CS 309: Autonomous Intelligent Robotics
FRI I

Lecture 4: AI Part 2 & C++ Part 2

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http://justinhart.net/teaching/2019_spring_cs309/

Today

- What is Artificial Intelligence? – Part 2
- C++ Primer – Part 2

Areas of Artificial Intelligence

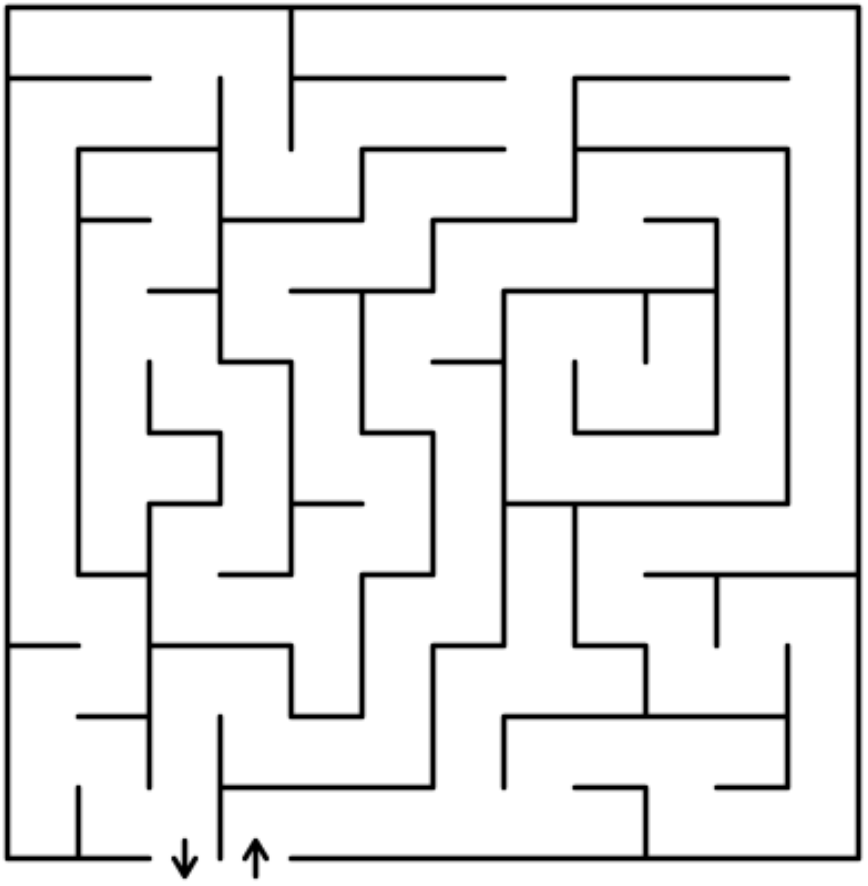
- Planning & Scheduling
  - Related:
    - Problem Solving
    - Knowledge Representation and Reasoning
- Machine Learning
  - Classification
  - Regression
  - Clustering

Areas of Artificial Intelligence

- Natural Language Processing
- Computer Vision
  - And more broadly, perception
- Robotics

