

Biological Vision and Applications

Module 01-01: About Biological Vision and the Course



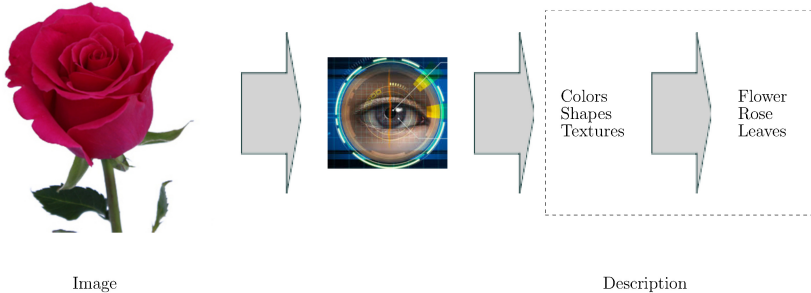
Hiranmay Ghosh



- Five sense organs to experience the world:
 - ▶ Eyes provide maximum information
- Vision is the process that transforms raw images to information
- This course is about study of principles of biological (human) vision
 - ▶ With an ulterior motive to apply them on computer vision systems

What does Human Vision System do?

Transforming visual signals to information



... This looks trivial !!

Let's have some insights

What does Human Vision System do? (contd.)

A more complex example



- Determines structural composition of the scene in 3D
- Visual search – where is my cat?

What does Human Vision System do? (contd.)

A still more complex example



- **Identification**

- ▶ Four players
- ▶ Ball, Goalpost
- ▶ Net, gallery, ...

- **Interpretation**

- ▶ Football game
- ▶ Free kick

- **Prediction**

- ▶ Goal score?

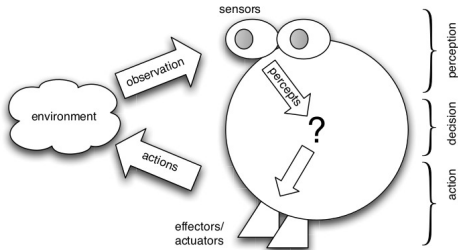
- **Action**

- ▶ Cheer (?)

... Intuitive and instantaneous for humans. Extremely difficult for computers.

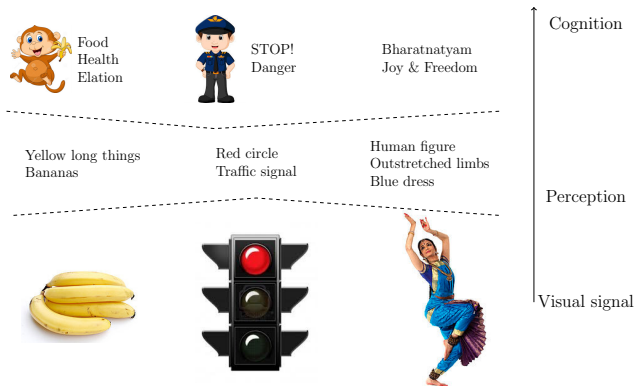
Situated Vision

An eternal cycle of sensing and acting



- **Sensing:** Sense the environment
 - **Processing:** Interpret the environment
- **Acting:** Influence the environment

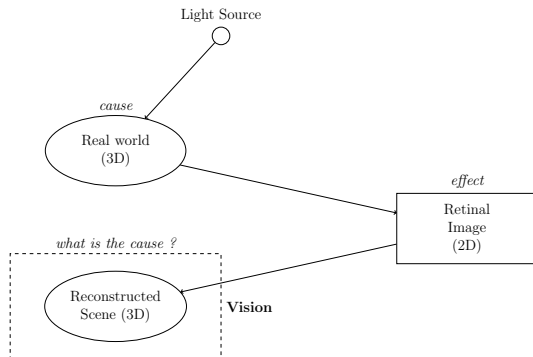
Layers of Interpretation



Goal of computer vision

- Emulate human vision system
 - ▶ ... Today's CV is far from achieving that
- How to bridge the gap?
 - ▶ Study principles of biological vision
 - ▶ Use them in computer vision algorithms

