

COMPUTER VISION

CSE/ECE 344/544

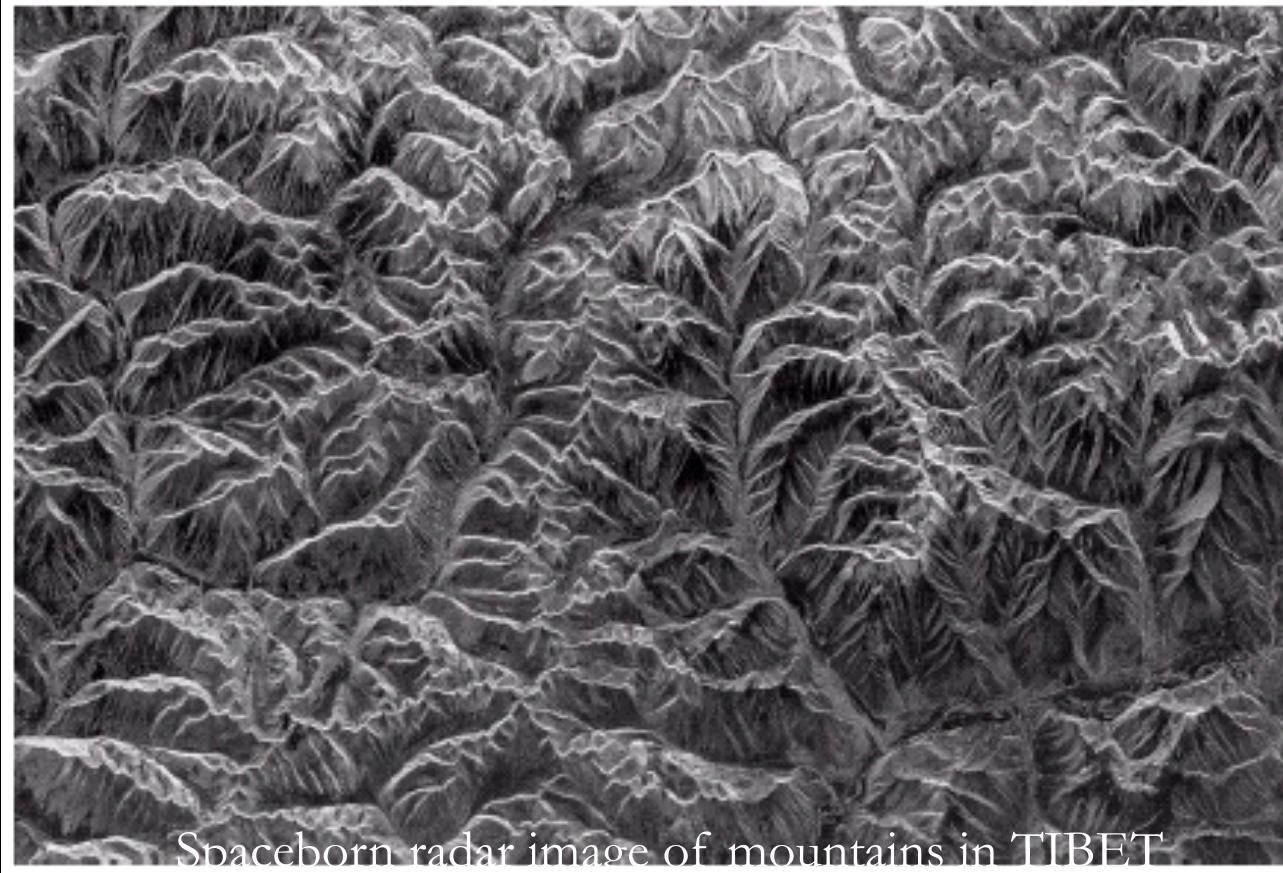
Course Instructor: Mayank Vatsa
TAs: Aakarsh and Yashasvi (so far)

Slides prepared from various sources ...
including my understanding of CV - no credits claimed

WHAT DO YOU SEE IN THIS IMAGE?



