Worksheet: Pseudocode

CS 101 Algorithmic Problem Solving

Fall 2023

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1. Candies Fight

There are three friends and a total of N candies. There will be a fight amongst the friends if all of them do not get the same number of candies.

Chef wants to divide all the candies such that there is no fight. Find whether such distribution is possible.

Constraints

- $1 \leq N \leq 100$

Interaction

The input comprises a single line containing an integer denoting the value of N.

The output must be a Yes or No, depending on whether the candies can be evenly distributed.

Sample

Input	Output
3	Yes
4	No

In the first case, Chef can distribute all 3 candies such that each friend gets 1 candy. Since all three friends have the same number of candies, there is no fight.

In the second case, there exists no way of distributing all candies such that all three friends have same number of candies.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
2	NO
6	YES
123	YES

Problem Identification
Briefly explain the underlying problem you identified in the above question that led you to your solution.

Answer: We are given an integer N as input and must find whether it can be divided equally amongst three friends without leaving a remainder.

Input: N Output: "YES" if N% 3 == 0, else "NO"

Pseudocode

```
if N % 3 == 0:
    return "YES"
else:
    return "NO"
```

Dry Run
Using any two of the inputs provided in the Exercise section above, dry run your psuedocode in the space below.

Input: $(N) = (2)$
Output: if 2%3 == 0, as this condition is False, the output should be "NO", which is the expected output, so correct!

Input: $(N) = (123)$
Output: if 123%3 == 0, as this condition is True, the output should be "Yes", which is the expected output, so correct!

This means the applied logic is correct

2. Football Match

Chef is watching a football match. The current score is $A : B$, that is, team 1 has scored A goals and team 2 has scored B goals. Chef wonders if it is possible for the score to become $C : D$ at a later point in the game (i.e. team 1 has scored C goals and team 2 has scored D goals).

Can you help Chef by answering his question?

Constraints

- $0 \leq A, B, C, D \leq 100$

Interaction

The input comprises a single line containing 4 space-separated integers denoting the values of A, B, C and D respectively.

The output shall state if the given score transitioning is Possible or Impossible.

Sample

Input	Output
1 5 3 5	Possible
3 4 2 6	Impossible

In the first case, The current score is 1:5. If team 1 scores 2 more goals, the score will become 3:5. Thus 3:5 is a possible score.

In the second case, The current score is 3:4. It can be proven that no non-negative pair of integers (x, y) exists such that if team 1 scores x more goals and team 2 scores y more goals score becomes 2:6 from 3:4. Thus in this case 2:6 is an impossible score.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
2 2 2 2	Possible
0 1 8 0	Impossible
9 9 7 13	Impossible

Problem Identification

Briefly explain the underlying problem you identified in the above question that led you to your solution.

Answer: Given natural numbers A,B,C,D as input, we need to determine if C is at least as large as A or if D is at least as large as B, it's considered "Possible." Otherwise, if C is smaller than A or D is smaller than B, it's labeled as "Impossible." because the scores cannot decrease after a certain time.

Input: A, B, C, D
Output:
"Possible" if $((C >= A)$ and $(D >= B)$),
else "Impossible"

Pseudocode

```
if C >= A and D >= B:
    return "Possible"
else:
    return "Impossible"
```

Dry Run

Using any two of the inputs provided in the Exercise section above, dry run your psuedocode in the space below. Input: $(A, B, C, D) = (2, 2, 2, 2)$
Output: if $(C >= A)$ and $(D >= B) =$
if $(2 >= 2)$ and $(2 >= 2)$, both the *And* conditions are True (the score hasn't changed), the output should be "Possible", which is the expected output, so correct!

Input: $(A, B, C, D) = (9, 9, 7, 13)$
Output: if $(C >= A)$ and $(D >= B) =$
if $(7 >= 9)$ and $(13 >= 9)$, as one of the *And* conditions $(7 >= 9)$ is False and no non-negative pair of integers (x, y) exist such that the score can decrease, the output should be "Impossible", which is the expected output, so correct!

This means the applied logic is correct

3. Group Assignment

Your professor is planning on giving the class a group assignment. There are $2N$ students in your class, with roll numbers from 1 to $2N$. Your roll number is X.

The professor has decided to create N groups of 2 students each. The groups are to be created as follows: the first group contains roll numbers 1 and $2N$, the second group contains roll numbers 2 and $2N-1$, the third group contains roll numbers 3 and $2N-2$, and so on, with the Nth group containing roll numbers N and $N+1$.

You want to find out who your partner will be beforehand.

Given values of N and X, determine the roll number of your partner.

Constraints

- $N, X \in \mathbb{N}$
- $1 \leq N \leq 10^8$
- $1 \leq X \leq 2N$

Interaction

The input comprises a single line containing 2 space-separated integers denoting the value of N and X respectively.

The output must contain a single number denoting the roll number of your partner.

Sample

Input	Output
2 2	3
3 1	6

In the first case, $(N, X) = (2, 2)$. There are $2 \cdot 2 = 4$ students in the class and your roll number is 2. The groups will be as follows: $\{(1,4),(2,3)\}$. You are partnered with roll number 3.

In the second case, $(N, X) = (3, 1)$. There are $2 \cdot 3 = 6$ students in the class and your roll number is 1. The groups will be as follows: $\{(1,6),(2,5),(3,4)\}$. You are partnered with roll number 6.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
15 5	26
35 23	48
123 189	58

Problem Identification

Briefly explain the underlying problem you identified in the above question that led you to your solution.

Answer: We are given two integers as input (N, X) and need to find $1 + (2 * N - X)$.

Input: N, X
Output: $1 + (2 * N - X)$

Pseudocode

```
return 1 + 2*N - X
```

Dry Run

Using any two of the inputs provided in the Exercise section above, dry run your psuedocode in the space below.

Input: $(N, X) = (15, 5)$
Output: $1 + (2 * 15) - 5 = 26$, which is the expected output, so correct!

Input: $(N, X) = (35, 23)$
Output: $1 + (2 * 35) - 23 = 48$, which is the expected output, so correct!

This means the applied logic is correct

4. Rooks Attack

You are given a standard 8×8 chessboard which has exactly 2 rooks on it and no other pieces. The rows are numbered 1 to 8 from bottom to top, and the columns are numbered 1 to 8 from left to right. The cell at the intersection of the i-th column and j-th row is denoted (i, j).

Given the initial positions of the rooks in the form of coordinates (x_1, y_1) and (x_2, y_2). you need to tell whether the 2 rooks currently attack each other or not. Assume, each square can contain at most one piece.

Hint: Rooks can only travel in straight lines along the row or column they are placed at, and can't jump over other pieces.

Constraints

- $1 \leq x_1, x_2, y_1, y_2 \leq 8$
- $(x_1, y_1) \neq (x_2, y_2)$

Interaction

The input comprises a single line containing 4 space-separated integers denoting the values of x_1, y_1, x_2 and y_2 respectively.

The output must contain a single line stating Yes if the rooks attack each other, and No otherwise.

Sample

Input	Output
1 2 5 2	Yes
1 1 8 8	No

In the first case, The two rooks can attack each other by moving along the second column.

In the second case, No matter how a rook moves it cannot reach the second rook in one move. Hence, they do not attack each other.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
1 2 1 5	YES
2 4 4 8	NO
3 3 4 3	YES

Problem Identification

Briefly explain the underlying problem you identified in the above question that led you to your solution.

Answer: Given four inputs x_1, y_1, x_2, y_2 which are the current coordinates of both rooks, we need to determine if either x coordinates or y coordinates are the same, then it means rooks attack each other.

Input: x_1, y_1, x_2, y_2
Output:
"Yes" if ($x_1 == x_2$ or $y_1 == y_2$),
else "No"

Pseudocode

```
if x1 == x2 or y1 == y2:
    return ``Yes''
else:
    return ``No''
```

Dry Run

Using any two of the inputs provided in the Exercise section above, dry run your psuedocode in the space below.

Input: x_1, y_1, x_2, y_2 = 1,2,1,5
Output: if ($x_1 == x_2$) or ($y_1 == y_2$), if (1 == 1) or (2 == 5), as one of the OR conditions (1 == 1) is True, the output would be "YES", which is the expected output, so correct!

Input: x_1, y_1, x_2, y_2 = 3,3,4,3
Output: if ($x_1 == x_2$) or ($y_1 == y_2$), if (3 == 4) or (3 == 3), as one of the OR conditions (3 == 3) is True, the output would be "YES", which is the expected output, so correct!

