[Patterns and Sequences]

Being able to identify patterns occurring is often seen as indicative of a fundamental logical intelligence. Can you predict what's going on in these sequences?

- 7, 13, 19, 25, …
- 1, 4, 9, 16, ...
- 2, 1, 3, 4, 7, 11, ...
- 7, 4, 1, 8, 5, ...
- 60, 90, 108, 120, ...
- 3, 3, 5, 4, 5, 3, 5, 5, ...

Sequences can follow a simple mathematical rule, e.g. the first pattern here has equal step-sizes so we can predict that the rule is just adding 6 each time. In the second pattern we should be okay if we know our times tables, and although the third pattern is a little trickier, if you try adding the preceding two terms you should be able to work out what comes next. If the last three patterns are baffling, this is okay, because the rules may only reveal themselves to you if you've come across them before or are aware of hidden "tricks" that might lead to a rule – some clues (ore giveaways) are: 7s; polygons; one, two, three…

Identifying patterns is seen to be such an indicator of logical intelligence that they are used for aptitude tests for banking, accounting and law firms. Here are some taken from a practice test for PWC (https://www.practiceaptitudetests.com/diagrammatic-reasoning-tests/
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The aim is to guess which of the options A-F should come next.

In some cases the sequences may be easy to pick, while at other times, we would have had to practice or see something before in order to be able to pick out what's going on. In fact, in this last example, the correct answer "F" is based only on the position of the telephones – the rest of the information is noise.

However being able to problem solve based on finding relationships and rules in sequences and patterns can be very useful.

Not just being able to see patterns, but understanding how to represent the problems as sequences is a key skill to being able to solve these problems.

When relationships are linear, we tend to be able to make reasonable predictions. For example, if I keep putting $100 under my bed each week, then I'll be able to work out how much should be there a year later. However if I put that money in the bank and it earns interest, then now it will be much more difficult to work out what the final total will be, because interest is earnt on how much is in the account while at the same time contributing to that money. We actually observe similar relationships when we look at population growth (the more people there are, the faster the population will grow) and the same understanding can be used to understand the spread of contagions, or reciprocally how much contamination may be left at a site after a radiation leak.

We will focus on two progressions, where a progression is defined as follows:

Def^{n} : A **progression** is a sequence of terms, where there is a constant relationship between any pair of sequential terms.

The two types of progressions we'll look at are arithmetic progressions, e.g. 2, 4, 6, 8, …, where the constant relationship is the

addition of 2, and geometric progressions, e.g. 2,4,8,16,32,…, where the constant relationship is the multiplication of 2.