Exercise 6.1 (Modeling in First-Order Logic)

Represent the following sentences in first-order logic, using a consistent vocabulary.
(a) Some students attend an AI exercise group.
(b) Every student who attends an AI exercise group passes the AI exam.
(c) There is exactly one AI exercise group held in English.

Exercise 6.2 (Davis-Putnam Procedure)

Use the Davis-Putnam procedure to compute models for the following clause sets or to prove that no model exists. Whenever possible, apply the pure symbol heuristic (i.e. assignment of the corresponding value to variables always occurring with the same polarity) and unit propagation. At each step, indicate which rule you have applied.
(a) \{\{P, \neg Q\}, \{\neg P, Q\}, \{Q, \neg R\}, \{S\}, \{\neg S, \neg Q, \neg R\}, \{S, R\}\}
(b) \{\{P, Q, S, T\}, \{P, S, \neg T\}, \{Q, \neg S, T\}, \{P, \neg S, \neg T\}, \{P, \neg Q\}, \{\neg R, \neg P\}, \{R\}\}

Exercise 6.3 (Programming Assignment: Davis-Putnam Procedure)

Implement the Davis-Putnam procedure in one of the languages Java, C or C++,\(^1\) first as presented in the lecture (i.e. with unit propagation and splitting), afterwards extended by sophistications of your own choice.

Compare the running times of the variants of the Davis-Putnam procedure you implemented on the basis of the benchmark formulae from the lecture website.\(^2\)

The formulae are encoded in the DIMACS input format.\(^3\) The output of your program should conform to the DIMACS output format.\(^4\) If the input formula is satisfiable your program should output a satisfying valuation.

Submit an archive file containing all source files you wrote (no binaries, but with a Makefile or similar, where necessary) to your tutors by e-mail. Document the code and point out which variants of the Davis-Putnam procedure you have implemented. Give a table showing the running times on the benchmark problems. Note that the difficulty of the benchmark formulae varies considerably and that you need not solve all problems.

\(^1\)Other programming languages can be agreed upon with your tutor.
\(^2\)http://www.informatik.uni-freiburg.de/~ki/teaching/ss07/gki/exercises.html
\(^3\)http://www.satlib.org/Benchmarks/SAT/satformat.ps, Abschnitt 2.1
\(^4\)http://www.satlib.org/Benchmarks/SAT/satformat.ps, Abschnitt 2.4