Concordia University
Engineering and Computer Science

Eternity: Function F1- Arccos(x)

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Introduction

The arccosine of x is defined as the inverse cosine function of x when -1≤x≤1. When the cosine of y is equal to x:

$$\cos y = x$$

Then, the arccosine of x is equal to the inverse cosine function of x, which is equal to y:

$$\arccos(x) = \cos^{-1} x = y$$

The domain of arccos(x) is $-1 \leq x \leq 1$ and the range of arccos(x) is $0 \leq y \leq \pi$.

Figure: The graph of Arccos(x)

Critical Decisions

- One of the critical decision was to implement the method of calculating the Arccos(x) using Taylor's Series instead of calculating cos(x) using right triangle concept and then inverting the function. It was difficult to deal with real numbers using other approach but was easy using Taylor's Series.

$$\arccos x = \frac{\pi}{2} - \sum_{n=0}^{\infty} \frac{(2n)!}{2^{2n}(n!)^2} \frac{x^{2n+1}}{(2n+1)}, |x|<1$$

- The time complexity as well as the code complexity of all other options were fairly higher than the current approach.
- Moreover, the code follows the rules as per coding standards, i.e., the functionalities in the code have been broken down into different methods, hence increasing **high cohesion and low coupling**.
- Lastly, the values of mathematical constants i.e. value of PI has been calculated again using Taylor's Series instead of initializing its value or using in-built function Math.PI. to maintain accuracy of π.

Advantages of the algorithm

1. A major advantage was better code understanding because of less coupling and high cohesion.
2. The algorithm which was preferred over the others, provides the most accurate results .
3. All the domains of the function i.e. Real numbers have been covered. Moreover, throwing exception messages for values out of domain.
4. The user has an advantage of retrieving the results in two formats i.e. radian and degree.

Disadvantages of the algorithm

1. The maximum and minimum value of the domain were not accurate, thus, the range values for the particular values were initialized in the program.
2. A large amount of registers and memory space is assigned to the program as the loops iterate 90-9999 times in different functions in the program.

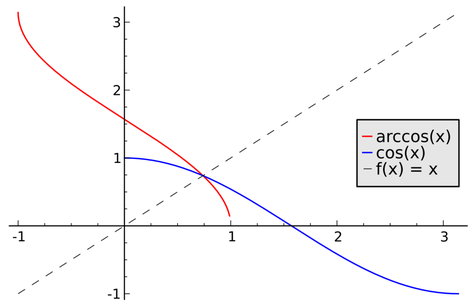

Figure: Graph of cos(x) and arccos(x)

Lessons Learned

1. Requirement analysis is very important before the actual implementation of project. If the requirements are clear, there are less chances of program and eventually project failure.
2. Test Driven Development (TDD) is necessary to develop any application.
3. Critical thinking is required to make test cases. Test cases should cover all aspects and scope of the program.
4. It is important to learn and use Version Control System (VCS). It maintains the track of the project, records the number of commits, changes and even helps for tracing. Moreover, VCS are widely used in industries nowadays.
5. It is critical to know the programming standards and coding styles to fit in software industry.
6. Code reviewing of other's project gave the real-time experience of working in industry. various tools are available for Code Review and by using them, its usefulness can be known.

Challenges

1. Initial stage for requirements gathering, critical thinking on algorithms was very challenging, as there are many techniques available that directs towards required solution.
2. Learning graph for the Taylor Series was challenging, because the series is used for many functions including the natural logarithm.
3. Integration of various methods for the proper functioning of the functionalities was also a challenge. All the functions have some or the other type of behaviour for the particular input.

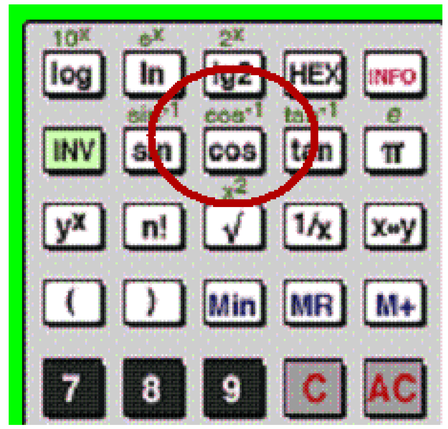

Figure: $Cos^{-1}(x)$ i.e.$arccos(x)$ in Scientific Calculator

Output of $arccos(x)$ function

```
Enter a value to calculate Arccos(x)...
0.8660
Calculated value of Arccos(x) in radians...
0.5237
Calculated value of Arccos(x) in degrees...
30.0058
```

Figure: Calculated value of arccos(x) in radian and degree

What's Next??

- The implementation of this function based on Command line Interface. As a future work, It can be implemented using Graphical User Interface.
- According to code review results, programming guidelines can be followed strictly.
- In future, design pattern can be implemented to add complex functions associated with this function.
- More emphasis can be given to precision of the output value by researching and studying techniques in-depth.

GitHub Link

https://github.com/BirvaShah/SOEN6011_Project