

# CS2022 ASSIGNMENT 01 (Due Date: Sept 09, 2022)

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**Instructions:** Answer all questions and compile your answers in a WORD or PDF file. Then, you have to submit the answer file to the Gmail account ([csformgtnchu@gmail.com](mailto:csformgtnchu@gmail.com)) before the due date.

Please be reminded that (i) the format of the email heading, (ii) the format of the file name and (iii) the exact time of the 'due date' have to follow firmly to the instructions specified in the document 'Class Schedule and Code of Conduct'. If you fail to do any one of it, your assignment submission will be ignored.

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## Question 1

- (a) What is the full name (in English) of the instructor of this class?

**Answer:** John Sum.

- (b) The instructor has earned three degrees, including a BEng, a MPhil and a PhD. State the years when and the universities where the instructor obtained the degrees.

**Answer:** In 1992, John obtained his BEng in Electronic Engineering from the Hong Kong Polytechnic University. In 1995, John obtained his MPhil in Computer Science and Engineering from the Chinese University of Hong Kong. In 1998, John obtained his PhD in Computer Science and Engineering from the Chinese University of Hong Kong.

- (c) Where is the birthplace of the instructor?

**Answer:** Hong Kong.

- (d) For how many years the instructor have been living in Taiwan?

**Answer:** 17 years.

- (e) If a student would like to apply for a leave or enquiry for information regarding the course, which email account should the email to be sent?

**Answer:** [pfsun@nchu.edu.tw](mailto:pfsun@nchu.edu.tw).

- (f) If a student would like to submit the answer file of an assignment, which email account should the file to be sent?

**Answer:** [csformgtnchu@gmail.com](mailto:csformgtnchu@gmail.com).

- (g) In accordance with the 'Code of Conduct', are you allowed to use a computer, a cell phone or calculator in the classroom?

**Answer:** No.

- (h) If happen to be, a student is waiting for an urgent call. What he/she should do?

**Answer:** The student has to inform Professor John Sum in advance.

- (i) If happen to be, a student is needed to eat something. What he/she should do?

**Answer:** The student needs to eat the food outside the classroom.

- (j) Normally, a student has to supply medical certificate to prove for his/her sick leave. Under one condition, a female student has no need to supply any proof for sick leave. The female student has only to email to the instructor about the leave/absent. What condition is it?

**Answer:** During menstrual cycle.

- (k) What is the full name of this course in English?

**Answer:** Introduction to computer science.

- (l) What is the title of the textbook, if any, for this course?

**Answer:** There is no textbook for this course.

- (m) Tentatively, how many assignments a student has to complete in this class?

**Answer:** 14.

- (n) Under what condition(s), a student will get 'ZERO' in his/her final score.

**Answer:** (1) A student has skipped more than three lectures without proper reason. (2) A student has copied any answer of an assignment from his/her fellow classmate. (3) A student has cheated in a test or examination.

- (o) While you send an email, you would need to add the email addresses on the 'TO' list. Sometimes, you might need to add some email addresses on the 'CC' list. In a formal letter, what a 'TO' recipient should do and what a 'CC' recipient should do?

**Answer:** Each recipient on the 'TO' list has to take actions and then response by replying an email to the sender. Each recipient on the 'CC' list does not have to do anything as the recipients on the 'CC' are only informed of something happen. The recipients on the 'CC' list do not have to reply the email.

## Question 2

- (a) State the names of five software which are commonly installed in a notebook computer (or desktop computer).

**Answer:** You should know the answer.

- (b) State the names of five APPs which are commonly installed in a cell phone.

**Answer:** LINE, WhatsApp, Facebook Messenger, Apple Maps, Safari, FaceTime, iMessage.

- (c) Imagine that there is no more electricity supply in the world. How would you compile the answers and how would you submit them to me?

**Answer:** We can write the answers on papers and then take the answer sheets to the office of Professor John Sum.

- (d) Imagine that there is no more electricity supply in the world. How would you communicate with your families and friends?

**Answer:** By sending letters.

## Question 3

- (a) You are given a set of 9 balls. All of them look the same. Eight of them weight 2000 grams and one of them weights 1999 grams. Human is unable to sense this little difference. Now, the only tool you have is a pan balance. Your job is to find out which of them is lighter. Describe in detail, step by step, how do you use the pan balance to find the lighter ball.

**Answer:** There are two solutions for solving the above problem.

*Solution 1:* Initially, label the balls with numbers  $B_1, B_2, \dots, B_9$ .

