COMP 354
Deliverable 3
Team I

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Outline

1. Glossary

- **Back-End:** In the realm of software engineering, back-end often refers to the code that is responsible for the logic of a system, but which the user never directly interacts with through the user interface. [1]

- **Collaborator:** This term will be used to refer to the members of the ETERNITY project.

- **ETERNITY:** The name of our web-based calculator.

- **Framework:** In the realm of software engineering, a framework is an abstraction tool that helps solve certain problems more efficiently and quickly by handling the minor details and allowing the software engineer to focus on problem solving. [2]

- **Front-End:** In the realm of software engineering, front-end refers to the code that is responsible for the user interface and user experience. It is the part of the software that a user interacts with. [3]

- **Full-Stack:** In the realm of software engineering, full-stack refers to both the front-end and back-end code and their integration with one another.

- **Function:** An assignment from an element of one set to exactly one element of the second set. [4]. Alternatively, in this project it is also a shorthand for the eight transcendental functions that are part of ETERNITY.

- **LaTeX:** A typesetting language used to create documentation and reports. It is commonly used for technical and scientific documents [5]

- **Merge Conflict:** A concept in source control that occurs when multiple branches have conflicting changes. Meaning the source control software is not able to integrate them automatically, requiring a person to do it — which is both time-consuming and difficult.

- **Pair-Editing:** A process in which two collaborators edit a document together. Thus facilitating greater communication and allowing for better decision making.

- **Persona:** Personas define who you're designing your product for and are based on real user data. Personas create a common language for everyone designing the product and avoids the ambiguous term "users." [6]

- **Scientific Calculator:** An electronic calculator that can handle trigonometric, exponential and often other advance functions. The output is generally showed in scientific notation. [7]

- **Software:** A set of instructions and data that operates a computer and tells it what to do. [8] The term is an opposition to hardware which designate the tangible or physical parts of a computer.

- **Standard Calculator:** A usually electronic device for performing mathematical calculations. [9]

- **STEM:** An abbreviation used to group together the disciplines of **S**cience, **T**echnology, **E**ngineering, and **M**athematics. [10]

- **Technical Debt:** Taking a shortcut in software development that leads to an increased amount of development time later in the project, due to difficulties associated with refactoring or fixing the rushed code.[11]

- **Typesetting:** The arrangement of text in a document. [12]

- **Unique Selling Point:** Often abbreviated as USP, the unique selling point is a feature or set of features that make a product different from other similar products. It is often these unique selling points that decide which product a consumer will decide to use. [13]

- **User:** Within the context of the ETERNITY project, a user is a person who will directly interact with the software.

- **User Experience:** Often referred to as UX, the user experience is how a user interacts with and experiences a product, system or service. It includes a person's perceptions of utility, ease of use, and efficiency. [14]

- **User Interface:** Often referred to as UI, the user interface is the space where interactions between humans and machines occur. [15]

- **Web Application:** Often shortened as "web app", this refers to any software that is accessed through a web browser and which runs on a server. [16]

2. Introduction

The following report centres around the work of group I as it relates to the ETERNITY project — the focus of which is to create a calculator while learning essential concepts in software engineering.

Team I aims to develop the ETERNITY calculator as a web application. The primary reason for this decision is that it allows the software to work seamlessly across all devices, making it portable and thus more accessible to a wide audience. Web applications are also incredibly popular, thanks to modern frameworks and tools that allow these browser-based software to be as feature-rich and fast as native applications. Another benefit of web applications is that they are easier to scale and update than native applications, as any changes will instantly be accessible to users — as opposed to requiring an update.

2.1   Programming Languages

HTML, CSS, and JavaScript are required because of the decision to make a web application. For the back-end we have decided to use Python because the language is easy to integrate into a web application, and because Python is well-suited to the problem domain of mathematics (as seen in its libraries like Pandas and Numpy, as well as in Jupyter Notebooks which is popular in data science).

2.2   Frameworks

In order to facilitate and improve the software development process, we have decided to use a number of front-end and back-end frameworks in the development of ETERNITY.

Django

Django is a web framework for Python, which made it easy to integrate the back-end Python with the front-end languages. This framework follows MVC architecture, which is common amongst most web applications and websites. It helps create the separation of concerns between the logic, display, and formatting. [17]

Vue.js

Vue.js (otherwise known as Vue) is a JavaScript framework for creating the views in the front-end of a web application. It eases the process by abstracting repeating HTML code into what are known as components, while attaching attributes and functions to them. This helped in the creation of buttons for the ETERNITY calculator, as they all served the same fundamental purpose. [18]

jQuery

jQuery is another popular JavaScript framework. Whereas Vue focuses on creating reusable components, jQuery is meant to assist in DOM manipulation and the application of CSS. That is why our team used it to implement the various visual themes in the ETERNITY calculator. [19]

3.   Collaboration Patterns And Tools

In order to maximize our team's productivity and efficiency, we decided to use a number of collaboration tools to streamline the creation of ETERNITY. Below you'll find the four main tools used to accomplish this.

3.1   Discord

Discord is a voice, video, and text communication service [20]. We chose it for the following reasons:

1. **Familiarity:** All collaborators have experience with Discord, so everyone was already familiar with the interface and basic set of features. No extra time was needed to learn how to use the software.

2. **Features:** Discord offers the ability to create different text channels which are used to keep track of different types of information — including notes, meeting information, and discussions on the deliverables.

   It also offers voice channels which are useful for weekly meetings. These also offer the ability to share screens, which can be used to communicate through the visual presentation of certain software or technologies.

3. **Portability:** Discord is available on a web browser, as a desktop program, and on mobile devices. This allows collaborators to keep in constant communication.

3.2   GitHub

A platform where developers build, ship, and maintain their software [21]. We chose it for the following reasons:

1. **Version Control:** GitHub builds off of Git, which is a version control system. By using GitHub we are adding version control to our work, allowing us to track changes to the software. It also allows everyone's code to use the most up-to-date version of other team member's code. This helps avoid the needless redoing of previous work.

2. **Project Management Features:** GitHub has a Kanban-like system integrated within, called GitHub Project. It allows collaborators to keep track of one another's progress, and see the overall progress of the deliverables. It is also directly linked with GitHub's issue feature.

3. **Wiki Features:** GitHub has a built-in wiki feature that allows collaborators to create wikis and glossaries for their projects. It's also a great place to keep documentation regarding the software. Since a glossary is already a requirement for the deliverables, this seemed like a great feature to use. It also allows us to slowly create parts of the report as the project progresses, so the report only involves us porting the information from the wiki to a LaTeX report.

4. **Pull Requests:** GitHub allows collaborators to create branches for their changes and to submit them as a pull request. These pull requests can then be viewed and improvements suggested before it is properly merged into the main branch. Thus acting as a form of code review.

3.3   Google Documents

An online word processor. We chose it for the following reasons:

1. **Collaborative Ability:** Google Documents allows multiple collaborators to work on a single document at the same time. This allows more cohesion and allows a large task to be broken into smaller chunks before collaborators begin working in parallel on each sub-task.

2. **Cloud Functionality:** All Google Documents reside on the cloud, so all members access the same document. This creates a single source of information for collaborators, allowing everyone to stay on the same page. Or to jot down ideas in a relatively unformatted way. While GitHub could be used instead, its focus on source code limits the flexibility of the types of notes taken — an issue not present in Google Documents.

3.4   Overleaf

An online LaTeX editor that allows simultaneous editing by multiple collaborators. We chose it for the following reasons:

1. **Ease Of Use:** Overleaf provides countless packages and an easy-to-use LaTeX compiler that automatically generates a PDF whenever the document is saved. This reduces the build process for document creation, as everything is already in-place.

2. **Portability:** Overleaf is a web application, so any computer or mobile device with internet access can access it. This means it behaves the same way, regardless of the operating system — something which is critical, as our team uses a mixture of Windows and Unix-inspired operating systems.

3. **Simultaneous Editing:** Overleaf provides the unique ability that allows multiple collaborators to edit a document at a time. This reduces the time taken to write reports, as one collaborator could write one section while a second writes a different section in parallel. It also makes the editing process much easier and allows pair-editing.

3.5   Draw.io

An open-source software for creating diagrams (including UML diagrams). We chose it for the following reasons:

1. **Ease Of Use:** The software is very well-developed, and the options provided are clear and easy to understand.

2. **UML Capabilities:** The software has basic UML diagramming features, allowing the creation of use case models.

4. Source Code Review

As mentioned previously (section 3.2), part of the reason we decided to use GitHub was to use pull requests as a form of code review. This featured allowed the team leader to inspect all incoming code before it is merged into the main development branch. This had great implications during most of the development period, as bugs or poorly written code were identified before being merged with the rest of the code.

Unfortunately, as ETERNITY approached the deadline, collaborators would often skip this step in order to move the project along at a faster pace. This resulted in the addition of unreviewed and buggy code. It also meant that any code submitted for review was often outdated by the time someone examined it, because direct pushes created merge conflicts. All of which led to technical debt. [11]

5. Testing

Testing is an essential part of the development of any software. In the course of creating ETERNITY, most collaborators did some form of testing on their own machines before submitting the code for review. Each collaborator also developed a set of unit tests using the Django or built-in Python libraries. This allowed us to test the expected behaviour of each transcendental function to ensure everything works as expected.

Unfortunately, these unit tests were introduced too late in the development process. Instead of creating the tests before or during the implementation of the functions, they were created well after the fact. This meant that the unit tests were not properly utilized due to the team's inexperience with software testing.

6. Software Design

6.1 Macro-Architecture

ETERNITY follows the model-view-controller (MVC) architecture pattern. This is a commonly used macro-architecture for web applications. The HTML document presented to the user is the view. The buttons on the calculator are the controllers. The model is handled by the functions implemented in the back-end. Using this architecture seemed like a natural choice as Django — the back-end framework we decided to use for the web application — already had a heavy emphasis on the MVC pattern.

Due to the logic of the calculator being handled by the server, and everything else being rendered on the client side, it can even be said that ETERNITY follows the client-server architecture. This architecture pattern is again quite common amongst web applications.

6.2 Micro-Architecture

ETERNITY's core logic is implemented using the functional programming paradigm. This seemed like a good decision, as functional programming is excellent for implementing logic, and it is especially well-suited to mathematics. This paradigm is also heavily supported by Python, thanks to the presence of lambda calculus and anonymous functions.

6.3 User Interface Design

One design principle which ETERNITY follows is the principle of metaphor [22]. This is done by making ETERNITY look similar to a physical calculator. Therefore, the user will immediately know how to interact with the software and how to use it.

ETERNITY also follows the principle of coherence [22], as each button behaves consistently with other buttons. The overall calculator should also be consistent with how physical calculators operate. These design principles will improve the user experience.

