

# ECG782: Multidimensional Digital Signal Processing

Spring 2014

TTh 14:30-15:45 CBC C313

Lecture 01

Introduction

14/01/21

# Outline

- Computer Vision Overview

# What is Computer Vision?



- Hanauma Bay, Hawaii

# What is Computer Vision?

- Goal is to develop algorithms and programs that can interpret and understand images
  - Image can be a single image or come from a video
- Must bridge the gap between what we see and what a computer “sees”

# Why is Computer Vision Difficult II

- Humans are very skilled with vision
  - We are designed with vision as our primary sensory input
  - It comes naturally
- Computers operate on numbers and do not have contextual clues we have wired in our brains



What we see

0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

What a computer sees

# Why is Computer Vision Difficult II

- Loss of information in 3D  $\rightarrow$  2D
  - The world is 3D but an image is only 2D
    - Loss of information from perspective imaging
- Interpretation
  - Many different interpretations of the same image
  - `interpretation: image data  $\rightarrow$  model`
  - How to develop a meaningful model
- Noise
- Big data
  - High resolution imagery, HD video, lots of training data
- Brightness measurement
  - Complicated physical process that is hard to determine from an image
- Local window vs. need for global view
  - Processing done locally but must make inference globally

# Humans vs. Computers

- Computers can't currently beat humans
  - Humans are much better at “hard” things
  - Computers can be better at “easy” things
- Computers are computational device so must be given memory and learn
- If the task requires lots of attention it may be better suited for a computer
  - Surveillance
  - Automotive blind spot detection
  - Searching for a face in a crowd

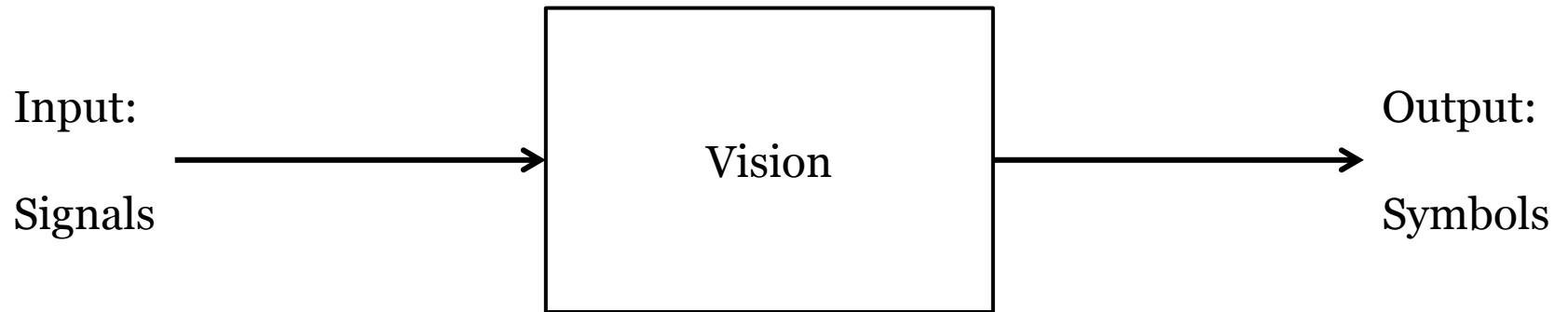
# CV as Intelligent Systems

- Intelligence
  - The capacity to acquire knowledge
  - The faculty of thought and reason
- System
  - A group of interacting, interrelated or interdependent elements forming a complex whole
- This class uses computer vision to give a system intelligence
- The systems should perceive, reason, learn, and act intelligently



