

Comp 440: Artificial Intelligence

Tuesdays/Thursdays 9:25 - 10:40
@KH 101
Devika Subramanian (devika@rice.edu)

Course information

- Course web page:
<http://www.owl.net.rice.edu/~comp440>
- Course staff
 - Devika Subramanian (devika@rice.edu)
 - Dave Piexotto (dmp@rice.edu)
 - Anna Youssefi (annay@rice.edu)

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2

Homework 0

- Fill out online information form at
<http://www.owl.net.rice.edu/~comp440/>
in "Handouts" section

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3

Course information (contd.)

- 4 homeworks
- 4 programming assignments
- 2 in-class exams
- Course project (emphasis on writing and presenting results) with intermediate written progress reports
- Groups of no more than two students
- Full schedule for term is up on the web page --- check it out!

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4

What is the AI question?

- Finding a theory of intelligence.
 - Thinking rationally (laws of thought)
 - Acting rationally (agent design)
- Finding a theory of how the human mind works.
 - Thinking humanly (cognitive science)
 - Acting humanly (Turing test)

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5

How can we answer the AI question?

- Study human behavior: psychology.
- Study human hardware: neuroscience.
- Think hard: philosophy & mathematics.
- Build computational theories that generate/explain intelligent behavior: computer science + decision theory + probability + control theory + game theory

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6

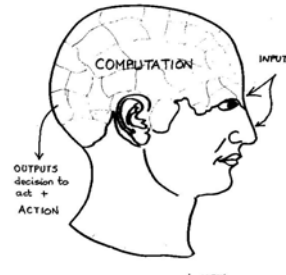
19th century view of the mind



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7

Late 20th/Early 21st century view of the mind

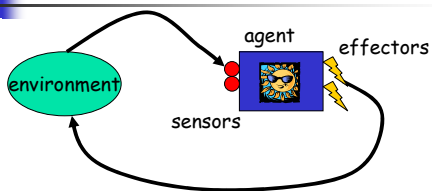


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THE COMPUTER SCIENTIST'S VIEW

8

The AI Problem



What should a rational agent do now?

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9

Structure of course

Decision making in deterministic environments

- Single agent
 - Dynamic programming, Classical search algorithms, randomized search algorithms, evolutionary computation, constraint satisfaction
- Multi-agent
 - Game theory, minimax search and approximations

Decision making in stochastic environments

- Single agent
 - Markov decision processes, Bayesian networks, decision theory and utility theory, HMMs, Kalman filters, dynamic Bayesian networks
- Multi-agent
 - Expectimax search, bargaining algorithms, stochastic game theory

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10

Structure of course (contd.)

Learning and decision making in unknown environments

- Supervised learning
 - Decision tree learning
 - Kernel methods and support vector machines
 - Neural networks
 - Bayesian learning over text
- Unsupervised/partially supervised learning
 - Reinforcement learning

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11

What you will do in this course

- Build a Mars rover team.
- Build a backgammon player that learns from experience.
- Build a minesweeper agent/Sudoku agent.
- Build a face recognizer.
- Do several exercises: design stochastic hill climbers for optimizing compilers, build bots for video games, find CpG islands, find genes implicated in prostate cancer, etc.
- Course project: Build evolutionary computation algorithms to win Pacwar!

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Goals of course

- introduce several state-of-the-art algorithms in artificial intelligence.
- show how each of these algorithms applies to real-world problems in science and engineering.
- provide practice in applying algorithms by solving real problems.

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13

What you should be able to do after this course

- Evaluate claims about intelligent systems in an informed way.
 - [Giant robot imprisons parked cars](#)
- Have a great algorithmic toolbox to help you design adaptive systems.
- Build intelligent bots for interesting problems.
- Contribute to AI research.

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14

Where are we now?

- **SKICAT**: a system for automatically classifying the terabytes of data from space telescopes and identifying interesting objects in the sky. 94% classification accuracy, exceeds human abilities (uses decision trees)
 - http://bubba.ucdavis.edu/~qal/science/dposs/dposs_frames_skicat.html
- **Deep Blue**: the first computer program to defeat champion Garry Kasparov (uses minimax + alpha-beta-pruning + lots of optimizations).
 - <http://www.research.ibm.com/deepblue/>

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15

Where are we now (contd..)

- **Pegasus**: a speech understanding that is a travel agent (1-877-LCS-TALK) (uses HMMs).
 - <http://groups.csail.mit.edu/sls//applications/pegasus.shtml>
- **Jupiter**: a weather information system (1-888-573-TALK) (uses HMMs).
 - <http://groups.csail.mit.edu/sls//applications/jupiter.shtml>

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16

Where are we now (contd..)

- **HipNav**: a robot hip-replacement surgeon (search algorithms for planning actuator moves).
 - <http://www.mrcas.ri.cmu.edu/projects/hipnav.html>
- **HeartLander**: an inchworm like robot for beating-heart cardiac surgery.
 - <http://www.cs.cmu.edu/afs/cs/project/heartlander/www/videos.html>
- **Navlab**: a Pontiac Trans Sport that steered itself from Washington DC to San Diego 98% of the way on its own! (uses neural network learning)
 - [No Hands Across America Home Page](#)

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17

Where are we now (contd.)

