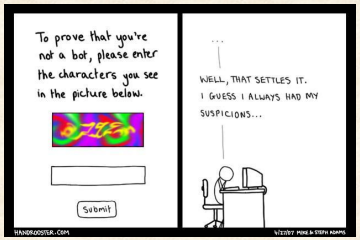
UNIVERSITY of WISCONSIN-MADISON
Computer Sciences Department

CS 202: Introduction to Computation — Professor Andrea Arpaci-Dusseau

How to Solve Challenging Problems?



Who Are You All?

Most everyone has a laptop
- Windows is still OS of choice

Very few have previous programming experience
- In past, programmers do learn lots from 202 as well

Half freshman
- 25% Sophomores
- 25% Juniors + Seniors

What might you major in?

Actuarial Science
African Languages
Anthropology
Atmospheric and Ocean Science
Biochemistry - 2
Biology - 2
Business - 2
Chemistry - 2
Communication Arts
Communicative disorders
Computer Engineering
Computer Science - 16
Economics - 4
Education
Engineering - 3
English - 4
Environmental Studies
Finance
French
Geography - 3
History
Industrial Engineering
Information Systems
International studies - 3
Journalism - 3
Languages and Cultures of Asia
Linguistics
Marketing
Math - 5
Meteorology
Nursing
Pre-Pharmacy
Pre-Med
Physics
Political Science - 3
Psychology - 4
Social Studies
Sociology
Undecided - 11

What do you want to do with computation?

Can you think of examples?

Solve interesting problems! (or entertain us!)
- Play games
- Recommend movies
- Find best priced items
- Connect us with our friends
- Find information for us
- Find best directions to destination
- Pick stocks
- Forecast the weather
- Recognize us to let us into our house
- Drive cars for us

Many Interesting Services Exist!

Popular, low-cost applications

- Song creation (Songify)
- Song recognition (Shazam)
- Itinerary planning (mTrip)
- Speech recognition (Dragon Dictation)
- Face recognition (Recognizr)
- Image recognition (SnapTell)
- Chatbot (AmyA.I.)

What is currently challenging?

Interesting + Challenging Apps

Interacting with human language

- Speech recognition, conversation, translation
- Answering questions for people

Understanding visual images

- Recognition (or "labeling")

Movement in human world

- Robotics

Today just examples

- Semester (+ more courses) to learn HOW

Natural language: Speech Recognition

First step: "Hear" words spoken by person

Why do you think this could be useful?

- Phone call routing (e.g., airline reservations)
  - "how can I help you?"
  - "speak your card number"
- dictation (translate to written form)

IBM ViaVoice

Dragon NaturallySpeaking

- Hands-free commands to car

Not easy, but relatively "solved"

Goal: Interact w/ computer as if human (smart!)

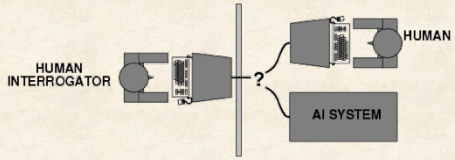
Acting Humanly: Turing Test

How to answer question: "Can machines think?"

- What does it mean to "think"???

A. Turing, Artificial Intelligence Pioneer, 1950

- "Can we tell it's a machine from conversation?"



Predicted by 2000, machine has 30% chance of fooling a lay person for 5 minutes

Natural Language: Chatbots

Valerie: CMU Robot Receptionist in Newell-Simon hall.

ALICE: 2004 Loebner Prize winner

ELIZA: psychotherapist

Future homework: Experiment with chatbots
- How long before obvious not human?

Natural Language: Translation

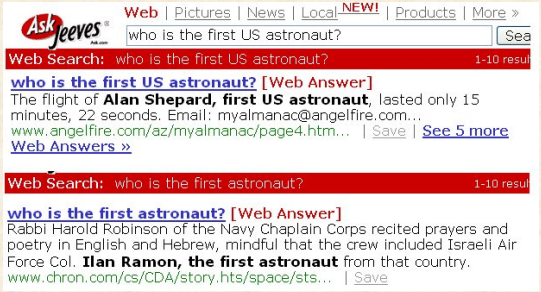
Google translate.google.com

The spirit is willing but the flesh is weak.
[Bible, Matthew 26:41]

Дух охотно готов но плоть слаба	Spirit is willingly ready but flesh it is weak
精神是愿意的但骨肉是微弱的	The spirit is wants but the flesh and blood is weak
精神は喜んでであるが、肉は弱い	Mind is rejoicing,, but the meat is weak
El alcohol está dispuesto pero la carne es débil	The alcohol is arranged but the meat is weak
الكحول مستعدّة غير أنّ للحمة ضعيفة.	The alcohol is ready nevertheless the meat is weak.

