

Get in small groups (about 4 students maximum) and work out these problems on the whiteboard. Ask one of the teaching assistants for help if your group gets stuck. You do **not** need to turn anything in.

1. Which of these are propositions and which are not?

- (a)  $2 + 9 = 13$
- (b) Rachel thinks it might rain today.
- (c) That backpack is definitely orange.
- (d)  $x^2 = 4$
- (e)  $x^3 = 8$
- (f) The truth value of a proposition is *true* if the proposition is *true*.

2. Propositions (warm-up) – translate these propositional statements into English by defining the propositions to mean something in English.

- (a)  $p \rightarrow q$
- (b)  $q \wedge r$
- (c)  $p \oplus \neg q$
- (d)  $p \leftrightarrow (q \vee r)$

3. Construct the truth tables for the following propositions -

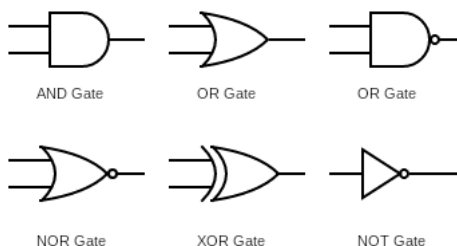
- (a)  $q \rightarrow \neg s$
- (b)  $r \wedge \neg p$
- (c)  $\neg(p \vee q) \leftrightarrow r$
- (d)  $\neg(p \wedge q) \rightarrow (p \vee q)$
- (e)  $\neg(p \rightarrow q) \leftrightarrow (r \wedge p)$
- (f)  $(q \rightarrow \neg p) \leftrightarrow (p \leftrightarrow q)$

4. *This is the same Knights and Knaves problem from last time's worksheet, but this time you have to use a truth table to solve it.*

On the Island of Knights and Knaves live two types of people: Knights who always tell the truth and Knaves who always lie. As you are exploring the Island of Knights and Knaves you encounter two people named Tony and Rachel. Consider the following two situations, and see if you can classify each of Tony and Rachel as either a knight or a knave.

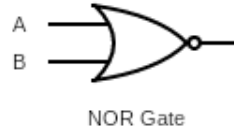
- (a) Rachel tells you that Tony is a knave. Tony says “Neither Rachel nor I are knaves.”
- (b) Tony tells you “Both of us are knights.” Rachel tells you “That is not true.”

5. The following figure has 6 common components of a logic circuit.



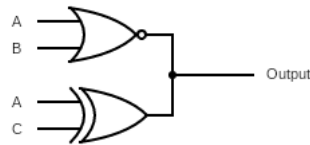
The 2 pins going into the gate are the inputs and the right pin represents the output. For more information on logic circuits ask the TA's.

We can construct a logic circuit and represent the propositional logic equation in the following way -



equation -  $\overline{A + B}$

- (a) What is the propositional logic equation for the following circuit?



- (b) Draw the circuit using only the above gates to represent the following equation -  $p \vee (q \oplus r)$   
 (c) *Challenge Problem:* Draw the circuit for the equation -  $xy\bar{z} + x\bar{y}\bar{z} \oplus \bar{x}y\bar{z} + \bar{x}\bar{y}z + \bar{x}\bar{y}\bar{z}$

6. *Challenge yourself to write the least code possible* - Write a python function that checks whether a set of 2 numbers is in a given list or not (if either of the numbers are present). The function takes two parameters. An example test case and function call is -

`function_name([2,5], [2,4,6,7,8]) → TRUE`

Best solution - 2 lines (including function definition)

*Challenge Problems:*

7. Suppose that you meet three people, Aiden, Tucker, and Willem, on the island of knights and knaves. Aiden says "I am a knave and Tucker is a knight." Tucker says "Exactly one of the three of us is a knight." Can you determine who is a knight and who is a knave? If there is no solution, state that is the case. If there are multiple solutions, state each possible solution.
8. A new type of person has joined the island of knights and knaves: the spy. Spies can tell the truth or lie. In this problem, there may be no solutions, one solution, or multiple solutions. If there are no solutions, state that is the case. If there are multiple solutions, state each possible solution. Aiden says "I am the knight." Tucker says "I am the knave." Willem says "Tucker is the knight."