

Subroutines are a way of managing and organising programs in a structured way. This allows us to break up programs into smaller chunks. Can make the code more modular and more easy to read as each function performs a specific task.

Procedures are subroutines that do not return values

Functions are subroutines that have both input and output and **return values**

Variable is an **identifier / name** of a **memory location** used to store data that can change during runtime

Constant is an identifier / name of a memory location used to store data, that remains unchanged for the duration of the program.

Passing by Value

A copy of the value is passed to the subroutine and discarded at the end

Its value outside of the subroutine remains unaffected

Passing by Reference

Address of parameter is given to the subroutine. Value of the parameter will be updated at the given address

```

GLOBAL globalMultiplier = 2 // A global variable used for modifying results

PROCEDURE calculateArea(length, width)
    area = length * width // Local variable for area calculation
    print( "Inside CalculateArea:")
    print( "Length: ", length)
    print( "Width: ", width)
    print( "Area: ", area)
END PROCEDURE

FUNCTION doubleArea(originalArea)
    doubled = originalArea * globalMultiplier // Uses global variable
    print( "Doubled Area: ", doubled)
    return doubled
END FUNCTION

// Main program
print( "Inside Main Program:")

length = float(input())
width = float(input())

calculateArea(length, width)
print(calculatedArea)
doubledResult = doubleArea(areaResult)
print(doubledResult)

```

Parameter – An item of data that is passed to a subroutine when it is called and is used as a variable within the subroutine.

Arguments – The values assigned to parameters when a subroutine is called.

Data Types – determines what value a variable can hold and the operation that can be performed on a variable

Integer	age = 12	A whole number
Float (real)	height = 1.52	A number with a decimal point
Character	a = 'a'	A single letter, number or symbol
String	name = "Bart"	Multiple characters
Boolean	a = True b = False	Has two values; true or false

Scope of variables

Scope is the section of code in which the variable can be accessed

A local variable within a subroutine takes can only be accessed within the subroutine, whereas global variables can be accessed across the whole program.

Local Variables:

- Only work inside the subroutine where they are created.
- Deleted when the subroutine finishes.
- Keep subroutines independent and organized.

Drawback

can only be accessed within the function they are declared in ...

which means their values cannot be easily shared with other parts of the program.

which means you gave to pass data as parameters

Which means you have to return data

Global Variables:

Global variables can be accessed and changed by any part of the program.

Global variable exists throughout the run-time of the program ...**which** wastes memory

Global variables can be accessed and changed by any part of the program ...**which** increases the risk of accidental changes and makes the program harder to debug.

Makes it difficult to maintain ...**as** it's difficult to understand where variables are changed

Reduces accuracy of data...**as** a change in one part can impact on another

Makes it difficult to test/test a single block...**as** the whole code may need to be run to setup the global variables

Programming Constructs

Sequence:

Sequencing represents a set of steps. Each line of code will have some operation and these operations will be carried out in order line-by-line

Selection

Represents a decision in the code according to some condition. The condition is met then the block of code is executed otherwise it is not. Often alternative blocks of code are executed according to some condition.

If statement		Switch Case Statement
Pseudocode	Python	
<pre>entry = input("Enter day of the week: ") if entry=="a" then print("You selected A") elseif entry=="b" then print("You selected B") else print("Unrecognised selection") endif</pre>	<pre>entry = input("Enter day of the week: ") if entry=="a": print("You selected A") elif entry=="b": print("You selected B") else: print("Unrecognised selection")</pre>	<pre>entry = input("Enter day of the week: ") switch entry: case "A": print("You selected A") case "B": print("You selected B") default: print("Unrecognised selection") endswitch</pre> <p>Not supported in python</p>

Iteration

Iteration Do a set of statements multiple times. Iteration is either '**count controlled**' or '**condition controlled**'.