7. Role Assignment

7.1 Iteration 1

For a team to work together effectively, there need to be some well-defined roles so everyone understands their responsibilities. That is why our team was quick to assign roles. These were based on both a person's preference and skills, so everyone could contribute in something they were comfortable and skilled at.

Person	Role(s)
Chelsie	Full-Stack
Elijah	Back-End
Hao	Communication, Organizer
Michael	Front-End, Major Presenter
Robert	Group Leader, Minor Presenter
Sobhan	Documentation, Wiki, Use Cases
Xavier	Documentation, LaTeX

7.2 Iteration 2

For iteration 2, our team decided to maintain the roles from iteration 1, while adding additional responsibilities were it was needed. This allowed us to continue working in a role we were comfortable and experienced in, thus leading to better collaboration.

Person	Role(s)
Chelsie	Full-Stack, Presenter
Elijah	Back-End
Hao	Communication, Organizer
Michael	Front-End
Robert	Group Leader, Poster Designer
Sobhan	Documentation, Wiki, Use Cases, Presenter
Xavier	Documentation, LaTeX

8. Function Mapping

To comply with the rules of the project, each team member was assigned one of the eight transcendental functions that are meant to be implemented. Seeing as there were only seven team members, $\Gamma(x)$ was ignored.

Team members were given ample amounts of time to research the different functions before arriving at the group meeting to decide each person's function. At that point, each member mentioned their preferred function, resulting in the following assignment that has not changed since iteration 1.

Person	Function
Chelsie	σ (Standard Deviation)
Elijah	$\sinh x$
Hao	ab^x
Michael	x^y
Robert	$\arccos x$
Sobhan	MAD (Mean Absolute Deviation)
Xavier	$\log_b x$

9. Function Definitions

Here are the definitions of seven of the transcendental functions.

9.1 σ (Standard Deviation)

Standard deviation is a measure of how spread out numbers are, and it is represented by the Greek letter sigma, σ.
The formal definition is as follows:

$$\sigma = \sqrt{\frac{\sum |x - \mu|^2}{N}} \tag{9.1}$$

Where x is a data point, μ is the mean of the data set, and N is the number of data points. [23]

9.2 $\sinh x$

The hyperbolic sine function is similar to the trigonometric sine function, but is based on a hyperbola instead of a circle. [24]

$$\sinh x = \frac{e^x - e^{-x}}{2} \tag{9.2}$$

9.3 ab^x

This is the exponential function and includes the exponentiation operation, which is described in section 9.4.
Let m be the exponentiation b^x, then

$$ab^x = a \times m \tag{9.3}$$

9.4 x^y

The exponentiation operator has several definitions. The most common is when y is an integer, in which case $x^y = x \times x \times ... \times x$ (y times). If $y = 0$, then $x^y = 1$, and if $y < 0$, then $x^y = \frac{1}{x^{|y|}}$. [25]

Yet if y is a real number, then it can often only be approximated using a Taylor series or other means of approximation.

One important instance of x^y is e^y which is defined as $e^y = \lim_{n \to \infty} (1 + \frac{y}{n})^n$. [26]

9.5 $\arccos x$

$\arccos x$ is an inverse trigonometric function. It is the inverse function of $\cos x$ with a limited domain.

If $y = \cos x$ then $x = \arccos y$, where $-1 \leq x \leq 1$ and $0 \leq y \leq \pi$. [27]

9.6 MAD (Mean Absolute Deviance)

Let μ be the average value in a data set of size n, and let x_i be a value in this set. The mean absolute deviance is defined as [28]

$$\frac{1}{n} \sum_{i=1}^{n} |x_i - \mu| \tag{9.4}$$

9.7 $\log_b(x)$

$\log_b(x)$ is defined as $\frac{\ln(x)}{\ln(b)}$, where $\ln(x)$ is the natural logarithm with base e (though this identity holds for other bases as well). [29]

If $y = e^x$, then the natural logarithm is the inverse such that $x = \ln(y)$. [30]

10. Function Implementation

This section includes the decision-making process that occurred while implementing the transcendental functions. Our primary criteria for these decisions were precision (how many digits after the decimal point were accurate) and time complexity (what the big-O notation is and how quickly we could return a value to the system's user).

10.1 σ (Standard Deviation)

There are multiple ways to find the standard deviation, and most of these follow the mathematical definition which is easy to compute by hand.

First Approach

$$SD = \sqrt{\frac{\Sigma|x - \mu|^2}{N}} \tag{10.5}$$

1. Find the mean of the data set

2. For each data point, find the square of its distance to the mean

3. Sum the values from Step 2

4. Divide by the number of data points

5. Take the square root

Second Approach

$$SD = \sqrt{\frac{\Sigma x^2 - \frac{(\Sigma x)^2}{N}}{N}} \tag{10.6}$$

1. Find the sum of the dataset

2. Find the sum of the square of the dataset

3. Square of the value from Step 1

4. Divide by the number of data points

5. Subtract the values from Step 2 and Step 4

6. Divide by the number of datapoints

7. Take the square root

Since standard deviation must measure the distance of each point, its complexity is $O(n)$, where n is the number of inputs in the data set.

The first approach is very straightforward yet inconvenient when there is a large dataset. The second approach is more advantageous as we avoid calculating the mean, the difference from the mean, and the square of the difference from the mean. Therefore, the latter was implemented to calculate the standard deviation of a dataset. [31]

Python Code

```python
def standard_deviation(*args):
    N = len(args)
    total = 0
    total_squared = 0
    # Step 1, 2
    for i in range(len(args)):
        total += args[i] # sum of dataset
        total_squared += args[i] * args[i] # sum of the square of the dataset
    # Step 3, 4
    sumOfDistances = (total * total) / N
    # Step 5, 6
    variance = (total_squared - sumOfDistances) / N
    # Step 7
    ans = exponential(variance, 0.5)
    return ans
```

10.2 $\sinh x$

Our implementation of $sinh$ uses the exponential function that we have implemented. There are three equivalent ways to compute the hyperbolic sine:

$$\sinh x = \frac{e^x - e^{-x}}{2} = \frac{e^{2x} - 1}{2e^x} = \frac{1 - e^{-2x}}{2e^{-x}} \tag{10.7}$$

We decided to use the first definition simply because division by 2 is much easier to compute than division by an exponential variable.

$$\sinh x = \frac{e^x - e^{-x}}{2} \tag{10.8}$$

Python Code

```python
def sinh(x):
    # Calculate the result using the previously defined exponential function
    result = (exponential(euler,x) - exponential(euler,-x))/2
    return result
```

10.3 ab^x

In order to implement ab^x, it's important to realize that there are two kinds of calculations here. The first is to calculate b^x which is the exponential calculation ($c = b^x$). And the other is multiplication.

The next operation is $a \times c$ (which is ab^x). Means that a is added b^x times: $a+a+a+\ldots+a$.

In this way, we can get 3 different and special bases to do the calculation. These are when $b = \pi$, $b = e$, and $b = 10$. And for calculation of the π and e, we can be accurate to 15 decimal places. The complexity is $O(nlog(n))$. Because this is more of a special case of x^y (see section 10.4), it heavily relies on the implementation of x^y.

Python Code

```python
def a_b_exponential(a,b,x):
    return a * exponential(b,x)

def euler_exponential(exponent):
    a = 1
    b = euler
    return a * exponential(b, exponent)

def ten_exponential(exponent):
    a = 1
    b = 10
    return a * exponential(b, exponent)

def pi_exponential(exponent):
    a = 1
    b = pi
    return a * exponential(b, exponent)
```

10.4 x^y

The implementation of x^y using only integers is fairly easy. One can simply write a recursive function to multiply x, y number of times, while decrementing the value of y after every loop iteration. The difficulty of implementing this function comes when making sure it also accurately works when passing in decimal or floating point values.

To approximate fractional powers, we implemented a Taylor series for e^y. In order to solve for any other bases, we simply need to do an exponential base change (10.9).

$$x^y = e^{yln(x)} \tag{10.9}$$

The cases where the base is negative and the power contains a fraction are omitted and directly return an "out of range error". Since most of those cases result in an imaginary solution. [32]

Python Code

```python
def taylor_exp(x):

    if x == 0:
        return 1

    x0 = absolute(x)

    Tn = 1

    n = ceil(x0 * euler) * 12
    for k in range(n, 0, -1):
        Tn = Tn * (x0 / k) + 1

    if x < 0:
        Tn = 1 / Tn
    return Tn

def exponential(a,x):

    if x%1 == 0 and a%1 == 0:
        return exponential_int(a,x)
    else:
        if x==0:
            return 1
        if a==0:
            return 0

        if a<0:
            x_floor= floor(x)
```

```
        if x_floor%2 == 0:
            sign=1
        else:
            sign=-1

        if x%1 != 0:
            ## The case where a is negative and x has a fraction is not
                covered, since the answer might be an imaginary number.
            return -1 * exponential(-a,x)
        temp=ln(-a)*x
        return sign*taylor_exp(temp)
    else:
        temp=ln(a)*x
        return taylor_exp(temp)
```

10.5 $\arccos x$

We have a basic understanding of how trigonometric functions such as sin, cos and tan work when picturing the trigonometric identity circle. On computers however, these functions are approximations that make use of derivatives or series such as the Taylor series (Abramowitz M., Stegun I.A. (eds.) - Handbook of mathematical functions p.81) Additionally, these approximations need to be fast. Trigonometry can be used in many applications, namely for calculating angles in video games or simulations.

$Arcco$ is simply the inverse function of the cos function. To be one-to-one, the range is limited to $[0, \pi]$. The implementation we chose was adapted by Nvidia, a computer graphics company which makes heavy use of fast and precise trigonometric calculations. The approximation uses polynomial approximations which is easy to implement through code (approximations by C. Hastings, Jr., Approximations for digital computers. Princeton Univ. Press, Princeton, N.J., 1955). https://developer.download.nvidia.com/cg/acos.html

The absolute error range is less than 6.7e-5 which is well enough for our application. The simple calculations make this implementation well within $O(1)$ time complexity. The advantage of this implementation is that it is fast and precise. The disadvantage is that it makes use of "magic numbers". However, those have been proven to be reliable over the decades that they were used.

Python Code

```
def arccos(x):
    if x < 0:
        negate = 1
        # get abs val
```

```
        x = -x
    else:
        negate = 0

    ret = -0.0187293
    ret = ret * x
    ret = ret + 0.0742610
    ret = ret * x
    ret = ret - 0.2121144
    ret = ret * x
    ret = ret + 1.5707288

    # THIS CONDITIONAL STATEMENT IS BEING USED TO HANDLE INVALID INPUT
    if (exponential((1.0-x), 0.5) != None):
        ret = ret * exponential((1.0-x), 0.5)
        ret = ret - 2 * negate * ret
        return negate * 3.14159265358979 + ret
    print("error in arccos")
```

10.6   MAD (Mean Absolute Deviation)

Computing the MAD is a straightforward process, because there is no need to make numerical approximations (unless the input values are themselves irrational). Therefore, the function implementation is inspired by the algorithm a human would use to calculate MAD by hand.

