UNIVERSITY COMPUTER SCIENCE • EXERCISE SHEET

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 → Delayed; R2 Weekend → HeavyTraffic; R3 HeavyTraffic → Delayed; R4 Delayed → 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 $P \to Q$. [3]

3 Exam-style questions

3.1 Add to the KB: F3 Weekend is false (a weekday); R5 Delayed → Compensated; R6 Compensated → 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 $P \to Q$ and P, conclude Q ✓.

2.3

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

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: goal ← Delayed (R5) ← Storm (R1) ← 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: ¬RefundRisk ✓.
- Contrapositive of R4: ¬RefundRisk → ¬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 ✓.

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