Foundations of Artificial Intelligence

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Spring Term 2020

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Exercise Sheet 9

Due: April 29, 2020

Important: For submission, consult the rules at the end of the exercise. Non-adherence to the rules will lead to your submission not being corrected.

Exercise 9.1 (1+2 marks)
Consider the propositional formula $\varphi = \neg(A \to (B \wedge \neg C)) \wedge ((A \wedge C) \vee \neg B)$.

(a) Is φ satisfiable, unsatisfiable, falsifiable, valid? Briefly justify your answer.

(b) Transform φ into CNF using the equivalences from slide 24 of the printout version of chapter 29. Provide all intermediate formulas that result from applying an equivalence transformation.

Exercise 9.2 (3 marks)
In the lecture, we have shown that the resolution method can be used for reasoning by a reduction to testing unsatisfiability. In this way, use the resolution method to show that $C \wedge \neg D$ follows logically from $\{\{A, B, C\}, \{\neg A, \neg B, D\}, \{A, \neg B, C\}, \{B, C, D\}, \{\neg D, F\}, \{E, \neg F\}, \{\neg D, \neg E\}\}$. Compare the number of required resolution steps to the size (number of rows) of a truth table that verifies the same statement.

Exercise 9.3 (2+1+1 marks)
Consider the formula $\varphi = (A \vee B) \wedge (\neg A \vee B) \wedge (\neg B \vee C) \wedge (\neg C \vee \neg D) \wedge (\neg C \vee D \vee E) \wedge (\neg B \vee \neg E)$.

(a) Perfom DPLL, choosing variables alphabetically and always assigning **T** first for splitting (and for unit propagation if there are multiple choices).

(b) Find a variable order with which DPLL terminates with fewer steps (when always picking **T** first). While you do not need to execute DPLL again, you must explain why your variable order is more efficient.

(c) With the variable order of (a), would the algorithm terminate faster if it always first picked **F**? Briefly explain your answer.

Exercise 9.4 (1+1 mark)

(a) Consider the following idea to solve SAT efficiently: "Given a CNF formula φ, transform it into an equivalent horn formula φ_h. Then use DPLL to decide φ_h in polynomial time." Where is the flaw in the idea?

(b) If the above idea worked, which important problem would we have solved?

Submission rules:

- Upload a single PDF file (ending .pdf). If you want to submit handwritten parts, include their scans in the single PDF. Put the names of all group members on top of the first page. Use page numbers or put your names on each page. Make sure your PDF has size A4 (fits the page size if printed on A4).
- Only upload one submission per group. Do not upload several versions, i.e., if you need to resubmit, use the same file name again so that the previous submission is overwritten.