Intelligent Control and Cognitive Systems

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What this course is about

- AI is a fusion of science and engineering. So is this course.
- You will learn to build human-like AI, partly by trial and error.
- You will also learn about and by reading & writing up research.

Why ‘human-like’?

- Until very recently, nature provided all the best examples of intelligence.
- The problems of real-time, resource-limited AI are different from less-constrained systems.
- This course is also about our own intelligence, including AI regulation.
  - Building intelligent systems lets us appreciate the complexity and finesse of nature’s solutions.

Survey: Before ICCS

1. Does artificial intelligence (AI) exist?
2. Can AI ever exist?
3. Does science understand consciousness?
4. When might we understand consciousness?
5. Could a robot love you?
6. Could you love a robot?

What is hard?

- What we spend our conscious cycles on is not necessarily the hardest part of the problem of intelligent behaviour.
- Some problems have *already been solved* for you (talent), or by you (skills).
- This is going to catch you when you start trying to build AI. You will need new intuitions.

Go Ahead, Prove Us Wrong!

- Some of you won't believe what I tell you about Intelligence and Cognition.
- Fortunately, you can try what you like in the coursework.

…and argue with us.

- Most but not all lecture content is prerecorded.
- One lecture a week discusses this content. There is also a quiz.
  - The material is complex (but not “hard”), ideal for flipped classrooms.
  - Also, I live in New Jersey.

Coursework (60% of Marks)

- 3 projects, with 1- or 2-page reports
  1. Robots: physical intelligence. 25%
  2. ABM: social intelligence. 12.5%
  3. Games: motivational intelligence. 12.5%
- Quizzes over video lectures 10%

Quizzes

- On Moodle. Marked automatically.
- At a specific time (mostly: start of Friday lecture slot.)
- Not at a specific place (but you can use the Friday lecture hall.)
- Your two worst marks are dropped.
- More formative than summative (really improved exam results!)

Report Submissions

- Lab report
  - Hypothesis: a general principle altering intelligence.
  - Experiment, test, ONE FIGURE.
- 1 page of latex (geometry 11pt), OR HTML
- Robot coursework must include a short movie; others include commented code.

Last 40% of Mark (30229 vs 50230)

- CM30229: An Exam
- CM50230: CW 4
  - Extend one of CW 1-3 to a conference paper
  - About two pages, two-column format
  - Introduction, Method, Results, Discussion, Conclusion

Time Management and Degree Outcomes

- Most of you are writing dissertations.
- 100 hours/course / 10 weeks/course ⇒ (10 hours/week
  - - 3 hours/week lectures) * 3 week/coursework ⇒ 21 hours/coursework.

4-6 hours in lab; robots longest.

~5 writing up ⇒ 16 hours to hack and read!

Note to 50230 (and keen undergraduates)

- This is a “research lead” course.
- Includes both history and cutting-edge material.
- The TAs and I are keen to see you publish – could help you get a funded PhD.
- Marks are individual, but publication after term could / should be collaborative. (So is learning.)

Schedule in Browser

Expectation Setting

- This course is about cognitive systems. It's intended to be the coolest course I could possibly write.
- It's about how to build intelligent machines…
- and about how our own minds work.

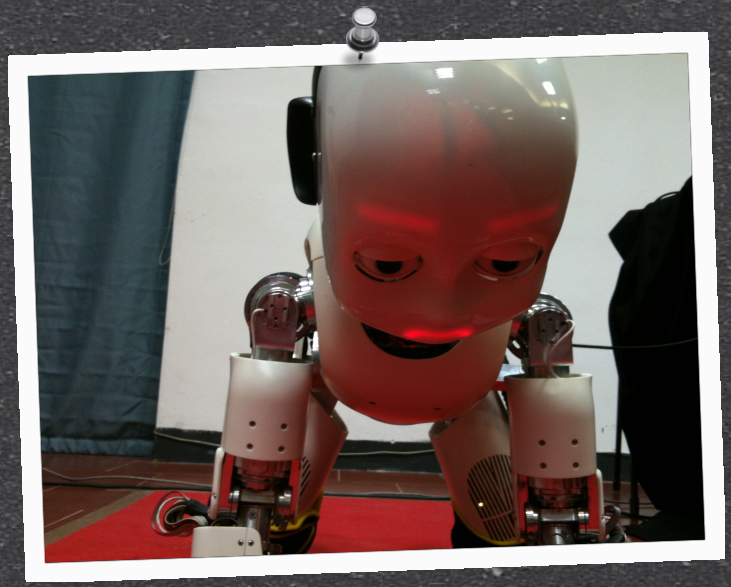
More Expectation Setting

- Lectures alternate between AI & NI.
  - They're necessarily just surveys.
  - You don't need detailed knowledge of lecture topics, they're to show you what's out there. Look at previous exams now!
- This field is moving very fast, with major industrial and public investment and interest.

