CMPE287 – Software Quality Assurance and Testing

Deliverable #2B – AI Test Report

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AI Testing Tool – Credentials

Username: saiteja377

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AI Testing Tool: http://3.14.249.198:8080/login

1. AI Function Test Requirement Analysis

1.1 Overview

Photo Math

Photo Math: Photo Math is an AI based educational mobile application owned and maintained by Google. It operates as a computer algebra system combined with an advanced optical character recognition system tailored for utilization with a smartphone's camera to scan and identify mathematical equations. Following the scanning process, the application proceeds to display methodical explanations directly on the screen.

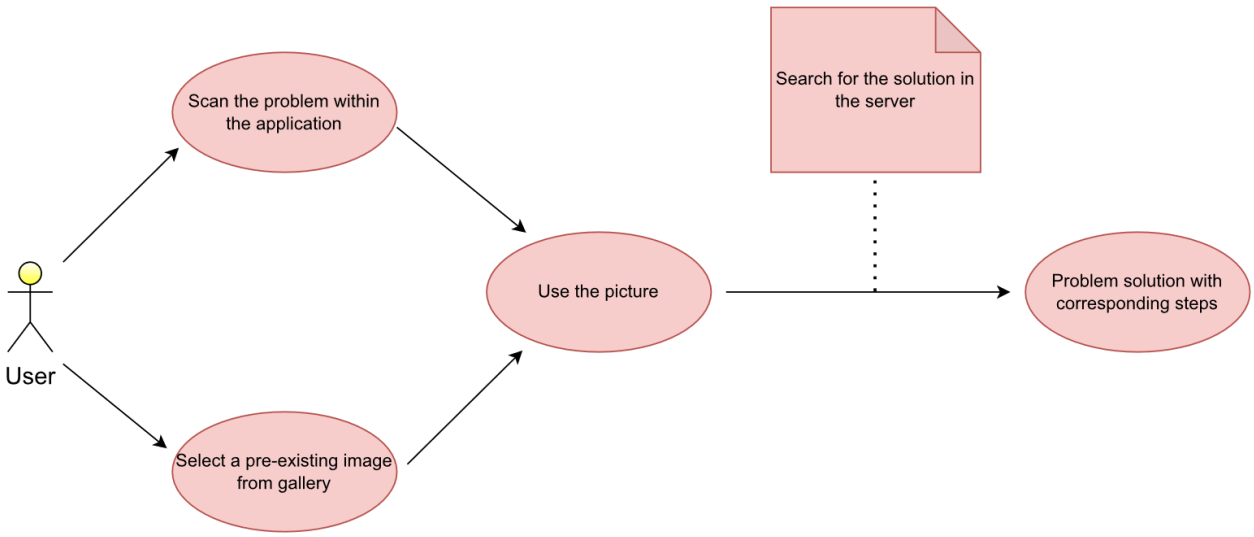


Figure 1.1– AI Function Scenario Diagram

1.2 AI Function Test Requirements

The primary divisions within artificial intelligence consist of machine learning (ML), natural language processing, and image recognition. To establish the criteria for testing the functionality of AI, we will assess whether the selected apps for testing incorporate these specific AI subcategories.

The AI feature we will investigate is Image Recognition. Here are the procedures for assessing this capability:

- Acquire the Image
- Evaluate the Input
- Produce the Outcome

1.3 AI Function Test Requirements Modeling

We are utilizing an AI testing tool to build models for AI function test requirements. This tool will assist us in constructing context trees as well as input and output classification trees. Our objective is to pinpoint the specific features and represent them within these trees. The main nodes within these trees are input, context, and output, which will be subdivided into subcategories based on the identified features. The terminal nodes, represented by leaf nodes, cannot be further divided into features. These leaf nodes represent distinct types of test cases that will undergo testing. The depth of each tree within the input, context, and output classifications is set at 3 levels.

2. AI Test Modeling for Selected AI Features

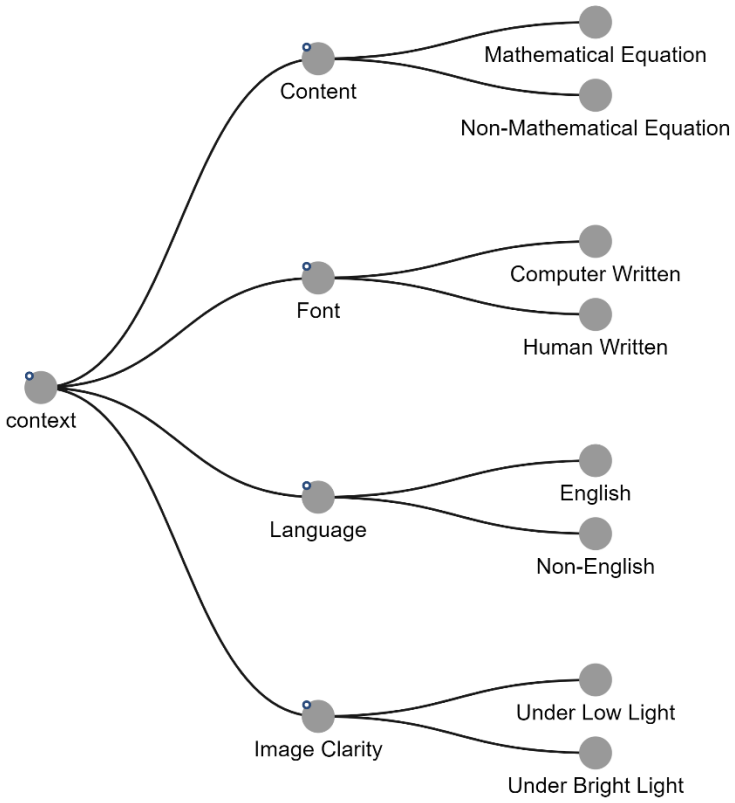
Image Recognition is the AI feature employed in Photomath application. Consequently, all the test cases conducted revolve around image inputs, and the specific AI function under test is Image Recognition. Numerous test cases, each involving distinct scenarios, are executed to evaluate the image recognition functionality of the Photomath application.

2.1 Context Modeling for each selected AI-powered Function/Feature

With respect to modeling the context for the selected AI feature (Image), we have categorized it into 4 types. We have content, font, language, and image clarity. Again, each of these categories is subdivided into two different categories. Content can be a Mathematical Equation, Non-Mathematical Equation. The font, on the other hand, can be

computer written or human written. Similarly, the language could be English or any language other than English. Finally, the image clarity can be good or bad.

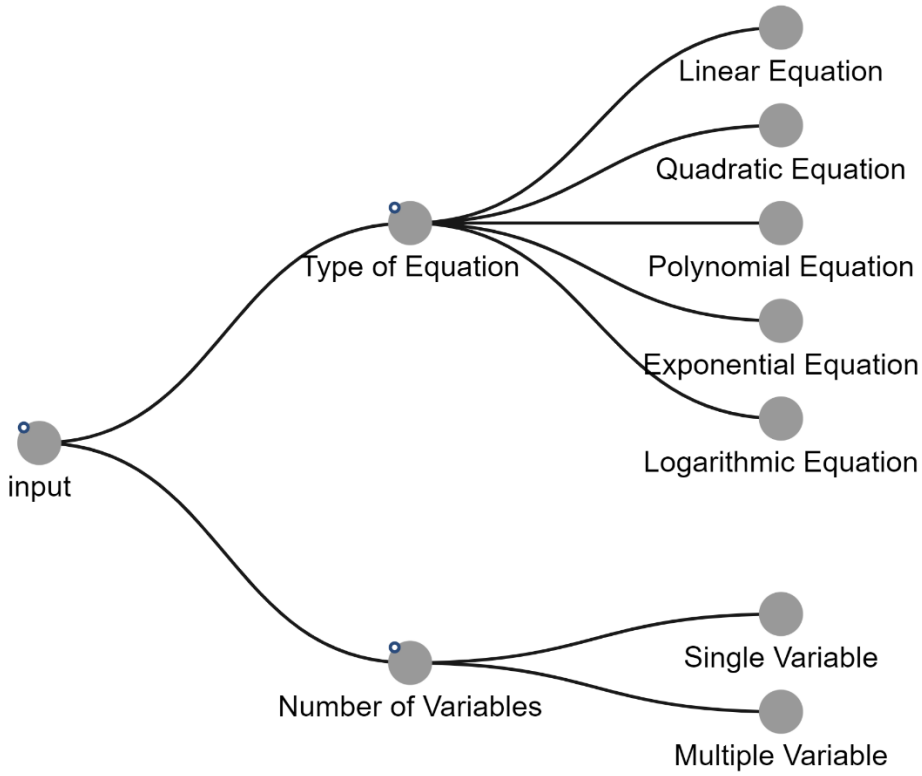
The following image shows the context modeling done using the AI Testing tool:



2.2 AI-powered function input classifications

With respect to the input modeling, we have categorized it into two variants. One is related to the type of equation, and other is regarding the number of variables used. The type of equation is again subcategorized into 5 different categories. They are, Linear Equation, Quadratic Equation, Polynomial Equation, Exponential Equation, Logarithmic Equation. Finally, the number of variables could be single variable inputs or multi-variable inputs.

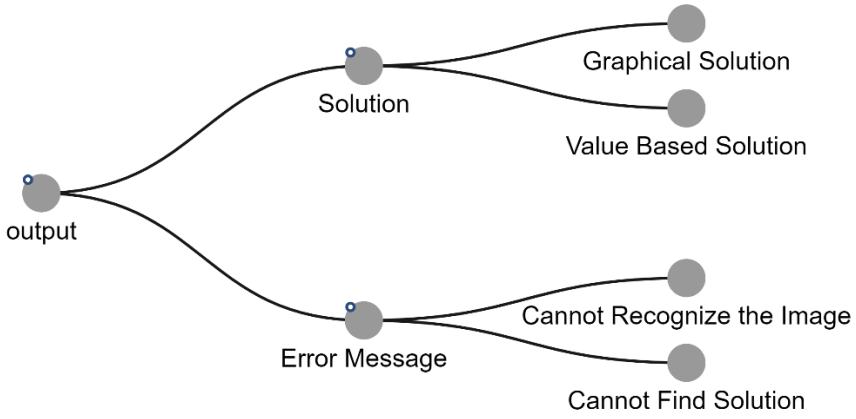
The following image shows the input modeling done using the AI Testing tool



2.3 AI-powered function output/event/action classifications

With respect to the output modeling, we have categorized it into two variants. One is related to the solution, and other is regarding the error message given. The solution is again subcategorized into 2 different categories. We can have Graphical-based solution and value-based solution. Finally, the error message could have ‘cannot recognize the image’ message or ‘cannot find the solution’ message.