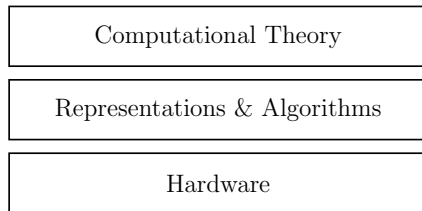
Computer Vision is an inverted problem



- Two approaches: Theory based and Machine learning based

Marr's abstractions (1976)

3-layer approach



- Independence of layers
- Same computational theories (as in biological vision system) can be implemented
 - ▶ On different hardware
 - ▶ With different representations and algorithms

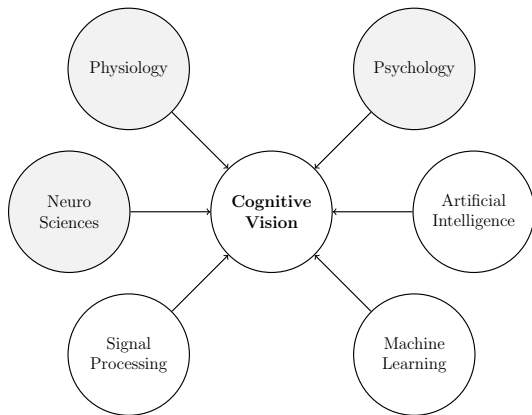
What are the challenges ?

- Too much of data to be handled
 - ▶ A HD video camera (1280×780) at 30 fps generates about 90 MB of data per sec.
- Interpreting visual data is ambiguous
 - ▶ Inter-class similarity: A red circular object may be a cricket ball or a tomato
 - ▶ Intra-class variations: No two roses are exactly identical!
 - ▶ Semantic gap
- Real-Time performance
 - ▶ Situated agents
 - ▶ Interacting continuously with the environment
 - ▶ Eternal cycle of sensing and acting

How does human mind cope up with the challenges ?

- Human mind does not have unlimited memory or processing power
 - ▶ Interpretation of a visual scene is mostly instantaneous and intuitively!
- How it happens ?
 - ▶ Data reduction: What to ignore and what to use?
 - ▶ Knowledge-based interpretation: Context, knowledge and experience
- Interpretation is subjective

What all are involved?



About the course

Pre-requisites

- **Mathematical/statistical skills**
- **Proficiency in programming**
 - ▶ Python: [Colab env](#)
 - ▶ Exposure to OpenCV library
- Computer Vision: Desirable, but not necessary
- AI / ML: Will be introduced as necessary
- Physiology / Psychology / Neurology: No

Study Material

- Textbook:
 - ▶ Hiranmay Ghosh. Computational Models for Cognitive Vision. Wiley-IEEE Press, 2020.
 - ▶ [Access link](#) (No download)
- Research papers & EdPuzzle videos will be announced in the class
- Lecture slides & videos will be uploaded in the classroom
- Background Study Material
 - ▶ [Metric Space and Image Features](#)
 - ▶ [Probability Theory](#)
- Recommend attending the class on a big screen (laptop / desktop)

- Google Classroom code: y7b2wfi
- GMeet: [Link](#)
- Class Timings: **Slot R**
 - ▶ Thu: 6:00 - 7:30 pm
 - ▶ Sat: 4:00 - 5:00 pm
- **All course resources are accessible on IIT-J login only**

- **Continuous Evaluation [60]**

- ▶ Simple quiz at the end of every class (well almost!) [20]
 - ▶ Immediate deadline (**No second chance**)
- ▶ EdPuzzle assignments [15]
- ▶ Programming / non-programming assignments [20]
 - ▶ Programming assignment: Python (CoLab Environment)
 - ▶ **Submit readable code only** [[Example of unreadable code](#)]
- ▶ Class participation [5]
 - ▶ Attendance, Interactions, Timely submissions

- **Examinations [40]**

- ▶ Minor 1 & 2 [20]
- ▶ Major [20]

- **Plagiarism Policy: Zero Tolerance**

No quiz for module 01-01

End of Module 01-01