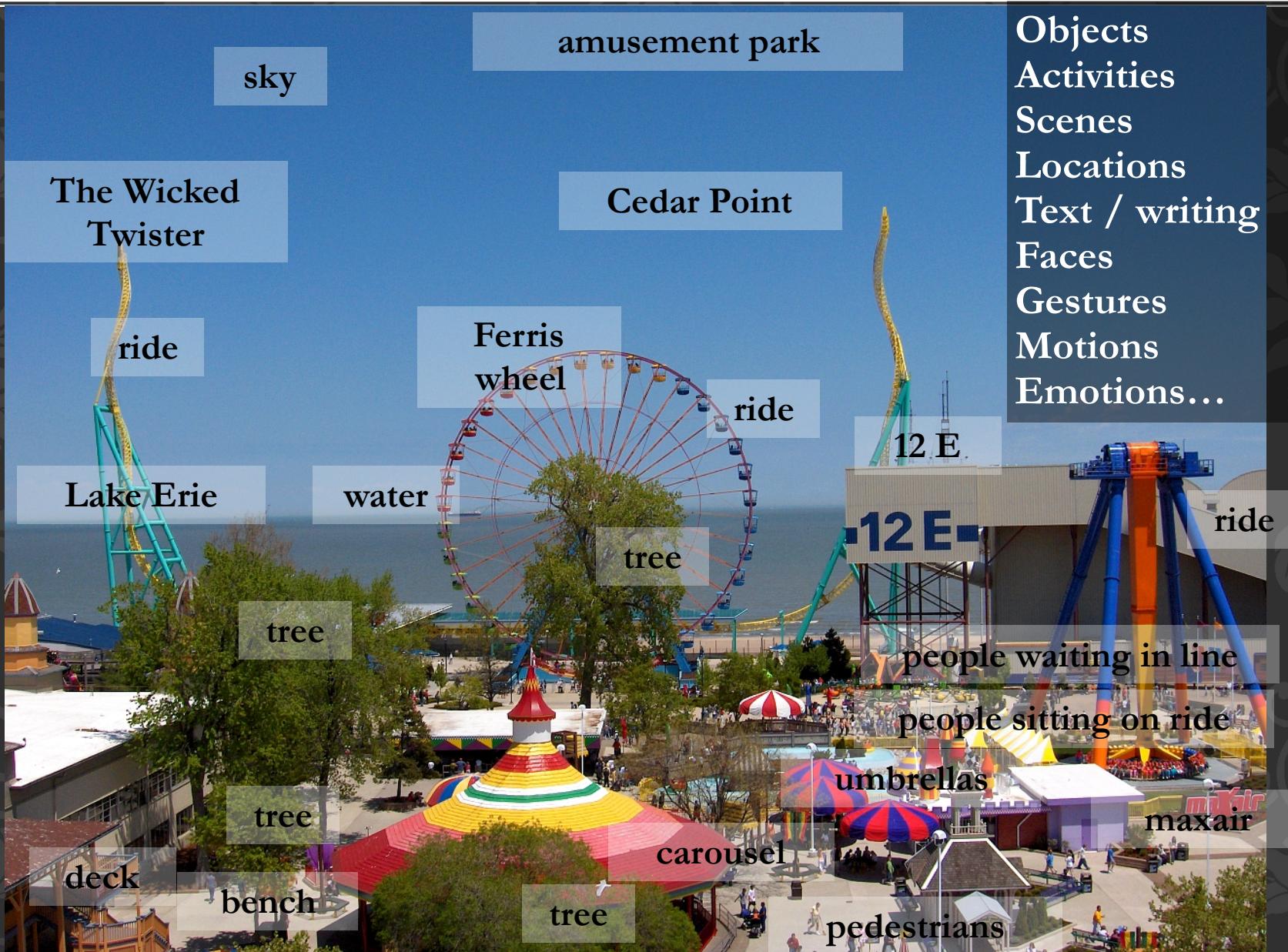
WHAT IS YOUR INTERPRETATION OF THIS IMAGE?



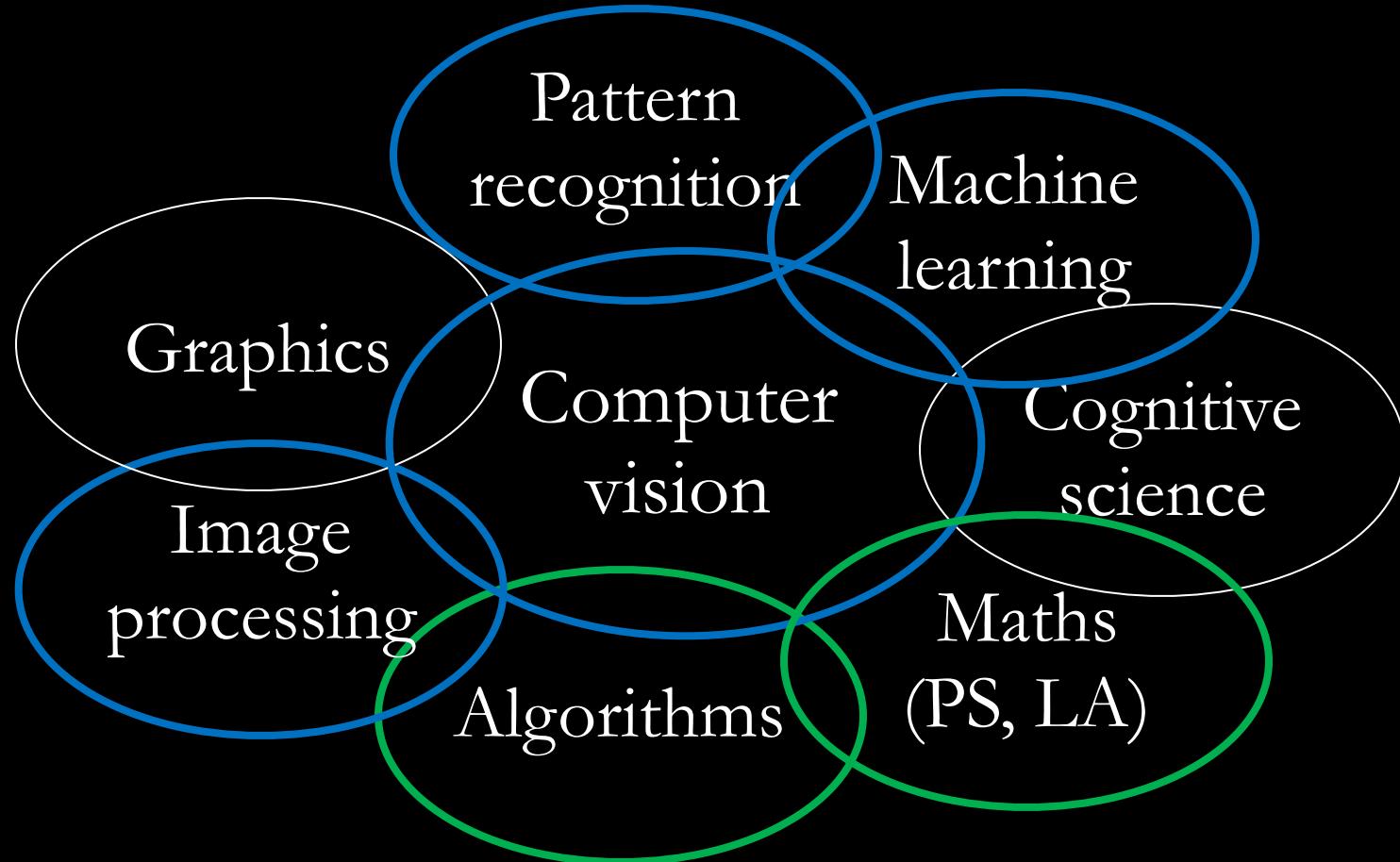
HOW WILL YOU PERFORM FACE RECOGNITION?



