

> Chapter 1

Algorithms and flowcharts

This chapter relates to Chapter 4 in the Coursebook.

The software used in this chapter is Word (Mac version).

LEARNING INTENTIONS

In this chapter you will learn how to:

- create an algorithm to solve a particular problem that demonstrates a decision-making process
- edit a given algorithm
- write an algorithm using pseudocode to solve a given problem
- edit a given flowchart
- draw a flowchart to solve a given problem.

Introduction

Algorithms are step-by-step instructions for solving a problem. In every area, algorithms are used to decide what action should be taken in a particular circumstance. As computers can consider all the possibilities far more quickly than a human brain, algorithms are becoming more important to the running of the world.

For example, in a game of chess, when each player has made three moves, there are over nine million possible moves available; after four moves there are over 288 billion possible moves. Computers have the ability to consider all these possible moves far more quickly than humans. That is why no chess grandmaster has beaten a top computer chess algorithm since 2005.

We use algorithms to carry out everyday tasks, often without thinking about them. For example, we use an algorithm or set of **procedures** to solve the complex problem of getting up and getting ready for school or college.

Algorithms can be displayed simply as written text or more formally using **flowcharts** or, when they are being designed to be used for a computer, as **pseudocode**. Pseudocode is a kind of structured English for describing algorithms. It is a generic, code-like language that can be easily translated into any programming language.

KEY WORDS

algorithm: a set of instructions or steps to be followed to achieve a certain outcome

procedure: a type of subroutine that does not return a value to the main program

flowchart: a set of symbols put together with commands that are followed to solve a problem

pseudocode: a language that is used to display an algorithm

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WORKED EXAMPLE

As a security measure, users are required to enter their password before accessing a computer system. They are allowed three attempts before password entry is locked. Create an algorithm for doing this and display it as a flowchart.

The algorithm will contain:

- **Input**, e.g. the password. (Red)
- **Output**, e.g. informing the user if the password is recognised or not. (Blue)
- Decisions, e.g. is the password correct. (Green)
- **Process**, e.g. keeping count of the number of attempts that have been made. (Purple)
- A **variable**, e.g. to store the number of attempts that have been made. After each incorrect attempt it must be incremented by 1.
- Start and end symbols. (Black)

The algorithm will use conditional branching. There will be different branches when the password is recognised or not.

It will use a **loop**, which may need to be repeated up to a maximum of three times.

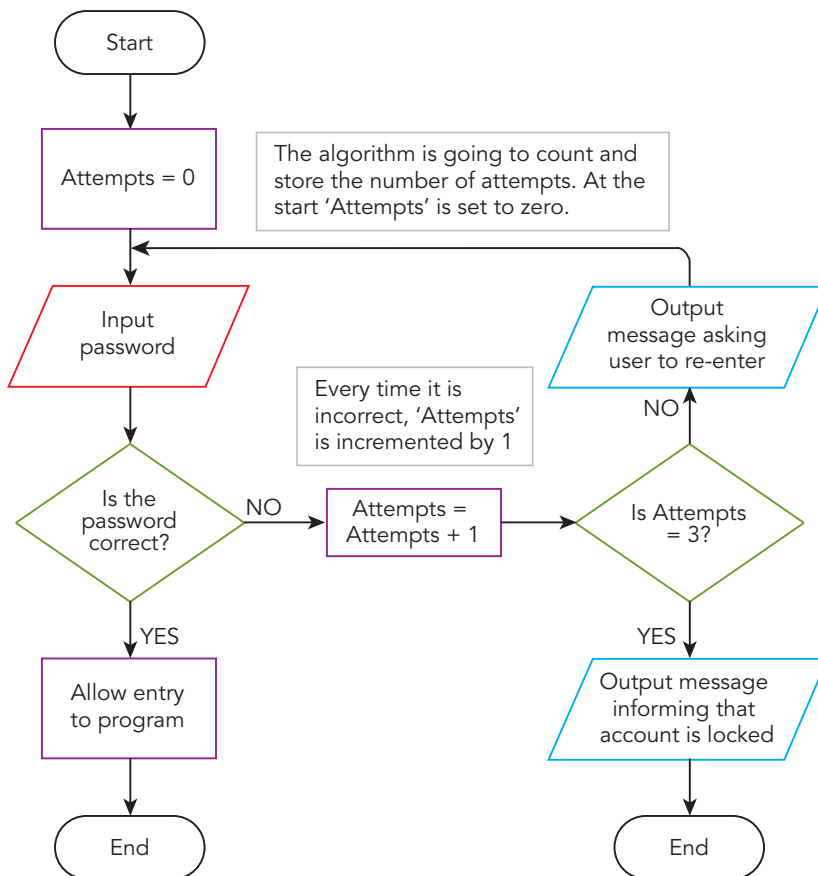


Figure 1.1: Flowchart of an algorithm that allows a user three attempts to enter a correct password.