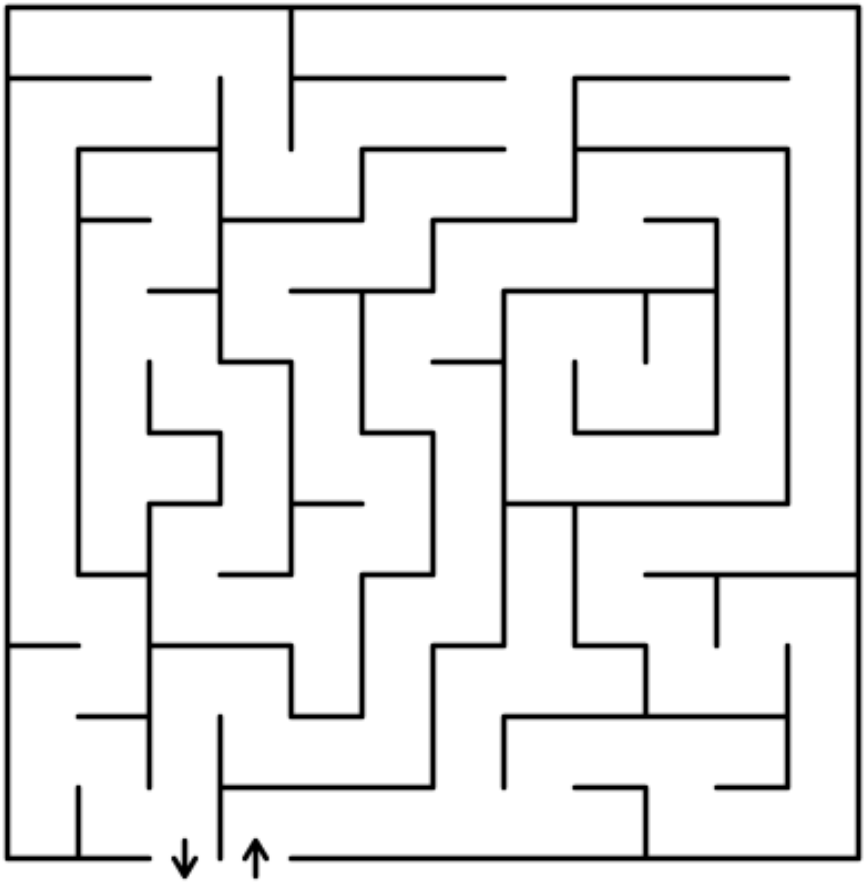
Planning & Scheduling

- Planning problems
  - An easy to picture planning problem is solving a maze



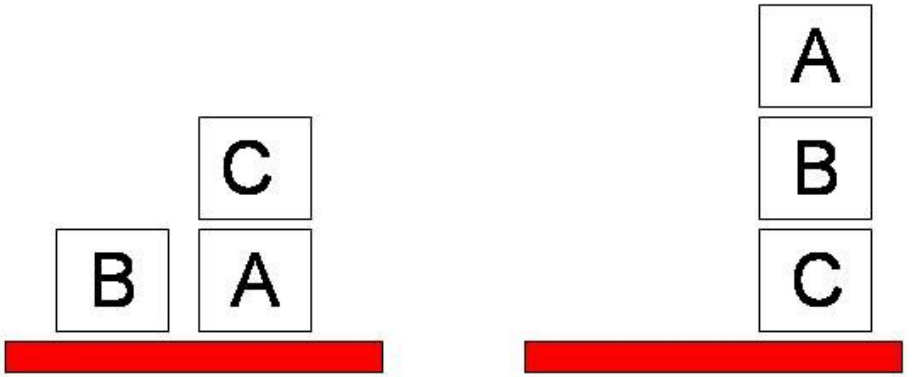
Planning & Scheduling

- Picture a robot in this maze
  - It runs a “search” algorithm
    - Up: Doesn't work
    - Left: Doesn't work
    - Right: Works!
    - Down: Doesn't work
    - “Search”
      - Repeat until you've solved the maze.
      - Storing each position and trying each move until you find a path through, so you can go back if you get stuck.



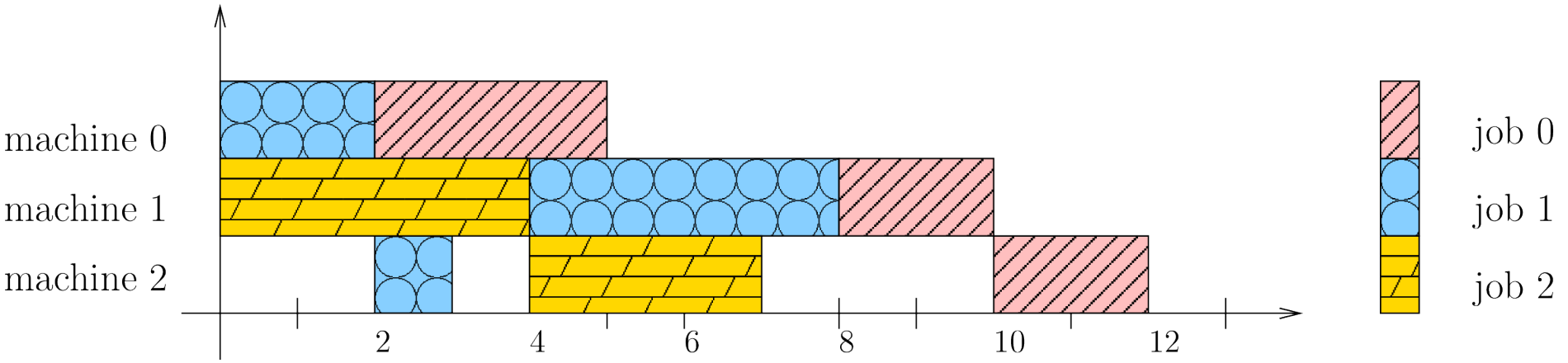
Planning & Scheduling

- More complicated & more abstract
  - The “agent” can do a set of actions:
    - Pick up block
    - Put down block
    - Stack block on another block
    - Stack block on table