- **DS1**: a NASA spacecraft that did an autonomous flyby an asteroid (uses propositional SAT solvers).
 - <http://ic.arc.nasa.gov/projects/remote-agent/>
- **Credit card fraud detection** and loan approval (uses decision trees and neural networks).
 - <http://www.aaai.org/AITopics/html/fraud.html>

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18

Where are we now (contd..)

- Chinook: the world's checkers champion.
 - <http://www.cs.ualberta.ca/~chinook/>
- Poker playing program: <http://poker.cs.ualberta.ca/>
- Spam Assassin and other spam detectors (use naive Bayes learning)
- Soccer playing Aibo robots (use reinforcement learning)
 - <http://www.cs.cmu.edu/~coral-downloads/leaged/movies/index.html>

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19

Where are we now (contd..)

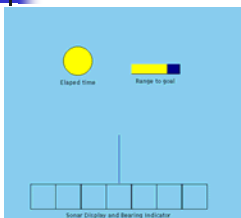
- Search engines: Google! (Ad Sense, Trends, Scholar, ...)
- TiVo, Quicken Tax Prep, GPS navigation systems in most high-end cars, voice recognition systems used by Amex, United, Lands End, fraud detection, arbitrage and options trading, airfare predictors, etc.

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20

Submarine School 101 The NRL Navigation Task



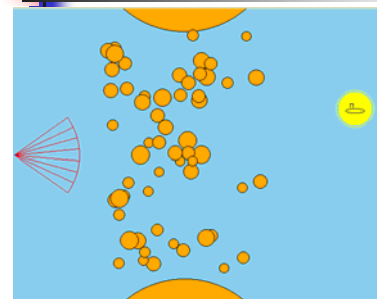
- Pilot a submarine to a goal through a minefield in a limited time period
- Distance to mines revealed via seven discrete sonars
- Time remaining, as-the-crow-flies distance to goal, and bearing to goal is given
- Actions communicated via a joystick interface



50% of class weeded out by this game!



The NRL Navigation Task



Mine configuration changes with every game.

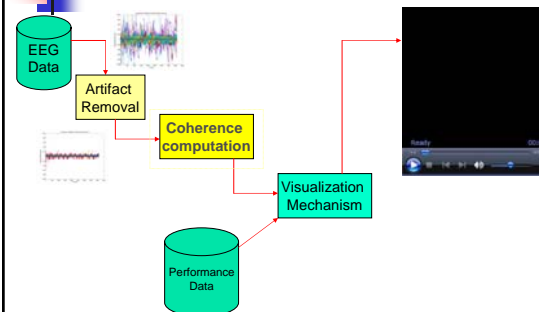
Game has a strategic and a visual-motor component!

