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Knowledge Based Systems

(CM0377)

Introductory lecture

(Last revised 28th January 2002)

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What is knowledge?

- **knowledge** *n.* knowing; what is known (of person, thing, fact or subject); sum of what is known to mankind ...; person's range of information.

  (Pocket Oxford Dictionary, 7th edition)

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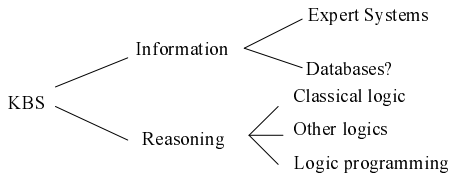
Some areas of KBS



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Wouldn't it be nice if we could ask a computer questions?

- Who is Jim's father?
- How should I fix my car?
- Is the moon made of cheese?

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Prolog: PROgramming in LOGic

- What kind of logic?
- How can logic programming be made efficient?
- What are the limitations of such a system?

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Classical logic (First order predicate logic)

- "If someone male is a parent of someone else, he is that person's father"

$$(\forall x)(\forall y)(male(x) \wedge parent_of(x,y) \Rightarrow father_of(x,y))$$

```
father_of(X,Y):-male(X),parent(X,Y).
```

- "Every person has a mother or a creator"

$$(\forall x)(person(x) \Rightarrow (\exists y)mother_of(y,x) \vee (\exists z)creator_of(z,x))$$

- (Prolog can't express this fully: later on, when we learn about Skolem variables, consider what options would be open to you)

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Proving theorems

- Prolog proves theorems using resolution. 2 major questions about any theorem prover:
  - Is it sound?
    (Does it prove only theorems that are correct?)
  - Is it complete?
    (If a theorem is true can it be proved?)

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Prolog is *un*sound and *in*complete!

- Unsound in a special case ("occurs check")
- Incomplete because of search strategy (depth first searching of search tree; may never find some solutions)

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Closed World Assumption

Consider

```
male(X):- \+female(X).
```

("not")

"Negation as failure"

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Expert Systems

- Rule-based systems (often diagnostic)
- JESS
- Forward chaining, e.g.
  IF it is too hot THEN switch off fire
- How to implement an inference engine?
- How to represent knowledge?
- How to handle uncertainty? e.g.
  IF it is cold THEN it may snow
  IF it is cold THEN it *will* snow (certainty 0.4)

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Databases

- No time to cover these in any detail, but you may wish to reflect on the following:
  - Is Prolog a database?
  - How can you link Prolog to a DBMS?
  - Deductive databases:
    - What can be efficiently expressed & deduced?
    - How can search be optimised?

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But humans don't do classical logic!

Tweety is a bird
Normally birds fly
Therefore Tweety flies

Non-monotonic reasoning;

Tweety is a bird
Normally birds fly
Tweety is an ostrich
Ostriches don't fly
Therefore Tweety *doesn't* fly

specifically, default reasoning.

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Abduction

- Default reasoning makes assumptions about what is false (e.g. that Tweety isn't exceptional)
- Abduction makes assumptions about what is true too - *explanation.*

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Abduction - example

Everyone likes his or her children
Andrew likes his students

So if we know
Andrew likes Peter
2 explanations:
Peter is his child, or
Peter is his student

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Induction

Tweety is a bird	Tweety has feathers
Polly is a bird	Polly has a beak
Tweety flies	**Polly flies**

Can we find some *hypothesis* explaining why Tweety and Polly fly?

(Something flies if it's a bird)

This is **induction**, inferring general rules from specific observations.

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Next time

- A tutorial introduction to Prolog.