Perception and Interpretation



Objects
Activities
Scenes
Locations
Text / writing
Faces
Gestures
Motions
Emotions...



WHY VISION?

Images and video are everywhere!



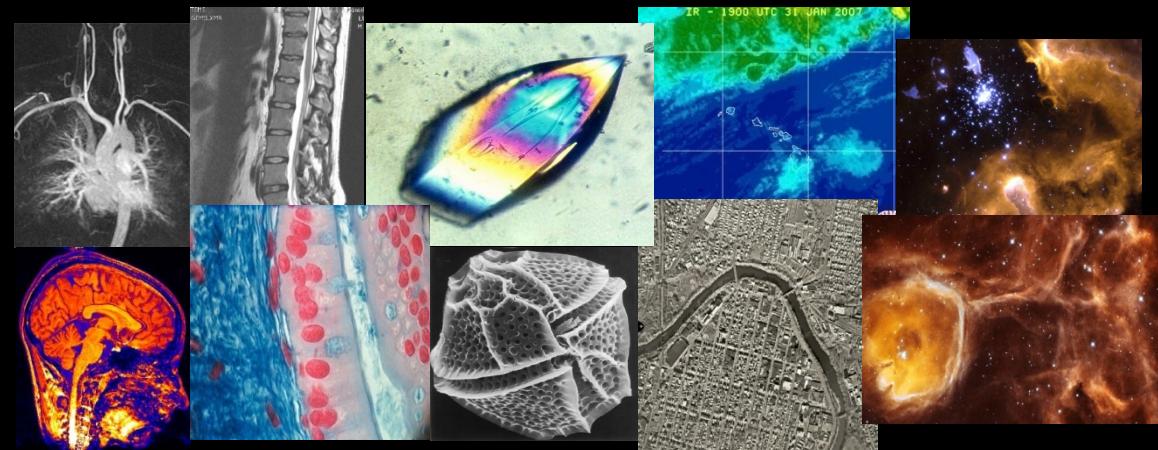
Personal photo albums



Movies, news, sports



Surveillance and security



Medical and scientific images

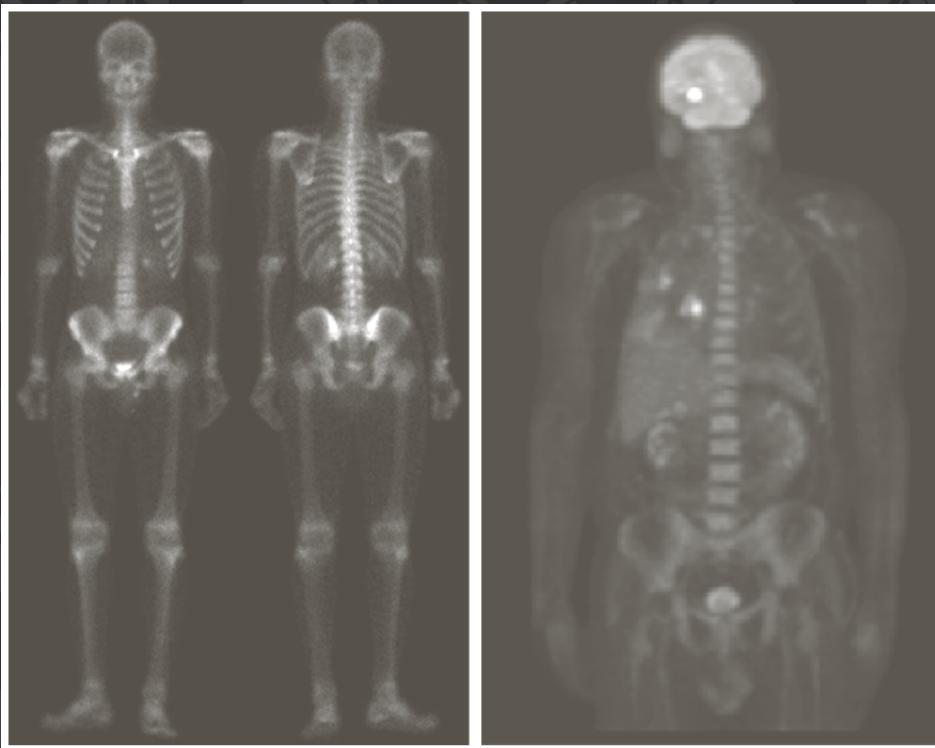
ULTIMATE GOAL ...



Terminator 2

we're not quite there yet....