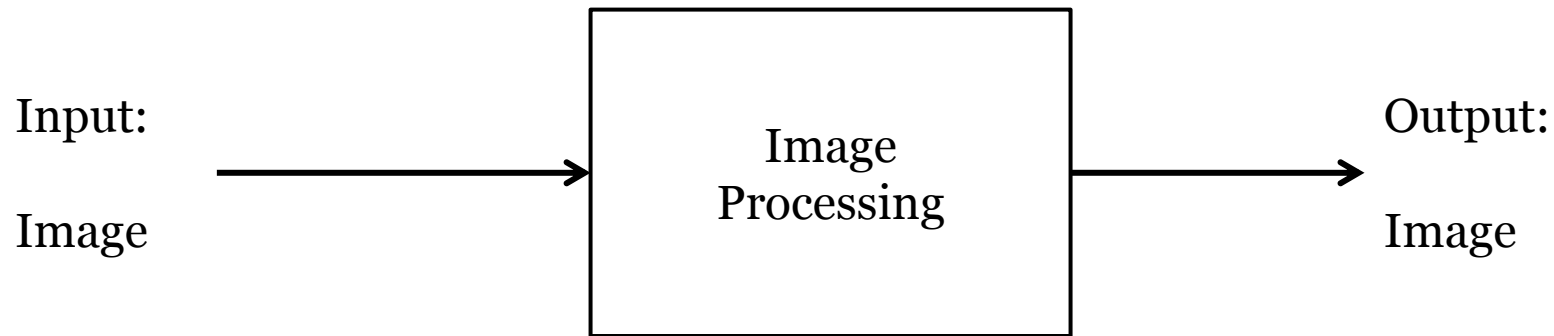
# Vision

- Signal to symbol transformation



# Image Processing

- Manipulation of images



Examples:

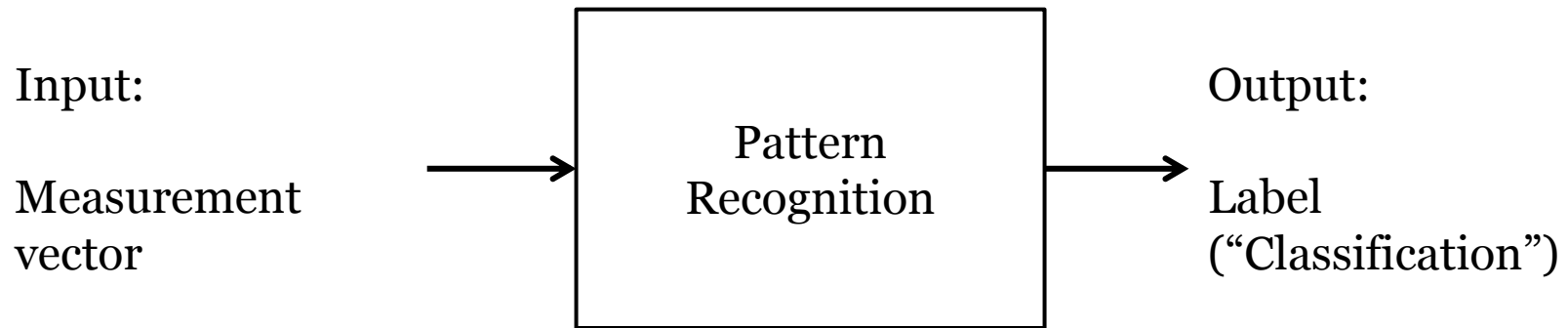
- “Photoshopping”
- Image enhancement
- Noise filtering
- Image compression

# IP Examples



# Pattern Recognition

- Assignment of a label to input value

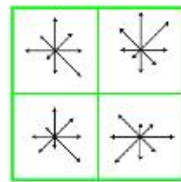


Examples:

- Classification (1/0)
- Regression (real valued)
- Labeling (multi label)