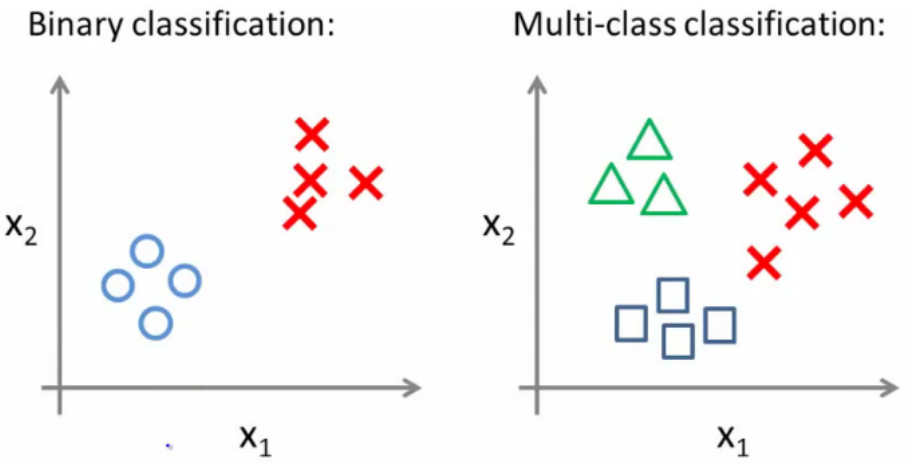
Planning & Scheduling

- Scheduling Problems
  - Classic: Job Shop Scheduling
    - You have 'n' jobs and 'm' machines
    - How do you find the fastest schedule to complete the job?
  - Another Example
    - How do you make the most money on Superbowl ads?



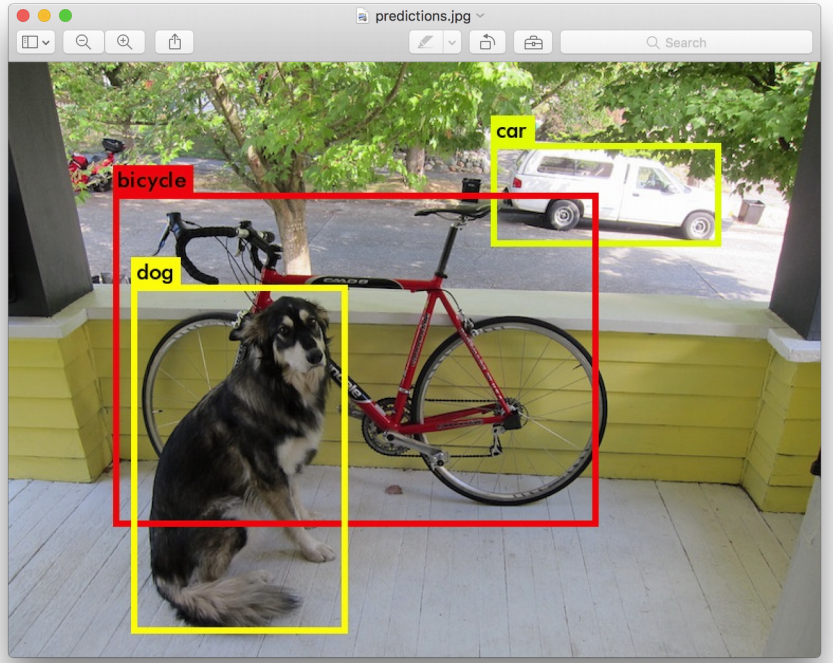
Machine Learning

- Classification
  - Identifying a class that a datum fits into
  - Binary classification
    - Two classes
      - Often, “it is or isn't something.”
      - Medical diagnosis
    - Multi-class classification (n-ary)
      - Image classification
        - It's a cat, or a dog, or a soda can