KEY WORDS

input: putting data into an algorithm

output: displaying data from an algorithm to the user

process: an action performed to some data to make a change

variable: a space in the memory of a computer, that has an identifier, where you can store data. This data can be changed

loop: code that is repeated

Practical tasks

Task 1

SKILLS

This task will cover the following skills:

- drawing a flowchart with the following:
 - input/output
 - decisions
 - start, stop and process boxes
 - connecting symbols / flow arrows
- declaring variables and using arithmetic operators.

Create an algorithm that will ask a user to input the length and width of a rectangle and will then calculate the area.

Display your algorithm as a flowchart.

Task 2

SKILLS

This task will cover the following skills:

- INPUT
- OUTPUT
- arithmetic operators.

Display the algorithm from Task 1 in pseudocode.

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Task 3

SKILLS

This task will cover the following skills:

- drawing a flowchart with the following:
 - input/output
 - decisions
 - start, stop and process boxes
 - connecting symbols / flow arrows
 - declaring variables and using arithmetic operators
- using a **count-controlled loop**.

KEY WORD

count-controlled loop: a loop where you know the number of times it will run

Draw a flowchart to display an algorithm to allow a user to enter ten numbers. The algorithm should then display the sum of the numbers.

Task 4

The flowchart in Figure 1.2 displays a partly completed algorithm for a game that simulates the throwing of three dice to find the player's score.

- If all three are equal, then the score is the total of the dice.
- If two are equal the score is equal to the sum of the two equal dice minus the third.
- If none are equal, then the score is zero.

- 1 Complete the flowchart of the algorithm.
- 2 Use the algorithm to calculate the scores from the following dice throws:
 - a 3 6 3
 - b 5 4 5
- 3 It is possible to obtain a negative score using the algorithm.

State three dice numbers that would result in a negative score.

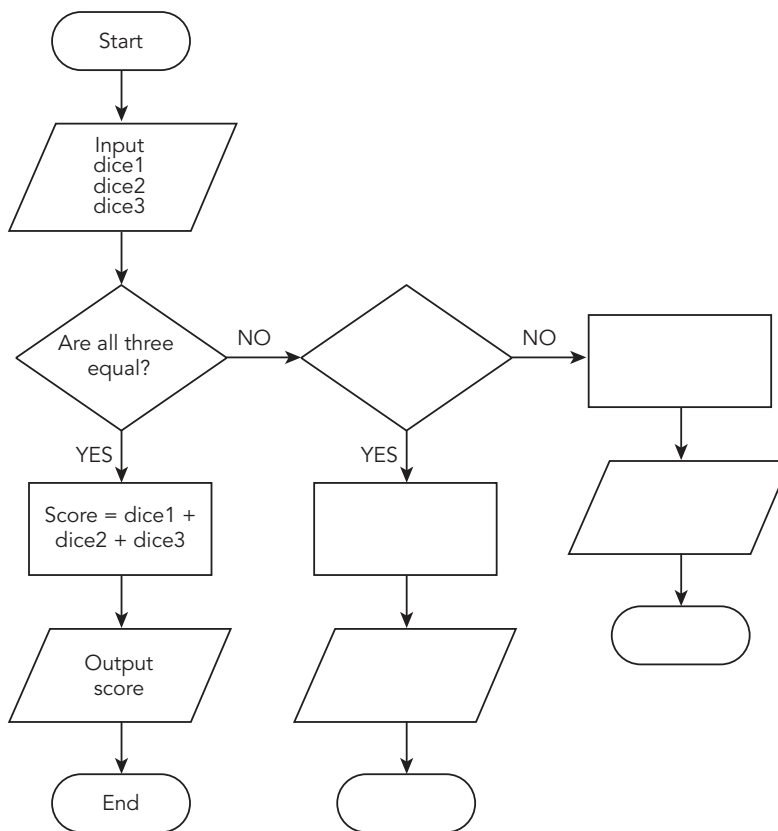


Figure 1.2: Flowchart of the algorithm to calculate the score.

Task 5

SKILLS

This task will cover the following skills:

- drawing a flowchart with the following:
 - input/output
 - decisions
 - start, stop and process boxes
 - connecting symbols / flow arrows
- declaring variables and using arithmetic operators
- using conditional branching
- using WHILE ... ENDWHILE
- using REPEAT ... UNTIL
- using IF... ELSE... ENDIF
- using INPUT/OUTPUT.

Create an algorithm to calculate the cost of sending a parcel using the following rules:

- If the weight of the parcel is 2 kg or under then the standard charge is \$3.
- There is then a charge of \$2 for each extra kilogram up to 10 kg.
- After 10 kg the charge per extra kilogram is \$3.

