

15-780: Graduate AI
Lecture 1. Intro & Logic

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Tuomas Sandholm

TAs Erik Zawadzki, Abe Othman



Admin

Website

15-780 ⊗ Graduate AI ⊗ Spring 2011

Tuesdays and Thursdays from 10:30-Noon in GHC 4307.
School of Computer Science, Carnegie Mellon University.

People This class is taught by Professors **Geoff Gordon** and **Tuomas Sandholm**. The TAs are **Abe Othman** and **Erik Zawadzki**.

Office hours are at noon after class on Tuesday (Tuomas - GHC 9205) and Thursday (Geoff - GHC 8105). Abe and Erik have their office hours Monday at 8pm and

<http://www.cs.cmu.edu/~ggordon/780/>
<http://www.cs.cmu.edu/~sandholm/cs15-780S11/>

Website highlights

- Book: Russell and Norvig. *Artificial Intelligence: A Modern Approach*, **3rd ed.**
- Grading: 4–5 HWs, “mid”term, project
- Project: proposal, 2 interim reports, final report, poster
- Office hours
- Recitation (*when?*)

Website highlights

- *Authoritative source for readings, HWs*
- *Please check the website regularly for readings (for Lec. 1–3, Russell & Norvig Chapters 7–9)*

Background

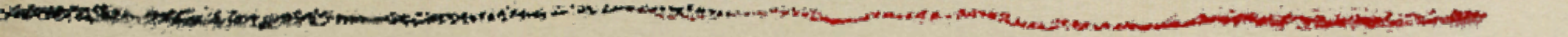
- *Suggest familiarity with at least some of the following:*
 - *Linear algebra*
 - *Calculus*
 - *Algorithms & data structures*
 - *Complexity theory*
 - *Logic*

Waitlist, Audits

- *Audits: register, fill out audit form*
 - *Must do final project, but no HWs, tests*
- *Waitlist: if you're on it, let us know*
- *If you need us to sign something, catch us after class or in office hours*

Course email list

- *15780students AT cs.cmu.edu*
- *To subscribe/unsubscribe:*
 - *email 15780students-request@ ...*
 - *word “help” in subject or body*
- *By the end of this week, everyone’s official email should be in the list—we’ll send a test message*