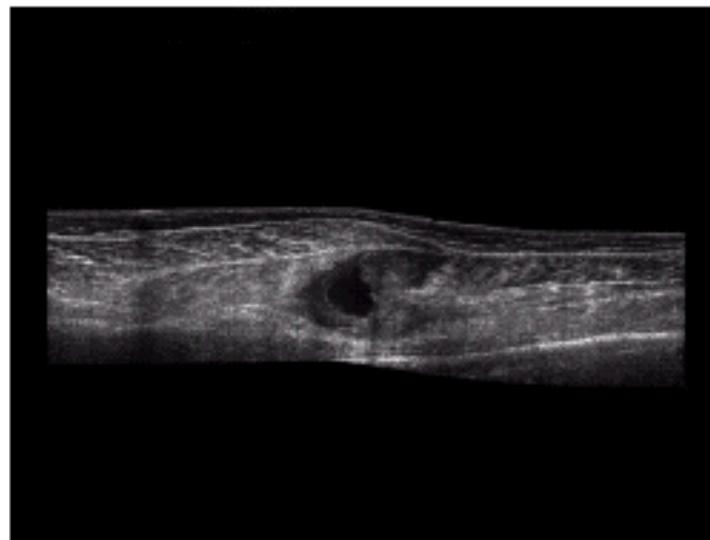
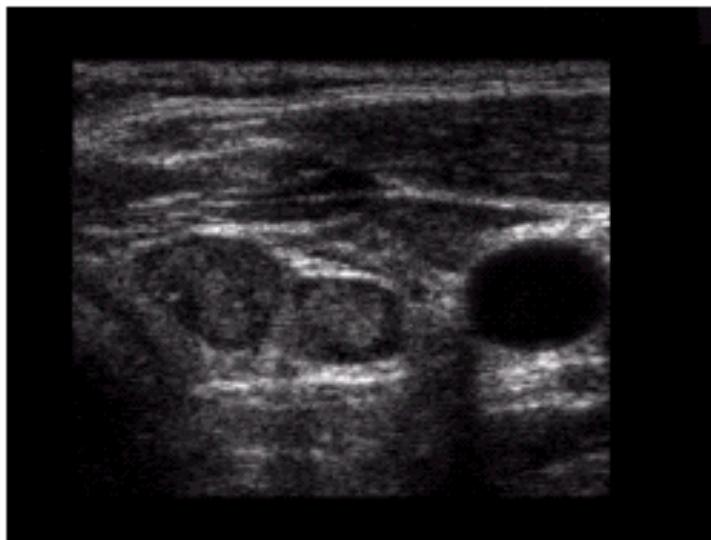
WHAT ARE REAL WORLD APPLICATIONS OF IA?



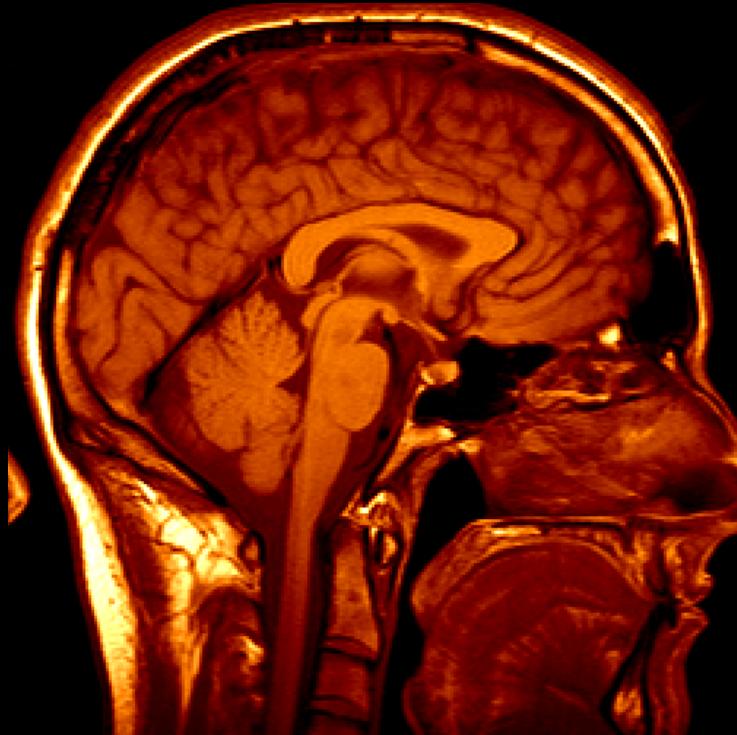
X-ray and PET Scan

a
b
c
d

FIGURE 1.20
Examples of ultrasound imaging. (a) Baby.
(2) Another view of baby.
(c) Thyroids.
(d) Muscle layers showing lesion.
(Courtesy of Siemens Medical Systems, Inc., Ultrasound Group.)



