



**SOEN 6441 - Winter 2023  
Advance Programming Practices**

**"CHEERS"  
DELIVERABLE 1**

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# 1 Problem 1

## 1.1 Introduction

A cold beverage in a glass is among many people's summertime survival strategies. The basic function of a coaster is to soak up condensation that drips along the glass, protecting the tabletop or other surface from damage. Tegestologists are also interested in the coasters. We call it as CHEERS in this project.

## 1.2 Problem Definition

Let there be two circular coasters of equal area (and negligible height). The purpose of CHEERS is to find how far the two coasters need to be moved on top of each other such that the area of the overlapping region is half the area of any one of the coasters. The length  $l$  of the segment  $X_1X_2$  is given by the equation.

$$l = 2R(1 - \cos(\alpha/2))$$

and  $\alpha$  is given by the equation

$$\alpha - \sin(\alpha) = \pi/2$$

## 1.3 CRC model

A Class Responsibility Collaborator (CRC) model is a collection of standard index cards that have been divided into three sections, as

- A class represents a collection of similar objects
- a responsibility is something that a class knows or does
- a collaborator is another class that a class interacts with to fulfill its responsibilities

Below are the CRC cards which relate to CHEERS.

### 1.3.1 CHEERS CRC Model

| <table> <tr> <th colspan="2">Length</th></tr> <tr> <td> <ul style="list-style-type: none"> <li>Calculating Length</li> <li>Precision of the calculation is maintained upto 100 digits</li> </ul> </td><td> <ul style="list-style-type: none"> <li>Sine</li> <li>Cosine</li> <li>Pi</li> <li>Bisection</li> </ul> </td></tr> </table>                                                               | Length                                                                                                |  | <ul style="list-style-type: none"> <li>Calculating Length</li> <li>Precision of the calculation is maintained upto 100 digits</li> </ul>                                                                                                           | <ul style="list-style-type: none"> <li>Sine</li> <li>Cosine</li> <li>Pi</li> <li>Bisection</li> </ul> | <table> <tr> <th colspan="2">Pi</th></tr> <tr> <td> <ul style="list-style-type: none"> <li>Calculating Pi.</li> <li>Pi calculated using Dartboard algorithm</li> <li>Running multiple times rounds of dartboard algorithm for better accuracy</li> </ul> </td><td></td></tr> </table>                                                                                                                  | Pi        |  | <ul style="list-style-type: none"> <li>Calculating Pi.</li> <li>Pi calculated using Dartboard algorithm</li> <li>Running multiple times rounds of dartboard algorithm for better accuracy</li> </ul>                                                 |                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| Length                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                       |  |                                                                                                                                                                                                                                                    |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                        |           |  |                                                                                                                                                                                                                                                      |                                                             |
| <ul style="list-style-type: none"> <li>Calculating Length</li> <li>Precision of the calculation is maintained upto 100 digits</li> </ul>                                                                                                                                                                                                                                                           | <ul style="list-style-type: none"> <li>Sine</li> <li>Cosine</li> <li>Pi</li> <li>Bisection</li> </ul> |  |                                                                                                                                                                                                                                                    |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                        |           |  |                                                                                                                                                                                                                                                      |                                                             |
| Pi                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                       |  |                                                                                                                                                                                                                                                    |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                        |           |  |                                                                                                                                                                                                                                                      |                                                             |
| <ul style="list-style-type: none"> <li>Calculating Pi.</li> <li>Pi calculated using Dartboard algorithm</li> <li>Running multiple times rounds of dartboard algorithm for better accuracy</li> </ul>                                                                                                                                                                                               |                                                                                                       |  |                                                                                                                                                                                                                                                    |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                        |           |  |                                                                                                                                                                                                                                                      |                                                             |
| <table> <tr> <th colspan="2">Bisection</th></tr> <tr> <td> <ul style="list-style-type: none"> <li>Define the equation to solve for alpha</li> <li>Calculate initial error between upper and lower bounds of range</li> <li>Solve for alpha using Bisection method</li> </ul> </td><td> <ul style="list-style-type: none"> <li>Sine</li> <li>Pi</li> </ul> </td></tr> </table>                      | Bisection                                                                                             |  | <ul style="list-style-type: none"> <li>Define the equation to solve for alpha</li> <li>Calculate initial error between upper and lower bounds of range</li> <li>Solve for alpha using Bisection method</li> </ul>                                  | <ul style="list-style-type: none"> <li>Sine</li> <li>Pi</li> </ul>                                    | <table> <tr> <th colspan="2">Factorial</th></tr> <tr> <td> <ul style="list-style-type: none"> <li>Calculates factorial of n.</li> <li>Checks the given number whether it ranges between 0 to n positive integers</li> </ul> </td><td></td></tr> </table>                                                                                                                                               | Factorial |  | <ul style="list-style-type: none"> <li>Calculates factorial of n.</li> <li>Checks the given number whether it ranges between 0 to n positive integers</li> </ul>                                                                                     |                                                             |
