# CPS 270 Introduction

Ron Parr

### **Contact Information**

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### About Me

- My seventh year at Duke
- Bachelor's degree in philosophy
   Philosophy of mind
- Ph.D. in computer science – Hierarchical planning under uncertainty
- Current interests:
  - Planning under uncertainty
  - Probabilistic reasoning
  - Reinforcement learning
  - Mobile robotics

### Requirements

- · Prior AI experience useful but not required
- Reasonable programming skills:
   C
  - matlab
- · Some mathematical sophistication
  - Short proofs
  - Basic probability concepts
  - Basic algorithmic concepts
    - ComplexityAnalysis of algorithms

# Major Topics Covered

- Search
- A\*, Games, SAT, CSPs
- Logic and Knowledge Representation
  - Propositional Logic
  - First Order Logic
- Planning
  - Classical, stochastic
- · Reasoning under uncertainty
- Bayes nets, decision theory, HMMs, trackingIntroduction to robotics
- Learning
  - Decision trees, Neural nets, Reinforcement learning

# Major Topics Not Covered

- Natural Language
- Vision

### **Class Mechanics**

- Textbook: Artificial Intelligence, A Modern Approach, Russell & Norvig (second edition)
- Homeworks: 10%
   Discussion OK, write-up must be your own
- Projects: 30%
- Discussion OK, coding, write-up must be your ownMidterm: 30%
- Closed book, in class, no collaboration
- Final: 30%
  - Closed book, finals week, no collaboration

## Why Study Al?

- · Important innovations have grown out of AI
  - Linked list manipulation (Lisp)
  - Timesharing
  - X
  - Formalization of search techniques
  - Heuristics for intractable (NP hard) problems
  - Pattern recognition methods
- Cool tools
- · Cool applications

# Cool Al Applications Al is lurking in more places than you think: PDAs This Program E-commerce Voice/anguage recognition Voice jail My car Dragon naturally speaking Deep Blue Mobile robotics Space exploration Logistics planning

# Future Challenges for Al

- Systems
  - Networking
  - Self healing systems
  - Defending against attacks
- More engaging computer games
- Understanding the human genome
- Better medical treatment and diagnosis ☺
- Better killing machines 🙁

# About AI and the military

- Any technology can be used for good or harm
- Improved surveillance, recognition, tracking, control and guidance reduce:
  - Need for big explosions
- Unintended death and destruction
   Don't worry about Terminator... Yet...
- Examples:
  - Soviet Missile Technology
  - DEFCON III in 1973 Arab Israeli Conflict



# So, what is this AI stuff?

- Make machines think like humans
  - Is this enough?
  - Is this too much?
- Make machines act like humans
  - Is this sufficient?
  - Is this desirable?

# **Turing Test**

- Computer must be indistinguishable from a human based upon written exchanges (Actually more complicated than this)
  - Does this imply intelligence?
  - How could the computer cheat?
  - Does intelligence imply a certain type of computation?
  - Could an intelligent machine still fail the test?
- Does our notion of intelligence transcend our concept of humanity?

### Ideal Intelligence

• Intelligence means making optimal choices

• Is anything truly intelligent?

• How do we define optimality?

· Is there a more modest goal?

# Our Compromise

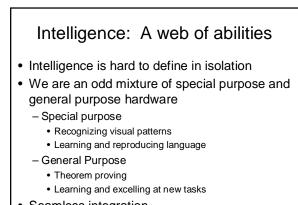
In Artificial Intelligence, we study algorithms for tasks typically associated with human intelligence to gain insight into the general question of intelligence.

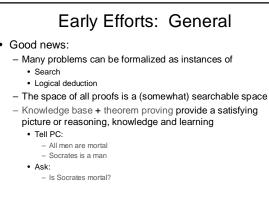
### The Moving Target

### • What is human intelligence?

- At one time, calculating ability was prized
  Now it is deprecated
- Calculators permitted earlier and earlier in school
- Chess was once viewed as an intelligent task
  - Now, massively parallel computers use not very intelligent search procedures to beat grand masters
    Some say Deep Blue wasn't Al
- Learning once thought uniquely human
  - Now it's a well-developed theory
  - Best backgammon player is a learning program
- Intelligence is like...

# Artificial Flight Even seemingly unambiguous terms such as "flight" were subject to biological chauvinism. Y Y Y Demonstrable, unambiguous success ended chauvinism





### Bad news for general methods

- · Searching in proof space is hard
- Representing knowledge is hard - What is a chair?
- · Knowledge interconnected in strange ways
  - Chairs
  - People
  - Gravity
  - Customs…
- · Early efforts were too general, ambitious

### Early Efforts: Special Purpose Methods

- Neural networks attempted to reproduce the function of human neurons
- Proverbial wing-flapping flying machine?
- Success at reproducing low-level tasks
   Pattern recognition, associative memory
- Nearly became a religion
- Huge gap between low level and high level
- Early efforts were too specific

### Overpromising and the Al Winter

- Years of
  - Naïve optimistism
  - Unrealistic assessments of challenges
  - Poor scientific/academic discipline
- · Lead to (early 90's)
- Backlash
- Reduced government funding
- Reduced investment from industry
- The "Al Winter"

# Modern Al

- · Study broad classes of problems
- Restrict problem somewhat:
   Develop a crisp input specification
  - Develop a well-defined success criterion
- · Develop results with
  - Provable properties
  - Broad applicability
- Extract and study underlying principles behind successful methods

### Eye on the prize

- Some senior researchers argue that modern Al has become too specific
- Making such claims is a privilege of tenure ☺
- Important point: Must not lose touch with the goal of general intelligence

# Outline

Search

- Intro probability, decision theory
- MDPs
- Reinforcement learning
- Games
- Logic CSPs

- PlanningAdvanced probability
- LearningBayes nets
- Advanced decision theory