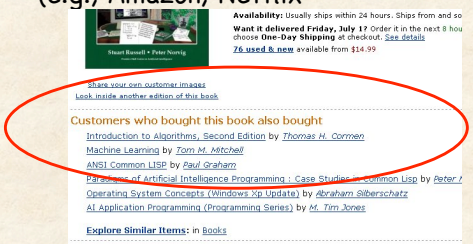
Future homework: Experiment with translation
- Which phrases/words cause confusion?

Natural Language: Answering Questions



Natural Language: Recommendation Systems

Recommendation based on other users' behavior (e.g., Amazon, Netflix



Future Homework: Explore recommendation systems
- How well do you think they work?

Future Lecture: How Natural Language Processing works

Interesting + Challenging Apps

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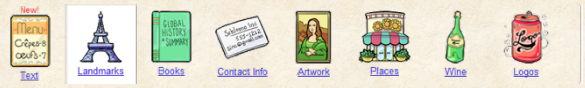
- Robotics

Today just examples
- Semester (+ more courses) to learn HOW

Visual Images: Recognition



Images: Face Recognition

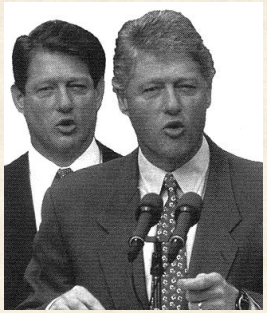
What makes recognizing faces difficult (or, identifying that two images are of same face)?

Many things can differ…
- Angle (front, left side, right side)
- Expressions
- Hairstyle
- Lighting (shadows, coloring)

Images: Face Recognition

Are these all the same people?

Images: Face Recognition



Context is important!

Images: Hard Problems

Face and image recognition is very hard

What should we do?

- Give up?
- Bang your head really hard?
- Learn an important lesson!
  - turn challenge into something useful

Not hard problem for humans!

What is useful about a problem that is very hard for machines, but trivial for humans?

Images: CAPTCHA

Completely Automated Public Turing test to tell Computers and Humans Apart

The "Anti-Turing test"

Tell human and machines apart, automatically

- Deny spam-bots free email registration
- Protect online poll from vote-bots

Random string

oamg →  →

Distorted image

What do you see?

Many different distortion techniques

Also audio Captcha

Images: Labeling

Task: label all images on the web with words

 → car, boy, hat, …

Why useful?

Image search engines

- Do not really understand the image
- Use image filename and surrounding text

How can we label?

Visual Images: ESP Game

Use real human intelligence!

How can we trick humans into doing this labeling work for computers?

Make it into a game!

- Two separate players find common label for image
- Benefits: Fun and hard to give bad labels

Explore in HW 1: Games with a purpose

Visual Images: ESP Game

PLAYER 1

GUESSING: CAR

GUESSING: HAT

GUESSING: KID

SUCCESS!
YOU AGREE ON CAR

PLAYER 2

GUESSING: BOY

GUESSING: SMILE

GUESSING: CAR

SUCCESS!
YOU AGREE ON CAR

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Robotics: Cars

DARPA Grand Challenges

DARPA Grand Challenge I
Barstow to Primm
March 13, 2004

142 miles
10 hours

DARPA Grand Challenge II
Desert Classic
October 8, 2005

132 miles
10 hours

DARPA Grand Challenge III
Urban Challenge
November 3, 2007

60 miles
6 hours

Robotics: Cars

DARPA Grand Challenge

- http://video.google.com/videoplay?docid=-4948445106261731330&hl=en
- http://video.google.com/videoplay?docid=-8274817955695344576&hl=en

