Government of **Western Australia**
School Curriculum and Standards Authority

Additional Syllabus Support Booklet

Computer Science
ATAR Years 11 and 12

Acknowledgement of Country

Kaya. The School Curriculum and Standards Authority (the Authority) acknowledges that our offices are on Whadjuk Noongar boodjar and that we deliver our services on the country of many traditional custodians and language groups throughout Western Australia. The Authority acknowledges the traditional custodians throughout Western Australia and their continuing connection to land, waters and community. We offer our respect to Elders past and present.

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Contents

Purpose

This document is intended to support the delivery of the Year 11 and Year 12 Computer Science Australian Tertiary Admission Rank (ATAR) syllabuses. It contains conventions, standards, specifications and examples to provide teachers and students with clarity relating to the expected depth of teaching of some relevant content points in each syllabus.

Programming

Python is the prescribed programming language for the Computer Science ATAR course and will be used in ATAR examination questions related to programming.

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Conventions for writing pseudocode

Although there is no specific format for writing pseudocode, the following conventions should be used in this course.

- Use capital letters for keywords.
- Indent lines of code to show the structure of the code and identify control structures; for example, commands in a loop should be indented.
- The end of structural elements and control structures should be explicitly indicated; for example, IF…END IF.
- Use the symbol = (a single equal sign) to indicate an assignment statement.
- Use the symbol == (two equal signs) to indicate a comparison statement.
- Initialise all variables at the start of each module.
- Clearly indicate constants using the CONST keyword.
- Clearly indicate global variables using the GLOBAL keyword.

Common commands for writing pseudocode

Command	Pseudocode
User input	INPUT(num)
User output	PRINT(“Hello world!”)
Assignment	=
Equals (comparison)	==
Not equal to	!=

Command	Pseudocode
Greater than	>
Greater than or equal to	>=
Less than	<
Less than or equal to	<=
Integer division	DIV or // e.g. 7 // 2 = 3
Modulus (remainder)	MOD or % e.g. 7 % 2 = 1
OR	x < 1 OR x > 10
AND	x > 1 AND x < 10

Arrays	scores = []
	scores[0] = 15
	scores[1] = 16
	scores.append(12) # add element to end of array
	scores.length # gives the number of elements in an array

Dictionaries	costOfGear = {
	“mask”: 2,
	“wetsuit: 5,
	“BCD”: 5,
	“tank”: 5
	}
	costOfGear[“fins”] = 2 # add new key:value pair
	costOfGear[“wetsuit”] = 6 # update value of wetsuit
	cost = costOfGear[“mask”] # value of cost will be 2
	costOfGear.keys # list of all keys in the dictionary
	costOfGear.values # list of all values in the dictionary
	costOfGear.items # list of all key/value pairs in the dictionary

Programming control structures

Structure	Example

Sequence:	INPUT(num1)
	INPUT(num2)
	product = num1 * num2
	PRINT(product)

One-way selection:
IF condition THEN
do something
END IF
	speed = 50
	IF speed > 50 THEN
	PRINT(“You are speeding”)
	END IF

Two-way selection:
IF condition THEN
do something
	speed = 50
	IF speed > 50 THEN

Structure	Example

ELSE
        do something
END IF
	PRINT(“You are speeding”)
	ELSE
	        PRINT(‘You are not speeding”)
	END IF

Multi-way selection:
Method 1 – IF…ELSE IF…ELSE
IF condition THEN
        do something
ELSE IF condition THEN
        do something
ELSE
        do something
END IF
Method 2 – CASE statement
CASE value OF
        choice 1: do something
        choice 2: do something
        OTHERWISE: do something
END CASE
	Method 1 – IF…ELSE IF…ELSE
	speed = 50
	IF speed < 20 THEN
	        PRINT(“You are going too slow”)
	ELSE IF speed > 50 THEN
	        PRINT(‘You are speeding”)
	ELSE
	        PRINT(‘You are not speeding”)
	END IF
	Method 2 – CASE statement
	colour = ‘red’
	CASE colour OF
	        ’red’: PRINT(“Stop”)
	        ‘yellow’: PRINT (“Slow down”)
	        ‘green’: PRINT(“Go”)
	        OTHER: PRINT(“Incorrect colour”)
	END CASE

Test-first loop (WHILE)
WHILE condition is True
        do something
END WHILE
	num = 0
	WHILE num < 10
	        PRINT(“The number is “ + num)
	        num = num + 1
	END WHILE

Test-last loop (REPEAT UNTIL) REPEAT do something UNTIL condition I True	REPEAT INPUT(Age) UNTIL (Age >= 6) AND (Age <= 17) PRINT (Age)

Fixed loop (FOR)
FOR variable = start TO finish [STEP increment]
        do something
END FOR
	FOR num = 1 TO 10
	        PRINT(“The number is “ + num)
	END FOR
	
	FOR num = 10 TO 1 STEP –1
	        PRINT(num)
	END FOR
	PRINT("Blast off!”)

Structure	Example

	FOR num = 1 TO 100 STEP 10
	    PRINT(“The number is “ + num)
	END FOR

Modularisation

Modularisation is a methodology that involves breaking a problem down into smaller, less complex parts. Benefits of modularisation include:

- it allows code to be reused and reduced code repetition
- it allows more people to work on a project – each person can work on separate modules
- it breaks a large complex problem down into smaller problems to make it easier to solve
- it makes it easier to read algorithms and programs
- it makes it quicker and easier to find errors.

As in most modern programming languages, there is no distinction made between modules and functions in the ATAR syllabus – the two terms can be used interchangeably in pseudocode. When a value needs to be returned from a module, then the RETURN keyword should be used.

Good programming practice suggests that a function should perform a single task, and where necessary return a single value using the RETURN keyword. The use of reference parameters in place of returning a value from a function should be avoided wherever possible.