Intro

Definition by examples

- *Card games*

- *Poker*

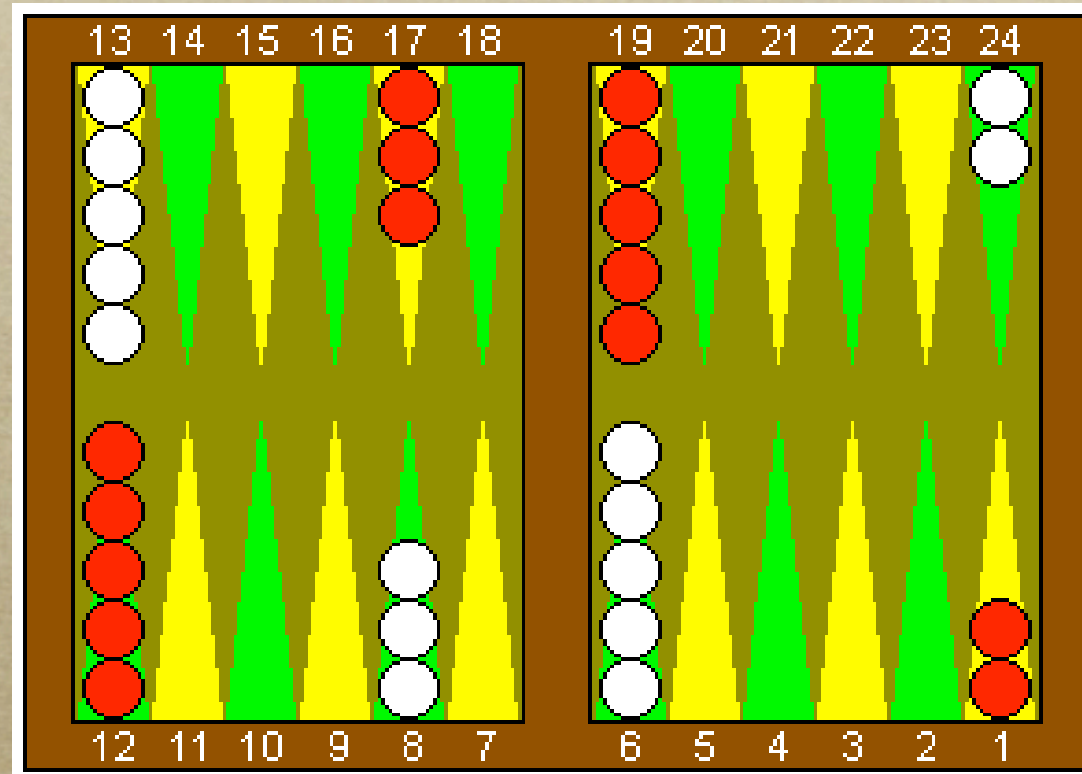
- *Bridge*

- *Board games*

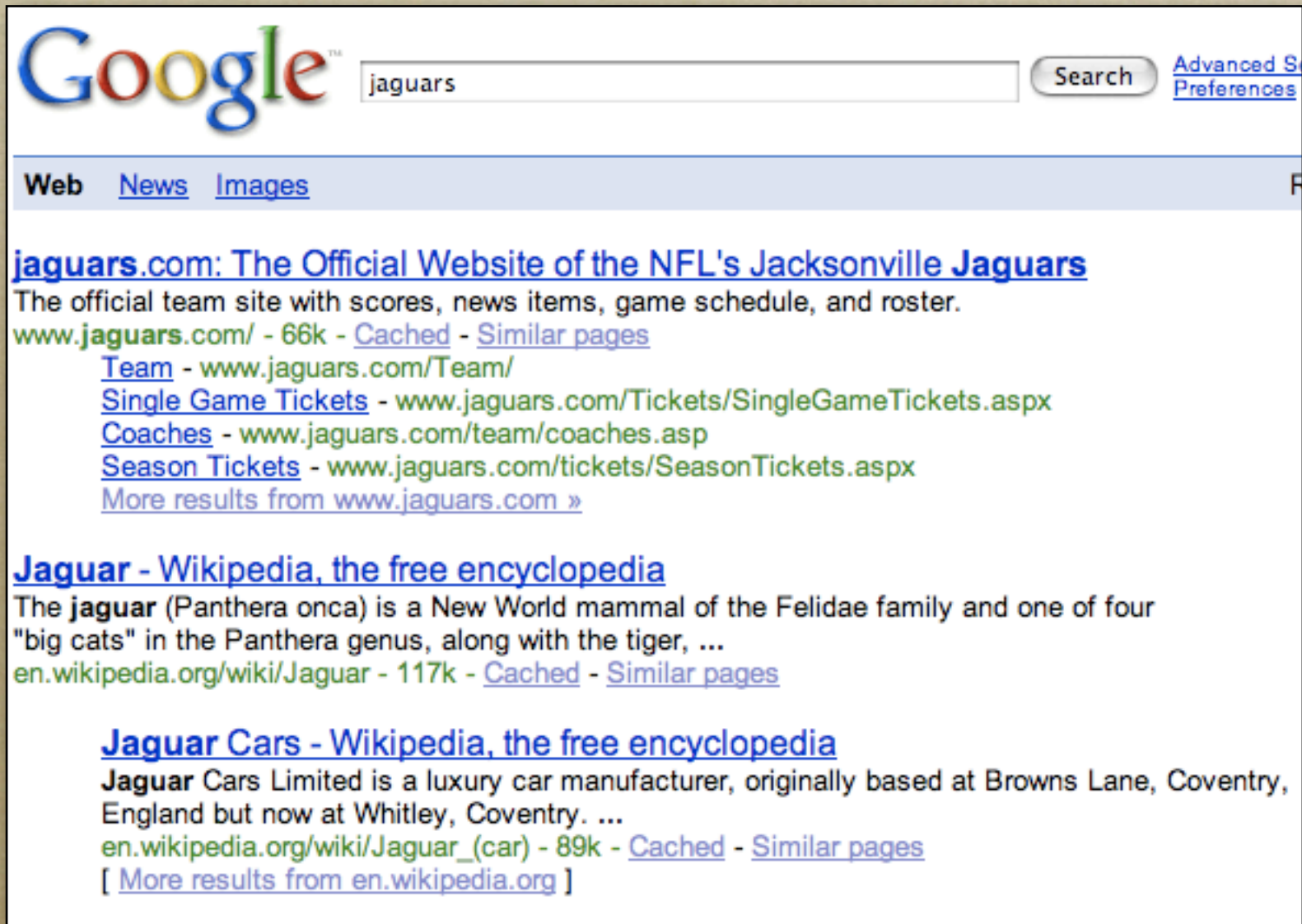
- *Deep Blue*

- *TD-Gammon*

- *Samuels's checkers player*



Web search



The image shows a screenshot of a Google search results page. At the top left is the Google logo. To its right is a search input field containing the text 'jaguars'. Further right is a 'Search' button and a link for 'Advanced Search Preferences'. Below the search bar is a navigation bar with links for 'Web', 'News', and 'Images'. The search results are listed below, starting with 'jaguars.com: The Official Website of the NFL's Jacksonville Jaguars'. This result includes a brief description, the URL 'www.jaguars.com/' with statistics, and several sub-links like 'Team', 'Single Game Tickets', 'Coaches', and 'Season Tickets'. The second result is 'Jaguar - Wikipedia, the free encyclopedia', which describes the jaguar as a New World mammal and provides the URL 'en.wikipedia.org/wiki/Jaguar'. The third result is 'Jaguar Cars - Wikipedia, the free encyclopedia', describing Jaguar Cars Limited as a luxury car manufacturer and providing the URL 'en.wikipedia.org/wiki/Jaguar_(car)'. Each result includes a brief description, the URL, and statistics.