Display the algorithm as

- a flowchart.
- pseudocode. Provide two versions of the algorithm. One should use a pre-condition loop and the other a post-condition loop.

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Task 6

SKILLS

This task will cover this extra skill in addition to the ones you have already used:

- **nested loops.**

KEY WORD

nested loops:
one construct that is inside another construct

Create an algorithm that will output the times tables from 2 to 12.

It should state the table being output and then that number multiplied from 2 to 12.

Display your algorithm using pseudocode.

Task 7

SKILLS

This task will cover this extra skill in addition to the ones you have already used:

- using CASE ... ENDCASE

In a multiple choice question, there are four possible answers, labelled A, B, C and D. To select their answer, users have to enter one of those letters. They will then be informed if they are correct or incorrect. There should also be a method to inform users if they have entered a character other than the four allowed.

For this question the correct answer is option C.

Create an algorithm to meet these requirements, using CASE...ENDCASE statements.

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Task 8

A student handed in three homework assignments, which were each given a mark out of 10. All of the marks were different.

The student designed an algorithm to print out the highest mark.

Figure 1.3 is a flowchart of the algorithm, but some decision symbols are empty.

- 1 Complete the decision symbols and add 'YES' and 'NO' labels where required.

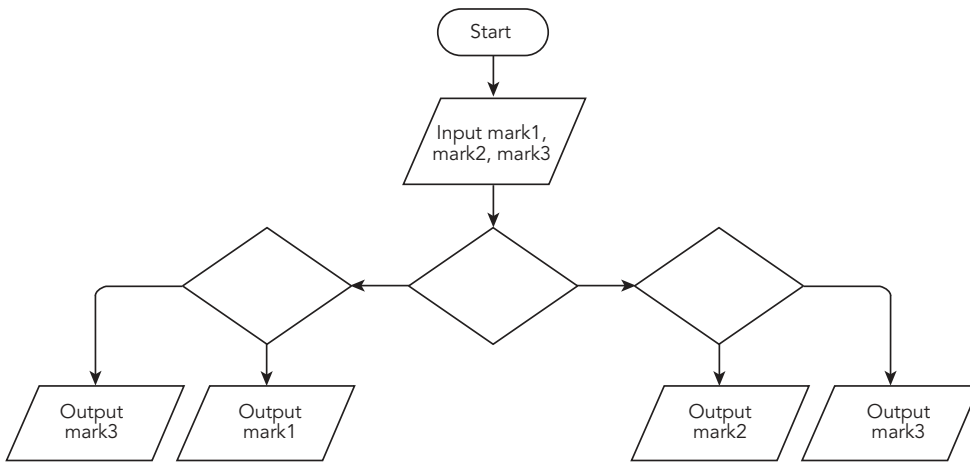


Figure 1.3: Flowchart of algorithm to print out the highest mark.

- 2 Display the algorithm using pseudocode.

Task 9

SKILLS

This task will cover these extra skills in addition to the ones you have already used:

- the use of procedures
- the use of **parameters**.

KEY WORD

parameter: a piece of data that is sent to a subroutine

Design an algorithm that will allow a user to enter two numbers.

They should then be asked to enter either 'D' or 'M'.

If the user enters 'D', then a procedure should divide the first number by the second and output the result.

If the user enters 'M', then a procedure should multiply the two numbers together.

Create an algorithm and display it as pseudocode and as a flowchart.

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Task 10

The following flowchart, Figure 1.4, displays an algorithm used by Holiday Theme Parks Limited to calculate the cost of customer entry, either individually or as part of a group.

- 1 Describe how the algorithm calculates the total amount that should be paid.
- 2 State two variables that are used in the algorithm.
- 3 In the flowchart, two of the constructs are labelled A and B. State the type of each construct.
- 4 The Smith family is visiting the park. The family consists of two children, one aged 8 and one aged 10, their two parents and their grandfather who is 65. Use the algorithm to calculate how much the family should pay for entry.

