**1.**

Which of the following concepts in object-oriented programming refers to the mechanism where you can to derive a class from another class for a hierarchy of classes that share a set of attributes and methods.

- ● ✓ **Inheritance**
- ○ **Abstraction**
- ○ **Polymorphism**
- ○ **Encapsulation**

1/1p

**2.**

The preferred diagram for modelling classes is

- ● ✓ **Universal Modelling Language**
- ○ **Context diagram**
- ○ **Class Data flow diagram**
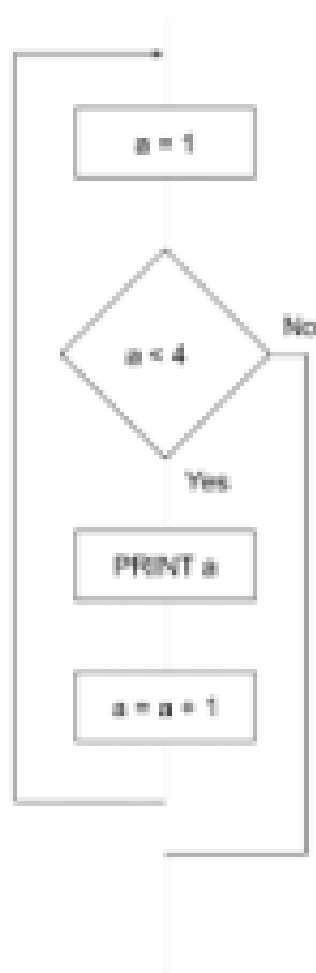- ○ **Class models**

1/1p

**3.**

Which type of testing is extensively used when developing mechatronic solutions.

- ● ✓ **Unit testing**
- ○ **Grey box testing**
- ○ **Black box testing**
- ○ **Oscilloscope testing**

1/1p

**4.**

What is the most significant issue with this flowchart?



- ● ✗ **There is an endless loop**
- ○ **The condition should be a<=1**
- ○ **The variable a is the incorrect data type**
- ○ ✓ **A non-standard control structure is used**

0/1p

**5.**

What does the following symbol represent when used in a data flow diagram?

```
┌─────────────┐
│             │
│             │
│             │
└─────────────┘
```

- ○ A data store
- ○ A subroutine
- ● ✓ An external entity
- ○ A manual process

1/1p

**6.**

Which statement explains why the below programming pattern is common in mechatronic system design.

**setup () # runs oncce**
    code...

**loop () # infinite loop**
    code...

- ○ As the loop allows for repetitive system design.
- ○ ✓ So the hardware can be configured before the software implementation.
- ○ Because it is a requirement of the IDE.
- ● ✗ As the loop needs to happen after setup.

0/1p

**7.**

Consider the following algorithm
The array arrAge contains 50 elements and is indexed from 0.

```
1  BEGIN
2      sumOfAges = 0
3      FOR index = 0 TO 50 STEP 1
4          sumOfAges = sumOfAges + arrAge(i)
5      NEXT index
6      averageAge = sumOfAges/numItems
7  END
```

a) What control structure is used in the algorithm?

- ○ Multiway loop
- ○ Post-test loop
- ● ✓ Counted loop
- ○ Pre-test loop

1/1p

b) When coded and executed an error occurs. Which of the following best describes this error?

- ○ Logic error
- ● ✗ Syntax error
- ○ Parsing error
- ○ ✓ Runtime error

0/1p

**8.**

Identify the appropriate headings for a "software requirements" document

- ☐ Software document
- ☐ Test data
- ☑ ✓ Functional requirements
- ☑ ✓ Non functional requirements

2/2p

**9.**

In linear regression, what is the primary goal of the model?

- ⦿ ✓ **To predict the value of a dependent variable based on one or more independent variables**
- ○ **To classify data into distinct categories**
- ○ **To cluster similar data points together**
- ○ **To minimize the number of features in the dataset**

1/1p

**10.**

What type of relationship does polynomial regression model?