Google™ jaguars Search [Advanced Search](#) [Preferences](#)

[Web](#) [News](#) [Images](#)

[jaguars.com: The Official Website of the NFL's Jacksonville Jaguars](#)
The official team site with scores, news items, game schedule, and roster.
[www.jaguars.com/](#) - 66k - [Cached](#) - [Similar pages](#)
[Team](#) - [www.jaguars.com/Team/](#)
[Single Game Tickets](#) - [www.jaguars.com/Tickets/SingleGameTickets.aspx](#)
[Coaches](#) - [www.jaguars.com/team/coaches.asp](#)
[Season Tickets](#) - [www.jaguars.com/tickets/SeasonTickets.aspx](#)
[More results from www.jaguars.com »](#)

[Jaguar - Wikipedia, the free encyclopedia](#)
The **jaguar** (*Panthera onca*) is a New World mammal of the Felidae family and one of four "big cats" in the Panthera genus, along with the tiger, ...
[en.wikipedia.org/wiki/Jaguar](#) - 117k - [Cached](#) - [Similar pages](#)

[Jaguar Cars - Wikipedia, the free encyclopedia](#)
Jaguar Cars Limited is a luxury car manufacturer, originally based at Browns Lane, Coventry, England but now at Whitley, Coventry. ...
[en.wikipedia.org/wiki/Jaguar_\(car\)](#) - 89k - [Cached](#) - [Similar pages](#)
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Recommender systems


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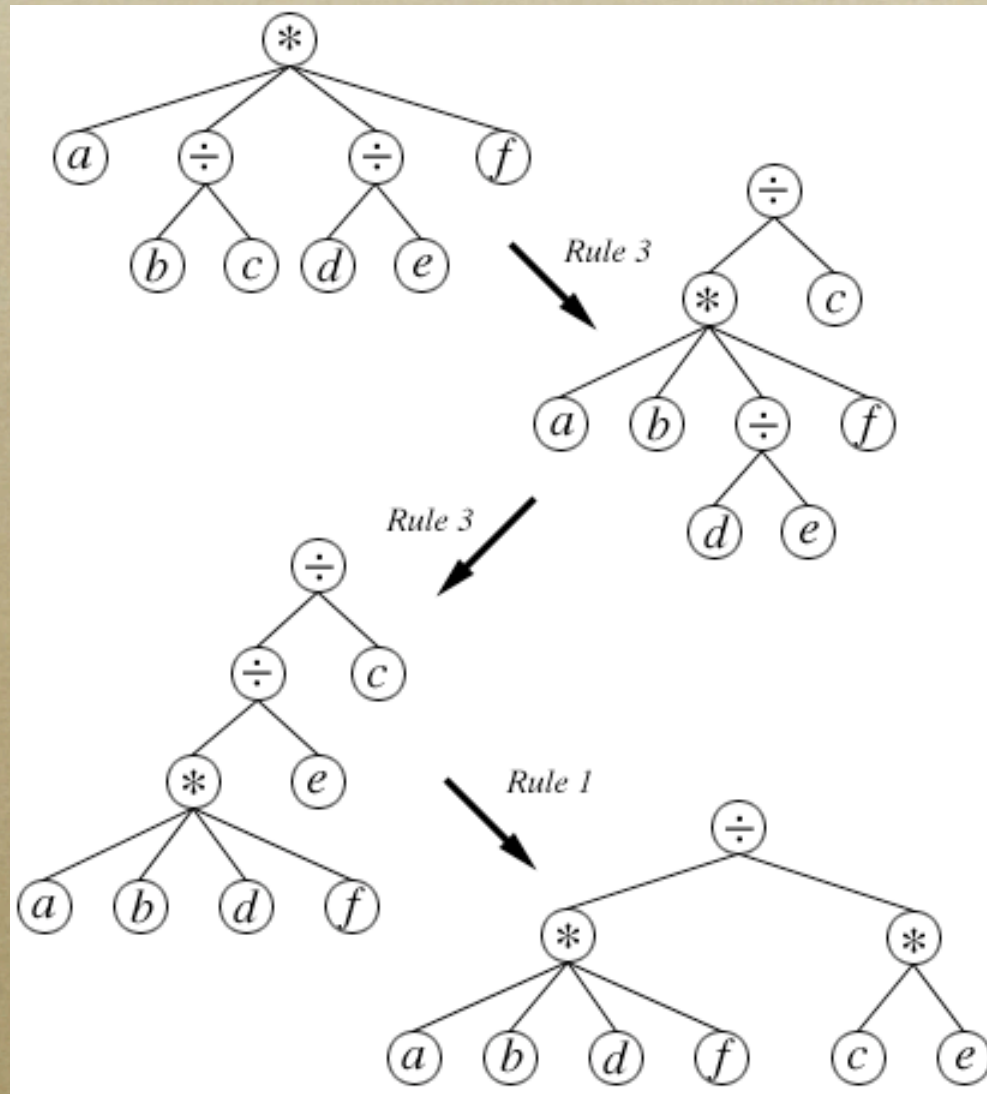
Girl Genius Volume 6: Agatha... Paperback by Phil Foglio
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Computer algebra systems



