Function 9:-Exponentiation

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Introduction

Exponentiation function involves two numbers the base x and the exponent y [3]. Here y can be a positive or negative integer. It corresponds to repeated multiplication of the base that is x is the product of multiplying y bases[2].

$$x^y = x * ....x \{y \text{ -times }\}$$

- **Positive power**:- If y is positive, the base is simply multiplied y times[3].
- **Zero power**:- If x is a non zero and y is 0[3]. For example:

$$2^0 = 1$$

- **Negative Power**:- If x is a positive integer and y is negative integer then x become fraction number with power y[3]. For example:

$$2^{-2} = \frac{1}{2^2}$$

Domain and Range

The Domain of the power function x^y is positive real numbers and range is real numbers. Domain is

$$[0,\infty)$$

Range is

$$[0,\infty)$$

Algorithm Used

Algorithm 1 Function x^y

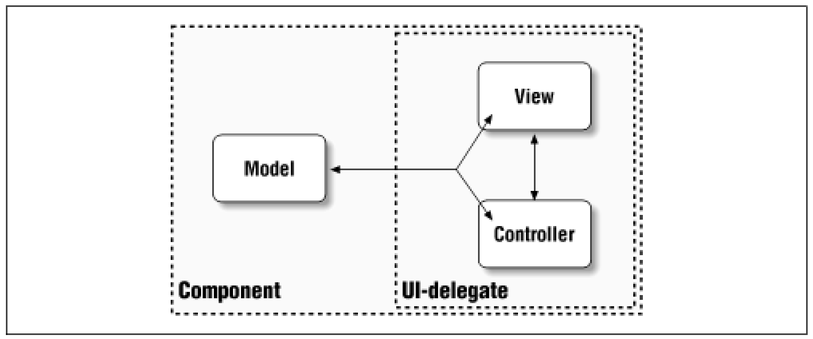
```
1:  procedure MAIN()
2:      Read x and y
3:      if y > 0 then
4:          result ← power(x, y)
5:      else
6:          temp ← power(x, y * −1)
7:          result ← 1/temp
8:      Print result
9:
10: procedure POWER(x,y)
11:     power ← 1
12:     while y > 0 do
13:         if yisodd then
14:             power* = x
15:             y ← y/2
16:             x ← x * x
17:     Return power
```

Critical Decisions

1.Choosing Algorithm:- Algorithm is very important for a computer program. It reduces complexity as well as increases performance of computing. So choosing best was very critical decision. Below are algorithm that were considered:-

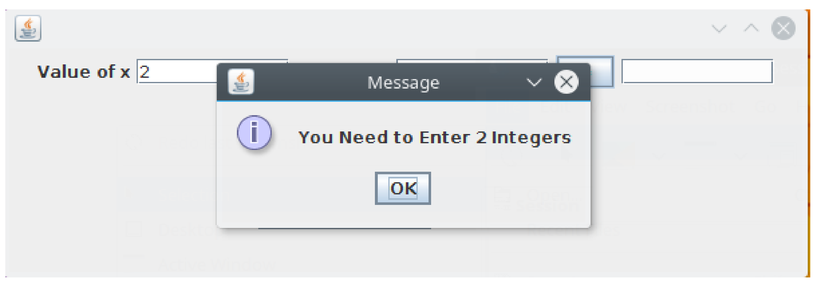
- **Naive Iterative Solution**:- A simple approach for calculating power is multiplying x exactly y time. This can be done by using for loop. Time complexity of this algorithm is O(n)[4].
- **Divide and Conquer**:- In this problem works recursively breaking down a problem into two or more sub problems[4]. For example:-
  $power(x, y) = power(x, y/2) * power(x, y/2)$ // If y is even
  $power(x, y) = x * power(x, y/2) * power(x, y/2)$ // If y is even
  Time complexity of this algorithm is O(n).
- **Low Level Programming**:- We can use binary operators to compute x^y. Time complexity in this case is O(log(n)). It has the best time complexity so we used this algorithm[1].

2.Architecture:- Architecture is fundamental structure of software system and discipline of creating such structures and systems. In order to increase maintainability of code MVC(Model View Controller) architecture is used in development.

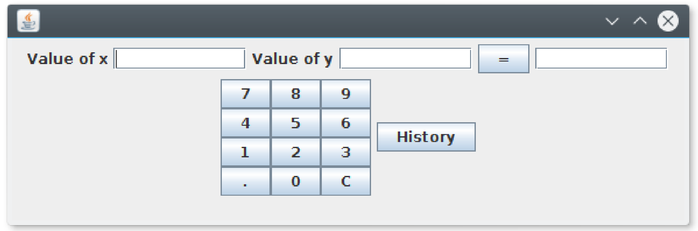


3.Exception Handling:- In order to minimize chances of error exception handling has been implemented in code. Exception handling can be found in below specified cases.

- Exception handling in input to prevent illegal inputs from users.
- Exception handling in calculation to prevent division of a number with 0.



Interface:- Interface is very important. Through interface user will interact with system. GUI based interface is used to make calculator user friendly. A virtual keyboard is also provided in calculator.



Lessons Learnt

- **Modularity**:- Modularity is the degree to which a system's components may be separated and recombined, often with the benefit of flexibility and variety in use. It is very important as it contributes to testability as well as maintainability of code.
- **Coding Standard**:- Main objective of coding standards are to provide you with an easy to follow and less boring set of practices to make your code easy to read and maintain. In this project we used Google coding standards.

GitHub Link

https://github.com/karanbehl/SOEN6011

References

[1] Udit Gupta. *Write an iterative O(Log y) function for pow(x, y)*. July 2019. URL: https://www.geeksforgeeks.org/write-an-iterative-olog-y-function-for-powx-y/.

[2] Duane Q. Nykamp. *Math Insight*. URL: https://mathinsight.org/exponential_function.

[3] Elizabeth Stapel. *Exponential Functions: Introduction*. URL: https://www.purplemath.com/modules/expofcns.htm.

[4] *Write a program to calculate pow(x,n)*. July 2019. URL: https://www.geeksforgeeks.org/write-a-c-program-to-calculate-powxn/.