UNIVERSITY OF WATERLOO

CS 484/684

Computational Vision

- Web page: cs.uwaterloo.ca/~yboykov/Courses/cs484/
  - announcements, assignments (text), code samples/libraries, **syllabus**
  - lecture notes

- LEARN
  - assignments collection/grading

UNIVERSITY OF WATERLOO

CS 484/684

Computational Vision

- Today
  - Overview of computer vision applications

CS 484/684

Computational Vision

What is (computer) vision?

image (or video)

Sensing(device

Interpreting device

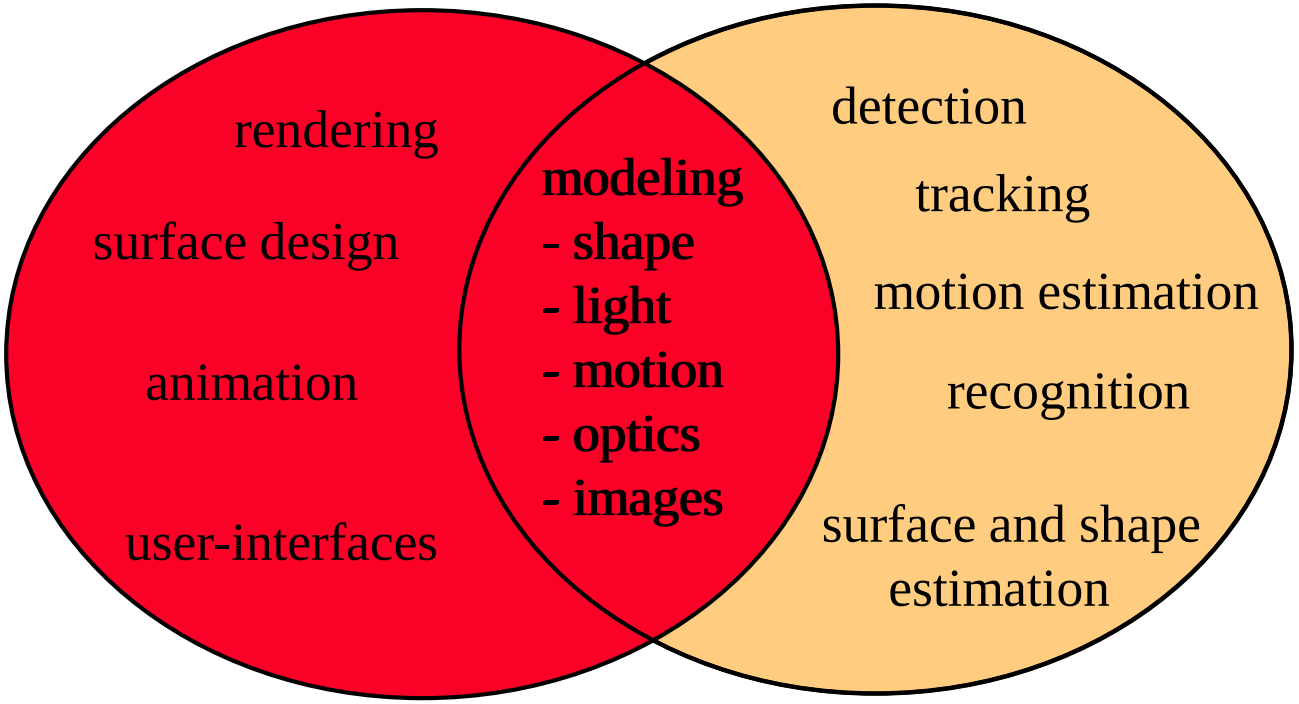
Interpretations

garden, spring, bridge, water, trees, 3D scene geometry, object shapes, etc.

Source: Fei-Fei Li

Computational Vision

What is it related to?



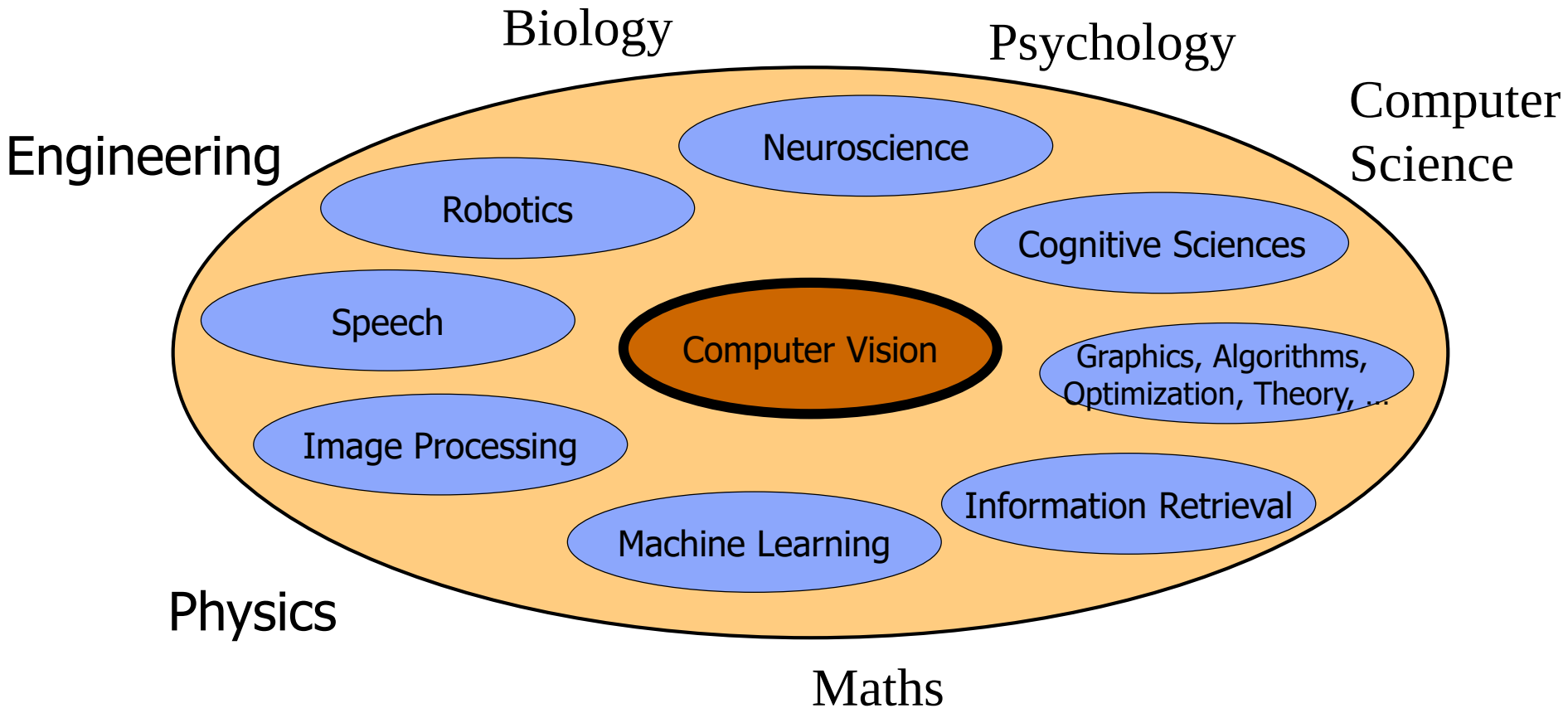
Computer Graphics
(Image Rendering)