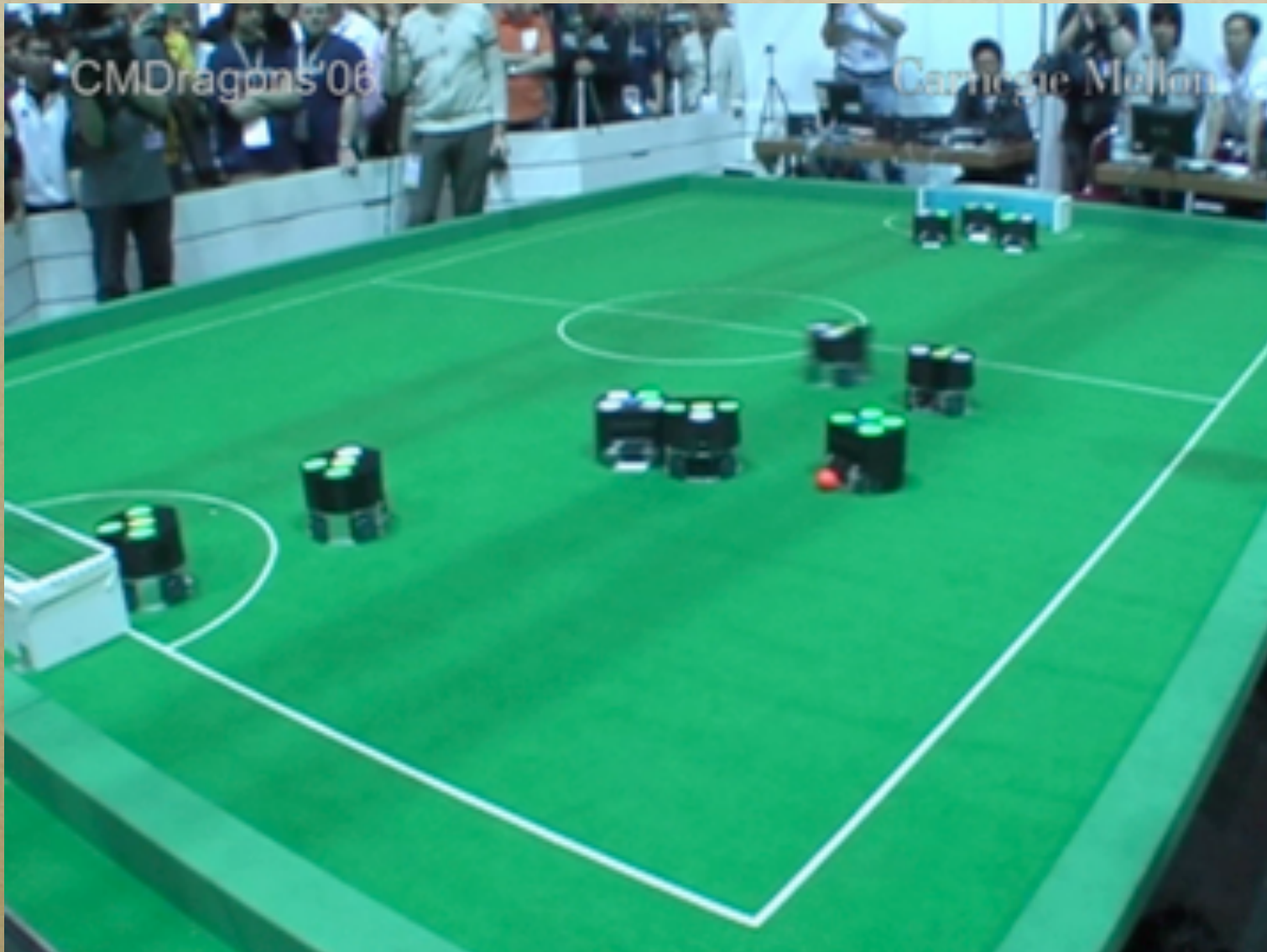
from <http://www.math.wpi.edu/IQP/BVCalcHist/calctoc.html>