This means the applied logic is correct

5. Grading

HackerLand University has the following grading policy:

- Every student receives a grade in the inclusive range from 0 to 100.
- Any grade less than 40 is a failing grade.

Sam is a professor at the university and likes to round each student's grades according to these rules:

- If the difference between the grade and the next multiple of 5 is less than 3, round the grade up to the next multiple of 5.
- If the value of the grade is less than 38, no rounding occurs as the result will still be a failing grade.

Given the grade g of Sam's student, find out the final grade after rounding as per his rules.

Constraints

- $0 \leq g \leq 100$

Interaction

The input comprises a single line containing an integer denoting the value of g.

The output must contain a single number denoting final grade after rounding.

Sample

Input	Output
84	85
57	57

In the first case, $g = 84$ and the next multiple of 5 is 85, 85 - 84 = 1 which is lesser than 3. Therefore, it is rounded to the next multiple of 5 which is 85.

In the second case, $g = 57$ and the next multiple of 5 is 60, 60 - 57 = 3 which is not lesser than 3. Therefore, it is is not rounded and remains as is.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
29	29
78	80
51	51

Problem Identification

Briefly explain the underlying problem you identified in the above question that led you to your solution.

Answer: Given input g (student's grade), we need to determine if the grade falls within the passing range (greater than or equal to 38). If it meets this condition, we proceed to find the next multiple of 5. This can be calculated by applying the formula ((g // 5) * 5) + 5. Then, we calculate the difference between the original grade (g) and this multiple. If the difference is less than 3, we round it up to the next multiple, which was already computed earlier. Otherwise, the output remains the same as the original grade, i.e., g.

Input: g
Output: g if $g < 38$,
((g//5 * 5) + 5) if (((g//5 * 5) + 5)- g) < 3),
else g

Pseudocode

```
if (g < 38):
    Grade = g
else:
    difference = ((g//5 * 5) + 5) - g)
if difference < 3 then
    Grade = (g // 5 * 5) + 5
else
    Grade = g
return Grade
```

Dry Run

Using any two of the inputs provided in the Exercise section above, dry run your pseudocode in the space below.

Input: $g = 29$
Output: We first check if $29 < 38$. As this condition is True, we don't need to check further and return the current grade i.e. 29, which is the expected output, so correct!

Input: $g = 78$
Output: We first check if $78 < 38$. As this condition is False, we enter the else block and find the next multiple of 5 by the formula $(78//5*5)+5 = 80$. We then find the difference between the current grade and the next multiple of 5 by $80 - 78 = 2$, as the difference is less than 3, we round the grade up to the next multiple i.e. 80, which is the expected output, so correct!

This means the applied logic is correct

6. Harley and the Chocolate Factory

Notorious chocolatier, Billy Bonka, has hidden a golden ticket in some of his chocolates. These ticket containing packets are incredibly rare and rumors say that there's only a dozen such packets around the globe. Bonka has announced that anyone who can get their hands on one of these precious tickets will be invited to visit his state-of-the-art chocolate factory.

Harley, who has been a fan of Bonka's chocolates since she was young, is infatuated by the idea of visiting Bonka's factory. She breaks open her piggy bank and finds that she has X 5-cent coins and Y 10-cent coins. Harley knows a packet of chocolate costs Z cents and wants to know how many packets she can purchase.

Given values of X, Y, and Z, determine how many packets Harley can purchase.

Constraints

- $X, Y, Z \in \mathbb{Z}$
- $1 \leq X, Y, Z \leq 1000$

Interaction

The input comprises a single line containing 3 space-separated integers denoting the values of X, Y, and Z respectively.

The output must contain a single number denoting the number of chocolates Harley can afford.

Sample

Input	Output
10 10 10	15
3 1 8	3

In the first case, $(X, Y, Z) = (10, 10, 10)$. Harley has 10 5-cent coins and 10 10-cent coins. She has a total of 150 cents. Since each packet costs 10 cents, she can afford 15 packets.

In the second case, $(X, Y, Z) = (3, 1, 8)$. Harley has 3 5-cent coins and 1 10-cent coins. She has a total of 25 cents. Since each packet costs 8 cents, she can afford 3 packets.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
4 4 1000	0
10 5 1	100
13 31 35	10

Problem Identification
Briefly explain the underlying problem you identified in the above question that led you to your solution.

Given three integers X, Y and Z, and we need to determine how many packets can Harley buy $((X * 5) + (Y * 10))//Z$.

Input: X, Y, Z
Output: $\frac{5X+10Y}{Z}$ rounded down

Pseudocode

```
packets  = (5 * X + 10 * Y) // Z
return packets
```

Dry Run
Using any two of the inputs provided in the Exercise section above, dry run your psuedocode in the space below.

Input: $X, Y, Z = 4, 4, 1000$
Output: We calculate the total amount owned by Harley and do an integer division of the total amount with the cost of each chocolate packet: $(5 * 4 + 10 * 4)//1000$ which gives us 0, the expected output for this input.

Input: $X, Y, Z = 13, 31, 35$
Output: We calculate the total amount owned by Harley and do an integer division of the total amount with the cost of each chocolate packet: $(5 * 13 + 10 * 31)//35$ which gives us 10, the expected output for this input.

This means the applied logic is correct

7. Simon cannot sleep

It's 12 o'clock at midnight (00:00) and Simon cannot sleep! So he decided to stare at the clock on his wall until he fell asleep. He saw the clock's hands and got to thinking 'How many times do they pass each other until I fall asleep'. Imagine that he fell asleep at (00:00).

Now, you must figure out how many times clock's hands overlap from (00:00) to $(hh : mm)$.

Hint: The hands of a clock coincide 11 times in every 12 hours.

Constraints

- $0 \leq m \leq 23$
- $0 \leq h \leq 59$

Interaction

The input comprises a single line containing 2 space-separated integers denoting the values of hh and mm.

The output must contain a single number denoting the total number of times clock's hands overlap.

Sample

Input	Output
01 05	1
08 22	8

In the first case, the hands pass each other only at (00:00).

In the second case, the hands will overlap 8 times from (00:00) to (08:22) which are a total of 502 minutes, including the overlap at (00:00). **Exercise**

In the space provided, indicate the outputs for the given inputs.

Input	Output
07 38	7
22 55	22
03 17	4

Problem Identification
Briefly explain the underlying problem you identified in the above question that led you to your solution.

Input: hh, mm
Output: $1 + (hh * 60 + mm) * \frac{11}{720}$ rounded down

Pseudocode

```
total_minutes = hh * 60 + mm
overlaps = (1 + (total_minutes * 11 // 720))
return overlaps
```

Dry Run
Using any two of the inputs provided in the Exercise section above, dry run your psuedocode in the space below.

Input: $(hh, mm) = (07, 38)$
Output: We first calculate the total minutes by converting hh to minutes and adding mm: $((07 * 60 + 38) = 458)$, and multiplying them with the total number of overlaps every 12 hours: $458 * 11//720 = 6$. Finally, we add 1 for the overlap at $00 : 00$ making it $6 + 1 = 7$, which is the expected output, so correct!

Input: $(hh, mm) = (03, 17)$
Output: We first calculate the total minutes by converting hh to minutes and adding mm: $((03 * 60 + 17) = 197)$, and multiplying them with the total number of overlaps every 12 hours: $197 * 11//720 = 3$. Finally, we add 1 for the overlap at $00 : 00$ making it $3 + 1 = 4$, which is the expected output, so correct!

This means the applied logic is correct

8. To concert or not?

Four friends want to attend a concert and have a combined budget of Rs. 10,000. They will attend the concert only if the total cost is within the budget.

Given X, the cost of each ticket, determine whether they will attend the concert.

Constraints

- $X \in \mathbb{N}$
- $1 \leq X \leq 10000$

Interaction

The input contains a single line containing a single integer denoting the value of X.

The output must contain a single string containing "YES" if they will attend the concert, and "NO" otherwise.

Sample

Input	Output
1000	YES
5000	NO

In the first case, $X = 1000$. Four tickets would cost $100 \times 4 = 4000$. The amount is within the budget and the friends will attend the concert.

In the second case, $X = 5000$. Four tickets would cost $5000 \times 4 = 20000$. The amount is not within the budget and the friends will not miss the concert.

Exercise

In the space provided, indicate the outputs for the given inputs.

