Introduction to knowledge-based systems

Overview of the course

- This course is about
    - knowledge-based systems
    - expert systems
    - knowledge systems.
    - three different terms which mean more or less the same thing.
- One could also say that it is about *applied artificial intelligence*.

KBSs & Knowledge

- What is a knowledge-based system?
  - A system which is built around a knowledge base. i.e. a collection of knowledge, taken from a human, and stored in such a way that the system can *reason* with it.
- What is knowledge?
  - Knowledge is the sort of information that people use to solve problems.

Knowledge

- Knowledge includes:
  - facts, concepts, procedures, models, heuristics, examples.
- Knowledge may be:
  - specific or general
  - exact or fuzzy
  - procedural or declarative

Expert systems

- What is an expert system?
  - A particular kind of knowledge-based system
  - One in which the knowledge, stored in the knowledge base, has been taken from an expert in some particular field.
- Therefore, an expert system can, to a certain extent, act as a substitute for the expert from whom the knowledge was taken.

Artificial intelligence

- What is Artificial Intelligence?

- Artificial Intelligence (AI) is concerned with exploring such aspects of human (and other animal) mental activity as:

  - understanding
  - perception
  - consciousness
  - intelligence

  - creativity
  - problem-solving
  - using language

  by simulating them using computers.

- It is therefore closely connected with such social sciences as:
  - psychology
  - linguistics
  - philosophy

Applied artificial intelligence

- What is applied AI?
- Applied AI is concerned with producing software which is "intelligent"
- It is intelligent in that it is based on what we know about human reasoning and other mental abilities
- We are therefore talking about a branch of advanced computing - computer technology - rather than social science

Knowledge engineering

- The term "knowledge engineering" is often used to mean the process of
  - designing
  - building
  - installing

  an expert system or other knowledge-based system.

- Some authors use the term to mean just the knowledge acquisition phase.

Experts

- An expert is an experienced practitioner in his/her particular field. More than that, he/she is a highly effective problem-solver and decision-taker in that field.
- Experts have three qualities:
  - They make good decisions
  - They make those decisions quickly
  - They are able to cope with a wide range of problems.

- As a result, they are valuable, highly-paid, and tend to be overworked.

Experts and expert systems

- Note that:
  - The task that an expert system performs will generally be regarded as difficult.
  - An expert system almost always operates in a rather narrow field of knowledge. The field of knowledge is called the knowledge domain of the system.
  - There are many fields where expert systems can usefully be built.
  - There are many fields where they can't.

Experts and expert systems

- Note also that an expert can usually
  - explain

  and
  - justify

  his/her decisions.

Reasons for building an E.S.

- One might build an expert system for any or all of the following reasons:
  - To archive an expert's knowledge, to insure against the day when he/she leaves, or retires, or dies.
  - To disseminate his/her knowledge, so that it is available in more (possibly many more) places than the location of the expert.
  - To ensure uniformity of advice/decisions.
  - As a basis for training other specialists.

Advantages of expert systems

- Put another way, E.S. have the following advantages over human experts:
    - The knowledge is permanent
    - The knowledge is easily replicated
    - The knowledge is represented explicitly, and can be evaluated
    - The system is consistent - whereas human practitioners have bad days, computers don't.
    - Once built, running costs are low

Disadvantages of expert systems

- Developing an expert system usually costs a great deal of time & money
- Historically, there has been a high failure rate in E.S. projects
  - The project may well fail during development - most likely during the "knowledge acquisition" phase.
  - The development may succeed, but the organisation may fail to accept and use the finished system.

Disadvantages of expert systems

- A human expert can update his/her knowledge in the light of
  - Common sense
  - Knowledge derived from other domain
  - Contacts with other experts.

An expert system can't.

Choosing an E.S.project

- Because of cost, and the danger of failure, it is important that E.S. projects are carefully chosen.

Choosing an E.S.project

- The expense must be justified, in the light of the possible benefits.

- E.S. technology must be appropriate

  - the right kind of expertise is involved

  - it isn't a problem which conventional programming could do better.

- Management, and the participants, must support the project fully.

Types of expertise

- Mike Greenwell's classification of types of expertise, according to identifiable mental components of the skill (with examples):
- [source: Greenwell (1988)]

Types of expertise (with examples)

	Deep cognitive skills	Judgmental skills	High-level social skills
Highly creative	Musician	Senior manager	Author, poet
Analytical	Mathematician	Economist, programmer	Social scientist
Strictly procedural	Typist	Driver	Social worker

- Greenwell argues that only expertise which is judgmental and analytical, i.e. only the middle box of the nine, is worth capturing and including in an expert system.

The phone call test

- A rather simpler approach to answering the question which domains are worth building into an expert system?

- "Any problem that can be and frequently is solved by your in-house expert in a 10-30 minute phone call can be automated as an expert system."

- *Prof.Morris Firebaugh*

Possible expert systems - case histories

- For discussion.

- The following seven problem areas may, or may not, be suitable for computerisation as expert systems.

Possible expert systems - case histories

- A certain third world country has a large population, very few trained doctors, and insufficient resources to train many more. It is proposed to provide paramedics, who can be trained relatively cheaply and easily, with medical kits and portable PCs, each PC to be loaded with an expert system that can advise on the diagnosis and treatment of a variety of common diseases.

Possible expert systems - case histories

- The housing department in a provincial English town is overworked, although the staff turnover is quite low. Much of the work the staff do involves interviewing clients, and there is a clear pattern of questioning (which varies to a limited degree, depending on the circumstances of the client). It is proposed to build an expert system, which will direct the questioning process.

Possible expert systems - case histories

- A firm of wine importers relies heavily on its chief wine expert, who is skilled at selecting wines that are destined to be popular, on the basis of their taste, colour, scent etc. She is soon to retire. It is proposed to build an expert system that will enable any of several junior wine specialists to do her job.

Possible expert systems - case histories

- An education authority has a severe shortage of primary school teachers. It is proposed that an expert system should be built which can do the job of teaching English and arithmetic to five year old children.

Possible expert systems - case histories

- A software company proposes to build an expert system which can perform book-keeping for small commercial concerns.

Possible expert systems - case histories

- A large manufacturer of diesel electric locomotives has problems in providing enough maintenance personnel who are sufficiently skilled to locate faults in these (highly complex) locomotives. They propose to build an expert system which can perform fault location on such a machine.

Possible expert systems - case histories

- A mineral exploitation company wishes to extend its operations, which involve searching for hitherto undiscovered deposits of valuable metal ores. It is short of trained geologists. It proposes to build an expert system which can assess a geological site and come to a conclusion about how likely it is that there is a worthwhile mineral deposit there.