- Count repeats the section n times,
- Condition waits until a condition has been met before stopping iteration

Count Controlled	While – (Condition Controlled)	do until Loop (Condition Controlled)					
Execute a sequence of statements multiple times							
Pseudocode <pre>for i=0 to 7 print("Hello") next i</pre> Will print hello 8 times (0-7inclusive).	Python <pre>for i in range(8): print("Hello")</pre>	Pseudocode <pre>Repeats a statement or group of statements while a given condition is true. It tests the condition before executing the loop body.</pre>	Like a while statement, except that it tests the condition at the end of the loop body. Pseudocode <pre>do answer=input("What is the password?") until answer=="computer"</pre>				
		Pseudocode <pre>while answer!="computer" answer=input("What is the password endwhile</pre>	Python <pre>while answer!="computer": answer=input("What is the password")</pre>				
Arithmetic Operators		Boolean Operators					
Add $7 + 2 = 9$	$7 + 2$	AN D	Less than False				
Subtract $7 - 2 = 5$	$7 - 2$	an d	$<$	$<$	$7 < 2$	-> False	
Multiply $7 * 2 = 14$	$7 * 2$	OR	Greater than True	$>$	$<$	$7 > 2$	-> True
Divide $4 / 2 = 2$	$4 / 2$	NO T	Equal to False	$=$	$==$	$7 == 2$	-> False
power $2 ** 3 = 8$	$2 ** 3$		Not equal to True	$!=$	\neq or $<>$	$7 != 2$	-> True
Integer division $7 // 2 = 3$	$7 \text{ DIV } 2$		Less than or equal to False	$<$ $=$	\leq	$7 \leq 2$	-> False
Modulus (remainder) $7 \% 2 = 1$	$7 \text{ MOD } 2$		Greater than or equal to True	$>$ $=$	\geq	$7 \geq 2$	-> True

Exam style question

Sally is a classroom teacher. She would like a program to be able to organise where students will sit in her classroom.

A plan of her classroom is shown [here](#).

Sally would like to increase the security of her program by adding a password to enter the program. She has created the procedure, checkPassword, to do this.

```

01  procedure checkPassword()
02      correctPassword = "ComputerScience12"
03      check = false
04      while check == false
05          enteredPassword = input("Enter Password")
06          if enteredPassword == correctPassword then
07              check = true
08          endif
09      endwhile
10  endprocedure

```

- Identify the programming construct used on lines 06 to 08 in the procedure checkPassword.

Selection

- Sally has used a while loop on line 04 of the procedure checkPassword.

Explain why Sally has used a while loop instead of a for loop. [2]

- The number of user attempts is not known
- The code will need to continue until the password entered is correct
- A while loop will keep repeating until the correct password has been input // condition is met
- A for loop will only repeat a certain number of times
- A for loop may continually ask for password even though it's been entered correctly

- Sally could have used a do until loop instead of a while loop.

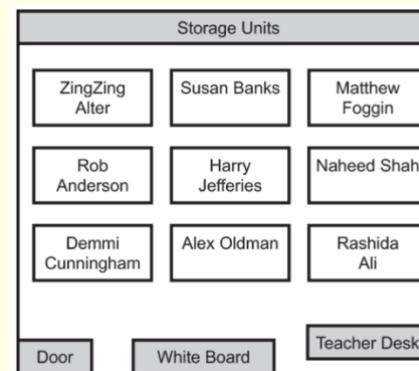
Rewrite lines 04 to 09 of the procedure checkPassword using a do until loop instead of a while loop.

```

do
    enteredPassword=input("Enter Password")
    if enteredPassword == correctPassword then
        check = true
    endif
until check == true

```

- Correct use of do at the start of the loop.
- Correct use of until at the end of the loop.
- Correct logic for inputting password, checking the entered password and for setting check to true/checking the password within the condition of the loop.



A function, toBinary(), is needed to calculate the binary value of a denary integer between 0 and 255.

toBinary() needs to:

- take an integer value as a parameter
- divide the number by 2 repeatedly, storing a 1 if it has a remainder and a 0 if it doesn't
- combine the remainder values (first to last running right to left) to create the binary number
- return the binary number.