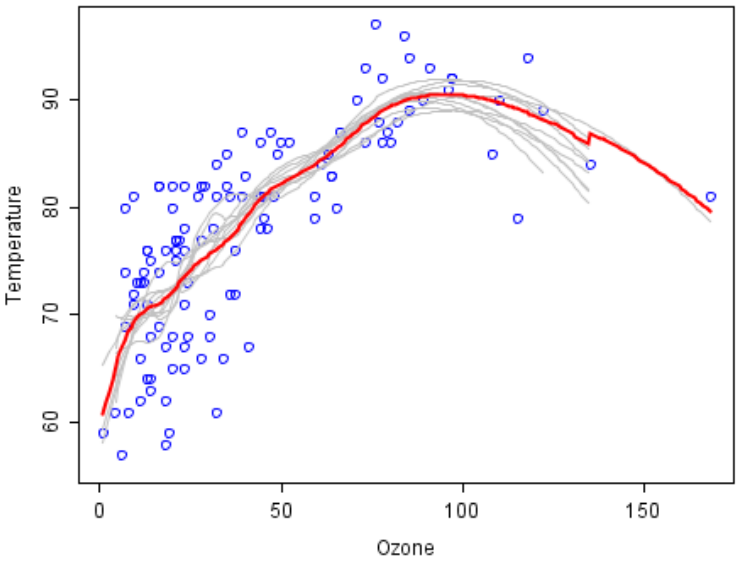
Machine Learning

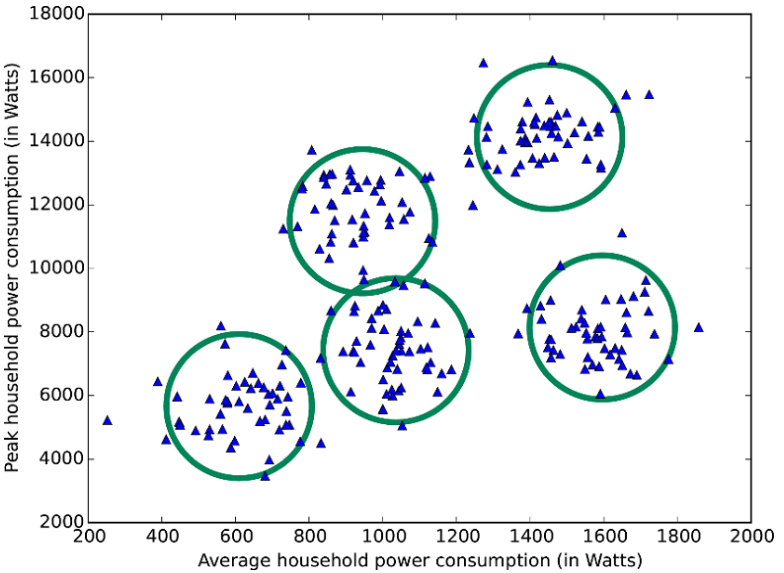
- Multi-Class Example
  - YOLO
    - You Only Look Once



Machine Learning

- Regression
  - Given these parameters, what is the value of <blank>?
  - I want my car to go at this speed
  - I want to know the predicted value of a stock
- Clustering
  - These data are similar in some way



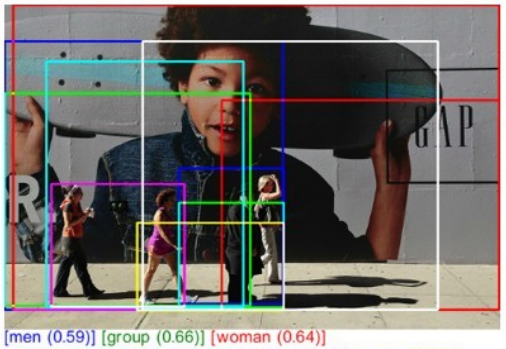


Natural Language Processing

- Parsing
  - Syntactic
    - The dog is in the yard.
    - The/DT dog/NN is/VBZ in/IN the/DT yard/NN
  - Semantic
    - in(yard,dog)
- Perceptual Grounding
  - Pairing percepts to semantics
    - For instance, teaching a robot what a can looks like, or the color red, or the word “heavy”

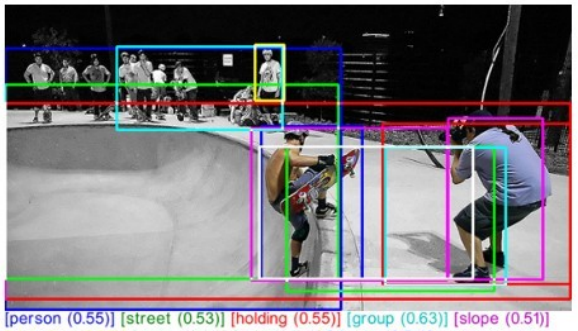
Natural Language Processing

- Sentiment analysis
  - Does this newspaper article say something positive or negative?
- Text summarization
  - Take a newspaper article, make 1-10 lines to summarize
- Image captioning
  - Look at a picture, tell me what is in it



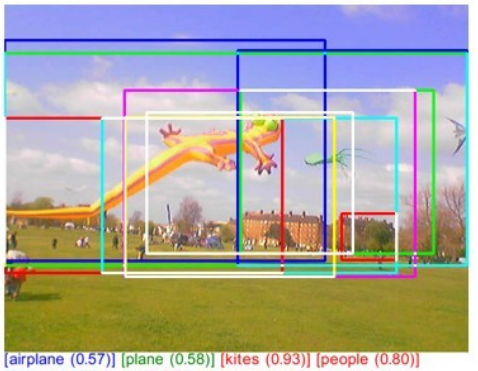
[men (0.59)] [group (0.66)] [woman (0.64)]
[people (0.89)] [holding (0.60)] [playing (0.61)] [tennis (0.69)]
[court (0.51)] [standing (0.59)] [skis (0.58)] [street (0.52)]
[man (0.77)] [skateboard (0.67)]

a group of people standing next to each other
people stand outside a large ad for gap featuring a young boy



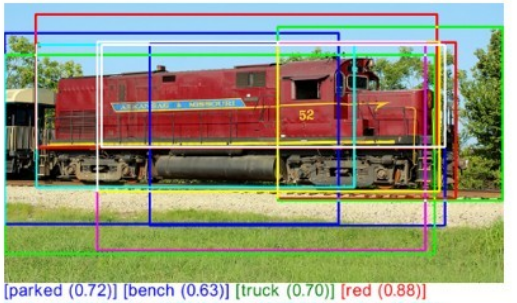
[person (0.55)] [street (0.53)] [holding (0.55)] [group (0.63)] [slope (0.51)]
[standing (0.62)] [snow (0.91)] [skis (0.74)] [player (0.54)]
[people (0.85)] [men (0.57)] [skiing (0.51)]
[skateboard (0.89)] [riding (0.75)] [tennis (0.74)] [trick (0.53)] [skate (0.52)]
[woman (0.52)] [man (0.86)] [down (0.61)]

a group of people riding skis down a snow covered slope
a guy on a skate board on the side of a ramp