- ⦿ ✓ **Non-linear relationships between variables**
- ○ **Only linear relationships**
- ○ **Random relationships without any pattern**
- ○ **Only relationships involving three variables**

1/1p

**11.**

Which of the following is a key advantage of using neural networks?

- ⦿ ✓ **They can learn complex patterns from large amounts of data**
- ○ **They require less data than traditional models**
- ○ **They are always faster than other algorithms**
- ○ **They do not require any tuning of parameters**

1/1p

**12.**

In a decision tree, what do leaf nodes primarily represent?

- ○ **They are used for splitting the data.**
- ○ **The connect different levels of the tree.**
- ○ **They represent the decision points in the tree.**
- ⦿ ✓ **They are the final output or classification.**

1/1p

**13.**

Which of the following is an example of supervised learning?

- ⦿ ✓ **Classification of emails as spam or not spam**
- ○ **Clustering customer segments**
- ○ **Market basket analysis**
- ○ **Anomaly detection in network traffic**

1/1p

**14.**

In mechatronics, which technique would you use to group similar sensor readings without prior labels?

- ○ **Supervised learning**
- ⦿ ✓ **Unsupervised learning**
- ○ **Reinforcement learning**
- ○ **Deep learning**

1/1p

**15.**

Email clients send mail using which protocol?

- ⦿ ✓ **SMTP**
- ○ **POP3**
- ○ **IMAP**
- ○ **FTP**

1/1p

**16.**

The following context diagram describes a food ordering app.



Based on the above diagram, which statements are correct?

- [ ] Food outlets, Customers and Financial Institutions are sub-modules or sub-programs
- [x] ✓ This is a level 0 data flow diagram
- [ ] Food Ordering App is an external entity that interacts with the system

- [x] ✓ Food outlets, Customers and Financial Institutions are external entities
- [x] ✗ The Food Ordering App sends the Order Details to the Food Outlet before the Transaction Status is received

1/2p

**17.**

A user logs into their bank's website, which allows money transfers via a button. A hacker sends the user a malicious email containing a link. When the user clicks the link, a money transfer request is executed without their knowledge.

What type of attack is this?

- (●) ✓ Cross-Site Request Forgery (CSRF)
- ( ) Cross-Site Scripting (XSS)
- ( ) Denial of Service (DoS)
- ( ) SQL Injection

1/1p

**Section II**
**Total marks (60)**
**Attempt ALL Questions (Q18 - Q30)**
**Allow about 1 hour and 55 minutes for this section**

**18.**

Match the debugging tool with the definition

| | |
|---|---|
| ✓ Breakpoint | An intentional stopping or pausing place in a program. |
| ✓ Single line step | Executing code one instruction or line at a time. |
| ✓ Compiler | Translate the entire code at once, displaying all syntax errors in a list. |
| ✓ Debugging output statements | Inserting in the source code statements that print the content of variables or notifying events have occurred. |
| | Installed tools to support debugging |

4/4p

**19.**

Distinguish between authentication and authorisation

**Answer:**

Authentication is the the process of verifying if a user is genuine, i.e. they are who they say they are. This can be done through login passwords or biometric scans which can check the true identity of a user who is logging in. On the other hand, authorisation is the concept of giving least privilege to people within a software system, meaning that they only have permission and access to data and features that they need. This prevents too many people having access to sensitive data when they do not need it, making the stored data more secured.

99 words

2/2p

**20.**

The Python code below defines a function that allows a user to purchase an item.

```python
import threading
lock = threading.Lock()
def purchase_item(user_id, item_id):
    with lock:
        if inventory[item_id] > 0:
            inventory[item_id] -= 1
            confirm_purchase(user_id, item_id)
```

Explain what a race condition is and how it could affect the purchase_item function if no lock was implemented.