For example, to convert 25 to a binary number the steps are as follows:

25 / 2 = 12	remainder 1
12 / 2 = 6	remainder 0
6 / 2 = 3	remainder 0
3 / 2 = 1	remainder 1
1 / 2 = 0	remainder 1

return value = 11001

Write the function toBinary().

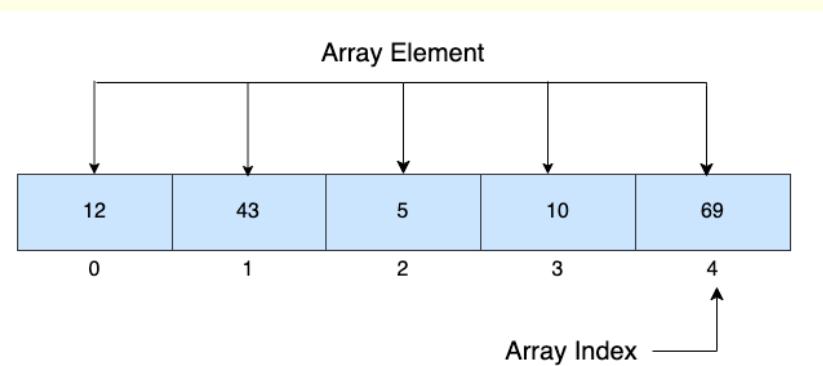
You should write your function using pseudocode or program code. [6]

[1]

Answer: 1 mark per bullet to max 6

- function header taking parameter
- looping appropriately e.g. until value is 0
- dividing by 2 and finding remainder e.g. MOD
- adding 1 or 0 correctly
- ...appending to a value to be returned // final string reversed
- reducing value to use within loop
- returning calculated value

Pseudocode	Python
<pre> function toBinary(denary) binaryValue="" while denary > 0 temp = denary MOD 2 binaryValue = str(temp) + binaryValue denary = denary DIV 2 endwhile return binaryValue endfunction </pre>	<pre> def toBinary(denary): binaryValue="" while denary > 0: temp = denary % 2 binaryValue = str(temp) + binaryValue denary = denary // 2 return binaryValue </pre>



Allows multiple items of data to be stored under one identifier
Can store a table structure
Reduces need for multiple variables

Array

Fixed size (static)

Same data type for all elements

Fast access using index positions

Mutable (elements can be changed, added, removed)

Not as flexible as lists (cannot grow/shrink)

Example:

```
birdName = ["robin", "blackbird", "pigeon", "magpie"]
```

```
birdName[2] = "pigeon" #the index here is 2
```

```
numSpecies = len(birdName) #will assign 4 to numSpecies.
```

2-dimensional arrays

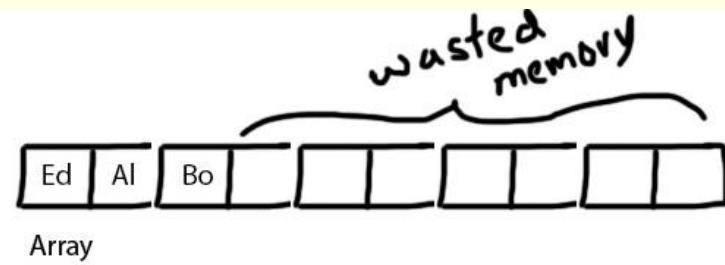
An array can have two or more dimensions.

Imagine a 2-dimensional array called numbers, with 3 rows and 4 columns.

Elements in the array can be referred to by their row and column number, so that:

numbers[1,3] = 8 in the example below.