That is, first the mean is found by summing all input values (using reduction in the implementation) and dividing by the number of input values. Then, the absolute difference from the mean and each input is found and summed together. Finally, the sum is divided by the number of inputs and the result returned.

The biggest advantage of this approach is that it is easy to read and understand the logical steps in the implementation, making this more maintainable and easy-to-fix. It also has the advantage of using separations of concerns as each logical part of the function is computed separately. There are no noticeable disadvantages to this implementation, as it achieves a complexity of $O(n)$, where n is the number of input values.

Python Code

```
from functools import reduce

# Calculates the mean of the input list and returns it.
def find_mean(input_list):
    return reduce((lambda x, y: x + y), input_list) / len(input_list)
```

```python
# Finds the mean absolute deviation.
def mean_absolute_deviation(input_list):
  mean = find_mean(input_list)
  absolute_difference = 0

  for input in input_list:
     absolute_difference += absolute(input - mean)

  return absolute_difference/len(input_list)
```

10.7 $\log_b(x)$

To implement $log_b(x)$, where the base b could take any value, the simplest way is to implement the logarithm with only one base and then to use the logarithm base change rule (10.10).

$$\log_b(x) = \frac{\log_c(x)}{\log_c(b)} \tag{10.10}$$

It is an elegant solution which requires the implementation of two functions: the base change rule and the logarithm of one base b. The commonly used base is e since the derivative is simple. The approach we used is to start with an algorithm to find the nth root (base) given a power and a number and to invert the algorithm to find the power given the base (e) and a number.

Proceeding this way the precision can be adjusted, a better precision would result in less performance and vice versa. The complexity is of degree $O(log(n))$. For the use of a calculator the performance when not noticeable is in our view less important than the precision. The precision goes up to 15 digits after the coma.

Python Code

```python
def log(x,base=10):
    if x<=0:
        return None
    return ln(x)/ln(base)

def ln(x):
    if x<=0 :
        return None

    precision=0.0001
    P=x
```

```
result = 0.0

while(P >= euler):
    P /= euler
    result+=1

result += (P / euler)
P = x

A = result
L = (P / taylor_exp(result - 1.0))
R = ((result - 1.0) * euler)
result = ((L + R) / euler)

while absolute(result-A)>precision:
    A = result
    L = (P / taylor_exp(result - 1.0))
    R = ((result - 1.0) * euler)
    result = ((L + R) / euler)
return result
```

11. Interviews

11.1 Target Audience

Before beginning the interview, we realized we needed to have an idea of who would want to use the ETERNITY calculator. Obviously, a lot of people use calculators, but only a small subset of them would use the kinds of functions that ETERNITY would include. Therefore, we did some brainstorming during one of our group meetings and came up with the following target audience:

- Students

- Statisticians

- Data Analysts

- Businessmen

- Accountants

- Engineers

- Professors

These groups helped us decide who to interview, what kind of questions to ask, and eventually the personas themselves.

11.2   Interview Format

Before creating the interview questions, we unanimously agreed to go for a semi-structured format of interview. This is because the majority of our team did not have experience interviewing people, so an open interview structure was not feasible at our skill level. A fully-structured interview was possible, but we were worried that a rigid structure would limit what we could learn from our interviewees.

We then chose the funnel model of interviews, where we start off with general questions and become more specific as the interview progresses. We believe that this ease's the interviewee's mind into the topic, allowing them to think more critically about the topic so that we can gain more useful information.

11.3   Interview Questions

We developed the interview questions by telling each member of our team to come up with five questions in the shared Google Document, for a total of thirty-five questions. We then filtered, refined, and structured the questions down to thirty, as seen below:

1. What is your age?

2. Which languages are you capable of speaking fluently?

3. What is your current employment status? If you are employed, what do you do?

4. What is the highest degree or level of education you have completed?

5. How would you describe your technological literacy level?

    (a) Very Good
    (b) Good
    (c) Average
    (d) Below Average
    (e) Not Good

6. How often do you use technology (computers, software, other hardware) on a daily basis?

    (a) Very often (more than twice a day)
    (b) Often (twice a day)
    (c) Once a day
    (d) Less than once a day
    (e) Once a week

7. As a follow-up to my previous question, what software, if any, do you use on a day to day basis?

8. In your work, do you like to use real tools or virtual network tools to complete your tasks through your computer? Handheld calculator vs. online calculator for example.

9. Do you use calculators often? If so, in what setting and for what purpose?

10. Are you familiar with transcendental functions? If so, which functions do you find yourself using most often than others?

11. What is your level of proficiency regarding a calculator? (How many functions do you use or know how to use on a normal calculator, e.g. CASIO)

12. If you find yourself using a calculator, what functions or types of calculations do you use/perform?

13. Does the complexity or features offered by a calculator matter? Will it affect which type of calculator you choose to buy or use over another?

14. As a follow-up to my previous question, does the appearance or size of the calculator matter to you? Explain.

15. When using a calculator at work, or for personal use, is the degree of precision important? i.e. are you calculating sensitive data or not?

16. If applicable, do you find yourself switching calculators throughout the day? Either at work or at home. If not, do you simply prefer to have a single calculator that offers every possible function needed?

17. Are you open to the idea of trying alternative tools, or do you prefer to sticking to what you are already using? If not, please explain why.

18. What best describes your willingness to try alternatives?

    (a) Curiosity
    (b) Better performance/ precision/ job done better
    (c) Didn't like current tool
    (d) Other (explain)

19. Which alternative strikes you as the most practical:

    (a) a calculator app on your phone,
    (b) a web app accessible from any device with Internet access,
    (c) a physical calculator
    (d) a desktop application, such as the default Windows calculator?

20. Have you ever used an online calculator?

21. If you have used an online calculator before, what were some of the difficulties you experienced with it? If not, would you use an online calculator?

22. As a follow-up to my previous question: If so what features or functions would you be interested in using/having in an online calculator? If not, why not?

23. Would customizability be a factor in choosing whether to use an online calculator over an alternative, yes or no?

24. Can you name 3 of your favorite calculator applications or alternatively, 3 of your favorite handheld calculator brands?

25. What aspect of these applications or calculators appeals to you the most?

26. Have you used your operating system's default calculator? If so, what did you like and dislike about it?

27. When using a calculator, does the appearance of the math expression matter to you? (xˆy vs x^y).

28. How often do you use trigonometric functions? And when using them, do you prefer to use radians or degrees? Do you like having the ability to switch between them?

29. Which functions that are generally not on a calculator, would you like to see added?

30. That's all for the interview. Do you have any questions for myself or things you'd like to add? Are there things that you'd like to discuss regarding either online calculators, calculators in general, or even different online tools/software?

11.4   Interview Takeaways

The seven interviews (see section 14.) provided us with a lot of valuable information, as well as plenty of insight into what makes a successful calculator and what we could do to make ETERNITY even more unique.

Convenience

We learned that the end user doesn't care about particular calculators and that they often go for the first thing at hand, whether it's a physical calculator, the default application on their phones or computers, or the first result in a search engine. This meant we had to make ETERNITY easy to access and use, which meant there shouldn't be a lengthy installation period. This helped guide us towards developing a web application as opposed to other software.

Customization

Some interviewees expressed a deep interest in being able to customize and personalize their calculators. This is a feature we noticed was not present in most other calculators, so we decided to make this a part of ETERNITY as a unique selling point.

Constants

Nearly all interviewees currently worked or studied in a STEM field, where they would frequently do calculations with certain constants relevant to their field (such as Avogadro's number, the gravity constant, or others). As one interviewee mentioned, these constants are missing in most modern calculators, so we seized this opportunity to create another unique selling point for ETERNITY.

Functions

Through our interviews we learned that most people only used calculators for basic addition, subtraction, multiplication, and division. Any other functions or operations were strictly used for academic purposes — such as in school or university — and were almost never used outside these contexts. Others who would use these functions often had specialized software relevant to their work fields. Therefore, we realized that ETERNITY's focus on transcendental functions may not be of use to most users.

12. Personas

This section includes the seven personas created to guide us through the software development process.

12.1 Jason Morin (Highschool Student)

Jason is a high school student that is currently studying from home due to the pandemic. His classes range from French and English to math and physics. At first, he was quite pleased with the idea of not physically having to go to school. However, after a year, he is really missing hanging out with his peers.

To pass the time, he is trying to find alternatives to his everyday routines. He recently switched from using Microsoft Word to LATEX to write his homework. He heard that it would be a useful tool to learn, and is enjoying the transition. After almost a year of online learning, he's completely switched over to digital learning and is no longer using any physical paper unless he needs to draw a graph for Math.

Jason has no problem using the computer or learning new programs. He's been using computers for as long as he remembers. In fact, he prefers using the computer as much

as possible. For example, his notes are written and saved on Google Drive. This way, he can switch from his laptop to desktop at any time and still have access to his notes.

Jason likes to customize his environment as much as possible, it is one of his main hobbies. He built his own computer and installed custom RGB lights in the computer case. His browser, Google Chrome is also customized with a custom theme that he created himself as a personal project.

Characteristic	Detail
Name	Jason Morin
Gender and age	Male, 15
Disabilities and restrictions	None
Education	Current highschool student
Profession	Student
Likes	Software, Portability, Customizability
Dislikes	Analog Tools
Location of use	Home
Computer literacy	Is very comfortable using computers, and a fast learner for new programs and tools, but is not a power user.
Computer environment	Google Chrome on Windows 10
Internet literacy	High; self-taught and fast learner.

12.2   Helen Hermann (University Student)

Helen Hermann is a 21 year old university student studying chemistry. Her classes are currently online due to the pandemic, but she can't wait until classes go back to being in person so she can get more lab experience.

She loves the natural sciences and the environment, so she frequently contributes to articles and blogs to the university's science and environment clubs. That's because she's a very outspoken person who wants to do what's best for the world.

While Helen uses a lot of math as part of her courses, she only really needs the basic functionalities like addition, multiplication, subtraction, division, powers, and logarithms. She has no preference for calculators, and she uses whatever is at hand — be it the university supplied calculator or the default calculator on her phone or computer.