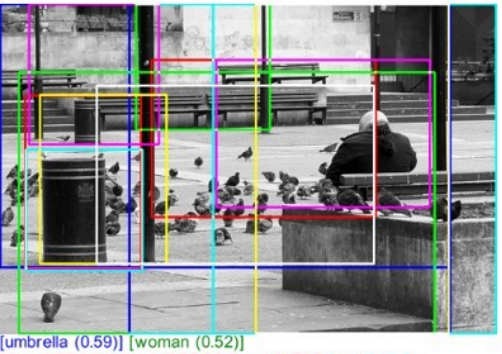
[airplane (0.57)] [plane (0.58)] [kites (0.93)] [people (0.80)]
[flying (0.93)] [man (0.57)] [beach (0.84)] [wave (0.61)]
[sky (0.61)] [kite (0.74)] [field (0.75)]

a couple of people flying kites in a field
people in a field flying different styles of kites



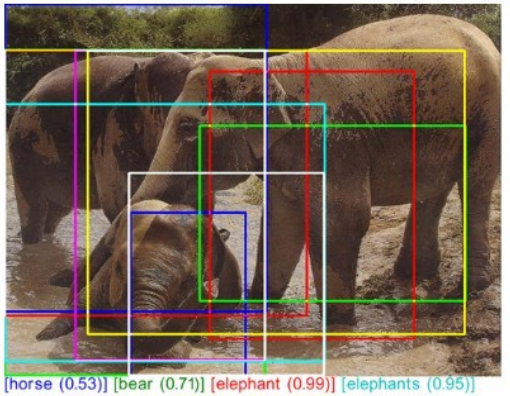
[parked (0.72)] [bench (0.63)] [truck (0.70)] [red (0.88)]
[train (1.00)] [sitting (0.73)] [cars (0.58)] [traveling (0.52)]
[grass (0.65)] [track (0.69)] [car (0.59)] [yellow (0.57)]
[field (0.80)] [engine (0.56)] [down (0.54)] [tracks (0.94)]

a train traveling down train tracks near a field
a red train is coming down the tracks



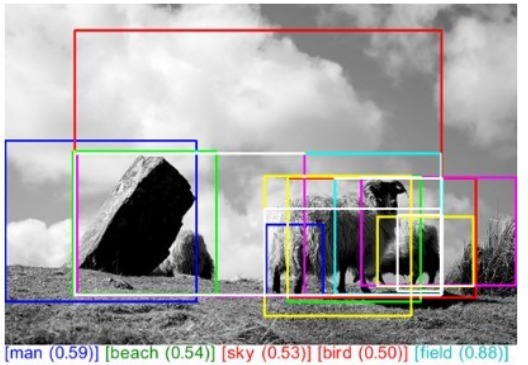
[umbrella (0.59)] [woman (0.52)]
[fire (0.96)] [hydrant (0.96)] [street (0.79)] [old (0.50)]
[bench (0.81)] [building (0.75)] [standing (0.57)] [baseball (0.55)]
[white (0.82)] [sitting (0.65)] [people (0.79)] [photo (0.53)]
[black (0.84)] [kitchen (0.54)] [man (0.72)] [water (0.56)]

a black and white photo of a fire hydrant
a courtyard full of poles pigeons and garbage cans also has benches on either side of it one of which shows the back of a large person facing in the direction of the pigeons



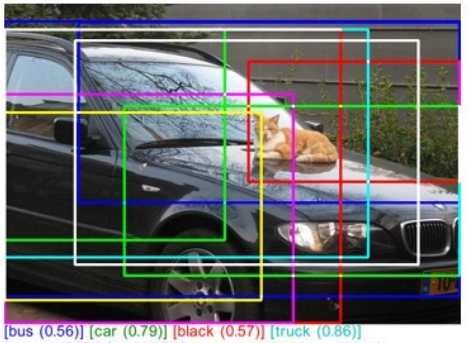
[horse (0.53)] [bear (0.71)] [elephant (0.99)] [elephants (0.95)]
[brown (0.68)] [baby (0.62)] [walking (0.57)] [laying (0.61)]
[man (0.57)] [standing (0.79)] [field (0.65)]
[water (0.83)] [large (0.71)] [dirt (0.65)] [river (0.58)]

a baby elephant standing next to each other on a field
elephants are playing together in a shallow watering hole



