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## **DAA Assignment**

### **Algorithm for SPI and CPI Calculation**

#### **Problem Statement:**

Write a program that calculates the Semester Performance Index (SPI) and Cumulative Performance Index (CPI) for a student over multiple semesters. The program will collect the number of subjects, credits, and grades for each subject and use this data to compute the SPI for each semester and the CPI across all semesters.

#### **❖ Algorithm:**

##### **1. Initialize Data Structures:**

- Create vectors grades, credits, and spi to store the grades, credits, and SPI for each semester.

##### **2. Input Number of Semesters:**

- Prompt the user to enter the number of semesters n.

##### **3. SPI Calculation for Each Semester:**

- For each semester, execute the following steps:
  - Prompt the user to enter the number of subjects.
  - Initialize total\_credit to 0.
  - For each subject:
    - Prompt the user to enter the credit and grade.
    - Append the credit and grade to the respective vectors.
    - Add the credit to total\_credit.
  - Compute the SPI using the formula:  $\text{SPI} = \frac{\sum (\text{grade} \times \text{credit})}{\text{total\_credit}}$ .
  - Append the calculated SPI to the spi vector.
  - Display the SPI for the semester.

#### 4. CPI Calculation:

- Compute the CPI using the formula: 
$$\text{CPI} = \frac{\sum \text{SPI}_i}{n}$$
where n is the number of semesters.
- Display the CPI.

#### 5. Main Function:

- Initialize vectors grades, credits, and spi.
- Prompt the user to enter the number of semesters.
- For each semester, call the SPI calculation function.
- After all semesters, call the CPI calculation function to display the overall CPI.

### ❖ Time Complexity

#### 1. SPI\_cal Function:

- **Input Reading (Lines 5-7):** This takes  $O(1)$  time as it just reads an integer.
- **Loop for Reading Credits and Grades :** This loop runs  $n$  times, and each iteration takes  $O(1)$  time. Hence, the total time for this loop is  $O(n)$
- **Loop for Calculating the Sum :** This loop also runs  $n$  times, with each iteration taking  $O(1)$  time. Therefore, the total time for this loop is  $O(n)$
- **Total Time Complexity:** The overall time complexity for SPI\_cal is  $O(n)$

#### 2. CPI\_cal Function:

- **Loop for Calculating the Sum (Lines 26-28):** This loop runs  $n$  times, with each iteration taking  $O(1)$  time. Therefore, the total time for this loop is  $O(n)$
- **Total Time Complexity:** The overall time complexity for CPI\_cal is  $O(n)$

## ❖ Space Complexity

### 1. SPI\_cal Function:

- **Local Variables:**  $n$ ,  $c$ ,  $g$ ,  $total\_credit$ ,  $sum$ , and  $SPI$  all take  $O(1)O(1)O(1)$  space.
- **Vectors credit and grade:** Each vector will store  $nnn$  elements, leading to a space complexity of  $O(n)O(n)O(n)$ .
- **Total Space Complexity:** The overall space complexity for  $SPI\_cal$  is  $O(n)O(n)O(n)$ .

### 2. CPI\_cal Function:

- **Local Variables:**  $n$ ,  $sum$ ,  $CPI$  take  $O(1)O(1)O(1)$  space.
- **Vector spi:** The vector  $spi$  is passed by value, and it stores  $nnn$  elements, leading to a space complexity of  $O(n)O(n)O(n)$ .
- **Total Space Complexity:** The overall space complexity for  $CPI\_cal$  is  $O(n)O(n)O(n)$ .

