# Robot Control Architectures

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# Outline

# Announcments

- Lab books
- We need your rubbish!

# Overview

- We've looked at low level control.
- Today we're going to look at software architectures for robot control.
- We're considering control at a slightly higher level here. We'll raise the level of abstraciton even higher in the next few lectures.

# Shakey versus the Ants!

- Shakey was the first robot that could reason about it's actions.
- Landmark in the 'symbolic' AI movement that was dominant till the 1980s.
- Incredibly successful. A huge number of fundamental advances came out of Shakey. E.g. A* search, STRIPS planning, the Hough transform.
- Ultimately flawed.

# Shakey, the video!

The Shakey Video

- Watch the Shakey video and think about
  - How were the systems within Shakey organised?
  - How did Shakey represent the world?
  - How did Shakey decide on a course of action?
  - What simplifying assumptions did the designers of Shakey make?
  - When would Shakey fail?

# Shakey Summary

- Functional decomposition
- Represented the world using first-order logic.
- Actions chosen by planning in the world model
  - (Actually, used a slightly different representation for performance)
  - Massive cheats to make it work
    - Solid colours and strong lines so vision worked
    - Objects were easy to push, floor was smooth
    - No other agents in the environment (most of the time :)
- Long feedback loops make Shakey error prone
- Shakey didn't transfer to the real world

# The Ants are Coming!

- In the 1980s people, mostly prominently Rodney Brooks, started looking at a different approach to robotics, dubbed *behaviouralism*.
- Behaviouralism started by rejecting functional decomposition and attempts at reproducing human level intelligence.
- Aimed at insect level intelligence embedded in the real world
  - Incremental increases in complexity.
  - Behavioural decomposition
  - No explicit representations

# Rodney and the Ants

- Rodney Brooks on Robotics

# Behaviours

- Simple units of interleaved action and perception
- Minimal processing requirements
- Often *reactive* – no internal memory of state
  - “World is the representation”
- Finite state machines also common
- E.g.
  - Avoid obstacles
  - Move towards light

# The Subsumption Architecture

- Arrange behaviours in priority hierarchy
- E.g.
  - Avoid predator
  - Find food
  - Make sweet love
- High priority behaviours suppress lower priority ones
- Operate in parallel
- Distributed – no central controller or representations

# Methodology

- Extensive testing in the real world
- Add behaviours incrementally

# Impact

- This course owes a lot to behavioural robotics
- Successful for insect level behaviours
- Short feedback pathways minimise error
- Doesn't transfer to more complex tasks
- No method for creating behaviour other than trial and error.

# Hybrid Architectures

- Combine behavioural robotics with representationalism.
- E.g. Cog-X / CAST at Birmingham.
- Parallel processes communicating through shared working memory.
- Processes updated on memory change.
- Choose level of representation appropriate for task.

# Notes

Read “Intelligence without Representation” by Rodney Brooks. It’s a fun read no matter what you think of it.