Defeasible Disjunctive Datalog

Logic in AI

Artificial Intelligence can be achieved using logic. We start with a knowledge base of statements known to be true:

"PENGUINS ARE BIRDS" "BIRDS DO FLY"

Then, we can use that knowledge to draw new conclusions:

"PENGUINS DO FLY"

Reasoning with Uncertainty

We want to express and reason about statements such as:

"BIRDS TYPICALLY FLY"

This is called *Defeasible Reasoning*. There are many ways to do this, so we require that a suitable way satisfies the *KLM properties*:

(Ref) $\mathcal{K} \mathrel{|\!\approx} \alpha \mathrel{|\!\sim} \alpha$

(LLE) $\dfrac{\alpha \equiv \beta,\ \mathcal{K} \mathrel{|\!\approx} \alpha \mathrel{|\!\sim} \gamma}{\mathcal{K} \mathrel{|\!\approx} \beta \mathrel{|\!\sim} \gamma}$

(RW) $\dfrac{\mathcal{K} \mathrel{|\!\approx} \alpha \mathrel{|\!\sim} \beta,\ \beta \models \gamma}{\mathcal{K} \mathrel{|\!\approx} \alpha \mathrel{|\!\sim} \gamma}$

(And) $\dfrac{\mathcal{K} \mathrel{|\!\approx} \alpha \mathrel{|\!\sim} \beta,\ \mathcal{K} \mathrel{|\!\approx} \alpha \mathrel{|\!\sim} \gamma}{\mathcal{K} \mathrel{|\!\approx} \alpha \mathrel{|\!\sim} \beta \wedge \gamma}$

(Or) $\dfrac{\mathcal{K} \mathrel{|\!\approx} \alpha \mathrel{|\!\sim} \gamma,\ \mathcal{K} \mathrel{|\!\approx} \beta \mathrel{|\!\sim} \gamma}{\mathcal{K} \mathrel{|\!\approx} \alpha \vee \beta \mathrel{|\!\sim} \gamma}$

(CM) $\dfrac{\mathcal{K} \mathrel{|\!\approx} \alpha \mathrel{|\!\sim} \beta,\ \mathcal{K} \mathrel{|\!\approx} \alpha \mathrel{|\!\sim} \gamma}{\mathcal{K} \mathrel{|\!\approx} \alpha \wedge \beta \mathrel{|\!\sim} \gamma}$

(RM) $\dfrac{\mathcal{K} \mathrel{|\!\approx} \alpha \mathrel{|\!\sim} \gamma,\ \mathcal{K} \not\mathrel{|\!\approx} \alpha \mathrel{|\!\sim} \neg\beta}{\mathcal{K} \mathrel{|\!\approx} \alpha \wedge \beta \mathrel{|\!\sim} \gamma}$

Datalog

Datalog allows us to make the following form of statements:

$P(X,Y) \wedge P(Y,Z) \rightarrow G(X,Z) \vee T(Y)$

Project Aim: Extend Defeasible Reasoning to Datalog and prove that it satisfies the *KLM properties*.

Rational Closure

To check if the following statement is true in our world:

"PECKY DOES NOT FLY"

1. Rank known statements according to typicality:

0	"BIRDS DO FLY"	"BIRDS HAVE WINGS"
1	"PENGUINS DO NOT FLY"	
∞	"PENGUINS ARE BIRDS"	"PECKY IS A PENGUIN"

2. Check if we can logically conclude that Pecky does not fly from the ranked statements:
   (a) Pecky cannot exist in our current world. So, we remove the least typical level of statements.

~~0~~	~~"BIRDS DO FLY"~~	~~"BIRDS HAVE WINGS"~~
1	"PENGUINS DO NOT FLY"	
∞	"PENGUINS ARE BIRDS"	"PECKY IS A PENGUIN"

   (b) Now, Pecky can exist in our world. So, we check if we can conclude that Pecky does not fly. We can!

Relevant & Lexicographic Closure

It is unnecessary to throw away an entire level of statements.

- *Relevant Closure* only throws away relevant statements.
- *Lexicographic Closure* throws away the smallest number of statements possible.

Conclusions: Rational and Lexicographic Closure satisfy the *KLM properties* for Datalog; Relevant Closure does not.

FIND OUT MORE

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