	Column 0	Column 1	Column 2	Column 3
Row 0	1	2	3	4
Row 1	5	6	7	8
Row 2	9	10	11	12



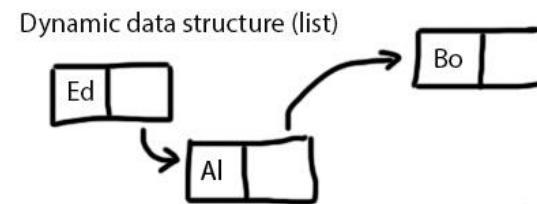
List

Dynamic size (can grow and shrink)

Can store different data types in the same list

Mutable (elements can be changed, added, removed)

Slightly slower than arrays in some operations due to dynamic memory allocation



Tuple

Fixed size

Immutable (values cannot change_

Can store different data types

More memory-efficient & faster than lists for iteration

Cannot be modified (no adding, removing, or changing elements)

```
colour = (255, 0, 0) # Red color
```

Exam style question

Programming Techniques KO

A 2-dimensional (2D) array, data, holds numeric data that Karl has entered. The declaration for the array is:

array data[16,11]

The array data, has 16 'rows' and 11 'columns'.

This is an extract from data:

The data in each 'row' is in ascending numerical order.

Karl needs to analyse the data.

Karl needs to find the mean average of each 'column' of the array. The mean is calculated by adding together the numbers in the column, and dividing by the quantity of numbers in the column.

For example, the first 'column' mean would be: $(1+3+0+12)/4 = 4$

Write an algorithm to output the mean value of each 'column' in the array data. [5]

1 mark per bullet

- Looping through each column [1]
- Looping through each row [1]
- ...Adding to a total [1]
- ...Calculating average correctly [1]
- Outputting average [1]

OCR Pseudocode	Using in range
<pre>for col =0 to 10 total = 0 for row = 0 to 15 total = total + data[row,col] next row print("Average", total/16) next y</pre>	<pre>for col in range (11): total = 0 for row in range(16): total = total + data[row,col] print("Average", total/16)</pre>

	0	1	2	3	...	10
0	1	5	7	12	...	36
1	3	4	15	16	...	48
2	0	0	1	3	...	10
3	12	16	18	23	...	100
...
15	6	10	15	25	...	96

1	5	7	12
3	4	15	16
0	0	1	3
12	16	18	23

A card game uses a set of 52 standard playing cards. There are four suits; hearts, diamonds, clubs and spades. Each suit has a card with a number from; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13.

The card game randomly gives 2 players 7 cards each. The unallocated cards become known as the deck.

The players then take it in turns to turn over a card. A valid move is a card of the same suit or the same number as the last card played.

The winner is the first player to play all of their cards.

The cards are held in the 2D array cards. The first index stores the card number and the second index stores the suit, both as strings.

Write a **pseudocode statement** or program code to declare the array cards.

array cards[7, 4] or array towns [3,8]

Exam style: When a user collects an item, the name and type are added to the array p1Items. At the end of the game, the name of each item collected is output.

Write an algorithm, using pseudocode or program code, to:

- output the name of each item in the array
- output a suitable message if there are no items in the array.
- If the item is "empty" it should not be output.

How to answer:

It is a 2D list [row] [column]

Example p1Items
`[["Fruit", "apple"],
["Fruit", "orange"],
["Empty", "Empty"]]`

Best way to iterate lists/print – For loop
 Best way to search for a specific item – While loop

Check if not "Empty":
 Use a count

What will change? row
 What will stay the same? column

row [x][0]

Output – Name of item
 Output – "No items" if count = 0

```
count = 0
for x = 0 to 9
    if p1Items[x,0]!="empty" then
        print(p1Items[x,0])
        count = count + 1
    endif
next x
if count== 0 then
    print("There are no items")
endif
```

```
count = 0
for x in range (10):
    if p1Items[x,0]!="empty":
        print(p1Items[x,0])
        count = count + 1
if count == 0:
    print("There are no items")
```

Records

A record is a data structure that groups together related items of data
 You can store more than one type of data together

Array of Records

Record

Class

Programming Techniques KO

A record is an unordered data structure
Can have multiple instances

Player records:

Player1 record

Olivia
35

Player 2 record

Luke
40

Creating a record structure

recordStructure recordstructurename

 fieldname : datatype

...

endRecordStructure

The pseudocode to define a new complex data structure called player:

```
RECORD player
    name: String
    score: int
ENDRECORD
```

Adding data to the record

```
recordidentifier : recordstructurename
recordidentifier.fieldname = data
```

The pseudocode to define a new complex data structure called Player:

```
Player1: player
Player1.player.name = 'Olivia'
Player1.player.score = 35
```

Records are treated as **data types**, so they can be held within a single **array**.

