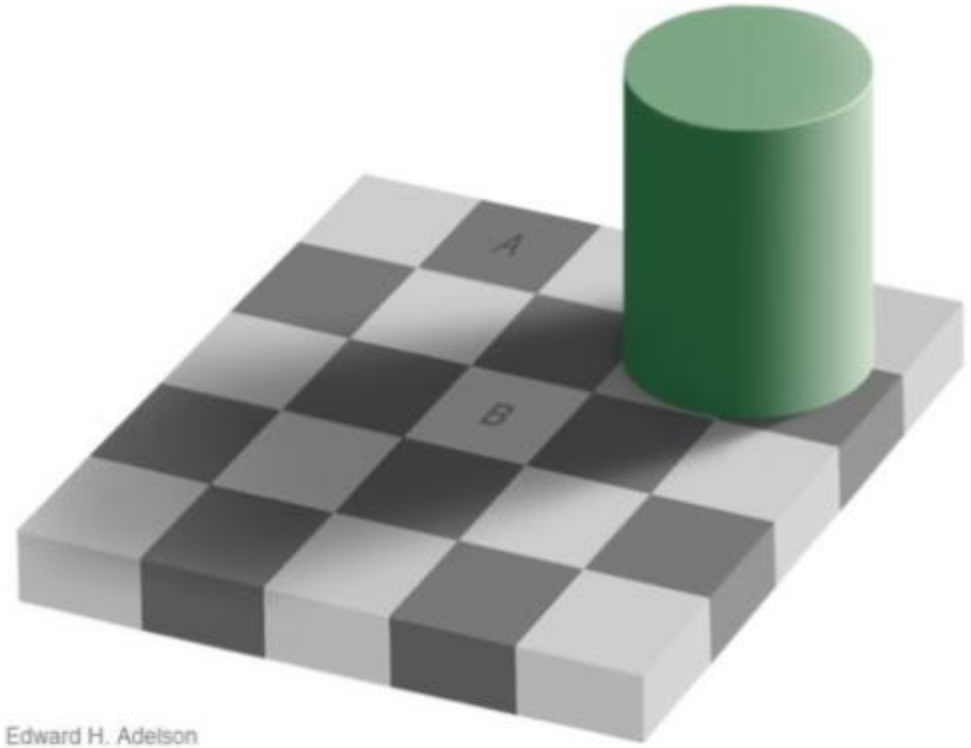
ظلال تتشكل على السطح الذي يحجب الضوء

Attached shadows sometimes include inter-reflections that result from light rays bouncing back from surrounding surfaces.

قد تتضمن Attached Shadow انعكاسات داخلية تنتج من الأشعة الضوئية المرتدة من الأسطح المحيطة

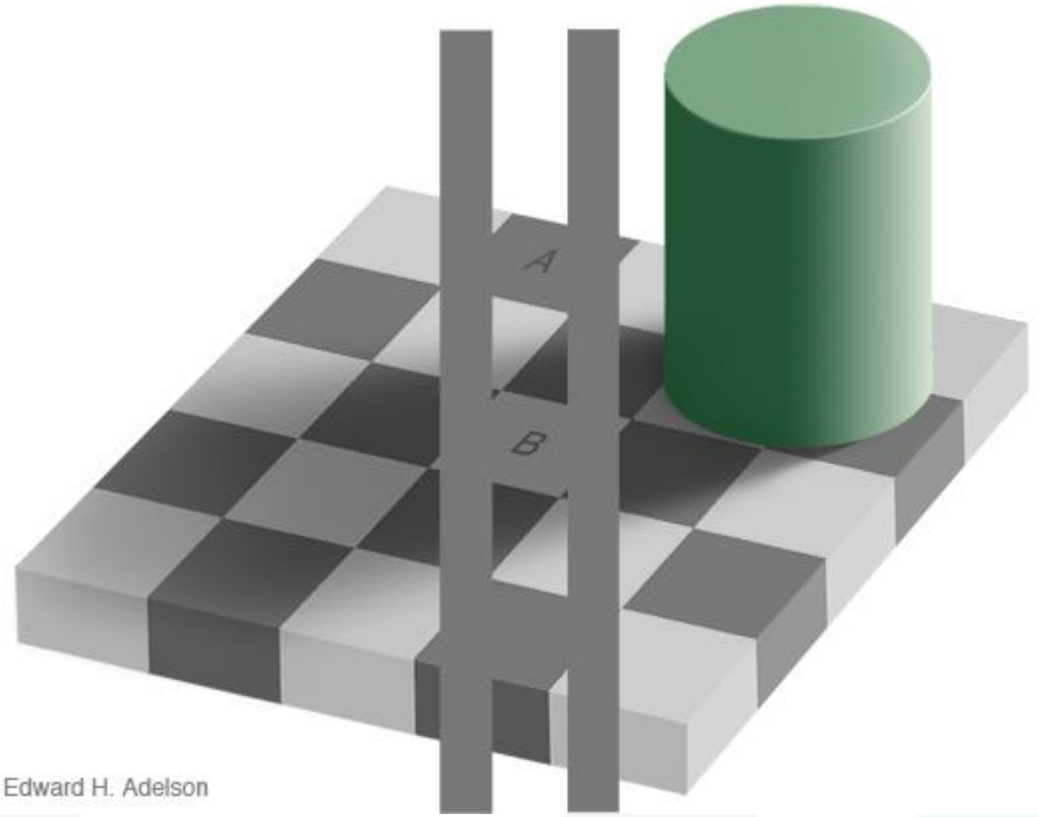
Mamassian et al. –Perception of shadows, Trends in Cognitive Sciences –Vol .2 , No .8 ,August 1998

Position and lighting cues: Cast shadows
دليل الضوء والموقع: إلقاء الظِّل



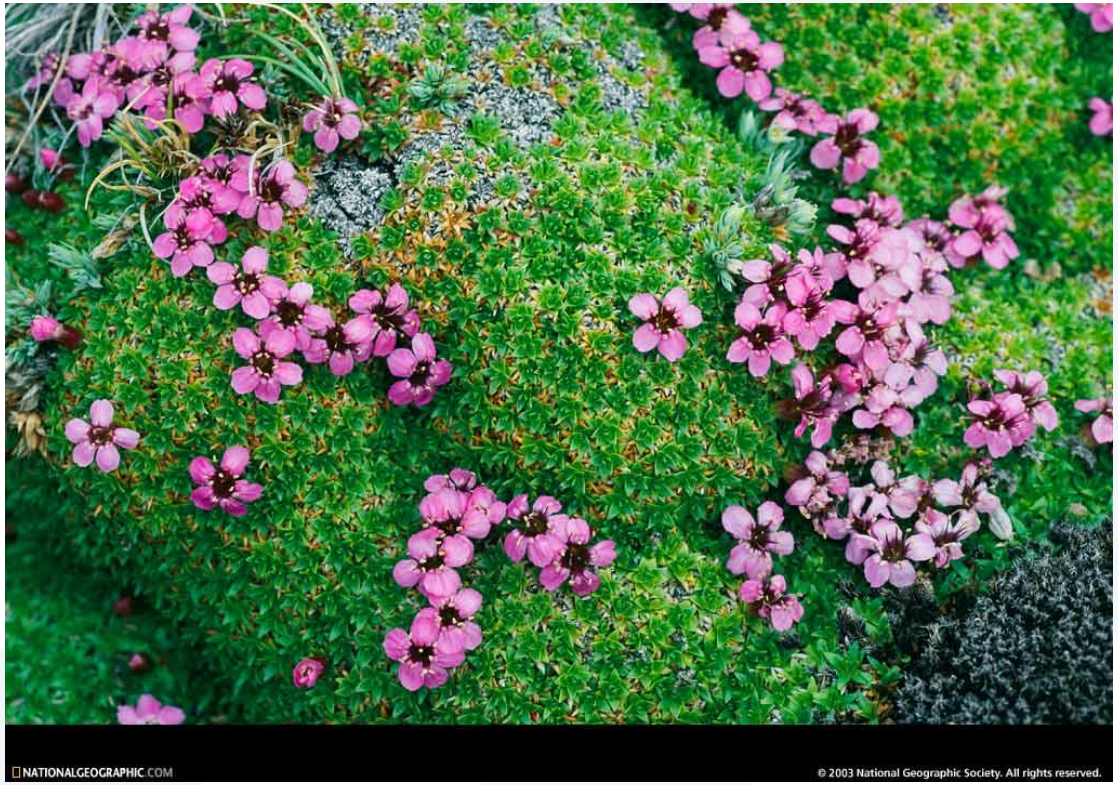
Which square is lighter, A or B?