The following image shows the output modeling done using the AI Testing tool



2.4 AI-powered function classification decision tables

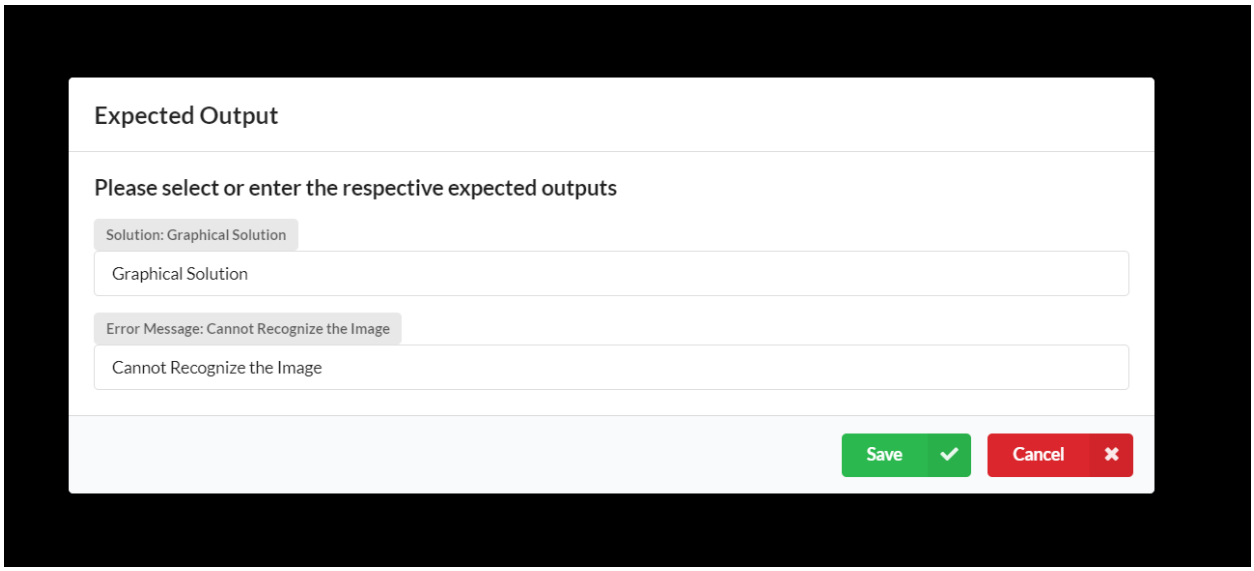
A 3D Decision table is generated from the AI testing tool by the utilizing the above context, input, and output modeling trees.

3. AI Function Test Cases with Inputs/Expected Outputs

3.1 Test data models

As you can see in the above 3D decision table, we have “undefined” in the output section of the decision table. This is because we have not yet defined the expected outputs in the tool.

The following snippet shows how we modified the expected output:



After changing the expected outputs of all the test cases, we have the following modified 3D decision table shown in various angles.

id	Error Message	Solution
1	Cannot Recognize the Image	Graphical Solution
2	Cannot Find Solution	Graphical Solution
3	Cannot Recognize the Image	Value Based Solution
4	Cannot Find Solution	Value Based Solution
5	Cannot Find Solution	Graphical Solution
6	Cannot Recognize the Image	Value Based Solution
7	Cannot Find Solution	Graphical Solution
8	Cannot Recognize the Image	Graphical Solution
9	Cannot Find Solution	Value Based Solution
10	Cannot Find Solution	Value Based Solution

id	Number of Variables	Type of Equation
1	Single Variable	Linear Equation
2	Multiple Variable	Logarithmic Equation
3	Multiple Variable	Linear Equation
4	Single Variable	Quadratic Equation
5	Multiple Variable	Quadratic Equation
6	Single Variable	Polynomial Equation
7	Multiple Variable	Polynomial Equation
8	Single Variable	Exponential Equation
9	Multiple Variable	Exponential Equation
10	Single Variable	Logarithmic Equation

id	Number of Variables	Type of Equation
1	Single Variable	Linear Equation
2	Multiple Variable	Logarithmic Equation
3	Multiple Variable	Linear Equation
4	Single Variable	Quadratic Equation
5	Multiple Variable	Quadratic Equation
6	Single Variable	Polynomial Equation
7	Multiple Variable	Polynomial Equation
8	Single Variable	Exponential Equation
9	Multiple Variable	Exponential Equation
10	Single Variable	Logarithmic Equation

The AI testing tool has generated testcases based on the given 3 tree models. The following series of snippets depict the generated testcases.

Project Name: MathScanner Function Name: MathImageScanner

Test Cases

Enter a keyword and press enter...

		Input Feature		Context Feature				Expected Output		Image Input	Upload
	id	Number of Variables	Type of Equation	Content	Font	Image Clarity	Language	Error Message	Solution		
	1	Single Variable	Linear Equation	Mathematical Equation	Computer Written	Under Low Light	English	Cannot Recognize the Image	Graphical Solution		Upload
	2	Multiple Variable	Linear Equation	Mathematical Equation	Computer Written	Under Low Light	English	Cannot Recognize the Image	Value Based Solution		Upload
	3	Single Variable	Quadratic Equation	Mathematical Equation	Computer Written	Under Low Light	English	Cannot Find Solution	Value Based Solution		Upload
	4	Multiple Variable	Quadratic Equation	Mathematical Equation	Computer Written	Under Low Light	English	Cannot Find Solution	Graphical Solution		Upload
	5	Single Variable	Polynomial Equation	Mathematical Equation	Computer Written	Under Low Light	English	Cannot Recognize the Image	Value Based Solution		Upload
	6	Multiple Variable	Polynomial Equation	Mathematical Equation	Computer Written	Under Low Light	English	Cannot Find Solution	Graphical Solution		Upload
	7	Single Variable	Exponential Equation	Mathematical Equation	Computer Written	Under Low Light	English	Cannot Recognize the Image	Graphical Solution		Upload

11	Single Variable	Linear Equation	Mathematical Equation	Computer Written	Under Bright Light	English	Cannot Recognize the Image	Graphical Solution		Upload
12	Multiple Variable	Linear Equation	Mathematical Equation	Computer Written	Under Bright Light	English	Cannot Recognize the Image	Value Based Solution		Upload
13	Single Variable	Quadratic Equation	Mathematical Equation	Computer Written	Under Bright Light	English	Cannot Find Solution	Value Based Solution		Upload
14	Multiple Variable	Quadratic Equation	Mathematical Equation	Computer Written	Under Bright Light	English	Cannot Find Solution	Graphical Solution		Upload
15	Single Variable	Polynomial Equation	Mathematical Equation	Computer Written	Under Bright Light	English	Cannot Recognize the Image	Value Based Solution		Upload
16	Multiple Variable	Polynomial Equation	Mathematical Equation	Computer Written	Under Bright Light	English	Cannot Find Solution	Graphical Solution		Upload
17	Single Variable	Exponential Equation	Mathematical Equation	Computer Written	Under Bright Light	English	Cannot Recognize the Image	Graphical Solution		Upload
18	Multiple Variable	Exponential Equation	Mathematical Equation	Computer Written	Under Bright Light	English	Cannot Find Solution	Value Based Solution		Upload
19	Single Variable	Logarithmic Equation	Mathematical Equation	Computer Written	Under Bright Light	English	Cannot Find Solution	Value Based Solution		Upload
20	Multiple Variable	Logarithmic Equation	Mathematical Equation	Computer Written	Under Bright Light	English	Cannot Find Solution	Graphical Solution		Upload

« ‹ 1 2 3 4 5 ... 8 › » Select rows per page Import Data Export Testcases Data Generation Data Augmentation

Project Name: MathScanner Function Name: MathImageScanner

Test Cases

Enter a keyword and press enter...

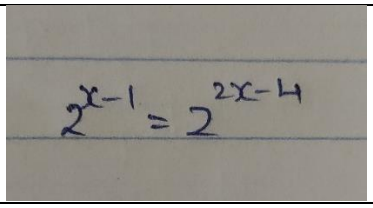
		Input Feature		Context Feature				Expected Output		Image Input	Upload
	id	Number of Variables	Type of Equation	Content	Font	Image Clarity	Language	Error Message	Solution		
	141	Single Variable	Linear Equation	Non-Mathematical Equation	Human Written	Under Low Light	Non-English	Cannot Recognize the Image	Graphical Solution		Upload
	142	Multiple Variable	Linear Equation	Non-Mathematical Equation	Human Written	Under Low Light	Non-English	Cannot Recognize the Image	Value Based Solution		Upload
	143	Single Variable	Quadratic Equation	Non-Mathematical Equation	Human Written	Under Low Light	Non-English	Cannot Find Solution	Value Based Solution		Upload
	144	Multiple Variable	Quadratic Equation	Non-Mathematical Equation	Human Written	Under Low Light	Non-English	Cannot Find Solution	Graphical Solution		Upload
	145	Single Variable	Polynomial Equation	Non-Mathematical Equation	Human Written	Under Low Light	Non-English	Cannot Recognize the Image	Value Based Solution		Upload
	146	Multiple Variable	Polynomial Equation	Non-Mathematical Equation	Human Written	Under Low Light	Non-English	Cannot Find Solution	Graphical Solution		Upload
	147	Single Variable	Exponential Equation	Non-Mathematical Equation	Human Written	Under Low Light	Non-English	Cannot Recognize the Image	Graphical Solution		Upload