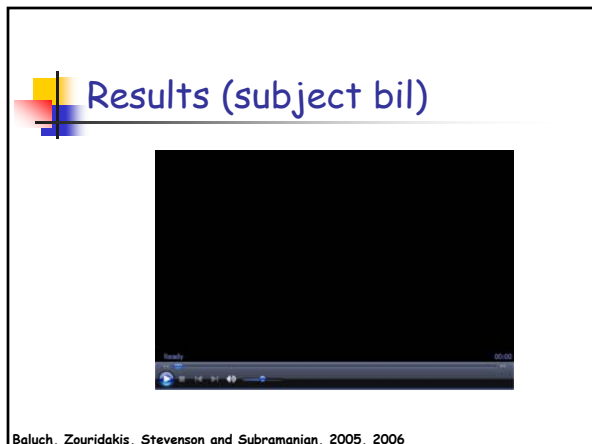
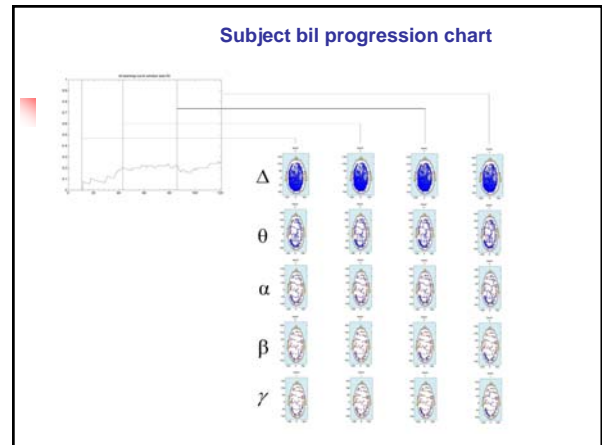
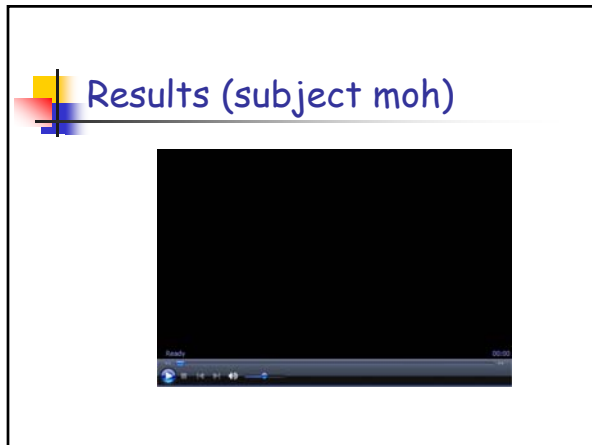
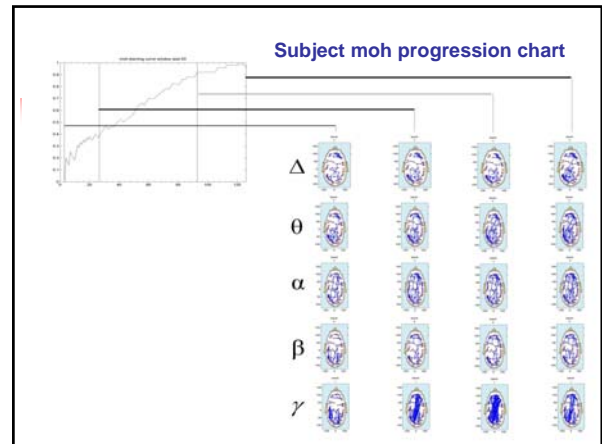
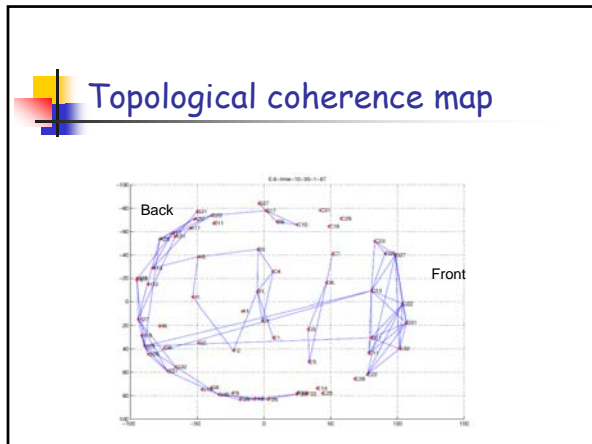
Gathering performance data



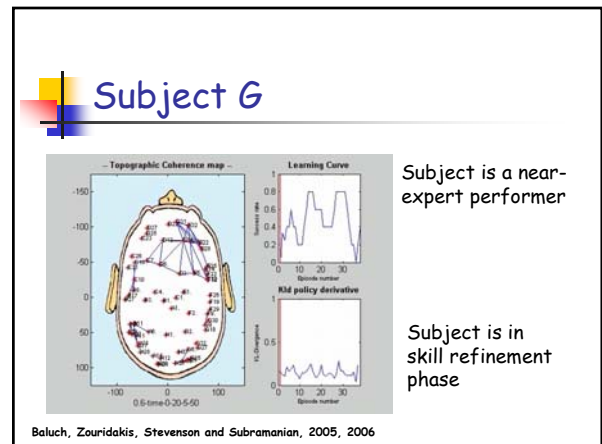
256 channel EEG recording

Fusing EEG and visualmotor data



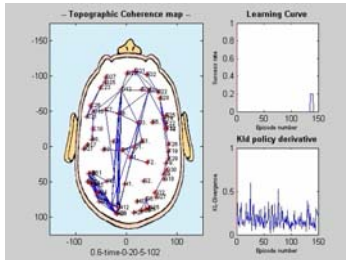


Baluch, Zouridakis, Stevenson and Subramanian, 2005, 2006



Baluch, Zouridakis, Stevenson and Subramanian, 2005, 2006

Subject V



Subject never learned a good strategy

It wasn't for lack of trying..

Baluch, Zouridakis, Stevenson and Subramanian, 2005, 2006

Surprises in AI research

- Tasks difficult for humans have turned out to be easy
 - Chess
 - Checkers, Othello, backgammon
 - Logistics planning (DART at DARPA)
 - Airline scheduling
 - Fraud detection
 - Sorting mail
 - Proving theorems
 - Design of airplane engines, elevator schedulers
 - Crossword puzzles

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32

Surprises in AI research

- Tasks easy for humans have turned out to be hard.
 - Speech recognition
 - Face recognition
 - Composing music/art
 - Autonomous navigation
 - Motor activities (walking)
 - Language understanding
 - Common sense reasoning

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Current grand challenges in AI

- How do we build reliable systems from unreliable components?
 - Sensor networks that cover the earth.
 - Rosie, the Jetson's maid.
- How do we engineer systems that adapt to unanticipated changes in their environments? That configure and heal themselves autonomously?
 - Mars Bioplex, DARPA grand challenge
 - Speech and face recognizers

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34

Summary of lecture

- AI is about the design and implementation of embedded systems that
 - make decisions, and
 - act to achieve specified goals
 - in the face of limited information and computational resources.
- AI is fun!