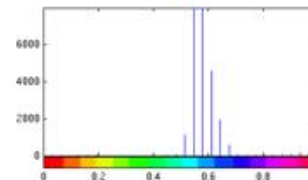
# PR Examples

SIFT



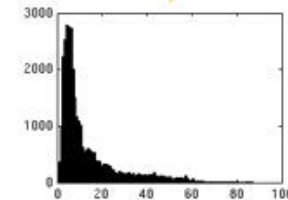
Dim 128

H histograms

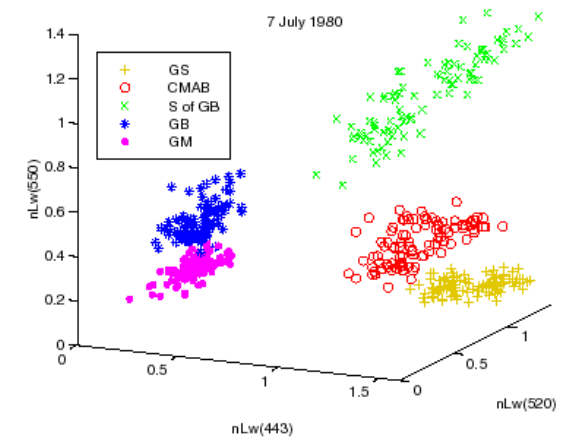
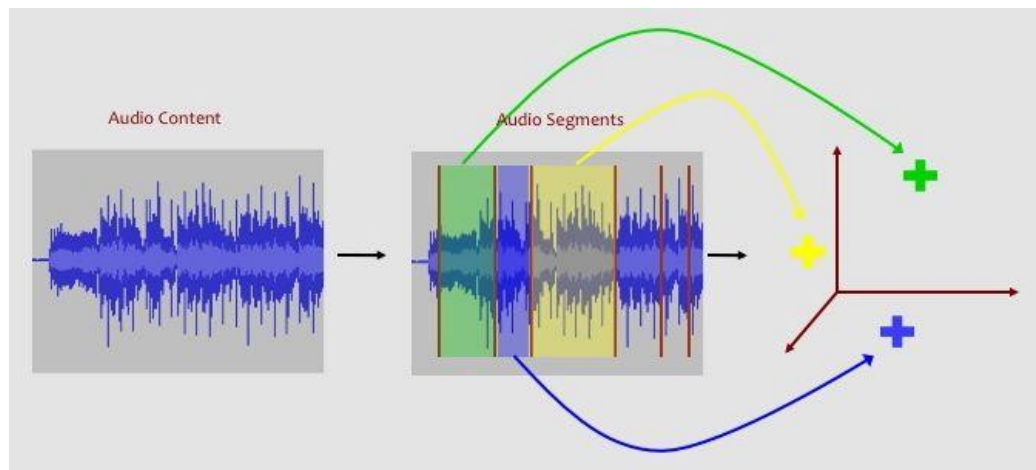


Dim 16

V histograms

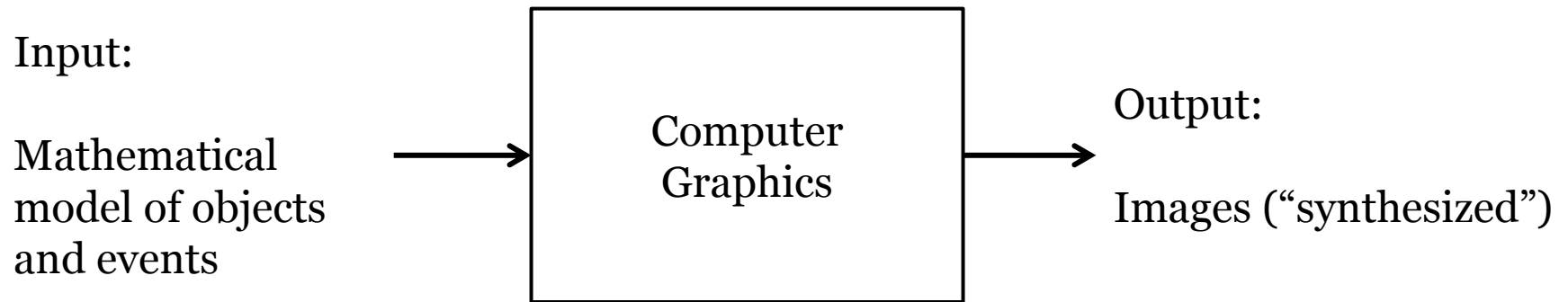


Dim 16



# Computer Graphics

- Create realistic images (“forward problem”)



Examples:

- Simulation (flight, driving)
- Virtual tours
- Video games
- Movies

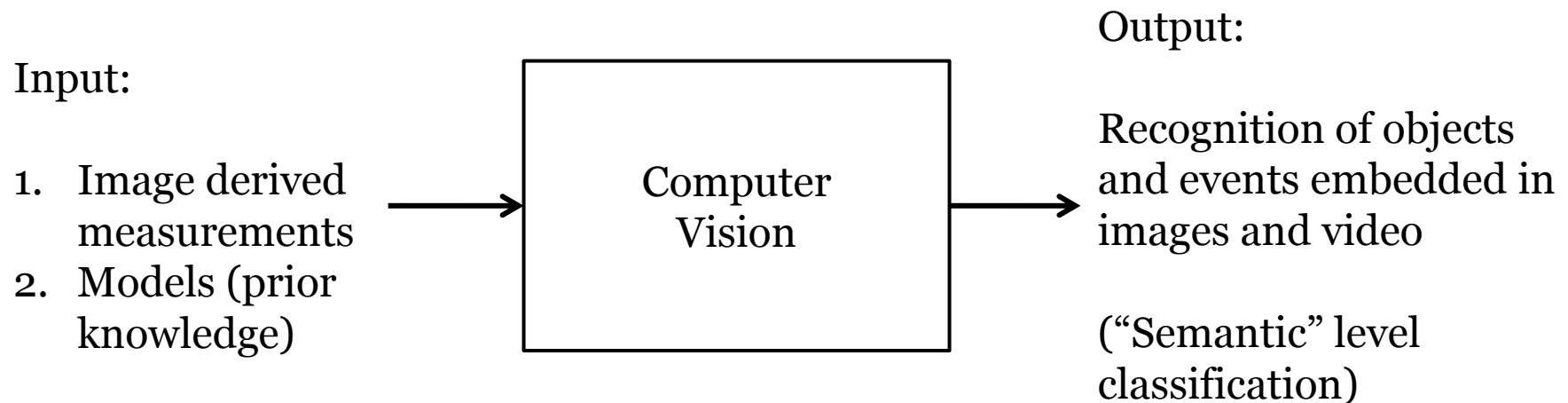


# CG Examples



# Computer Vision

- Interpretation and understanding of images



Examples:

- Object recognition
- Face recognition
- Lane detection
- Activity analysis



# Scope of Computer Vision

- Very broad
- Cfp for the Computer Vision and Pattern Recognition (CVPR) conference:

<ul style="list-style-type: none"><li>• Motion and Tracking</li><li>• Stereo and Structure from Motion</li><li>• Shape-from-X</li><li>• Color and Texture</li><li>• Segmentation and Grouping</li><li>• Image-Based Modeling</li><li>• Illumination and Reflectance Modeling</li><li>• Shape Representation and Matching</li><li>• Sensors</li><li>• Early and Biologically-Inspired Vision</li><li>• Computational Photography and Video</li></ul>	<ul style="list-style-type: none"><li>• Object Recognition</li><li>• Object Detection and Categorization</li><li>• Video Analysis and Event Recognition</li><li>• Face and Gesture Analysis</li><li>• Statistical Methods and Learning</li><li>• Performance Evaluation</li><li>• Medical Image Analysis</li><li>• Image and Video Retrieval</li><li>• Vision for Graphics</li><li>• Vision for Robotics</li><li>• Applications of Computer Vision</li></ul>
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# Examples of State-of-the-Art

# Autonomous Cars

- Google Car
- <http://www.youtube.com/watch?v=-3ulKUJtZ3o>

# Augmented Reality

- Google Glasses
- <http://www.youtube.com/watch?v=JSnBo6um5r4>
- <http://www.youtube.com/watch?v=fhFzStkoEo>

# 3D Structure

- <http://www.youtube.com/watch?v=UwBd1RbKljk>

# Robotics

- <http://www.youtube.com/watch?v=c3Cq0sy4TBs>

# Panoramas

- <http://www.youtube.com/watch?v=zVlO3PAYM-Q>