

13.2 Knowledge and reasoning

Name: _____ Class: _____ Date: _____

Total: 24 marks

KEY WORDS inference • forward chaining

Objective

Chain both directions and prove by refutation.

1 Key knowledge and worked examples

■ The KB

F1 Storm; F2 Weekend; R1 Storm $\rightarrow$ Delayed; R2 Weekend $\rightarrow$ HeavyTraffic; R3 HeavyTraffic $\rightarrow$ Delayed; R4 Delayed $\rightarrow$ RefundRisk ✓.

■ Worked example: both chains

Forward: wave one derives Delayed and HeavyTraffic; wave two RefundRisk. Backward from RefundRisk: R4, R1, fact – three steps ✓.

2 Practice

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]

3 Exam-style questions

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]

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]

Solutions

2.1

- Backward chaining: it starts at the query ✓.

2.2

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

2.3

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

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: $\text{goal} \leftarrow \text{Delayed (R5)} \leftarrow \text{Storm (R1)} \leftarrow \text{fact F1}$: three steps ✓.
- Total derived facts at closure: Storm, Weekend(false), Delayed, RefundRisk, Compensated – three derived truths plus the two base facts ✓.

3.2

- 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 ✓.