COL 780
Computer Vision

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http://fortune.com/2015/10/16/how-tesla-autopilot-learns/

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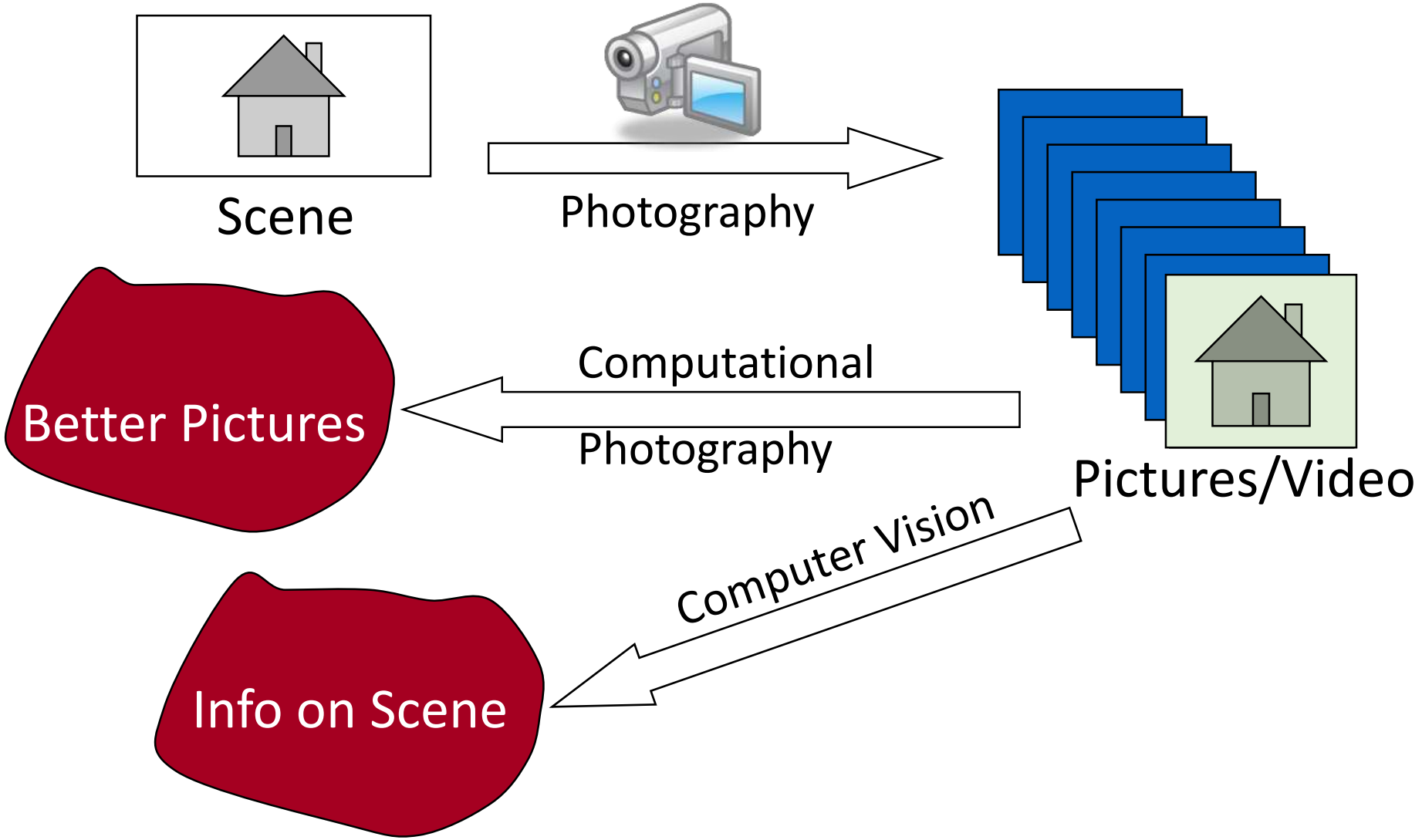
Computer Vision