Grand Challenge road race



*Red team: Whittaker et al
Junior: Thrun et al*

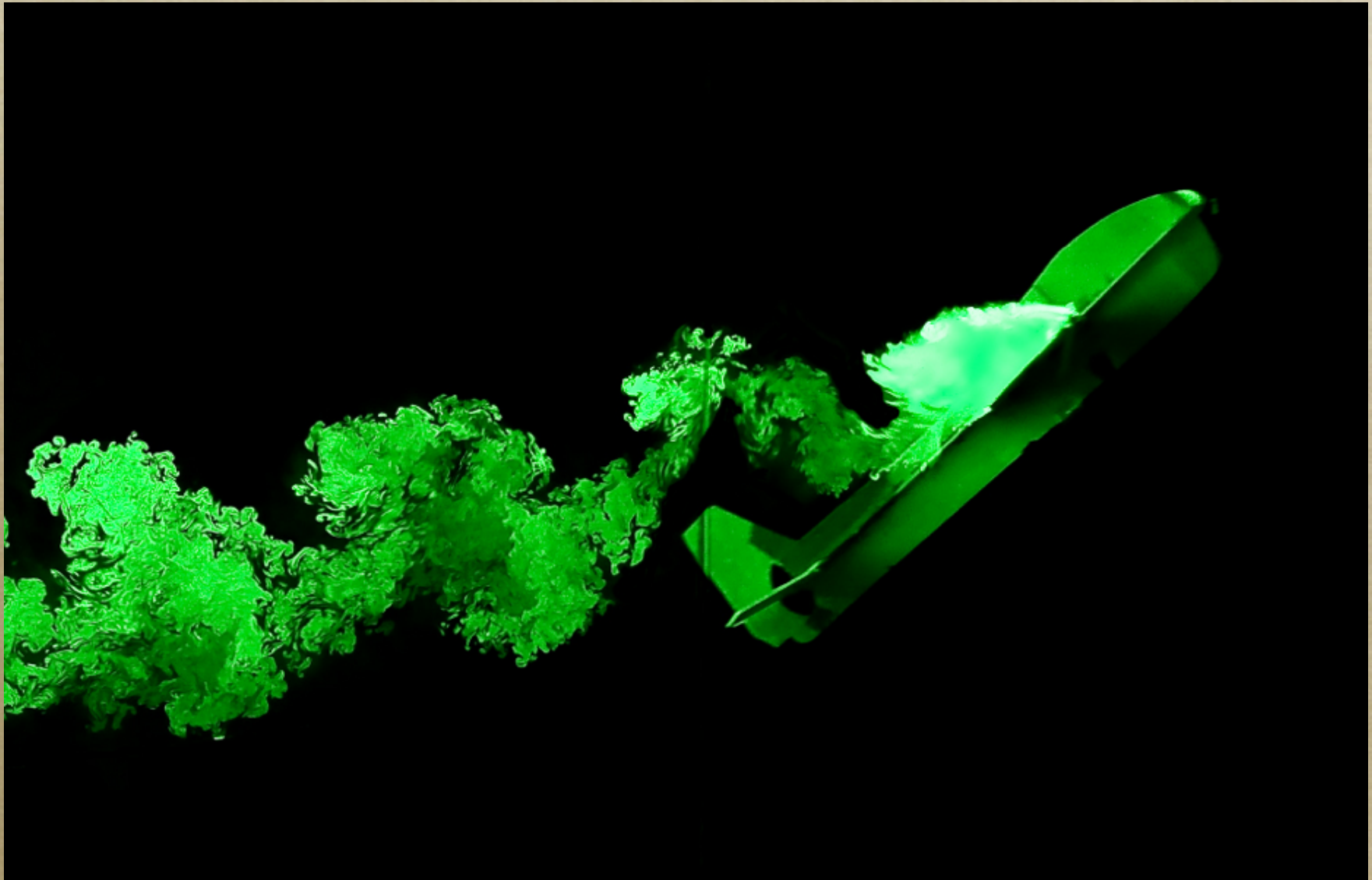
Robocup



Landing a “bird”

- *Standard airplane: laminar flow over wings*
 - *“easy” simulation and control problem*
- *Birds: way beyond performance envelope of planes* http://www.youtube.com/watch?v=LA6XSrM0V_0&feature=player_embedded
- *Secret: exploit turbulent flow (e.g., push off from vortex)*
- *But can't efficiently solve diff eqs for simulation, much less use them to plan optimal landing*

Landing a “bird”



Cory, Tedrake, et al.