| Bisection                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                       |  |                                                                                                                                                                                                                                                    |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                        |           |  |                                                                                                                                                                                                                                                      |                                                             |
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| Factorial                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                       |  |                                                                                                                                                                                                                                                    |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                        |           |  |                                                                                                                                                                                                                                                      |                                                             |
| <ul style="list-style-type: none"> <li>Calculates factorial of n.</li> <li>Checks the given number whether it ranges between 0 to n positive integers</li> </ul>                                                                                                                                                                                                                                   |                                                                                                       |  |                                                                                                                                                                                                                                                    |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                        |           |  |                                                                                                                                                                                                                                                      |                                                             |
| <table> <tr> <th colspan="2">Sine</th></tr> <tr> <td> <ul style="list-style-type: none"> <li>Calculates Sine of a parameter theta (given in radians)</li> <li>Uses Taylor series expansion up to 100 values maintaining.</li> <li>Calculates the answer precision of upto 100 decimal digits.</li> </ul> </td><td> <ul style="list-style-type: none"> <li>Factorial</li> </ul> </td></tr> </table> | Sine                                                                                                  |  | <ul style="list-style-type: none"> <li>Calculates Sine of a parameter theta (given in radians)</li> <li>Uses Taylor series expansion up to 100 values maintaining.</li> <li>Calculates the answer precision of upto 100 decimal digits.</li> </ul> | <ul style="list-style-type: none"> <li>Factorial</li> </ul>                                           | <table> <tr> <th colspan="2">Cosine</th></tr> <tr> <td> <ul style="list-style-type: none"> <li>Calculates Cosine of a parameter theta (given in radians)</li> <li>Uses Taylor series expansion up to 100 values maintaining.</li> <li>Calculates the answer precision of upto 100 decimal digits.</li> </ul> </td><td> <ul style="list-style-type: none"> <li>Factorial</li> </ul> </td></tr> </table> | Cosine    |  | <ul style="list-style-type: none"> <li>Calculates Cosine of a parameter theta (given in radians)</li> <li>Uses Taylor series expansion up to 100 values maintaining.</li> <li>Calculates the answer precision of upto 100 decimal digits.</li> </ul> | <ul style="list-style-type: none"> <li>Factorial</li> </ul> |
| Sine                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                       |  |                                                                                                                                                                                                                                                    |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                        |           |  |                                                                                                                                                                                                                                                      |                                                             |
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| Cosine                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                       |  |                                                                                                                                                                                                                                                    |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                        |           |  |                                                                                                                                                                                                                                                      |                                                             |
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Figure 1: CRC model of CHEERS

### **1.3.2 Reason for collaboration**

Length class: sine, cosine, pi, and bisection are used in the formula to calculate the length of the segment. Sine and Cosine class: Factorial function is required to calculate Taylor series. Bisection class: sine and pi are required to solve for alpha. Pi and Factorial class: there are no collaborators

## 1.4 Object Oriented Principles

The code must be created in a way that allows for future updates to be made without taking a lot of time or money. Hence, we adhere to Object-Oriented design principles during the design and development phases. A highly cohesive and loosely coupled solution should always be our goal. The following are the primary guiding principles:

- Single Responsibility Principle
- Balanced Responsibility Principle
- DRY (Don't repeat yourself)

Each function that was used in Incarnation 1 and Incarnation 2 has a single duty in CHEERS. This would satisfy the SRP by improving cohesion and reducing coupling in each class.

The OOD principle is DRY (don't repeat yourself), which indicates that rather than duplicating code, we call the relevant functions when required.