**Answer:**

A race condition is a security vulnerability in which two processes in a system happening simultaneously can lead to unexpected outputs. In this scenario, if no lock was implemented, if two users were to purchase an item at once, resulting in two simultaneous calls of purchase_item, the system may check the inventory of one item which is 0 and then another item which is greater than 0. As these processes would be running at the same time, if the confirm_purchase() for both items were called after the second check of inventory, both items would have their purchase confirmed even though one of the items did not have any inventory. Thus, for one of the items, purchase_item() would have returned an incorrect output due to race conditions.

129 words

3/3p

**21.**

A school's online portal allows students to upload assessment files. Recently, a student discovered that by modifying the URL, they could access and download other students' submitted files. It was also found that students could re-upload their work multiple times, overwriting previous submissions without detection even after the due date.

Describe how confidentiality, accountability and integrity has been compromised in this scenario.

**Answer:**

Confidentiality:
Confidentiality describes whether or not sensitive data in an application is kept private. In this scenario, students are able to access other students' files, meaning that they have accessed information that was meant to be private to that student. Thus, confidentiality has been compromised.

Accountability:
Accountability refers to the ability of an app to log all the actions done in its running, thus making all actions retraceable back to a certain user to make them accountable. However, in this case, a student is able to overwrite previous submissions without detection due to the lack of a logging system, meaning that accountability has been compromised as edits to their submissions cannot be traced back to the student who reuploaded their work.

Integrity:
Integrity refers to the trustworthiness and accuracy of data stored in an app. In this scenario, the student is able to overwrite previously stored submissions even after the due date while the app has no ability to detect differences in this data. Thus, integrity of the stored submission files is compromised as teachers can no longer trust the submissions to be ones before the due date.

188 words

4/4p

**22.**

Discuss the benefits of collaboration in software engineering.

In your response:

- Highlight at least three key advantages that effective collaboration can bring to a software development project.
- Provide an example of a collaboration tool and explain how it facilitates collaboration among developers.

**Answer:**

Due to the scale of most software solutions, often collaboration is required to ensure the quality and efficient production of an application. Three key advantages of effective collaboration are:

1. Faster and more efficient production time: Compared to an individual making a software solution on their own, a collaborative team would be able to split workloads amongst each other, allowing for each developer to focus on their own aspect of the project and thus allow for efficient production.

2. Sharing of experience: With a whole team collaborating for one big project, team members are able to share their experience developing to aid other developers, helping them fix errors or recommending more effective methods to perform the same task. Through the collaborative sharing of experience, there would be a much higher production quality and efficiency in the development of the app compared to an individual working on their own.

3. Specialisation: With many major software projects, many aspects would require different skills from the developer. These skills may include UI design or security aspects of the app. Compared to a single individual having to know all these different aspects of software development, having a collaboration between individuals specialising in different areas can result in a product of much higher quality compared to what an individual can make on their own.

An example of a popular collaborative tool used by developers is GitHub, which allows users to collaborate on a single project through committing and pushing various changes to an app. The tool also allows for version control and logging, allowing for the effective collaboration between developers as they can tell who has developed what aspect of the project and easily see what everyone else has completed.

282 words

**Feedback**

Excellent answer, well structured and demonstrates your detailed understanding

**23.**

You have been tasked with designing and developing a Progressive Web App (PWA) aimed at enhancing the accessibility and inclusivity of educational resources for infants school students.

Outline how you would address the following key design principles when creating the user interface (UI) and user experience (UX) of your PWA.

- Font selection and typography
- Colour schemes and contrast
- The use of audio and video elements
- Navigation design

**Answer:**

- Font selection and typography

As this PWA is targetted at the accessibility towards infants, the font of the PWA would be large and readable in design so as to prevent eye strain and damage in these infants if they were forced to read small text. The lines in text would also be spaced out so that these infants wouldn't accidently skip lines or get confused when reading. To make the text accessible for any student to read, an option to change the font size and spacing would also be available to promote inclusivity as various students can have different levels of eyesight.