Step 1: Weight B1 and B2. GOTO Step 2.  
 Step 2: IF B1 < B2, B1 is abnormal. STOP! ELSE GOTO Step 3.  
 Step 3: IF B1 > B2, B2 is abnormal. STOP! ELSE GOTO Step 4.  
 Step 4: SET N = 3. GOTO Step 5.  
 STEP 5: 5.1: Weight B1 and BN.  
           5.2: IF B1 > BN, BN is abnormal. STOP! ELSE GOTO Step 5.3.  
           5.3: N = N+1. GOTO Step 5.1.

For the above algorithm, the number of WEIGHT for finding the abnormal ball is no more than 7. It happens if the abnormal ball is  $B_9$ .

*Solution 2:* Initially, arbitrarily partition the balls in three groups, say Group A, B and C. Each group has three balls. Label the balls  $A_1, A_2$  and  $A_3$  for the balls in Group A. Label the balls  $B_1, B_2$  and  $B_3$  for the balls in Group B. Label the balls  $C_1, C_2$  and  $C_3$  for the balls in Group C.

Step 1: Weight (A1,A2,A3) and (B1,B2,B3). GOTO Step 2.  
 Step 2: IF (A1,A2,A3) < (B1,B2,B3), GOTO Step 5.  
 Step 3: IF (A1,A2,A3) > (B1,B2,B3), GOTO Step 6.  
 Step 4: IF (A1,A2,A3) = (B1,B2,B3), GOTO Step 7.  
 Step 5: 5.1: Weight A1 and A2. GOTO Step 5.2.  
           5.2: IF A1 < A2, A1 is abnormal. STOP! ELSE GOTO Step 5.3.  
           5.3: IF A1 > A2, A2 is abnormal. STOP!  
               ELSE A3 is abnormal. STOP!  
 Step 6: 6.1: Weight B1 and B2. GOTO Step 6.2.  
           6.2: IF B1 < B2, B1 is abnormal. STOP! ELSE GOTO Step 6.3.  
           6.3: IF B1 > B2, B2 is abnormal. STOP!  
               ELSE B3 is abnormal. STOP!  
 Step 7: 7.1: Weight C1 and C2. GOTO Step 7.2.  
           7.2: IF C1 < C2, C1 is abnormal. STOP! ELSE GOTO Step 7.3.  
           7.3: IF C1 > C2, C2 is abnormal. STOP!  
               ELSE A3 is abnormal. STOP!

For the above algorithm, the number of WEIGHT for finding the abnormal ball is no more than 2.

- (b) You are given a set of 9 balls. All of them look the same. Eight of them weight 2000 grams and one of them weights 2001 grams. Pan balance is the only tool to be used. Describe in detail, step by step, how do you use the pan balance to find the heavier ball.

**Answer:** Similar to the solutions for Question 3a.

- (c) Again, you are given a set of 9 balls which are looked and sensed the same. Eight of them are 2000 grams. For the abnormal ball, we do not know if it is lighter or heavier. Describe in detail, step by step, how do you use the pan balance to find the abnormal ball.

**Answer:** There are two solutions for the above problem.

*Solution 1:* Initially, label the balls with numbers 1, 2,  $\dots$ , 9.

Step 1: Weight B1 and B2. GOTO Step 2.  
 Step 2: IF (B1 < B2) or (B1 > B2), GOTO Step 3. ELSE GOTO Step 4.  
 Step 3: 3.1: Weight B1 and B3.  
           3.2: IF B1 = B3, B2 is abnormal.  
               ELSE, B1 is abnormal. STOP!

Step 4: SET  $N = 3$ . GOTO Step 5.  
 STEP 5: 5.1: Weight  $B_1$  and  $B_N$ .  
           5.2: IF  $B_1 = B_N$ , GOTO Step 5.3. ELSE,  $B_N$  is abnormal. STOP!  
           5.3:  $N = N+1$ . GOTO Step 5.1.

For the above algorithm, the number of WEIGHT for finding the abnormal ball is no more than 7. It happens if the abnormal ball is  $B_9$ .

*Solution 2:* Initially, arbitrarily partition the balls in three groups, say Group A, B and C. Each group has three balls. Label the balls  $A_1, A_2$  and  $A_3$  for the balls in Group A. Label the balls  $B_1, B_2$  and  $B_3$  for the balls in Group B. Label the balls  $C_1, C_2$  and  $C_3$  for the balls in Group C.

