Assignment 1 - Practicing Basics

Problem 1. Understanding complicated Boolean expressions can be tricky if we try to evaluate it all at once in our heads. Computer Scientists use *truth tables* to systematically break down expressions by systematically evaluating all possible combinations of input values and recording their corresponding outputs. Let p and q be two Boolean variables and let us consider the expression $p \wedge \neg q$ (p AND not q). When p is true, and q is true, $p \wedge \neg q$ is false. When p is true, and q is false, $p \wedge \neg q$ is true. We can record all 4 combinations of the values of p and q in a truth table:

p	q	$p \wedge \neg q$
T	T	F
T	F	T
F	T	F
F	F	F

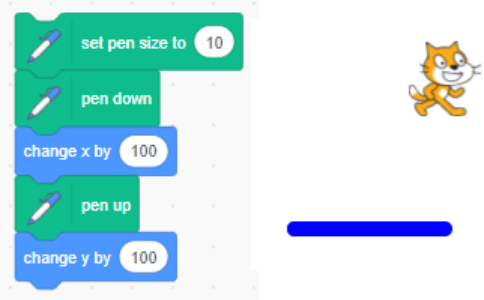
Write down the the truth table of $p \wedge (\neg p \vee q)$ (p AND (not p OR q)). It may be helpful to first write down columns for $\neg p$ and then $\neg p \vee q$. What simpler Boolean expression is it equivalent to?

Solution. The truth table is:

p	q	$p \wedge (\neg p \vee q)$
T	T	T
T	F	F
F	T	F
F	F	F

Notice this is the same as just $p \wedge q$. So if you ever write a conditional that is effectively $p \wedge (\neg p \vee q)$, you can simplify it to $p \wedge q$.

Problem 2. Scratch includes a number of extensions that give you access to additional Blocks. The Pen extension allows Sprites to act like pens and draw on the screen as they move around. Here is an example snippet and the resulting drawing:



When the pen is down, the sprite draws a line as it travels. Therefore, the sprite draws the blue line from left to right when the "Change x by 100 block" is called. When the pen is up, no drawing occurs. Hence no vertical line is made when "Change y by 100" block is executed. The "Set Pen Size" simply increases the width of the pen stroke.

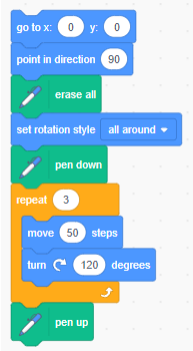
a) Consider running the following code snippets in sequence from left to right.

What shape would this draw? What are the coordinates of all of its corners? Remember that in Scratch, the center of the Stage is (0,0), the x direction is horizontal, the y direction is vertical, and the angles $-90, 0, 90, 180$ correspond to the directions left, up, right, and down respectively. The Move x block moves the sprite x units in the direction its currently facing.

Solution. This code draws a smiley face:

The corners of its mouth are (-50, 0) (-50, 25), (50, 25), (50, 0) and it's eyes are at (-30, 55), and (30, 55).

b) This code snippet draws an equilateral triangle.



How can you modify this code so that it draws a square? What about a regular pentagon? Hint: The total rotation of the sprite should be a full 360.

Solution. We need to change the number of loop iterations to 4 and 5 for the square and pentagon respectively. Then we need to modify the angle of rotation to be $\frac{360}{4} = 90$ and $\frac{360}{5} = 72$.

c) Write a Custom Block that uses a sprite to draw a regular n-gon, where n is given as input. You can write your solution in *pseudocode*, an informal list of steps, for example:

Define DrawUp n

1. Pen Down
2. Set Direction to 0
3. Repeat n times:
   (a) Move 10

Solution. Following the problem above, we just need to change the angle of rotation to $\frac{360}{n}$ and have the loop run n times. Doing so we get the following code:

Since the side length is fixed in the above solution, the more sides the n gon has, the bigger it'll be. If we want a fixed shape, then we need a bit more math: