

Graphing Calculator

Project Backlog

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Problem Statement

We have decided to make a PC version graphing calculator that helps identify the trend and growth rate of the function more intuitively. Additionally, our graphing calculator is capable of drawing the diagram of a user-input elementary function or finite piecewise elementary functions. It should allow the user to compare the diagram of multiple functions on a single graph, rescale the axis and identify the discontinuities.

Background Information

User:

Students in mathematics and statistics sometimes need graphing calculators to demonstrate specific graphs, they need some application to construct these graphs. At the same time, they need to track specific points and acquire information. In addition, They often need to demonstrate the difference between graphs, as well as find traits or gather information on various domains.

Similar platforms:

There are some graphing calculator such as Wolfram Alpha, Wolfram Mathematica, Matlab, Maple and Symbolab. These softwares are professionally designed, can perform a lot of functionalities upon request, and are capable of outputting vectograms.

Limitations:

The existing softwares are either very large and resource-consuming, like Mathematica, or requires a network connection, like Wolfram Alpha. In addition, their

Solution:

Our program will be local, light weight, specialized in comparing multiple functions, and able to set the range of x for each function as needed. Furthermore, our program supports user to change color of each graph to give a better visual comparison.

Environment

We will use Jpanel for the graphical user interface, parsing user input into a tree structure. We will also use Java for the calculation and plotting. We will use pixel graph to represent our output graph. Our development environment is IntelliJ.

Functional Requirements

Backlog ID	Functional Requirements	Hours	Status
Input & Parse			
1	As a user, I would like to input an elementary function in a natural liner format	15	Completed in sprint1
2	As a user, I would like to input a set of piecewise elementary functions with its corresponding range of x .	10	Planned in sprint 2
3	As a user, I would like to display multiple elementary functions on the same canvas.	10	Planned in sprint 2
4	As a user, I would like to set the range of x in a graph.	5	In-progress: moves to sprint 2
5	As a user, I would like to set the color of each graph for multiple functions.	4	Planned in sprint 2

6	As a user, I would like system to select the color for all the graphs when not specified.	2	Planned in sprint 2
7	As a user, I would like to have indication areas where I should put numbers around an operand.	5(provided 8 is completed)	Completed in sprint1
8	As a user, I would like to have buttons and hot keys for operands that are hard to find on a traditional keyboard.	5	Completed in sprint1
9	As a user, I would like the system to check if my input is correct and give corresponding information when input is wrong.	10	In-Progress: moved to sprint 2
10	As a user, I would like to have a menu to select my color.	5	Planned for sprint 2
11	As a user, I would like the system provide some common constant like π and e .	8	Complete in sprint1
12	As a user, I would like the system to remember a list of my old inputs for future use.	10	Planned for sprint 2
Analyze			
13	As a user, I would like to identify the discontinuities by looking at the graph. (This requires an algorithm to identify the discontinuities of the input function)	20	In-Progress: moved to sprint 2
14	As a user, I would like to see the endpoints of the interval where the function is defined to be indicated on the graph, with a solid dot indicating closed endpoint, and an open circle indicating open endpoint.	30(provided 13 is completed)	Planned for sprint 2
15	As a user, I would like the system to have a preset range of x axis when I don't set the range manually.	5	Complete in sprint1
16	As a user, I would like the graph to be of rational size on the canvas when the range of y axis is not set manually	15	Complete in sprint1
17	As a user, I would like to see each pieces of a piecewise function to be plotted with the same color.	10	Planned for sprint 2
18	As a user, I would like to see the coordinates of the intersections of two functions.	15	Planned for sprint 2
19	As a user, I would like to see the corresponding points on the graph given a y-value.	5(provided 18 is completed)	Planned for sprint 2
Output			
20	As a user, I would like to see my function plotted.	20	Complete in sprint1
21	As a user, I would like to see the axis plotted with scales on it.	15	Complete in sprint1

22	As a user, I would like to zoom in or zoom out the canvas.	10	Complete in sprint1
23	As a user, I would like the scales of the axis to be logarithmic if I choose it to be.	25	In-Progress: moved to sprint 2
24	As a user, I would like to see zig zagged lines indicating shrunk axis	15	In-Progress: moved to sprint 2
25	As a user, I would like to see the exact y component and the corresponding point highlighted by entering x component manually	10	Planned for sprint 2
26	As a user, I would like to click on a special point(intersections, endpoints) on the graph to see its coordinates.	20	Planned for sprint 2
27	As a user, I would like to have a comprehensive text instruction available along with the calculator	5	Complete in sprint1
28	As a user, I would like to center the graph at specific location.	5	Planned for sprint 2

