Master of Science in Computing & Data Analytics

Take-Home Programming Test

September 2024 Admission

Applicants to the Master of Science in Computing & Data Analytics program at Saint Mary's University must complete both a take-home programming test and a technical interview to be considered for admission into the program.

Take-Home Programming Test

Complete the following three questions on your own. You can write programs in any language; however, we strongly recommend Java, C++, C, or C#.

Compile, run, and test your programs and please submit to cda.test@smu.ca:

1. The code for your programs (.docx or .txt format)
   *NOTE we will not review any code sent in pdf or image formats

2. Screenshots of three successful program runs proving that your programs function (.pdf format)

   * Alternately, you can submit your code by sharing your repo through Replit (https://replit.com/) instead of the text/docx file. We still require the screenshots of the three successful program runs even with the Replit repo sharing.

If we discover errors in your submission, we will provide feedback and request you to correct problems and resubmit for review. The Admissions Committee typically provides one opportunity to correct errors.

Question 1

Write a program to calculate the volume, LSA, TSA and slant height of a square pyramid having height h being an odd number ranging from 1 to N and side length a, where N and a are inputs provided by the user.

Please find out the formulae for volume, LSA, TSA and slant height of a square pyramid.
(* Hint: Round off the value of Volume of the square pyramid)

```
The program prints the volume, LSA, TSA and slant height of a square pyramid
with height h being an odd number ranging from 1 to N and side length a
Enter the value for N: 7
Enter the length of side a: 8

Height       Volume        Lateral Surface Area    Total Surface Area      Slant Height
--------------------------------------------------------------------------------------
1            21 m³         65.970 m²               129.970 m²              4.123 m
3            64 m³         80.000 m²               144.000 m²              5.000 m
5            107 m³        102.450 m²              166.450 m²              6.403 m
7            149 m³        128.996 m²              192.996 m²              8.062 m
```

```
The program prints the volume, LSA, TSA and slant height of a square pyramid
with height h being an odd number ranging from 1 to N and side length a
Enter the value for N: 15
Enter the length of side a: 7

Height       Volume        Lateral Surface Area    Total Surface Area      Slant Height
--------------------------------------------------------------------------------------
1            16 m³         50.961 m²               99.961 m²               3.640 m
3            49 m³         64.537 m²               113.537 m²              4.610 m
5            82 m³         85.446 m²               134.446 m²              6.103 m
7            114 m³        109.567 m²              158.567 m²              7.826 m
9            147 m³        135.192 m²              184.192 m²              9.657 m
11           180 m³        161.608 m²              210.608 m²              11.543 m
13           212 m³        188.481 m²              237.481 m²              13.463 m
15           245 m³        215.641 m²              264.641 m²              15.403 m
```

Question 2

Write a program to measure the economy of countries by calculating their Growth Rate.
If for a given period the GDP value at the beginning and subsequent year is known, calculate the Growth Rate (GR) of the country for each year, the Average Annual Growth Rate (AAGR) and the Compound Annual Growth Rate (CAGR). Also, measure the relative riskiness of the country's economy based on its standard deviation.

The program should:
- Read the number of countries a
- Read the number of years n
- Use array of length a to store the following:
    - the name of the country
    - an array of GDP i.e., of length of years n
    - an array of GR values i.e., of length of years n

- For each country's GDP value and corresponding year, calculate the growth rate (GR) and its ranking.
  i.e.:
  <Growth Rate (GR)> = (EV-BV)
                      BV

          where:
          EV (Ending Value) = <GDP Value of the current year >
          BV (Beginning Value) = < GDP Value of the previous year>
  (* Hint: Round the GR value to two decimal places)

  *<Ranking> = GR > 25 = **Exceptional***
                 *GR > 0 = **Good***
                 *GR < 0 = **Poor***

- For each country calculate the average annual growth rate, compound annual growth rate and standard deviation.

  <Average Annual Growth Rate> = <Sum of "Growth Rate" / n>
  < Compound Annual Growth Rate > =

  $$\left(\frac{EV}{BV} \right)^{\frac{1}{n}} - 1$$

  where:
          EV = <GDP Value of the final year >
          BV = < GDP Value of the beginning year>
  <Standard Deviation> =

  $$\sqrt{\frac{\sum_{i=1}^{n} (x_i - \overline{x})^2}{n-1}}$$

  where:
          $\overline{x}$ *= <Mean of GR values>*
          x_i *= < GR Value of each year>*

  (* Hint: Round the GR, AAGR and CAGR to two decimal places and Stdev to three decimal places)

Print the following for each country:

- the country name
- for a specific year; the GDP Value, Growth Rate and Ranking
- the average annual growth rate
- the compound annual growth rate
- the standard deviation

At the end:

- Compare the standard deviation of each country to measure the economy volatility based on the **minimum standard deviation** with the following condition:
  - ➢ If **minimum standard deviation < 25**, then print;
    "The Country <country name>'s economy is most stable"
  - ➢ If **minimum standard deviation > 25**, then print;
    "The Country <country name>'s economy is least risky"

(Example runs of the completed program are shown on the next page)

```
Enter the number of countries: 2
Enter the number of years: 2
Enter the name of country 1: A

Country A
--------------------------------------------------
Enter the beginning GDP value: 12000000
Enter the end of year 1 GDP value: 12600000
Enter the end of year 2 GDP value: 12900000

Enter the name of country 2: B

Country B
--------------------------------------------------
Enter the beginning GDP value: 20000000
Enter the end of year 1 GDP value: 25000000
Enter the end of year 2 GDP value: 35000000

                        Country A
-----------------------------------------------------------------
Year |          GDP Value       |   Growth Rate   |    Ranking
-----------------------------------------------------------------
1    |       $12,600,000.00     |      5.00%      |    Good
2    |       $12,900,000.00     |      2.38%      |    Good
Average Annual Growth Rate: 3.69%
Compound Annual Growth Rate: 3.68%
Standard Deviation: 1.852

                        Country B
-----------------------------------------------------------------
Year |          GDP Value       |   Growth Rate   |    Ranking
-----------------------------------------------------------------
1    |       $25,000,000.00     |     25.00%      |    Good
2    |       $35,000,000.00     |     40.00%      |    Exceptional
Average Annual Growth Rate: 32.50%
Compound Annual Growth Rate: 32.29%
Standard Deviation: 10.607


The Country A's economy is most stable
```

```
Enter the number of countries: 3
Enter the number of years: 3
Enter the name of country 1: X

Country X
------------------------------------------
Enter the beginning GDP value: 160000000
Enter the end of year 1 GDP value: 170000000
Enter the end of year 2 GDP value: 189700000
Enter the end of year 3 GDP value: 191000000

Enter the name of country 2: Y

Country Y
------------------------------------------
Enter the beginning GDP value: 567800000
Enter the end of year 1 GDP value: 567800000
Enter the end of year 2 GDP value: 732100000
Enter the end of year 3 GDP value: 890101100

Enter the name of country 3: Z

Country Z
------------------------------------------
Enter the beginning GDP value: 410000000
Enter the end of year 1 GDP value: 452200000
Enter the end of year 2 GDP value: 763020290
Enter the end of year 3 GDP value: 987376183

                        Country X
---------------------------------------------------------------
Year |       GDP Value      |   Growth Rate   |   Ranking
---------------------------------------------------------------
1    |    $170,000,000.00   |     6.25%       |    Good
2    |    $189,700,000.00   |    11.59%       |    Good
3    |    $191,000,000.00   |     0.69%       |    Good
Average Annual Growth Rate: 6.17%
Compound Annual Growth Rate: 6.08%
Standard Deviation: 5.452
```

```
                         Country Y
----------------------------------------------------------------
Year |        GDP Value        |  Growth Rate  |   Ranking
----------------------------------------------------------------
1    |    $567,800,000.00  |       0.00%     |   Poor
2    |    $732,100,000.00  |      28.94%     |   Exceptional
3    |    $890,101,100.00  |      21.58%     |   Good
Average Annual Growth Rate: 16.84%
Compound Annual Growth Rate: 16.17%
Standard Deviation: 15.040

                         Country Z
----------------------------------------------------------------
Year |        GDP Value        |  Growth Rate  |   Ranking
----------------------------------------------------------------
1    |    $452,200,000.00  |      10.29%     |   Good
2    |    $763,020,290.00  |      68.74%     |   Exceptional
3    |    $987,376,183.00  |      29.40%     |   Exceptional
Average Annual Growth Rate: 36.14%
Compound Annual Growth Rate: 34.04%
Standard Deviation: 29.799


The Country X's economy is most stable
```

Question 3

Using **SQL** perform the below functions on the following table showing list of products sold.

```
+-----------------+--------------+----------------------+--------+---------------+
| Product Name    | Category Id  |      Category        | Year   |   Quantity    |
|                 |              |                      |        |   Purchased   |
+-----------------+--------------+----------------------+--------+---------------+
| Shampoo         | 006          | Health and beauty    | 2020   |    10070      |
| Bowl            | 005          | Home and lifestyle   | 2021   |    210        |
| Potato          | 002          | Produce              | 2021   |    30130      |
| Protein Powder  | 001          | Sports and travel    | 2022   |    400        |
| Energy Drink    | 001          | Sports and travel    | 2020   |    834        |
| Light Bulbs     | 005          | Home and lifestyle   | 2022   |    900        |
| Baking Powder   | 004          | Baking               | 2020   |    5000       |
| Skimmed Milk    | 003          | Dairy                | 2021   |    300000     |
| Yogurt          | 003          | Dairy                | 2020   |    98700      |
| Cake Mix        | 004          | Baking               | 2020   |    720        |
| Lotion          | 006          | Health and beauty    | 2020   |    100        |
| Grapes          | 002          | Produce              | 2020   |    59000      |
| Hand Soap       | 006          | Health and beauty    | 2021   |    89211      |
| Flour           | 004          | Baking               | 2021   |    39091      |
| Brownie Mix     | 004          | Baking               | 2021   |    2131       |
| Tomato          | 002          | Produce              | 2021   |    653        |
+-----------------+--------------+----------------------+--------+---------------+
```

1. There are functional dependencies in this table, so first, normalise the relation/table to the second normal form (2NF). Please show the resulting table(s) after the normalization.

2. Using the table(s) in 2NF, write a query to display the **total quantity purchased** per year for each category, sorted by category and year.

   (P.S. - for this question we are just looking for the SQL table(s) and query)

   (Example output of the query is shown below)

Category_Id	Category	Year	TotQuantity
004	Baking	2020	5720
004	Baking	2021	41222
003	Dairy	2020	98700
003	Dairy	2021	300000
006	Health and beauty	2020	10170
006	Health and beauty	2021	89211
005	Home and lifestyle	2021	210
005	Home and lifestyle	2022	900
002	Produce	2020	59000
002	Produce	2021	30783
001	Sports and travel	2020	834
001	Sports and travel	2022	400