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COMP 354-BB

**Project Notes**

* Underline means possible glossary term.

**Collaboration Patterns**

Weekly Meetings: Sundays at 3:00 pm

Realized through Discord, which is also used to exchange messages and contact other members

Sharing code and programs through online GitHub service and Overleaf

Zoom meetings during lab time on Fridays at 9:15

Documenting meetings and shared information in Google Docs

**Exponential Function**

*y = abx* is an exponential function, where *b* is defined as the base and is any real constant number where *b* > 0 and *b* ≠ 1 [1]. *a* is any constant real number where *a* ≠ 0 [1]. And *x* is any real variable, defined as the independent variable [2]. In exponential functions, the rate of change changes over time, with the rate of growth either becoming faster or slower depending on the value of the base, *b* [3].

The features of exponential functions are:

* Domain is all real numbers.
* Range is all real numbers, excluding 0.
* For *b* > 1, the function increases, meaning the values of *y* grow in value.
* For 0 < *b* < 1, the graph decreases meaning the values of *y* decrease in value.
* The function can approach but never reach the value of 0. [1]

The exponential function works by multiplying the base, *b*, by itself, *x*, number of times, where *x* is the input of the function. Exponential functions don’t have a constant rate of change, but instead have constant ratios, meaning they grow by common factors over equal intervals [1]. For example, the function y = 2x (seen in Figure below) displays an exponential growth, where the value is doubled for every 1 interval of *x*, which is usually any unit of time, and increases rapidly [2].

Chart, line chart

Description automatically generated

**Figure**: Graphical representation of the function y = 2x, which is an example of exponential growth. [1]

**Glossary**

Base: used to refer to a particular mathematical object that is used as a building block [4].

Domain: the set of input values for which a function is defined [5].

Exponential: containing an exponent; a number or sign that shows how many times another number is to be multiplied by itself [6].

Exponential Growth: a pattern of data that shows greater increases with passing time, creating the curve of the exponential function [7].

Function: a relation from a set of inputs to a set of possible outputs, where each input is related to exactly one output [8].

Independent Variable: represents a quantity that is being manipulated, the inputs of the function [9].

Range: The set of values a function outputs [5].

Rate of Change: Is used to mathematically describe the percentage change in value over a period of time; the speed at which variables change over a specific period of time (Chen "Rate of Change (ROC)").

Rate of Growth: refers to the percentage change of a specific variable within a specific time period [11].

Real Number: any number where all arithmetic operations can be performed and can be represented in the number line. Excludes any imaginary numbers [12].

Variable: a symbol, usually a letter standing in for an unknown numerical value in an equation [13].

Subordinate Function: a simpler or smaller function used to evaluate the special functions included in the Eternity system, such as square root or factorial.

Special Function: the seven functions that are described within the report and to be included in the Eternity system; exponential, arccos, log, MAD, standard deviation, sinh and xy.

**References**

[1] D. Roberts, “Exponential Functions - MathBitsNotebook(A1 - CCSS Math),” *MathBitsNotebook*. https://mathbitsnotebook.com/Algebra1/FunctionGraphs/FNGTypeExponential.html (accessed May 22, 2021).

[2] D. Q. Nykamp, “The exponential function - Math Insight,” *Math Insight*. https://mathinsight.org/exponential\_function (accessed May 22, 2021).

[3] “Exponential Functions - Definition, Formula, Properties, Rules,” *BYJUS*. https://byjus.com/maths/exponential-functions/ (accessed May 24, 2021).

[4] E. W. Weisstein, “Base.” https://mathworld.wolfram.com/Base.html (accessed May 22, 2021).

[5] “Domain and Range | Boundless Algebra,” *Lumen Learning*. https://courses.lumenlearning.com/boundless-algebra/chapter/domain-and-range/ (accessed May 22, 2021).

[6] “exponential,” *Cambridge Dictionary*. https://dictionary.cambridge.org/dictionary/english/exponential (accessed May 22, 2021).

[7] J. Chen, “What Is Exponential Growth?,” *Investopedia*, Apr. 30, 2021. https://www.investopedia.com/terms/e/exponential-growth.asp (accessed May 22, 2021).

[8] D. Q. Nykamp, “Function definition - Math Insight,” *Math Insight*. https://mathinsight.org/definition/function (accessed May 22, 2021).

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[10] J. Chen, “Rate of Change (ROC),” *Investopedia*. https://www.investopedia.com/terms/r/rateofchange.asp (accessed May 24, 2021).