This allows for storage of more than one **record** within the same structure. This structure is essentially an **array of records**.

The table below simplifies the way that this data would be held in memory.

- The records for the players could be stored in a 1D array.
- It allows easy access/indexing/manipulation of each data item in turn
- 1D Array can hold multiple items of same data type – record
- Maximum number of array elements is known

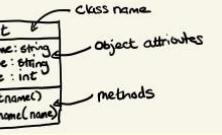
0	1	2	3
Olivia 35	Luke 40	Adam 25	Alex 35

Pseudocode of Arrays of records:

Players(100) As player

We can then reference any element of the array:

Players(3).name = "Jane"

Similarities		
Data structure	A record is a data structure that stores data together, organised by attributes.	A class is a record with associated methods. Each object is a data structure with attributes stored together
Set up in advance	Attributes and structure for the record are set up. Meaning that it is created by the programmer for a particular purpose.	Constructor method defines the class object
Store data of different types	recordStructure pets name : String type : String age : Int endRecordStructure	
Both can have multiple instances	Yes	Yes
Accessed by their names	Yes	Yes
Differences		
Class also has methods Class can include visibility of properties / private		

Working with strings

Strings

Get length of a string

len("Hello")

Exam style Question

The function validateAnswer takes in the randomLetters as an array of letters and the player's answer as a string. It then

Mark scheme

- Function traverses every letter of answer (1)
- Function traverses every randomLetters (1)

Programming Techniques KO

Character to character code	asc("a")
Character code to character	CHR(101)
String to integer	a=INT("12")
String to float	a=FLOAT("12.3")
integer to string	a=STR(12)
real to string	a=STR(12.3)

substrings - select parts of a string

Example	student="Harry Potter"	
Output the first two characters	print(student[0:2])	Ha
Output the first three characters	print(student[:3])	Har
Output characters 2-4	print(student[2:5])	Rry
Output the last 3 characters	print(student[-3:])	Ter
Output a middle set of characters	print(student[4:-3])	y Pot

*A negative value is taken from the end of the string.

checks if the word the player has entered only contains letters from the 10 random letters with each letter being used only once. (At this stage the program doesn't check if the answer provided is an actual word.) It then returns a score, out of 10, for a valid word or 0 for an invalid word.

Example:

If the random letters are: OPXCMURETN

The word COMPUTER returns 8

Whereas

The word POST returns 0 (there is no S in the random letters).

The word RETURN returns 0 (there is only one R in the random letters).

Complete the function validateAnswer

function validateAnswer(answer, randomLetters[]) [6]

- Correctly checks each letter of answer against each of randomLetters (1)
- Returns 0 if answer contains a letter that doesn't occur in randomLetters (1)
- Returns 0 if letter occurs more times in answer than randomLetters (1)
- Returns answer length for a valid word.(1)

Solution:

```
function validateAnswer(answer, randomLetters)
```

```
    valid = True
```

```
    score = 0
```

```
    lengthAnswer = len(answer)
```

```
    lengthRandom = len(randomLetters)
```

```
    index = 0
```

```
    while (valid == True) and (index < lengthAnswer)
```

```
        numChar = 0 # Initialise numChar for each letter
```

```
        currentLetter = answer[index:1]
```

```
        for i = 1 to lengthRandom-1
```

```
            if currentLetter == randomLetters[i]
```

```
                numChar = numChar + 1
```

```
# If the letter does not exist in randomLetters list
```

```
if numChar == 0
```

```
    valid = False
```

```
    index = index + 1 # Move to the next letter in answer
```

```
# If all letters pass check, answer is valid
```

```
if valid == True
```

```
    score = lengthAnswer
```

```
return score
```

```
print(validateAnswer("POST", "OPXCMURETN"))
```

Working with files

Open file Whatever we are doing to a file whether we are reading, writing or adding to or modifying a file we first need to open it using:

```
open(filename,access_mode)
```

Exam style Question

Albert runs a competition each week in his local village hall. So that Albert can contact the winner he would like a program for the winner to enter their telephone number which is then checked and written into a text file.