Computer Vision
(Image Analysis)

Source: S. Seitz

Computational Vision

Interdisciplinary area, maths are important



Source: Fei-Fei Li

CS 484/684

Computational Vision

The goal of computer vision?

To bridge the gap between pixels and "meaning"

What we see

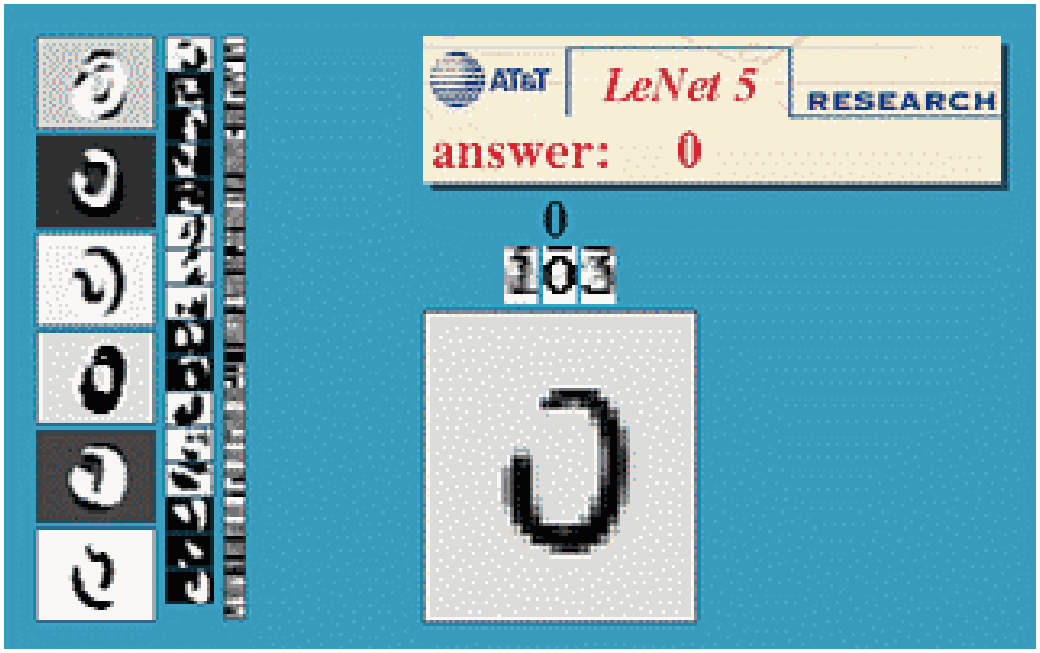
0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