[11] J. Chen, “Growth Rates,” *Investopedia*. https://www.investopedia.com/terms/g/growthrates.asp (accessed May 24, 2021).

[12] “Real Numbers- Definition, Properties, Set of Real Numerals,” *BYJUS*. https://byjus.com/maths/real-numbers/ (accessed May 22, 2021).

[13] T. E. of E. Britannica, “Variable | mathematics and logic,” *Encyclopedia Britannica*, Oct. 10, 2012. https://www.britannica.com/topic/variable-mathematics-and-logic (accessed May 22, 2021).

**Interview**

Interviewee: Marco Mignacca

Occupation: Student at Concordia University

Age: 20

Gender: Male

**1.** What is your current program of study/profession?

**A1: Pure and Applied Math.**

**2.** How much experience do you have in this field of study/work?

**A2: 1 and half years in current program. 3 years in Pure and Applied Science at Marianopolis.**

**3.** Do you enjoy your studies/work? If yes, which part interests you the most? If no, what do you not like about it?

**A3: Yes**

**Enjoys problem solving, given a problem and have all the necessary solutions to solve the problem.**

**Doing calculations, calculator work, Algebra is most preferred subject.**

**Having tools necessary for computations, steps to get to final answer.**

**Dislikes, proofs, and analysis, does not enjoy creativity, prefer more step wise procedures and approach.**

**4.** What tasks or jobs would you say you mostly do in your field of study/work?

**A4: Taking notes for class.**

**A lot of proofs, here is statement and proof using rules provided.**

**Some classes are theoretical with proofs, others include calculations with proofs and matrices.**

**Computation and proofs combined.**

**Solving problems and taking notes in general.**

**5.** Can you tell me some of your likes and dislikes and what you enjoy doing?

**A5: Enjoys drawing and baking, music (J-pop or pop).**

**Don’t enjoy news, dealing with economy money, or politics.**

**Reading (Informational and Learning new fields like Psychology/Math/Physics).**

**Watching tv shows and movies (Anime and documentary/informational).**

**Spending time with family.**

**6.** What are your values when it comes to your field of study?

**A6: Honesty, Hard-Working, Self-Work, Self-Understanding, Integrity, Thorough, Not Assuming, Neatness.**

**7.** What occupation are you aiming towards, if you are not already employed?

**A7: Short Term, TA for a Math class.**

**Future, Professor or Researcher in the Math.**

**Unsure of specific field, desires more experience and understand more.**

**8.** What skills have you been developing which you feel will be the most important for this future career?

**A8: Organization, being organized in studies.**

**Interpersonal skills and working with others, trying to improve.**

**Timeliness and reliability, making sure tasks are done on time and being reliable.**

**9.** What are your current goals for yourself? If you have none, do you think you will have some in the future?

**A9: Learn more about programming, LaTeX, Python.**

**Trying to develop more relations with professors to gain a TA position.**

**10.** Do you prefer to use to use the hand-held calculator or computer calculator?

**A10: Prefers handheld over computer. Used to it more and is more portable for class. Rather not have another window open on computer while doing work.**

**11.** Do you have experience using the command line of your computer? And using a calculator on your computer?

**A11: Experience using handheld calculator over computer.**

**Has used command line to remedy problems with computer.**

**Not much experience with programs that use command line.**

**12.** Are you comfortable enough to use a calculator without a Graphical Interface and just with the command line?

**A12: Would prefer user interface, with buttons over typing on command line.**

**13.** Currently, my team and I are designing a scientific calculator and we are hoping to get your input to improve our design. How much experience do you have with a Scientific Calculator, and how often do you use one?

**A13: Quite a bit of experience, used all through college and university, not much as of late.**

**Current learning field is dealing with proofs and not much with procedures and input.**

**Uses it a few times a week within class, less often then in college.**

**Row reducing matrix is example of not available.**

**14.** Are there any functions you feel should be included in a Scientific Calculator but aren’t?

**A14: Doing operation to get answer, no way to return to original function to check if unput was correct.**

**No way to return to previous function and input values**

**Better way to deal with a lot of brackets, losing track of open and closing brackets in expression.**

**More functions to input a matrix, perform row reduction or allow for matric multiplication or addition.**

**15.** Does your operating system provide any calculator? if yes, Do you think its functions are enough for you?

**A15: Yes, it does offer one, but there are not all the scientific functions needed.**

**Missing some trigonometric like sinh. Also doesn't have for other roots besides square.**

**16.** What function/ functions do you usually need from a Scientific Calculator most?

**A16: Mostly used for values cannot calculate alone.**

**Trigonometric, log and roots of values. Also, for factorial.**

**17.** Do you think you will use a scientific calculator in your field of study and in your future career. If yes, what will some of your uses for it, if no, do you think you would use for personal use?

