

TMCS Fall 2016, HW 3

Please bring your solutions to class on Thursday October 6. You are invited to work in teams of two but not larger. If you work in a team, submit only a single sheet with both names marked on it.

Problem 1 (60 pts) Derive a lower bound on the number of elementary facts that you know. Think of all aspects of your life, from elementary physical facts ("the sun is a celestial body", "water boils at 100 degrees") to your sensory experiences to social interaction to politics to the tickling feeling when an ant crawls on your skin... *everything*. A fact is elementary if it cannot be split into a conjunction or disjunction of facts. For instance, "the sun shines or the sun does not shine", or "Mount Everest is a mountain and Bremen is a city" are facts alright but not elementary.

Of course you cannot *list* all the elementary facts you know. The lower bound you give should be based on a plausible reasoning – like, "*I know at least 10,000,000 facts, which are grouped in the following areas, ..., ..., area 20: outdoor and nature experiences: at least 1 Mio facts in this area because... ... ; and there must be dozens of more areas of life experience which I couldn't think of, which add ...*". Target size: one page in 12 point font, or the equivalent in handwriting (discouraged; please type and print).

Particularly imaginative and complete treatments get up to 5 bonus points. Bonus points are valuable: at the end of the semester they will be added to your course percentage undiluted; 5 bonus points mean a course grade improvement of 0.33. If you work in a team of 2, the bonus points are split between the two of you.

Problem 2 (40 pts). An exercise in formalizing a bit of the real world. Assume you have chemical apparatuses at your disposal to synthesize



Assume further that you have the raw chemicals MgO, H₂, O₂ and C available. Find a Boolean formula φ whose *unsatisfiability* is equivalent to synthesizability of H₂CO₃ in your lab. Hint: for designing φ , associate each chemical substance with a Boolean variable.