What a computer sees

Source: S. Narasimhan

Computational Vision

Optical character recognition



early 90's

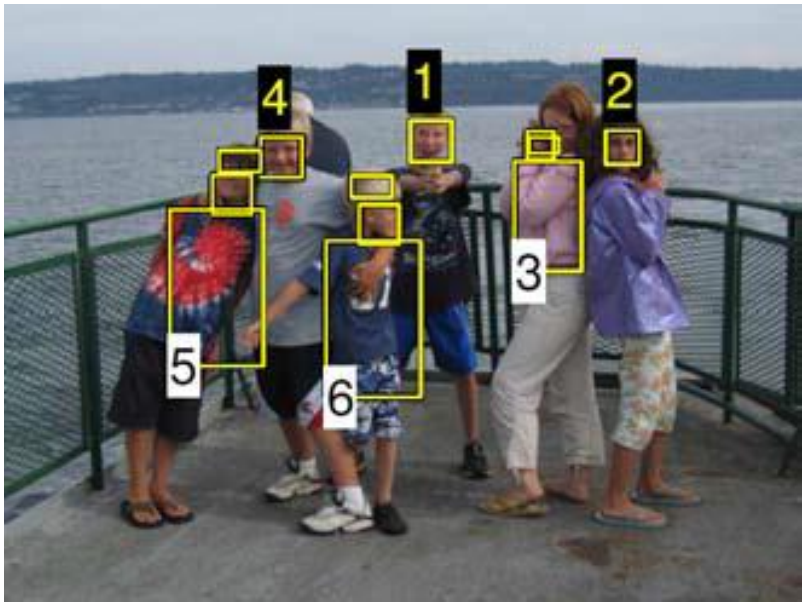
must be older

Source: S. Seitz

CS 484/684

Computational Vision

Object Detection



face detection around 00's

CS 484/684

Computational Vision

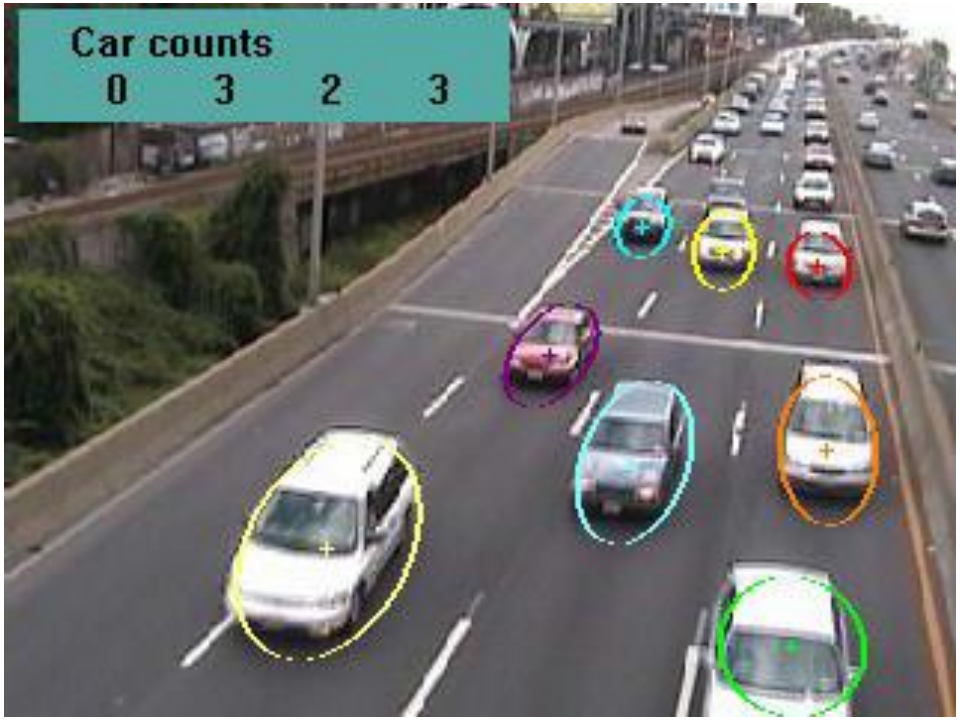
Object Detection

and now

CS 484/684

Computational Vision

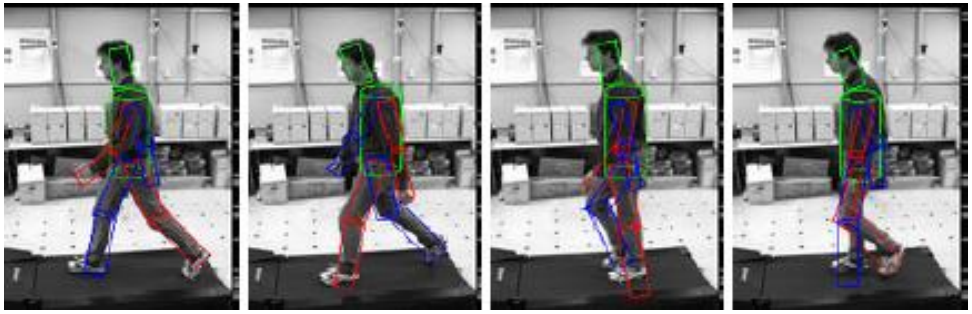
Object Detection and tracking:



CS 484/684

Computational Vision

Object Detection and tracking:

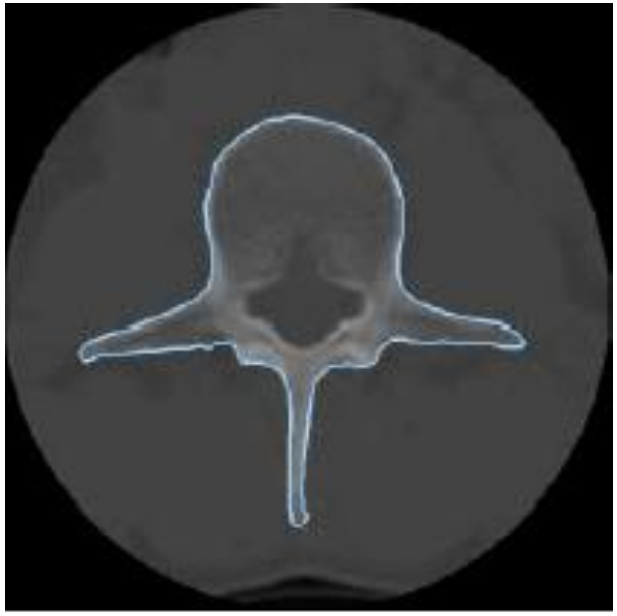


tracking pictorial structures

CS 484/684

Computational Vision

Segmentation (pixel accurate labeling):



2D model

CS 484/684

Computational Vision

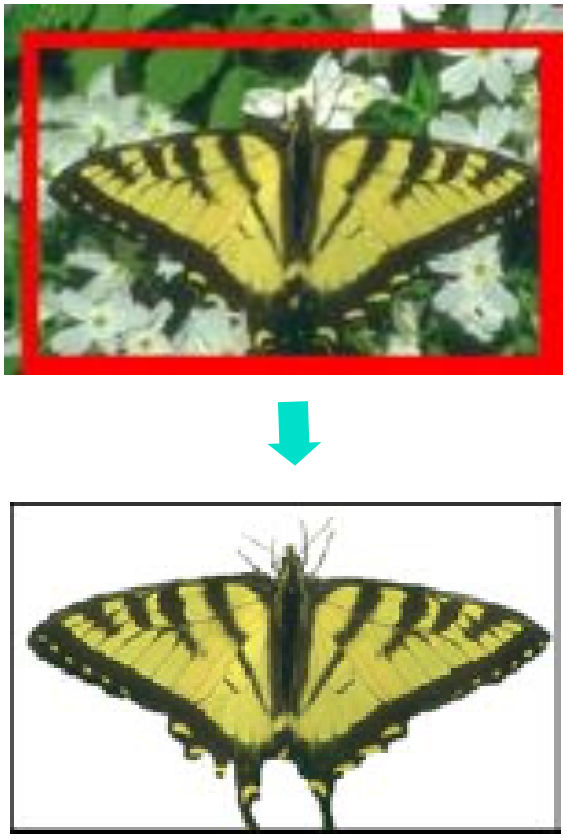
Segmentation ?