من هي الخلية الأكثر إضاءةً؟



Grouping cues: Similarity (color, texture, proximity)
دليل المجموعات: التشابه (اللون، النسيج، التقارب)

- التشابه هو معيار (لوني، نسيجي، تقارب) لدمج المكونات المتشابهة ضمن مجموعة واحدة Grouping.



Computer Vision Levels

Early vision: Image formation and processing

Mid-level vision: Grouping and fitting

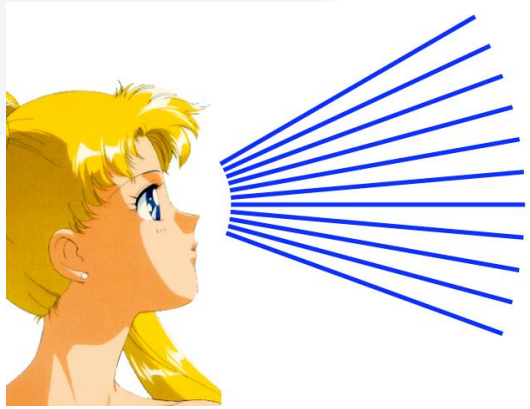
Recognition

Multi-view geometry

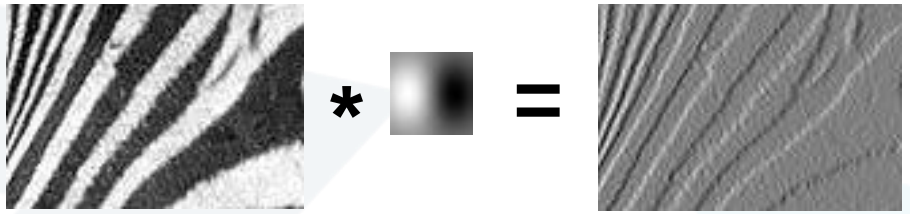
Advanced topics

Computer Vision Levels: “Early vision”

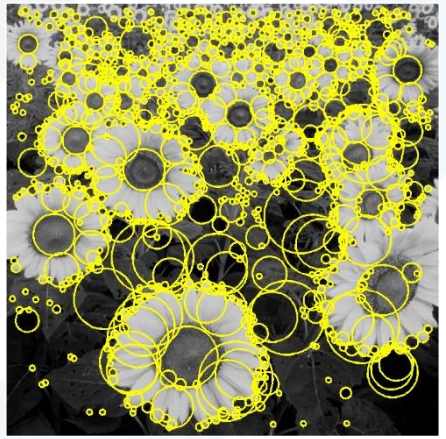
Basic image formation and processing



Cameras and sensors
Light and color



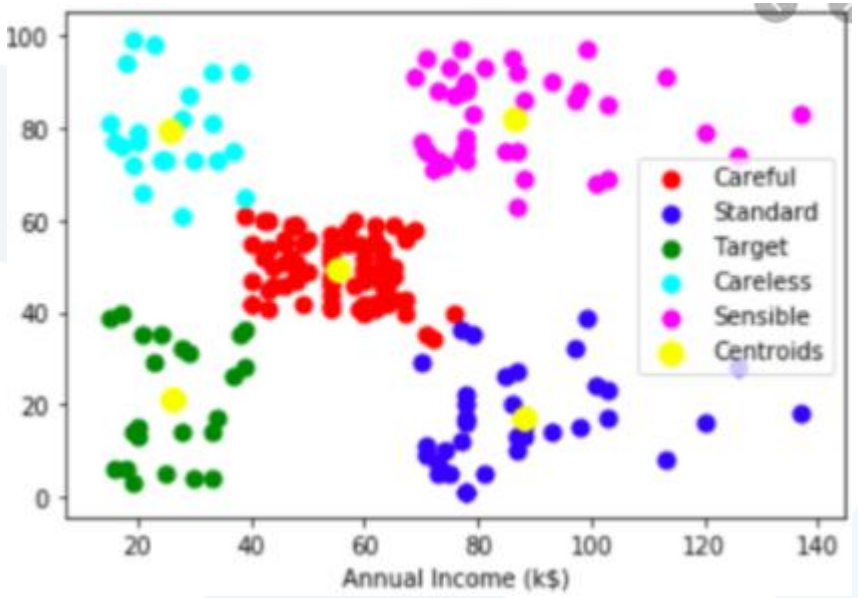
Linear filtering
Edge detection



Feature extraction: corner and blob detection

Computer Vision Levels: “Mid-level vision”