In both iterations, when defining classes and method allocation, we adhere to the SRP and BRP concepts. For illustration, the main math class is only tasked with computing the solution. So, if manipulating the equation becomes necessary in the future, the developer only needs to edit this class.

## 2 Problem 2

### 2.1 Algorithms and Psuedo code

There are five primary functions which are made from scratch, which are used in CHEERS. They are as follows,

#### 2.1.1 Algorithm for Sine

Psuedo code:-

```
//Design Sine function
x < -θ
m < -0
k < -0
for k < -0 to k < -10
```

$$y = \sum_{k=0}^{10} \frac{(-1)^k (x^1 + 2k)}{(1 + 2k)!}$$

```
m < -m + y
return m
```

- **Reason for choosing this algorithm :**

A function can be represented mathematically as an infinite sum of terms using the Taylor series expansion, where each term is a power of the independent variable multiplied by a coefficient. By truncating the infinite sum after a certain number of terms, the Taylor series expansion may be used to approximate a function. The Taylor series expansion is very helpful for sine and cosine functions because it enables us to determine the value of the function at any point using just a small number of expansion terms. In the series expansion by truncating these series after a finite number of terms, we can calculate an approximation of the value of sine or cosine for any given value of x. The more terms we use in the expansion, the more accurate the approximation will be. For sine and cosine functions, the Taylor series expansion is:

$$\begin{aligned} \sin(x) &= x - x^3/3! + x^5/5! - x^7/7! + \dots \\ \cos(x) &= 1 - x^2/2! + x^4/4! - x^6/6! + \dots \end{aligned}$$

### 2.1.2 Algorithm for Cosine

Pseudo code:-

```
//Design Cosine function
x < -θ
m < -0
k < -0
for k < -0 to k < -10
```

$$y = \sum_{k=0}^{10} \frac{(-1)^k (x^{2k})}{(2k)!}$$

```
m < -m + y
return m
```

- **Reason for choosing this algorithm :**

Same as for sine (look the description given in sine section)

### 2.1.3 Algorithm for Pi

Pseudo code:-

```
//Design Pi function
score < -0
darts < -100000
for i=0 to darts
    x_coord < -randomnumberbetween -1to1
    y_coord < -randomnumberbetween -1to1
    if(square(x_coord) + square(y_coord)) <= 1
        score = score + 1
return 4 * (score / darts)
```

- **Reason for choosing this algorithm :**

The dartboard algorithm, also known as the Monte Carlo method, is a statistical technique that can be used to estimate the value of pi.

The reason this algorithm works is that as you generate more and more random points, the ratio of the number of points that fall within the



circle to the total number of points generated will converge to the true ratio of the areas of the circle and the square. This means that the estimate of pi will become more and more accurate as you generate more points.

#### 2.1.4 Algorithm for Factorial

Pseudo code :-

```
//Design Factorial function
ans < -1
for i < -1 to i < -n
    ans < -ans * i
return ans
```

- **Reason for choosing this algorithm :**

Because they show the sum of all positive integers up to a certain number, factorials are frequently employed repeatedly in mathematical computations. In an illustration, 5! (read as "five factorial") equals 5 x 4 x 3 x 2 x 1, or 120.

We frequently need to compute factorials iteratively when dealing with huge numbers that are difficult to calculate manually. To compute 100! for instance, we would need to multiply 100 x 99 x 98 x.. x 2 x 1, which is a very big number.

#### 2.1.5 Algorithm for Bisection Method

Pseudo code:-

```
//Design Bisection function
P < 0, N > 0
Check the sign for two values if one is P and another is N
    Midpoint < -  $\frac{P+N}{2}$ 
Check the sign of Midpoint and N
If the Midpoint > 0
    N = Midpoint
Else
    P = Midpoint
Return Midpoint
```

- **Reason for choosing this algorithm :**

The bisection method is a relatively simple algorithm that is easy to implement in code. Also The bisection method is a guaranteed convergent method, meaning that it will always converge to a root of the function within the given interval, as long as the function is continuous and changes sign within the interval. This makes it a reliable method for finding roots. It can be very accurate, particularly when used with a small tolerance value. It is therefore a good choice when high accuracy is required.

## 3 Problem 3

### 3.1 Quality of Code

There are several quality aspects by which the quality of the code can be improved.

- **Understandability**

The use of comments throughout the code makes it intelligible. Furthermore, self-explanatory names are used for the functions, photos, files, etc.

- **Readability**

To make the code legible by the user, the entire piece has been appropriately indented.

- **Traceability**

Code, documentation, tool sources, and test data have all been kept under version control for CHEERS. This task was completed using GitHub.

- **Complexity**

Each incarnation contains at most two files; one serves as the library and the other as the main file. This method of separating the code makes things simpler. Also, the code was kept in manageable chunks, which further lessens complexity.

- **Testability**

Unit testing was done in the debugger after each tiny piece of code, which helps find mistakes and fix them quickly. Also, the developer can quickly fix problems before integrating the entire code.

- **Maintainability**

In CHEERS, it is simple to change the code, fix errors, manage exceptions, make enhancements, etc. because of the code's high readability, high understandability, and minimal complexity. Maintainability is therefore obtained.

- **Reusability**

Reusability is the usage of pre-existing resources in the software in some way. For example, sine, cosine,  $\pi$ , and other functions developed for CHEERS can be utilised for any other problem.

- **Modifiability**

As whole code of CHEERS is written under the OOP concepts, we can modify anypart of the code very easily without impacting the other section of it.

- **General**

We can input any value for the radius in both incarnations dynamically. The code is not specific to any static values.

- **Robust**

It's handling all the possible exceptions And giving appropriate error messages on wrong input. So when any user tries to break our code We are handling it with try catch and exception Handling

## 3.2 Style Programming

A set of guidelines used when creating the source code for a computer programme is known as programming style. It is sometimes asserted that adhering to a specific programming style will make it easier for programmers to read and comprehend source code that adheres to the style and prevent errors from being introduced.[4]

- **PEP8:** A Python style manual that covers matters like how to name variables, how to utilise indentation in your code, how to organise your import statements, etc. Other Python developers will find it simpler to read and comprehend our code and to understand how their contributions should be formatted if our follow PEP8. Our code can be examined for PEP8 compliance using the Python library and PEP8 application.[6]

### 3.3 Experimental results

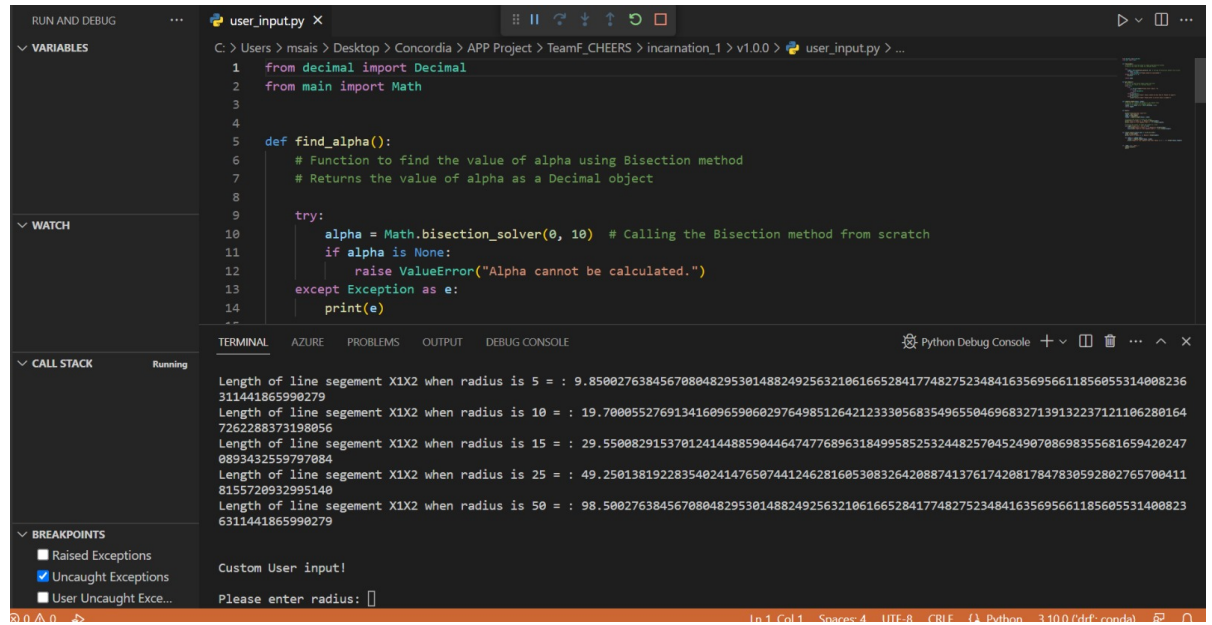
Below are the outputs(length of line segment  $X_1X_2$ ) for different values of  $R$  which are generated in Scratch method and inbuilt method respectively.

| Table 1: Values of length(l) |                   |                    |
|------------------------------|-------------------|--------------------|
| Radius                       | incarnation 1     | incarnation 2      |
| 5                            | 05.95884937227576 | 5.960245153200647  |
| 10                           | 11.91769874455153 | 11.920490306401295 |
| 15                           | 17.87654811682730 | 17.880735459601944 |
| 20                           | 23.83539748910307 | 23.84098061280259  |
| 25                           | 29.79424686137884 | 29.801225766003235 |
| 30                           | 35.75309623365461 | 35.76147091920389  |
| 35                           | 41.71194560593038 | 41.72171607240453  |
| 40                           | 47.67079497820615 | 47.68196122560518  |
| 45                           | 53.62964435048192 | 53.642206378805824 |
| 50                           | 59.58849372275769 | 9.60245153200647   |

### 3.4 Debugger

A debugger or debugging tool is a computer program that is used to test and debug other programs[7]. In CHEERS the code has been debugged in command prompt.

#### 3.4.1 Debugger for CHEERS



```
1 from decimal import Decimal
2 from main import Math
3
4
5 def find_alpha():
6     # Function to find the value of alpha using Bisection method
7     # Returns the value of alpha as a Decimal object
8
9     try:
10         alpha = Math.bisection_solver(0, 10) # Calling the Bisection method from scratch
11         if alpha is None:
12             raise ValueError("Alpha cannot be calculated.")
13     except Exception as e:
14         print(e)
```

TERMINAL

Length of line segment X1X2 when radius is 5 = : 9.850027638456708048295301488249256321061665284177482752348416356956611856055314008236311441865990279

Length of line segment X1X2 when radius is 10 = : 19.70005527691341609659060297649851264212333056835496550469683271391322371211062801647262288373198056

Length of line segment X1X2 when radius is 15 = : 29.55008291537012414488590446474776896318499585253244825704524907086983556816594282470893432559797084

Length of line segment X1X2 when radius is 25 = : 49.25013819228354024147650744124628160530832642088741376174208178478305928027657004118155720932995140

Length of line segment X1X2 when radius is 50 = : 98.50027638456708048295301488249256321061665284177482752348416356956611856055314008236311441865990279

Custom User input!

Please enter radius:

Figure 2: Debugger of CHEERS

### 3.5 Version Control

A system known as version control keeps track of changes made to a file or set of files over time so that you can later recall particular versions.

The version control for CHEERS can be found below,

- ([https://github.com/ShrawanSai/TeamF\\_CHEERS](https://github.com/ShrawanSai/TeamF_CHEERS))



### 3.6 Exception handling

Exception handling is a mechanism that separates code that detects and handles exceptional circumstances from the rest of your program. Note that an exceptional circumstance is not necessarily an error. When a function detects an exceptional situation, you represent this with an object.

Below are the Screenshots for exception handling in CHEERS. This makes it **Robust**.

- Incarnation 2

```
(def) C:\Users\msais\Desktop\Concordia\APP Project\TeamF-CHEERS\incarnation_2\v1.0.4>python main.py

Custom User input!

Please enter radius: uu
Invalid Input! Please enter a correct value (a number)
Please enter radius: -765
Invalid Input! radius cannot be less than 0. Please try again
Please enter radius:
```

Figure 3: Error message for String as radius as well as negative radius

- Incarnation 1

```
(def) C:\Users\msais\Desktop\Concordia\APP Project\TeamF-CHEERS\incarnation_1\v1.0.4>python user_input.py
Value of Alpha is: 2.3095703125 Radians
Length of line segment X1X2 when radius is 5 = : 5.95884937227576975312115989045780565171153271491070846869469050124471
5922935171063207291726237869549
Length of line segment X1X2 when radius is 10 = : 11.917698744551539506242319780915611303423065429821416937389381002489
43184587034212641458345247573910
Length of line segment X1X2 when radius is 15 = : 17.8765481168273092593634796713734169551345981444732125406084071503734
14776880551318962187517871360865
Length of line segment X1X2 when radius is 20 = : 23.835397489103079012484639561831222606846130859642833874778762004978
86369174068425282916690495147820
Length of line segment X1X2 when radius is 25 = : 29.794246861378848765605799452289028258557663574553542343473452506223
57961467585531603645863118934774
Length of line segment X1X2 when radius is 30 = : 35.753096233654618518726959342746833910269196289464250812168143007468
29553761102637924375035742721729
Length of line segment X1X2 when radius is 35 = : 41.711945605930388271848119233204639561980729004374959280862833508713
01146054619744245104208366508684
Length of line segment X1X2 when radius is 40 = : 47.670794978206158024969279123662445213692261719285667749557524009957
72738348136850565833380990295639
Length of line segment X1X2 when radius is 45 = : 53.629644350481927778090439014120250865403794434196376218252214511202
44330641653956886562553614082594
Length of line segment X1X2 when radius is 50 = : 59.588493722757697531211598904578056517115327149107084686946905012447
15922935171063207291726237869549

Custom User input!

Please enter radius: abc
Invalid Input! Please enter a correct value (a number)
Please enter radius:
```

Figure 4: Error message for String as radius

```

Value of Alpha is: 2.3895703125 Radians
Length of line segment X1X2 when radius is 5 = : 5.95884937227576975312115989045780565171153271491070846869469050124471
5922935171063207291726237869549
Length of line segment X1X2 when radius is 10 = : 11.917698744551539506242319780915611303423065429821416937389381002489
43184587034212641458345247573910
Length of line segment X1X2 when radius is 15 = : 17.876548116827309259363479671373416955134598144732125406084071503734
14776880551318962187517871360865
Length of line segment X1X2 when radius is 20 = : 23.835397489103079012484639561831222606846130859642833874778762004978
86369174068425282916690495147820
Length of line segment X1X2 when radius is 25 = : 29.794246861378848765605799452289028258557663574553542343473452506223
57961467585531603645863118934774
Length of line segment X1X2 when radius is 30 = : 35.753096233654618518726959342746833910269196289464250812168143007468
29553761102637924375035742721729
Length of line segment X1X2 when radius is 35 = : 41.711945605930388271848119233204639561980729004374959280862833508713
01146054619744245104208366508684
Length of line segment X1X2 when radius is 40 = : 47.670794978206158024969279123662445213692261719285667749557524009957
72738348136850565833380990295639
Length of line segment X1X2 when radius is 45 = : 53.629644350481927778090439014120250865403794434196376218252214511202
44330641653956886562553614082594
Length of line segment X1X2 when radius is 50 = : 59.588493722757697531211598904578056517115327149107084686946905012447
15922935171063207291726237869549

Custom User input!

Please enter radius: abc
Invalid Input! Please enter a correct value (a number)
Please enter radius: -5
Invalid Input! radius cannot be less than 0. Please try again
Please enter radius:

```

Figure 5: Error message for negative radius

## 4 Instruction for processing Source code

- For Incarnation 1 :
  - 1) Navigate to version folder
  - 2) Open cmd(Comand prompt)/Terminal.
  - 3) Type python *user\_input.py*
- For Incarnation 2 :
  - 1) Navigate to version folder
  - 2) Open cmd(Comand prompt)/Terminal.
  - 3) Type python main.py
- To generate the PyDoc:
  - 1) Open cmd or command prompt (or terminal)
  - 2) Type 'python -m pydoc modulename.py',  
Modulename can be main, scratch, inbuilt or main-inbuilt

```

PS C:\Users\gouth\Documents\GitHub\TeamF_CHEERS\incarnation_2\v1.0.4> python -m pydoc main
Help on module main:

NAME
    main

FUNCTIONS
    SubElement(...)

    bisection_solver(lower_bound: float, upper_bound: float, error_tolerance=0.001)
        Solves for a root of a non-linear function, given root boundaries and acceptable error

    compute_length(radius, alpha)
        computes the length

    find_alpha()
        Finds the value of alpha using Bisection method

    get_radius()
        Gets a valid input from user

    main()

    write_to_xml(alpha, length)
        writes the output to XML file

DATA
    VERSION = '1.3.0'

FILE
    c:\users\gouth\documents\github\teamf_cheers\incarnation_2\v1.0.4\main.py