Non-Functional Requirements

Architecture and performance

The desktop application will have separated *parse* and *plot* part. Both parts will be involved in developing frontend and backend. *Parse* is responsible for parsing input equation, constructing a tree structure, sending the function tree to the *plot* part for future plotting. Additionally, *Parse* is also handling user input, preference settings (interval, color, etc), operator buttons, etc. *Plot* is responsible for developing self-constructed functions to show the graph. Besides, *plot* also handles the rescale of the graph when user zoom in/out the canvas.

Usability

The application will be responsive so users can use it on desktops. The user interface is going to be straightforward and easy to use. There is user-defined color of the graph and user-defined function domain available.

Use Cases

Case: Plot an elementary function

Action	System Response
1. Enter your equation	
2. Click on plot button	If input has no error,corresponding graph will be shown on canvas, with system chosen x range and y range, otherwise, error will be displayed.

Case: Plot a piecewise elementary function

Action	System Response
1. Enter your first equation	
2. Enter corresponding x range for your first equation	
3. Click on “plus” button to add another equation and its corresponding x range	
4. Choose color for each equation (optional)	
5. Click on “plot” button	If input has no error,corresponding graph will be shown on canvas,otherwise, error will be displayed. Graph is shown with breakpoints and selected color

Case: Check the component of a point

Action	System Response
1. Plot your graph	Graph is shown on the canvas
2. Click on a point of your graph	Corresponding x, y value will be shown

Case: Zoom in / Zoom out

Action	System Response
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1. Plot your graph	Graph is shown on the canvas
2. Zoom in/out with user declared input value	Graph is shown with scaled size

Case: Plot multiple graphs on the same canvas

Action	System Response
1. Plot your first graph	
2. Select the color of first graph	
3. Click on “plot” button	First graph with selected color is shown
3. Click on “plus” button	A new column will be shown for user to enter extra equation
4. Select the color of second graph	
5. Click on “plot” button	Second graph with selected color is shown, intersection points are shown with points if any
6. Keep adding ...	

Case: Display user-specified point and its information

Action	System Response
1. Repeat Case “Plot multiple graph on the same canvas”	Graphs will shown in different colors
2. Click on intersect point	Corresponding x,y value will be shown

Case: Display user-specified point and its information

Action	System Response
1. Repeat Case “Plot multiple graph on the same canvas”	Graphs will shown in different colors
2. User input a x value in specific area on	Corresponding y value and the point itself

the UI.	will be shown
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Case: Set range of x

Action	System Response
1. Enter your equation	
2. User can choose specific range of x or leave it blank as default	If defined, graph will be shown in specified x range and its corresponding y range; If not, graph will be shown in default range

Case: Set color of a graph

Action	System Response
1. Enter first equation	
2. Select color of first graph from the menu (either before clicking on “plot” or after doing so)	
3. Click “plot” button	Graph with specified color is shown

Case: Identify the discontinuities

Action	System Response
1. Enter a discontinuous function (e.g: $\frac{1}{x}$, $\sin(x)$, $\sqrt{1-x}$, etc)	
2. Click on “plot” button	Graph is shown with open points, which are not defined on the graph

Case: Set graph scale logarithmically

Action	System Response
1. Enter equation	
2. Choose the “logarithmically” checkbox	

2. Click on the “plot” button	Graph is shown with proper logarithmic scale.
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Case: Check user input and give corresponding information

Action	System Response
1. Enter equation that can't run	
2. Click on the “plot” button	Show information that indicates the function is unable to run, or provides corresponding revision suggestion.

Case: Show list of old inputs for user to select

Action	System Response
1. Click on the input field	Show list of previous old inputs.

Case: plot a graph far away from origin

Action	System Response
1. Input a function that is very far away from the origin	System decides that the graph should have zigzagged axis to indicate that the graph is far away from the origin

Case: Look for instruction

Action	System Response
1. Click on the instruction button	Show a comprehensive text instruction