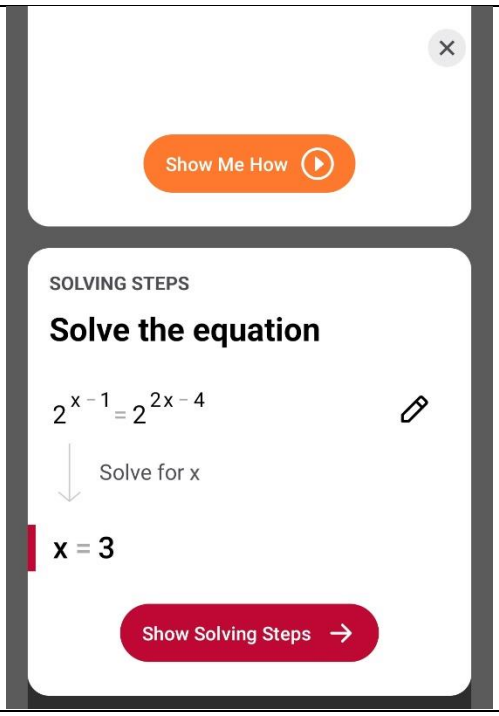
151	Single Variable	Linear Equation	Non-Mathematical Equation	Human Written	Under Bright Light	Non-English	Cannot Recognize the Image	Graphical Solution		Upload
152	Multiple Variable	Linear Equation	Non-Mathematical Equation	Human Written	Under Bright Light	Non-English	Cannot Recognize the Image	Value Based Solution		Upload
153	Single Variable	Quadratic Equation	Non-Mathematical Equation	Human Written	Under Bright Light	Non-English	Cannot Find Solution	Value Based Solution		Upload
154	Multiple Variable	Quadratic Equation	Non-Mathematical Equation	Human Written	Under Bright Light	Non-English	Cannot Find Solution	Graphical Solution		Upload
155	Single Variable	Polynomial Equation	Non-Mathematical Equation	Human Written	Under Bright Light	Non-English	Cannot Recognize the Image	Value Based Solution		Upload
156	Multiple Variable	Polynomial Equation	Non-Mathematical Equation	Human Written	Under Bright Light	Non-English	Cannot Find Solution	Graphical Solution		Upload
157	Single Variable	Exponential Equation	Non-Mathematical Equation	Human Written	Under Bright Light	Non-English	Cannot Recognize the Image	Graphical Solution		Upload
158	Multiple Variable	Exponential Equation	Non-Mathematical Equation	Human Written	Under Bright Light	Non-English	Cannot Find Solution	Value Based Solution		Upload
159	Single Variable	Logarithmic Equation	Non-Mathematical Equation	Human Written	Under Bright Light	Non-English	Cannot Find Solution	Value Based Solution		Upload
160	Multiple Variable	Logarithmic Equation	Non-Mathematical Equation	Human Written	Under Bright Light	Non-English	Cannot Find Solution	Graphical Solution		Upload

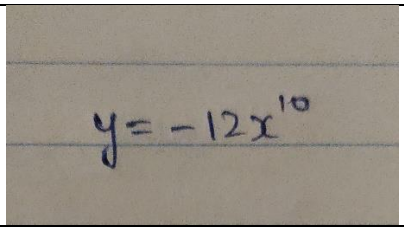
« ‹ 1 ... 4 5 6 7 8 › » Select rows per page Import Data Export Testcases Data Generation Data Augmentation

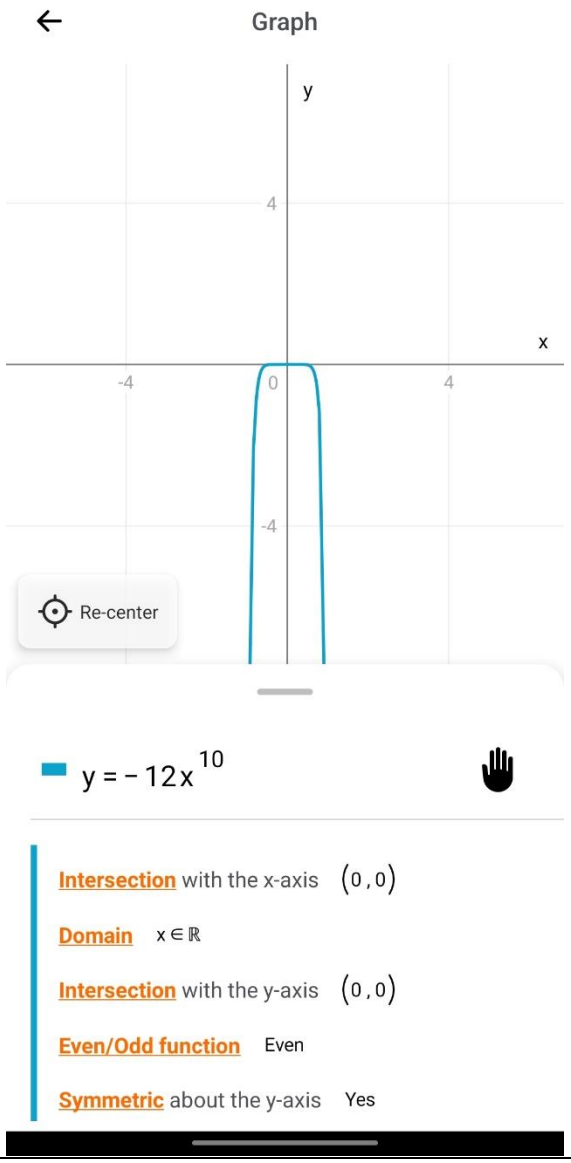
3.2 Test Case Reports

The following are some of the test case tables chosen from the AI test tool.

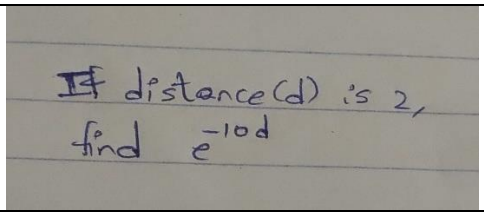
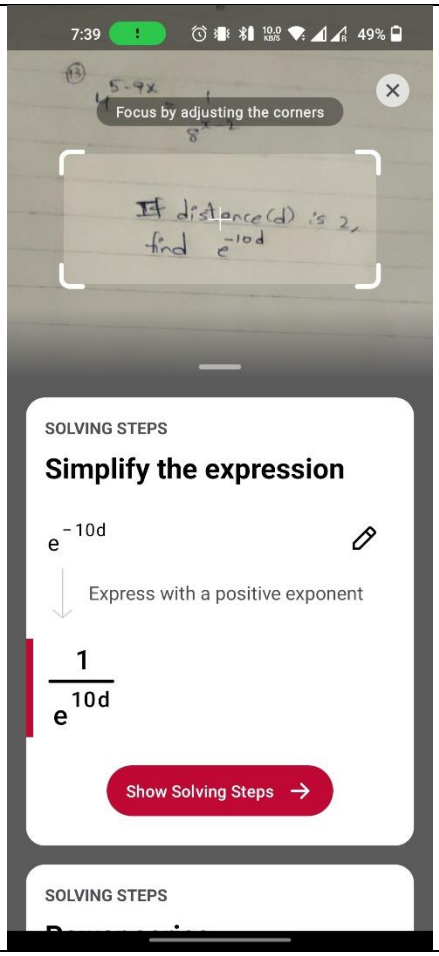
Test Case ID	**1**
Test Topic	Algebra (Exponential Equations)
Test Description	Maths – Single Variable
AI Context Type	Maths
AI Input Type	Single variable
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Value-based
Expected Result	x = 3

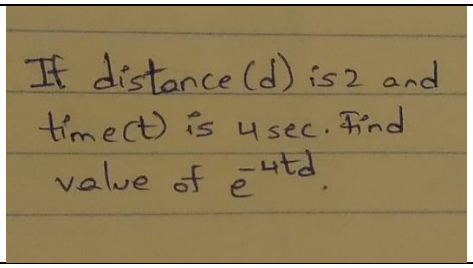
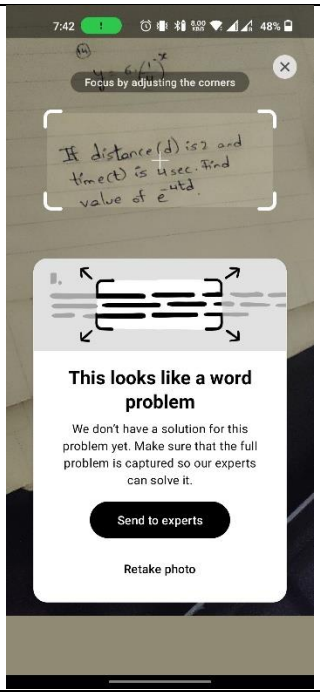
Actual Result	
Test Case Result	Pass

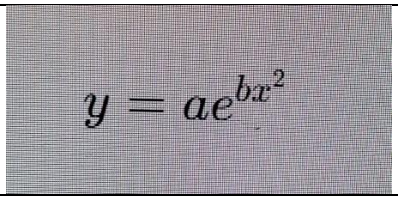
Test Case ID	**2**
Test Topic	Algebra (Exponential Equations)
Test Description	Maths – Multi Variable
AI Context Type	Maths
AI Input Type	Multiple variables
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023

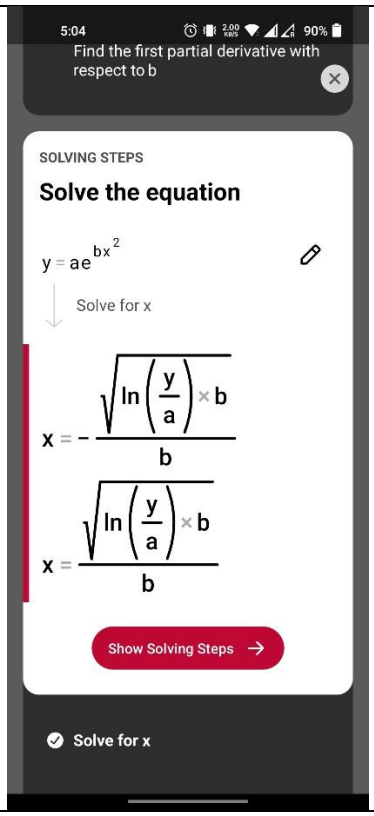
AI Output Type	Graph based
Expected Result	A graph
Actual Result	
Test Case Result	Pass

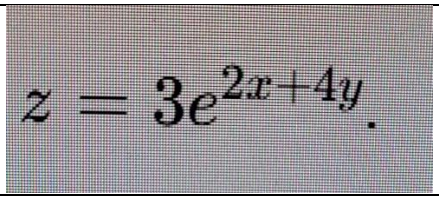
Test Case ID	**3**
Test Topic	Algebra (Exponential Equations)
Test Description	Non-Maths – Single Variable

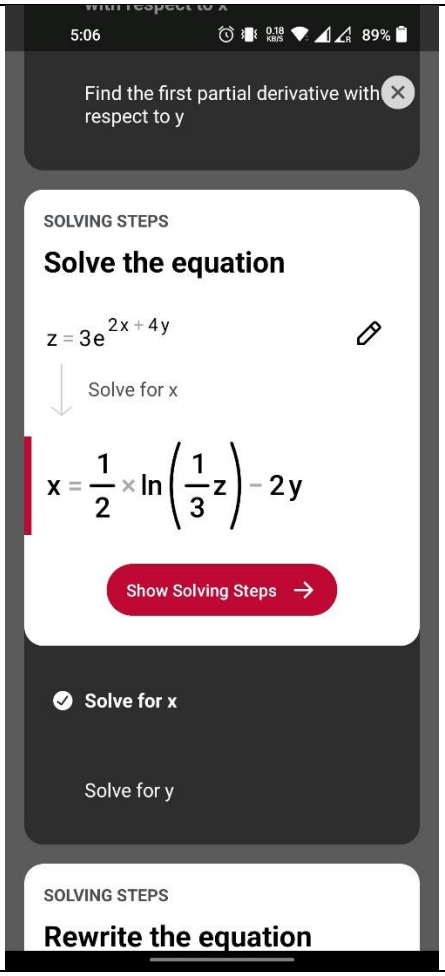
AI Context Type	Non-Maths
AI Input Type	Single variable
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Value-based
Expected Result	e^{-20}
Actual Result	
Test Case Result	Fail