Without Modularisation	With Modularisation

FUNCTION Main
    INPUT(length)
    INPUT(height)
    area1 = length * height
 	
    INPUT(length)
    INPUT(height)
    area2 = length * height
 	
    INPUT(length)
    INPUT(height)
    area3 = length * height
 	
    total = area1 + area2 + area3
 	
    PRINT(“The total area is”, total)
END Main
	FUNCTION Main
	    INPUT(length)
	    INPUT(height)
	    area1 = CalculateArea(length, height)
	
	    INPUT(length)
	    INPUT(height)
	    area2 = CalculateArea(length, height)
	
	    INPUT(length)
	    INPUT(height)
	    area3 = CalculateArea(length, height)
	
	    total = area1 + area2 + area3
	    PRINT(“The total area is”, total)
	END Main
	
	FUNCTION CalculateArea(length, height)
	    area = length * height
	    RETURN area
	END CalculateArea

The code on the left repeats the same lines of code three times where it calculates the area based on the length and height. The code on the right reduces this repetition by moving those lines of code to a separate module.

Parameters

We use parameters to pass values between functions. There are two types of parameters.

- **Value parameters**: a copy of the actual data is passed to the function that is being called. Any changes to the parameter inside the function do not affect the original value.
- **Reference parameters**: a pointer to the variable's memory location is passed to the function being called. Any changes to the parameter cause the original value to be changed.

In most programming languages, simple data types will be passed by value, and complex data types (such as arrays and records) will be passed by reference.

To indicate a parameter is a reference parameter, it is suggested that the REF keyword is used. A reference parameter would be used when passing a variable that could be quite large (such as a list of objects). For example:

```
FUNCTION DoSomethingToMyList(REF bigList)

END DoSomethingToMyList

aReallyBigList = [obj1, obj2, … , obj1000]

DoSomethingToMyList(aReallyBigList)
```

Object-oriented programming

Object-oriented programming (OOP) programs are based around the data that is needed and the operations that need to be performed on that data, rather than the procedural logic of the program.

Classes: user-defined template that represents an object. This defines the attributes of each object and the methods that can be performed.

Objects: specific instances of a class using data for that instance.

Attributes: data stored about each object that show the current state of the object.

Methods: functions defined in the class that define the behaviours of the object.

Creating a new class

```
CLASS Animal
    Attributes:
        name
        hunger = 5
        food_list = []

    Methods:
        FUNCTION Animal(new_name)
            name = new_name
        END Animal

        FUNCTION eat(food)
            result = ""
            IF food IN food_list
                result = "Not hungry"
                IF hunger > 0
                    hunger = hunger - 1
                    result = "That was yummy"
                END IF
            ELSE
                result = "I don't like that food"
            END IF
            RETURN result
        END eat

        FUNCTION is_hungry()
            RETURN hunger > 0
        END is_hungry
END Animal
```

Instantiating and using an object:

Instantiation refers to creating a specific object from a class that can be used in your program.

```
horse = new Animal(“Silver”) #Creates a horse with the name
"Silver"horse.food_list.append(“grass”)  # Will add grass to the food_list
```

```
horse.eat("potato")              # Will return "I don't like that food"
```

Inheritance

One of the powerful features of OOP is that it allows the programmer to easily re-use code by classifying objects and inheriting common features from a base class. For example, a dog is a type of animal that has the base attributes of hunger and food_list. The Dog class sets a default food_list specific to dogs and adds two new attributes, has_fur and legs.

```
CLASS Dog : Animal
    Attributes:
        has_fur = True
        legs = 4
        food_list = ["meat", "bones"]

    Methods:
        FUNCTION bark()
            RETURN name + "is barking"
        END

        FUNCTION number_of_legs()
            RETURN legs
        END number_of_legs
END Dog

CLASS Fish : Animal
    Attributes:
        has_fins = True
        food_list = ['algae', 'plankton']

    Methods:
        FUNCTION swim()
            RETURN name + 'is swimming'
        END swim
END Fish

Fido = new Dog()
PRINT(fido.number_of_legs())

Goldie = new Fish()
PRINT(goldie.has_fins)
```

Common algorithms

Arrays

Load an array

```
FUNCTION LoadArray
    name = “”
    i = 0
    names = []
    PRINT(“Enter a name: ”)
    INPUT(name)
    WHILE name != “”
        names[i] = name
        i = i + 1
        INPUT(name)
    END WHILE
    PRINT(“There were”, i, “names entered.”)
END LoadArray
```

Print contents of an array

```
FUNCTION PrintArray
    names = [“Peter”, “Jane”, “Hugo”, “Kai”, “Sally”, “Arman”]
    FOR i = 0 TO names.length – 1
        PRINT names[i]
    END FOR
END PrintArray
```

Add contents of an array

```
FUNCTION AddArray
    numbers = [4, 8, 23, 52, 3, 27, 86]
    total = 0
    FOR i = 0 TO numbers.length – 1
        total = total + numbers[i]
    END FOR
    PRINT(total)
END AddArray
```

Minimum value in array

```
FUNCTION FindMinimumValue
    numbers = [4, 8, 23, 52, 3, 27, 86]
    min = numbers[0]
    minIndex = 0
    FOR i = 1 TO numbers.length – 1
        IF numbers[i] < min THEN
            min = numbers[i]
            minIndex = i
        END IF
    END FOR
    PRINT(“The minimum value is”, min)
    PRINT(“The minimum value is at position”, minIndex)
END AddArray
```

Maximum value in array

```
FUNCTION FindMaximumValue
    numbers = [4, 8, 23, 52, 3, 27, 86]
    max = numbers[0]
    maxIndex = 0
    FOR i = 1 TO numbers.length – 1
        IF numbers[i] > max THEN
            max = numbers[i]
            maxIndex = i
        END IF
    END FOR
    PRINT(“The maximum value is”, max)
    PRINT(“The maximum value is at position”, maxIndex)
END AddArray
```