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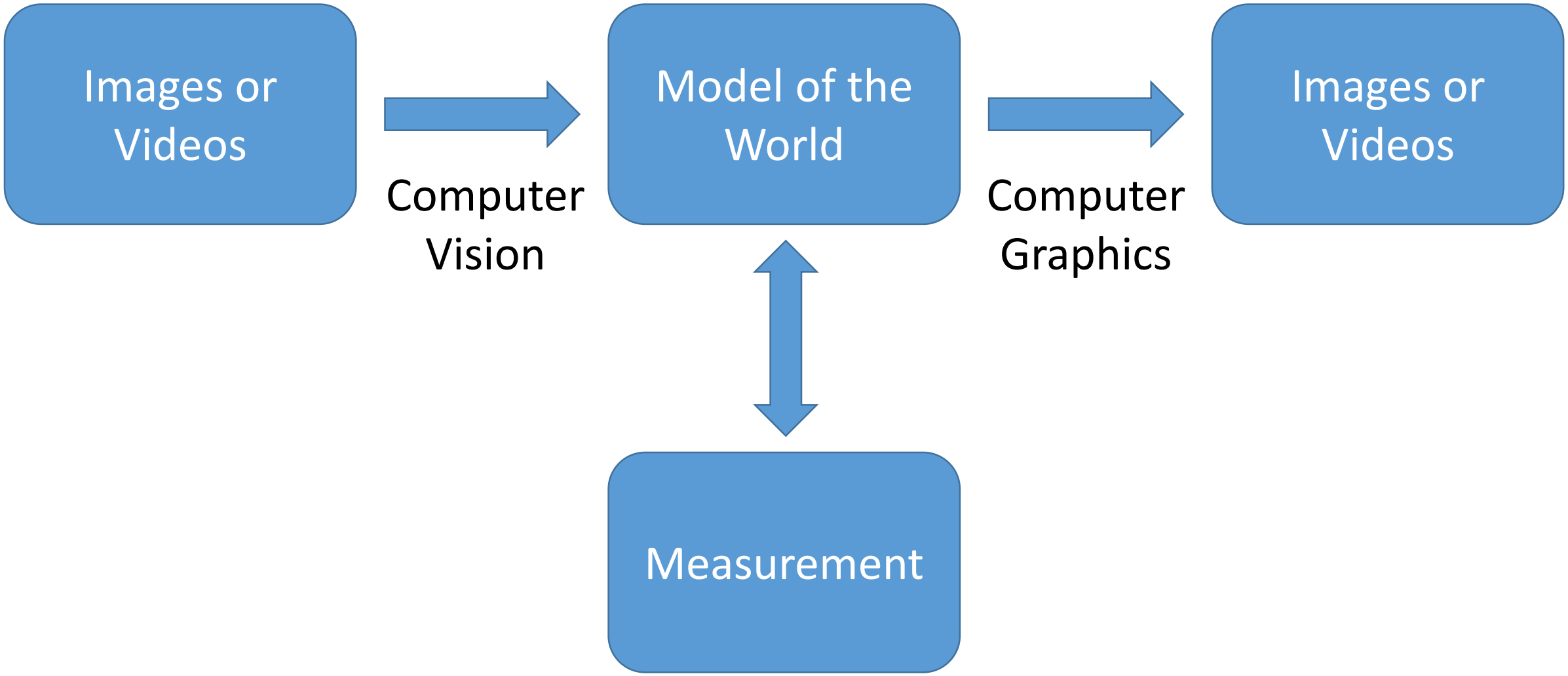
Computer Vision Vs Graphics

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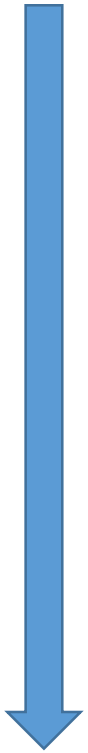
Stages in Computer Vision