Landing a “bird”

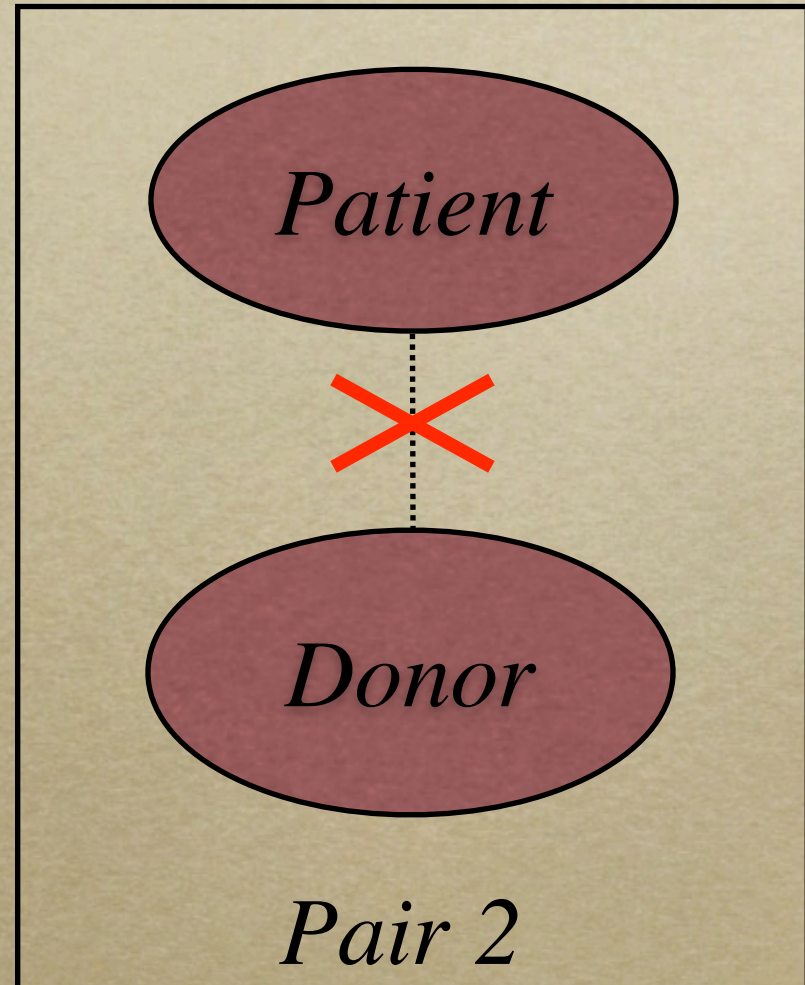
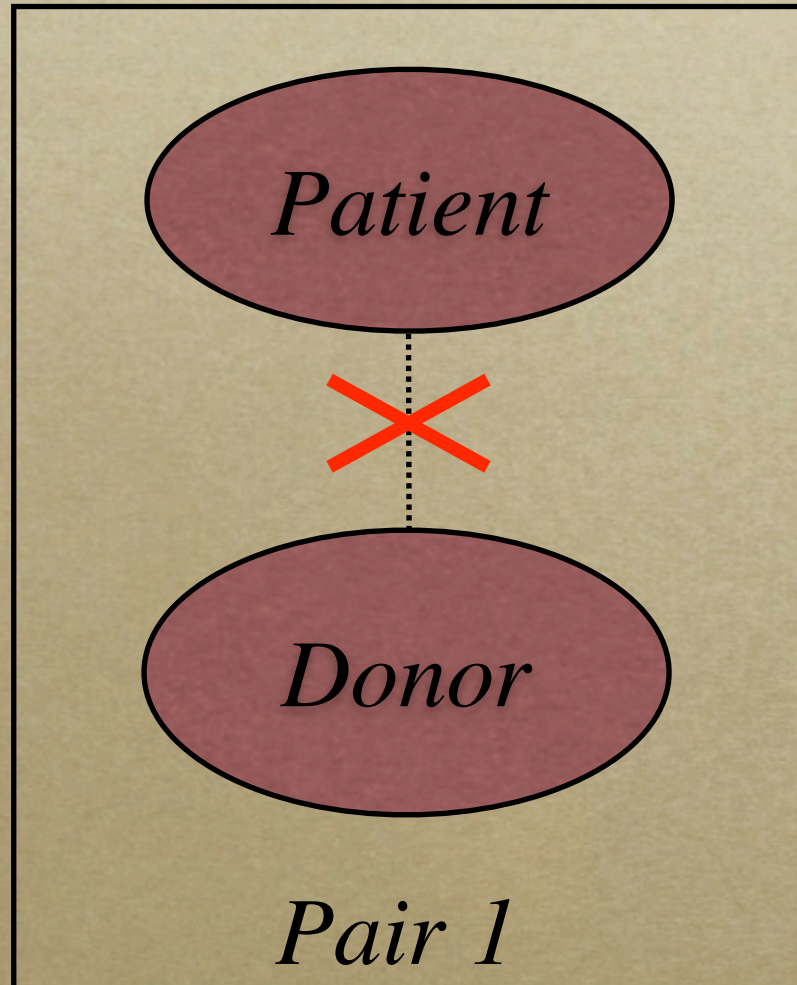