File processing

```
FUNCTION ReadFile
    myfile = OPEN_READ(“data.txt”)
    lines = []
    WHILE NOT myfile.EOF
        line = myfile.READLINE()
        lines.append(line)
    END WHILE
    CLOSE(myfile)
END ReadFile

FUNCTION WriteFile
    myfile = OPEN_WRITE(“ouputfile.txt”)
    lines = [“Twinkle Twinkle Little Star”, “Baa Baa Black Sheep”, “Hickory Dickory Dock”]
    FOR i = 0 TO (lines.length – 1)
        myfile.WRITELINE(lines[i])
    END FOR
    CLOSE(myfile)
END WriteFile

FUNCTION AppendFile
    myfile = OPEN_APPEND(“names_file.txt”)
    names = [“James Smith”, “Aaron Jones”, “Sally Gonzales”]
    FOR i = 0 TO (names.length – 1)
        myfile.WRITELINE(names[i])
    END FOR
    CLOSE(myfile)
END WriteFile
```

Search algorithms

Linear search

The linear search will go through an array and check each element for the target until it is found. If it does not find the target, it will move through the array until the end.

The algorithm below will return the index of the target element if it is found. If the target element is not found it will return -1.

```
FUNCTION LinearSearch(searchArray, target)
    index = 0
    position = -1
    WHILE index < searchArray.length AND position == -1
        IF searchArray[index] = target THEN
            position = index
        END IF
        index = index + 1
    END WHILE
    RETURN position
END LinearSearch
```

Binary search

The binary search works by comparing the middle element of an array to the target element. If a match is not found, then the element array is split into two. If the element is less than the middle element, then the sub-array continues the search until the numbers can be split.

Note: The binary search requires the array to be sorted to work properly.

```
FUNCTION BinarySearch(searchArray, target)
    position = -1
    lowerBound = 0
    upperBound = searchArray.length – 1
    WHILE lowerbound <= upperBound AND position == -1
        midpoint = (lowerBound + upperBound) / 2
        IF searchArray[midpoint] < target THEN
            lowerBound = midpoint + 1
        ELSE IF searchArray[midpoint] > target THEN
            upperBound = midpoint – 1
        ELSE
            position = midpoint
        END IF
    END WHILE
    RETURN position
END BinarySearch
```

Sort algorithms

Bubble sort

```
FUNCTION BubbleSort(arrayToSort)
    last = arrayToSort.length - 1
    swapped = TRUE
    WHILE swapped
        swapped = FALSE
        i = 0
        WHILE i < last
            IF arrayToSort [i] > arrayToSort [i + 1] THEN
                temp = arrayToSort [i]
                arrayToSort [i] = arrayToSort [i + 1]
                arrayToSort [i + 1] = temp
                swapped = TRUE
            END IF
            i = i + 1
        END WHILE
        last = last - 1
    END WHILE
    RETURN arrayToSort
END BubbleSort
```

Insertion sort

```
FUNCTION InsertionSort(arrayToSort)
    position = 0
    WHILE position < arrayToSort.length
        currentValue = arrayToSort[position]
        sortedPosition = position - 1
        WHILE sorted  position >= 0 and arrayToSort[sortedPosition] > currentValue
            arrayToSort[sortedPosition + 1] = arrayToSort[sortedPosition]
            sortedPosition = sortedPosition - 1
        END WHILE
        arrayToSort[sortedPosition + 1] = currentValue
        position = position + 1
    END WHILE
    return arrayToSort
END InsertionSort
```

Selection sort

```
FUNCTION SelectionSort(arrayToSort)
    unsortedIndex = arrayToSort.length – 1
    WHILE unsortedIndex > 0
        i = 0
        max = arrayToSort[i]
        maxIndex = i
        WHILE i <= unsortedIndex
            i = i + 1
```

```
                IF arrayToSort[i] > max THEN
                    max = arrayToSort[i]
                    maxIndex = i
                END IF
            END WHILE
            temp = arrayToSort[maxIndex]
            arrayToSort[maxIndex] = arrayToSort[unsortedIndex]
            arrayToSort[unsortedIndex] = temp
            unsortedIndex = unsortedIndex - 1
        END WHILE
        RETURN arrayToSort
    END SelectionSort
```

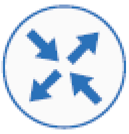
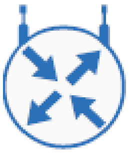
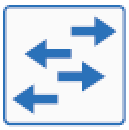
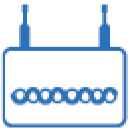
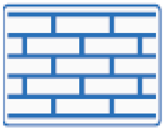
Network communications