- Colour schemes and contrast

To enhance the UX of the PWA, bright and contrasting colour schemes would be implemented to engage the infants through these flashy colours, compared to bland black and white colour schemes that may cause these students to get bored and become distracted in their learning. There would also be an option for various colour schemes to account for any visual disabilities such as colourblindness, thus promoting accessibility and inclusivity in the PWA.

- The use of audio and video elements

To further enhance the UX, the PWA would include engaging audio feedback to user inputs as well as educational videos integrated in the content to allow for effective learning for these students. Furthermore, there would be a limit to the audio volume that is played by the application to ensure the safety of the infants as their hearing can be easily damaged by very loud noises.

- Navigation design

Navigation of the PWA will be easily accessible for infant students who may not fully understand how technology works. This can be done with a clear navbar on all pages with the functionality to be able to direct users to any page on the PWA with clear labels, thus minimising any confusion that students may have when navigating the app. There would also be a search option to address the issue of a student being lost, allowing them to search for the page they are looking for instead.

341 words

**24.**

Compare and contrast between supervised and unsupervised learning. Give a real world example for each

**Answer:**

Supervised learning involves training a machine learning algorithm using labelled data and is often structured. An example of this is K Nearest Neighbour, where a real world equivalent would be trying to classify a student in a class as sporty or not sporty based on the people around them. In this case, the people around the new student could have values for "Plays Soccer: 1" or "Is in a sports team: 1", and be labelled as "Sporty" or "Not Sporty". Using these values, supervised learning in KNN can look at Euclidean distance of K nearest students to this new student and predict whether or not they are sporty by getting the mode label. On the other hand, unsupervised learning involves training a machine learning algorithm using non labelled and unstructured data. An example of this is K-means clustering, where the algorithm finds groups in data by averaging the euclidean distances of a randomly selected point to find a new centroid, which they make the new point and further find the average distances until the algorithm ultimately finds central points amongst the data, allowing the algorithm to identify patterns in this unstructured and non-labelled set of data. While both supervised and unsupervised learning train models differently, they both have the ultimate goal of finding patterns and making predictions using training data.

220 words

3/4p

**Feedback**

Your answer correctly identifies the core difference between supervised (uses labeled data) and unsupervised learning (uses unlabeled data) and provides relevant examples with KNN and K-means. However, the explanations for how these algorithms work are a bit muddled, and the response lacks a clear "compare and contrast" structure. To improve, focus on explicitly highlighting the goals and different uses of each type of learning (e.g., prediction vs. pattern discovery) and refine your descriptions of how the examples you chose actually function.

**25.**

For the algorithm

```
1   START myFunction (array[])
2       SET num = array[0]
3       FOR index = 0 TO 4 STEP 1
4           IF array[index] > num
5               num = array[index]
6           ENDIF
7       NEXT index
8       PRINT num
9   END myFunction
```

a) Outline the purpose of the algorithm

**Answer:**

This algorithm cycles through each list item of the given array of numbers, starting from the first number, to check for the largest number in the list. The purpose of this algorithm is to find and print the largest number in an array or list.

45 words

2/2p

b) There is an error in the algorithm. Perform a Desk check of the algorithm assuming the passed in array is [1, 6, 19, 3] and identify the line and type of error.

**Answer:**

| Process | Input | Output |
|---|---|---|
| Set num as the first list item | [1,6,19,3] | 1 |
| Check if 1 > 1 | 1 | False |
| Check if 6 > 1 | 6 | True |
| Check if 19 > 6 | 19 | True |
| Check if 3 > 19 | 3 | False |

After this check, the algorithm tries to get the array of index 4, which would mean it tries to search for the 5th item in the list. However, the list only has 4 items. Therefore, an IndexError would occur at line 4 when it tries to check for the array[4] term.

90 words

1/3p

c) Identify and outline three improvements you can make to this algorithm

**Answer:**

1. Can first sort the list in ascending order using the sort() function, allowing the algorithm to grab the last term which must be the largest number, no matter how big the list is. This also makes the algorithm faster as it no longer has to iterate through every list item and save the largest number each time, making it highly scalable.
2. Can check the length of the list instead of hard coding a for loop from 0 to 4 so that lists of many lengths can be put through the function
3. There can be a check put in place to validate the inputted list, making sure that there are no other characters and only integers or floats to ensure that no error occurs when trying to use the > operator, as you cannot use it with strings.