Test Case ID	**4**
Test Topic	Algebra (Exponential Equations)
Test Description	Non-Maths – Multi Variable
AI Context Type	Non-Maths
AI Input Type	Multiple variables
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Value based
Expected Result	e^{-32}
Actual Result	
Test Case Result	Fail

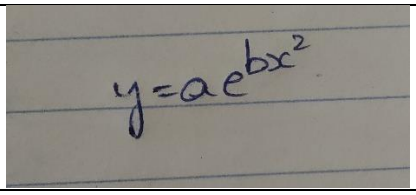
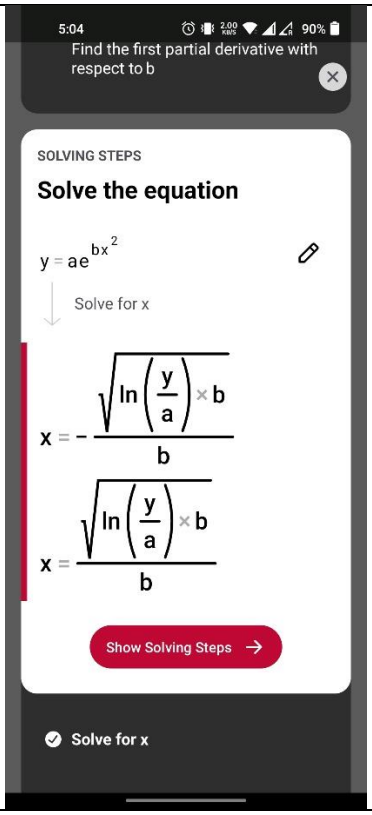
Test Case ID	**5**
Test Topic	Algebra (Exponential Equations)
Test Description	Computer Written – Single Variable
AI Context Type	Computer Written
AI Input Type	Single variable
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Value-based
Expected Result	Solved equation

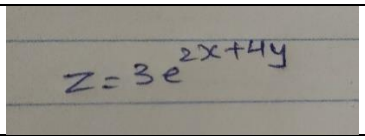
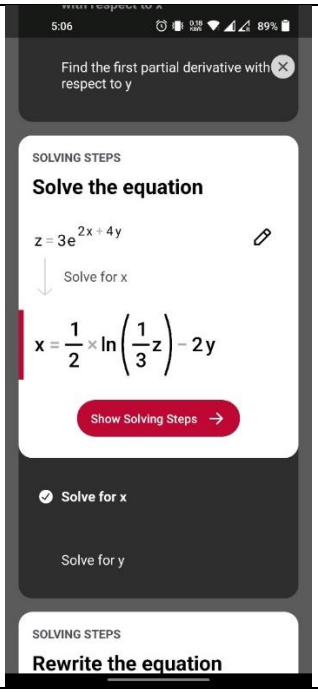
Actual Result	
Test Case Result	Pass

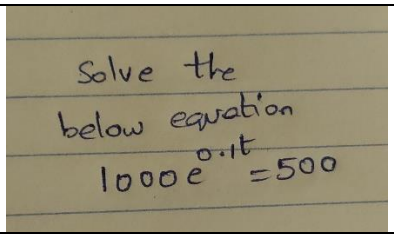
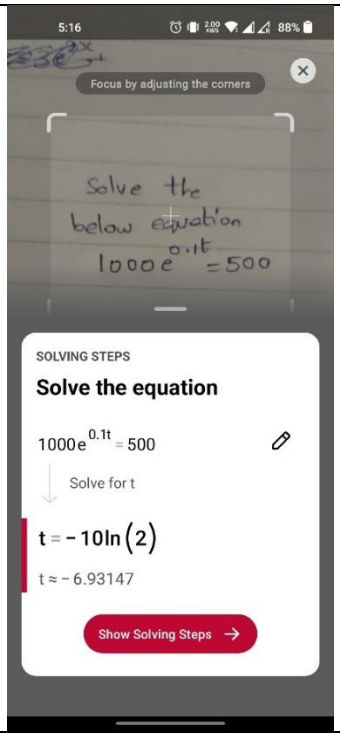
Test Case ID	**6**
Test Topic	Algebra (Exponential Equations)
Test Description	Computer Written – Multi Variable
AI Context Type	Computer Written
AI Input Type	Multiple variables
Test Case Input	
Performed By	Saiteja Goruganthu

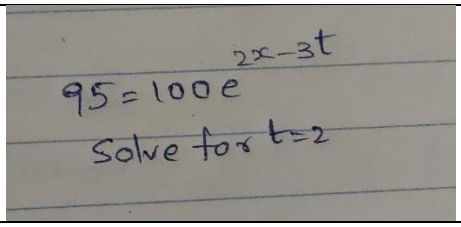
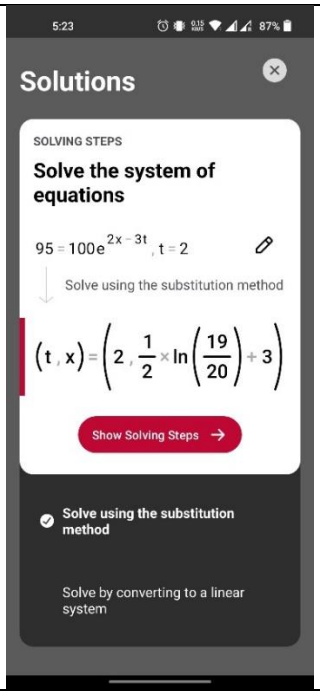
Execution Date	16th November 2023
AI Output Type	Value-based
Expected Result	Solved equation
Actual Result	
Test Case Result	Pass

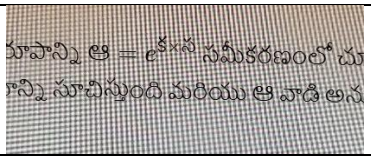
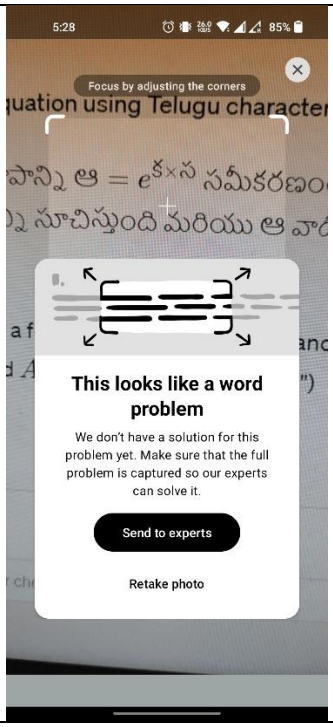
Test Case ID	**7**
Test Topic	Algebra (Exponential Equations)
Test Description	Human Written – Single Variable
AI Context Type	Human Written

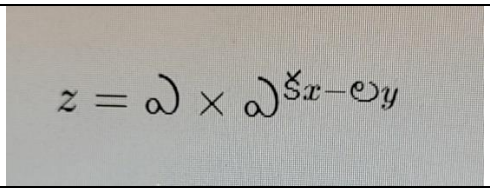
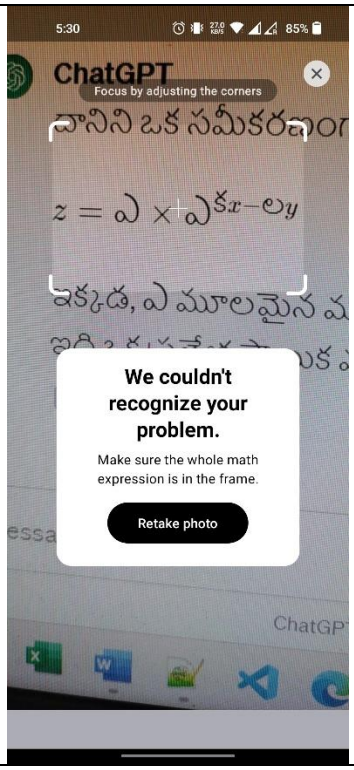
AI Input Type	Single variable
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Value-based
Expected Result	Solved equation
Actual Result	
Test Case Result	Pass

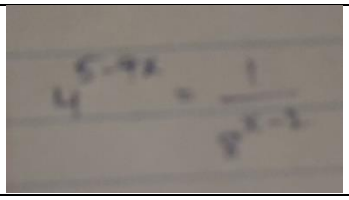
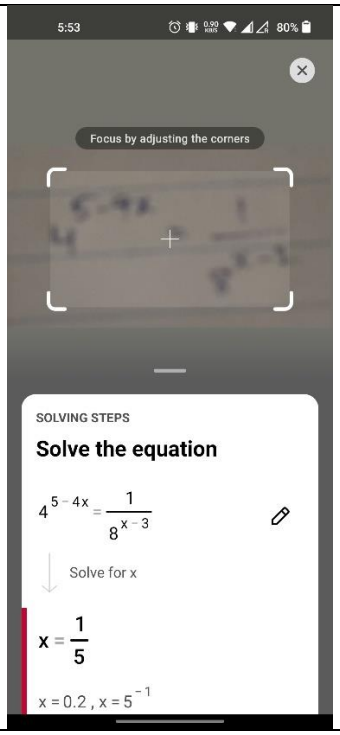
Test Case ID	**8**
Test Topic	Algebra (Exponential Equations)
Test Description	Human Written – Multi Variable
AI Context Type	Human Written
AI Input Type	Multiple variables
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Value-based
Expected Result	Solved equation
Actual Result	
Test Case Result	Pass