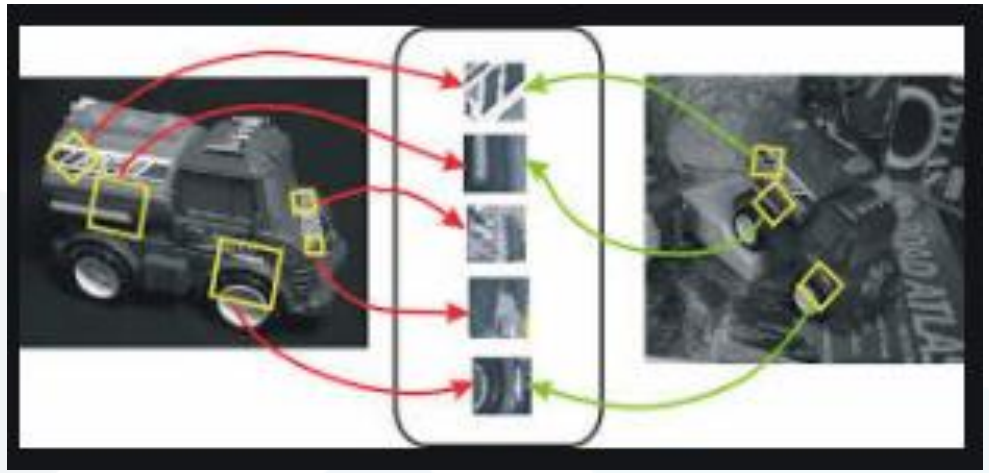
Segmentation and grouping

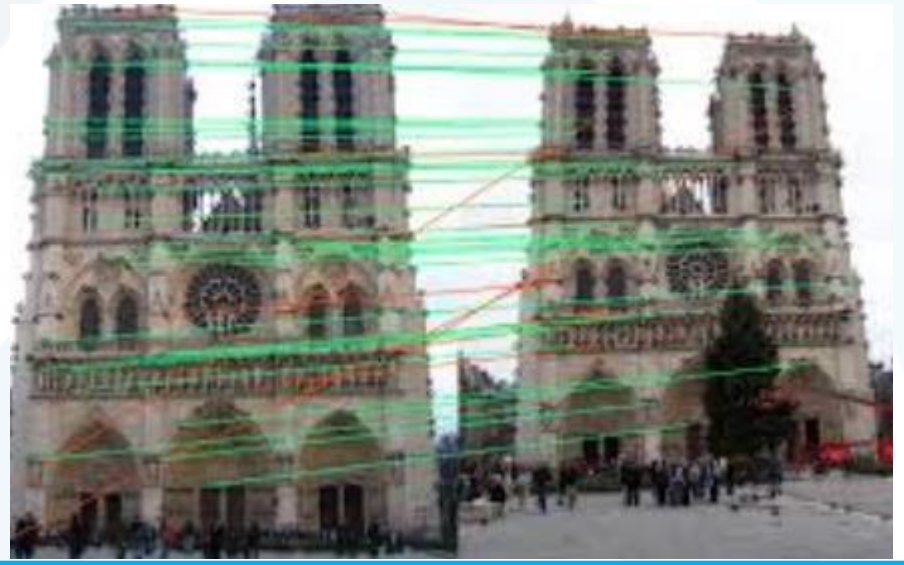


Computer Vision Levels: “Multi-view geometry”