CS 484/684

Computational Vision

User-assisted Segmentation (photo/video editing):

Livewire 1995

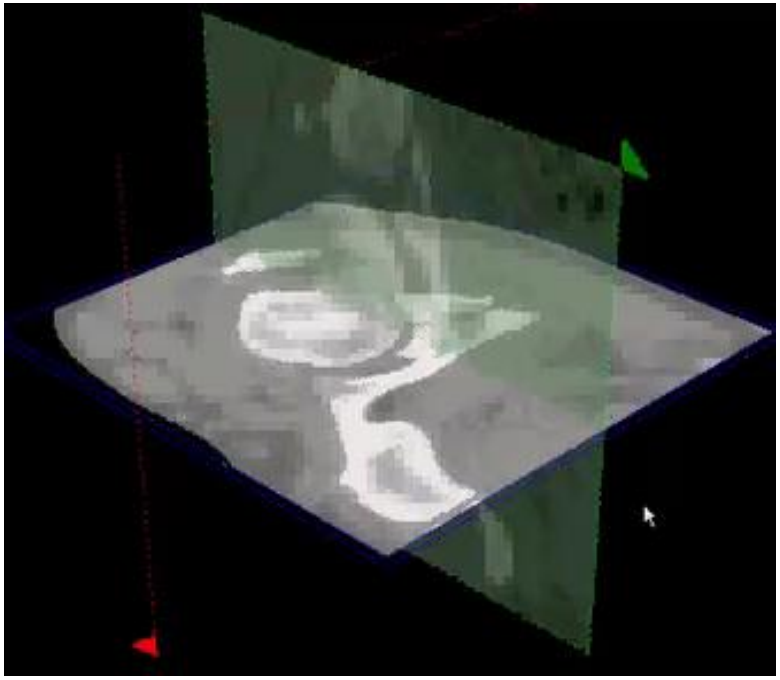


Graph cut 2001-2004

CS 484/684

Computational Vision

Segmentation in Medical Imaging:



3D object extraction

Graph cut 2001

CS 484/684

Computational Vision

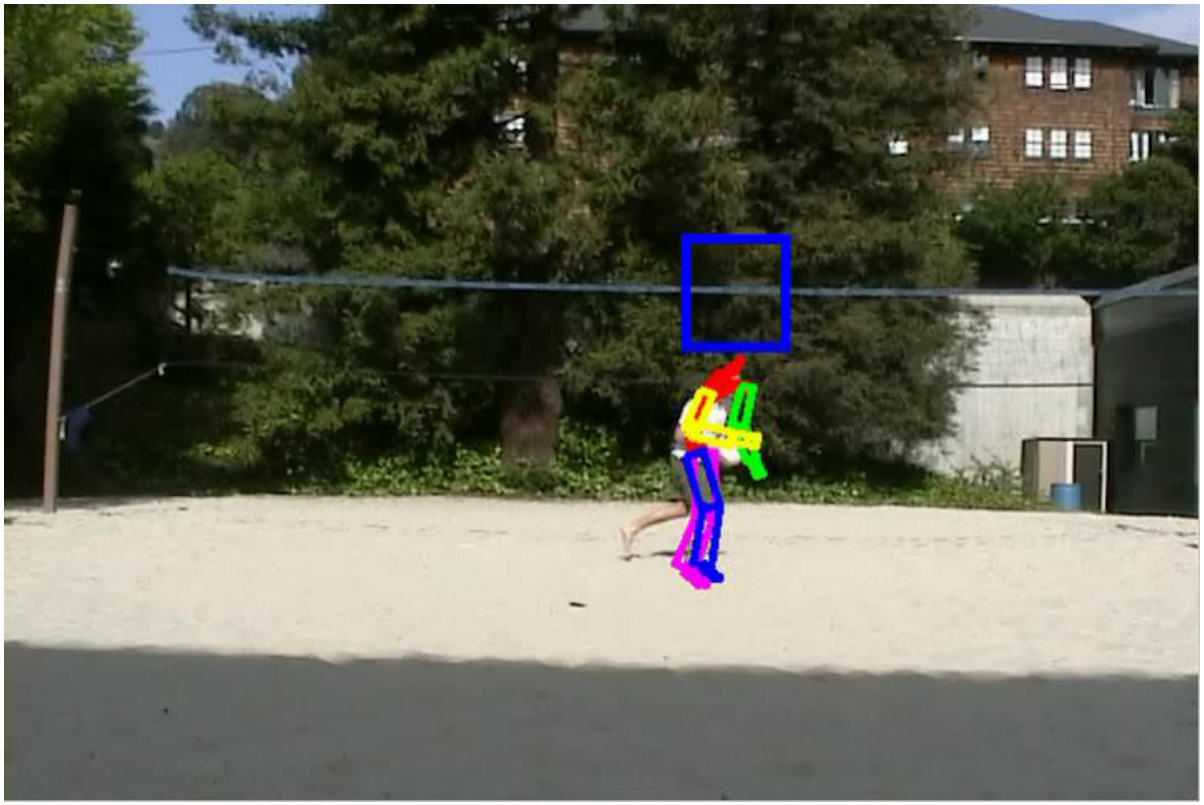
Combining Detection and Segmentation

Source: "CityScapes" data set

CS 484/684

Computational Vision

Activity recognition:



Bottom-up tracker

CS 484/684

Computational Vision

Vision-based interaction (gaming)