**A17: In future career, will most likely use it in the future and will need it.**

**Currently uses it for derivative and integrals, using log, e and trigonometric functions.**

**Taking roots of numbers.**

**Mainly dealing with trigonometric and exact values, convert fractional to decimal, complicated algebra to reduce down to single number.**

**18.** Do you use Scientific Calculator during your work or your exams or your course projects or anything else?

**A18: Yes, less than in previous years currently. mostly in class and for exams.**

**Not many projects, used for assignments and algebra exams.**

**19.** Our calculator will include the functions for exponential functions, arccos, log, Gamma, Mean Absolute Deviation, Standard Deviation, sinh and a special exponential function which allows variables and expressions for the base instead of natural numbers. Can you tell us which function you would find most usable for yourself? Why?

**A19: Gamma function and standard deviation will most likely be used, from statistics.**

**Standard deviation to input the data and get answer.**

**Gamma in probability.**

**Trigonometric function.**

**To plug in input and get final answer from standard deviation or gamma.**

**20.** If no, is it because you don’t see yourself using any of the functions mentioned, or some other reason?

**A20: Do not really see specific use for other functions.**

**Others mentioned will be more certain in the future.**

**Not clear of a context for the other functions.**

**21.** How familiar are you with these functions and how they work?

**A21: Very familiar, have used them all before. Less familiar with MAD and xy, haven't used in a while**

**Most familiar with log, Gamma, Standard deviation since used in classes now.**

**22.** Do you think it is necessary that a Scientific Calculator should take a function as input?

**A22: Yes, would prefer if calculator could help simplify long expressions.**

**Easier to input functions to help get exact values as well.**

**23.** Are there any features you would like to see included in this calculator that you think would make the design better?

**A23: Being able to put in a long expression and simplify it, instead of just decimal.**

**After plugging in big trigonometric function, can use trig identities to simplify.**

**24.** What should the precision for a Scientific Calculator be?

**A24: Don’t need more or less decimal places but would prefer feature that gives exact values when wanted (trigonometric or sin function).**

**Instead of decimal rounding, prefer exact values in identity or fraction, simplify and shorter answer.**

**25.** When using a calculator do you prefer to receive a step-by-step solution or simply a final answer?

**A25: Prefers using online calculator that shows expressions in proper formatting. See the expression on how you would see on paper (not 2^5). Help see if inputting is done properly.**

**Easier to see if mistakes were made, would help when answering questions later.**

**26.** Do you think a history is essential for a calculator? If yes, how big should the history be?

**A26: Yes, being able to have a window to see everything being written down, being able to see previous inputs, have a history of values, helpful to check your work.**

**History should last until calculator is cleared or new function is started.**

**27.** Do you have any positive experiences with a Scientific Calculator, if yes please elaborate?

**A27: Enjoyed the use of factorial function and the choose function.**

**Being able to use trig functions regularly, much simpler.**

**Regular operations, simple arithmetic and trig were simple to use and easy to understand right away.**

**28.** Do you have any negative experiences with a Scientific Calculator, if yes please elaborate?

**A28: Annoying that for a lot of functions have to click the shift function to access.**

**The input is not very intuitive for some functions, for e function, need to place brackets around exponent.**

**Doesn’t show the input as exponent, looks more like multiplication (format not as nice).**

**After writing long chain of operations, difficult to go back and look through your large input and expression.**

**Taking cube root or fourth root, have to enter the number of root first before value, choose you want to do a root and then specify the root number and the input value.**

**Screen is too small, would like to see more of input, instead of having to go back.**

**29.** In your opinion, what would improve your experience when using a Scientific Calculator on a computer? What features would improve its usage for you?

**A29: Having a dedicated button for all the functions to use, instead of using shift or second function to access all the same.**

**Nice, formatted input so it looks more like on paper then, see everything nicely and clear.**

**Summary of Interview Processes (Deliverable 2)**

The interview was conducted using funnel model. First by getting to know the interviewee’s personal likes and dislikes, how they feel about their work/studies. This was used to help build a base for the persona and to establish more of a connection with interviewee. After getting a background, the questions became more specific to the use of a scientific calculator, their familiarity with the functions that will be included in ours, what would make it more appealing to them and any extra features they would like to see. Asking these questions after getting to know the interviewee makes it easier to explain the questions or understand their opinions. Interviewee can trust us more and if they are stuck on a question, we can help them.

