Robot Software Architectures

COMP3431

Course Outline

Introduction & History

Reactive Agents

Learning by trial-and-error and memorising

Perception (Computer Vision)

Knowledge Representation and Reasoning

Learning Structure

Cooperation and Coordination

Human-Robot Interaction

Assessment

Assignment 1: 20%

Assignment 2:

   practical: 35%

   report 35%

Compulsory reading assignments: 10%

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 note-book 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

Robots

Complex behaviours in dynamic environments

Have to integrate almost all aspects AI

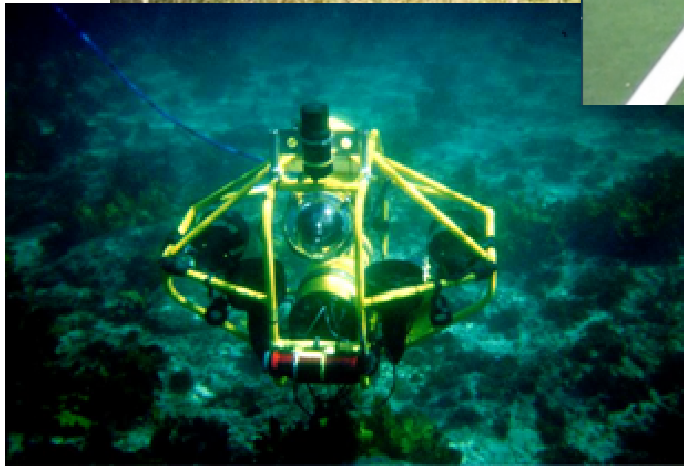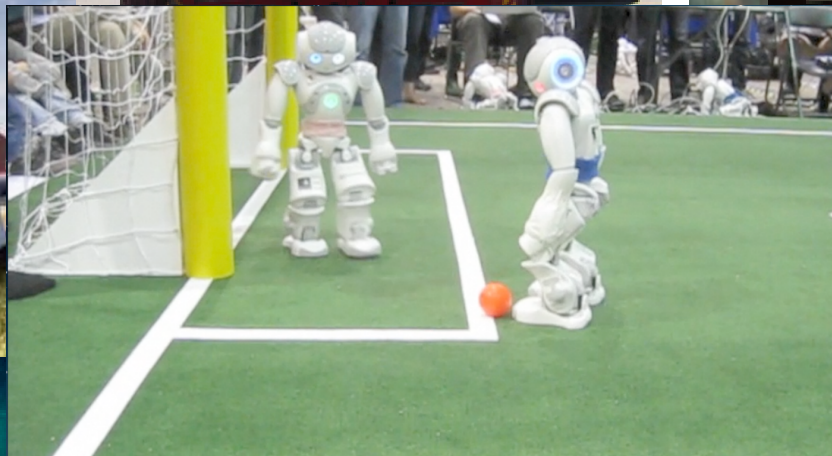plus mechanical, electrical and computer engineering

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

Possible Projects

Learning to find soccer ball

Picking and stowing

RoboCup@home with Turtlebot

RoboCup@work

Mini Rescue

Map new area in iCinema

Drive Turtlebot using VR

Virtual tour with 360 degree camera.

Reinforcement learning for robots.

Learn strategy from logs of games

Machine learning to see another robot

TR control of multiple robots

Rescue drone

Handling natural lighting

RoboCup@Home

RoboCup German Open 2011

Final NimbRo@Home

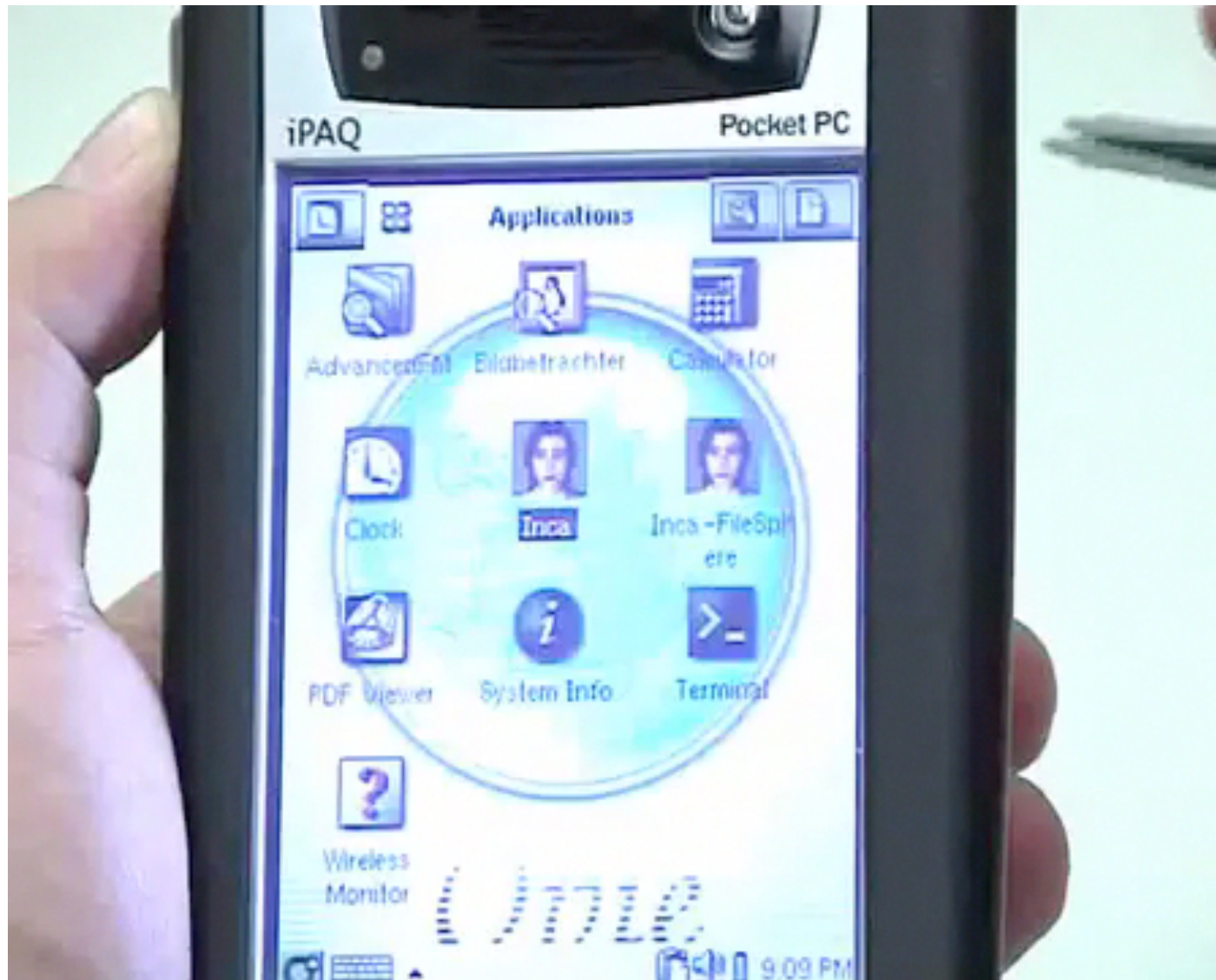Autonomous Intelligent Systems
University of Bonn

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

Available Robots