Microsoft Kinect
2010

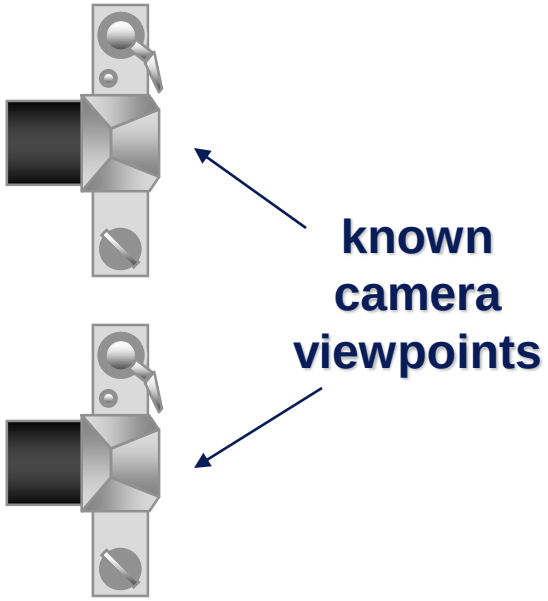
Assistive technologies

Source: S. Seitz

CS 484/684

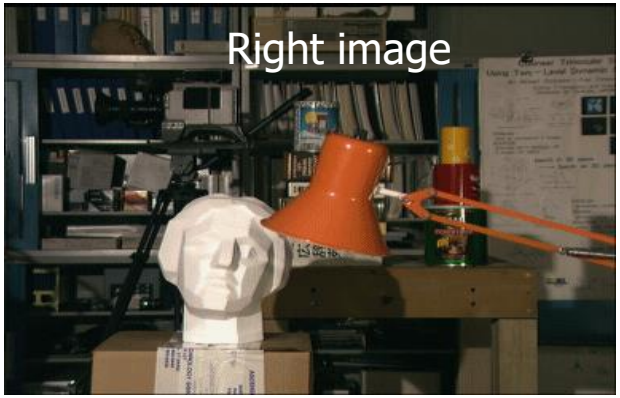
Computational Vision

- Stereo Reconstruction from Photo Images
  - Shape from two (or more) images
  - Biological motivation



