NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 2 EXAMINATION 2015-2016

CE2006/CZ2006 – SOFTWARE ENGINEERING

Apr/May 2016 Time Allowed: 2 hours

INSTRUCTIONS

1. This paper contains 4 questions and comprises 5 pages.

2. Answer **ALL** questions.

3. This is an open-book examination.

4. All questions carry equal marks.

5. Refer to **Appendix A** on page 5 for the project description which is needed to answer all questions.

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1. In Appendix A there is an initial description of a proposed new mobile CloudPSI service which will estimate the Pollutant Standards Index (PSI) at a particular geographical location based on analysis of photographs submitted by registered users.

   (a) Identify the actors and the activities they perform as part of the CloudPSI Application and draw a UML Use Case Diagram to show the main functionality of the mobile CloudPSI Application and its host system. Use <<include>> and <<extend>> relationships where appropriate.

   (12 marks)

   (b) Write the Use Case Description(s) for the CloudPSI Application when a registered user uses their mobile phone to upload a new photograph to the CloudPSI system. Your Use Case Description(s) must include any pre-conditions, post-conditions and the flow of events.

   (13 marks)

2. (a) From your Use Case Description of the CloudPSI Application developed in Q1(b), identify the main Classes and their associations when a registered CloudPSI user uses their mobile phone to upload a new photograph to the CloudPSI system. Clearly label each Class as a Boundary, Control or Entity Class.

(8 marks)

(b) Design a Dialog Map to represent the functionality of the mobile CloudPSI Application. The Dialog Map should illustrate the main user functionalities identified in Q1(a).

(12 marks)

(c) A core software component of the CloudPSI Application is the machine learning algorithm which analyses uploaded photographs and correlates them with known PSI levels and associated photographs taken in Singapore to estimate the PSI at the location and time the uploaded photograph was taken. Propose, with reasons, how you would estimate the difficulty and complexity of implementing this machine learning algorithm and estimate the manpower effort required to complete this work component in a plan to implement the CloudPSI system.

(5 marks)

3. (a) Refer to the initial project description in Appendix A, on page 5, and the statement "The CloudPSI users can access the system via web or mobile applications".

Propose a software architecture to support this system feature and briefly explain the benefit(s) of the proposed architecture.

(4 marks)

(b) Refer to the initial project description in Appendix A, on page 5, and the statement "Depending on the estimated PSI level, the CloudPSI system sends hazard alerts to the registered users in a particular location".

(i) Propose a design pattern to support this system feature. Explain the mechanism you will adopt so that the system sends alerts to the registered users in a particular location.

(4 marks)

Note: Question No. 3 continues on Page 3

(ii) Depict the design pattern proposed in Q3(b)(i) in a Class Diagram. Explain briefly the roles each Class plays in the design pattern.

(8 marks)

(c) Refer to the extensibility requirement in Appendix A, on page 5 "The CloudPSI system must be able to use new machine learning algorithms to estimate the PSI value, but the system's internal structure and data must be minimally or not affected".

Propose a design pattern to support this non-functional requirement and depict the proposed design pattern in a Class Diagram. Explain briefly the roles each Class plays in the design pattern.

(9 marks)

4. (a) Table Q4 defines the alerts that the CloudPSI system sends based on the PSI level and the health status of a person.

Table Q4

PSI level	Healthy persons	Elderly, pregnant women, children	Persons with chronic lung disease, heart disease
≤100	No alert	No alert	No alert
101 – 200	Reduce prolonged or strenuous outdoor physical exertion	Minimize prolonged or strenuous outdoor physical exertion	Avoid prolonged or strenuous outdoor physical exertion
201 – 300	Avoid prolonged or strenuous outdoor physical exertion	Minimize outdoor activity	Avoid outdoor activity
>300	Minimize outdoor activity	Avoid outdoor activity	Avoid outdoor activity

(i) Determine the equivalence classes of the TWO input parameters (i.e., PSI level and health status) relevant to testing the alert sending component.

