Theory of Answer Set Programming

Negation as Failure: Informal Introduction

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Objectives

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Explain the intuitive meaning of negation as failure

Stable Models of Programs with Negation

Recall: Syntax of Propositional Rules

A (propositional) rule is either

- a propositional formula F that does not contain any implication symbol, or
- a formula of the form $F \leftarrow G$ where F and G are implication-free.

A propositional program is a set of propositional rules.

Prolog vs. ASP

?p

```
p :- not q
q :- not p
```

$p \leftarrow \neg q$

$q \leftarrow \neg p$

Prolog does not terminate on query p or q

```
?- p.
   ERROR: Out of local stack
      Exception: (729,178)
```

clingo returns

```
Answer: 1
p
Answer: 2
```

q

Finite ASP programs are guaranteed to terminate

Negation as Failure

Q: How do we extend the definition of a stable model in the presence of negation?

$$\begin{aligned} &p, \\ &q, \\ &r \leftarrow p, \\ &s \leftarrow q \end{aligned}$$

$\{p, q, r, s\}$

$$\begin{aligned} &p, \\ &q, \\ &r \leftarrow p \wedge \overset{\perp}{\cancel{\neg s}}, \\ &s \leftarrow q. \end{aligned}$$

$\{p, q, s\}$

$$\begin{aligned} &p, \\ &q, \\ &r \leftarrow p \wedge \overset{\top}{\cancel{\neg s}}, \end{aligned}$$

$\{p, q, r\}$

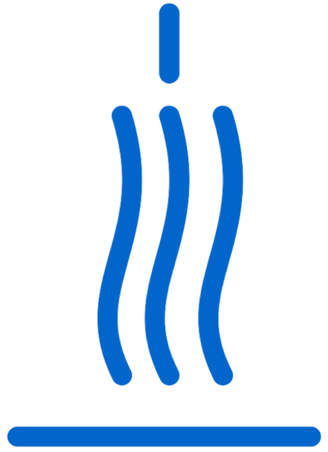
$$\begin{aligned} &p, \\ &r \leftarrow p \wedge \overset{\top}{\cancel{\neg s}}, \\ &s \leftarrow q. \end{aligned}$$

$\{p, r\}$

Add r to the model if p is included under the condition that s is not included in the model and will not be included in the future.

Informal Reading: Rationality Principle

- **Informally, program Π can be viewed as a specification for stable models--sets of beliefs that could be held by a rational reasoner associated with Π.**
- **Stable models will be represented by collections of atoms.**
- **In forming such sets the reasoner must be guided by the following informal principles:**
  - Satisfy the rules of Π.
    - If one believes in the body of a rule, one must also believe in its head.
  - Adhere to the “the rationality principle.”
    - “Believe nothing you are not forced to believe.”



Negation as Failure, cont'd

SM

- $p \leftarrow q$ $\qquad \emptyset$

- $p \leftarrow \overset{\top}{\cancel{\neg} q}$ $\qquad \{p\}$

- $p \leftarrow q$
  $q \leftarrow \cancel{\neg} r \; \top$ $\qquad \{p, q\}$

- $p \leftarrow \cancel{\neg q} \; \bot$
  $q \leftarrow \cancel{\neg r} \; \top$ $\qquad \{q\}$

- $p \leftarrow \overset{\top}{\cancel{\neg q}}$ $\qquad \{p\}$
  $q \leftarrow \underset{\bot}{\cancel{\neg p}}$ $\qquad \{q\}$

Lecture Wrap-Up