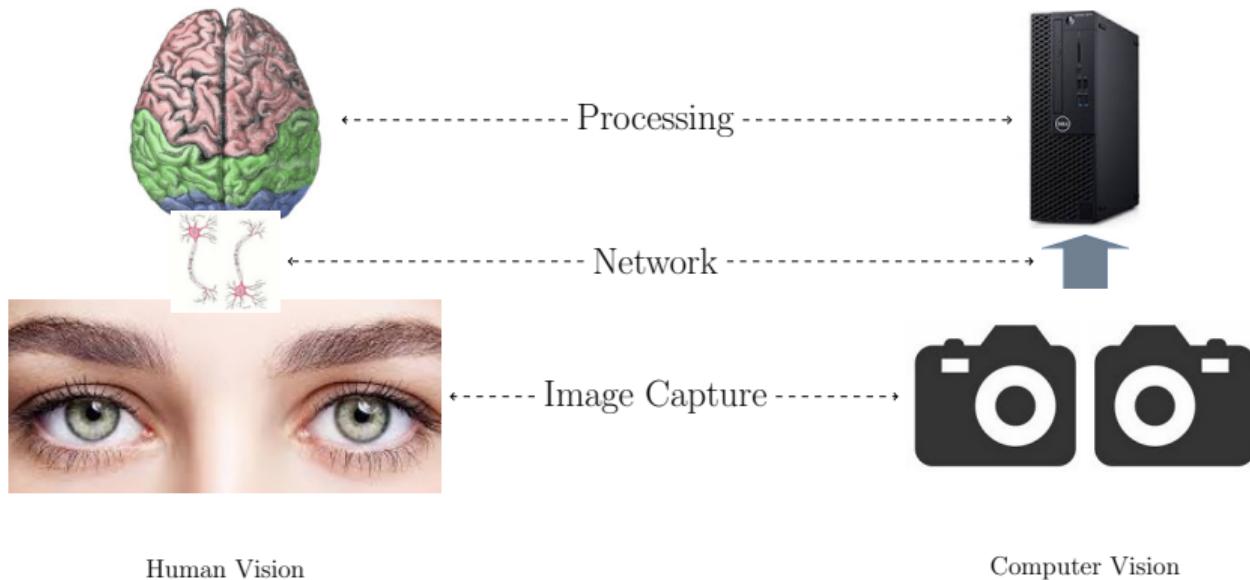


Biological Vision and Applications

Module 01-02: Human Vision System

Hiranmay Ghosh

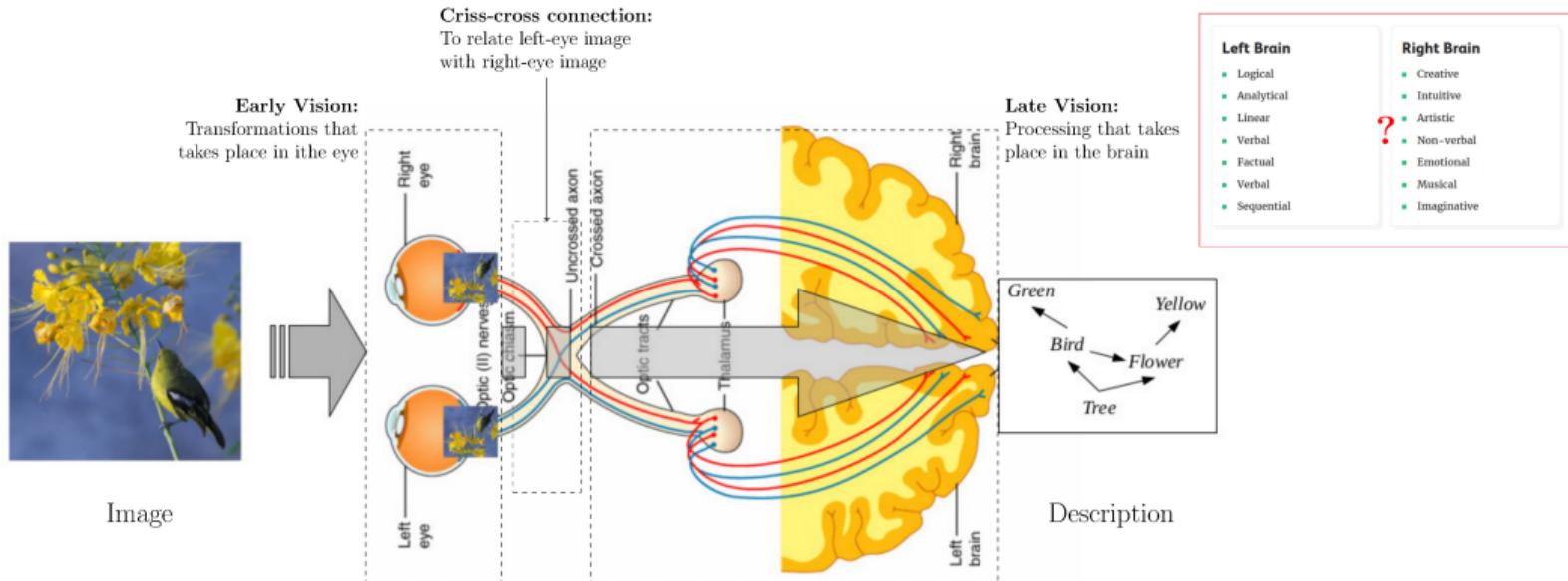
A Simplistic Analogy



... But, there is much more to it

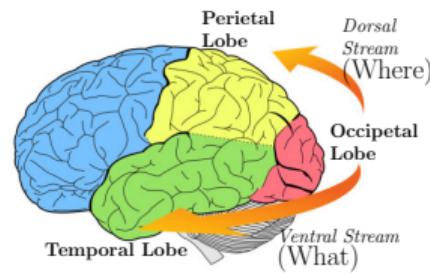
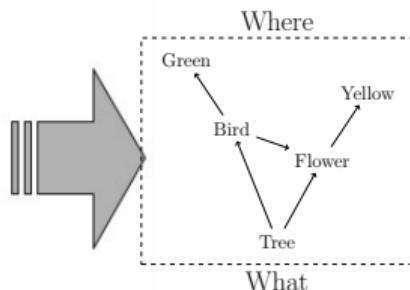
Overview of Human Vision System

Early Vision and Late Vision



Ventral and Dorsal Streams

Answering “What” and “Where”



- Ventral Stream is responsible for answering **What**
- Dorsal Stream is responsible for answering **Where**

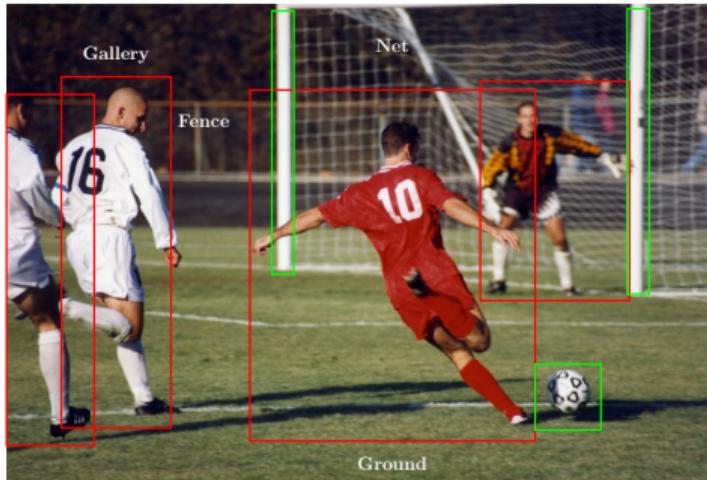
What is “Vision”?



- **Recognition and localization**
 - ▶ Four players, Ball, Goal post
 - ▶ Net, viewers' gallery, fence ...
- **Semantic interpretation**
 - ▶ Football game
 - ▶ Free kick
- **Prediction**
 - ▶ Possible goal score

Perception

Identify objects, locations: What and where

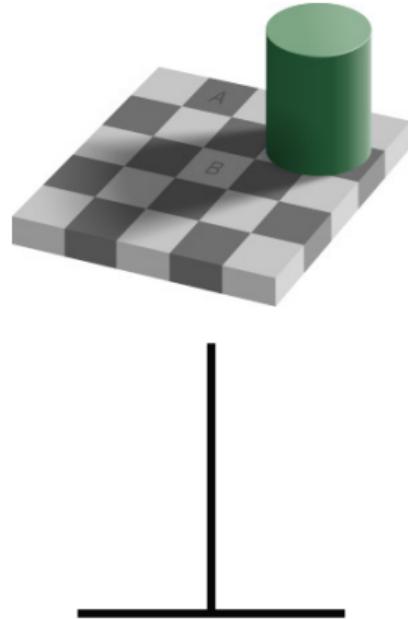


- Foreground and background
- **What ?**
 - ▶ Four Players, Ball, Goal Posts
 - ▶ Net, Fence, Gallery, Ground ...
- **Where ?**
 - ▶ Absolute & relative positions
 - ▶ Geometric organization

What is perception

- Interpretation of the sensory data - signal processing
- Some assertions made about the environment
- From signals to semantic representation
 - ▶ Results in data reduction
- Different viewers can make different assertions about the same scene
 - ▶ Depending on viewpoint, signal noise, sensory capabilities, etc.
- May be correct, partially correct, or incorrect
 - ▶ There can be “illusions”

Optical illusions



My Wife and My Mother-in-law (German postcard 1888)

Attention

Decide what is important



- We never look at the whole scene
 - ▶ We look at **selective** places for understanding the scene
- Lots of information gets filtered out before entering cognitive system
- Visual semantics is conveyed by very small regions of a picture