Characteristic	Detail
Name	Helen Hermann
Gender and age	Female, 21
Disabilities and restrictions	None
Education	Current chemistry undergraduate student
Profession	Student, Part-time Blogger
Likes	Accessibility, Ease-Of-Use
Dislikes	Complicated Tools
Location of use	Home, University
Computer literacy	Medium computer skills. Likes using word processors and other programs on her computer.
Computer environment	Safari on Mac OS
Internet literacy	Medium; uses it for online shopping and films.

12.3   Daniel Paradis (Statistician)

Daniel Paradis is a 42-year-old statistician working for the Canadian government in Ottawa. After a bachelor in mathematics, he did a master's degree in statistical science, both at the university of Toronto.

He enjoys playing Chess online and practices martial arts three times a week. Before the pandemic, he would often gather to play bass with his close friends.

His job consists mostly of collecting, analysing, and interpreting data for the government. Doing so requires knowledge of spreadsheets and databases which he has. He is asked to do complex analysis of situations, but most of the time the calculations are redundant, which is why he relies heavily on his calculator. An appropriate tool for is line of work, should have functionalities to perform sample variance, standard deviation, and correlation coefficient. The best would be a tool able to perform all the calculations needed given the sample points. So he can focus his work on interpretations and recommendations.

Characteristic	Detail
Name	Daniel Paradis
Gender and age	Male, 42
Disabilities and restrictions	None
Education	Master's degree in Statistics
Profession	Statistician
Likes	Feature-Rich Software
Dislikes	Using Multiple Different Tools To Accomplish One Task
Location of use	Work office, Online (due to COVID-19)
Computer literacy	High computer skills. Uses software such as Excel, SQL Sentry. Also uses online sites such as Wolfram Alpha.
Computer environment	Windows 10
Internet literacy	High; daily work.

12.4   John Smith (Data Analyst)

John Smith is a 32 year old data analyst working at a popular company that specializes in home appliances. Although he initially graduated with a degree in physics, John was able to adjust to a career in data analytics by first learning the required skill set through online courses and eventually completing a certificate program on the topic.

In his spare time, John likes to read foreign literature and practice his guitar. He also often spends some time playing online video games with his friends when they can't meet each other in person.

Due to his line of work as well as his educational background, John has considerable experience using many data driven frameworks and tools, such as SQL and especially those that make use of Python and Javascript libraries such as SciKitLearn and D3.js. The usage of calculation tools is particularly important for John's job when he must make sense of and visualize the data he is exposed to every single day.

Characteristic	Detail
Name	John Smith
Gender and age	Male, 32
Disabilities and restrictions	ADHD
Education	Bachelor's degree in Physics, Data Analytics Certificate
Profession	Data Analyst
Likes	Data Visualization Software
Dislikes	None
Location of use	Work
Computer literacy	High computer skills. Does some light scripting, uses python data analytics APIs, database querying, and Microsoft Office.
Computer environment	Windows 10
Internet literacy	High; remote work, light research, and VoIP

12.5 Jeremy Ladovka (Accountant)

Jeremy is a 38 year old accountant who works for a large web agency in the Greater Montreal area. Jeremy is a very educated individual, having completed his Master Degree in Accountancy at Concordia University in Montreal. Being an extrovert, Jeremy enjoys going out with friends and communicating with people on a day to day basis. As a result, COVID-19 has been really hard on him, causing him to miss office life at work. Although working from home has its perks for Jeremy, he ultimately can't wait to get back into the office to socialize and communicate face-to-face with his colleagues once again.

In addition to going out with friends, Jeremy enjoys playing sports and playing video games. With that being said, Jeremy has been playing football since his youth and plays with his friends weekly on a competitive football team. Interestingly, Jeremy also loves math and problem solving. This is especially useful in his day-to-day work as an Accountant, considering he loves working due to often needing to solve complex mathematical problems.

At work, Jeremy uses a computer and a plethora of software in order to successfully complete his work every day. Jeremy states that despite using a Windows machine most of his life, nothing compares to the Mac operating system. With that being said, Jeremy is very educated when it comes to technology and computers, especially when it comes to both computer hardware and software. Jeremy uses Safari as his main means of navigating the web while also using the entire Microsoft Office suite in order to get his Accounting related tasks completed (Word, Excel, OneNote, OneDrive, etc. . .). Although Jeremy uses several different hardware and software to get his work done, he says his favorite piece of hardware is his standard Casio calculator which includes only the absolute necessary functions.

Characteristic	Detail
Name	Jeremy Ladovka
Gender and age	Male, 38
Disabilities and restrictions	None
Education	Master's degree, Accountancy
Profession	Accountant
Likes	Physical Calculators
Dislikes	None
Location of use	Office, Home (due to COVID-19)
Computer literacy	Very strong computer skills. Uses computers on a daily basis to perform both work related tasks and personal hobbies.
Computer environment	Safari on Mac OS
Internet literacy	High; daily communicates via the Internet.

12.6 Mingming Liu (Project Manager)

Mingming Liu is a project manager who works for an engineering company in Brossard. She graduated from McGill University Engineering Budget Graduate Program. Since work requires a lot of calculations, she likes to read a lot to make up for her time in contact with words. Even though she has a lot of time to study at home due to the COVID-19, she hopes to still find time to exercise and socialize.

In addition to reading, she also likes to spend time with her pet cat. Especially because of the COVID-19, she has more time with the cat. Each morning, she drinks coffee and spends time in the backyard garden with her cat. In the afternoon she will have a nap with the cat on the recliner in the backyard. After dinner, she also has more time to clean the cat litter.

At work, because she needs to calculate a reasonable number of people for each project, and ensure that the materials are sufficient and will not be wasted. Therefore, she often uses a calculator. She usually uses Google to browse the web, but also uses Word and Excel to complete related tasks. Furthermore, Liu has strong computer skills and is proficient in network administration. As the workload grows, she hopes to have a convenient and fast calculator to help her with new tasks.

Characteristic	Detail
Name	Mingming Liu
Gender and age	Female, 40
Disabilities and restrictions	None
Education	Master's degree, Budget
Profession	Project Manager
Likes	Fast Software, Web Applications
Dislikes	None
Location of use	Office, Home (due to COVID-19)
Computer literacy	Strong computer skills. Use only at work.
Computer environment	Google Chrome on Windows 10
Internet literacy	High; daily work and entertainment is through the Internet

12.7 Mohammad Memarbashi (Civil Engineer)

Mohammad Memarbashi is a 29 year old civil engineer who's been working in the field since completing his master's degree.

He enjoys spending his weekends with friends, by going out and having barbecues. He also considers himself to be a bit of a chef as he tries to make all his food from scratch.

He frequently uses software like MATLAB, Excel, and AutoCAD in his line of work, so he prefers using the built-in math functions in these tools when doing calculations. Yet he also always keeps a small calculator and some pen and paper on his work desk, in case he ever needs to do some quick calculations.

| Characteristic	Detail
Name	Mohammad Memarbashi
Gender and age	Male, 29
Disabilities and restrictions	None
Education	Master's degree in Civil Engineering
Profession	Civil Engineer
Likes	Specialized Mathematical Software, Feature-Rich Software, Physical Calculators
Dislikes	Calculator Applications
Location of use	Work office
Computer literacy	High computer skills. Is comfortable doing some light programming and using more complex software.
Computer environment	Firefox on Windows 10
Internet literacy	Medium; uses it to communicate with friends.

13.   Use Case Modeling

The interview results were further analyzed to create two groups of use cases.

The first group involved the user's environment and the other software they will be using. This came directly from the interviews, and told us **why** the user would use ETERNITY. We referred to these as high-level use cases, as they are the way the user would think of their interactions with ETERNITY.
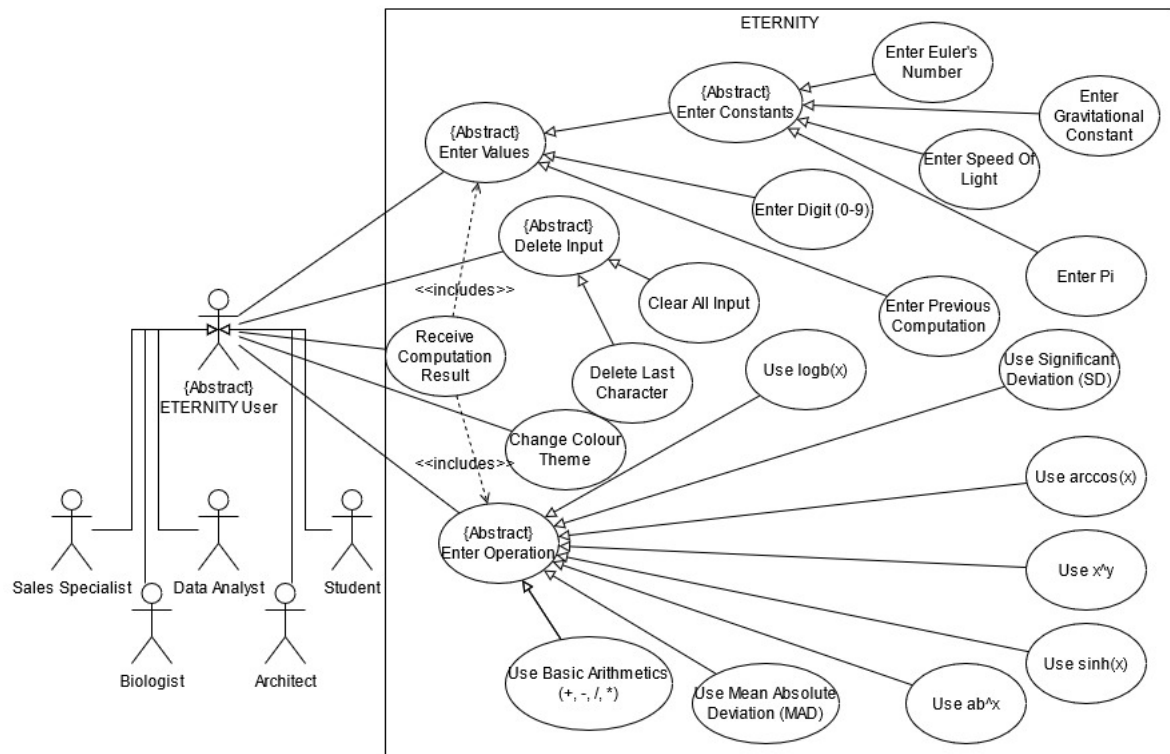
Once we understood that, we analyzed the common aspects of these high-level use cases in order to understand **how** the user would use ETERNITY. Because this was much less abstract and closer to the actual code written, we referred to these as low-level use cases.

Below you will see the diagrams for both.