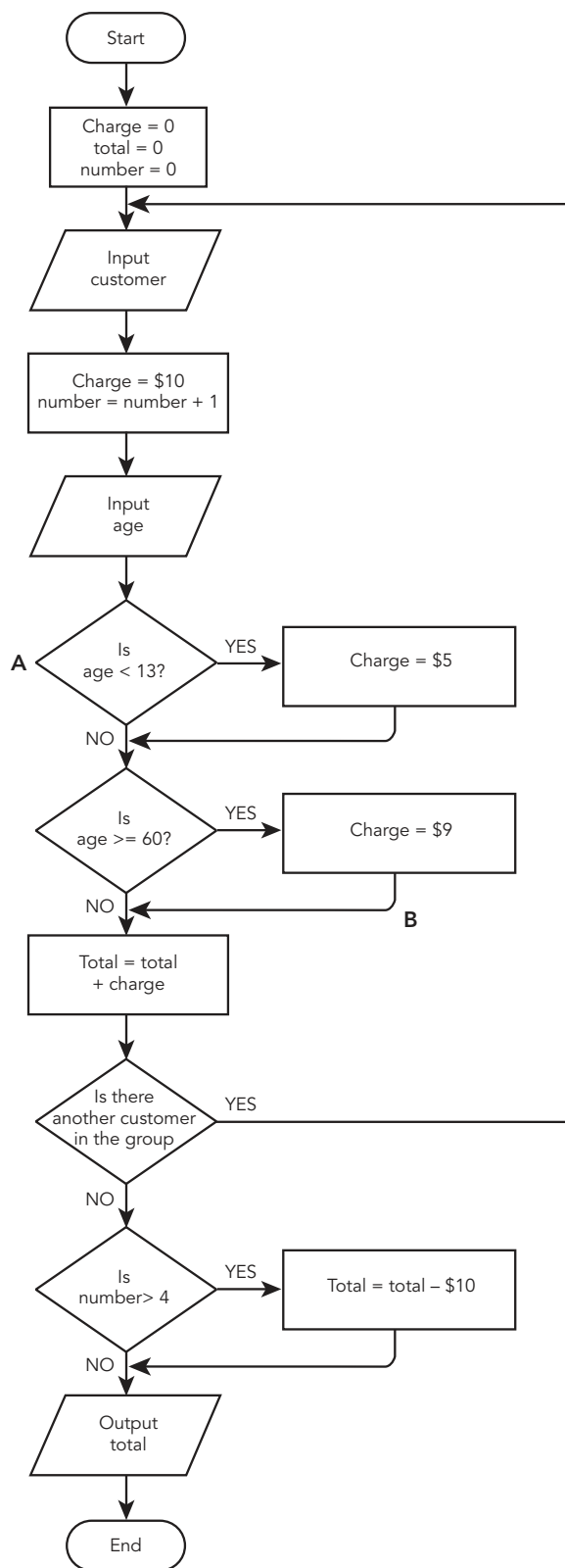


Figure 1.4: Flowchart to calculate the cost of entry.

1 Algorithms and flowcharts

Task 11

Part of an algorithm that a student has created to simulate the change given by a payment system is shown below. A user enters their payment and the algorithm determines the note and coins that should be returned.

```

1   charge ← RANDOMBETWEEN(1, 50) // This creates
   a random number between 1 and 50. This line is
   correct.
2   payment ← 0
3   money ← 0
4   OUTPUT "Please enter payment"
5   INPUT money
6   payment ← payment + money
7   WHILE payment < charge DO
8     OUTPUT "The charge is ", charge, ". Please
   enter more money."
9   Input money
10  payment ← payment - money
11  ENDWHILE
12  change ← payment - charge
13  OUTPUT "Thank you. Change required is $, change
14  WHILE change >= 10 DO
15    OUTPUT "$10 note"
16    change ← change - 10
17  ENDWHILE
18  WHILE change <= 5 DO
19    OUTPUT "$5 note"
20    change ← change - 5
21  ENDWHILE
22  WHILE change >= 2 DO
23    OUTPUT "$2 note"
24    change ← change +2
25  ENDWHILE

```

- 1 There are **four** errors in this algorithm. Some are logic errors and some are syntax errors. Identify the line numbers and state the correct version.
- 2 Explain the purpose of the loop between lines 7 and 11.

REFLECTION

- Before you used a formal flowchart or pseudocode on the computer, did you design the algorithm on paper?
- When you had written pseudocode or used a flowchart to display an algorithm, did you go through it using some test data to check it gave the correct result?
- Did you carry out online research, e.g. on loops or procedures?

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SUMMARY CHECKLIST

- I can write an algorithm to solve a given problem.
- I can edit a given algorithm.
- I can use conditional branching.
- I can use looping.
- I can use nested loops.
- I can use procedures/subroutines.
- I can draw a flowchart to solve a given problem.
- I can edit a given flowchart.
- I can use input/output in a flowchart.
- I can use decisions in a flowchart.
- I can use start, stop and process boxes in a flowchart.
- I can use connecting symbols/flow arrows in a flowchart.
- I can use the following when writing pseudocode.
 - INPUT/READ
 - WRITE/PRINT
 - IF... ELSE... ENDIF
 - WHILE... ENDWHILE
 - REPEAT...UNTIL
 - CASE...ENDCASE
 - Comparison operators $>$, $<$, $=$
 - Arithmetic operators $+$, $-$, $*$, $/$
- I can identify errors in an algorithm/flowchart for a given scenario.