MEDICAL IMAGE ANALYSIS

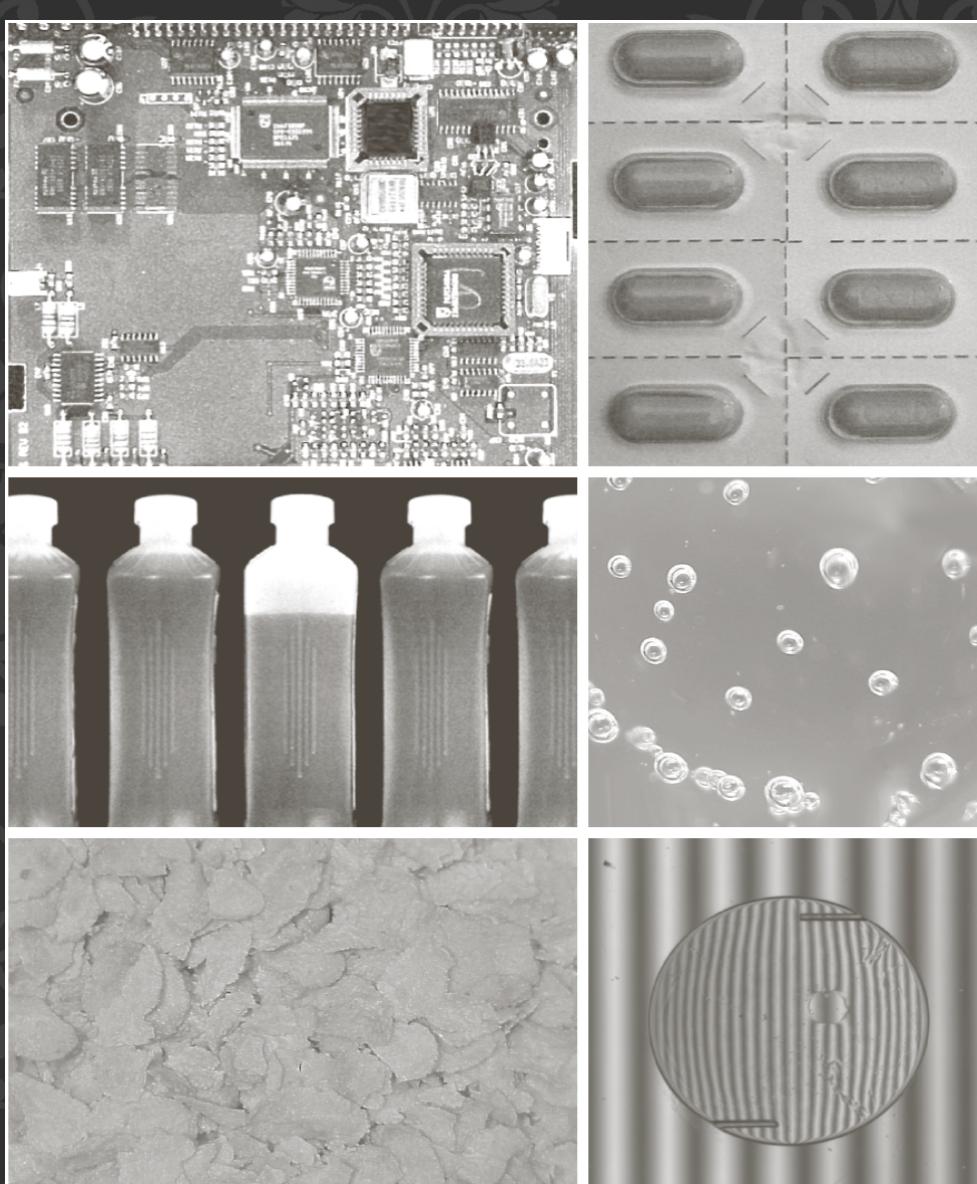


3D imaging
MRI, CT



Image guided surgery
[Grimson et al., MIT](#)

INDUSTRIAL VISION



a
b
c
d
e
f

FIGURE 1.14
Some examples of manufactured goods often checked using digital image processing.
(a) A circuit board controller.
(b) Packaged pills.
(c) Bottles.
(d) Air bubbles in a clear-plastic product.
(e) Cereal.
(f) Image of intraocular implant.
(Fig. (f) courtesy of Mr. Pete Sites, Perceptics Corporation.)

FACE DETECTION



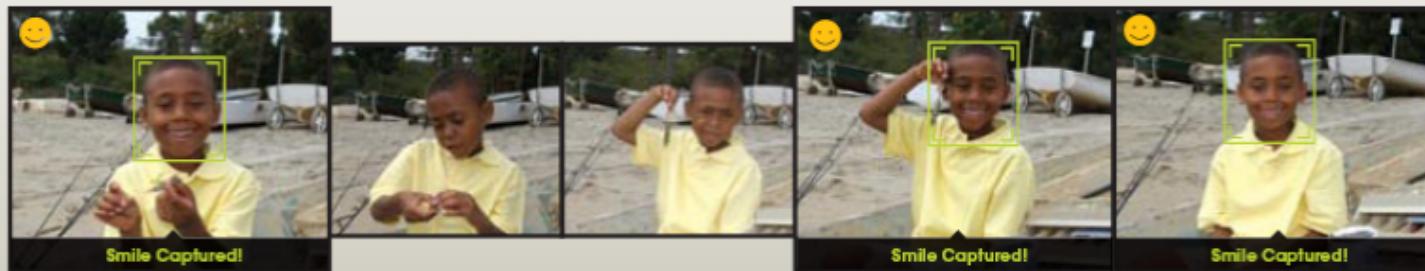
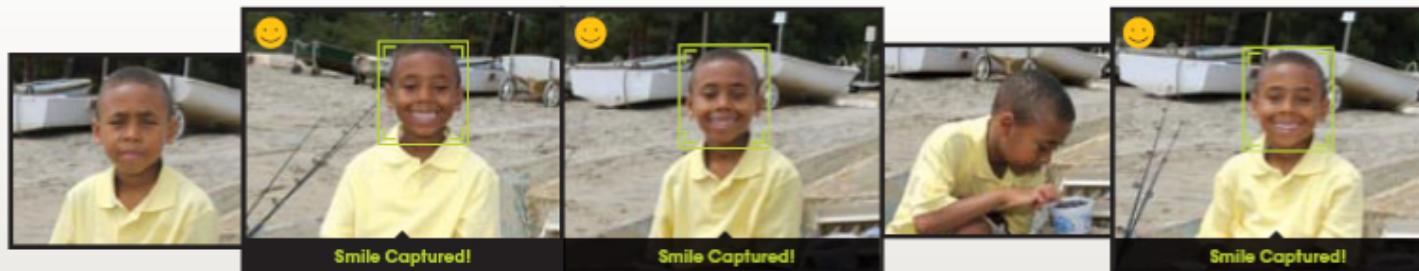
Many new digital cameras now detect faces

Canon, Sony, Fuji, ...