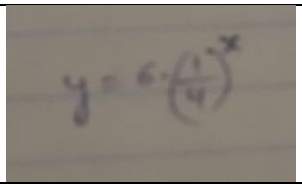
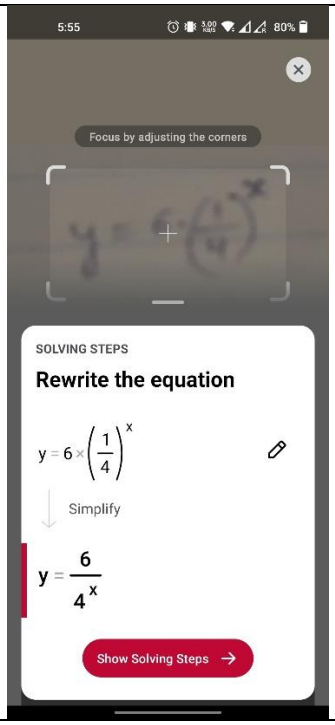
Test Case ID	**9**
Test Topic	Algebra (Exponential Equations)
Test Description	English – Single Variable
AI Context Type	English
AI Input Type	Single variable
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Value-based
Expected Result	t = 6.93
Actual Result	
Test Case Result	Pass

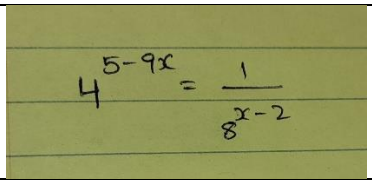
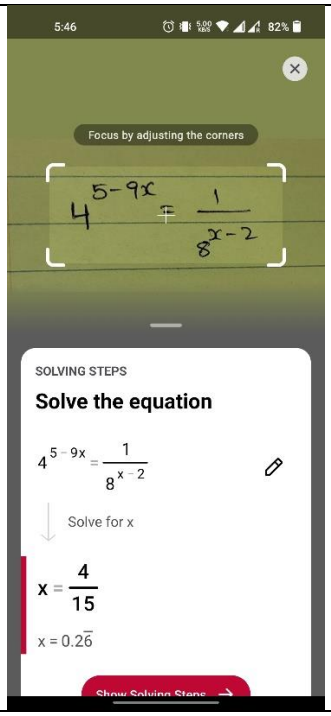
Test Case ID	**10**
Test Topic	Algebra (Exponential Equations)
Test Description	English – Multi Variable
AI Context Type	English
AI Input Type	Multi variables
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Value-based
Expected Result	Solved equation
Actual Result	
Test Case Result	Pass

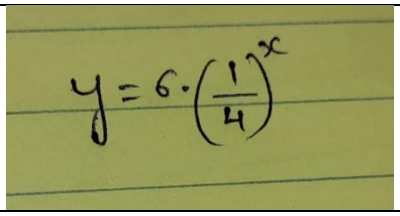
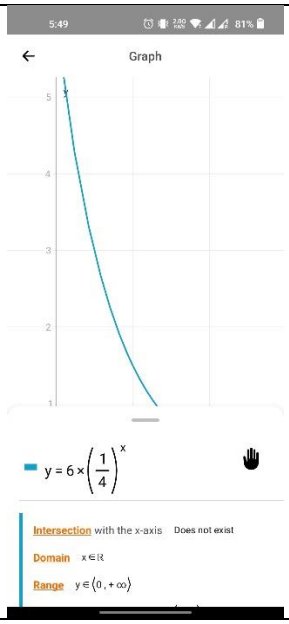
Test Case ID	**11**
Test Topic	Algebra (Exponential Equations)
Test Description	Non-English – Single Variable
AI Context Type	Non-English
AI Input Type	Single variable
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Value-based
Expected Result	Error Message
Actual Result	
Test Case Result	Pass

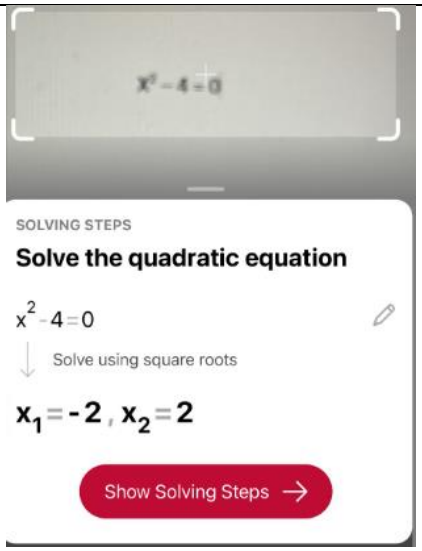
Test Case ID	**12**
Test Topic	Algebra (Exponential Equations)
Test Description	Non-English – Multi Variable
AI Context Type	Non-English
AI Input Type	Multiple variables
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Value-based
Expected Result	Error Message
Actual Result	
Test Case Result	Pass

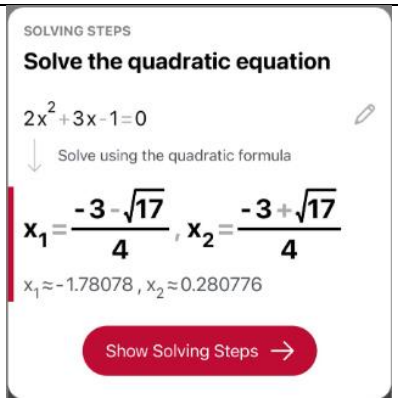
Test Case ID	**13**
Test Topic	Algebra (Exponential Equations)
Test Description	Under Low Light – Single Variable
AI Context Type	Under Low Light
AI Input Type	Single Variable
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Value-based
Expected Result	X = 4/15
Actual Result	
Test Case Result	Fail

Test Case ID	**14**
Test Topic	Algebra (Exponential Equations)
Test Description	Under Low Light – Multi Variable
AI Context Type	Under Low Light
AI Input Type	Multiple Variables
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Value-based
Expected Result	Solved equation
Actual Result	
Test Case Result	Pass

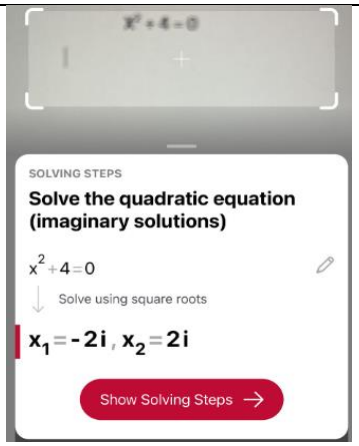
Test Case ID	15
Test Topic	Algebra (Exponential Equations)
Test Description	Under Bright Light – Single Variable
AI Context Type	Under Bright Light
AI Input Type	Single Variable
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Value-based
Expected Result	X = 4/15
Actual Result	
Test Case Result	Pass

Test Case ID	**16**
Test Topic	Algebra (Exponential Equations)
Test Description	Under Bright Light – Multiple Variable
AI Context Type	Under Bright Light
AI Input Type	Multiple Variables
Test Case Input	
Performed By	Saiteja Goruganthu
Execution Date	16th November 2023
AI Output Type	Graph-based
Expected Result	A graph
Actual Result	
Test Case Result	Pass

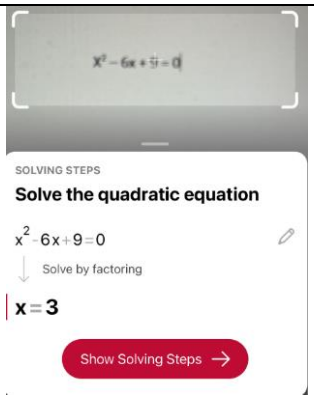
Test Case ID	**17**
Test Topic	Algebra (Quadratic Equations)
Test Description	Basic Quadratic Equation
AI Context Type	Maths equation, Computer Written, English, bright light.
AI Input Type	Single variable
Test Case Input	$X^2 - 4 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	x = 2, x = -2
Actual Result	
Test Case Result	Pass

Test Case ID	**18**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic equation with non-integer coefficients
AI Context Type	Maths equation, Computer Written, English, bright light.
AI Input Type	Single variable
Test Case Input	$2x^2 + 3x - 1 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	$x = (-3+\sqrt{17})/4$, $x = (-3-\sqrt{17})/4$
Actual Result	
Test Case Result	Pass

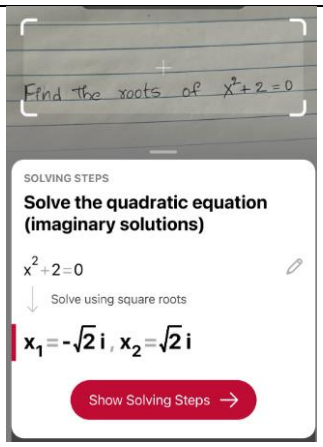
Test Case ID	**19**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic equation with imaginary roots
AI Context Type	Maths equation, Computer Written, English, bright light.

AI Input Type	Single variable
Test Case Input	$X^2 + 4 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	x = 2i, x = -2i
Actual Result	
Test Case Result	Pass

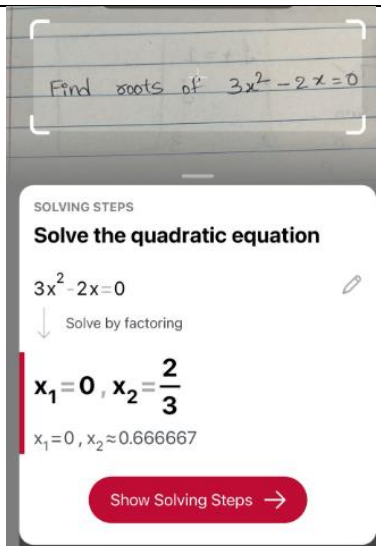
Test Case ID	**20**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with repeated real roots
AI Context Type	Maths equation, Computer Written, English, bright light.
AI Input Type	Single variable
Test Case Input	$X^2 – 6x + 9 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023

AI Output Type	Value-based
Expected Result	X = 3 (double root)
Actual Result	
Test Case Result	Pass

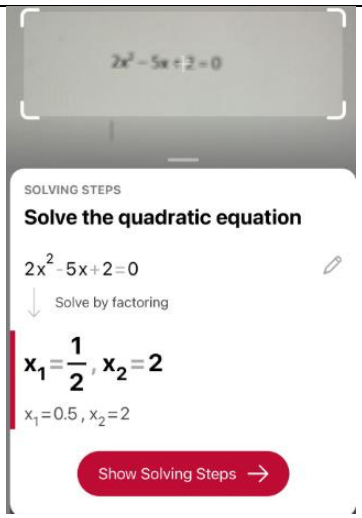
Test Case ID	**21**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with no real roots
AI Context Type	Maths equation, Human Written, English, bright light.
AI Input Type	Single variable
Test Case Input	$x^2 + 2 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	$x = \sqrt{2}i, x = -\sqrt{2}i$

