Course: Common Sense Reasoning

2. Simulating Common Sense Reasoning

Martin Molina

Why is it difficult to simulate common sense reasoning?

- Simulation of reasoning about actions and effects
  - Indirect effects, low of inertia, continuous change, …
- Simulation of non-monotonic reasoning
  - Default reasoning, …
- Efficient use of a large amount of common sense knowledge

The frame problem

Reasoning about the things that do not change when an event occurs

```
If I move glass A then it changes the position
   ( but glass B remains in the same position,
     and knife C remains in the same position,
     and plate D remains in the same position,
     and  … )
```

The qualification problem

Reasoning about qualifications, i. e.
conditions that cancel the effect of an event

```
If A calls B on the phone then A will talk to B
    (unless B does not want to answer the phone,
     unless the phone´s battery is dead,
     unless the phone is broken,
     unless the phone is a toy phone,
     unless B is dead,
     unless B does not speak the same language,
     …)
```

The ramification problem

Representing and reasoning about indirect effects of events

```
The box A contains B, C and D. I move A from X to Y.
    (B moves from X to Y,
     C moves from X to Y,
     D moves from X to Y)
```

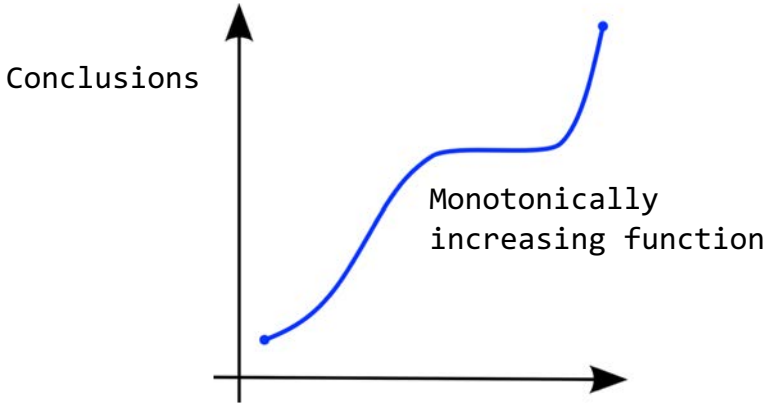
} Indirect effects

Monotonic reasoning

In classical logic, the more knowledge you have, the more facts you can conclude (the addition of more knowledge does not affect to previous conclusions)

A day is cloudy when it rains, it is raining today
→ today is cloudy

A day is cloudy when it rains, it is raining today, today is Saturday
→ today is cloudy

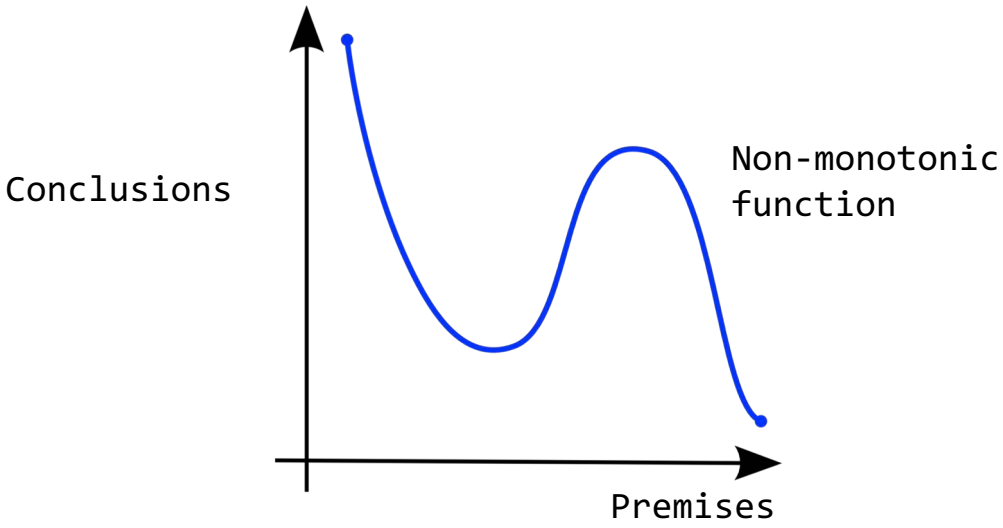


Non-monotonic reasoning

The addition of more knowledge may change previous conclusions

All birds fly, X is a bird
→ X flies

All birds fly, X is a bird, X is a penguin
→ ???



Circumscription is a logic-based form of non-monotonic reasoning

- Some predicates are assumed to be “as false as possible”
- A circumscribed predicate is false for every object except for those for which they are known to be true
- Minimizes the semantic extension of predicates

[McCarthy, 1980]

Example: birds typically fly

$$\forall x[Bird(x) \wedge \neg Abnormal(x) \rightarrow Flies(x)]$$

If we circumscribe the predicate $Abnormal(x)$ we assume that $Abnormal(x)$ is false unless $Abnormal(x)$ is known to be true, for example:

$$Abnormal(Penguin)$$
$$Abnormal(Ostrich)$$
$$\forall x[Dead(x) \rightarrow Abnormal(x)]$$

There are multiple approaches to simulate common sense reasoning

- Logic-based models
  - Default logic (Reiter, 1980)
  - Situation Calculus (McCarthy, Hayes, 1969)
  - Event Calculus (Kowalski, Sergot, 1986; Mueller 2006)
  - Natural logic (Angeli, Manning, 2014)
- Qualitative physics
  - Naïve physics (Hayes, 1979)
  - Qualitative reasoning (Forbus, 84; De Kleer, Brown, 1984; Kuipers, 2001)
  - Micro-theories (Davis, 2008; Davis, 2010)
- Domain specific methods
  - Temporal reasoning (Allen, 1985; Barringer, Gabbay, 2005)
  - Spatial reasoning (Cohn, et al. 1997; Mossakowski, Moratz, 2012)
  - Diagramatic reasoning (Chandrasekaran, 2006)

Course “Common sense reasoning”.

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