136 words

3/3p

## 26.

Consider the following class diagram which models a student management system:
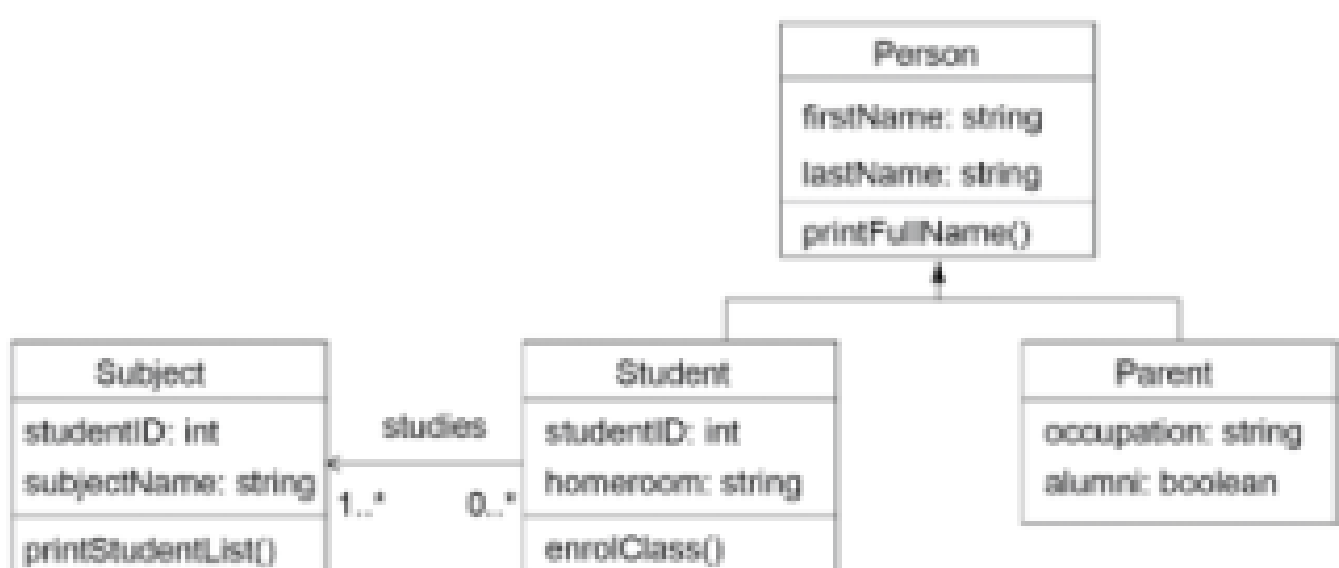


Based on the provided class diagram for Student Management System discuss the relationships and key principles of Object-Oriented Programming (OOP) that are demonstrated. Your answer should specifically address:

