Course: **Satisfiability Modulo Theories (SMT): ideas and applications**

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1. Mark the following formulas as valid, satisfiable or unsatisfiable.
    a. $p \vee q \Rightarrow p \wedge q$
    b. $(p \vee q) \wedge (\neg p \vee q) \wedge (p \vee \neg q) \wedge (\neg p \vee \neg q)$
    c. $p \wedge (\neg p \vee q) \wedge (\neg q \vee r) \wedge (\neg r \vee \neg p)$
    d. $p \wedge q \Rightarrow p$
    e. $\neg(p \wedge q) \vee q$
2. Explain the difference between interpreted and uninterpreted symbols. Give examples.
3. In a 3CNF formula, every clause has three literals. Show that every CNF formula is equisatisfiable to a 3CNF formula.
4. Describe a linear time algorithm for solving 2CNF.
5. Show the following formula is unsatisfiable using Resolution.
    a. $\neg r \wedge (r \vee \neg s) \wedge (p \vee q \vee s) \wedge (\neg p \vee q \vee s) \wedge (p \vee \neg q \vee s) \wedge (\neg p \vee \neg q \vee s)$
6. What is the main disadvantage of Resolution with respect to DPLL?
7. What is a theory conflict?
8. How many equivalence classes (aka “blue balls) do we have after processing the following set of equations using the union-find & congruence closure algorithm? Show also the contents of each equivalence class.
    a. { a=b, b=c, f(a) = d, f(b) = e, f(c) = s }
9. Pivot variables x and z in the following tableau. What are the sets of basic variables before and after the pivoting step?
    a. $x = r + z$
       $y = 2r - z$
       $s = 3z$
10. Give an example of a non-stably infinite theory.
11. Show that the bit-vector theory is not convex.
12. Show a model for the following satisfiable formula. Assume the symbols +, -, 0, 1, 2 are interpreted by the theory of linear arithmetic.
    a. $x\text{-}y \leq 2 \wedge y\text{-}z \leq -1 \wedge z\text{-}x \leq -1$
13. What is the Bland’s rule? What is it used for?
14. What kind of atoms is allowed in the difference logic fragment?