- **Physics:** Image Formation (Light, Reflectance)
- **Physics:** Cameras: Optics (Lens), Sensors (CCD, CMOS)
- **Image Processing:** Coding (Transmission, Compression)
- **Comp. Photo.:** Enhancement (Noise, Resolution, Colors)
- **IP-CV:** Feature Detection (Objects, Actions, Motion)
- **Computer Vision:** Scene recovery (3D, Reflectance)
- **Computer Vision:** Object Classification / Recognition
- **Human and Machine Vision:** Visual Perception
- **Robotics:** Control Action (Autonomous Driving)

Low Level Vision



High Level Vision

Have You Used Computer Vision?

- **Laptop:** Biometrics auto-login (face recognition, 3D), OCR

- **Smartphones:** QR codes, computational photography (Android Lens Blur, iPhone Portrait Mode), panorama construction (Google Photo Spheres), face detection, expression detection (smile), Snapchat filters (face tracking), Google Tango (3D reconstruction), Night Sight (Pixel)

- **Web:** Image search, Google photos (face recognition, object recognition, scene recognition), Facebook (image captioning), Google maps aerial imaging (image stitching), YouTube (content categorization)

Have You Used Computer Vision?

- **VR/AR:** Outside-in tracking (HTC VIVE), inside out tracking (simultaneous localization and mapping, HoloLens), object occlusion (dense depth estimation)

- **Motion:** Kinect, full body tracking of skeleton, gesture recognition, virtual try-on

- **Medical Imaging:** CT / MRI reconstruction, assisted diagnosis, automatic pathology, endoscopic surgery

James Tompkin, Brown University

Have You Used Computer Vision?

- **Industry:** Vision-based robotics (marker-based), ANPR (number plates), surveillance, drones, shopping
- **Transportation:** Assisted driving (everything), face tracking/iris dilation for drunken-ness, drowsiness.
- **Media:** Visual effects for film, TV (reconstruction), virtual sports replay (reconstruction), semantics-based auto edits (reconstruction, recognition)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Nature: Vision ≡ Smart ≡ Moving

- Only smart and moving organisms can see!
  - Bacteria & Plants do not see
- Visual recognition at early development
  - Babies recognize and track the mother very early
- Most of the human brain is involved in vision processing.