Perching Sequence 1 - Slowed Down 11x

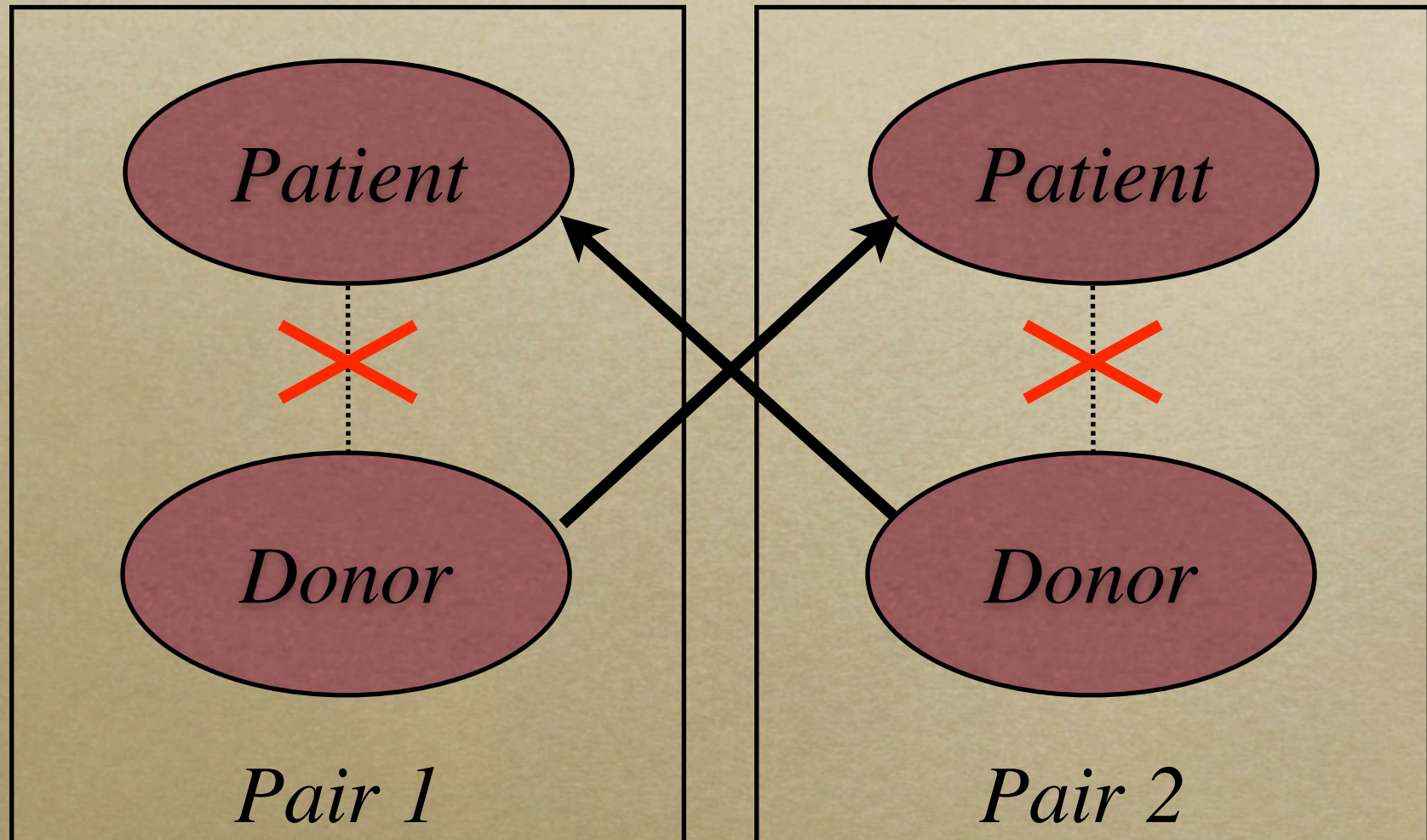
Kidney exchange

- *In US, $\geq 50,000$ /yr get lethal kidney disease*
- *Cure = transplant, but donor must be compatible (blood type, tissue type, etc.)*
- *Wait list for cadaver kidneys: 2–5 years*
- *Live donors: have 2 kidneys, can survive w/ 1*
- *Illegal to buy/sell, but altruists/friends/family donate*

