Propositional Logic

If statements

- We often use if statements in programming

```
if a == b:
    #do something
```

- Sometimes we need something more complex

```
if a > 0 and a < 10:
    #do something
if b < 0 or b > 10:
    #do something
```

Simplifying

- Sometimes there is a simpler form that is **logically equivalent**, for example
  - if !(!(a or c) and (a or c))) and (a == c):
  - if (a == c):
- How do we know when we can do this?
- How can we prove it is valid?
  - Propositional Logic

Logical Operators

- The rules that Python and other programming langauges use for **logical operators** come from a branch of maths called **propositional logic**.

  and = ∧

  or = ∨

  not = ¬

- Understanding propositional logic will help you use them well

What is Logic?

- In this context, logic refers to a specialised branch of mathematics
  - Used to study arguments
  - Used to understand reasoning
  - Used to look at premises and conclusions
  - And whether conclusions can be truthfully drawn from premises

Propositional Logic

- The kind of logic we are going to study here is called **propositional logic**
  - Or propositional calculus
- It deals with stringing together expressions called **propositions**
  - Which can be either true or false
- And determining whether combinations of those propositions are true or false

Propositions

- Propositions are statements that are either true or false
  - I am wearing socks
  - 12 + 1 = 13
  - The sun rises in the east
- These are also called **atomic propositions** because their truth or falsity is not dependant on any other proposition.

Truth Values

- A proposition *p* must be **either** true or false
  - Often written T and F

p
T
F

Negation

- $\neg p$ is the **negation** of the proposition p
- Let p be the proposition ‘It is raining outside’
  - ¬p = It is not raining outside

p	$\neg p$
T	F
F	T

Compound Propositions

- $\neg p$ is a **compound proposition** because it combines:
  - other propositions (p); and
  - logical operators (¬)
- We can also use letters to stand for compound propositions, e.g. $q = \neg p$

Summary

- Propositional logic works with propositions
  - Atomic (e.g. p = “It is raining outside”)
  - Compound (e.g. $q = \neg p$)
- Each proposition is either **true** or **false**
- We can determine whether a statement is true **relative to the atomic propositions it contains**