The structure of the interview was Semi-structured, as some follow up questions were asked when getting to know the interviewees likes and dislikes as well as their reasoning behind some answers. Or to help clarify something the interviewee said that was related to their work/studies and not familiar to us. The interviewee was also given the ability to explain an answer when they wanted to, but not for all of them, since the interviewee felt they were intuitive or required no explanation.

They type of questions were both close ended and open ended. The questions that were open ended were used to gain information about the interviewee’s likes and dislikes as well as what they thought would improve the calculator. While the close ended questions were used to verify information such as their profession, preference between hand-held or online calculators and experiences.

**Analysis of Responses (Deliverable 1)**

From the responses, I understood the interviewee had more negative experiences with a calculator then positive, and that they desired more functions to be added. They would prefer a scientific calculator more suited to their current studies and tasks for school, such as ones that allow for matrices to be entered and that provide more trigonometric possibilities like simplification. The interviewee also expressed interest in a calculator that can keep a better history and format than most handheld ones, which a computer scientific calculator can provide more easily, and improve its usage. The responses were generally quick and to the point, with the interviewee expressing interest in improving calculators and helping us.

**Persona**

**Name**: Marco Mignacca

**Gender**: Male

**Age**: 20

**Disabilities and restrictions**: None

**Education**: One year and a half at Concordia University, Pure and Applied Math program

**Profession**: Student

**Description**: Currently studying at Concordia Pure and Applied Math program. He is interested in developing new math skills and working on a problem after being given all the tools needed. Prefers more algebraic and stepwise problem solving over proofs and theoretical work. Most preferred field is Algebra, but current studies include a mix of both computation and proofs.

**Values**: Honesty, Hard-Working, Integrity, Thoroughness, Not Assuming, Neatness

**Goals**: To become a TA (Teaching Assistant) for a math class soon.

To become a professor or researcher in a math field but is unsure of specific field now.

**Frustrations**: Does not enjoy proofs and theoretical math studies

No way to return to previous functions and work with current scientific calculator. Difficult to manage open and closing brackets.

Having one button dedicated to more than one function, needing to click shift or second function to use some functions.

Screen is too small on regular calculator, makes it difficult for longer expressions.

**Hobbies**: Drawing and baking

Listening to music (mostly pop)

Reading (informational texts/learning new things)

Watching TV and movies (Anime and documentaries)

**Needs**: Ability to return to previous functions, history for calculator.

Functions to input matrix and perform matrix operations.

Exact values be returned, instead of decimal, either fraction or simplified version of expression.

Nice, formatted input, like one would see on paper.

**Location of use**: School and at home

Computer literacy: Has used command line before, but not for programs.

Has used calculator on computer.

**Special needs when using a computer**: None.

**Mathematical proficiency**: Familiar with all the functions to be included in Eternity.

1 and a half years in Pure and Applied Math, 3 years in Pure and Applied Sciences, mostly Physics.

Preferred fields are algebra and statistics.

**Summary of Personas (Deliverable 2)**

The Personas chosen were to help show the different kinds of users and fields in which the Eternity Scientific Calculator could be used. While the primary targets may be students in Math related programs or physics, the personas also showed those in graduate programs, ones with full time jobs and even in programs not immediately related to Math. The approach for the personas was to establish them as a person first with their likes and dislikes as well as information about them as individuals, before addressing the Eternity calculator.

The fields used in the template were used to display the information gathered from the interviews. First with personal information about the user, a description, likes and dislikes, experiences. Then, focusing on their thought for Eternity, their needs, frustrations, experience in Math and tasks to be performed. The personas help organize the wants and pain points of the target audience as well as the uses for Eternity. The template also makes it easy to structure the personas using a table. Any special needs or disabilities could also be addressed from the personas which could be used to improve the calculator even more.

Diagram

Description automatically generated**Use Case**

**Figure**: UML Use Case Diagram for Eternity Scientific Calculator by Student for Assignment Problem in Pure and Applied Math.

**Analysis of Use Cases (Deliverable 2)**

The use cases were gathered from the interviews after determining what the different interviewees would use the Eternity system for. They were modeled using the UML Use Case Diagram and realized after organizing the responses from our interviews together. The use cases describe more general uses of Eternity, and how different actors may use the system for different reasons or uses. In the case of the student in Pure and Applied Math use case, the functions used are a mix of simple arithmetic, subordinate functions and special functions, since the student is not specializing in a specific math field yet.