SMILE DETECTION

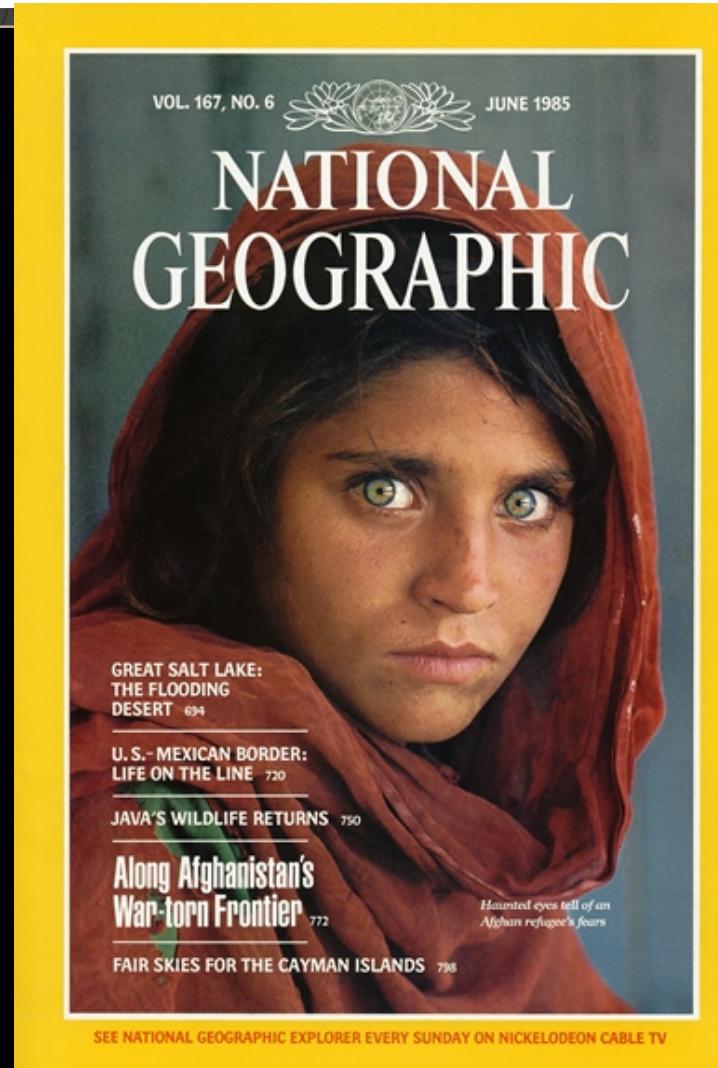
The Smile Shutter flow

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.



Sony Cyber-shot® T70 Digital Still Camera

FACE RECOGNITION



Who is she?

CV+ML+PR = BIOMETRICS



“How the Afghan Girl was Identified by Her Iris Patterns”

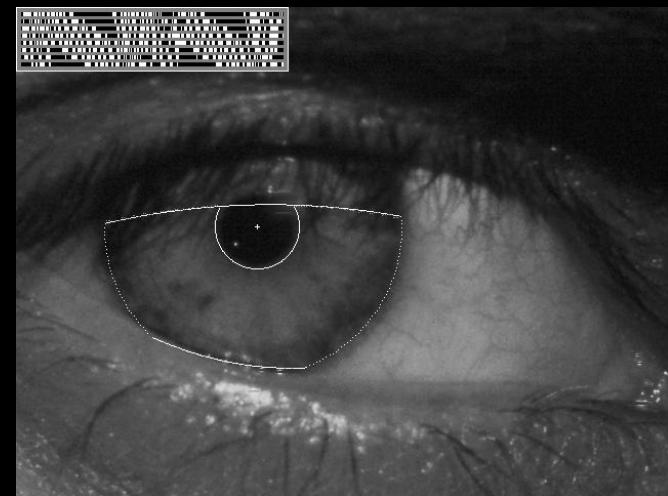
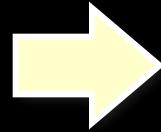
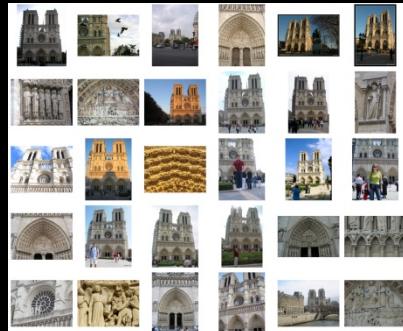
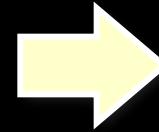


PHOTO TOURISM



Scene
reconstruction



LICENSE PLATE RECOGNITION (OCR)



OPTICAL CHARACTER RECOGNITION (OCR)

Technology to convert scanned docs to text

- If you have a scanner, it probably came with OCR software



Digit recognition, AT&T labs
<http://www.research.att.com/~yann/>



License plate readers
http://en.wikipedia.org/wiki/Automatic_number_plate_recognition

OBJECT RECOGNITION (IN SUPERMARKETS)



LaneHawk by EvolutionRobotics

“A smart camera is flush-mounted in the checkout lane, continuously watching for items. When an item is detected and recognized, the cashier verifies the quantity of items that were found under the basket, and continues to close the transaction. The item can remain under the basket, and with LaneHawk, you are assured to get paid for it...”