Step 1: 1.1: Weight  $(A_1, A_2, A_3)$  and  $(B_1, B_2, B_3)$ . GOTO Step 1.2.  
           1.2: SET  $(GA > GB) = \text{TRUE}$ , IF  $(A_1, A_2, A_3) > (B_1, B_2, B_3)$ .  
                   GOTO Step 2. ELSE GOTO Step 1.3.  
           1.3: SET  $(GA < GB) = \text{TRUE}$ , IF  $(A_1, A_2, A_3) < (B_1, B_2, B_3)$ .  
                   GOTO Step 2. ELSE SET  $(GA = GB) = \text{TRUE}$ . GOTO Step 2.  
 Step 2: 2.1: Weight  $(A_1, A_2, A_3)$  and  $(C_1, C_2, C_3)$ . GOTO Step 2.2.  
           2.2: SET  $(GA > GC) = \text{TRUE}$ , IF  $(A_1, A_2, A_3) > (C_1, C_2, C_3)$ .  
                   GOTO Step 3. ELSE GOTO Step 2.3.  
           2.3: SET  $(GA < GC) = \text{TRUE}$ , IF  $(A_1, A_2, A_3) < (C_1, C_2, C_3)$ .  
                   GOTO Step 3. ELSE SET  $(GA = GC) = \text{TRUE}$ . GOTO Step 3.

[Note: After Step 2, it comes up with six possible outcomes only.]

Step 3: 3.1: IF  $(GA < GB)$  and  $(GA < GC)$ , GOTO Step 4.  
           ELSE GOTO Step 3.2.  
           3.2: IF  $(GA > GB)$  and  $(GA = GC)$ , GOTO Step 5.  
                   ELSE GOTO Step 3.3.  
           3.3: IF  $(GA = GB)$  and  $(GA > GC)$ , GOTO Step 6.  
                   ELSE GOTO Step 3.4.  
           3.4: IF  $(GA > GB)$  and  $(GA > GC)$ , GOTO Step 7.  
                   ELSE GOTO Step 3.5.  
           3.5: IF  $(GA < GB)$  and  $(GA = GB)$ , GOTO Step 8.  
                   ELSE GOTO Step 3.6.  
           3.6: IF  $(GA = GB)$  and  $(GA < GC)$ , GOTO Step 9.

[The abnormal ball is lighter.]

Step 4: 4.1: Weight  $A_1$  and  $A_2$ . GOTO Step 4.2.  
           4.2: IF  $A_1 < A_2$ ,  $A_1$  is abnormal. STOP! ELSE GOTO Step 4.3.  
           4.3: IF  $A_1 > A_2$ ,  $A_2$  is abnormal. STOP!  
                   ELSE  $A_3$  is abnormal. STOP!  
 Step 5: 5.1: Weight  $B_1$  and  $B_2$ . GOTO Step 5.2.  
           5.2: IF  $B_1 < B_2$ ,  $B_1$  is abnormal. STOP! ELSE GOTO Step 5.3.  
           5.3: IF  $B_1 > B_2$ ,  $B_2$  is abnormal. STOP!  
                   ELSE  $B_3$  is abnormal. STOP!  
 Step 6: 6.1: Weight  $C_1$  and  $C_2$ . GOTO Step 6.2.  
           6.2: IF  $C_1 < C_2$ ,  $C_1$  is abnormal. STOP! ELSE GOTO Step 6.3.  
           6.3: IF  $C_1 > C_2$ ,  $C_2$  is abnormal. STOP!  
                   ELSE  $A_3$  is abnormal. STOP!

[The abnormal ball is heavier.]

Step 7: 7.1: Weight A1 and A2. GOTO Step 7.2.  
 7.2: IF A1 > A2, A1 is abnormal. STOP! ELSE GOTO Step 7.3.  
 7.3: IF A1 < A2, A2 is abnormal. STOP!  
 ELSE A3 is abnormal. STOP!

Step 8: 8.1: Weight B1 and B2. GOTO Step 8.2.  
 8.2: IF B1 > B2, B1 is abnormal. STOP! ELSE GOTO Step 8.3.  
 8.3: IF B1 < B2, B2 is abnormal. STOP!  
 ELSE B3 is abnormal. STOP!

Step 9: 9.1: Weight C1 and C2. GOTO Step 9.2.  
 9.2: IF C1 > C2, C1 is abnormal. STOP! ELSE GOTO Step 9.3.  
 9.3: IF C1 < C2, C2 is abnormal. STOP!  
 ELSE A3 is abnormal. STOP!

For the above algorithm, the number of WEIGHT for finding the abnormal ball is 3.

#### Question 4

Similar to the previous question, you are given a set of 9 balls which are looked and sensed the same. Now, there are two abnormal balls inside and their weights are unknown. Describe in detail, step by step, how do you use the pan balance to find the abnormal balls.

**Answer:** Weight  $B_1$  to  $B_N$  for  $N = 2, \dots, 9$  and record all the results. Three cases of results will be observed. Let me denote these cases as Case 1.1, Case 1.2 and Case 1.3.

**Case 1.1:**  $B_1$  is a normal ball. There will be exactly six "=" signs recorded.

$B_1$  is a normal ball.