## ❖ Pseudo Code:

Initialize vectors grades, credits, spi

Prompt user to enter number of semesters

Read  $n$

For  $i$  from 0 to  $n-1$  do:

    Call  $SPI\_cal(grades, credits, spi)$

Call  $CPI\_cal(spi)$

End of algorithm

Function  $SPI\_cal(grades, credits, spi)$ :

    Prompt user to enter number of subjects

    Read number of subjects ( $n$ )

    Initialize  $total\_credit$  to 0

For i from 0 to n-1 do:

    Prompt user to enter credit and grade for subject i

    Read credit, grade

    Append grade to grades vector

    Append credit to credits vector

    Add credit to total\_credit

Initialize sum to 0

For i from 0 to n-1 do:

    Add grades[i] \* credits[i] to sum

Calculate SPI as  $\text{sum} / \text{total\_credit}$

Append SPI to spi vector

Display SPI

End of function

Function CPI\_cal(spi):

    Initialize sum to 0

    For i from 0 to size of spi - 1 do:

        Add spi[i] to sum

Calculate CPI as  $\text{sum} / \text{size of spi}$

Display CPI

End of function

## ❖ Code :

```
#include <bits/stdc++.h>
using namespace std;

void SPI_cal(vector<int>& credit, vector<int>& grade, vector<int>& spi){
    cout<<"Enter number of subjects:"<<endl;
    int n, c, g;
    cin>>n;

    int total_credit = 0;
    for(int i = 0; i<n; i++){
        cout<<"Enter credit and grade for subject "<<i<<endl;
        cin>> c >> g;
        grades.push_back(g);
        credit.push_back(c);
        total_credit += c;
    }

    int sum = 0;
    for(int i = 1; i <= n; i++){
        sum += grade[i]*credit[i];
    }

    float SPI= 1.0*sum/tot ered;
    spi.push_back(SPI);
    cout <<"Your spi is: "<< SPI <<endl;
}

float CPI_cal(vector<int> spi){
    int n = spi.size();

    //calculation float tot spi=0; int tot cred=0;
    int sum = 0;
    for(int i = 0; i < n; i++){
```

```
        sum += spi[i];
    }

    //result
    float CPI=1.0*sum/n;
    cout <<"Your cpi is: "<<CPI<<endl;
    return CPI;
}

int main(){

    vector<int> grades;
    vector<int> credits;
    vector<int> spi;

    int n;
    cout << "enter number of semester: ";
    cin >> n;

    for (int i = 0; i<n; i++){
        SPI_cal(grades, credits, spi);
    }

    CPI_cal(spi);
    return 0;
}
```

## ❖ Test Cases

### Input

```
Enter number of semesters: 1
Enter number of subjects:
3
Enter credit and grade for subject 1:
3 10
Enter credit and grade for subject 2:
4 9
Enter credit and grade for subject 3:
2 8
```

### Output

```
Your SPI is: 9.22
Your CPI is: 9.22
```

### Input

```
Enter number of semesters: 2
Enter number of subjects:
3
Enter credit and grade for subject 1:
3 7
Enter credit and grade for subject 2:
4 8
Enter credit and grade for subject 3:
3 9
Enter number of subjects:
2
Enter credit and grade for subject 1:
4 6
```

Enter credit and grade for subject 2:

4 8

## Output

Your SPI is: 7.91

Your SPI is: 7.00

Your CPI is: 7.45

## Input

Enter number of semesters: 4

Enter number of subjects:

2

Enter credit and grade for subject 1:

4 5

Enter credit and grade for subject 2:

3 6

Enter number of subjects:

3

Enter credit and grade for subject 1:

2 7

Enter credit and grade for subject 2:

3 8

Enter credit and grade for subject 3:

4 9

Enter number of subjects:

4

Enter credit and grade for subject 1:

1 10

Enter credit and grade for subject 2:

2 9

Enter credit and grade for subject 3:

3 8

Enter credit and grade for subject 4:

4 7

Enter number of subjects:

3

Enter credit and grade for subject 1:



4 6

Enter credit and grade for subject 2:

3 5

Enter credit and grade for subject 3:

2 4

## Output

Your SPI is: 5.57

Your SPI is: 8.00

Your SPI is: 8.16

Your SPI is: 5.33

Your CPI is: 6.76