Key protocols associated with layers in models

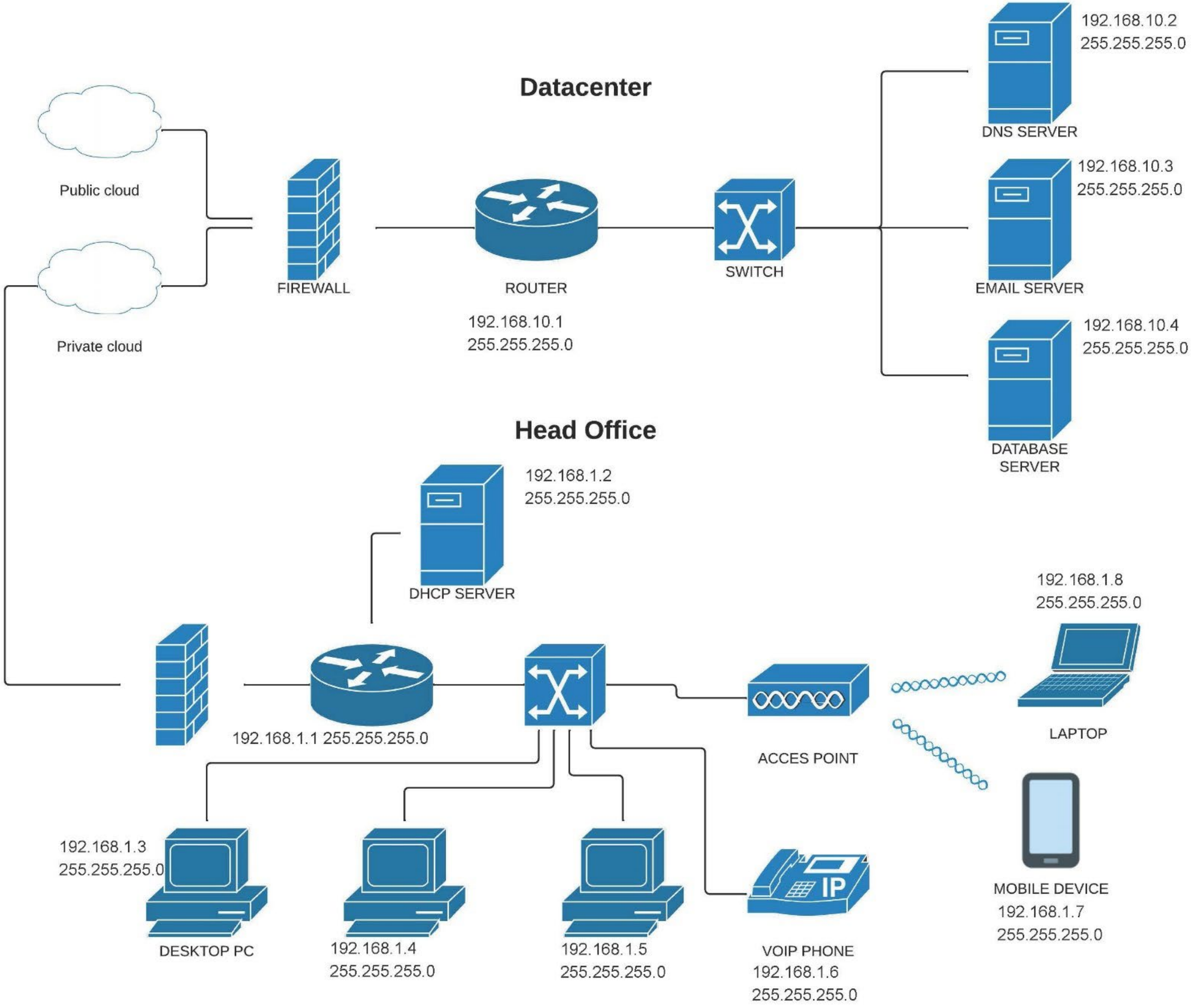
The following table shows some of the key protocols associated with the different layers of the Department of Defence Transfer Communication Protocol/Internet Protocol (DoD TCP/IP) model.

DoD TCP/IP model	OSI model	Key protocols
Application	Application	SMTP, FTP, HTTP, HTTPS, DHCP, DNS, PING
	Presentation	
	Session	
Transport	Transport	TCP & UDP
Internet	Network	IPV6, IPv4, ARP
Network	Data Link	Ethernet (802.3), Wi-Fi (802.11)
	Physical	

Network diagram conventions (CISCO)

Router	Wired 	Wireless 
Switch		
Wireless access point		
Firewalls		

Network diagram example:



Cyber security

Types of malware

- Ransomware
- Viruses
- Rootkits
- Spyware
- Backdoors
- Phishing

Common methods of encryption

Early methods and weaknesses

- **Substitution cipher** swaps out characters. Assuming 26 alphabet characters, it is easily broken using character frequency.
- **Vigenère cipher** uses a repeated key combing plain text with the key. Easily broken if we know the length of the key and use the character frequency method similar to the substitution cipher.
- **Mechanical encryption** such as the World War II (WW2) Enigma machine. Each mechanical method had its own weakness. The Enigma's weakness was it never encrypted a letter as itself.
- **Data Encryption Standard (DES)** was the first digital encryption standard used a key size of 56 bits. That is small compared to today's standards and is quickly cracked with fast processing speeds available today.
- **Advanced Encryption Standard (AES)** replaced DES as the commonly used method of encryption. It uses 128, 192 and 256 bits and is yet to be cracked.

DES and AES use symmetric keys, which means the key used to encrypt is the same key to decrypt. This is a problem if you need to securely communicate with someone who does not have the private key. **RSA (Rivest–Shamir–Adleman)** encryption solves the problem with asymmetric encryption – data is encoded with a public key that is then decrypted using a private key. It is very slow compared to AES, so it's often used to securely communicate the private AES key. RSA uses 2048–4096 key sizes and works using a key produced by an algorithm using two prime numbers.

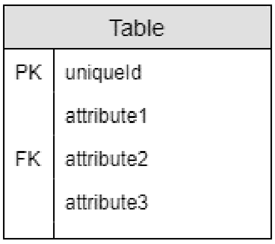
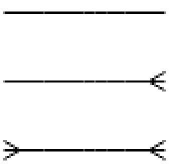
Current best practice

- Secure your private key – a stolen key means your data is no longer secure. Ensure only those who need the key are able to access it.
- Back up your key – a lost key means lost data as it will be permanently encrypted.
- Use longer length keys to ensure brute force cracking is harder.
- Use audit logs to check if keys been accessed by unauthorised users.
- Best practice is that users should encrypt any messages, critical or sensitive files they send. This extends to the encryption of storage devices in case they fall into the wrong hands.
- Best practice is based upon the guidelines from NIST: (National Institute of Standards and Technology) https://csrc.nist.gov/Projects/cryptographic-standards-and-guidelines.