Input	Output
2500	YES
3680	NO
8900	NO

Problem Identification

Briefly explain the underlying problem you identified in the above question that led you to your solution.

> Input: X
> Output: "YES" if $X \leq 2500$ else "NO"

Pseudocode

```
if (X <= 2500):
    return ``YES''
else:
    return (``NO)'')
```

Dry Run

Using any two of the inputs provided in the Exercise section above, dry run your psuedocode in the space below.

Input: $(X) = (2500)$
Output: if (2500 <= 2500), as the condition is True, if block will be executed and print "YES", which is the expected output, so correct!

Input: $(X) = (3680)$
Output: if (3680 <= 2500), as the condition is False, else block will be executed and print "NO", which is the expected output, so correct!

This means the applied logic is correct

LET'S LEARN TO DEBUG

9. Tax Money

In Chefland, a tax of rupees 10 is deducted if the total income is strictly greater than rupees 100.

Given that total income is X rupees, find out how much money you get.

Constraints

- $X \in \mathbb{N}$
- $1 \leq X \leq 1000$

Interaction

The input comprises a single line containing an integer denoting the value of X.

The output must contain a single number denoting the amount of money you get.

Sample

Input	Output
5	5
105	95

In the first case, Your total income is 5 rupees which is less than 100 rupees. Thus, no tax would be deducted and you get 5 rupees.

In the second case, Your total income is 105 rupees which is greater than 100 rupees. Thus, a tax of 10 rupees would be deducted and you get 105 - 10 = 95 rupees.

Proposed Solution

```
new_income = 0
if X < 100:
  new_income = x - 10
print(new_income)
```

Dry Run

Using any two of the inputs provided in the Sample section above, dry run the proposed psuedocode in the space below.

Input: $(X) = (5)$

```
 new_income = 0
if 5 < 100:
  new_income = 5 - 10
print(new_income)
```

Output: -5 (expected output = 5

Error Identification

Briefly explain the errors you identified in the proposed code solution. Mention the line number and errors in each line.

incorrect range in line 2, income decremented by 10 even if it is less than 100

Correct Solution

Rewrite the lines of code you mentioned above with their errors corrected.

```
new_income = 0
if X > 100:
  new_income = X - 10
print(new_income)
```

10. Favorite Numbers

Alice likes numbers that are even, and are a multiple of 7. Bob likes numbers that are odd, and are a multiple of 9. Alice, Bob, and Charlie find a number A.

- If Alice likes A, Alice takes home the number.
- If Bob likes A, Bob takes home the number.
- If both Alice and Bob don't like the number, Charlie takes it home.

Given A, find who takes it home.

Constraints

- $1 \leq A \leq 1000$

Interaction

The input comprises a single line containing an integer denoting the value of A.

The output must contain the name of the person who takes A home. Name shall be as the following: Alice, Bob or Charlie.

Sample

Input	Output
7	Charlie
27	Bob

In the first case, 7 is not even, hence Alice doesn't like it. It is odd, but isn't a multiple of 9. Hence Bob doesn't like it. Therefore, Charlie takes it home.

In the second case, 27 is odd and a multiple of 9. Therefore, Bob likes it and takes it home.

Proposed Solution

```
if (A % 2 != 0) and (A % 7 == 0):
  print("Alice")
elif (A % 2 != 0) or (A % 9 == 0):
  print("Bob")
else:
  print("Charlie")
```

Dry Run

Using any two of the inputs provided in the Sample section above, dry run the proposed psuedocode in the space below.

Input: $(A) = (7)$

```
if (7 % 2 != 0) and (7 % 7 == 0):
  print("Alice")
elif (7 % 2 != 0) or (7 % 9 == 0):
  print("Bob")
else:
  print("Charlie")
```

Output: “ALICE” (expected output: “CHARLIE”)

Error Identification

Briefly explain the errors you identified in the proposed code solution. Mention the line number and errors in each line.

Incorrect condition at line 1 (checking if A is an even number), and line 3 (checking if a number is simultaneously odd and a multiple of 9)

Correct Solution

Rewrite the lines of code you mentioned above with their errors corrected.

```
if (A % 2 == 0) and (A % 7 == 0):
  print("Alice")
elif (A % 2 != 0) and (A % 9 == 0):
  print("Bob")
else:
  print("Charlie")
```

Rough Work