# Homework 5: Abstraction and automation Answers

1. High level languages such as Python, Java and Visual Basic use the principle of **abstraction** to make it faster and easier for programmers to code the algorithms they have designed to solve different problems.

Name **three** types of abstraction used in programming languages, and explain, with an example in each case, how they are used. [6]

Answers:

**Information hiding** – a high-level programming language hides from the programmer the details which are not related to the problem actually being solved. The programmer does not have to worry about the memory addresses where his program and data are being held, or the actual operations taking place when he/she writes “x = a + b”. Implementation details are hidden.

**Procedural abstraction** – the actual values used in a procedure are abstracted away. The same procedure can be used to sort a list of 1000 names or 10 numbers. The relevant variables are passed as **parameters**. e.g. SUB bubblesort(unsortedArray)

**Functional abstraction** – the computation method is abstracted away. When you write x = sqrt(y) you don’t need to know how the computer finds the square root of y. Details are abstracted away.

**Data abstraction** - complex data objects like lists, arrays, trees, stacks and queues can be constructed from previously defined data types. The data object is separated from the details of how it is constructed.

2. A team of developers is working on the design and implementation of a new school timetabling system. They have been given data that the school administration felt might be useful for this task

(a) Explain why it is necessary for the developers to use abstraction in solving the problem. [2]

(b) List **five** data items that would be relevant in designing this system. [5]

(c) List **three** data items that would be irrelevant, even though they may have been supplied by the school office. [3]

Answers:

(a) They need to use **problem abstraction** to remove details until the problem can be represented in a way that it is possible to solve, because it reduces to one that has already been solved. e.g. using a database. Timetabling and scheduling are very common problems with well-defined solutions.

They need to use **procedural decomposition** to break down the problem into a number or sub-problems, each accomplishing an identifiable task.

(b) Whether some subjects have to be taught in particular classrooms

Whether some teachers teach only one subject, and others teach many subjects

Whether some teachers teach only on certain days

Whether some classes can/cannot run concurrently (e.g. A level/GCSE options)

Whether each teacher needs to be allocated a given teaching load – e.g. HOD has fewer teaching hours

Whether different classrooms have different capacities

Whether maximum number of students allowable in a class varies for different subjects/levels

Allow any reasonable answers – they should be general rather than specific

(c) Names of teachers, pupils, subjects – these are not relevant to solving the problem but will be relevant to using the final system

Maximum number of students in a class

Number of different subjects studied by each student

In general, where test data can be substituted for real data when developing the system, real data does not need to be supplied. However, sometimes real data is helpful in understanding the problem!

3. Police have have known for a long time that everyone’s shoeprint is unique. In some areas of the UK, about 70% of suspects’ shoeprints are scanned and compared with the ones left at the scene of crime.

(a) Identify **one** similarity and **one** difference between fingerprint scanning and shoeprint scanning. [2]

(b) Give **one** reason why shoeprint scanning may be **less** effective than fingerprint scanning in catching criminals. [1]

(c) Give **one** reason why shoeprint scanning may be **more** effective than fingerprint scanning in catching criminals. [1]

Answers:

(a) Both use pattern recognition to detect similarities and differences between parts of a complete image

A shoeprint is a 3-D image – the weight on each part of the foot is what gives a shoeprint its unique qualities. A fingerprint is two dimensional and easier to scan.

(b) The criminal may discard his shoes after committing a burglary.

(c) The criminal may wear gloves, but cannot avoid leaving footprints.

*There are interesting articles on the Internet about footprint scanning, which would make a good class discussion. e.g.*

[*http://www.artec3d.com/case\_studies/Identifying+footprints%3A+Forensics+of+21st+century\_3363*](http://www.artec3d.com/case_studies/Identifying+footprints%3A+Forensics+of+21st+century_3363)

[*http://www.forensicmag.com/articles/2009/12/primer-3d-scanning-forensics-part-1*](http://www.forensicmag.com/articles/2009/12/primer-3d-scanning-forensics-part-1)

[Total 20 marks]