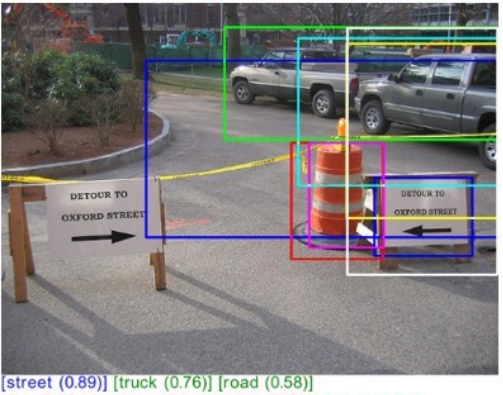
[man (0.59)] [beach (0.54)] [sky (0.53)] [bird (0.50)] [field (0.88)]
[snow (0.86)] [mountain (0.59)] [standing (0.81)] [white (0.64)]
[people (0.51)] [dog (0.60)] [cows (0.55)]
[sheep (0.97)] [black (0.84)] [grass (0.64)] [horse (0.60)]
[elephants (0.57)] [bear (0.81)]

a black bear standing on top of a grass covered field
a couple of sheep standing up on a small hill



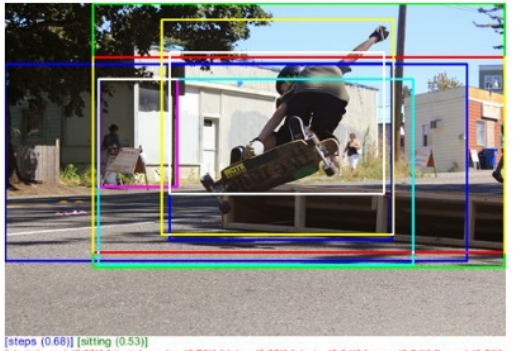
[bus (0.56)] [car (0.79)] [black (0.57)] [truck (0.86)]
[street (0.57)] [bed (0.51)] [parked (0.55)] [dog (0.65)]
[sitting (0.55)] [man (0.53)] [cat (0.72)]

a dog sitting on top of a car
a cat is lying on the hood of a black car



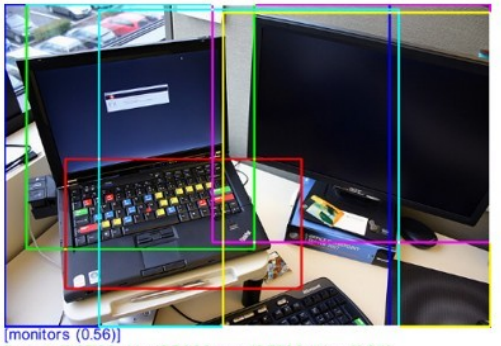
[street (0.89)] [truck (0.76)] [road (0.58)]
[fire (0.95)] [hydrant (0.91)] [sitting (0.53)] [black (0.51)]
[red (0.53)] [parking (0.69)] [parked (0.82)] [sign (0.78)]

a fire hydrant on the side of a road
two signs with arrows pointing to each other for detour



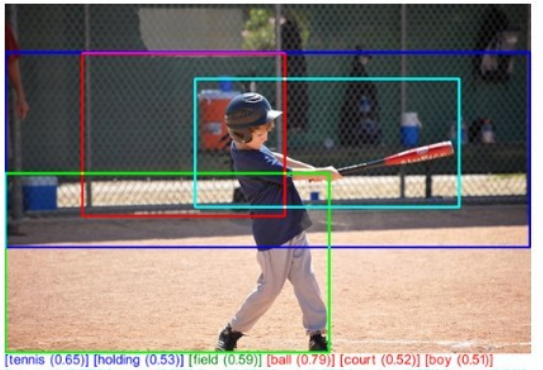
[steps (0.68)] [sitting (0.53)]
[skateboard (0.99)] [skateboarder (0.76)] [doing (0.65)] [skate (0.64)] [ramp (0.54)] [board (0.51)]
[street (0.79)] [riding (0.73)] [motorcycle (0.59)] [person (0.54)] [people (0.57)]
[man (0.91)] [trick (0.78)] [parked (0.53)] [horse (0.53)] [truck (0.55)]

a man doing a trick on a skateboard
a skateboarder is is mid air performing a stunt



[monitors (0.56)]
[laptop (0.97)] [table (0.74)] [open (0.71)] [sitting (0.61)]
[station (0.52)]
[desk (0.97)] [computer (0.94)] [keyboard (0.68)] [computers (0.65)]
[tv (0.54)] [television (0.50)] [monitor (0.69)]

an open laptop computer sitting on top of a desk
two computers are shown together on a desk

