Mental Events and Mental Objects

Mental Events and Mental Objects

- For a single- agent domains, knowledge about one's own knowledge and reasoning processes is useful for controlling inference.

- In a multiagent domains, it becomes important for an agent to reason about the mental states of the other agents.

- Example Bob and Alice scenario

- It requires a model of the mental objects in someone's head(knowledge base) and the processes that manipulate these mental objects.

A formal theory of beliefs

- Relationships between agents and mental objects: believes, knows, wants, intends ... are called **propositional attitudes**

- Lois knows that Superman can fly:
  - Knows (Lois , CanFly (Superman))

- If Superman is Clark, then we must conclude that Lois knows that Clark can fly:
  - (Superman = Clark) $\land$ Knows (Lois , CanFly (Superman)) |= Knows(Lois, CanFly(Clark))

- "Can Clark fly?" – No. Need descriptions

- If an agent knows that 2 + 2 = 4 and 4 < 5, then we want an agent to know that 2 + 2 < 5. This property is called **referential transparency**

A formal theory of beliefs

- For propositional attitudes like *believes* and *knows*, we would like to have **referential opacity**

Modal logic address this problem

- Modal logic includes special modal operators that take sentences (rather than terms) as arguments.

- Example: "*A* knows *P*" is represented with the notation $K_A P$,
  - where **K** is the modal operator for knowledge,
  - agent A (written as the subscript) and a sentence

Opacity: blur, condition of lacking transparency

Possible Worlds And Accessibility Relations

- In modal logic, consider both the possibility that Superman's secret identity is Clark and that it isn't.
  - **Clark=Superman and Clark!=Superman**
- Build a model, that consists of a collection of **possible worlds** rather than just one true world and the worlds are connected in a graph by **accessibility relations**
- "Bond knows that someone is a spy" is ambiguous.

$$\exists x \ K_{Bond}Spy(x)$$

which in modal logic means that there is an x that, in all accessible worlds, Bond knows to be a spy.

- Bond just knows that there is at least one spy:

$$K_{Bond}\exists x \ Spy(x)$$

The modal logic interpretation is that in each accessible world there is an x that is a spy, but it need not be the same x in each world.

Knowledge and belief

- Knowledge in terms if AI is something which is always true

- Belief on the other hand deals more with probability

- After extensive study, it is commonly said that knowledge is justified true belief

- Example:
  - Eating food necessary for living, so we eat.
  - Gambling to gain money. Probability. Believe we will win

- **Knows(a, p)** – agent a knows that proposition p is true

- Lois knows whether Clark can fly if she either knows that Clark can fly or knows that he cannot
  - **Knowswhether(a, p) ⇔ knows(a, p) v knows(a, ¬p)**

Knowledge, time and action

- Belief is also something which can change over time. For example:

- Lois believes Superman flies today

  T(Believes(Lois, flies(Superman)),Today)

- The same will not be true in 100 years when he died of old age