More Course Details

- Primary communication with me is in & after lecture/discussion.
- Everyone may attend any lab, but students in their own lab have precedence.
- Moodle forums are best place for help (not email! except individual e.g. job references, discussing CW4, marks).
  - There's a forum for PhDs & jobs.

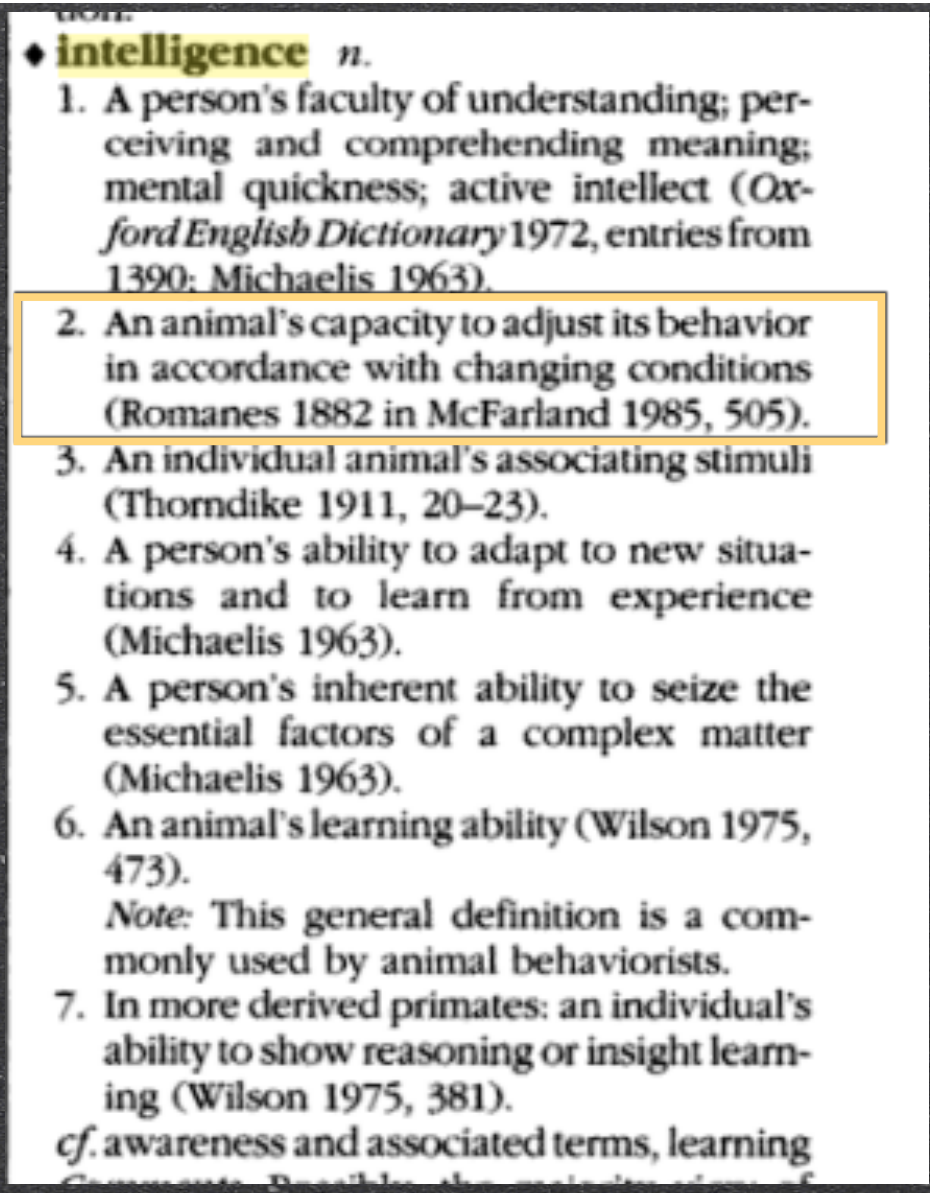
Questions? or



Back to Content

Intelligence

- What is intelligence?
- The computation of action from perception.
- Doing the right thing at the right time.
- Judged by expressed behaviour.
  - Judgement by people.
  - "Judgement" by Natural Selection.