13.1   High-Level Use Cases
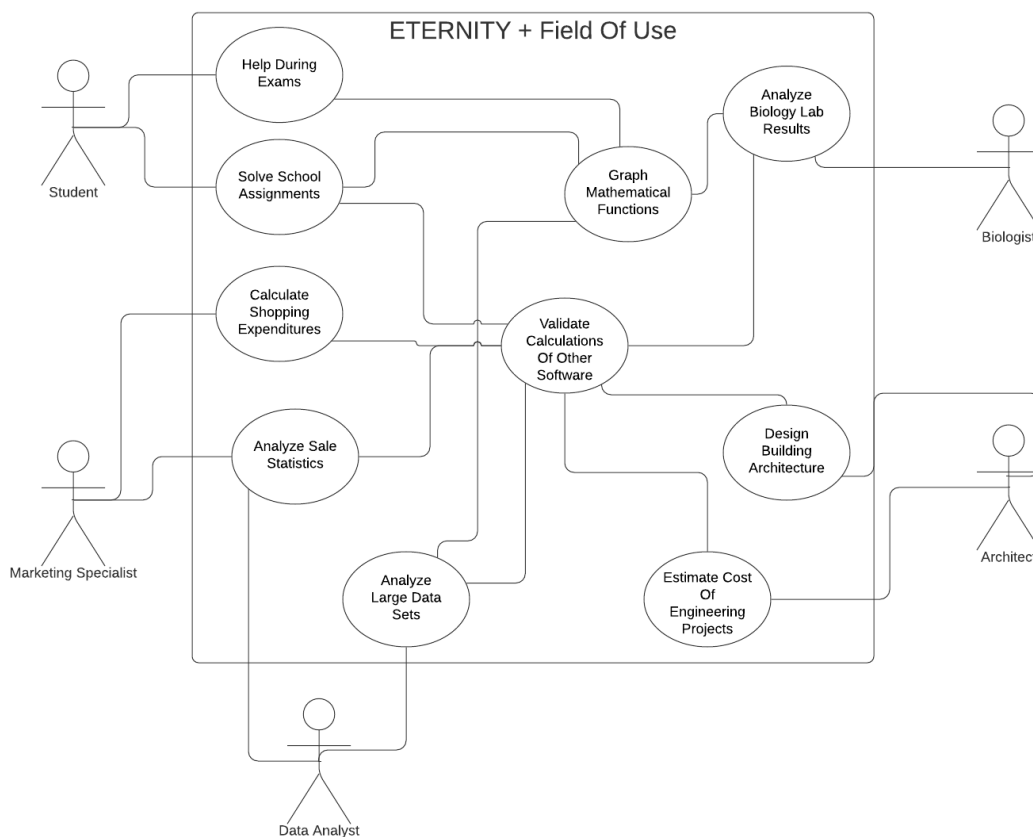
13.2   Low-Level Use Cases

14.   Transcripts

Here you'll find the transcripts of the seven interviews.

14.1   Interview 1

1. What is your age?
   22.

2. Which languages are you capable of speaking fluently?
   English, French, and Chinese.
   Mandarin?
   Yes.

3. What is your current employment status? If you are employed, what do you do?
   I'm going to start a new part-time job next week.
   And what is that?
   I will be a marketing specialist.

Okay, for which company, if you don't mind?
For Unilever Canada under the shopper-marketing department.
You mentioned that you will be starting your internship soon. Have you had another internship recently?
Yes, I was a customer development intern for Unilever Canada during the winter semester.

4. What is the highest degree or level of education you have completed?
Cegep. But, right now I'm pursuing my bachelor degree of Commerce, specializing in marketing. I will graduate in August.

5. How would you describe your technological literacy level?

   (a) Very Good

   (b) Good

   (c) Average

   (d) Below Average

   (e) Not Good

   I would say average
   Could you elaborate?
   I can function using day-to-day technology, laptop, ipad, etc... But I wouldn't be using anything that takes some research to be able to learn the technology.
   Alright, so you wouldn't be doing any troubleshooting or anything like that, right?
   Exactly.

6. How often do you use technology (computers, software, other hardware) on a daily basis?

   (a) Very often (more than twice a day)

   (b) Often (twice a day)

   (c) Once a day

   (d) Less than once a day

   (e) Once a week

   Very often, more than twice a day for sure.

7. As a follow-up to my previous question, what software, if any, do you use on a day to day basis?
   I use Android.
   Okay, so do you use a browser?
   Yes, I use Google Chrome.
   Do you use any other software, like Microsoft Word, Powerpoint, etc.
   Yes, I use Microsoft Office, so, like Power BI, Word, Excel, PowerPoint, etc.

Okay, on Power BI and Excel, do you do a lot of calculation?

Yeah, I do a lot of analysis on Excel, and sometimes on Power BI.

8. In your work, do you like to use real tools or virtual network tools to complete your tasks through your computer? Handheld calculator vs. online calculator for example.

I like to use virtual tools to do my daily work. I have a work laptop so we usually do everything on the computer.

9. Do you use calculators often? If so, in what setting and for what purpose?

Yes, I'll use one multiple times a week. In the setting of my work, for instance, especially during my previous internship, it was a lot of analysis about prices, numbers, sales volume, percentage, etc. So to double check everything that was automatic on Excel, I would just use the online calculator to double check my numbers.

Wait, so you used an online calculator?

I type "calculator" on my laptop, and an app comes out.

Oh, so the Microsoft Calculator?

Yeah, the one that comes with the laptop.

10. Are you familiar with transcendental functions? If so, which functions do you find yourself using most often than others?

I am not.

11. What is your level of proficiency regarding a calculator? (How many functions do you use or know how to use on a normal calculator, e.g. CASIO)

I really only use the basic functions.

So you use sum, minus, division, etc. But do you use power, sqrt, etc?

For work, no. But I did have to use it for school, yeah.

12. If you find yourself using a calculator, what functions or types of calculations do you use/perform?

So, usually, for work I only use basic functions such as addition, division, multiplication and subtraction.

13. Does the complexity or features offered by a calculator matter? Will it affect which type of calculator you choose to buy or use over another?

Honestly, I don't mind but I really only need a simple calculator.

14. As a follow-up to my previous question, does the appearance or size of the calculator matter to you? Explain.

You mean online?

Just in general, it doesn't matter.

If it's physical, I prefer my calculator to be pink. If it's online, then no, it doesn't matter. If it's simple to use, I am OK.

15. When using a calculator at work, or for personal use, is the degree of precision important? i.e. are you calculating sensitive data or not?

Oh, no it doesn't really matter. Most of the time, I'm dealing with dollars, so as long as there is two decimal precision for the cents, I'm OK.

16. If applicable, do you find yourself switching calculators throughout the day? Either at work or at home. If not, do you simply prefer to have a single calculator that offers every possible function needed?
I don't. I would prefer to have a single calculator that offers everything I need.

17. Are you open to the idea of trying alternative tools, or do you prefer to sticking to what you are already using? If not, please explain why.
Could you elaborate on "alternative tools"?
So, for example you're already using a word processor that you're used to. Would you be open to trying another one? Or in our case, you're used to the Microsoft calculator, but would you be open to trying a different one.
Yes.

18. What best describes your willingness to try alternatives?

    (a) Curiosity
    (b) Better performance/ precision/ job done better
    (c) Didn't like current tool
    (d) Other (explain)

    If it has better performance, is more precise or adds value to my day-to-day work, then I'd be open to trying it out.

19. Which alternative strikes you as the most practical:

    (a) a calculator app on your phone,
    (b) a web app accessible from any device with Internet access,
    (c) a physical calculator
    (d) a desktop application, such as the default Windows calculator?

    A Desktop application. If it's for work, sometimes, I won't have my phone next to me. But, for day-to-day tasks, like if there's a big promotion when I'm grocery shopping, then I like to use my phone since I don't have my laptop and it's more convenient.

20. Have you ever used an online calculator?
Yes.

21. If you have used an online calculator before, what were some of the difficulties you experienced with it? If not, would you use an online calculator?
There wasn't much of a difficulty. It was more about the fact that I had to type "calculator" on Google and had to click a link. So right now, I'd rather just use an app on my laptop because it's easier.

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22. As a follow-up to my previous question: If so what features or functions would you be interested in using/having in an online calculator? If not, why not?
Just the basic functions, like I mentioned before.

23. Would customizability be a factor in choosing whether to use an online calculator over an alternative, yes or no?
Customizability. . . so like, the appearance of the calculator?
Yes, so for example, a light or dark theme. Or, like you said, you like to have a pink calculator, so there could be a pink theme for an online calculator.
...Yes, it [opinion] would change a lot. If I could choose the appearance of the online calculator, I'd choose something like a Sailor Moon theme, and for sure I would use that over any other calculator...

24. Can you name 3 of your favorite calculator applications or alternatively, 3 of your favorite handheld calculator brands?
I like Casio because I've used the brand through highschool, cegep and university. And they also make a pink version, which I have.
And you mentioned that you like the Windows Calculator because it's easy to uset?
Yeah, I like it because it's easy to use. I just have to open the search bar on my laptop and type "ca-" and it will show up.

25. ~~What aspect of these applications or calculators appeals to you the most?~~

26. ~~Have you used your operating system's default calculator? If so, what did you like and dislike about it?~~ Speaking of the Windows Calculator, is there anything that you dislike, or like about it?
Like about it. . . nothing. Dislikes, I would prefer to be able to customize the look of the calculator, I think that would be very cool.

27. When using a calculator, does the appearance of the math expression matter to you? (x^y vs x^y).
Yeah, so for example I prefer to see the actual fraction, with the line and both numbers on top and at the bottom. I used both types and I much prefer to be able to see it. And for the exponents, I also prefer the option where you see it on top [not ^].

28. How often do you use trigonometric functions? And when using them, do you prefer to use radians or degrees? Do you like having the ability to switch between them?
Not anymore, I used to use it for class but not anymore.

29. Which functions that are generally not on a calculator, would you like to see added?
I'm good.

30. That's all for the interview. Do you have any questions for myself or things you'd like to add? Are there things that you'd like to discuss regarding either online calculators, calculators in general, or even different online tools/software?
Are you guys building a calculator?

Yes, we're making an online calculator.
Wow, that's cool. Will we be able to use it, and will we be able to customize it?
Yeah, for sure. For customizability, since there is demand for it, I think that's something we want to implement.
That'd be great. It would be fun to see different colours and themes.

14.2   Interview 2

1. What is your age?
   45.

2. Which languages are you capable of speaking fluently?
   English and Chinese (Mandarin)

3. What is your current employment status? If you are employed, what do you do?
   Permanent Employee, I am a cost estimator.