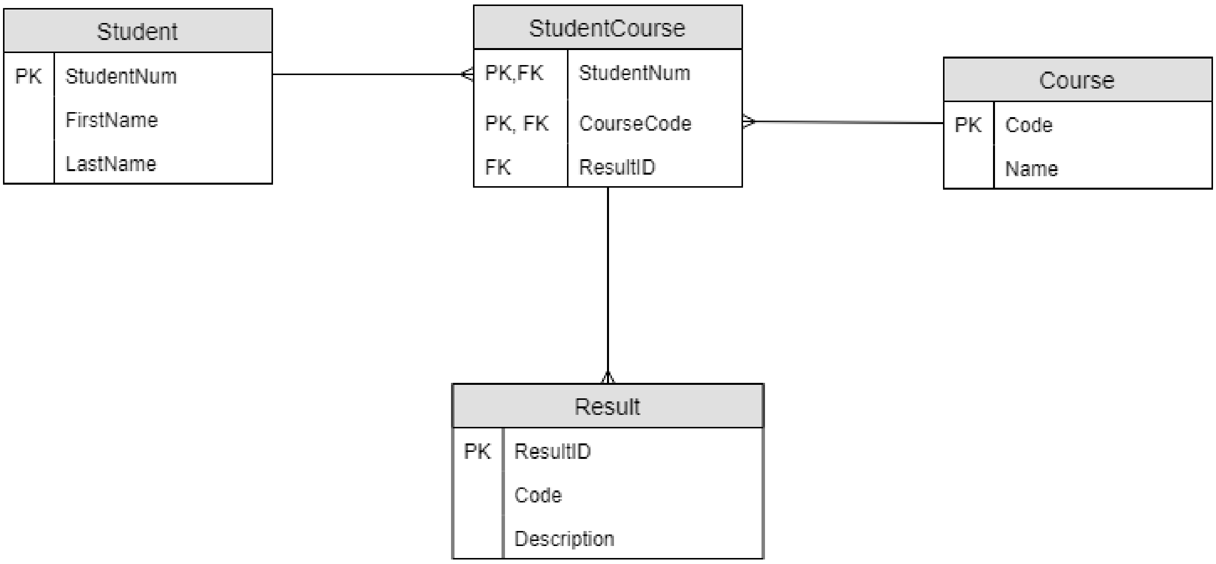
Data management

Entity relationship diagrams

An Entity relationship (ER) diagram provides a graphical representation of the relationships between the entities in a database. In this course, ER diagrams are to be drawn using crow's foot notation as shown below.

Entity and attributes	Relationships between entities
 Table PK uniqueId attribute1 FK attribute2 attribute3	 One to one One to many Many to many

ER diagram example



Data dictionaries

Data dictionaries provide metadata that describes the attributes of data to be stored in a database.

Fields include:

Element Name	Data Type	Size	Description	Constraints

Data dictionary example

Element Name	Data Type	Size	Description	Constraints
StudentNum	Integer		Unique identifier for student	Must be unique and not null
GivenName	Text	20	Student’s given name	Not null
FamilyName	Text	20	Student’s family name	Not null

NOTE: Description should include a brief description of the data being stored, the format of the data and the default value if applicable.

Normalisation

Normalisation is the process of identifying and eliminating data anomalies and redundancies, thereby improving data integrity and efficiency for storage in a relational database. This process is designed to remove repeated data and improve database design.

Data Anomalies

Consider the data in the table below. This unnormalised data can cause problems when data is updated, added or deleted.

Student Number	Given Name	Family Name	Email	Course	Course Name
10010504	David	Rossi	drossi@student.edu.au	MATH1001	Mathematics 1A
10010504	David	Rossi	drossi@student.edu.au	COMP1001	Computing 1A
10010504	David	Rossi	drossi@student.edu.au	MATH1002	Mathematics 1B
24352494	Debbie	Tainton	dtainton@student.edu.au	MATH1002	Mathematics 1B
24352494	Alison	Roach	aroach@student.edu.au	MATH2001	Mathematics 2B

Update anomaly

An update anomaly occurs when you try to update data that is stored in multiple locations. If all records are not updated, then data could become inconsistent and/or inaccurate. For example, if David Rossi updates his email address, then all three occurrences need to be updated

Delete anomaly

A delete anomaly occurs when by deleting one piece of data you delete the only instance of another piece of data. For example, if Alison Roach was removed from the database, then we would also lose all the information about the subject Mathematics 2B.

Insert anomaly

An insert anomaly occurs when data cannot be added because only part of the data is available. For example, if a new subject is added, but no student allocated, then we would be unable to add the subject as we would not have all the necessary information to create a new record.

Normalisation to 3NF (3rd Normal Form)

Steps to normalisation of data:

1. ensure data is in the form of a relation
2. convert data to 1NF (1st Normal Form)
3. convert data to 2NF (2nd Normal Form)
4. convert data to 3NF (3rd Normal Form).

Converting data to a relation

For data to be in the form of a relation:

1. it must have no repeated attributes
2. all cells must be atomic (that is, they must only contain a single piece of data).

Repeated Fields

The following table is **not** in the form of a relation as it has repeating fields – the Course field is repeated multiple times.

Student Number	Given name	Family name	Course 1	Course 2	Course 3
10010504	David	Rossi	MATH1001	COMP1001	MATH1002
24352494	Debbie	Tainton	MATH1001		

Non-atomic Field

The following table is **not** in the form of a relation as one of the fields is not atomic – the Course field for David Rossi has information about three different courses.

Student Number	Given name	Family name	Course
10010504	David	Rossi	MATH1001, COMP1001, MATH1002
24352494	Debbie	Tainton	MATH1001

Relation

The following table **is** in the form of a relation as all fields are atomic and there are no repeating fields. This data is not normalised and would not make a good database structure, but we can now start the process of normalisation.

