University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath

2022/2023 AUTUMN TRIMESTER EXAMINATIONS

COMP30520

Cloud Computing (UG)

Module Coordinator: Dr Dimitrios Chatzopoulos

Student Number

Seat Number

Time Allowed: 120 minutes

Materials Permitted in the Exam Venue:
None

Materials to be Supplied to Students:
12 Page Answer Booklets

Instructions to Students:
This is a closed-book exam. **Answer all the questions.** Please write your answers in the provided answer booklets.

Question 1 – Terminology understanding (35%)

Use up to 100 words to answer each of the following questions.

A) Provide a definition for cloud-native applications (7%).
B) List three characteristics of cloud native applications (7%).
C) List four challenges of cloud native applications (7%).
D) Discuss one of the limitations of cloud computing (7%).
E) Discuss the differences between virtual machines and containers (7%).

Question 2 – Pig Scripting (20%)

Consider the dataset in Table 1, where all the values in columns two to seven are between 0 and 100. Write Pig code that performs each of the following tasks:

Student_ID	CA_1	CA_2	CA_3	CA_4	Essay	Project	Final_exam
SID_i	$ca1_i$	$ca2_i$	$ca3_i$	$ca4_i$	es_i	pr_i	fe_i
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

Table 1: Student grades on course X.

A) Calculate the final grade of each student if each CA counts for 5%, the essay counts for 15%, the project counts for 15% and the final for the rest (5%).
B) Calculate the average final grade without considering the students who had the highest and the lowest project grades. For example, if students with IDs 18 and 27 had the lowest project grade because they didn't submit their work, their final grade should not be considered in this calculation. Similarly, if students with IDs 5 and 17 got full marks on the project, their final grade should not be considered in this calculation too (5%).
C) Calculate the difference between the best submitted project and the worst submitted project of the students whose grade in the final exam was more than 70%. You can assume that any submitted project got a grade greater or equal to 1 (5%).
D) Sort the students based on the difference of their final grade to their essay grade (5%).

Question 3 – Map/Reduce (30%)

Consider two files that store the two different datasets shown at Tables 2 and 3. Table 2 contains information related to patients (i.e., their IDs and age, and where they live), and Table 3 contains information related to general practitioners (i.e., their ID, where they operate and their average waiting time). Additionally, each GP has a maximum capacity of adults and a maximum capacity of children that can be registered on their practice. You are asked to implement an operator, FINDGP(Patient_ID), that returns the GP a patient Patient_ID should register. The goal is to register each patient to the GP who has available capacity and will serve them as fast as possible since they leave their apartment. You can assume that every patient will find a GP in their area. You need to use the Map/Reduce model for your implementation. You can assume that each worker and reducer can call another operator named TRAVELDURATION(Location A, Location B) that returns the time (in minutes) needed to go from one location to another.

$\texttt{Patient}_{ID}$	age	Area Code	Patient Location
P_i	A_i	Area_a	L_x
P_j	A_j	Area_b	L_y
P_k	A_k	Area_c	L_z
P_l	A_l	Area_d	L_w
⋮	⋮	⋮	⋮

Table 2: List of Patients

GP_{ID}	Adults Capacity	Kids Capacity	Adults Registered	Kids Registered	Area Code	GP Location	Average Waiting Time (minutes)
GP_i	AC_i	KC_i	AR_i	KR_i	Area_a	L_x	t_u
GP_j	AC_j	KC_j	AR_j	KR_j	Area_b	L_y	t_v
GP_k	AC_k	KC_k	AR_k	KR_k	Area_c	L_z	t_w
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

Table 3: List of GPs

A) Define the inputs and the outputs of the Map and Reduce functions for this operator (10%).
B) Using MapReduce model, define the mapper and reducer of this operator. Explain your implementation (15%).
C) Assuming that you can use as many mappers and reducers you want and that all the mappers and the reducers have the same computing capabilities, how many mappers and reducers you would use to solve the problem, and why (5%)?

Question 4 – Combining topics (15%)

You are the CTO of a start-up that builds a mobile augmented reality application that is helpful to mobile users who navigate in Dublin. The users of your application see information (also known as virtual objects) rendered on the screen of their mobile device when they are looking towards an element of interest. For example, if a user is outside of a museum and uses your application, they may see the opening hours and the price of the tickets. If they use their phone to point towards a Luas station, your application will show them how many minutes until the next tram arrives. Moreover, your application allows users to login with their social media accounts and presents virtual objects to the users that are based on their friends' activity. For example, if one user sees, via your application, a restaurant that was visited by a contact of them, your application informs the user about their friend's check-in and any potential review.

A) Discuss whether computation offloading techniques will be used on your application and why (5%).
B) In case of using computation offloading techniques, where would the computing resources that your application will use be placed (5%)?
C) Discuss whether the design of your application will follow a monolithic paradigm or will be composed of microservices and why (5%).

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