Actual Result	
Test Case Result	Pass

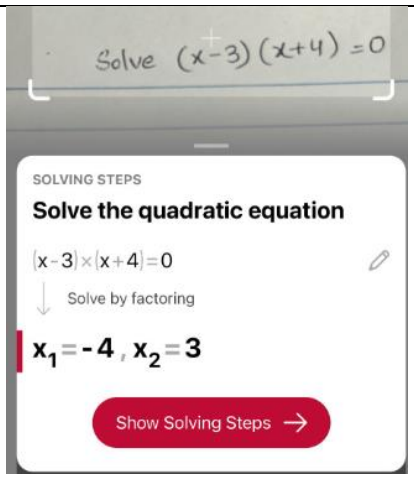
Test Case ID	**22**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with zero constant term
AI Context Type	Maths equation, Human Written, English, bright light.
AI Input Type	Single variable
Test Case Input	$3x^2 – 2x = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	X = 0, x = 2/3

Actual Result	
Test Case Result	Pass

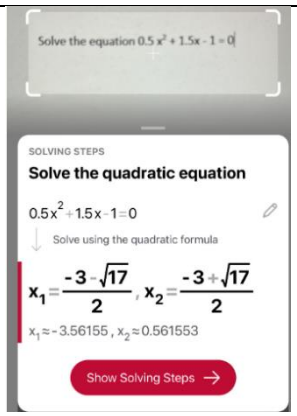
Test Case ID	**23**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with leading coefficient greater than 1
AI Context Type	Maths equation, Computer Written, English, low light.
AI Input Type	Single variable
Test Case Input	$2x^2 – 5x + 2 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	X = 2, x = 1/2

Actual Result	
Test Case Result	Pass

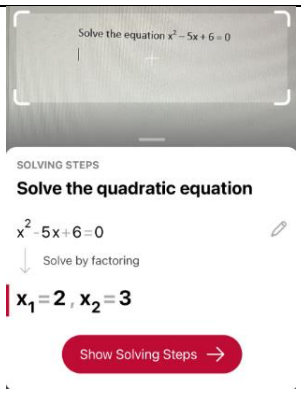
Test Case ID	**24**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation in factored form
AI Context Type	Maths equation, Human Written, English, bright light.
AI Input Type	Single variable
Test Case Input	(x-3) (x+4) = 0
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	x = 3, x = -4

Actual Result	
Test Case Result	Pass

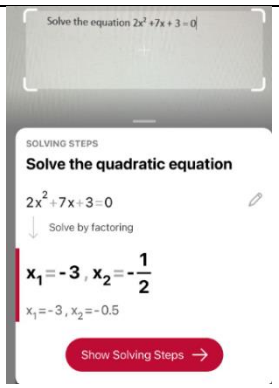
Test Case ID	**25**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with coefficients as decimals
AI Context Type	Maths equation, Computer Written, English, bright light.
AI Input Type	Single variable
Test Case Input	$0.5\ x^2 + 1.5x - 1 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	x = 0.56, x = -3.56

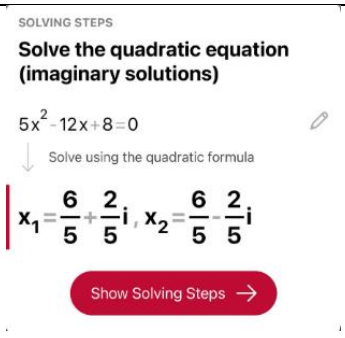
Actual Result	
Test Case Result	Pass

Test Case ID	**26**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with two distinct real roots
AI Context Type	Maths equation, Computer Written, English, bright light.
AI Input Type	Single variable
Test Case Input	$x^2 – 5x + 6 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	x = 2, x = 3

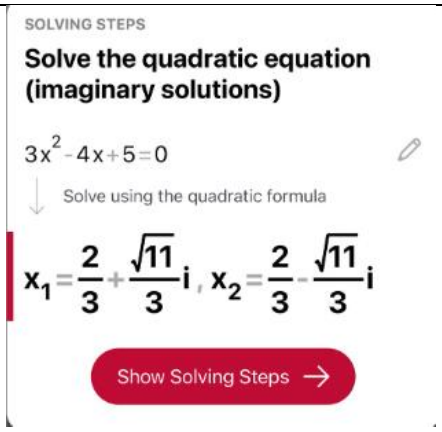
Actual Result	
Test Case Result	Pass

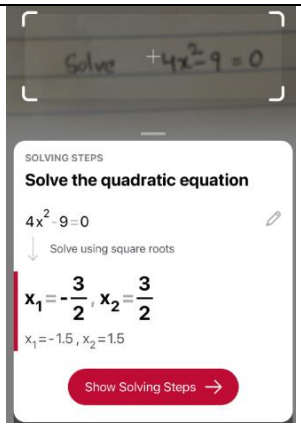
Test Case ID	**27**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with positive coefficients
AI Context Type	Maths equation, Computer Written, English, bright light.
AI Input Type	Single variable
Test Case Input	$2x^2 + 7x + 3 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	x = -1/2, x = -3

Actual Result	
Test Case Result	Pass

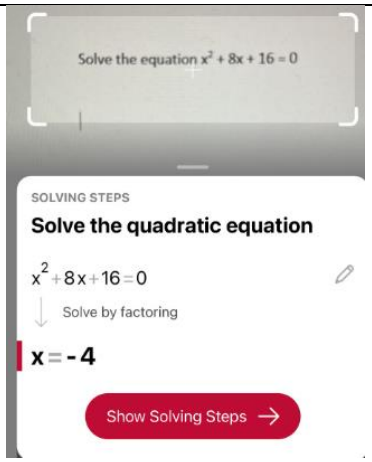
Test Case ID	**28**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with large coefficients
AI Context Type	Maths equation, Computer Written, English, bright light.
AI Input Type	Single variable
Test Case Input	$5x^2 - 12x + 8 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	X = (6/5) + (2/5) i, x = (6/5) - (2/5)i
Actual Result	

Test Case Result	Pass

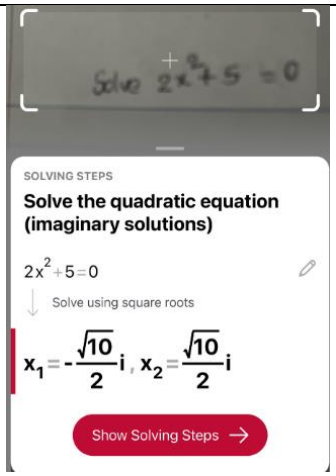
Test Case ID	**29**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with negative discriminant
AI Context Type	Maths equation, Computer Written, English, bright light.
AI Input Type	Single variable
Test Case Input	$3x^2 – 4x + 5 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	x= (2/3) +($\frac{\sqrt{11}}{3}i$), x = (2/3) - ($\frac{\sqrt{11}}{3}i$)
Actual Result	
Test Case Result	Pass

Test Case ID	**30**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with zero coefficient for x term
AI Context Type	Maths equation, Human Written, English, low light.
AI Input Type	Single variable
Test Case Input	$4x^2 – 9 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	X = 3/2, x = -3/2
Actual Result	
Test Case Result	Pass

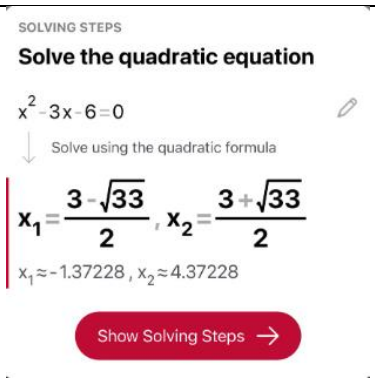
Test Case ID	**31**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with a coefficient of 1 for x^2
AI Context Type	Maths equation, Computer Written, English, bright light.

AI Input Type	Single variable
Test Case Input	$x^2 + 8x + 16 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	X = -4 (double root)
Actual Result	
Test Case Result	Pass

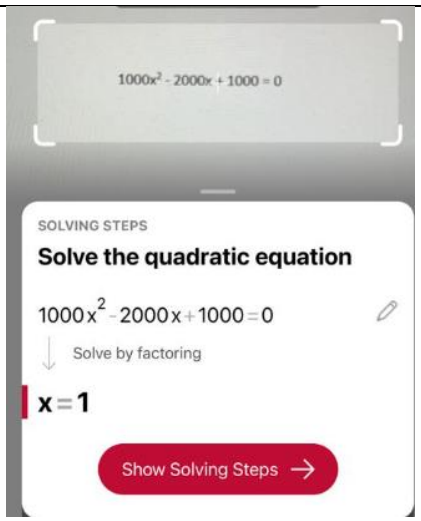
Test Case ID	**32**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with coefficient of 0 for x term
AI Context Type	Maths equation, Human Written, English, low light.
AI Input Type	Single variable
Test Case Input	$2x^2 + 5 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based

Expected Result	x = $\frac{\sqrt{10}}{2}i$, x = - $\frac{\sqrt{10}}{2}i$
Actual Result	
Test Case Result	Pass

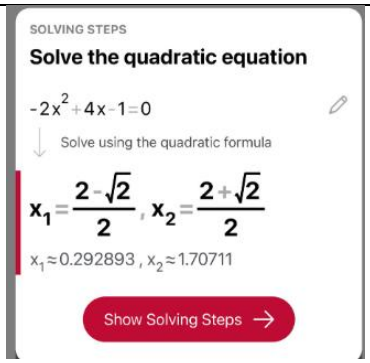
Test Case ID	**33**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with a negative constant term
AI Context Type	Maths equation, Computer Written, English, bright light.
AI Input Type	Single variable
Test Case Input	$x^2 – 3x - 6 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	x = $(\sqrt{33}+3)/2$, x = $(-\sqrt{33}+3)/2$

Actual Result	
Test Case Result	Pass

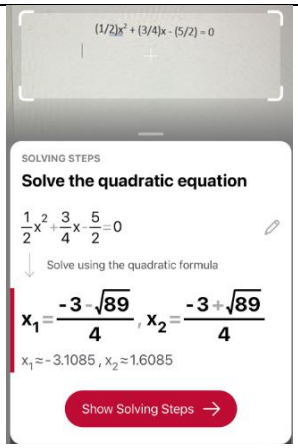
Test Case ID	**34**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with large coefficients
AI Context Type	Maths equation, Computer Written, English, bright light.
AI Input Type	Single variable
Test Case Input	$1000x^2 - 2000x + 1000 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	x = 1

Actual Result	
Test Case Result	Pass

Test Case ID	**35**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with a mix of positive and negative coefficients
AI Context Type	Maths equation, Computer Written, Non-English, bright light.
AI Input Type	Single variable
Test Case Input	$-2x^2 + 4x - 1 = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	$x = (\sqrt{2} + 2)/2, x = (-\sqrt{2} + 2)/2$

