

GenICT Fall 2014, Module 2 (Boolean logic), HW 2

Please upload a pdf file with your solutions (legibly hand-written and scanned, or typeset documents) to <https://jgrader.de> by Monday, Oct 13, 23:59.

Problem 1 (20 pts). Consider the following truth table:

| X | Y | Z | φ |
|-----|-----|-----|-----------|
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 |

Give a Boolean expression for φ in CNF!

Problem 2 (30 pts). Consider the following facts (well, facts...).

- (a) Everybody who has a good sense of hearing can sing well.
- (b) Nobody is a true musician who cannot inspire her audience.
- (c) Nobody without a good sense of hearing can inspire her audience.
- (d) Nobody except a true musician can write a symphony.

Question: which characteristics must everybody necessarily have who wrote a symphony? First formalize each of the facts (a) – (d) as an implication between two propositions, which gives you four implications, and then use those to find out the answer to the question.

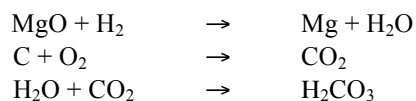
Help: Here is an example of how an English sentence similar to the sentences (a)-(d) above can be cast as an implication:

- (x) No human is immortal.

This is turned into an implication by introducing a Boolean variable H to be understood as "is human" and a Boolean variable M meaning "is mortal", then (x) becomes formalized as $H \rightarrow \neg M$.

For your formalization of (a) – (d), use the Boolean variables H = has a good sense of hearing, S = can sing well, T = is true musician, I = can inspire audience, W = can write symphony.

Problem 3 (30 pts). Another 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 , H_2 , O_2 and C available. Find a Boolean formula φ whose *unsatisfiability* is equivalent to synthesizability of H_2CO_3 in your lab. Hint: for designing φ , associate each chemical substance with a Boolean variable.

Problem 4 (20 pts). Is $e^{2n} = O(e^n)$? Prove or disprove.