Exercises for the Lecture Summer Semester 2017 Assignment 3
Practical SAT Solving

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Exercise 1 (Resolution Proof) [3 points]

Construct a resolution proof of unsatisfiability for the following formula

$(x_3 \vee x_4 \vee \bar{x}_1 \vee x_5) \wedge (\bar{x}_3 \vee x_4 \vee x_5) \wedge (x_3 \vee \bar{x}_4 \vee \bar{x}_1) \wedge (x_1 \vee x_2) \wedge (x_1 \vee \bar{x}_2) \wedge (\bar{x}_1 \vee \bar{x}_5) \wedge (\bar{x}_3 \vee \bar{x}_4 \vee x_5)$

Exercise 2 (Hidden Horn $\subseteq$ SLUR) [5 points]

Prove that every hidden Horn formula is a SLUR formula, i.e., that the SLUR algorithm from slide 20 of Lecture 3 would never give up if its input is a hidden Horn formula.

Exercise 3 (Hamming Ball Search) [5 points]

Prove that the Hamming ball search algorithm HB-Search(α, r) of Lecture 4, Slide 9 returns `Nothing` iff there is no satisfying assignment within the Hamming ball $H(\alpha, r)$.

You may prove and use the following lemma: Let F be a formula and α be an assignment such that F is false under α. Let C be an arbitrary clause in F that is false under α. Then F has a satisfying assignment $\beta \in H(\alpha, r)$ iff there is a literal $l \in C$ such that $F|_{l=1}$ has a satisfying assignment $\gamma \in H(\alpha, r-1)$.

Exercise 4 (Probabilistic Hamming Ball Search Algorithm) [3 points]

In Lecture 4, Slide 13, we have shown that the run-time of the probabilistic algorithm using $w = c \cdot 2^{(1-h(\rho))n}$ iterations is minimal for $\rho = \frac{1}{k+1}$, however leaving out some intermediate steps of the computation. Fill in the remaining steps and provide a complete computation of the result. Also show explicitly that the run-time of the probabilistic algorithm is $\left(\frac{2k}{k+1}\right)^n$.

Exercise 5 (Local Search Challenge) [10(+10) points]

Implement a (stochastic) local search SAT solver. Follow the SAT Competition input/output format `http://www.satcompetition.org/2004/format-solvers2004.html` For a working solver you get 10 points. The author of the best solver receives a bonus of 10 points. The solvers will be evaluated on satisfiable random 3-SAT problems (like the ones here: `http://www.cs.ubc.ca/~hoos/SATLIB/benchm.html`).