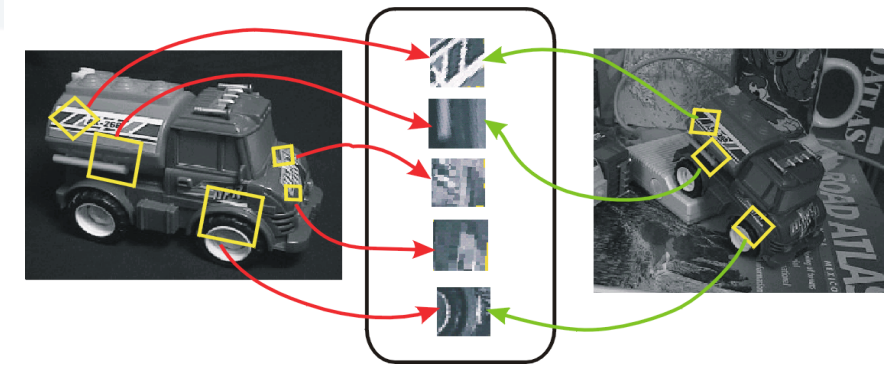
Local invariant features: detection

Local invariant features: description and matching

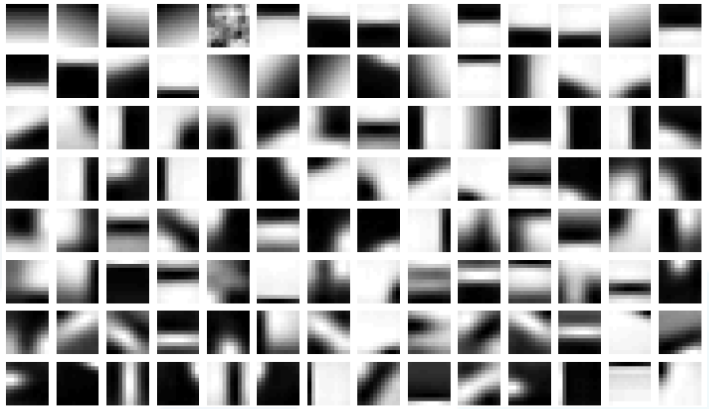




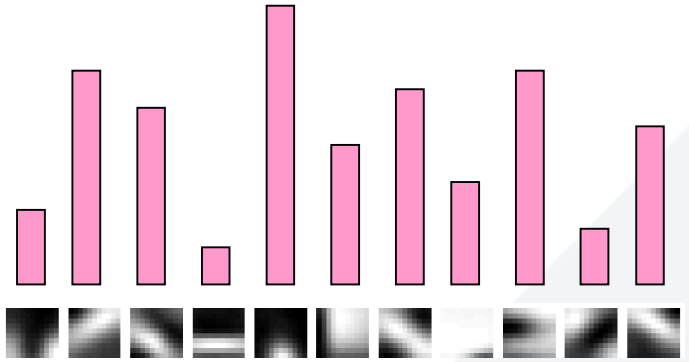
Computer Vision Levels: “Recognition”



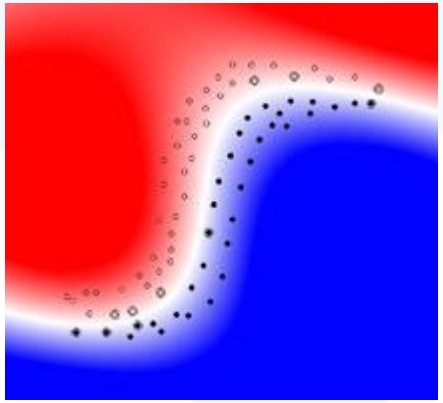
Patch description and matching



Clustering



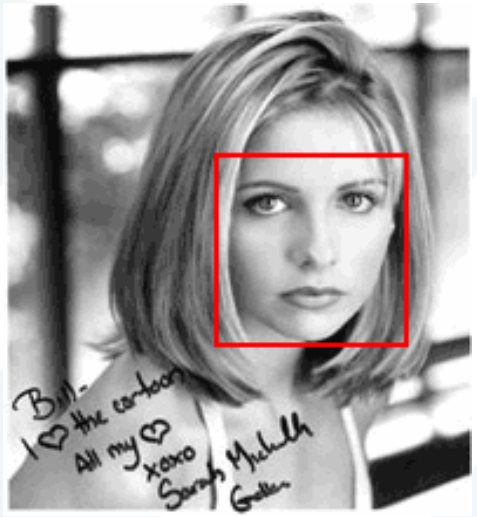
Bag-of-features models



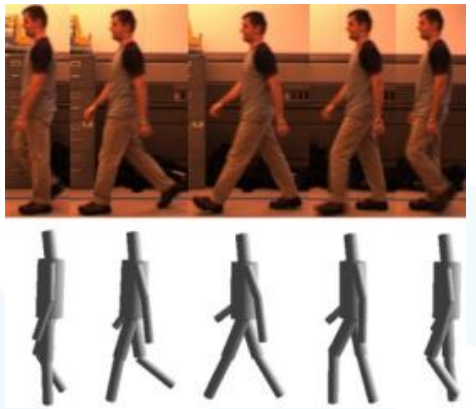
Classification

Computer Vision Levels: “Advanced Topics”

Segmentation



Face detection



Motion and tracking

تذكير بمفاهيم رؤية الحاسب