Automatic car parking

- http://www.youtube.com/watch?v=_piO849uRdI&feature=player_embedded

Other vehicle control systems

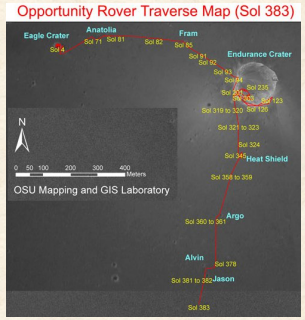
- Mercedes semi-automatic braking system
- iRobot Roomba automated vacuum cleaner

Robotics: Mars Rovers

Autonomous (part time) driving on Mars by Sojourner, Spirit, and Opportunity rovers

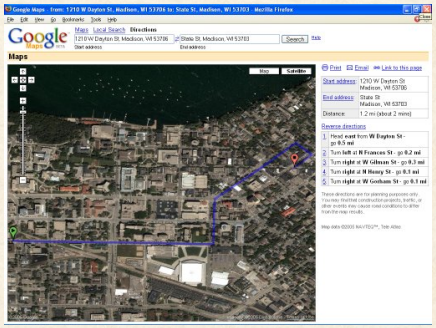
Robot motion planning

not always autonomously…



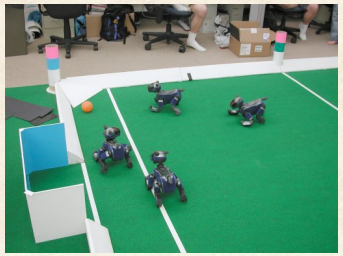
Robotics: Navigation at Home

From UW CS to State street



Robotics: Soccer

Robocup http://www.robocup.org/



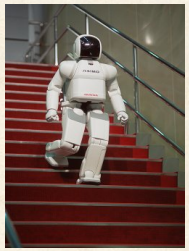
http://www.youtube.com/watch?v=a9r4bvChWFc

2006: http://video.google.com/videoplay?docid=-4644250650954958O6&hl=en

2010: http://www.youtube.com/watch?v=4wMSiKHPKX4

Robotics: Humanoid

Bipedal, human-like walking



Asimo (Honda)

QRIO (Sony)

Later lecture: Social Robotics

Is solving these problems Artificial Intelligence (AI)?

"AI is the study of complex information processing problems that often have their roots in some aspect of biological information processing. The goal of the subject is to identify solvable and interesting information processing problems, and solve them."

-- David Marr

Focus of most all of computer science!

Part 1: How do we win strategy games against humans?

How do computers...?	Answer
Interact with humans?	Artificial intelligence
Solve problems?	Algorithms
Know what to do?	Programming languages
Make art?	Control flow: Sequential and Repeat
Show animated stories?	Flowcharts and Abstraction
Make decisions?	Decision Trees and If statements
Remember what has happened?	Variables
Avoid race conditions?	Critical sections
Create educational games?	Private vs. shared variables
Understand human language?	Natural language processing
Interact with humans?	Social robots
Guess what may happen?	Probability trials
Win games against you?	Game trees

Homework 1

Homework 1 Due Friday at 5:00 pm

A) Investigate on-line Scratch projects
- How to hand in? Friend TA Scratch account

B) Explore Games with a Purpose
- Help humanity by playing 3 on-line games
- How to hand in? Upload screenshot to Learn@UW dropbox

C) Help CS Education with on-line survey
- How to hand in? Upload screenshot to Learn@UW dropbox

See www.cs.wisc.edu/~cs202-1 for details

Need Help?

Send email to cs202-tas@cs.wisc.edu

Come to office and lab hours

Day	Time	Instructor or TA	Room
Mon	11:00 - 12:00	Prof. A Arpaci-Dusseau	CS 7375 (office)
Wed	11:00 - 12:00	Prof. A Arpaci-Dusseau	CS 7375 (office)
Wed	12:00 - 2:00	Victor Bittorf	CS 1370 (lab)
Thurs	12:00 - 2:00	Thea Hinkle	CS 1370 (lab)
Thurs	4:15 - 6:15	Thea Hinkle	CS 1370 (lab)
Friday	11:00 - 1:00	Victor Bittorf	CS 1370 (lab)