(1, 2)	(1, 3)	(1, 4)	(1, 5)	(1, 6)	(1, 7)	(1, 8)	(1, 9)	Abnormal balls
=	=	≠	=	=	=	=	≠	$B_3, B_9$

Once the above result has been observed, the abnormal balls are identified. There is no further work to be done.

**Case 1.2:**  $B_1$  is lighter than the normal balls. Thus, the other abnormal ball must be the same weight as  $B_1$  or heavier than  $B_1$ . Under such circumstance, there will be at least seven "≠" signs recorded.

$B_1$  is lighter than the normal balls.

(1, 2)	(1, 3)	(1, 4)	(1, 5)	(1, 6)	(1, 7)	(1, 8)	(1, 9)	Abnormal balls
≠	≠	≠	≠	≠	≠	≠	≠	$B_1$
≠	≠	≠	≠	≠	≠	≠	=	$B_1, B_9$

For the first situation, only  $B_1$  can be identified as an abnormal ball. A second round of weighting is needed. For the second situation, the abnormal balls are identified. There is no further work to be done.

**Case 1.3:**  $B_1$  is heavier than the normal balls. Thus, the other abnormal ball must be the same weight as  $B_1$  or lighter than  $B_1$ . Under such circumstance, there will be at least seven "≠" signs recorded.

$B_1$  is heavier than the normal balls.

(1, 2)	(1, 3)	(1, 4)	(1, 5)	(1, 6)	(1, 7)	(1, 8)	(1, 9)	Abnormal balls
≠	≠	≠	≠	≠	≠	≠	≠	$B_1$
≠	≠	≠	≠	≠	≠	≠	=	$B_1, B_9$

For the first situation, only  $B_1$  can be identified as an abnormal ball. A second round of weighting is needed. For the second situation, the abnormal balls are identified. There is no further work to be done.

**Second Round:** As long as  $B_1$  has been identified as an abnormal ball, we could thus weight  $B_2$  to  $B_N$  for  $N = 3, \dots, 9$  and record all the results. Again, three cases will be observed. Let me denote these cases as Case 2.1, Case 2.2 and Case 2.3.

**Case 2.1:**  $B_2$  is a normal ball. There will be exactly five "=" signs recorded.

$B_2$  is a normal ball.

(2, 3)	(2, 4)	(2, 5)	(2, 6)	(2, 7)	(2, 8)	(2, 9)	Abnormal balls
=	=	=	=	=	=	≠	$B_1, B_9$

All abnormal balls are identified. There is no further work to be done.

**Case 2.2:**  $B_2$  is lighter than the normal balls. There will be exactly seven "≠" signs recorded.

$B_2$  is lighter than the normal balls.

(2, 3)	(2, 4)	(2, 5)	(2, 6)	(2, 7)	(2, 8)	(2, 9)	Abnormal balls
≠	≠	≠	≠	≠	≠	≠	$B_1, B_2$

All abnormal balls are identified. There is no further work to be done.

**Case 2.3:**  $B_2$  is heavier than the normal balls. There will be exactly at seven "≠" signs recorded.

$B_2$  is heavier than the normal balls.

(2, 3)	(2, 4)	(2, 5)	(2, 6)	(2, 7)	(2, 8)	(2, 9)	Abnormal balls
≠	≠	≠	≠	≠	≠	≠	$B_1, B_2$

All abnormal balls are identified. There is no further work to be done.

While the tricks behind the solution for solving the problem are complicated, the procedure for solving the above problem is simple. In summary, the algorithm for solving this 2-abnormal ball problem is depicted as below.

```

Step 1.1: FOR N = 2 to 9
           Weight B1 with BN.
           Record the result.
        END
Step 1.2: IF exactly six '=' signs are recorded,
           the balls with unequal signs are abnormal balls.
           STOP.
        ELSE
           B1 is an abnormal ball.
           GOTO Step 2.1.
        END
Step 2.1: FOR N = 3 to 9
           Weight B2 with BN.
           Record the result.
        END
Step 2.2: IF exactly six '=' signs are recorded,
           the ball with unequal sign is abnormal balls.
           STOP.
        ELSE
           B2 is an abnormal ball.
           STOP.
        END
END

```

It should be noted that  $B_1$  has already been identified as an abnormal ball if Step 2.1 has to be conducted. Therefore, there is only one abnormal ball in  $B_2, B_3$  to  $B_9$ .

**Note:** The idea behind the above algorithm can be applied in solving a larger scale problem, in which there are  $M$  abnormal balls in a group of  $N$  balls. Here  $N > 2M$ . For instance, one problem is to identify all 10 abnormal balls in a group of 21 balls. In such case, there will require at most 10 rounds of weighting to identify all the abnormal balls.