Relation example

Student Number	Given name	Family name	Email	Course	Course Name
10010504	David	Rossi	drossi@student.edu.au	MATH1001	Mathematics 1A
10010504	David	Rossi	drossi@student.edu.au	COMP1001	Computing 1A
10010504	David	Rossi	drossi@student.edu.au	MATH1002	Mathematics 1B
24352494	Debbie	Tainton	dtainton@student.edu.au	MATH1002	Mathematics 1B
24352494	Alison	Roach	aroach@student.edu.au	MATH2001	Mathematics 2B

Process of normalisation:

1NF (1st Normal Form)

To be in 1st Normal Form, we must:

1. ensure that all fields are atomic
2. remove all repeating attributes.

Each relation that is formed will have a primary key. Primary keys are indicated with the use of underlining the attribute. Foreign key (FK) attributes are indicated with the use of FK. The relation formed from the non-repeating attributes will have a foreign key to the relation formed from the repeating attributes. The primary key for the relation for the non-repeating fields will now be a composite key comprising the primary key from the non-repeating relation and the repeating relation.

2NF (2nd Normal Form)

To be in 2nd Normal Form, we must:

1. be in 1NF
2. have no partial dependencies.

Partial dependencies occur when a non-key attribute is only dependent on part of the composite key. If a relation does not have a composite key (that is, the primary key is made up of a single attribute) then it must already be in 2NF.

3NF (3rd Normal Form)

To be in 3rd Normal Form, we must:

1. be in 2NF
2. have no transitive dependencies.

All non-key fields in a relation must be fully functionally dependent on nothing but the primary key. Transitive dependencies occur when a non-key field is dependent on a field other than the primary key.

Normalisation example

Relation

Student Number	Given name	Family name	Course	Course Name	Result	Result Description
10010504	David	Rossi	MATH1001	Mathematics 1A	A	Highly Skilled
10010504	David	Rossi	MATH1002	Mathematics 1B	B	Skilled
10010504	David	Rossi	COMP1001	Computing 1A	A	Highly Skilled
10020423	James	Stanton	MATH1001	Mathematics 1A	C	Competent
10020423	James	Stanton	COMP1001	Computing 1A	C	Competent
23521461	Debbie	Tainton	MATH1001	Mathematics 1A	B	Skilled
23521461	Debbie	Tainton	MATH1002	Mathematics 1B	A	Excellent
23521461	Debbie	Tainton	COMP1001	Computing 1A	A	Excellent
24352494	Alison	Roach	MATH1002	Mathematics 1B	C	Competent
24352494	Alison	Roach	COMP1001	Computing 1A	A	Excellent

This can be written using relational notation:

Student Results(Student Number, Given Name, Family Name, Course, Course Name, Results, Result Description)

Convert to 1NF

Firstly, check that all attributes are atomic. Then, remove all repeating attributes and place them in another relation.

Student Number	Given name	Family name
10010504	David	Rossi
10020423	James	Stanton
23521461	Debbie	Tainton
24352494	Alison	Roach

Student Number	Course	Course Name	Result	Result Description
10010504	MATH1001	Mathematics 1A	A	Highly Skilled
10010504	MATH1002	Mathematics 1B	B	Skilled
10010504	COMP1001	Computing 1A	A	Highly Skilled
10020423	MATH1001	Mathematics 1A	C	Competent
10020423	COMP1001	Computing 1A	C	Competent
23521461	MATH1001	Mathematics 1A	B	Skilled
23521461	MATH1002	Mathematics 1B	A	Excellent
23521461	COMP1001	Computing 1A	A	Excellent
24352494	MATH1002	Mathematics 1B	C	Competent
24352494	COMP1001	Computing 1A	A	Excellent

This can be written using relational notation:

Student(Student Number, Given Name, Family Name)

StudentCourse(Student Number FK, Course FK, Course Name, Result, Result Description)

Convert to 2NF

Check for and remove any partial dependencies. Partial dependencies will only occur in a relation that has a composite key, so Student is already in 2NF.

Student Number	Given name	Family name
10010504	David	Rossi
10020423	James	Stanton
23521461	Debbie	Tainton
24352494	Alison	Roach

Course	Course Name
MATH1001	Mathematics 1A
MATH1002	Mathematics 1B
COMP1001	Computing 1A

Student Number	Course	Result	Result Description
10010504	MATH1001	A	Highly Skilled
10010504	MATH1002	B	Skilled
10010504	COMP1001	A	Highly Skilled
10020423	MATH1001	C	Competent
10020423	COMP1001	C	Competent
23521461	MATH1001	B	Skilled
23521461	MATH1002	A	Excellent
23521461	COMP1001	A	Excellent
24352494	MATH1002	C	Competent
24352494	COMP1001	A	Excellent

This can be written using relational notation:

Student(Student Number, Given Name, Family Name)

Course(Course, Course Name)

StudentCourse(Student Number FK, Course FK, Result, Result Description)

Convert to 3NF

Finally, check there are no transitive dependencies. In this case, the result description is dependent on the result, not the course.

Student Num	Given name	Family name
10010504	David	Rossi
10020423	James	Stanton
23521461	Debbie	Tainton
24352494	Alison	Roach

Course	Course Name
MATH1001	Mathematics 1A
MATH1002	Mathematics 1B
COMP1001	Computing 1A

Student Number	Course	Result
10010504	MATH1001	A
10010504	MATH1002	B
10010504	COMP1001	A
10020423	MATH1001	C
10020423	COMP1001	C
23521461	MATH1001	B
23521461	MATH1002	A
23521461	COMP1001	A
24352494	MATH1002	C
24352494	COMP1001	A

Result	Result Description
A	Highly Skilled
B	Skilled
C	Competent

This can be written using relational notation:

Student(<u>StudentNum</u>, Given Name, LastName)

Course(<u>Course</u>, CourseName)

StudentCourse(<u>StudentNum</u> FK, <u>Course</u> FK, Result FK)

Result(<u>Result</u>, ResultDescription)