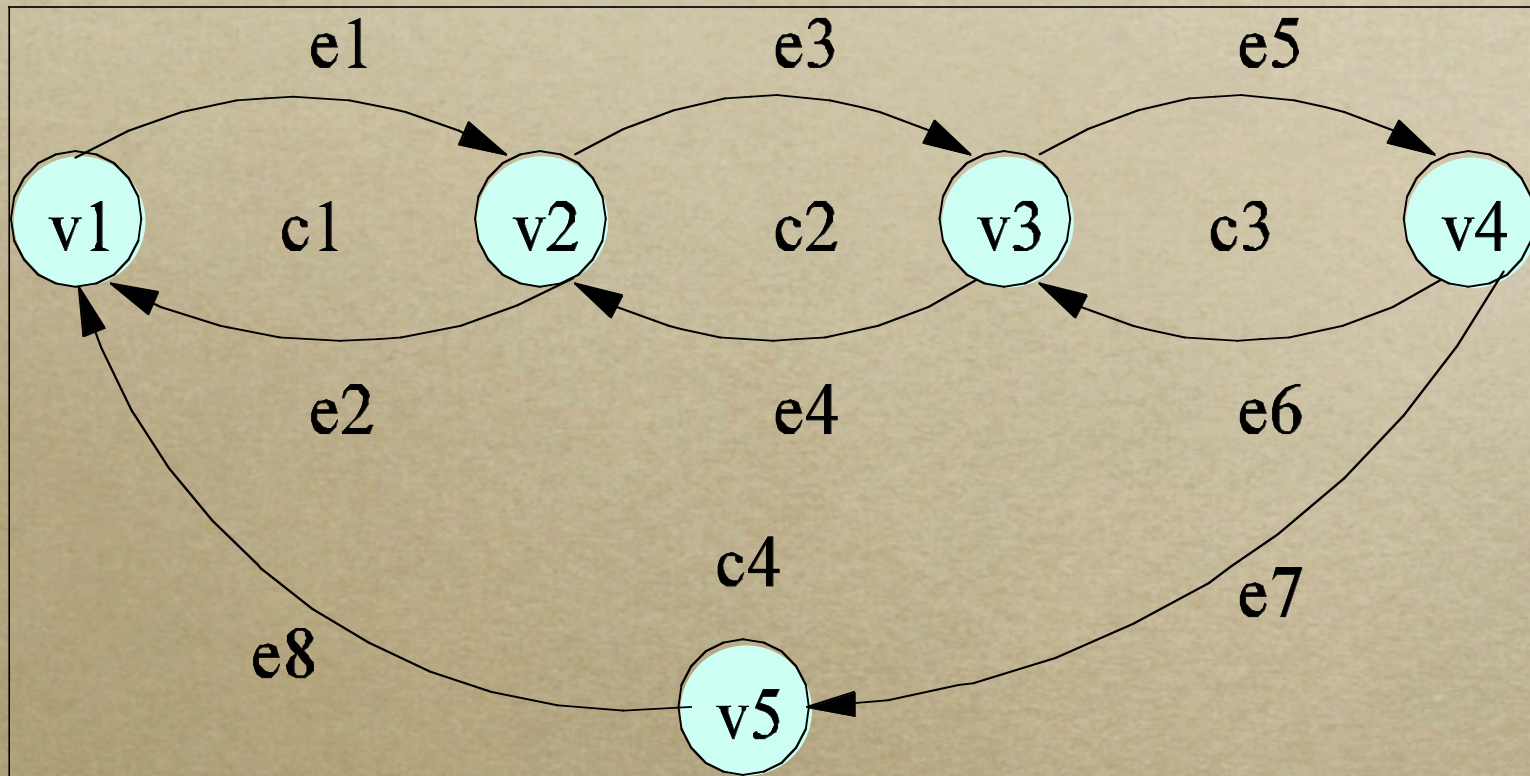
Kidney Exchange



Kidney Exchange



Optimization: cycle cover



Cycle length constraint \Rightarrow NP-complete combinatorial optimization
National market: $\sim 10,000$ patients at any one time

More examples

- *Motor skills: riding a bicycle, learning to walk, playing pool, ...*
- *Vision*
- *Social skills: attending a party, giving directions, ...*

More examples

- *Natural language understanding*
- *Speech recognition*

Common threads

- *Finding the needle in the haystack*
 - *Search*
 - *Optimization*
 - *Summation / integration*
- *Set the problem up well (so that we can apply a standard algorithm)*

Common threads

- *Sequential decisions, delayed feedback*
 - *Shoot or pass*
 - *Steering a car*
 - *Landing a “bird”*

Common threads

- *Managing uncertainty*
 - *chance outcomes (e.g., dice)*
 - *sensor uncertainty (“hidden state”)*
 - *other agents*

Classic AI

- *No uncertainty, pure search*
 - *Mathematica*
 - *deterministic planning*
 - *Sudoku*
- *This is the topic of Part I of the course*

SuDoku Puzzle

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

<http://www.cs.qub.ac.uk/~I.Spence/SuDoku/SuDoku.html>

Uncertainty

- *Adding outcome or sensor uncertainty to planning: unsolved problem, lots of current AI research*
 - *one-step decisions: graphical models*
 - *outcome only: MDPs*
 - *sensors: POMDPs, DBNs*
 - *other agents: game theory*
- *Topic of Part II of course*