OBJECT RECOGNITION IN MOBILE PHONES



This is becoming real:

Lincoln Microsoft Research

Point & Find, Nokia

SnapTell.com (now amazon)

SPECIAL EFFECTS: MOTION CAPTURE



Pirates of the Caribbean, Industrial Light and Magic

SPORTS



Sportvision first down line
Nice [explanation](#) on www.howstuffworks.com

SMART CARS

► manufacturer products consumer products ◀◀

Our Vision. Your Safety.

rear looking camera forward looking camera side looking camera

EyeQ Vision on a Chip

> read more

Vision Applications

Road, Vehicle, Pedestrian Protection and more

> read more

AWS Advance Warning System

> read more

News

- > [Mobileye Advanced Technologies Power Volvo Cars World First Collision Warning With Auto Brake System](#)
- > [Volvo: New Collision Warning with Auto Brake Helps Prevent Rear-end](#)

> all news



Events

- > [Mobileye at Equip Auto, Paris, France](#)
- > [Mobileye at SEMA, Las Vegas, NV](#)

> read more

Mobileye

Vision systems currently in high-end BMW, GM, Volvo models

By 2010: 70% of car manufacturers.

SMART CARS

► manufacturer products consumer products ◀◀

Our Vision. Your Safety.

rear looking camera forward looking camera side looking camera

> EyeQ Vision on a Chip

[> read more](#)

> Vision Applications

Road, Vehicle, Pedestrian Protection and more

[> read more](#)

> AWS Advance Warning System

Mobileye (C) 1999-2002

96.4 m

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News

- > **Mobileye Advanced Technologies Power Volvo Cars World First Collision Warning With Auto Brake System**
- > **Volvo: New Collision Warning with Auto Brake Helps Prevent Rear-end**

[> all news](#)

Events

- > **Mobileye at Equip Auto, Paris, France**
- > **Mobileye at SEMA, Las Vegas, USA**

Vision systems currently in high-end BMW,
By 2010: 70% of car manufac

VISION-BASED INTERACTION (AND GAMES)



Nintendo Wii has camera-based IR tracking built in. See [Lee's work at CMU](#) on clever tricks on using it to create a [multi-touch display](#)!

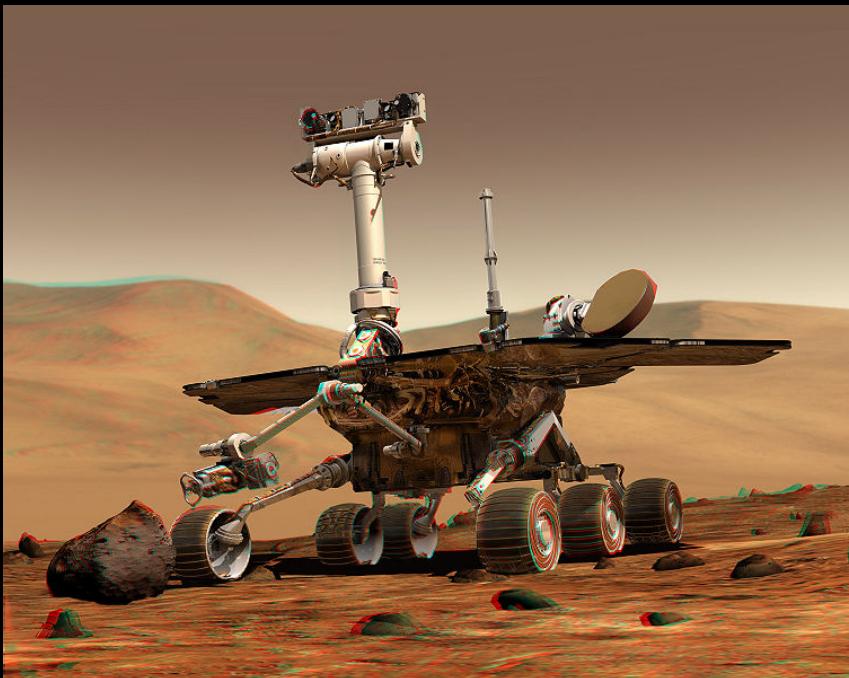


Digimask: put your face on a 3D avatar.