(2 marks)

(ii) Determine the boundaries of the equivalence classes identified in your answer to Q4(a)(i). For each boundary, identify a value on the boundary, a value just below the boundary, and a value just above the boundary.

(2 marks)

Note: Question No. 4 continues on Page 4

(iii) You intend to perform defensive testing of the alert sending component. Design a set of test cases to test the alert sending component based on the equivalence classes and boundary values identified in your answers to Q4(a)(i) and Q4(a)(ii).

(8 marks)

(b) When the user selects a position on Google maps, the CloudPSI determines the closest city within 10 kilometers of the selected position. The findCity(List<City> cities, Position position) method (as shown in the Java code in Figure Q4) implements this application logic.

(i) Draw the control flow graph for the findCity(List<City> cities, Position position) method.

(4 marks)

(ii) You intend to perform unit testing of the findCity(List<City> cities,Position position) method. Do you need to test the computeDistance(cities[i].position, position) method at LINE 5?

(1 mark)

(iii) List the set of basis paths for performing basis path testing of the findCity(List<City> cities, Position position) method. Design a test case (including the input parameter List<City> and the distance between the input position and a city's position and the expected return value) for each of the basis paths.

(8 marks)

```
1.    City findCity(List<City> cities, Position position) {
2.       City city = null;
3.       double shortestDistance = MAX_DOUBLE;
4.       for(int i = 0; i < cities.size(); i++) {
5.          double distance = computeDistance(cities[i].position, position);
6.          if(distance <= 10) {
7.             if(distance < shortestDistance) {
8.                city = cities[i];
9.                shortestDistance = distance;
10.            }
11.         }
12.      }
13.      return city;
14.   }
```

Figure Q4

Note: Appendix A is on Page 5

Appendix A

CloudPSI Project Description

Project Mission Statement
The Singapore government releases Pollutant Standards Index, or PSI data. In periods of heavy haze when the PSI goes high, this information helps people plan their daily activities. However, many regional countries do not have such a public service. Our mission is to exploit the crowd data and the Singapore PSI data to estimate PSI levels elsewhere to benefit the crowd.

Initial Project Description
The CloudPSI is an intelligent cloud platform that makes use of user-shared photographs and historic PSI data to benefit the crowd who may not have access to publicly available pollution tracking data. It must support the following features:

- The CloudPSI users can access the system via web or mobile applications.
- The CloudPSI application allows users to register and login to the system and upload photographs. Users upload photographs with the date, time and location at which they were taken.
- The CloudPSI system uses a novel machine learning algorithm to learn the correlation between photograph clarity and the publicly available Singapore PSI data based on historical and current data associated with analysis of photographs taken in Singapore during known PSI levels. Each uploaded photograph is analysed using this algorithm to estimate the PSI at the photograph location. If the PSI can be estimated the photograph is accepted. An email is sent to the registered user informing them whether their photograph was accepted or not.
- The CloudPSI system must be able to use new machine learning algorithms to estimate the PSI value, but the system's internal structure and data must be minimally or not affected.
- The CloudPSI system attempts to track PSI at 12 hour intervals depending on the number and quality of photographs uploaded. Users can view the estimated PSI levels at any location based on city name or by selecting a position on Google maps. Depending on the estimated PSI level, the CloudPSI system sends hazard alerts to the registered users in a particular location.

END OF PAPER

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Please read the following instructions carefully:

1. **Please do not turn over the question paper until you are told to do so. Disciplinary action may be taken against you if you do so.**

2. You are not allowed to leave the examination hall unless accompanied by an invigilator. You may raise your hand if you need to communicate with the invigilator.

3. Please write your Matriculation Number on the front of the answer book.

4. Please indicate clearly in the answer book (at the appropriate place) if you are continuing the answer to a question elsewhere in the book.