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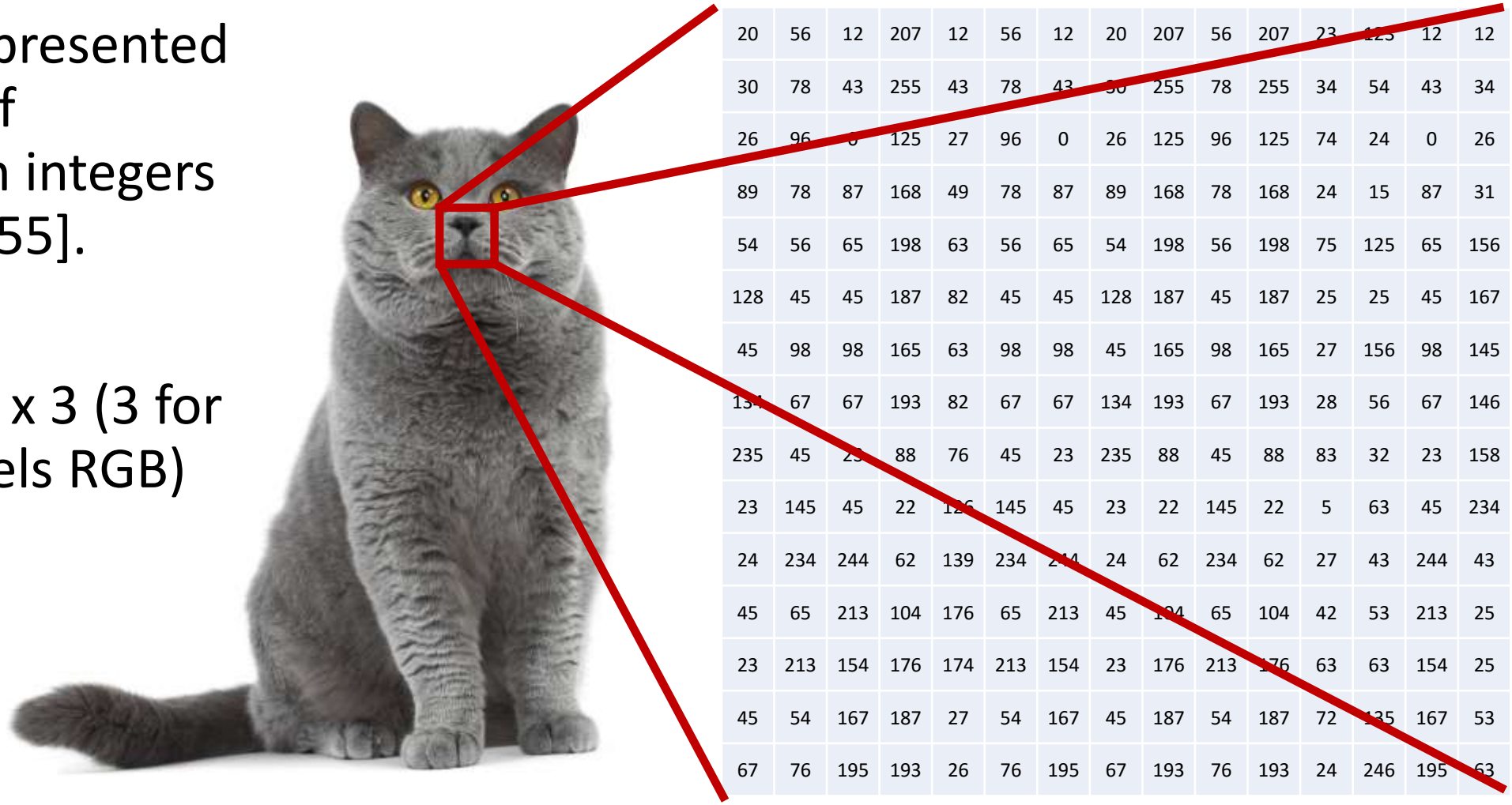
Why is Computer Vision Hard: Semantic Gap

- Images are represented as 3D arrays of numbers, with integers between [0, 255].
- E.g. 300 x 100 x 3 (3 for 3 color channels RGB)



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Visual Recognition Challenges

Intra class variation

Background Clutter

Deformation

Illumination

Occlusion

Size


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Computer Vision Vs Deep Learning

- Just like for many other domains, deep learning is an enormous disruption to the computer vision.

- Since 2012, many of the state of the art computer vision techniques are based on deep learning models.

- For many of the problems like image classification or face recognition it has been shown to even surpass human performance.


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Is there More to Computer Vision than DL?

- Not every problem is a learning problem. Geometry? Measurement?

- DL is data hungry. Not practical for many problems. Medical Imaging?

- Lots of data = lots of potential bias in the data.
  - Needs understanding of possible failures.
  - Responsible approach.
  - Techniques to overcome bias

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Course Contents

Image Processing

- Camera model. Calibration, multi-views projective geometry and invariants.
- Feature detection, correspondence and tracking.

Applications

- 3D structure/motion estimation.
- Application of machine learning in object detection and recognition, category discovery, scene and activity interpretation.

Evaluation

- Minor 1: 15
- Minor 2: 15
- Quizzes: 10
- Major Exam: 30
- Assignments(3): 30


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Course Policies

- Scoring less than 40% marks in any of the exams/assignments will lead to failing the course.
- Any plagiarism detected in any of the assignments will lead to failing the course.
- No deadline extension in any submission.
- No auditing the course.