Knowledge

Knowledge is information and processing
Knowledge can be derived from information with logical reasoning

Inference the logical course by which new facts are derived from old facts using inference rules.

Knowledge is our belief about the world and knowledge we knowledge

How to represent knowledge
How to implement reasoning

State space – possible (courses of inference) outcomes when we combine
Beliefs about the world
General Knowledge
Rules of inference

Knowledge System Conceptualization
System engineering level – Physical realization of the system
Symbol level – Symbol system (a program specification)
Knowledge level – knowledge (that will be represented) specification

Knowledge Level Hypothesis
Computer level above the program (symbol level), this is where knowledge is the medium method and rationality is behaviour

Knowledge allows a system to determine consequences based on logic rather than actions.
i.e. Reason that a cup will hit the floor, not drop it to see.

Knowledge is a set of questions and answers

Knowledge is a method of reasoning
WHAT DOES THIS MEAN ??
It is a fragmentary **theory of intelligent reasoning**, expressed in terms of three components: (i) the representation's fundamental conception of intelligent reasoning; (ii) the set of inferences the representation sanctions; and (iii) the set of inferences it recommends.

Methods of knowledge representation
Logic based - first order predicate logic and others like description logic OWL
(backward chaining, from negated goals back)

Procedural – rules, production systems (forward chaining)

Network – semantic networks, conceptual graphs, links represent relationships, works by graphical link tracing, (spreading activation)

Structural – scripts frames objects, reasoning by inheritance executing demons or procedural attachments

Logic

Propositional

˅ ˄ => ≡, true false, and rules like de morgans

FOPL (First Order Predicate Logic)

enriched by variables predicates functions
quantifiers (upside down a (for all))(upside down e (exists))

inference representation, used for proof
rules of inference, modus ponens
if (p is true and p => q is true the infers q is true)

A rule of inference can be

Sound, if all conclusions are true
Complete, if it infers all true consequences

modus ponens is sound but not complete

Production Rule Systems

Intuitive

rule learning -> expert systems
cognitive productions for functional descriptions, i.e. A newspaper is a thing to read, yet we have mental models for its use for fire lighting etc

forward chain, reason on rules

working memory, keeps current ideas and changes as rules are reasoned on

operation

recognise rule (find ones which satisfy conditions)
resolve conflict (choose a rule)
act based on chosen rule

Declarative & Procedural Representations

Are general, reusable in situations not thought about (easily modified by changing knowledge base)

Actions and inference (decisions) should reflect beliefs which can be explicitly articulated i.e. can be categorised.

Separates knowledge from the symbol level

Separates knowledge from the use of the knowledge
i.e model -> control

usually domain – specific as the knowledge is retrieved via programs designed for such a task i.e. googlebot finds Internet content not tv content

Domain-specific skills are more easily represented i.e. We dont have to look at all possible uses of item X. i.e. Googlebot categorises website for reading not viewing so cant catagorise websites on how they look

A lot more computationally efficient than general purpose declarative representations for similar reason to last point.

Based on the idea that representations get meaning by how they effect thinking and ultimately perception and actions.

Meaning not tied to what is (implied) inferences

Semantic Networks

Early ones anything went, could lead to bad reasoning
i.e. Car has wheel, plane has wheel, car = plane

no semantics for concepts or links

Transitivity (concept meaning, reason, a number of objects) is a requirement if you want to follow links,

Semantic Networks – Generalities

Represent knowledge as a graph

Each node is a name

Generic Nodes are one-place predicates (i.e. Car surrounded by wheel, brake, windscreen, steering wheel, engine

Links are rational predicates such as part of, contains etc

Answering questions by inferance, starting with a relavent node and following links (spreading activation though the network).

All related knowledge is in one location i.e everything about robins is here rather than with FOPL where its spread out all over the place

Negativity and disjunction are problems as everything is linked i.e. is things like part of.

Inference still works tho as you can still find forward paths

Points out poorly specified semantics

Frame

NO-FRAMES – each node is self contained ie a robin knows everything about being a robin

FRAMES – each frame corresponds to a node in the network each frame contains variables basically, which provide background knowledge. Helps by presenting chunks of knowledge. And combines procedural and declarative aspects / approaches to knowledge.

REMEMBER FRAMES – it looks more like a class diagram it has methods(demons/servants) and variables (shots) and links to other items, the slots can have restrictions on them. The methods can compute the values of slots when they are created deleted or modified.

When someone encounters a new situation they select an appropriate frame (framework) to fit what's happening and its adapted by changing its properties, A frame represents a stereotype situation, i.e. going to a party)

SCRIPTS these say how multiple frames work together and say how things should happen, if things go wrong the system can compare what's meant to happen with what happened and work out what's wrong.

Scripts useful in decision support system process modelling.

To make it better for reasoning classes are organised hierarchically so that inheritance can pass on common attributes.

ONTOLOGY

A formalised conception of a domain
A domain that has been set out formally.

Design logic for structured descriptions

LOGIC

Use English or other Normal Language words to refer to singular terms predicates

Logical constants, (connectives, quantifiers) ^ v etc

Identify objects as elements in sets

Why Logic?

Logic is reasoning
Correct reasoning - soundness
A role of AI is to provide meaning, often constructed as model theory.

If B represents A, we manipulate parts of B to reach A

The rules of inference for elements of B is called proof theory, WHYWHYWHY, who knows

The domain is seen in terms of sets and the model theory and semantics of the system try to keep this.

Which Logic
FOPC (First Order Predicate Logic)

Every expression is a sentence which represents a fact
Objects are represented by terms see notes

Inference in FOPC

AI as theorem proving: KB |= p
but reasoning is difficult to manage

Resolution for propositional logic ensures that a set of clauses ius satisfiable but not for FOL

Satisfiability is NP-complete

Convert frames and semantic networks into logic based formalisms (such as description logics)

Using logic to Formalise Frames and Semantic Networks

(Popular hence ontologies etc)

Ontologies are big buisness used for many things like search and can be reused

Analytic / Synthetic
Sense / Reference
Intension / Extension

i.e. Can mean the same but can mean completely different

Structures Logical Descriptions

Semantic of Description Logic

Reasoning with Logical Descriptions

Subsumpton in Description Logics

subsume – Contain or include
Given two concepts C and D, does one include the other ?

Remarks on OWL

Expressiveness of FOL: Incomplete knowledge

Non-monotonic Logic

Not sure about rest