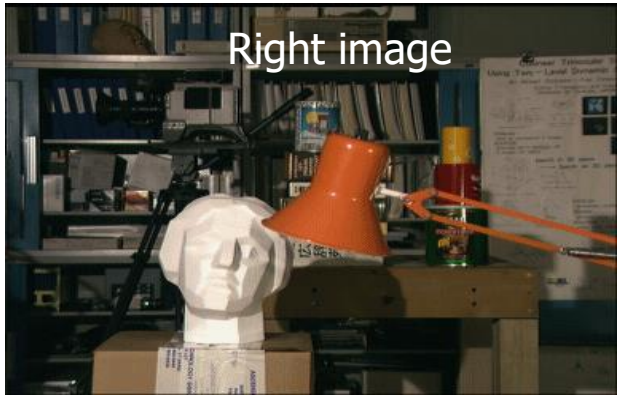
CS 484/684

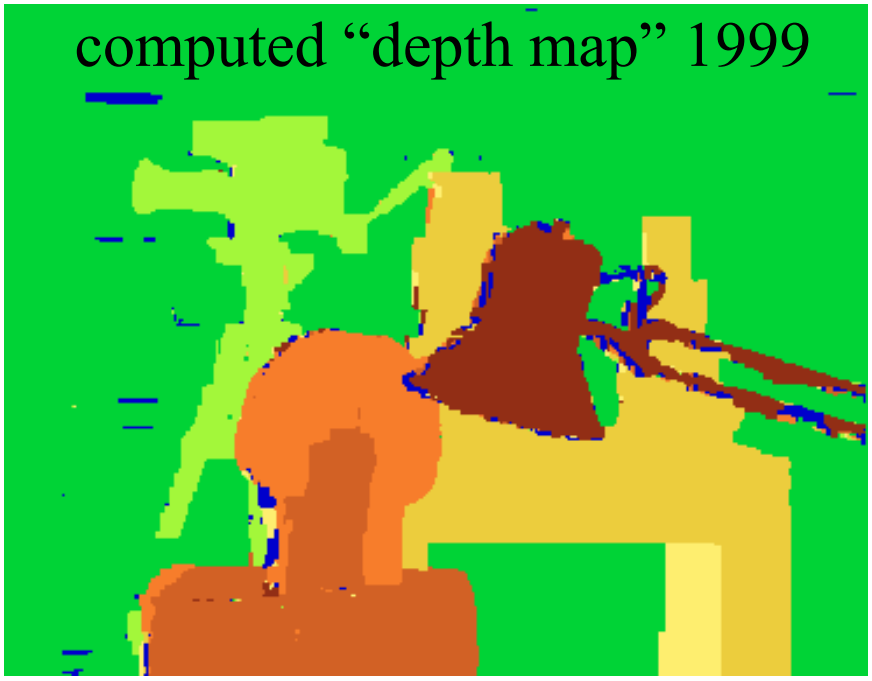
Computational Vision

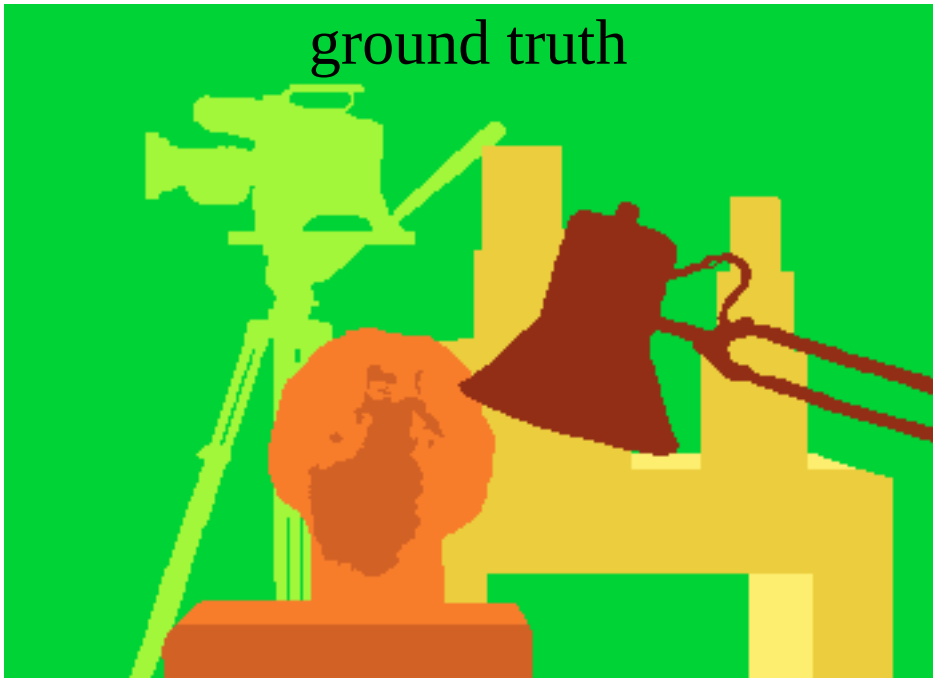


CS 484/684

Computational Vision







CS 484/684

Computational Vision



More then 2 images

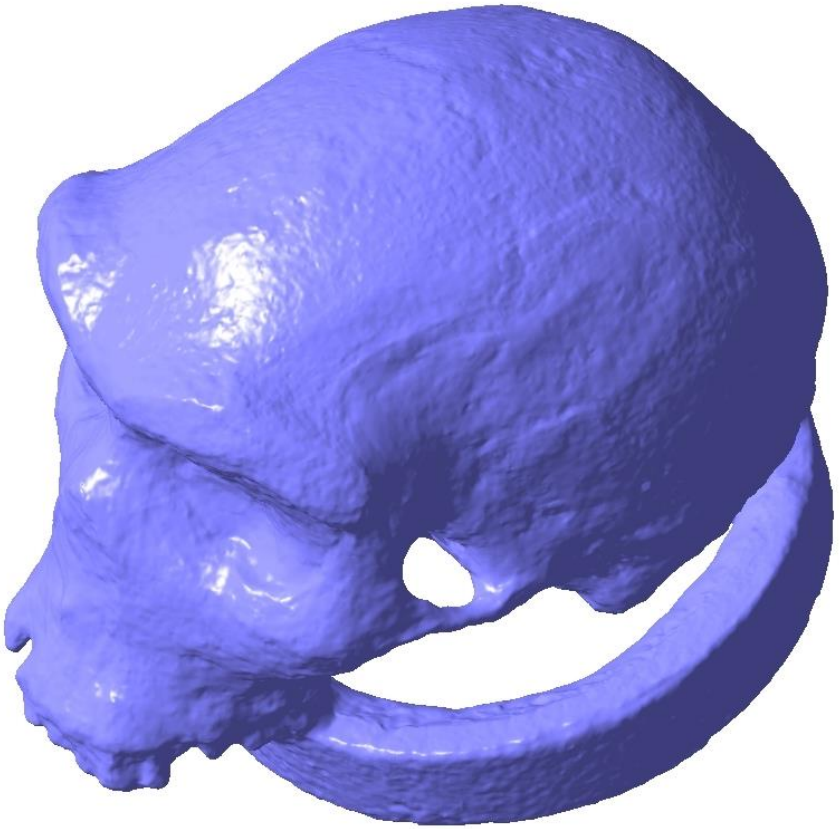
3D model 2005

UNIVERSITY OF WATERLOO

CS 484/684

Visual Computing

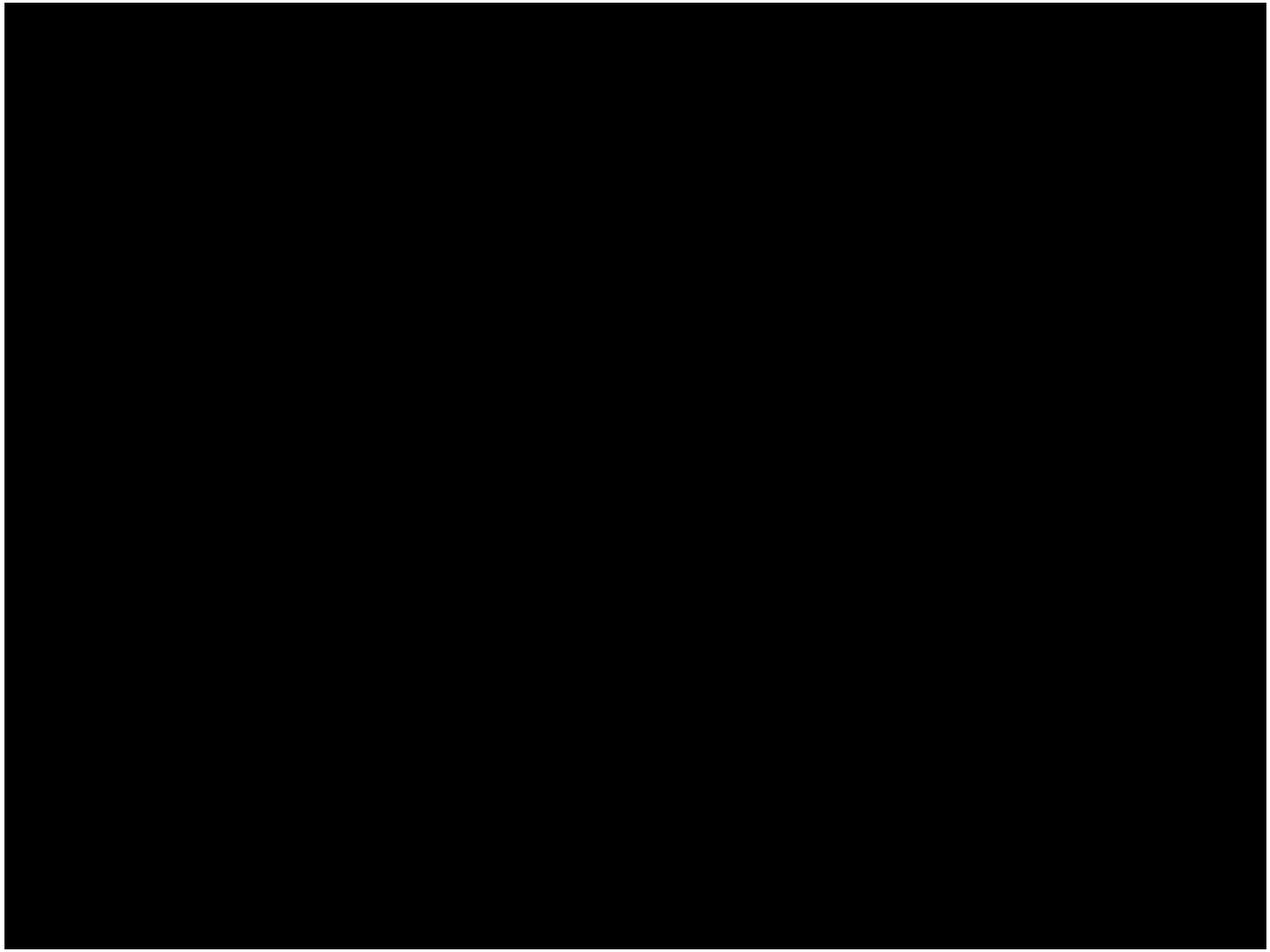
multi-view reconstruction
from high resolution cameras



3D model
2006

CS 484/684

Computational Vision



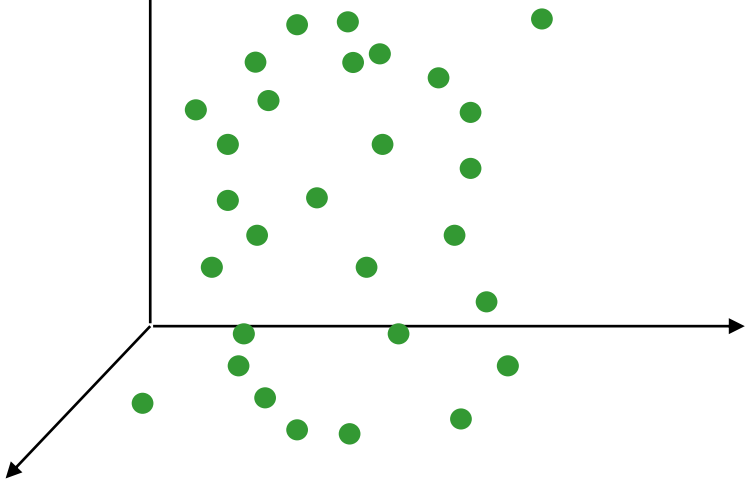
Structure from Motion (video from Carl Olsson)

CS 484/684

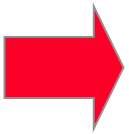
Computational Vision

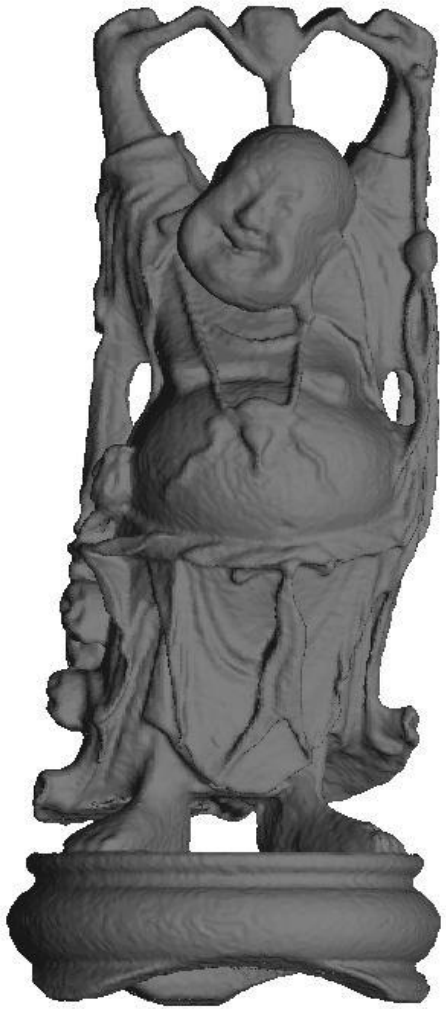
a cloud of 3D points

(e.g. from a laser scanner)



surface fitting:



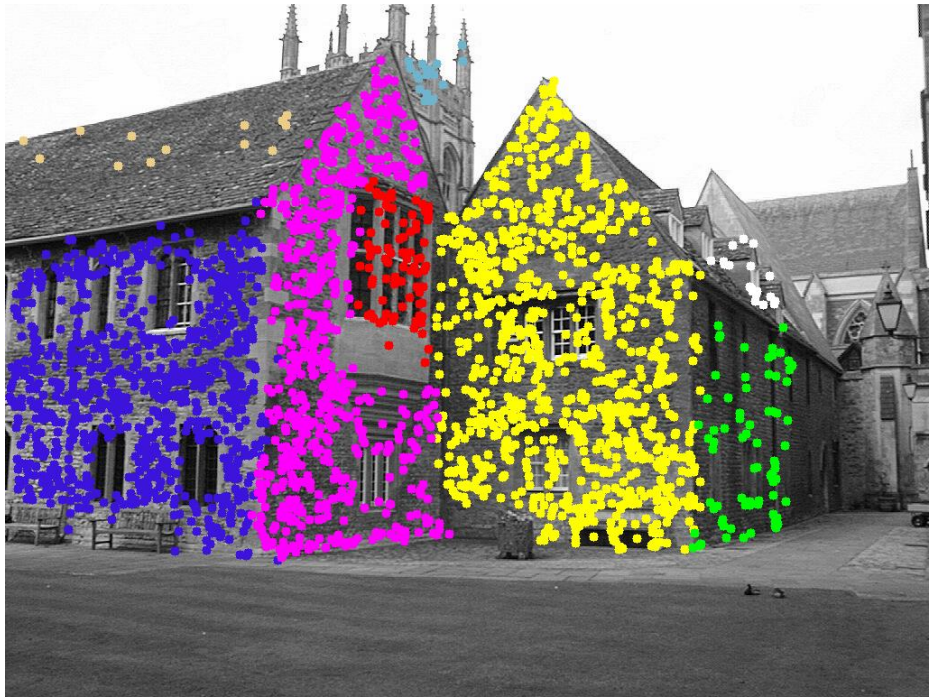


3D model:

CS 484/684

Computational Vision

Multiple views



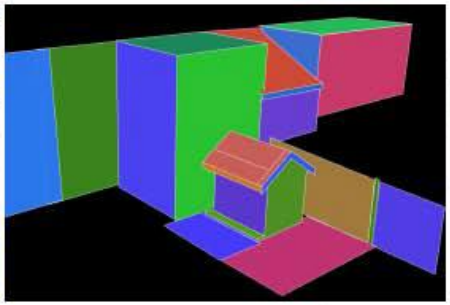
feature detection +
plane fitting

CS 484/684

Computational Vision

Input Photographs

2D Sketching Interface



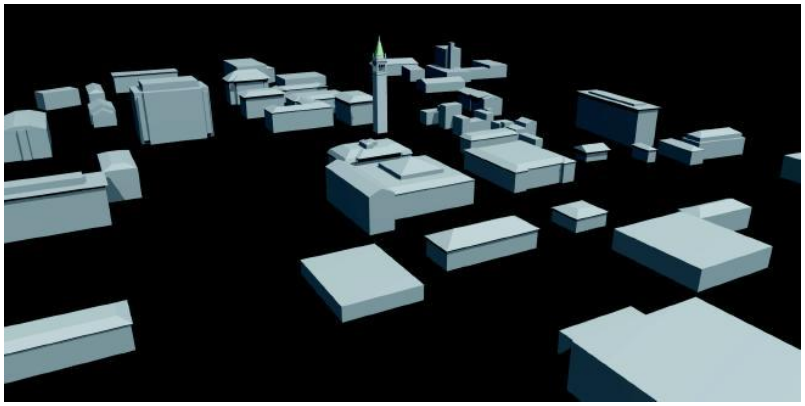
Geometric Model

Texture-mapped model

3D model constructed form 9 images

CS 484/684

Computational Vision



3D Scene Reconstruction:

Debevec, Taylor, and Malik, SIGGRAPH 1996

CS 484/684

Computational Vision

3D Scene Reconstruction:

From a single view!!!

Courtesy
Criminisi et al.

CS 484/684

Computational Vision

3D Scene Reconstruction:

From a single view!!!

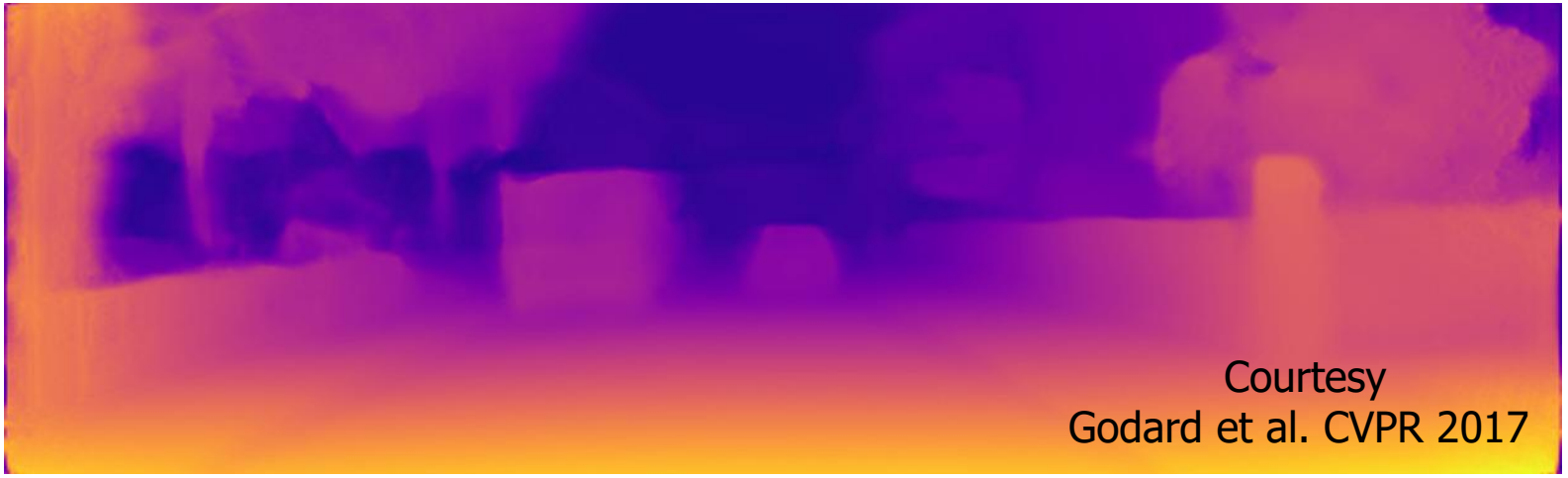
Courtesy
Criminisi et al.

CS 484/684

Computational Vision

3D Scene Reconstruction:

From a single view!!!



CS 484/684

Computational Vision

Vision for robotics (e.g. space exploration)

NASA's Mars Exploration Rover Spirit captured this westward view from atop a low plateau where Spirit spent the closing months of 2007.

Vision system solves the following tasks:

- panorama stitching
- 3D terrain modelling
- position tracking
- obstacle detection

Source: S. Seitz