Concordia University

SOEN 6011 - Software Engineering Process

ETERNITY: FUNCTION
ab^x

Deliverable 1

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1 Introduction

An exponential function is a function with the general form ab^x, $a \neq 0$, b is a positive real number and $b \neq 1$ .In an exponential function, a is constant, the base b is a constant, and the exponent x is a real variable.[1]

1.1 Domain

- The domain is all real numbers.
  $-\infty < x < +\infty$, $x \in R$ [1]

1.2 Co-Domain

- The co-domain is also set of all real numbers.

1.3 Characteristic

- **Exponential growth** : In the function f(x) = b^x when $b > 1$, the function represents exponential growth. In figure 1, it is evident on the left side. [3]
- **Exponential decay** : In the function f(x) = b^x when $0 < b < 1$, the function represents exponential decay. In figure 1, it is evident on the right side.[3]
- **Commutativity**: Exponential function is not commutative which means $x^y \neq y^x$ for $x \neq y$. For example, $0^1 = 0$ and $1^0 = 1$.
- **Natural Exponential Function**: When the base is chosen to be b=e, the function f(x) = e^x is called natural exponential function.[1]
- In the function f(x) = ab^x when $|a| > 1$, it increases the speed of either growth or decay, and $0 < |a| < 1$ decreases the speed of either growth or decay.[2]

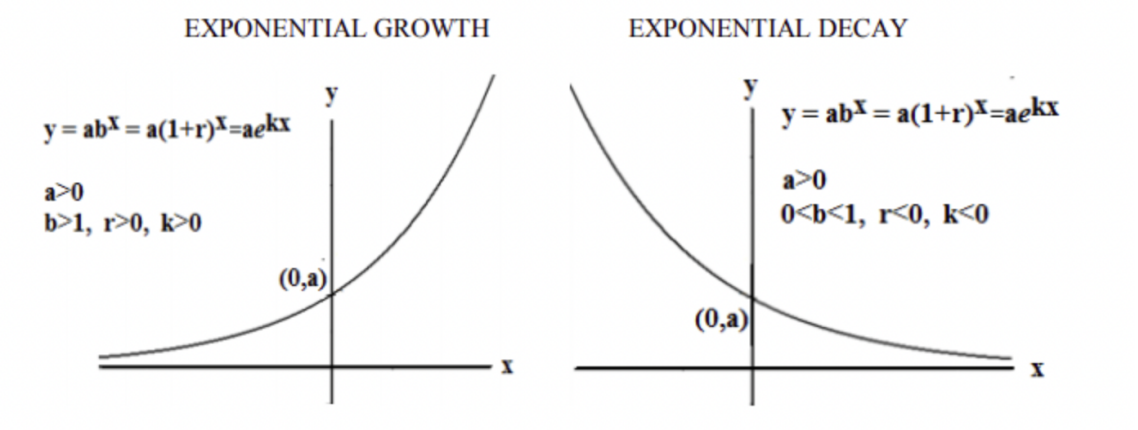

Figure 1: Exponential Growth and Exponential Decay

2 Functional Requirement

2.1 Definitions and abbreviations

Term	Definition
FR	Functional Requirement
NFR	Non-Functional Requirement
User	End user are the human users who interacts with the system
System	Application which is used for solving exponential function.

Table 1: Definitions and abbreviations

2.2 Assumptions

- The calculator must accepts the exponential constant like e in addition to the constants a and b.
-

2.3 Requirements

Functional Requirements

- **ID** :FR1
  Type :Functional
  Version Number :1.0
  Owner : Avneet

Priority : High
Difficulty : Easy
Description :The calculator should ask the user to input a, b, and x.
Rationale :In order to process function f(x) = ab^x and give output system needs input form the user.

- **ID** :FR2
  Type :Functional
  Version Number :1.0
  Owner : Avneet
  Priority : High
  Difficulty : Easy
  Description :When a user input is not a number, the system should provide an error message.
  Rationale :The only acceptable input for an exponential function calculation is a number.

- **ID** :FR3
  Type :Functional
  Version Number :1.0
  Owner : Avneet
  Priority : High
  Difficulty : Easy
  Description :If a user enters incorrect data, the system shouldn't shut down but rather prompt users to reenter their data.
  Rationale :The ability to perform calculations again and without closing the programme should be available to the user.

- **ID** :FR4
  Type :Functional
  Version Number :1.0
  Owner : Avneet
  Priority : High
  Difficulty : Easy
  Description : Whole numbers and rational numbers are accepted as user inputs.
  Rationale : The code does not handle irrational numbers.

