COS30019 - Introduction to Artificial Intelligence
Tutorial Problems Week 7

Task 1: Use truth tables to show that the following are valid (i.e. that the equivalences hold).

$P \wedge (Q \vee R) \Leftrightarrow (P \wedge Q) \vee (P \wedge R)$	(Distribution of $\wedge$)
$\neg(P \wedge Q) \Leftrightarrow \neg P \vee \neg Q$	(de Morgan's Law)
$\neg(P \vee Q) \Leftrightarrow \neg P \wedge \neg Q$	(de Morgan's Law)
$(P \Rightarrow Q) \Leftrightarrow (\neg Q \Rightarrow \neg P)$	(Contraposition)
$(P \Rightarrow Q) \Leftrightarrow \neg P \vee Q$	

Task 2: Decide whether each of the following sentences is valid, unsatisfiable, or neither. Verify your decisions using truth tables or the equivalence rules from the lecture.

a. $Smoke \Rightarrow Smoke$
b. $Smoke \Rightarrow Fire$
c. $(Smoke \Rightarrow Fire) \Rightarrow (\neg Smoke \Rightarrow \neg Fire)$
d. $Smoke \vee Fire \vee \neg Fire$
e. $((Smoke \wedge Heat) \Rightarrow Fire) \Leftrightarrow ((Smoke \Rightarrow Fire) \vee (Heat \Rightarrow Fire))$
f. $(Smoke \Rightarrow Fire) \Rightarrow ((Smoke \wedge Heat) \Rightarrow Fire)$
g. $Big \vee Dumb \vee (Big \Rightarrow Dumb)$
h. $(Big \wedge Dumb) \vee \neg Dumb$

Task 3: Represent the following sentences in propositional logic. Can you use truth table to determine whether or not the unicorn is *mythical*? What about *magical*? *Horned*?

> If the unicorn is mythical, then it is immortal, but if it is not mythical, then it is a mortal mammal. If the unicorn is either immortal or a mammal, then it is horned. The unicorn is magical if it is horned.

Task 4:

a. For each of the following, find a satisfying truth assignment, (values of the propositions which make the formula true), if any exists.
   1. $((a \Rightarrow \neg b) \wedge a)$
   2. $(((a \Rightarrow c) \Rightarrow \neg b) \wedge (a \vee b))$
b. For each of the following, find a falsifying truth assignment, (values of the propositions which make the formula false), if any exists.
   1. $((a \Rightarrow \neg b) \vee a)$
   2. $((\neg b \Rightarrow (a \Rightarrow c)) \vee (a \wedge b))$

Task 5: Your friend Tracy argues: "It is bad to be depressed. Watching the news makes me feel depressed. Thus, it's good to avoid watching the news."

Regardless of whether the premises and conclusion are true, show that the argument is not, by converting it to propositional logic.