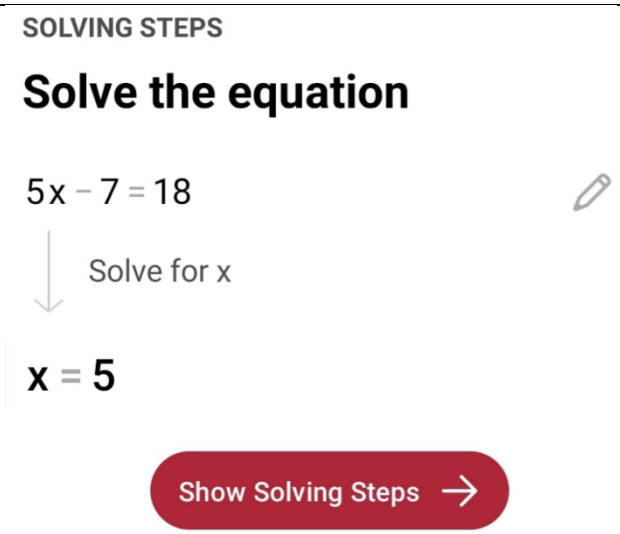
Actual Result	
Test Case Result	Pass

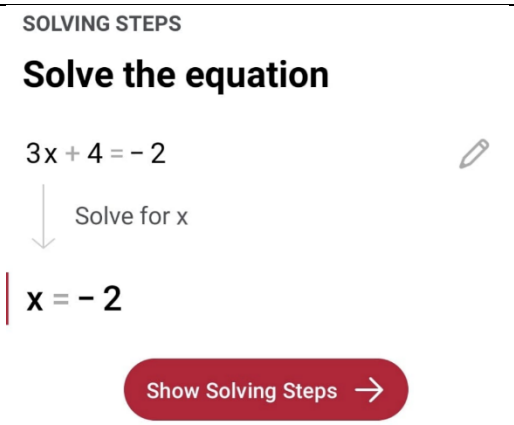
Test Case ID	**36**
Test Topic	Algebra (Quadratic Equations)
Test Description	Quadratic Equation with fractional coefficients
AI Context Type	Maths equation, Computer Written, Non-English, bright light.
AI Input Type	Single variable
Test Case Input	$(1/2)\ x^2 + (3/4)x - (5/2) = 0$
Performed By	Sowjanya Bheemineni
Execution Date	17th November 2023
AI Output Type	Value-based
Expected Result	$x = (\sqrt{89} - 3)/4, x = (-\sqrt{89} - 3)/4$

Actual Result	
Test Case Result	Pass

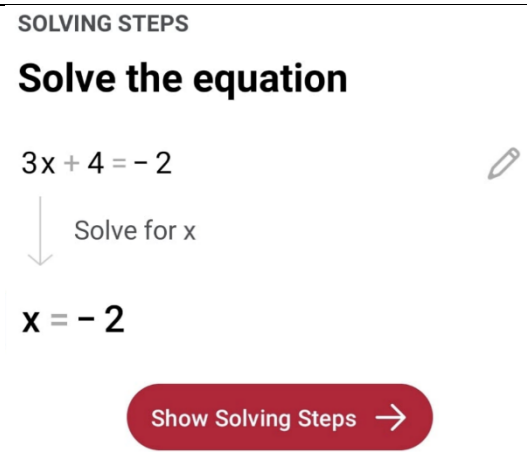
Test Case ID	**37**
Test Topic	Algebra (Linear equations)
Test Description	Single variable equation
AI Context Type	Maths Equation, Computer written, Under bright light.
AI Input Type	Single variable
Test Case Input	2x + 3 = 11
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	Non-graphical
Expected Result	X = 4
Actual Result	SOLVING STEPS **Solve the equation** 2x + 3 = 11 Solve for x **x = 4** Show Solving Steps

Test Case Result	Pass

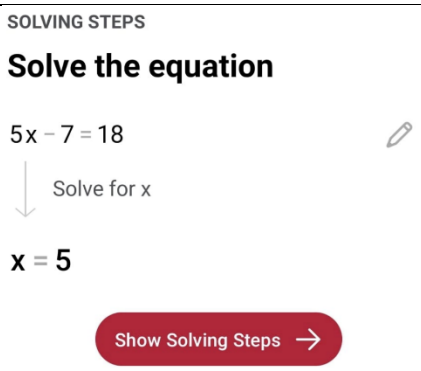
Test Case ID	**38**
Test Topic	Algebra (Linear equations)
Test Description	Single variable equation
AI Context Type	Maths Equation, Human Written, English, Under bright light.
AI Input Type	Single variable
Test Case Input	5x – 7 = 18
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	Non-graphical
Expected Result	X = 5
Actual Result	
Test Case Result	Pass

Test Case ID	39
Test Topic	Algebra (Linear equations)
Test Description	Single variable equation
AI Context Type	Maths equation, Computer written, English, Under low light.
AI Input Type	Single variable
Test Case Input	3x + 4 = -2
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	Non- graphical
Expected Result	X = -2
Actual Result	
Test Case Result	Pass

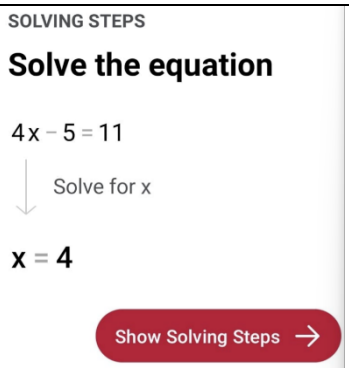
Test Case ID	40
Test Topic	Algebra (Linear equations)
Test Description	Single variable equation

AI Context Type	Non-Maths Equation, Computer Written, English, Under bright light.
AI Input Type	Single variable
Test Case Input	Imagine you are a detective trying to solve a mystery. You know that exactly 3 clues lead to the location of a hidden treasure. You already have 4 clues in your possession. To find the treasure, you need to figure out which one of your clues is a red herring and doesn't lead to the treasure.
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	Non- graphical
Expected Result	X = -2
Actual Result	
Test Case Result	Pass

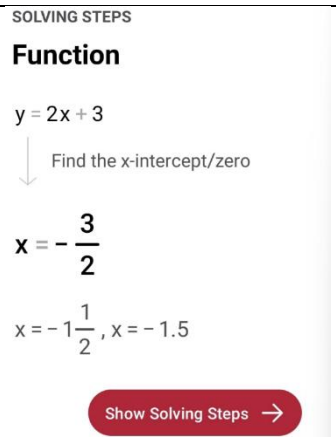
Test Case ID	**41**
Test Topic	Algebra (Linear equations)
Test Description	Single variable equation
AI Context Type	Non-Maths Equation, Human Written, English, Under bright light.

AI Input Type	Single variable
Test Case Input	Imagine you're organizing a book club and you need to choose exactly 5 books for the upcoming month. You currently have a selection of 7 books to choose from. However, you discover that to meet the club's theme, you need to exclude 2 books that don't fit the criteria.
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	Non-graphical
Expected Result	X = 5
Actual Result	
Test Case Result	Pass

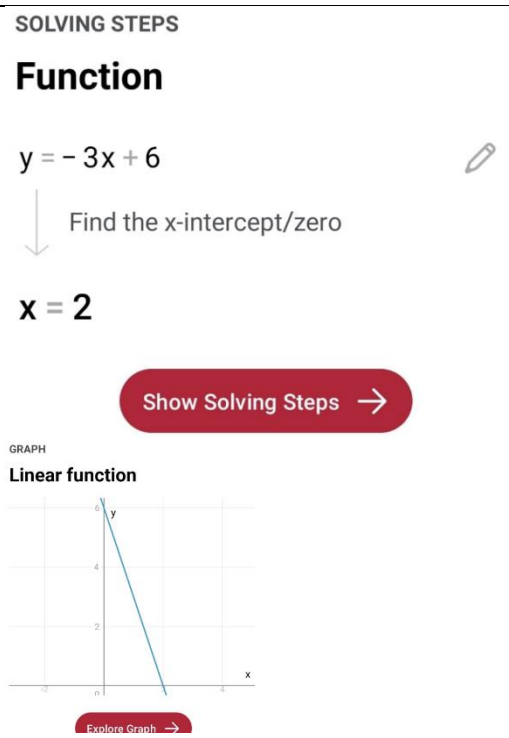
Test Case ID	**42**
Test Topic	Algebra (Linear equations)
Test Description	Single variable equation
AI Context Type	Maths, Computer written, English, Under Lowlight.
AI Input Type	Single variable
Test Case Input	4x – 5 =11
Performed By	Sohan Leburu
Execution Date	18th November 2023

AI Output Type	Non-graphical
Expected Result	X = 4
Actual Result	
Test Case Result	Pass

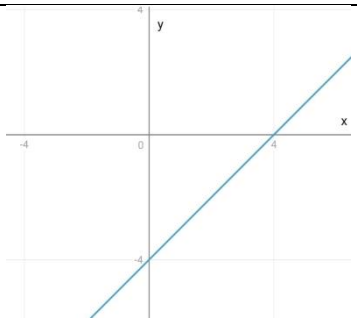
Test Case ID	**43**
Test Topic	Algebra (Linear equations)
Test Description	Multiple variable
AI Context Type	Maths equation, Computer Written, English, Under bright light.
AI Input Type	Multi variable
Test Case Input	Y = 2x + 3
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	Graphical
Expected Result	X = 0, x= 2

Actual Result	
Test Case Result	Fail

Test Case ID	**44**
Test Topic	Algebra (Linear equations)
Test Description	Multiple variable
AI Context Type	Maths, Human Written, English, Under bright light.
AI Input Type	Multi variable
Test Case Input	Y = -3x + 6
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	graphical
Expected Result	X=2

Actual Result	
Test Case Result	Pass

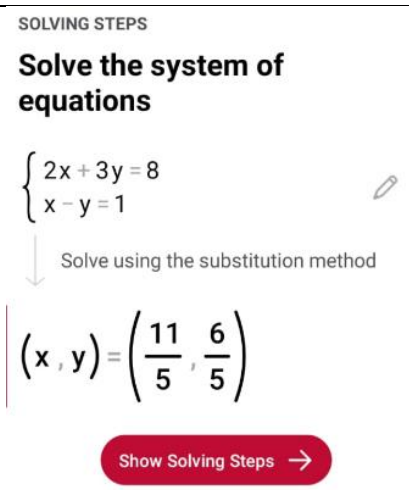
Test Case ID	**45**
Test Topic	Algebra (Linear equations)
Test Description	Multi-variable maths equation
AI Context Type	Maths Equation, Human Written, English, Under Lowlight.
AI Input Type	Multi variable
Test Case Input	Y = x-4
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	graphical