Programming Techniques KO

There are a range of access mode depending on what we want to do to the file, the principal ones are given below:

Access Mode	Description
r	Opens a file for reading only
w	Opens a file for writing only. Create a new file if one does not exist. Overwrites file if it already exists.
a	Append to the end of a file. Create a new file if one does not exist.

Reading text files

read – Reads in the whole file into a single string	<pre>f=open("filetxt","r") print(f.read()) f.close()</pre>
readline – Reads in each line one at a time	<pre>f=open("file.txt","r") print(f.readline()) print(f.readline()) print(f.readline()) f.close()</pre>
readlines – Reads in the whole file into a list	<pre>f=open("file.txt","r") print(f.readlines()) f.close()</pre>

Writing text files

Write in single lines at a time	<pre>file=open("days.txt",'w') file.write("Monday\n") file.write("Tuesday\n") file.write("Wednesday\n") file.close()</pre>
Write in a list	<pre>say=["How\n","are\n","you\n"] file=open("say.txt",'w') file.writelines(say) file.close()</pre>

The rules for Albert's program are as follows:

1. The telephone number is entered. This is checked to ensure that the first digit is a 0
2. If the first digit is not a 0 then a message saying "Needs To Start With 0" is printed
3. If the first digit is a 0 then the telephone number is passed into a pre-existing function called checkLength as a parameter. This will return true if the length of the telephone number is long enough
4. If the telephone number is long enough then it is written into a text file called "winner.txt"
5. If the telephone number is not long enough then a message saying "Not Long Enough" is printed.

Complete the procedure competitionWinner so that it meets the rules of Albert's program.

You should write your procedure using pseudocode or program code.

procedure competitionWinner() [5]

```
telNum = input("Enter Telephone Number")
if telNum[0] == "0" then
    length = checkLength(telNum)
    if length == true then
        myfile = openWrite("winner.txt")
        myfile.write(telNum, 'w')
        myfile.close()
    else
        print ("Not Long Enough")
    endif
else
    print ("Needs To Start With 0")
endif
Endprocedure
```

Answer: 1 mark per bullet up to a maximum of 5 marks, e.g.:

- Suitable logic for inputting the telephone number
- Suitable logic for ensuring the telephone number starts with a 0
- Suitable logic for passing the telephone number into the function checkLength
- If true, suitable logic for opening and closing winner.txt
- ...suitable logic for writing the telephone number to winner.txt
- Suitable logic for printing "Needs To Start With 0" and "Not Long Enough"

Recursive algorithms

Recursion

When a subroutine calls itself during execution.
Continues until a stopping condition is met.
(Base Case)

Recursion produces the same result as iteration, but is more suited to certain problems which are more easily expressed using recursion.

Example

A common example of a naturally recursive function is **factorial**, shown below:

- The Factorial of a positive integer, n, is defined as the product of the sequence n, n-1, n-2,
- The factorial of a number is the product of all the integers from 1 to that number.
- For example, the factorial of 3 (denoted as 6!) is $1 \times 2 \times 3 = 6$
- Factorial is not defined for negative numbers and the factorial of zero is one, $0! = 1$

Iterative Solution

```
Function factorial(number):
    factorial = 1
    # loop from the number till 1
    for number in range(number, 1,-1):
        # multiply current number with the
        # product of previous numbers
        factorial = factorial * number
    return factorial
```

Recursive Solution

```
function factorial(number)
    if number == 0 or 1 then #base case
        return 1
    else:
        return number * factorial(number - 1);
    endif
end function
```