4. What is the highest degree or level of education you have completed?
   Master in Engineering.

5. How would you describe your technological literacy level?

   (a) Very Good
   (b) Good
   (c) Average
   (d) Below Average
   (e) Not Good

6. How often do you use technology (computers, software, other hardware) on a daily basis?

   (a) Very often (more than twice a day)
   (b) Often (twice a day)
   (c) Once a day
   (d) Less than once a day
   (e) Once a week

7. As a follow-up to my previous question, what software, if any, do you use on a day to day basis?
   Microsoft Excel, Words, PowerPoint; Prism; InEight; AutoCAD;

8. In your work, do you like to use real tools or virtual network tools to complete your tasks through your computer? Handheld calculator vs. online calculator for example.
   Like to use online tools;

9. Do you use calculators often? If so, in what setting and for what purpose?
   No, don't use it very often.

10. Are you familiar with transcendental functions? If so, which functions do you find yourself using most often than others?
    No.

11. What is your level of proficiency regarding a calculator? (How many functions do you use or know how to use on a normal calculator, e.g. CASIO)
    Basic functions.

12. If you find yourself using a calculator, what functions or types of calculations do you use/perform?
    $+$, $-$, $\times$, $\div$

13. Does the complexity or features offered by a calculator matter? Will it affect which type of calculator you choose to buy or use over another?
    Doesn't matter. I don't use the real calculator most of time.

14. As a follow-up to my previous question, does the appearance or size of the calculator matter to you? Explain.
    No.

15. When using a calculator at work, or for personal use, is the degree of precision important? i.e. are you calculating sensitive data or not?
    Yes, the figure accurate to four decimal places would be ok.

16. If applicable, do you find yourself switching calculators throughout the day? Either at work or at home. If not, do you simply prefer to have a single calculator that offers every possible function needed?
    The software I use has function to do calculation.

17. Are you open to the idea of trying alternative tools, or do you prefer to sticking to what you are already using? If not, please explain why.
    yes. I open to alternative tool if it is more simple and easy to use.

18. What best describes your willingness to try alternatives?

    (a) Curiosity
    (b) Better performance/ precision/ job done better
    (c) Didn't like current tool
    (d) Other (explain)

19. Which alternative strikes you as the most practical:

    (a) a calculator app on your phone,

(b) a web app accessible from any device with Internet access,

(c) a physical calculator

(d) a desktop application, such as the default Windows calculator?

20. Have you ever used an online calculator?
Yes.

21. If you have used an online calculator before, what were some of the difficulties you experienced with it? If not, would you use an online calculator?
Yes, I like to use online calculator.

22. As a follow-up to my previous question: If so what features or functions would you be interested in using/having in an online calculator? If not, why not?
Convenience to use, easy to reach.

23. Would customizability be a factor in choosing whether to use an online calculator over an alternative, yes or no?
Yes, but it is not necessary for me

24. Can you name 3 of your favorite calculator applications or alternatively, 3 of your favorite handheld calculator brands?
Scientific Calculator (just use a normal online calculator)

25. What aspect of these applications or calculators appeals to you the most?
Convenient, fast, and accurate calculation

26. Have you used your operating system's default calculator? If so, what did you like and dislike about it?
Yes. I like that it is easy to reach, dislike: it is not easy to use, except to have a touchable screen.

27. When using a calculator, does the appearance of the math expression matter to you? (x^y vs x^y).
Yes, standard expression would be better.

28. How often do you use trigonometric functions? And when using them, do you prefer to use radians or degrees? Do you like having the ability to switch between them?
Sometimes. I prefer to use degree. If have the ability to switch between radians and degrees would be great.

29. Which functions that are generally not on a calculator, would you like to see added?
No. For me, ordinary calculators have met my work needs.

30. That's all for the interview. Do you have any questions for myself or things you'd like to add? Are there things that you'd like to discuss regarding either online calculators, calculators in general, or even different online tools/software?
No. But I wish you success in creating your calculator!

14.3   Interview 3

1. What is your age?
   21.

2. Which languages are you capable of speaking fluently?
   Mauritian Creole, French and English.

3. What is your current employment status? If you are employed, what do you do?
   I am an undergraduate student and this Summer is my last semester.
   And what is your field of study?
   Computer Science

4. What is the highest degree or level of education you have completed?
   High School.

5. How would you describe your technological literacy level?

   (a) Very Good
   (b) Good
   (c) Average
   (d) Below Average
   (e) Not Good

   Very good.

6. How often do you use technology (computers, software, other hardware) on a daily basis?

   (a) Very often (more than twice a day)
   (b) Often (twice a day)
   (c) Once a day
   (d) Less than once a day
   (e) Once a week

   Very often. Actually, I am a software developer so I work with technology every day.

7. As a follow-up to my previous question, what software, if any, do you use on a day to day basis?
   Phone, my laptop, social media.
   Which phone, laptop, social media?
   Oneplus 6T, Huawei matebook x pro, Facebook, Instagram, YouTube.

8. In your work, do you like to use real tools or virtual network tools to complete your tasks through your computer? Handheld calculator vs. online calculator for example.
Whatever is the most convenient. In an exam, I will use my real calculator but in everyday life, I won't bother looking for my calculator, I will just perform calculations on my phone.

9. Do you use calculators often? If so, in what setting and for what purpose?
Yes I use it for school and in my everyday life, such as calculating the cost of my groceries or any other payments.

10. Are you familiar with transcendental functions? If so, which functions do you find yourself using most often than others?
Yes, I most often used trigonometric functions in my high school years. These functions were only used for academic purposes and not for my personal life.
How about during university?
That's what I meant, high school, uni, academic purposes, same thing.

11. What is your level of proficiency regarding a calculator? (How many functions do you use or know how to use on a normal calculator, e.g. CASIO)
I know how to use everything man.

12. If you find yourself using a calculator, what functions or types of calculations do you use/perform?
The basic things. Simple addition, subtraction, division, multiplication and functions that my math classes use. Eg, trigonometric functions.

13. Does the complexity or features offered by a calculator matter? Will it affect which type of calculator you choose to buy or use over another?
Yes the more features the better so that I am not limited. Appearance also matters.

14. As a follow-up to my previous question, does the appearance or size of the calculator matter to you? Explain.
As I said above, yes. I like to use something good looking.

15. When using a calculator at work, or for personal use, is the degree of precision important? i.e. are you calculating sensitive data or not?
No if I was using it for academic purposes it would matter but at work or in my personal life it is not an issue.

16. If applicable, do you find yourself switching calculators throughout the day? Either at work or at home. If not, do you simply prefer to have a single calculator that offers every possible function needed?
Single calculator.

17. Are you open to the idea of trying alternative tools, or do you prefer to sticking to what you are already using? If not, please explain why.
I prefer sticking to what I already have. I have no problem with my current calculator

so I will not bother changing.

18. What best describes your willingness to try alternatives?

    (a) Curiosity
    (b) Better performance/ precision/ job done better
    (c) Didn't like current tool
    (d) Other (explain)

19. Which alternative strikes you as the most practical:

    (a) a calculator app on your phone,
    (b) a web app accessible from any device with Internet access,
    (c) a physical calculator
    (d) a desktop application, such as the default Windows calculator?

    It would also be nice if the webapp is responsive for my phone and available offline.

20. Have you ever used an online calculator?
    Yes.

21. If you have used an online calculator before, what were some of the difficulties you experienced with it? If not, would you use an online calculator?
    The user interface and its use were not intuitive. E.g. WolframAlpha does provide symbols to write functions.

22. As a follow-up to my previous question: If so what features or functions would you be interested in using/having in an online calculator? If not, why not?
    I prefer a scientific calculator. Every standard function you can find in a Casio calculator. More is better. Responsiveness of the online calculator is a must.

23. Would customizability be a factor in choosing whether to use an online calculator over an alternative, yes or no?
    No. I prefer a simple calculator.

24. Can you name 3 of your favorite calculator applications or alternatively, 3 of your favorite handheld calculator brands?
    I have only one favourite. Symbolab is the best so far.

25. What aspect of these applications or calculators appeals to you the most?
    It's user friendly. They have extensive functions available such as matrix calculations. The symbols and format of the equations are ready to be formatted by just clicking on them.

26. Have you used your operating system's default calculator? If so, what did you like and dislike about it?
    Yes. What I like about it is that it does what I want it to do. An improvement would be to have scientific functions as well and not only basic operations.

27. When using a calculator, does the appearance of the math expression matter to you? (x^y vs x^y).
    It is a plus to display math expression like this x^y but it does not bother me.

28. How often do you use trigonometric functions? And when using them, do you prefer to use radians or degrees? Do you like having the ability to switch between them?
    Degrees and yes.

29. Which functions that are generally not on a calculator, would you like to see added?
    Mean, standard deviation, matrices.

30. That's all for the interview. Do you have any questions for myself or things you'd like to add? Are there things that you'd like to discuss regarding either online calculators, calculators in general, or even different online tools/software?
    No thank you. I am tired. I just got vaccinated.

14.4 Interview 4

1. What is your age?
   20.

2. Which languages are you capable of speaking fluently?
   I can speak English and Persian fluently.

3. What is your current employment status? If you are employed, what do you do?
   Freelance. I work as a content creator and specialist.

4. What is the highest degree or level of education you have completed?
   I have completed secondary school and am currently in university.
   And what are you studying in university?
   Biology.

5. How would you describe your technological literacy level?

   (a) Very Good
   (b) Good
   (c) Average
   (d) Below Average
   (e) Not Good

Very good but not excellent. On a scale of 1 to 10, a 7 or 8.

6. How often do you use technology (computers, software, other hardware) on a daily basis?

    (a) Very often (more than twice a day)

    (b) Often (twice a day)

    (c) Once a day

    (d) Less than once a day

    (e) Once a week

    Very often.

7. As a follow-up to my previous question, what software, if any, do you use on a day to day basis?
   So I use Google Chrome, I use Notion, and Adobe Photoshop.

8. In your work, do you like to use real tools or virtual network tools to complete your tasks through your computer? Handheld calculator vs. online calculator for example.
   Handheld calculator if I had to use a calculator. Since I use photo editing software for work, it's virtual.

9. Do you use calculators often? If so, in what setting and for what purpose?
   Yes. I use them for my education and just to study and for exams.

10. Are you familiar with transcendental functions? If so, which functions do you find yourself using most often than others?
    I have heard of them. I believe I have dealt with them. [pause to think about it] Yes, I am aware of them and am familiar with them. Yes, I'd say I use them often. At least half of the time.

11. What is your level of proficiency regarding a calculator? (How many functions do you use or know how to use on a normal calculator, e.g. CASIO)
    Just for basic things, like logarithms and trigonometric functions and basic division and multiplication and those basic functions.

12. If you find yourself using a calculator, what functions or types of calculations do you use/perform?
    I kind of answered that with my previous answer. So a little bit of everything.