Common SQL

Function	SQL syntax
Create table	CREATE TABLE name (pk INTEGER PRIMARY KEY, field1 type NOT NULL, field2 type NULL, …)
Select all data	SELECT * FROM table

Select specific fields	SELECT field1, field2, field3
	FROM table

Select matching rows	SELECT field1, field2
	FROM table
	WHERE expression

Select data from multiple tables	SELECT table1.field1, table2.field1
	FROM table1, table2
	WHERE table1.pk = table2.fk

Use aggregate functions	SELECT AVG(field1)
	FROM table

Select unique rows	SELECT DISTINCT field1
	FROM table

Sort rows	SELECT field1, field2
	FROM table
	ORDER BY field2 DESC

Group results	SELECT field1, AVG(field2)
	FROM table
	GROUP BY field1

Filter grouped results	SELECT field1, AVG(field2)
	FROM table
	GROUP BY field1
	HAVING expression

Concatenate fields	SELECT field1 || field2, field 3
	FROM table

Remove table from database	DROP TABLE IF EXISTS table

Insert record into table	INSERT INTO table (field1, field2)
	VALUES (value1, value2)

Delete all records from table	DELETE FROM table

Delete specific records from table	DELETE FROM table
	WHERE condition

Change records in a table	UPDATE table
	SET field1 = value
	WHERE expression

Function	SQL syntax	
Comparison operators	=	Equal to
	<> or !=	Not equal to
	<	Less than
	>	Greater than
	<=	Less than or equal to
	>=	Greater than or equal to
Logic operators	ALL	returns TRUE if all expressions are TRUE.
	AND	returns TRUE if both expressions are TRUE, and FALSE if one of the expressions is FALSE.
	ANY	returns TRUE if any one of a set of comparisons is TRUE.
	BETWEEN	returns TRUE if a value is within a range.
	EXISTS	returns TRUE if a subquery contains any rows.
	IN	returns TRUE if a value is in a list of values.
	LIKE	returns TRUE if a value matches a pattern (use with the wildcard characters % and _)
	NOT	reverses the value of other operators such as NOT EXISTS, NOT IN, NOT BETWEEN, etc.
	OR	returns TRUE if either expression is TRUE
Aggregate functions	AVG	calculate the average value
	COUNT	count the number of items in a set
	MAX	find the maximum value
	MIN	find the minimum value
	SUM	calculate the sum of values

Appendices

Python is the prescribed programming language for the Computer Science ATAR course and will be used in ATAR examination questions related to programming.

Control Structure Python Examples

Pseudocode	Python

INPUT(num1)
INPUT(num2)
product = num1 * num2
PRINT(product)
	#sequence
	num1 = int(input("First num: "))
	num2 = int(input("Second num: "))
	product = num1 * num2
	print(product)

speed = 50
IF speed > 50 THEN
    PRINT(“You are speeding”)
END IF
	#selection - IF
	speed = 50
	if speed > 50:
	  print("You are speeding")

speed = 50
IF speed > 50 THEN
    PRINT(“You are speeding”)
ELSE
    PRINT(‘You are not speeding”)
END IF
	#selection - IF ELSE
	speed = 50
	if speed > 50:
	  print("You are speeding")
	else:
	  print("You are not speeding")

Method 1 – IF…ELSE IF…ELSE
speed = 50
IF speed < 20 THEN
    PRINT(“You are going too slow”)
ELSE IF speed > 50 THEN
    PRINT(“You are speeding”)
ELSE
    PRINT(“You are not speeding”)
END IF
	#selection - IF ELIF ELSE
	speed = 50
	if speed < 20:
	  print("You are going too slow")
	elif speed > 50:
	  print("You are speeding")
	else:
	  print("You are not speeding")

Pseudocode	Python

Method 2 – CASE statement
colour = ‘red’
CASE colour OF
’red’: PRINT(“Stop”)
‘yellow’: PRINT (“Slow down”)
‘green’: PRINT(“Go”)
OTHER: PRINT(“Incorrect colour”)
END CASE
	`#selection CASE (match in Python)`
	`colour = "red"`
	`match colour:`
	`case "red":`
	`print("Stop")`
	`case "yellow":`
	`print("Slow down")`
	`case "green":`
	`print("Go")`
	`case other:`
	`print("Incorrect colour")`

num = 0
WHILE num < 10
PRINT(“The number is “ + num)
num = num + 1
END WHILE
	`#Test first loop (while)`
	`num = 0`
	`while num < 10:`
	`print("The number is {num}")`
	`num = num + 1`

REPEAT
INPUT(Age)
UNTIL (Age >= 6) AND (Age <= 17)
PRINT (Age)
	`#Test last loop (repeat until)`
	`#No structure exists to natively implement this in Python, but this is functionally identical`
	`age = input("Age: ")`
	`while age < 6 and age > 17:`
	`age = input("Age: ")`
	`print(age)`

FOR num = 1 TO 10
PRINT(“The number is “ + num)
END FOR
 	
FOR num = 10 TO 1 STEP –1
PRINT(num)
END FOR
PRINT("Blast off!”)
 	
