

# Robot Software Architectures

COMP3431/9434

<http://www.cse.unsw.edu.au/~cs3431>

# Course Outline

Introduction & History; ROS (Robot Operating System)

More ROS; Robot Software Architectures

Mapping and Navigation

Robot Vision

Flexibility Week

More Robot Vision

Human-Robot Interaction

Robot Learning / Planning

Project Work

Project Demonstrations

# Assessment

Project 1: 20% (week 4 - individual report)

Project 2:

practical: 40% (week 10)

report 40% (week 11 - individual)

# Artificial Intelligence: the first 2,400 years

The mechanisation of thinking dates back to Aristotle and the invention of logic

Influenced middle-eastern logicians who brought it back to Europe

The motivation for much mathematics

# Thought as Calculation

The only way to rectify our reasonings is to make them as tangible as those of the Mathematicians, so that we can find our error at a glance, and when there are disputes among persons, we can simply say: Let us calculate [calculemus], without further ado, to see who is right

Liebnitz (1685)  
The Art of Discovery

# The AI Program

"... to investigate the fundamental laws of those operations of the mind by which reasoning is performed; to give expression to them in the symbolical language of a Calculus, and upon this foundation to establish the science of Logic and construct its method; to make that method itself the basis of a general method for the application of the mathematical doctrine of Probabilities; and, finally, to collect from the various elements of truth brought to view in the course of these inquiries some probable intimations concerning the nature and constitution of the human mind.

George Boole (1854)

An Investigation of the Laws of Thought

# Turing's Mind Paper

Introduced the imitation game

Also discussed how a computer could be "educated" to the point that it could play the game

# The Child Machine

“Instead of trying to produce a programme to simulate the adult mind, why not rather try to produce one which simulates the child's? If this were then subjected to an appropriate course of education one would obtain the adult brain. Presumably the child-brain is something like a notebook as one buys from the stationers. Rather little mechanism, and lots of blank sheets... Our hope is that there is so little mechanism in the child-brain that something like it can be easily programmed. The amount of work in the education we can assume, as a first approximation, to be much the same as for the human child.”

Alan Turing (1950)  
Computing Machinery and Intelligence



# The World Brain

"...a sort of mental clearing house for the mind, a depot where knowledge and ideas are received, sorted, summarized, digested, clarified and compared."

"any student, in any part of the world, will be able to sit with his projector in his own study at his or her convenience to examine any book, any document, in an exact replica."

H.G. Wells (1937)

World brain: the idea of a permanent world encyclopaedia

# Where has AI gone?

More focussed on the world brain than the child machine

Masses of data enable solving problems in ways we couldn't anticipate

E.g. Crowd-sourcing

Data centres have enormous computing power

# Robotics

*The intelligent connection of perception to  
action*

Michael Brady

# Robots

Complex behaviours in dynamic environments

Have to integrate almost all aspects AI

plus mechanical, electrical and computer  
engineering

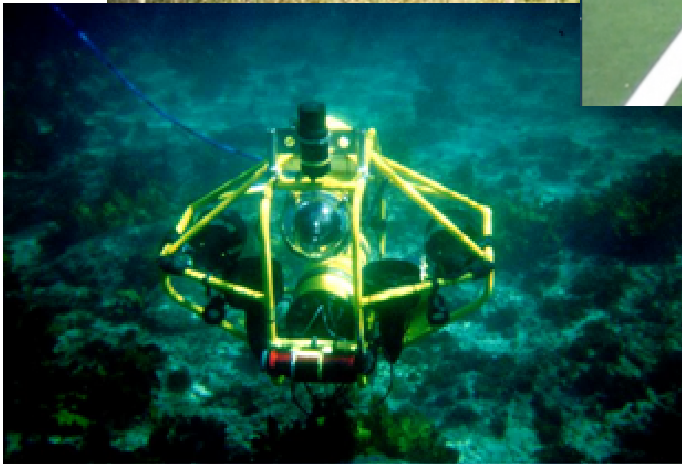
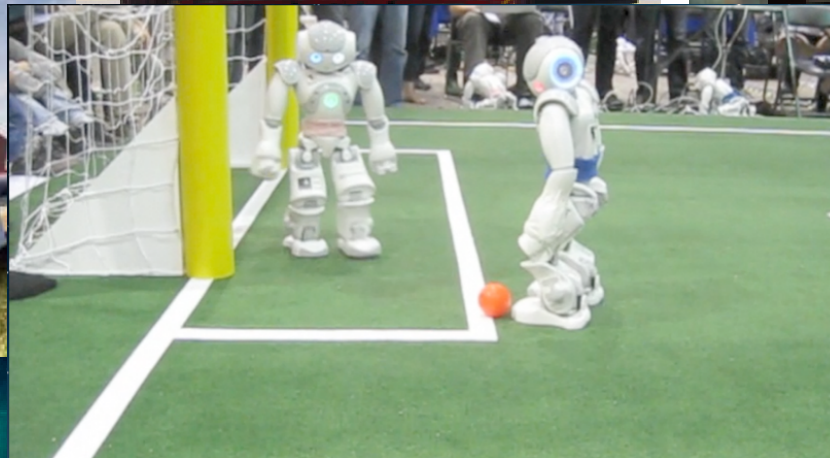
# Shakey



# Freddy



# Autonomous Systems



# Logic and Probability

Before we can determine the mode in which the expected frequency of occurrence of a particular event is dependent upon the known frequency of occurrence of any other events, we must be acquainted with the mutual dependence of the events themselves.... Now this explicit determination belongs in all instances to the department of Logic. Probability, however, in its mathematical acceptation, admits of numerical measurement.