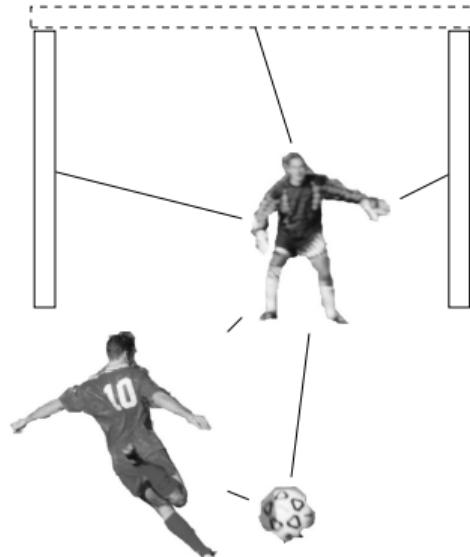
What is attention

- Selective filtering of the sensory data
 - ▶ Deciding what is important
- Results in data reduction
- Depends on context, user intention, task at hand
- Can result in change blindness
 - ▶ Adversarial attempt to “divert” attention

[EdPuzzle assignment](#)

Cognition

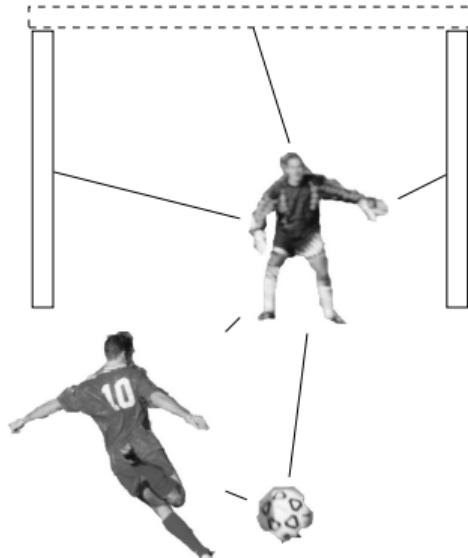
What do you “infer” from this picture ?



- Focus on a few things and interactions
- Draw inferences:
 - ▶ It is a football game
 - ▶ It is a free-kick
 - ▶ The goal-keeper is ready to defend
- How do you make these inferences?
 - ▶ Knowledge of football and other games
 - ▶ Information about this game, identity of the players ...

Prediction

What do you “predict” ?



- What will be the likely trajectory of the ball?
- What will be the goal-keeper's reaction?
- What is the probability of a goal score?
- How do you make these inferences?
 - ▶ Knowledge of football and other games
 - ▶ Experience of this game, reputation of the players ...

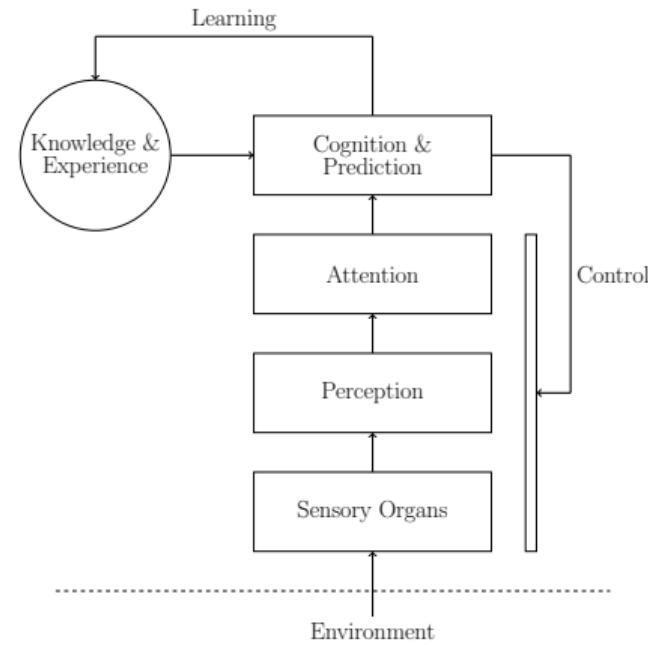
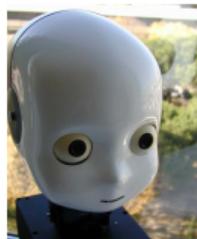
What is cognition

- Experiential interpretation of the filtered percept
- Cognition is subjective, depending on
 - ▶ Intentional state of the observer
 - ▶ Background knowledge, context, experience, etc.
- Can fill-in the missing percept / correct erroneous perceptions
- Cognition includes prediction (past and future)

In summary ...

- **Perception:**
 - ▶ Acquisition of new information about the environment through the sensors
 - ▶ Sensory signals to symbolic representation
- **Attention:**
 - ▶ Selective filtering of percept (decide what to filter)
 - ▶ Depends on user task, intention, context, etc.
- **Cognition:**
 - ▶ Experiential interpretation of filtered sensory data
 - ▶ Inferencing about the (past / present / future) state of the world

Simplified process model for Vision System



Quiz



Quiz 01-02

End of Module 01-02