1. **Inheritance**: Identify an example of inheritance and explain its purpose.
2. **Encapsulation**: Describe how encapsulation is applied within the classes, referencing attributes and methods.
3. **Composition or Aggregation**: Explain the relationship between the classes. Justify your answer.
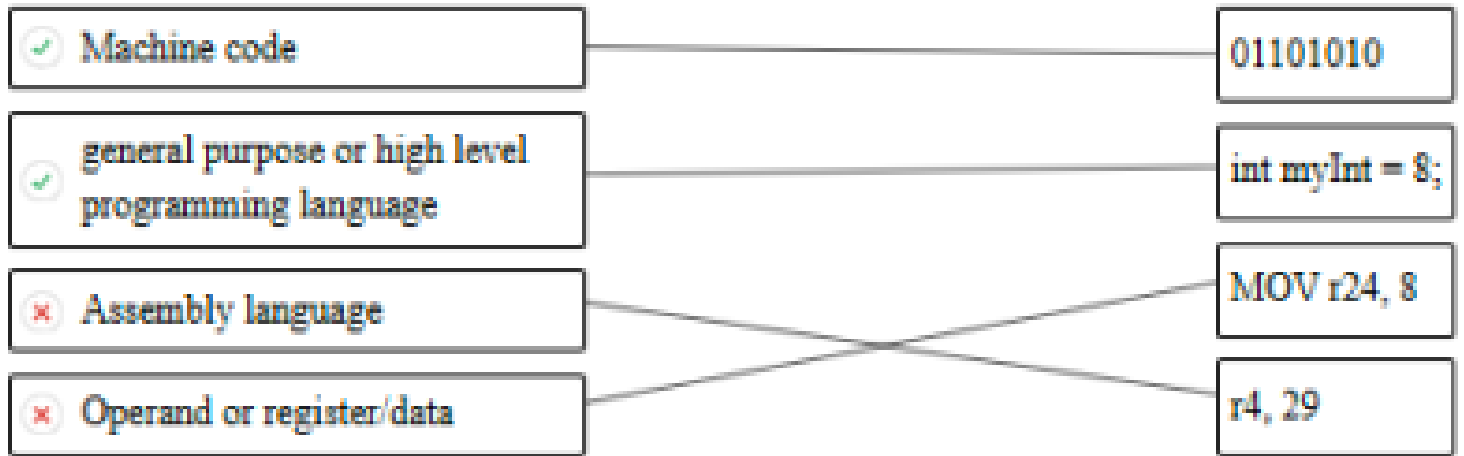
**Answer:**

1. Inheritance is the OOP concept of having a class take methods and attributes from other classes, making the new class a specialised version of the parent class. In the diagram, both Student and Parent inherit from the Person class. The purpose of this is to make the program more efficient. As both students and parents have a first name, last name and a printFullName() function that all person objects have, there would be no need to make separate non inherited classes for Parent and Student with the same attributes and methods, thus making inheritance very useful in making this program more efficient by making Parent and Student classes inherit from Person.
2. Encapsulation in OOP refers to the hiding of the background processes of an algorithm through a method. In this UML diagram, the enrolClass() function of Student is encapsulated, hiding all the backend algorithms that allow for a student to enrol into a class. Furthermore, the printStudentList() method of the Subject class is encapsulated in a function as similarly, the back end program is hidden.
3. Subject is an aggregation of Student, where multiplicity shows that a subject can have 0 or more students studying it while a student must have at least 1 subject. Aggregation of the class shows that the Subject class can exist on its own without the student.

221 words

5/5p

**27.**

Match the code snippet with it's type.

| | |
|---|---|
| ✓ Machine code | 01101010 |
| ✓ general purpose or high level programming language | int myInt = 8; |
| ✗ Assembly language | MOV r24, 8 |
| ✗ Operand or register/data | r4, 29 |

1/2p

**28.**

a) Identify the error in the following SQL query and provide the correct version: SELECT * FROM users WHERE age = '20';

Answer:

> When looking for a number in SQL, you should not use quotations around number values, whereas here they have put quotations around the '20' signifying that it is a string instead of a number. To fix this, the SQL query should be: SELECT * FROM users WHERE age=20.

48 words

1/1p

b) Fix the syntax error in the following SQL statement: INSERT INTO students VALUES (1, 'John', 'Doe',);

Answer:

> In this SQl statement, the values are not mapped to any column labels, resulting in the query not being able to identify where 1, "John" and "Doe" are meant to be under.

32 words

0/1p

c) What is wrong with this SQL query? UPDATE products SET price = '19.99' WHERE id = 5;

Answer:

> there should be no quotations around 19.99

8 words

0.5/1p

d) Identify the mistake in this SQL statement: SELECT name, age FROM employees WHERE age > '30';

Answer:

> Similarly to part A, there should be no quotations around the numbers when trying to use operators. Checking age > '30' is invalid as '30' is recognised as a string rather than an integer value. Thus, to fix this, the correct statement should be SELECT name, age FROM employees WHERE age > 30.