◆ **intelligence** *n.*

1. A person's faculty of understanding; perceiving and comprehending meaning; mental quickness; active intellect (*Oxford English Dictionary* 1972, entries from 1390; Michaelis 1963).
2. An animal's capacity to adjust its behavior in accordance with changing conditions (Romanes 1882 in McFarland 1985, 505).
3. An individual animal's associating stimuli (Thorndike 1911, 20–23).
4. A person's ability to adapt to new situations and to learn from experience (Michaelis 1963).
5. A person's inherent ability to seize the essential factors of a complex matter (Michaelis 1963).
6. An animal's learning ability (Wilson 1975, 473).

   Note: This general definition is a commonly used by animal behaviorists.
7. In more derived primates: an individual's ability to show reasoning or insight learning (Wilson 1975, 381).

cf. awareness and associated terms, learning

Behaviour

- Behaviour is the interaction between an agent and its environment.

space

caffiene

Noever, R., J. Cronise, and R. A. Relwani. 1995. Using spider-web patterns to determine toxicity. NASA Tech Briefs 19(4):82. Published in New Scientist magazine, 29 April 1995.

Obligatory Cat Video

- https://www.youtube.com/watch?v=nlz0IMWwYw8
  - second cat, 16 sec in

Components of Behaviour

- Behaviour is the interaction between an agent and its environment.
- Morphology. How the robot hits its environment
- Sensing. How the robot knows it got hit
- Action Reflexes / Motor Skills. Require sensing / perception
- Cognition. Realtime search

Designing Intelligent Systems

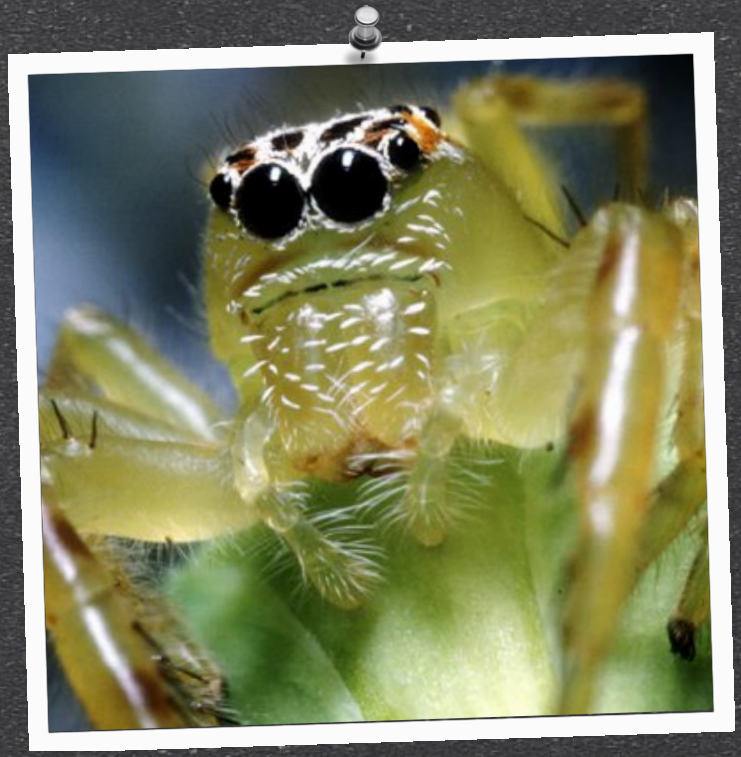
- “Programming the robots isn’t hard…”
  - Making them Intelligent is.
- AI development requires trading off and integrating many techniques.
  - Programming, sensors, morphology, actuators, cognition, learning.

Tristan Caufield, first ICCS TA

- All of these combined are AI.