```

Figure 6: pydoc for incarnation2 main.py

```

Windows PowerShell
PS C:\Users\gouth\Documents\GitHub\TeamF_CHEERS\incarnation_1\v1.0.4> python -m pydoc main
Help on module main:

NAME
    main

CLASSES
    builtins.object
        Math

    class Math(builtins.object)
        | A Class that returns the Math functions: Sine, Cosine, Factorial.
        |
        | Static methods defined here:
        |
        | bisection_solver(lower_bound: float, upper_bound: float, error_tolerance=0.01) -> decimal.Decimal
        |     Solves for a root of a non-linear function, given root boundaries and acceptable error
        |
        | cos(x: float) -> decimal.Decimal
        |     Compute the cosine of x using a Taylor series expansion
        |
        | factorial(n: int) -> int
        |     Calculate factorial of n.
        |
        | get_pi(ROUNDS=1000) -> float
        |     Calculate the value of pi.
        |     Where we run the dartboard algorithm number of times to get better accuracy.
        |
        | sin(x: float) -> decimal.Decimal
        |     Compute the sine of x using a Taylor series expansion
        |
        |-----
        | Data descriptors defined here:
        |
        | __dict__
        |     dictionary for instance variables (if defined)
        |
        | __weakref__
        |     list of weak references to the object (if defined)

```

Figure 7: pydoc for incarnation1 main.py

```
PS C:\Users\gouth\Documents\GitHub\TeamF_CHEERS\incarnation_1\v1.0.4> python -m pydoc user_input
Help on module user_input:

NAME
    user_input

FUNCTIONS
    compute_length(radius, alpha)

    find_alpha()

    get_radius()

    main()

    sample_outputs(sample_radii=[5, 10, 15, 20, 25, 30, 35, 40, 45, 50])

FILE
    c:\users\gouth\documents\github\teamf_cheers\incarnation_1\v1.0.4\user_input.py
```

Figure 8: pydoc for incarnation1 user\_input.py

## 5 Software Tools Used

- PyCharm
- VSCode
- Github
- lucidchart
- Autopep8
- Msais
- Spyder

## 6 Team Contribution

| Team Member | Contributions                                                                                                                                                                                                                        |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Jwalit      | <ul style="list-style-type: none"><li>• Participated in brainstorming sessions.</li><li>• Participated in the review meetings.</li><li>• Implement pi function from scratch</li><li>• Participated in Coding.</li></ul>              |
| Shrawan     | <ul style="list-style-type: none"><li>• Participated in brainstorming sessions.</li><li>• Participated in the review meetings.</li><li>• Implement sine and cosine function from scratch</li><li>• Participated in Coding.</li></ul> |

|                    |                                                                                                                                                                                                                                                                                  |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Leesha Shah        | <ul style="list-style-type: none"> <li>• Participated in brainstorming sessions.</li> <li>• Participated in the review meetings.</li> <li>• Participated in creating CRC Cards.</li> <li>• Participated in Coding.</li> <li>• Participated in Documentation in Latex.</li> </ul> |
| Vishwassingh Tomar | <ul style="list-style-type: none"> <li>• Participated in brainstorming sessions.</li> <li>• Participated in the review meetings.</li> <li>• Participated in creating CRC Cards.</li> <li>• Participated in Coding.</li> <li>• Participated in Documentation in Latex.</li> </ul> |
| Goutham            | <ul style="list-style-type: none"> <li>• Participated in brainstorming sessions.</li> <li>• Participated in the review meetings.</li> <li>• Participated in Coding.</li> <li>• Implement Factorial function</li> </ul>                                                           |
| Anant Bir Singh    | <ul style="list-style-type: none"> <li>• Participated in brainstorming sessions.</li> <li>• Participated in the review meetings.</li> <li>• Participated in Coding.</li> <li>• Implement Bisection Method</li> </ul>                                                             |

## 7 References

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- [3] [http://www.softpanorama.org/SE/programming\\_style.shtml](http://www.softpanorama.org/SE/programming_style.shtml)
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- [6] <https://alistairwalsh.github.io/python-novice-gapminder/20-style/>
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- [10] [https://users.ensc.concordia.ca/kamthan/courses/soen-6441/project\\_description.pdf](https://users.ensc.concordia.ca/kamthan/courses/soen-6441/project_description.pdf)
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