51 words

1/1p

**29.**

The K-Nearest Neighbours (KNN) algorithm is used to classify a new data point by comparing it to existing classified/labelled data points. It calculates the Euclidean distance between the new data point (shown as a question mark on the chart below) and every other point in the training data. It then counts the labels of the k closest points. The most common label among these neighbours is the predicted label assigned to the new point.
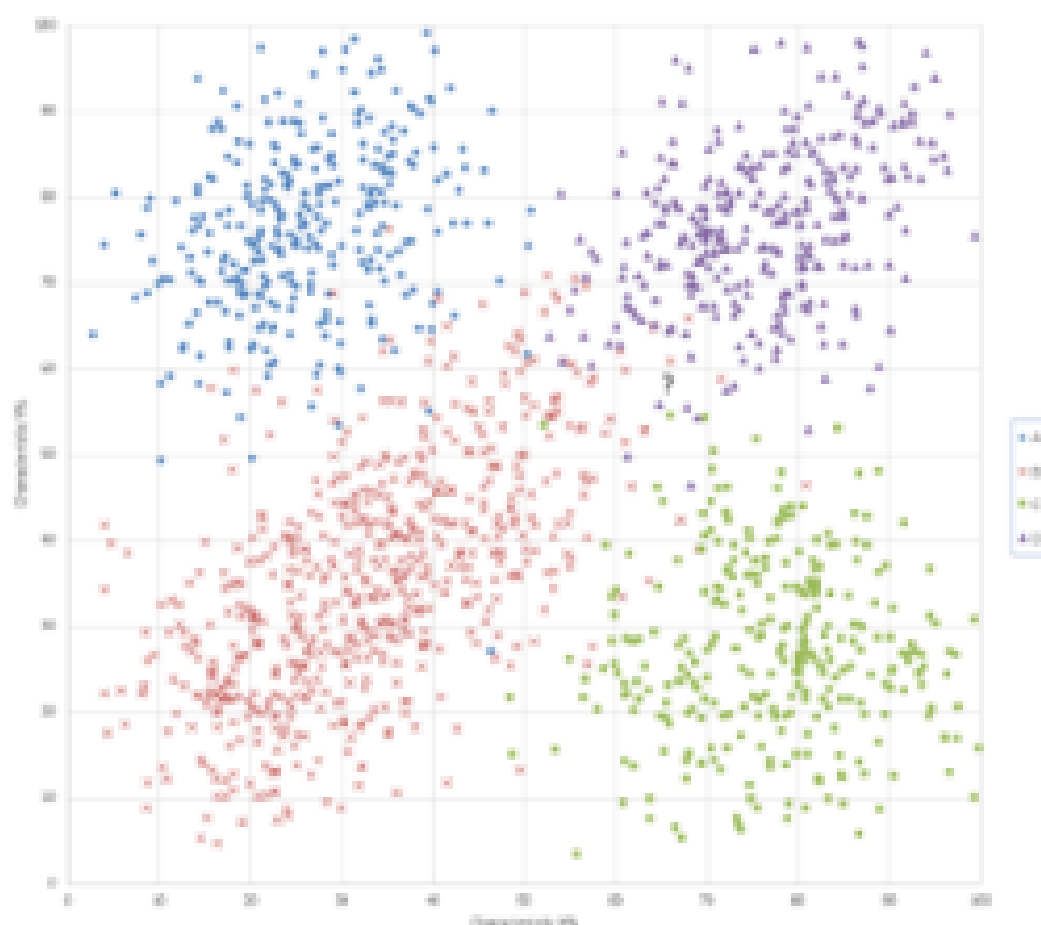


Write a pseudocode algorithm for a function called knn. It is passed:

- newPoint: the x and y coordinates of the point to classify as A, B, C or D
- tData: an array of x and y coordinates for all labelled points
- tLabels: an array of strings with the label A, B, C or D for each known point
- k: an integer

You may use the following pre-defined functions in your algorithm:

- distance(p1, p2): returns the Euclidian distance between two (x, y) points
- sort(pairlist): sorts an array of [distance, label] pairs in ascending order by distance
- mode(array): returns the label that occurs most frequently in an array

Your algorithm should return the predicted label for the new data point.