Decomposing Behaviour

- A plan from nature:
- Little side eyes get you to rotate.
- Big eyes help you pounce.
- Sensing is for action.



Strategy for CW1

- Decompose behaviour into parts.
- Figure out how to do the parts.
- Figure out when to do the parts.
- Use morphology to solve problems, e.g. by avoidance.

Keep It Simple (KISS).

Types of Robot Sensors

- Contact sensors
  - e.g. bump sensors
- Range sensors:
  - e.g. sonar, infrared, lazer range finders.
- Proprioception

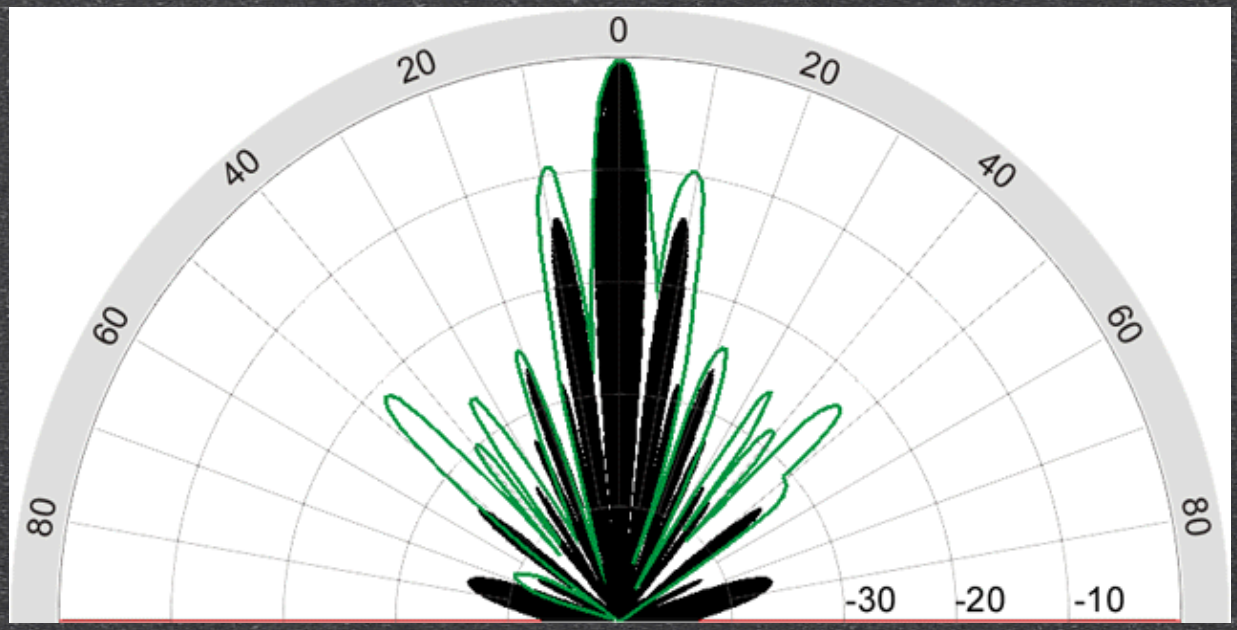
Using Sensors

- Range sensors allow continuous functions, easy plans.
  - But range sensors aren't reliable.
- Contact sensors are (almost) unambiguous.
  - But they only give you one bit of information.

Using Range Sensors

- IR is very accurate, but
  - Works on a limited range.
  - Depends on the colour it reflects from.
- Sonar has a range longer than most rooms, but...

Sonar Beam Pattern



Green is real, Black is simulated

http://www.beugungsbild.de/sidescan/sidescan_simulations.html

Vision: So Why Not Just Look?

- It's harder.
  - Anyone taking Vision?
  - How much of our brain does vision?
  - Paper in today's lecture notes.
- If you use vision more like a range sensor it gets more tractable (more on this in a later lecture.)

Upshot

- Intelligence needs robust algorithms to handle noisy input (see Reading on course web page).
- Bad to design for a snapshot / time slice, need to consider information over a range of time and sources.
- Need to unit test!

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  - Timebox your coursework!
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  - Timebox your coursework!
- Intelligent behaviour may not be (best?) composed the way you think.
- Robots can't sense much, but that may be a good thing (more later).