

Exercise walk-through

13.2

Knowledge and reasoning

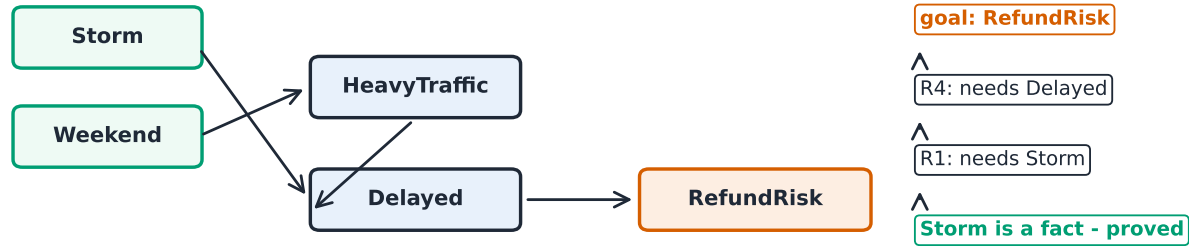
University Computer Science

Knowledge and reasoning: rules make sound by construction

- 1 **KB** F1 Storm, F2 Weekend; R1 Storm-Delayed, R2 Weekend-HeavyTraffic, R3 HeavyTraffic-Delayed, R4 Delayed-RefundRisk.
- 2 **Waves** Forward: wave one Delayed and HeavyTraffic, wave two RefundRisk; backward for RefundRisk walks R4, R1 to a fact in three steps.
- 3 **Refute** Assume not-Q and resolve to the empty clause - the machinery behind SAT solvers and unit 10 chain.

Inference chain

two chains through the same rules



facts green; forward chaining derives the blues
then the orange - two waves

backward chaining touches only
the relevant rules - R2/R3 never fire

modus ponens makes every derivation sound by construction

The backward chain from Delayed walks up to the known facts.

Exercises 2.1-2.3

2.1 Which chaining direction is goal-directed? [3]

2.2 What rule makes every step sound? [3]

2.3 State the converse error with $P \rightarrow Q$. [3]

Exercises 2.1-2.3

2.1 Which chaining direction is goal-directed? [3]

2.1

- Backward chaining: it starts at the query ✓.

2.2 What rule makes every step sound? [3]

2.2

- Modus ponens: from $P \rightarrow Q$ and P , conclude Q ✓.

2.3 State the converse error with $P \rightarrow Q$. [3]

2.3

- Reading $P \rightarrow Q$ as licensing $Q \rightarrow P$ ✓.

Exercise 3.1

3.1 Add to the KB: F3 Weekend is false (a weekday); R5 Delayed $\rightarrow$ Compensated; R6 Compensated $\rightarrow$ RefundRisk.

Run forward chaining to closure: list each wave's new facts. State whether R2 ever fires and why. Give the backward chain for Compensated, naming each rule applied. State the total derived facts at closure. [8]

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3.1

- Wave one: Delayed (R1 from Storm; R3 unused until HeavyTraffic); HeavyTraffic needs Weekend – F3 says false, so R2 never fires ✓.
- Wave two: RefundRisk (R4) and Compensated (R5) ✓.
- Wave three: nothing new – closure ✓.
- Backward for Compensated: goal $\leftarrow$ Delayed (R5) $\leftarrow$ Storm (R1) $\leftarrow$ fact F1: three steps ✓.
- Total derived facts at closure: Storm, Weekend(false), Delayed, RefundRisk, Compensated – three derived truths plus the two base facts ✓.

Exercise 3.2

3.2 Prove RefundRisk by refutation.

Write the assumption. Apply rules (contrapositives where needed) until the empty clause or a direct contradiction with a fact. State which proof the course KB makes shorter – forward or refutation – and why. Name the solver family built on this machinery. [7]

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- Assumption: $\neg \text{RefundRisk}$ ✓.
- Contrapositive of R4: $\neg \text{RefundRisk} \rightarrow \neg \text{Delayed}$; with the derived Delayed, resolution gives a contradiction; F1 (Storm) closes the other branch via R1 ✓.
- Shorter here: the forward chain already has RefundRisk at wave two – refutation pays when the query is deep and rules are many ✓.
- Solver family: SAT solvers (resolution-based), the same machinery as unit 10's NP chain ✓.