13. Does the complexity or features offered by a calculator matter? Will it affect which type of calculator you choose to buy or use over another?
    Yes. I have a TI Inspired CX calculator and I have a Casio calculator, but I always opt for the TI inspired unless it's basic addition or multiplication.

14. As a follow-up to my previous question, does the appearance or size of the calculator matter to you? Explain.
    To some extent. Shouldn't be too large that you can't carry it around or hold it in your hand. But shouldn't be so small that you make mistakes when pressing buttons. But I don't care about the colour or appearance. Just has to be easy to use.

15. When using a calculator at work, or for personal use, is the degree of precision important? i.e. are you calculating sensitive data or not?
    In day to day, no. But for university there's rigorous calculations so high degree is best. At least 3 decimal points.

16. If applicable, do you find yourself switching calculators throughout the day? Either at work or at home. If not, do you simply prefer to have a single calculator that offers every possible function needed?
    Yes.

17. Are you open to the idea of trying alternative tools, or do you prefer to sticking to what you are already using? If not, please explain why.
    If the alternate is much better, then I'd gladly switch. If it offers the same things as the tools I'm already using and it's not really different, then I'll continue using the tools I'm familiar with.

18. What best describes your willingness to try alternatives?

    (a) Curiosity
    (b) Better performance/ precision/ job done better
    (c) Didn't like current tool
    (d) Other (explain)

    Curiosity.

19. Which alternative strikes you as the most practical:

    (a) a calculator app on your phone,
    (b) a web app accessible from any device with Internet access,
    (c) a physical calculator
    (d) a desktop application, such as the default Windows calculator?

    Can I choose two of them?
    Sure thing.
    One on my phone and a physical one.

20. Have you ever used an online calculator?
    Yes.

21. If you have used an online calculator before, what were some of the difficulties you experienced with it? If not, would you use an online calculator?
    Great question. Some online calculators say they perform a difficult task, but when the difficulty increases they break down and stop working.

22. As a follow-up to my previous question: If so what features or functions would you be interested in using/having in an online calculator? If not, why not?
    It has to have a UX design and interface so it would be easy to use. I could see the solution easily and input the question or function easily. The placement of the functions should also be logical, since I sometimes spend 2 minutes searching for it.

23. Would customizability be a factor in choosing whether to use an online calculator over an alternative, yes or no?
    Yes.

24. Can you name 3 of your favorite calculator applications or alternatively, 3 of your favorite handheld calculator brands?
    TI Inspire CX, SymboLab, and I also use graphic calculators on my phone like Desmos and 3D Calculator.

25. What aspect of these applications or calculators appeals to you the most?
    First of all speed. Symbolab is really quick when inputting the problem and getting the results. Accuracy which is what I like about Symbolab and TI Inspire. It just being easy to use, and can input things quickly.

26. Have you used your operating system's default calculator? If so, what did you like and dislike about it?
    Only if it's very very very basic multiplication division. It doesn't offer anything other than the basic calculations.
    And what operating systema are you using?
    Mac OS

27. When using a calculator, does the appearance of the math expression matter to you? (x^y vs x^y).
    It would be best if it's a superscript. Especially if it's a long expression, since I'll be more likely to make a mistake reading it otherwise.

28. How often do you use trigonometric functions?
    Whenever I'm studying for math, which is several times a week.
    And when using them, do you prefer to use radians or degrees?
    Radians, unless vectors are involved.
    Do you like having the ability to switch between them?
    Yes

29. Which functions that are generally not on a calculator, would you like to see added?
    Great question. Multivariable functions, whether in terms of graphing or finding the

limits of. That's pretty much it. Composite transcendental functions as well.
Could you elaborate on what you mean by composite transcendental functions?
Some calculators won't really let you do e^(x^something).

30. That's all for the interview. Do you have any questions for myself or things you'd like to add? Are there things that you'd like to discuss regarding either online calculators, calculators in general, or even different online tools/software?
Just pretty much what I said. Has to look good and be easy to use. And it's best the symbols don't look messed up or weird so you wouldn't misunderstand or overlook them.

14.5   Interview 5

1. What is your age?
I'm 38 year old.

2. Which languages are you capable of speaking fluently?
English is my first language and I am fluent in French, since I studied at the University of Montreal.

3. What is your current employment status? If you are employed, what do you do?
I work at IQVIA in the West of Montreal. I am employed as a statistician.

4. What is the highest degree or level of education you have completed?
PhD in bio-statistics at University of Montreal.

5. How would you describe your technological literacy level?

   (a) Very Good
   (b) Good
   (c) Average
   (d) Below Average
   (e) Not Good

   Very good

6. How often do you use technology (computers, software, other hardware) on a daily basis?

   (a) Very often (more than twice a day)
   (b) Often (twice a day)
   (c) Once a day
   (d) Less than once a day

(e) Once a week

Very often.

7. As a follow-up to my previous question, what software, if any, do you use on a day to day basis?
   I mainly deal with databases, SQL, Stata, VB and python.

8. In your work, do you like to use real tools or virtual network tools to complete your tasks through your computer? Handheld calculator vs. online calculator for example.
   Most of our tools are partially virtual since the information is shared via a network, but my daily calculations, depending on the scale, are performed on my computer.

9. Do you use calculators often? If so, in what setting and for what purpose?
   Less and less...

10. Are you familiar with transcendental functions? If so, which functions do you find yourself using most often than others?
    I am in fact familiar with those. I would say the logarithm.

11. What is your level of proficiency regarding a calculator? (How many functions do you use or know how to use on a normal calculator, e.g. CASIO)
    Good question. I think I know how to use most of them.

12. If you find yourself using a calculator, what functions or types of calculations do you use/perform?
    The basics, plus, minus, multiplication, division, sin, cos, log, square root.

13. Does the complexity or features offered by a calculator matter? Will it affect which type of calculator you choose to buy or use over another?
    It has to have more than the four basic operations. Like you asked earlier, a Casio is perfect.

14. As a follow-up to my previous question, does the appearance or size of the calculator matter to you? Explain.
    Not really, they all kind of look the same anyway.

15. When using a calculator at work, or for personal use, is the degree of precision important? i.e. are you calculating sensitive data or not?
    I don't think it ever causes me any problem.

16. If applicable, do you find yourself switching calculators throughout the day? Either at work or at home. If not, do you simply prefer to have a single calculator that offers every possible function needed?
    I have a calculator at home and one at my desk, the rest of the time I would use my phone.

17. Are you open to the idea of trying alternative tools, or do you prefer to sticking to what you are already using? If not, please explain why.
I would be open minded, impress me.

18. What best describes your willingness to try alternatives?

    (a) Curiosity
    (b) Better performance/ precision/ job done better
    (c) Didn't like current tool
    (d) Other (explain)

    Curiosity.

19. Which alternative strikes you as the most practical:

    (a) a calculator app on your phone,
    (b) a web app accessible from any device with Internet access,
    (c) a physical calculator
    (d) a desktop application, such as the default Windows calculator?

    A calculator app on your phone,

20. Have you ever used an online calculator?
I used Wolfram Alpha, but it's way more than a calculator. You can ask for any type integral for example. I think it can even tell you the weather.

21. If you have used an online calculator before, what were some of the difficulties you experienced with it? If not, would you use an online calculator?
For Wolfram, much of the advanced stuff costs money, this generally bothers me.

22. Would customizability be a factor in choosing whether to use an online calculator over an alternative, yes or no?
Not really, maybe having a dark mode.

23. Can you name 3 of your favorite calculator applications or alternatively, 3 of your favorite handheld calculator brands?
Wolfram Alpha, Casio and Python :)

24. What aspect of these applications or calculators appeals to you the most?
Wolfram can pretty much solve anything, Casio is portable and straight to the point, Python you can do anything.

25. Have you used your operating system's default calculator? If so, what did you like and dislike about it?
Yes for sure, for those kinds of calculations I always prefer to use the handheld one, that is why I always keep one at my desk.

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26. When using a calculator, does the appearance of the math expression matter to you? (x^y vs x^y).
Not really, I am used to different notations. However some are more elegant.

27. How often do you use trigonometric functions?
Not that often, but I am definitely on the radian team, it is so much more elegant, sorry to our Babylonian friends. Yes it could be convenient, why not.

28. Which functions that are generally not on a calculator, would you like to see added?
This is very difficult, maybe some constants could be added, like the gravity constant or the speed of light for our fellow engineer.

29. That's all for the interview. Do you have any questions for myself or things you'd like to add? Are there things that you'd like to discuss regarding either online calculators, calculators in general, or even different online tools/software?
I can't wait to see your calculator, good luck.

14.6 Interview 6

1. What is your age?
You know my age..., 50.

2. Which languages are you capable of speaking fluently?
I can speak French, English and Portuguese fluently. I can also write in all of these languages.

3. What is your current employment status? If you are employed, what do you do?
I am a business associate at my own Architectural firm called UN Architecture. I work fulltime at around 45 hours per work and manage my own office and employees.

4. What is the highest degree or level of education you have completed?
I have a DEC in Architectural Technology Vanier College. .

5. How would you describe your technological literacy level?

   (a) Very Good
   (b) Good
   (c) Average
   (d) Below Average
   (e) Not Good

   A. Very Good.

6. How often do you use technology (computers, software, other hardware) on a daily basis?

    (a) Very often (more than twice a day)

    (b) Often (twice a day)

    (c) Once a day

    (d) Less than once a day

    (e) Once a week

    Oh I use technology a lot. More than half of my day consists of sitting in front of a computer or using my phone for calls and meetings.

7. As a follow-up to my previous question, what software, if any, do you use on a day to day basis?
   I use the entire Microsoft Office Suite, mostly Excel and Word. I also use AutoCad every day since that is the primary tool that Architects and Engineers use for their projects.

   For Excel and Word, I mostly use these software to either calculate employee salaries or to prepare legal documents for new or old projects.

8. In your work, do you like to use real tools or virtual network tools to complete your tasks through your computer? Handheld calculator vs. online calculator for example.
   I definitely prefer to use online tools. Nothing is more convenient than having to only carry a single laptop or tablet and have access to any tools you might need throughout the day online and through software.

9. Do you use calculators often? If so, in what setting and for what purpose?
   Yes, I use calculators every day, especially when working with so many Engineers and other Architects.

10. Are you familiar with transcendental functions? If so, which functions do you find yourself using most often than others?
    Yes I am, but I never use them. That is some stuff you only use as either an Engineer or as a student studying calculus.

11. What is your level of proficiency regarding a calculator? (How many functions do you use or know how to use on a normal calculator, e.g. CASIO)
    I would say I am very strong when it comes to using a calculator. Although I only use the very basic functions, like plus, minus, division, addition, and so on. . .

12. If you find yourself using a calculator, what functions or types of calculations do you use/perform?
    I just answered that!