FOR num = 1 TO 100 STEP 10
PRINT(“The number is “ + num)
END FOR
	`#Fixed loops - FOR`
	`for num in range(1,11):`
	`print("The number is: {num}")`
	
	`for num in range(10,0, -1):`
	`print(num)`
	`print("Blast off!")`
	
	`for num in range(1,100,10):`
	`print("The number is {num}")`

Object Oriented Python Examples

```
class Animal:
  name = ""
  hunger = 5
  food_list = []

   #Functions named "__init__" act as constructors in Python
  def __init__(self, new_name):
    name = new_name

   def eat(self, food):
    result = ""
    if food in self.food_list:
      result = "Not hungry"
      if hunger > 0:
        self.hunger = self.hunger - 1
        result = "That was yummy"
    else:
      result = "I don't like that food"
    return result

   def is_hungry(self):
    return self.hunger > 0

horse = Animal("Silver")         #Creates a horse with the name "Silver"
horse.food_list.append("grass")  #Will add grass to the food_list
horse.eat("potato")              #Will return “I don’t like that food”

#To indicate inheritance in Python, the class will receive the parent as a parameter
class Dog(Animal):
  has_fur = True
  legs = 4
  food_list = ["meat", "bones"]

  def bark(self):
    return f"{self.name} is barking"

  def number_of_legs(self):
    return self.legs
class Fish(Animal):
  has_fins = True
  food_list = ["algae", "plankton"]

  def swim(self):
    return f"{self.name} is swimming"

fido = Dog("Fido")
print(fido.number_of_legs())

goldie = Fish("Goldie")
print(goldie.has_fins)
```

Array Examples

```
#Load an array
def LoadArray():
  name = ""
  i = 0
  names = []
  name = input("Enter a name: ")
  while name != "":
    names.append(name)
    i = i + 1
    name = input("Enter a name: ")

  print(f"There were {i} names entered.")

#Print contents of an array
def PrintArray():
  names = ["Peter", "Jane", "Hugo", "Kai", "Sally", "Arman"]
  for i in range(len(names)):
    print(names[i])

#Add contents of an array
def AddArray():
  numbers = [4, 8, 23, 52, 3, 27, 86]
  total = 0

  for i in range(len(numbers)):
    total = total + numbers[i]

  print(total)

#Minimum value in array
def FindMinimumValue():
  numbers = [4, 8, 23, 52, 3, 27, 86]
  min = numbers[0]
  minIndex = 0

  for i in range(len(numbers)):
    if numbers[i] < min:
      min = numbers[i]
      minIndex = i
  print(f"The minimum value is {min}")
  print(f"The minimum value is at position {minIndex}")
```

```
#Maximum value in array
def FindMaximumValue():
  numbers = [4, 8, 23, 52, 3, 27, 86]
  max = numbers[0]
  maxIndex = 0
  for i in range(len(numbers)):
    if numbers[i] > max:
      max = numbers[i]
      maxIndex = i

  print(f"The maximum value is {max}")
  print(f"The maximum value is at position {maxIndex}")
```

File Processing

```
#Note that Python has several methods to open and access files
#These examples have been created to most closely match the provided
pseudocode

def ReadFile():
  myfile = open("data.txt")
  lines = []
  line = myfile.readline()

  while line != "":
    lines.append(line.strip())
    line = myfile.readline()

  myfile.close()

def WriteFile():
  newline = "\n"
  myfile = open("outputfile.txt", "w")

  lines = ["Twinkle Twinkle Little Star", "Baa Baa Black Sheep", "Hickory
Dickory Dock"]

  for i in range(len(lines)):
    myfile.write(lines[i] + newline)

  myfile.close()

def AppendFile():
  newline = "\n"
  myfile = open("names_file.txt", "a")

  names = ["James Smith", "Aaron Jones", "Sally Gonzales"]

  for i in range(len(names)):
    myfile.write(names[i] + newline)

  myfile.close()
```

Search Algorithms

```
def LinearSearch(searchArray, target):
    index = 0
    position = -1
    while index < len(searchArray) and position == -1:
      if searchArray[index] == target:
        position = index
      index = index + 1
    return position
```

```
def BinarySearch(searchArray, target):
    position = -1
    lowerBound = 0
    upperBound = len(searchArray) - 1
    while lowerBound <= upperBound and position == -1:
        midpoint = (lowerBound + upperBound) // 2
        if searchArray[midpoint] < target:
            lowerBound = midpoint + 1
        elif searchArray[midpoint] > target:
            upperBound = midpoint - 1
        else:
          position = midpoint
    return position
```

Sort Algorithms

```
def BubbleSort(arrayToSort):
    last = len(arrayToSort) - 1
    swapped = True
    while swapped:
        swapped = False
        i = 0
        while i < last:
            if arrayToSort[i] > arrayToSort[i + 1]:
                temp = arrayToSort[i]
                arrayToSort[i] = arrayToSort[i + 1]
                arrayToSort[i + 1] = temp
                swapped = True
            i = i + 1
        last = last - 1
    return(arrayToSort)
```

```
def BubbleSort(arrayToSort):
    last = len(arrayToSort) - 1
    swapped = True
    while swapped:
        swapped = False
        i = 0
        while i < last:
            if arrayToSort[i] > arrayToSort[i + 1]:
                temp = arrayToSort[i]
                arrayToSort[i] = arrayToSort[i + 1]
                arrayToSort[i + 1] = temp
                swapped = True
            i = i + 1
        last = last - 1
    return(arrayToSort)
```

```
def InsertionSort(arrayToSort):
    position = 0
    while position < len(arrayToSort):
        currentValue = arrayToSort[position]
        sortedPosition = position - 1
        while sortedPosition >= 0 and arrayToSort[sortedPosition] > 
currentValue:
            arrayToSort[sortedPosition + 1] = arrayToSort[sortedPosition]
            sortedPosition = sortedPosition - 1
        arrayToSort[sortedPosition + 1] = currentValue
        position = position + 1
    return arrayToSort

def SelectionSort(arrayToSort):
    unsortedIndex = len(arrayToSort) - 1
    while unsortedIndex > 0:
        i = 0
        max = arrayToSort[i]
        maxIndex = i
        while i < unsortedIndex:
            i = i + 1
            if arrayToSort[i] > max:
                max = arrayToSort[i]
                maxIndex = i

        temp = arrayToSort[maxIndex]
        arrayToSort[maxIndex] = arrayToSort[unsortedIndex]
        arrayToSort[unsortedIndex] = temp
        unsortedIndex = unsortedIndex - 1
    return arrayToSort
```