**Answer:**

```
FUNCTION knn(newPoint, tData, tLabels, k)
   SET length = len(tData)
   SET pairlist = []
   FOR index = 0 TO length STEP 1
      SET x, y = tData[index]
      SET dist = distance(x, y)
      SET label = tLabels[index]
      SET pair = [dist, label]
      ADD pair TO pairlist
   SET newlist = sort(pairlist)
   SLICE newlist UP TO INDEX k-1
   SET label_array = []
   FOR pair IN newlist
      ADD pair[1] TO label_array
   RETURN mode(label_array)
```

68 words

3/4p

**Feedback**

The algorithm correctly outlines the fundamental steps of KNN—calculating distances, sorting, and finding the mode of the k nearest neighbors. It's easy to read and logically sound. However, the pseudocode has a couple of minor flaws. The distance calculation distance(x, y) is incorrect; it should be between the newPoint and tData[index]. Additionally, the line SET x, y = tData[index] assumes a two-dimensional dataset, which isn't always the case for KNN. A more general approach would be better.

**30.**

Your friends have asked you for a simple program to convert their results to a band where:

- Band 6 = 90 - 100 marks.
- Band 5 = 80 - 89 marks.
- Band 4 = 70 - 79 marks.
- Band 3 = 60 - 69 marks.
- Band 2 = 50 - 59 marks.
- Band 1 = 0 - 49 marks.

Write a Python CLI program where students input their grade for atleast 4 different subjects and the program outputs:

- a Band for each subject along with subject name
- calculate the average or overall marks and Band
- print the average/overall marks and band.

Your program must demonstrate efficient logic, validations where appicable, intrinsic documentation, loop/repition for multiple students.

Attach your program to this question.

**Answer:**

No student answer.

7.5/8p

```python
PYTHON
scores = {
    "Math": 96,
    "Science": 93,
    "English": "80", #Demonstrating Input Validation
    "Software": 95,
    "Art": "N", #Demonstrating error handling
    "Tech": 1000 #Demonstrating validation
}

def check_band(score):
    try:
        integ = int(score) # Converting strings to integers
        if integ < 50 and integ >= 0:
            return 1
        elif integ < 60:
            return 2
        elif integ < 70:
            return 3
        elif integ < 80:
            return 4
        elif integ < 90:
            return 5
        elif integ < 100:
            return 6
        else:
            return "Not a valid score"
    except ValueError:
        return "Not an integer"
valid_scores = []
for subject, score in scores.items():
    band = check_band(score)
    print(subject + ": " + str(band))
    try:
        integ = int(score)
        if integ <= 100:
            valid_scores.append(integ)
    except ValueError:
        continue

total = sum(valid_scores)
avg = total/len(valid_scores)
avg_band = check_band(avg)
print("Average: " + str(avg))
print("Average Band: " + str(avg_band))
```

**Feedback**

This is a well-written and effective program that showcases strong programming fundamentals. You've correctly used a dictionary for your data, defined a function to encapsulate specific logic, and implemented robust error handling with a try...except block to manage non-numeric inputs. Your code also correctly handles input validation by checking for scores outside the valid 0-100 range. The program successfully iterates through the data, processes only the valid scores to calculate an average, and then correctly determines the average band. While the program is excellent, the logic for the check_band function has a slight flaw: it will never return a band 6 for a score of exactly 90 because the condition is integ < 100, which is a correct grade band. It would be better to change the condition to integ <= 100 to be more inclusive of a perfect score. Additionally, the average band calculation could be simplified by using a single try...except block instead of two.