For instance, π, $\sqrt{2}$

- **ID** :FR5
  Type :Functional
  Version Number :1.0
  Owner : Avneet
  Priority : High
  Difficulty : Easy
  Description : Fractional inputs must be entered as double values.
  Rationale : If a user wants to provide a base or exponent value of 1/2, they must do so as 0.5.

- **ID** :FR6
  Type :Functional
  Version Number :1.0
  Owner : Avneet
  Priority : High
  Difficulty : Easy
  Description : Base b is restricted to positive number.
  Rationale : In order to guarantee b^x is real number.

- **ID** :FR7
  Type :Functional
  Version Number :1.0
  Owner : Avneet
  Priority : High
  Difficulty : Easy
  Description : When any base value of b is raised to the power of x=0, the function's b^x portion must return the value 1.
  Rationale : For instance: 11 raised to the power 0 gives 1.

- **ID** :FR8
  Type :Functional
  Version Number :1.0
  Owner : Avneet
  Priority : High
  Difficulty : Easy

Description : When base value b=0 is raised to any exponent value, the b^x portion of the function must return 0.
Rationale : For instance, 0 raised to the power 11 yields 0.

Non-Functional Requirements

- **ID** :NFR1
  Type :Non-Functional
  Version Number :1.0
  Owner : Avneet
  Priority : High
  Difficulty : Easy
  Description :An error message should be informative and relevant to the user.
  Rationale : The user should be able to resolve simple problems on their own by understanding error message to enhance usability.

- **ID** :NFR2
  Type :Non-Functional
  Version Number :1.0
  Owner : Avneet
  Priority : High
  Difficulty : Easy
  Description :The command line interface ought to be user-friendly.
  Rationale : The system should be simple for the user to operate.

- **ID** :NFR3
  Type :Non-Functional
  Version Number :1.0
  Owner : Avneet
  Priority : High
  Difficulty : Easy
  Description :The outcome must be accurate.
  Rationale : To enhance the accuracy of system. It is inappropriate to display incorrect ouptut to the user.

- **ID** :NFR4
  Type :Non-Functional
  Version Number :1.0
  Owner : Avneet
  Priority : High
  Difficulty : Easy
  Description :There should be no more than 5 seconds of calculation time.
  Rationale : In order to improve the performance of the system.

- **ID** :NFR5
  Type :Non-Functional
  Version Number :1.0
  Owner : Avneet
  Priority : High
  Difficulty : Easy
  Description : System should be maintainable for the duration of its anticipated lifetime and able to accommodate new requirements in response to stakeholders' changing needs.
  Rationale : Since future changes to software systems are inevitable. Maintainable systems are therefore simpler to alter.

- **ID** :NFR6
  Type :Non-Functional
  Version Number :1.0
  Owner : Avneet
  Priority : High
  Difficulty : Easy
  Description : The system should be developed using widely used and standardised language.
  Rationale : Java is used to build a system which is platform independent hence make the system portable.

3 Algorithm

3.1 Pseudocode

Algorithm 1 Iterative Algorithm to calculate: ab^x

```
procedure calculateExponentialFunction(a, b, x)
    input:  String a, b, x
    output:  double res
    res = 1
    temp = 1
    if ((a || b) == "0") then return res
    else
        if (b == "e") then
            exposum = 1
            nterms = 25
            for i <= nterms
            exposum = 1+x * exposum/i
            end
            return a*exposum
        else
            for temp <=x
            res = res * b
            temp = temp + 1
            end
            return a*res
```

Algorithm 2 Recursive Algorithm to calculate: ab^x

```
procedure calculateExponentialFunction(a, b, x)
    input:  string a, b, x
    output:  double res
    res=0
    if (a || b == 0) then
        return res
    else if (b=="e") then
        res = naturalExponential(x)
    else
        res = calculatePower(b,x)
    res = a * res
    return res

procedure naturalExponential(x)
    input:  int x
    output:  double exposum
    nterms = 25
    exposum = 1
    for i <= nterms
    exposum = 1+x * exposum/i
    end
    return exposum

procedure calculatePower(b, x)
    input:  double b, int x
    output:  double res
    if ((x < 0) then
        return 1.0/powHelper(b, x)
    return powHelper(b, x)

procedure powHelper(b, x)
    input:  double b, int x
    output:  double res
    if (x == 0) then return 1
    if (x == 1) then return b
    if (xmod2 == 0) then
        return powerHandler(b * b, n/2)
    else
        return b * powerHandler(b * b, n/2)
```

3.2 Description

Algorithm1

Description:
Rationale:
Complexity:
Advantages:
Disadvantages:

Algorithm2

Description:
Rationale:
Complexity:
Advantages:
Disadvantages:

3.3 Mindmap for Pseudocode format Selection

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