Knowledge Bases

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Objectives:

- Understand Knowledge Bases
- Learn how a Knowledge-Based Agent functions
- Understand inference and inference engines

Knowledge Base – a database for the system that contains all the facts and beliefs that the system knows. It is a representation of the systems idea of the world
Inference engine – domain-independent algorithms – a mechanism for reasoning about those beliefs

The knowledge is *domain specific* but the inference engine is *domain independent*

Knowledge Bases = **sentences in a formal knowledge representation language** - but implementation could be anything – linked lists, arrays, databases etc

1. A declarative approach to building an agent – we tell is what it needs to know – it can then ask itself what to do. Answers should follow from the KB through inference
2. **TELL** and **ASK** are standard names for adding sentences and querying KB
3. Result of ASK must follow from previous TELLS as determined by inference mechanism

Each time the agent program is called, it firstly TELLS the knowledge base what it perceives, and then ASKS the knowledge base what action it should perform

We have to build agents that can take a knowledge base and use some inference mechanism to perform actions – **planning is about building that inference engine**

Knowledge Based Agents

- Can reason using inference and their knowledge.
- Can accept new tasks in the form of goals
- Can adapt to environmental change by updating knowledge
- Are able to infer unseen properties of the world from perceptions
- Can often find better solutions than simple search

Moreover, significantly more flexible with respect to **adopting new goals**, **partially observable environments, dynamic environments**

Characterising KBA's

1. **Knowledge Level** – what is known? Allows us to work at an abstract level of ASK and TELL (AKA epistemological level) e.g. a taxi might know that the Golden Gate Bridge links San Francisco to Marin County
2. **Logical Level** – knowledge encoded in formal sentences e.g. links(GGB, SF, M)
3. **Implementation Level** – data structures in KB and algorithms that manipulate them e.g. this could be a 1 in a 2D array of places, where 1 means Links X to Y

Simple KBA

The agent must be able to:

- Represent states and actions
- Incorporate new percept's
- Update internal representations of the world

- Deduce hidden properties of the world
- Deduce appropriate actions

Algorithm:

```
function KB-AGENT(percept) returns an action
  static : KB, a knowledge base
    t, a time counter, initially 0
  TELL(KB,MAKE-PERCEPT-SENTENCE(percept, t))
  action ← ASK(KB, MAKE-ACTION-QUERY(t))
  TELL(KB,MAKE-ACTION-SENTENCE(action, t))
  t ← t + 1
  return action
```

- Knowledge base may contain initial background knowledge
- Each iteration, TELL KB of perceptions, ASK What actions to perform
- Note: TELL and ASK refer to KB – they are internal
- Representation details hidden by MAKE-PERCEPT-SENTENCE and MAKE-ACTION-QUERY allow us to work at knowledge level
- Inference details hidden in TELL and ASK

Wumpus World

- Managed to get the goal because we can make inferences about knowledge gained from perceptions
- Combining knowledge obtained at different times and in different places allows us to infer more about the world
- Using lack of a particular perception rather than just the existence of a perception allows us to extract more knowledge from the world
- We rely on persistence of knowledge – the world is not fully observable