

CSC421 Intro to Artificial Intelligence



UNIT 18: Knowledge Engineering

Making Plans



- Initial condition in KB:
 - $At(\text{Agent}, [1,1], S_0)$
 - $At(\text{Gold}, [1,2], S_0)$
- Query: $Ask(KB, \exists s \text{ Holding}(\text{Gold}, s))$
 - i.e in what situation will I be holding Gold
 - Answer $\{s / \text{Result}(\text{Grab}, \text{Result}(\text{Forward}, S_0))\}$
- This assumes that the agent is interested in plans starting at S_0 and that S_0 is the only situation in KB

Making Plans: a better way



- Plans = actions sequences
- $\text{PlanResult}(p, s)$ is the resulting of executing p in s
- Then the query $\text{Ask}(\text{KB}, \exists p \text{ Holding}(\text{Gold}, \text{PlanResult}(p, S_0)))$
- Answer: $\{p / [\text{Forward}, \text{Grab}]\}$
- Define PlanResult in terms of Result

Definition of PlanResult



- In terms of Result
 - $\forall s \text{ PlanResult}([], s) = s$
 - $\forall a, p, s \text{ PlanResult}([a|p], s) = \text{PlanResult}(p, \text{Result}(a, s))$
- **Planning systems** are special purpose reasoners designed to do this type of inference more efficiently than a general purpose reasoner

Event Calculus



- Fluents hold at points in time
- Reasoning over intervals of time
 - $\text{Initiates}(e, t, f)$ event e at time t cause fluent f to become true
 - $\text{Terminates}(e, f, t)$ f ceases to be true
 - $\text{Happens}(e, t)$
 - $\text{Clipped}(f, t, t_2)$ terminated by some event between t and t_2
- Many extensions
 - Duration, indirect effects, concurrent events

Generalized Events



- Aspects of some space-time chunk
- Generalizes: actions, locations, times, fluents and physical objects
 - Subevent(BattleofBritain, WorldWarII)
 - Subevent(WorldWarII, 20th century)
 - Duration(Period(WorldWarII)) > Year(5)
- $\exists w \quad w \in \text{CivilWars} \wedge \text{SubEvent}(w, 1640s) \wedge \text{In}(\text{Location}(w), \text{England})$

Processes (Liquid Events)



- Flying(Shankar)
- Any segment is still a member of Flying(Shankar)
- Fluent calculus
 - Both($e1, e2$)
 - One of($e1, e2$)
 - Either($e1, e2$)
- Time intervals
 - Meet
 - Before/After
 - During
 - Overlap

Internet Shopping World



- $\text{RelevantOffer}(\text{page}, \text{url}, \text{query}) \iff \text{Relevant}(\text{page}, \text{url}, \text{query}) \wedge \text{Offer}(\text{page})$.
- $\text{Offer}(\text{page}) \iff (\text{InTag}(\text{"a"}, \text{str}, \text{page}) \wedge \text{In}(\text{"price"}, \text{str}))$
- $\text{Amazon} \in \text{Online Stores} \wedge \text{HomePage}(\text{Amazon}, \text{"amazon.com"})$.
- $\text{Relevant}(\text{page}, \text{url}, \text{query}) \iff$
 $\exists \text{store, home } \text{store} \in \text{OnlineStores} \wedge$
 $\text{Homepage}(\text{store}, \text{home}) \wedge \exists \text{url2}$
 $\text{RelevantChain}(\text{home}, \text{url2}, \text{query}) \wedge \text{Link}(\text{url2}, \text{url}) \wedge \text{page} = \text{GetPage}(\text{url})$.

Procedural attachment



- GetPage(url)
 - Execute the right HTTP procedure
 - It appears to the inference engine as if the entire Web is inside the knowledge base
- Other stuff
 - Relevant names
 - Synomy (laptops, notebooks)
 - Ambiguity (CD, Certificate of Deposits)