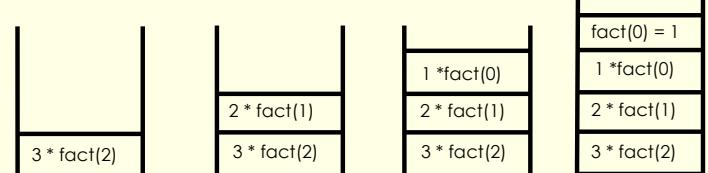
Example: Trace code where n=3

Call	n	Return
factorial(3)	3	6
factorial(2)	2	2 * (factorial(1))
factorial(1)	1	1 * (factorial(0))
factorial(0)	0	

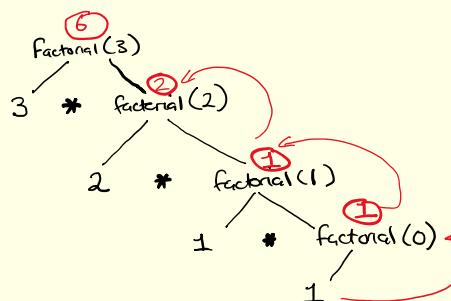
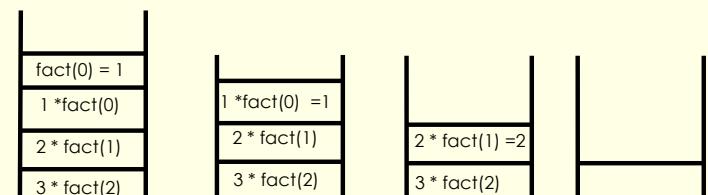
Final answer 6

Each time the function calls itself, a new stack frame is created within the call stack , where parameters , local variables and return addresses are stored.

Recursive calls stored into the stack



Returning values once base case is met



Benefit

- Easier to read and understand** – The logic often follows the problem's natural structure.
- Concise and quick to write** – Requires fewer lines of code than iterative solutions.
- Ideal for specific problems** – Particularly useful for tree structures and divide-and-conquer algorithms.
- Breaks problems into smaller parts** – Each recursive call simplifies the problem step by step.

Drawbacks of Recursion:

- Risk of stack overflow** – Too many recursive calls can exceed memory limits, causing a crash.
- Requires a well-defined base case** – Without a proper stopping condition, recursion can lead to infinite loops.
- Harder to trace and debug** – Each call has its own set of variables, making execution more complex to follow.
- Higher memory consumption** – Recursive calls store additional data on the stack, using more memory than iteration.
- Often slower than iteration** – Maintaining the call stack adds extra processing overhead.

Exam Style Questions

- Re-write an iterative algorithm into a recursive algorithm (vice versa)
- Discuss the benefits and drawbacks of recursive algorithms compared to iterative algorithms.