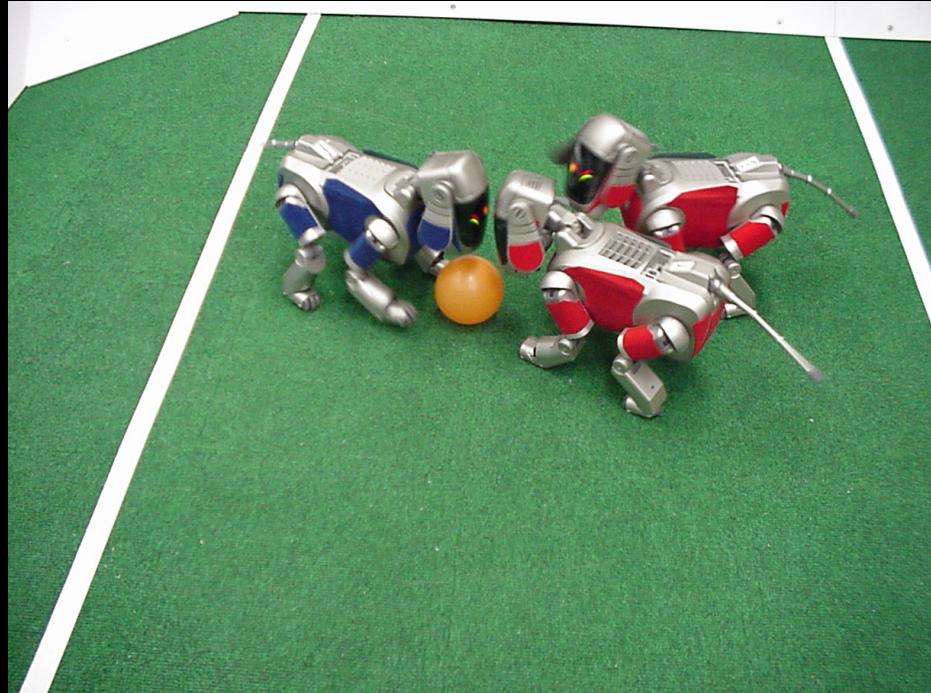


"Game turns moviegoers into Human Joysticks", CNET
Camera tracking a crowd, based on [this work](#).

ROBOTICS



NASA's Mars Spirit Rover
http://en.wikipedia.org/wiki/Spirit_rover



<http://www.robocup.org/>

EVERY PICTURE TELLS A STORY



Goal of CV is to write computer programs that can process and interpret images

CAN COMPUTERS MATCH (OR BEAT) HUMAN VISION?



La Gare Montparnasse, 1895

Yes and no (but mostly no!)
humans are much better at “hard” things
computers can be better at “easy” things

WHAT IS AN IMAGE?



La Gare Montparnasse, 1895



1 23 56 77 ...

....

....

....

....

....

....

....

213 123 255 ...

2D matrix representing image

OBJECTIVES OF THE COURSE

Prepare you for (i) understanding existing computer vision technology, (ii) pursuing research in computer vision, (iii) developing and evaluating computer vision modules and/or standalone systems

We will focus on 2D, 3D vision: from handcrafted to deep learning based approaches

ADMINISTRATIVE ANNOUNCEMENTS

ADMIN ISSUES

- **Grading** (Absolute grading)
- 30% project - example: Kaggle CV Competitions
- 20% written and programming assignments (4 planned assignments)
- 3 best out of 4 exams ($15+15+20 = 50\%$ weight) (end sem will be compulsory) - end of Jan, Mid Sem, end of March and end sem
- 5% review (1-2 papers to review)
- You will get chances to earn “bonus” marks
- You will get 4 free days to extend your assignment deadlines
- **Grading Thresholds**
- 100% above: A+
- 85-100%: A, A-
- 70-84.99%: B, B-
- ... and so on
- Less than 35%: F

ADMIN ISSUES

- Office hours: will inform soon
- Appointment/questions by email: mayank@
- Cheating and plagiarism: Zero Tolerance
- Project team size: 2 to 3
 - Proposal by end of Jan 2019
- Programming environment: Python
- Libraries allowed: sklearn, OpenCV, and PyTorch (not Keras)
- Auditing requires taking all exams and completing all assignments

WEBSITE AND GROUP EMAIL

- <https://sites.google.com/iiitd.ac.in/cv2019/home> (for slides and course updates)
- cse544@iiitd.ac.in – group (register yourself) – class announcements will be sent through this group (will be available in next 2-3 days)

Expectation vs Reality :)

- Expectation: It is instructor and TAs' job to ensure that I have learnt a great deal about CV
- Reality: No, it is your responsibility to learn a great deal about CV - our job is to facilitate learning
- Expectation: CV is going to be an easy course and I will be hand-held throughout by instructor and TAs'
- Reality: I do not like spoon-feeding and generally, courses that I have taught are not considered easy

Expectation vs Reality :)

- Expectation: Course instructor is very friendly
- Reality: I am not your friend
- Expectation: I can meet course instructor any time I want
- Reality: Sorry, I am typically busy with many other things - you need to take prior appointment or come during office hours

Expectation vs Reality :)

- Expectation: I can easily get A grade in the course by cheating and plagiarism
- Reality: Your instructor follows “Zero-tolerance policy”, i.e. if you are caught in any component, you will get F in the course (I do not have time to actively police you but if you are caught then zero-tolerance policy)
- Expectation: I can inform the instructor about cheating without proof
- Reality: Do not send any complaint against your classmates without solid proof

Expectation vs Reality :)

- Expectation: I can copy course project from anywhere (or minor extension from previous year's course or other courses - without informing) and get a good grade
 - Reality: hmm ... really
-
- Expectation: If we all demand, instructor will change grading scheme from absolute to relative
 - Reality: It's a wishful thinking!!!

Disclaimer

- I will be using material from many sources, including images, videos, text, definitions, examples - so I will not claim authorship

**NEXT CLASS: WE WILL START WITH A
SPECIAL QUIZ (BONUS)**

SPECIAL QUIZ

Linear Algebra

Calculus

Probability

Geometry

You need to pass the quiz in order to take the course