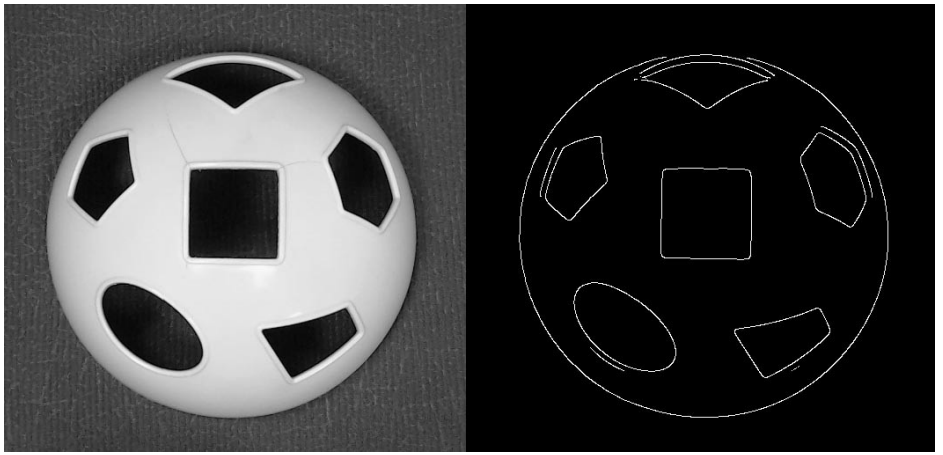


[tennis (0.65)] [holding (0.53)] [field (0.59)] [ball (0.79)] [court (0.52)] [boy (0.51)]
[baseball (0.97)] [player (0.83)] [bat (0.82)] [man (0.80)] [playing (0.65)] [game (0.60)]

a baseball player swinging a bat at a ball
a boy is playing with a baseball bat

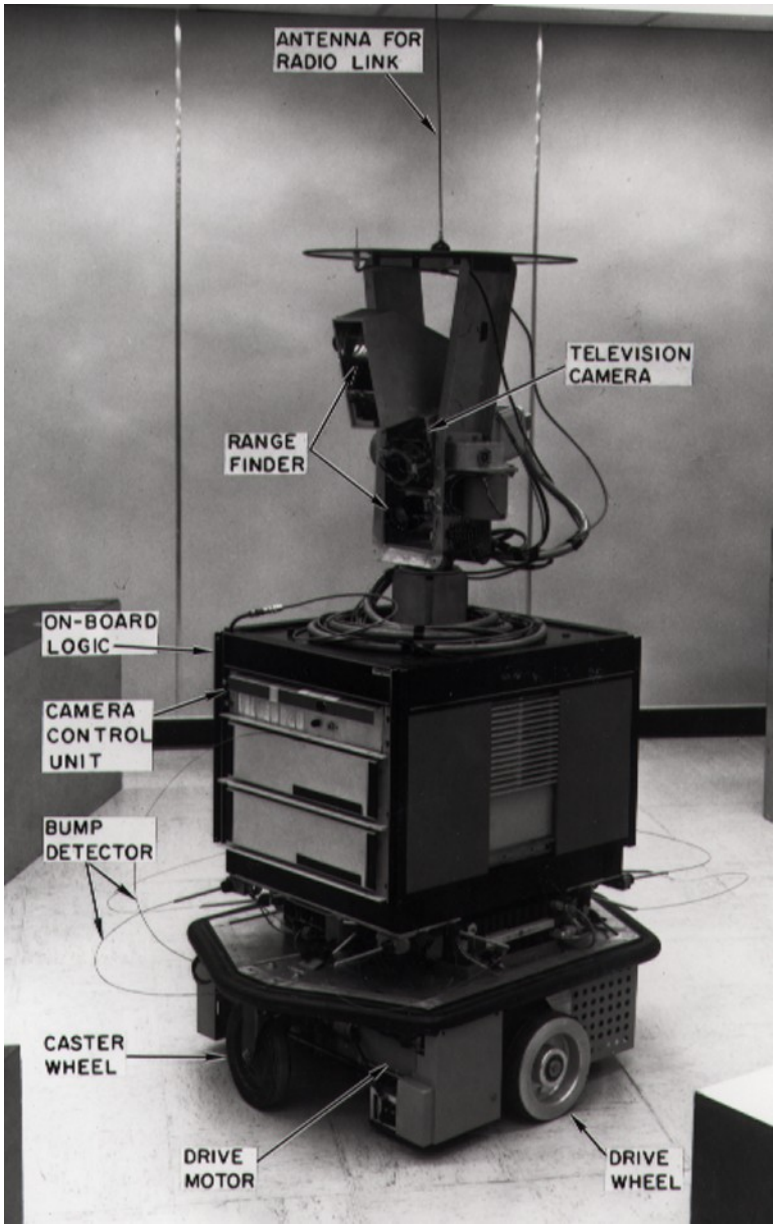
Computer Vision

- Image Recognition
  - Identify image contents
  - YOLO
- Stereo Reconstruction
  - Given 2 images, reconstruct 3D scene
- Segmentation
  - Pick apart the pieces of an image
- Edge Detection