George Boole (1854)  
An Investigation of the Laws of Thought



# Learning and Reasoning at different levels of abstraction

Symbolic representations for long-term planning assuming the world is mostly deterministic

Probabilistic representation for short-term control assuming uncertainty

# Projects

## Project 1

Map a room

Identify simple markers (QR codes)

## Project 2

Autonomous driving

Navigate TurtleBots around “city streets”

# RoboCup@Home



RoboCup German Open 2011

Final NimbRo@Home

Autonomous Intelligent Systems  
University of Bonn

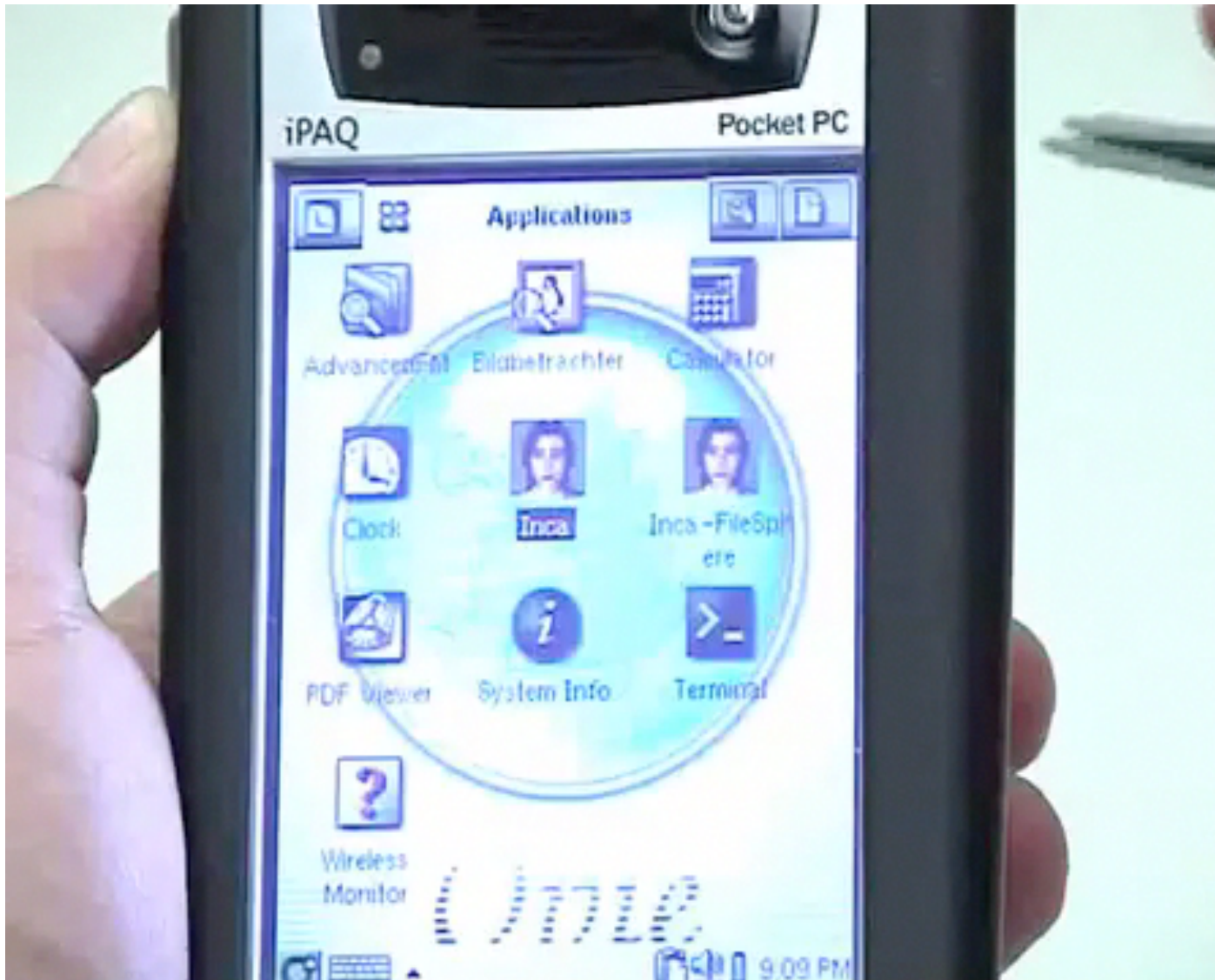
# Robots in the Cloud

We could all become robot trainers in the future.

Everything we teach our robot is shared with other robots through the "cloud"

So maybe because of the world brain, there may only ever be one distributed child machine

# Conversational Agents



# Robotics Laboratory