Semantic Networks

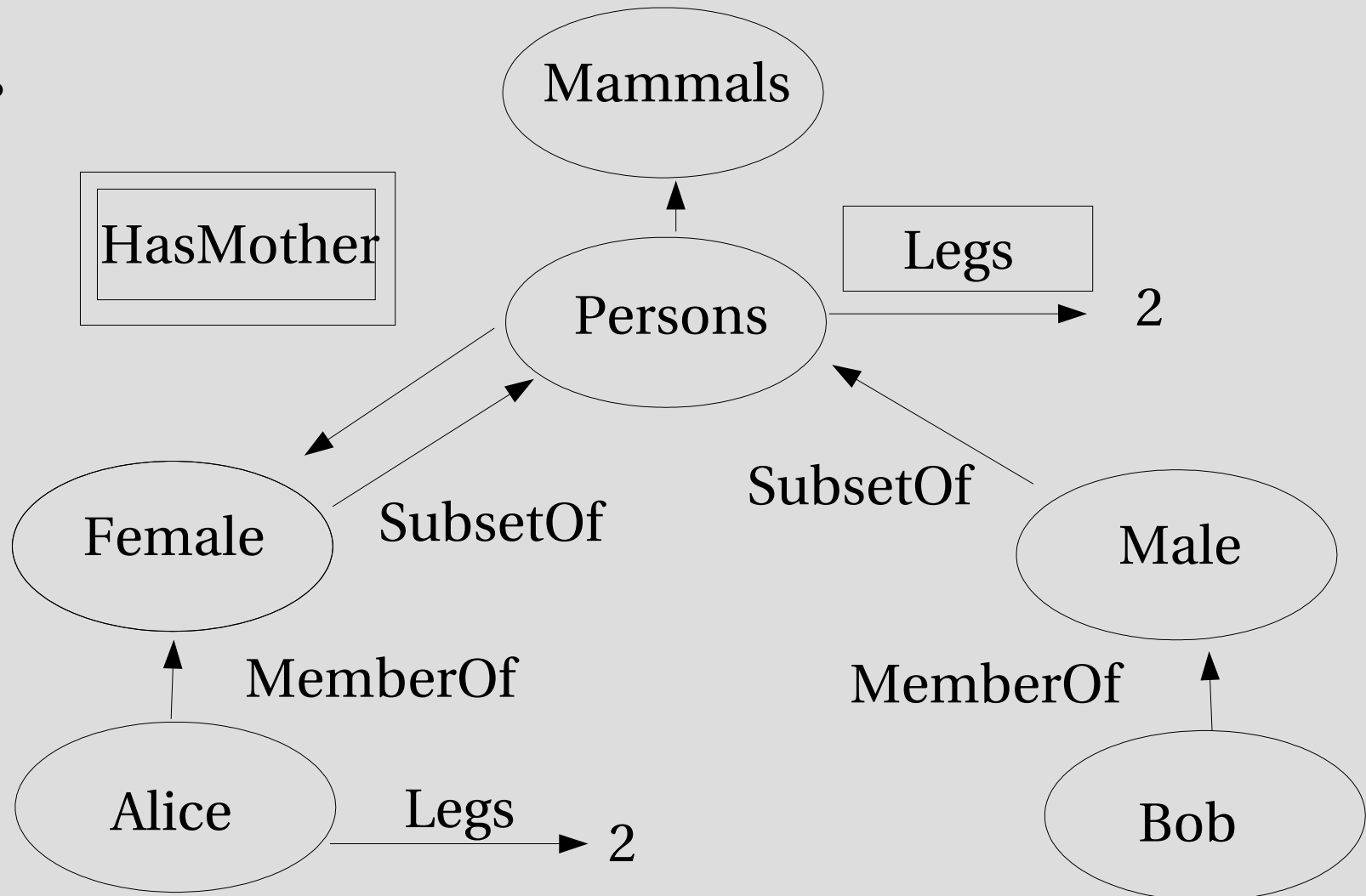


- Graphic notation (Pierce 1909)
- Many variants
 - Objects, categories, relations
- Essentially type of logic

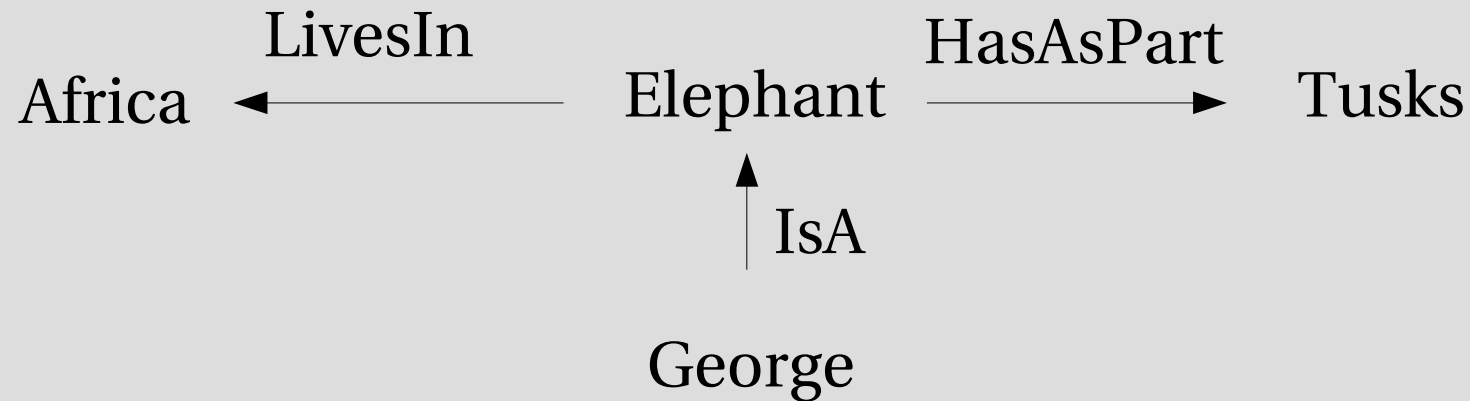
Example



Pros ?
Cons ?



How about this ?



George lives in Africa the same Africa as all elephants but his tusks are his own.

Description Logics



- FOL easy to say things about object
- DL easier to describe definitions and properties of categories
 - Subsumption: checking if category is subset of another
 - Classification
- CLASSIC (direct logical ops on predicates)
 - Bachelor = And(Unmarried, Adult, Male).
- FOL
 - $\text{Bachelor}(x) \iff \text{Unmarried}(x) \wedge \text{Adult}(x) \wedge \text{Male}(x)$.