

**Exercise 1.** Build the truth tables for the following propositional formulas:

(a)  $(p \wedge q) \vee r$

(b)  $(p \Rightarrow q) \Rightarrow r$

(c)  $p \Rightarrow (q \Rightarrow r)$

**Exercise 2.** Fontano's is an Italian sandwich shop near campus. Let  $p$  mean "you get a bag of chips and a drink for free from Fontano's",  $q$  mean "you buy a sandwich from Fontano's",  $r$  mean "you buy a slice of pizza from Fontano's", and  $t$  mean "it's a Tuesday".

What does the following propositional formula mean in plain English?

$$t \wedge (q \vee r) \Rightarrow p$$

(note that this statement is not true in real life)

**Exercise 3.** Consider the statement “The Blue Line will be delayed if it has snowed more than one inch, and if the Blue Line is delayed, Kevin will be late for his class”. Write this statement as a propositional formula. Be sure to specify what each propositional variable represents.

**Exercise 4.** Let  $p$  and  $q$  be propositional variables, and suppose that  $p \Rightarrow q$  has some truth value  $X$ .

- (a) For each of the propositional formulas  $q \Rightarrow p$ ,  $\neg p \Rightarrow \neg q$ , and  $\neg q \Rightarrow \neg p$ , determine whether or not the formula must have the same truth value as  $p \Rightarrow q$ .

For example, given that  $p \Rightarrow q$  has truth value  $X$ , can we say for sure that  $q \Rightarrow p$  must also have truth value  $X$ ?

You can do this by building the truth tables for  $q \Rightarrow p$ ,  $\neg p \Rightarrow \neg q$ , and  $\neg q \Rightarrow \neg p$ , and comparing them to the truth table for  $p \Rightarrow q$ .

- (b) For each of the formulas from the previous part, give an explanation in plain English why the formula either must have the same truth value as  $p \Rightarrow q$  or can differ from  $p \Rightarrow q$ .