HW#1. Due Oct 3rd (Wed 11AM)

KAIST

1. Show validity and satisfiability of the following propositional formulas using both
   1. Truth table
   2. Semantic tableau

(a) $p \vee (\neg(q \wedge (r \rightarrow q)))$
(b) $(p \wedge q) \rightarrow (p \vee q)$
(c) $((p \rightarrow \neg q) \rightarrow \neg p) \rightarrow q$
(d) $(p \rightarrow q) \vee (p \rightarrow \neg q)$
(e) $((p \rightarrow q) \rightarrow p) \rightarrow p$
(f) $((p \vee q) \rightarrow r) \rightarrow ((p \rightarrow r) \vee (q \rightarrow r))$
(g) $(p \rightarrow q) \rightarrow (\neg p \rightarrow \neg q)$.

- 2. Show that semantic tableau method is sound and complete. I.e. prove that ϕ is satisfiable if and only if a semantic tableau tree of ϕ is open
  - In other words, prove Theorem 2.49 (read 34-38 pg carefully)

- 3. Verify the following program using SAT solver
  1. Translate the program into a SSA form
  2. Create a boolean formula from the SSA representation
  3. Completely translate arithmetic and equality into propositional formula
  4. Translate the formula ϕ into CNF form
  5. Run Minisat on ϕ''' and capture the result (see the class homepage to find relevant information) and interpret the result

```
/* Assume that x and y are 2 bit unsigned integers */
/* Also assume that x+y <= 3 */
void f(unsigned int y) {
    unsigned int x=1;
    x=x+y;
    if (x==2)
        x+=1;
    else
        x=2;
    assert(x ==2);
}
```

- 4. Write down your own C program and verify it using CBMC
  - write down a simple program (should be larger than 10 lines)
  - add a positive assertion (i.e. which is true) to your program and then execute CBMC to capture the result and interpret it
  - remove the previous position assertion and add a negative assertion (i.e. which is false) to your program and then execute CBMC to capture the result and interpret it