13. Does the complexity or features offered by a calculator matter? Will it affect which type of calculator you choose to buy or use over another?
    Not really. Since all of the calculators that exist would have all the necessary basic functions, that's enough for me. Although I know that many of my Engineering colleagues use very complex calculators, so I suppose it would matter greatly to them.

14. As a follow-up to my previous question, does the appearance or size of the calculator matter to you? Explain.
    Appearance no. Size, definitely! I don't like to carry many things on me. Therefore, the smaller the calculator the better.

15. When using a calculator at work, or for personal use, is the degree of precision important? i.e. are you calculating sensitive data or not?
    Oh yes of course. Who wants to use a calculator that is not accurate.

    For this type of question, we were talking about more the accuracy of transcendental functions which are often times very complex and time consuming to calculate.
    Oh right. But I mean the point still stands. Who wants to use a calculator that is not accurate? I understand that because these types of functions are exponential it might take long to calculate, but that is your job to try to optimize it right?

16. If applicable, do you find yourself switching calculators throughout the day? Either at work or at home. If not, do you simply prefer to have a single calculator that offers every possible function needed?
    Never. I have always used the built in Windows calculator ever since I have been using a computer. Which is a very long time.

17. Are you open to the idea of trying alternative tools, or do you prefer to sticking to what you are already using? If not, please explain why.
    Definitely, in any field that deals with computers or technology you have to be willing to try new tools. Things adapt and evolve all the time, if you do not adapt with it you are putting yourself at a disadvantage. So, I would say I am always trying new tools to simplify my life.

18. What best describes your willingness to try alternatives?

    (a) Curiosity
    (b) Better performance/ precision/ job done better
    (c) Didn't like current tool
    (d) Other (explain)

    I would say it is more of a combination of A and B. I love computers so I try different things that come out. But, if it doesn't work well I will stop using it.

19. Which alternative strikes you as the most practical:

    (a) a calculator app on your phone,

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(b) a web app accessible from any device with Internet access,

(c) a physical calculator

(d) a desktop application, such as the default Windows calculator?

Either a web application or desktop application. I don't like taking out my phone during work so that is out of the equation. And I don't like carrying around physical things, so I would say software is the best way to go.

20. Have you ever used an online calculator?
Yes, I use it all the time. I often find myself using the Google Calculator found when you search "Calculator" on Google.

21. If you have used an online calculator before, what were some of the difficulties you experienced with it? If not, would you use an online calculator?
I don't really have any issues using the Google calculator. It is very simple and easy to use, loads quickly and is easy to access. I would say those are the things that make it successful. Other calculators I've used just don't load up as quickly or are not as accessible as the one on Google.

22. 22. As a follow-up to my previous question: If so what features or functions would you be interested in using/having in an online calculator? If not, why not?
Just all of the basic math operators are all I need. Addition, subtraction, multiplication, division, etc... Sometimes I will need exponents but that is very rare. But I suppose that would be useful eventually.

23. Would customizability be a factor in choosing whether to use an online calculator over an alternative, yes or no?
Oh yes! That is actually one of the things you cannot do with the Google Calculator. The idea of a dark or light theme is very interesting, especially when working at night and you don't want an all white page to blind you while working in the dark.

24. Can you name 3 of your favorite calculator applications or alternatively, 3 of your favorite handheld calculator brands?
Google Calculator, Windows Calculator, Calculator from Dollarama.

25. What aspect of these applications or calculators appeals to you the most?
Like I said before, the simplicity and ease of use is the most important thing for me. If a calculator has all the things I need and does them quickly then that is a good calculator. But now that you make me think of it, a calculator that has all this plus allows me to have a dark theme version for it is really appealing.

26. Have you used your operating system's default calculator? If so, what did you like and dislike about it?
Yes. I use the one that comes with Windows. It is good, does everything I need.

27. When using a calculator, does the appearance of the math expression matter to you? (x^y vs x^y).
    Yes, I have not seen the first way of writing x power y since CEGEP. Keep it simple and show the expression the way it is meant to be shown.

28. How often do you use trigonometric functions?
    I use them rarely, but when I do I always talk in degrees. Who wants to talk in radians? Most people don't even know what radians even are.

29. Which functions that are generally not on a calculator, would you like to see added?
    I can't think of any since I use only the simple ones. But adding a function or button to change the theme of the calculator would be cool.

30. That's all for the interview. Do you have any questions for myself or things you'd like to add? Are there things that you'd like to discuss regarding either online calculators, calculators in general, or even different online tools/software?
    Are you guys building a calculator?

    Yeah, we are building an online calculator using Django which allows you to use Python on the web as well as other web frameworks for the UI.
    Oh cool! Will you be adding ways for people to change the colour or theme of the calculator?

    Yup! That's in the plans. A lot of people are saying they would want that.
    Yeah it's a great idea. No calculators I've used have done that. When you guys finish send it to me and I will use it if it has a dark theme.

14.7   Interview 7

1. What is your age?
   32

2. Which languages are you capable of speaking fluently?
   Fluently? Only English, but I also know a bit of French.

3. What is your current employment status? If you are employed, what do you do?
   I am employed full time. I work as a data analyst.

4. What is the highest degree or level of education you have completed?
   I have an Undergraduate in Physics and a certificate in Data Analysis.

5. How would you describe your technological literacy level?

   (a) Very Good
   (b) Good

    (c) Average

    (d) Below Average

    (e) Not Good

I'd say very good.

6. How often do you use technology (computers, software, other hardware) on a daily basis?

    (a) Very often (more than twice a day)

    (b) Often (twice a day)

    (c) Once a day

    (d) Less than once a day

    (e) Once a week

Every day.

7. As a follow-up to my previous question, what software, if any, do you use on a day to day basis?
I use various Python libraries such as Pandas, SciKitLearn, Seaborn as well as some querying languages such as SQL.

8. In your work, do you like to use real tools or virtual network tools to complete your tasks through your computer? Handheld calculator vs. online calculator for example.
Not many people use handheld calculators anymore. I mostly use online or desktop software.

9. Do you use calculators often? If so, in what setting and for what purpose?
While calculations are a big part of my daily work, most of the computations are done by the software tools I use.

10. Are you familiar with transcendental functions? If so, which functions do you find yourself using most often than others?
Yes. I often use logarithms and standard deviation.

11. What is your level of proficiency regarding a calculator? (How many functions do you use or know how to use on a normal calculator, e.g. CASIO)
Given my educational background, I would like to say that I'm quite proficient. It has been a long time since I graduated however...

12. If you find yourself using a calculator, what functions or types of calculations do you use/perform?
As a Data Analyst, most of my computations involve simple sums over large data sets.

13. Does the complexity or features offered by a calculator matter? Will it affect which type of calculator you choose to buy or use over another?
Because most of my work involves domain specific computations on large datasets, I mostly use Python libraries rather than calculators.

14. As a follow-up to my previous question, does the appearance or size of the calculator matter to you? Explain.
No, the appearance generally doesn't matter to me if it works, although we all have some ergonomic and aesthetic standards when it comes to using a product.

15. When using a calculator at work, or for personal use, is the degree of precision important? i.e. are you calculating sensitive data or not?
That is highly dependent on the task at hand and the granularity of the underlying data sets. If somebody is asking you to predict a price for example, two decimal points suffices. If you are modeling a system however, or compounding several functions, the precision matters.

16. If applicable, do you find yourself switching calculators throughout the day? Either at work or at home. If not, do you simply prefer to have a single calculator that offers every possible function needed?
No.

17. Are you open to the idea of trying alternative tools, or do you prefer to sticking to what you are already using? If not, please explain why.
I'm open to trying new things. It is very much a part of the job to become familiar with as many new tools as possible if they can speed up the workflow.

18. What best describes your willingness to try alternatives?

    (a) Curiosity
    (b) Better performance/ precision/ job done better
    (c) Didn't like current tool
    (d) Other (explain)

    Generally I prioritize ease of use and performance over any other metric. One thing that matters a lot, is the ability to integrate with existing tools.

19. Which alternative strikes you as the most practical:

    (a) a calculator app on your phone,
    (b) a web app accessible from any device with Internet access,
    (c) a physical calculator
    (d) a desktop application, such as the default Windows calculator?

    Most of my work is done on the computer, so desktop applications suit my needs the most, especially if it can integrate with my current tools.

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20. Have you ever used an online calculator?
    Yes.

21. If you have used an online calculator before, what were some of the difficulties you experienced with it? If not, would you use an online calculator?
    I was unfamiliar with the syntax used. Some people expect you to type out the word "Sin" whereas others expect you to click a button on the interface. They also seem to be pretty ambiguous when it comes to how or if it saves your previous answer and whether it is available for subsequent calculations.

22. 22. As a follow-up to my previous question: If so what features or functions would you be interested in using/having in an online calculator? If not, why not?
    For online calculators, I would mostly be interested in graphing. The default calculator that comes with Windows suits most of my needs as is.

23. Would customizability be a factor in choosing whether to use an online calculator over an alternative, yes or no?
    No, typically all I care about is something that is intuitive where... I don't want to spend my time on a calculator and the best type of software is the type I don't have to tinker with at all.

24. Can you name 3 of your favorite calculator applications or alternatively, 3 of your favorite handheld calculator brands?
    WolframAlpha, Desmos, Symbolab - CASIO calculator watches also seem pretty cool.

25. What aspect of these applications or calculators appeals to you the most?
    For WolframAlpha and Symbolab, the ability to calculate integrals is very useful to get quick answers. They are also useful because you can use natural language. Desmos is nice because it graphs things well. I should mention however, that most of the graphing that I personally do at work is done using a graphing tool like Seaborn.

26. Have you used your operating system's default calculator? If so, what did you like and dislike about it?
    I have used it. I like that it is built in and readily available. I have a shortcut on my keyboard to access it in fact. It is good for simple calculations that I don't want to solve in my head. I don't think there is anything to dislike because I think it serves its purpose well.

27. When using a calculator, does the appearance of the math expression matter to you? (x^y vs x^y).
    Not that often, but I am definitely on the radian team, it is so much more elegant, sorry to our Babylonian friends. Yes it could be convenient, why not.

28. How often do you use trigonometric functions?
    I personally don't use trigonometric functions at work, but I generally prefer using

radians. It is useful to have the ability to switch between radians and degrees though.

29. Which functions that are generally not on a calculator, would you like to see added?
    I don't know, I generally use calculators for simple calculations. Anything more involved or specific to a certain domain would generally be more easily done through code rather than a GUI.

30. That's all for the interview. Do you have any questions for myself or things you'd like to add? Are there things that you'd like to discuss regarding either online calculators, calculators in general, or even different online tools/software?
    No.

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