<p>High Level Programming Languages</p> <ul style="list-style-type: none"> • Much easier to learn, write and debug. • Examples include Python, Java and C • Code written in these languages must be translated to machine code before it can be executed. <p>Advantages</p> <ul style="list-style-type: none"> • Much more widely understood and used. • Easier to learn, code in and understand. • Much quicker to produce usable code. • More support and learning resources are available. • Easier to debug and find issues <p>Disadvantages</p> <ul style="list-style-type: none"> • Less flexible. • Must be translated before being executed • Very difficult to write and understand. • Much more time consuming to produce code. 	<p>Test data</p> <p>Code needs to be tested with a range of different input data to ensure that it works as expected under all situations. Data entered need to be checked to ensure that the input values are:</p> <ul style="list-style-type: none"> • within a certain range • in correct format • the correct length • The correct data type (eg float, integer, string) <p>The program is tested using normal, erroneous or boundary data.</p> <p>Normal data - Data that we would normally expect to be entered. For example for the age of secondary school pupils we would expect integer values ranging from 11 to 19.</p> <p>Erroneous data - Data that are input that are clearly wrong. For instance, if some entered 40 for the age of a school pupil. The program should identify this as invalid data but at the same time should be able to handle this sensibly which returns a sensible message and the program does not crash.</p> <p>Boundary data - Data that are on the edge of what we might expect. For instance if someone entered their age as 10, 11, 19 or 20.</p>
<p>Programming Standards</p> <ul style="list-style-type: none"> • No function may be longer than a single page of code: this is to reduce complexity and aid readability. • Variable identifiers must conform to a standard convention: this helps others to understand the code and reduces the likelihood of duplication, makes maintenance easier. • Each function must have a single entry point: this reduces complexity and makes the search for any bugs more straightforward. • Variables must not be set up outside the scope of a function: this sets a limit on where to look for bugs and reduces the likelihood of a problem spread across many modules. • Indentation • Global variables – use upper case UPPER_CASE_WITH_UNDERSCORES • In python - function names should be lowercase • Comment your code - Do not do line-by-line comments - makes the code look almost unreadable 	<p>Debugging</p> <p>Syntax errors – Errors in the code that mean the program will not even run at all. Normally this is things like missing brackets, spelling mistakes and other typos.</p> <p>Runtime errors – Errors during the running of the program. This might be because the program is writing to a memory location that does not exist for instance. eg. An array index value that does not exist.</p> <p>Logical errors - The program runs to termination, but the output is not what is expected. Often these are arithmetic errors.</p>

IDE and Debugging

Source code editor
The editor aims to make the coding process easier by providing features such as autocompletion of words, indentation, syntax highlighting.

Identifying and describing **three** IDE features that can help the programmer to develop or debug a program.

[6]

Syntax highlighting... to identify keywords, variables and help identify syntax errors

Breakpoints... stop a program running at a point to check variables

Error diagnostics... to locate and fix errors

Auto-complete... start typing a command/identifier and it completes it

Variable watch window... view how variables change while the program executes

Stepping / step through... run the program line by line to check variable values at each stage

The diagram illustrates the use of various IDE features in an IDE interface. A code editor window shows Python code with syntax highlighting. A shell window shows a traceback for a type error. A variable watch window displays variable values. A code editor window shows auto-complete suggestions for a random module call. A code editor window shows a stepped execution with a cursor on line 16.

```
example.py
1 def add_numbers(a, b):
2     """This function adds two numbers and returns the result."""
3     result = a + b
4     print("The result is ", result)
5
6 def multiply_numbers(a, b):
7     """This function multiplies two numbers and returns the result."""
8     result = a * b
9     print("The result is ", result)
10
11 # Main program
12 num1 = float(input("Enter first number: "))
13 num2 = input("Enter second number: ")
14
15 # Call the subroutines
16 sum_result = add_numbers(num1, num2)
17 product_result = multiply_numbers(num1, num2)

Shell
%Run example.py
Enter first number: 23
Enter second number: 43
Traceback (most recent call last):
  File "/Users/elizabetthallgar/Library/CloudStorage/OneDrive-KingJames'sSchool/example.py", line 16, in <module>
    sum_result = add_numbers(num1, num2)
  File "/Users/elizabetthallgar/Library/CloudStorage/OneDrive-KingJames'sSchool/example.py", line 3, in add_numbers
    result = a + b
TypeError: unsupported operand type(s) for +: 'float' and 'str'
>>>

Variables
Name Value
add_numbers <function add_numbers at 0x1012e6cb0>
multiply_numbers <function multiply_numbers at 0x10133ce50>
num1 23.0
num2 '43'

example.py
1 def add_numbers(a, b):
2     """This function adds two numbers and returns the result."""
3     result = a + b
4     print("The result is ", result)
5
6 def multiply_numbers(a, b):
7     """This function multiplies two numbers and returns the result."""
8     result = a * b
9     print("The result is ", result)
10
11 # Main program
12 num1 = float(input("Enter first number: "))
13 num2 = float(input("Enter second number: "))
14
15 # Call the subroutines
16 sum_result = add_numbers(23.0, 12.0)
17 product_result = multiply_numbers(num1, num2)
```