

Time: 2 hours.

Please write the answers to exercises 1-2, 3-4 and 5-6 on three different sheets of paper.

1. (5 points) Consider the language of propositional logic. Use natural deduction to prove that the following holds, or find a counter-example to show that it does not hold (remember that $\neg F$ is only a shorthand for $F \rightarrow \perp$).

- $\vdash (\neg\neg F \rightarrow \neg\neg G) \rightarrow (F \rightarrow G)$
- $\vdash (A \wedge B \wedge C) \rightarrow (A \rightarrow \neg(B \rightarrow C))$

2. (5 points) Transform the following propositional logic formula into an equivalent formula in Disjunctive Normal Form

$$\neg(A \wedge B) \rightarrow (B \wedge ((A \wedge \neg D) \rightarrow C))$$

3. (5 points) Formalize the following arguments using propositional logic:

- a) If you play and you study you'll pass the exams, while
- b) if you play and don't study you won't pass.
- c) Then, if you play, either you study and you'll pass the exams, or you don't study and you won't pass.

Verify whether the above reasoning "If ... Then ..." is correct.

4. (5 points) Sudoku is a placement puzzle. The aim of the puzzle is to enter a numeral from 1 through 9 in each cell of a 9x9 grid, made up of 3x3 subgrids (called "regions"), starting with various numerals given in some cells (the "givens"). Each row, column and region must contain only one instance of each numeral.

Provide a formalization in propositional logic of the sudoku problem, so that any truth assignment to the propositional variables that satisfy the axioms is a solution for the puzzle.

5. (6 points) Adam, Beatrice, Christina and Daniel have been friends since high school. They want to have dinner together next week, but unfortunately they are all really busy now:

- Adam plays the guitar and has a concert on Saturday, and he also will not be available on Monday.
- Beatrice plays volleyball, and she needs to train every Tuesday and Thursday.
- Christina is only free the first three days of the week.
- Daniel is only busy on the weekend because he has organized a ski trip.

Model the problem using MiniZinc or CLP.

6. (6 points) Create a Prolog program that, given a list and an element, removes that element from the list. If the element is not in the list, the program should return the list that it was given as input. For example:

- `?- remove_el([a,b,c,d], b, Res).`
`Res = [a,c,d]`
- `?- remove_el([a,b,c,d], k, Res).`
`Res = [a,b,c,d]`