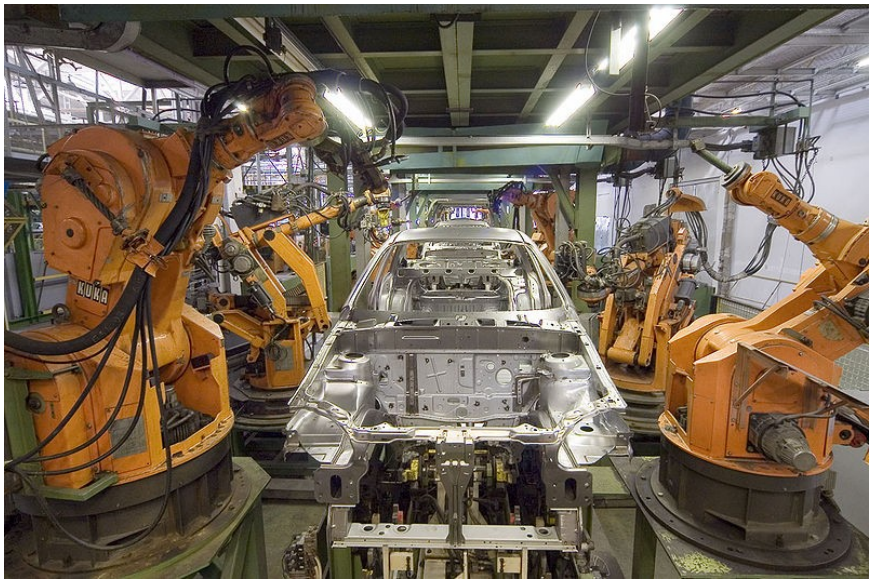
Robotics

- Shakey the robot
  - Stanford Research Institute
    - Now SRI international
    - 1966
  - Simple computer vision
  - Navigation in multiple rooms
  - Blocks
  - Planning in STRIPS
    - Stanford Research Institute Planning System
    - In the next few lectures, we will learn about STRIPS in detail



Robotics

- Waseda WABOT
  - First full-scale humanoid
  - 1967
- Kuka Robots
  - 1970s
  - Used in automotive production



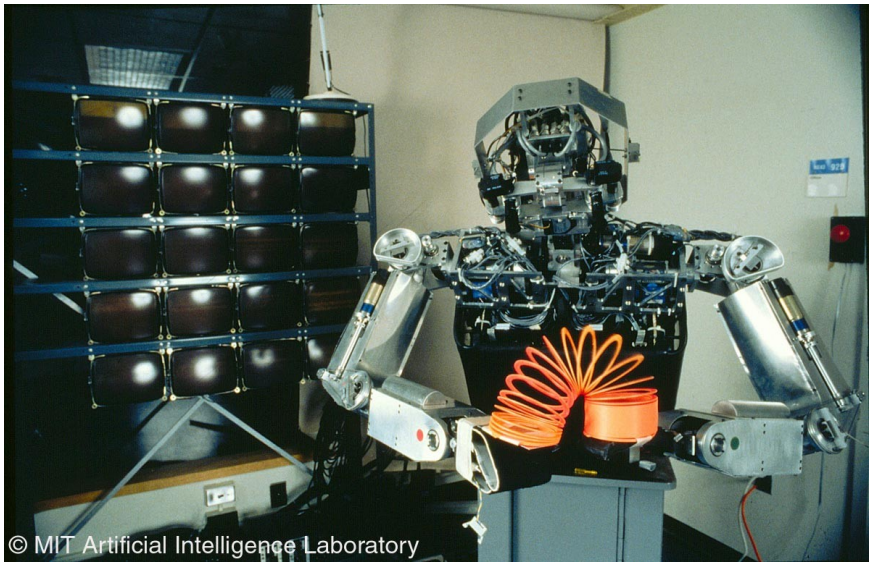
Robotics

- Genghis
  - 1989
  - Inexpensive, tested gait patterns

- No Hands Across America
  - CMU NavLab
  - 1995!!

Robotics

- Cog
  - MIT
  - Late 90s, early 00's
  - An attempt to emulate human-like intelligence and human development



Robotics

- DARPA Grand Challenge
  - Autonomous vehicle race across Mojave Desert
  - Kicked off autonomous vehicles commercially

Robotics

- Androids
  - Geminoid

  - Erica
    - https://www.youtube.com/watch?v=oRlwvLubFxg

Robotics

- A Rock Paper Scissors Robot
  - https://www.youtube.com/watch?v=3nxjjztQKtY

Robotics

- Honda
  - ASIMO
- Toyota
  - Partner Robot
  - Human-Support Robot (HSR)

Robotics

- Building-Wide Intelligence

On to C++

- We will talk a LOT about robots and AI in this class, but we need to move on to some C++
- We will put off make/cmake this lecture to focus more on C++

Hello World!

- Hello World is kind of a traditional programming exercise to demonstrate the basics of a programming language.
  - C & C++ versions of this look similar, but different

- Exercise Objectives:
  - #include
  - main()
  - printf/std::cout
  - return
  - Basic syntax
  - Invoking the compiler

g++

- GNU c++ compiler
- G++ <input> -o