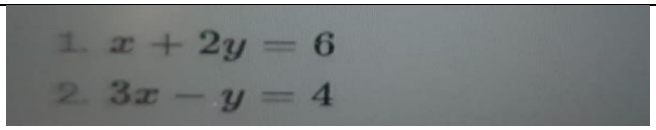
Expected Result	X = 4
Actual Result	
Test Case Result	Pass

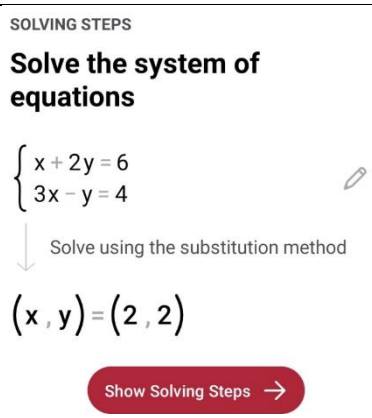
Test Case ID	**46**
Test Topic	Algebra (Linear equations)
Test Description	Multi-variable maths equation
AI Context Type	Maths equation, Computer Written, English, Under Lowlight.
AI Input Type	multi variable
Test Case Input	Y = 3x + 2
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	graphical
Expected Result	X = -2/3

Actual Result	
Test Case Result	Pass

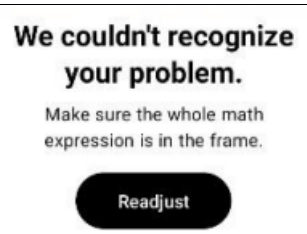
Test Case ID	**47**
Test Topic	Algebra (Linear equations)
Test Description	Multi-variable maths equation
AI Context Type	Maths Equation, Computer Written, English, Under Lowlight.
AI Input Type	multi variable
Test Case Input	2x + 3y = 8 X – y = 1
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	Non-graphical
Expected Result	X = 11/5, y = 6/5

Actual Result	
Test Case Result	Pass

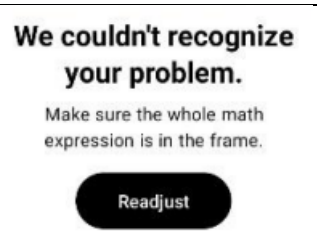
Test Case ID	**48**
Test Topic	Algebra (Linear equations)
Test Description	Multi-variable maths equation
AI Context Type	Maths equation, Human Written, English, Under Lowlight.
AI Input Type	multi variable
Test Case Input	
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	Non-graphical
Expected Result	X = 2, y =2

Actual Result	
Test Case Result	Pass

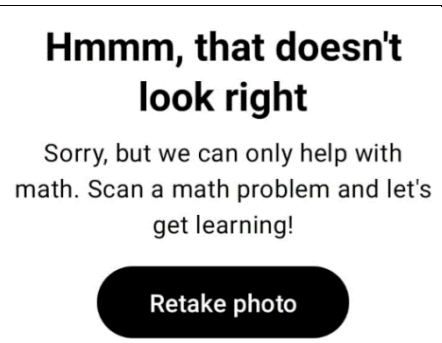
Test Case ID	**49**
Test Topic	Algebra (Linear equations)
Test Description	Multi-variable maths equation
AI Context Type	Maths Equation, Computer Written, English, Under bright light.
AI Input Type	multi variable
Test Case Input	
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	Non-graphical
Expected Result	X = 18/7, y = 15/7
Actual Result	
Test Case Result	Pass

Test Case ID	**50**
Test Topic	Algebra (Linear equations)
Test Description	Non-mathematical expression
AI Context Type	Non-Maths Equation, Computer Written, English, bright light.
AI Input Type	Single variable
Test Case Input	Three(x) + Two(x) = Nine
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	-
Expected Result	Error
Actual Result	
Test Case Result	Pass

Test Case ID	**51**
Test Topic	Algebra (Linear equations)
Test Description	Non-mathematical expression
AI Context Type	Non-Maths Equation, Computer Written, English, Under Lowlight.
AI Input Type	Single variable or multi variable

Test Case Input	Three(x) + Two(x) = Nine
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	-
Expected Result	Error
Actual Result	
Test Case Result	Pass

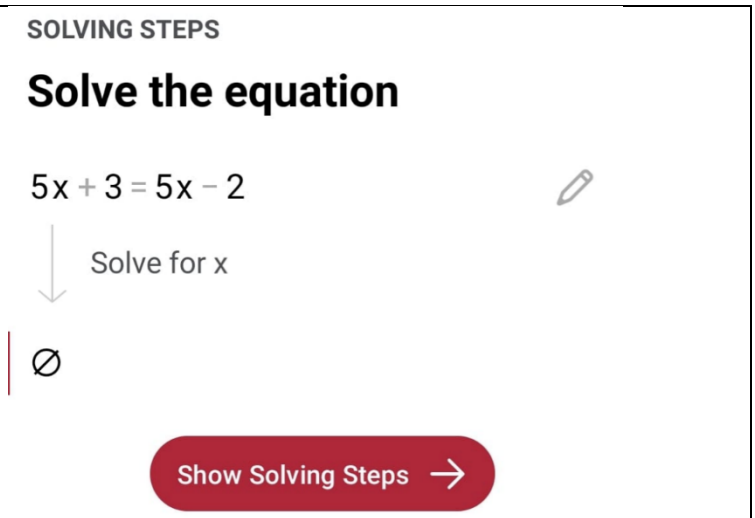
Test Case ID	**52**
Test Topic	Algebra (Linear equations)
Test Description	Blank
AI Context Type	Maths/Non-Maths Equation, Computer or Human Written, English or Non-English, Under Lowlight or bright light.
AI Input Type	Single variable or multi variable
Test Case Input	[redacted]
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	Error
Expected Result	Cannot recognize the image

Actual Result	
Test Case Result	Pass

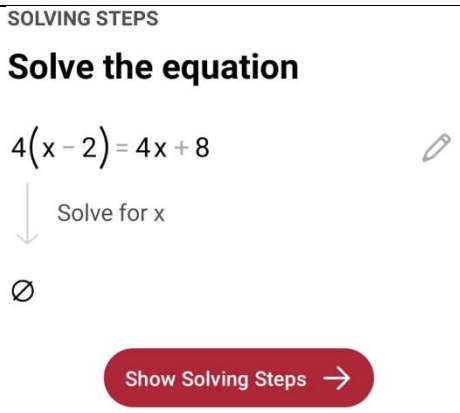
Test Case ID	**53**
Test Topic	Algebra (Linear equations)
Test Description	Non-mathematical English
AI Context Type	Non-Maths Equation, Computer written, English, Under Lowlight or bright light.
AI Input Type	Multi variable
Test Case Input	Imagine you're trying to balance a scale. On one side, you have a bag that's labeled "2x - 5", but there's a special rule: if the bag's contents are negative, you have to reverse them to make them positive. On the other side, you have a bag labeled "3x + 1". Your goal is to make sure both sides of the scale have the same weight. This is tricky because the "2x - 5" bag can change depending on what "x" is
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	Error
Expected Result	Cannot recognize the problem

Actual Result	
Test Case Result	Pass

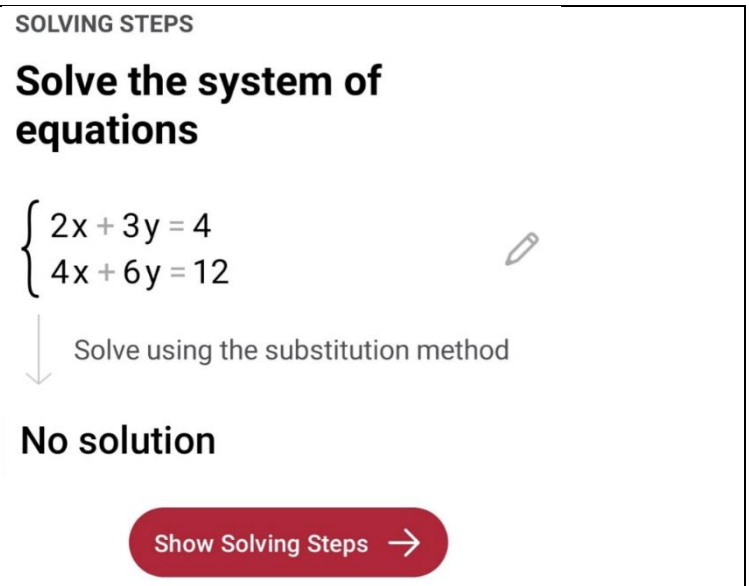
Test Case ID	**54**
Test Topic	Algebra (Linear equations)
Test Description	Single variable equation
AI Context Type	Maths Equation, Computer written, English, Under bright light.
AI Input Type	Single variable
Test Case Input	5x + 3 = 5x - 2
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	No solution
Expected Result	No solution

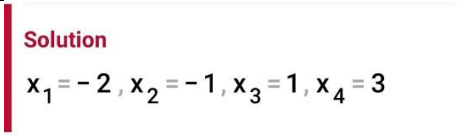
Actual Result	
Test Case Result	Pass

Test Case ID	**55**
Test Topic	Algebra (Linear equations)
Test Description	Single variable equat
AI Context Type	Maths Equation, Computer written, English, Under low light.
AI Input Type	Single variable
Test Case Input	4(x – 2) = 4x + 8
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	No solution
Expected Result	No solution

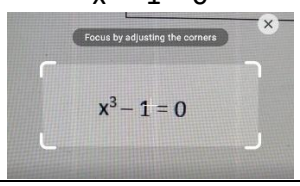
Actual Result	
Test Case Result	Pass

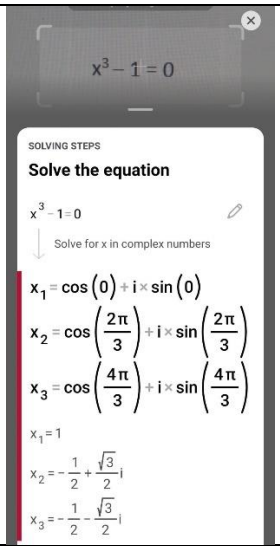
Test Case ID	**56**
Test Topic	Algebra (Linear equations)
Test Description	Multiple variable
AI Context Type	Maths Equation, Computer Written, English, Under bright light.
AI Input Type	multi variable
Test Case Input	2x + 3y = 4 4x + 6y = 12
Performed By	Sohan Leburu
Execution Date	18th November 2023
AI Output Type	No solution
Expected Result	No solution

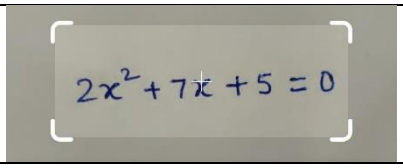
Actual Result	
Test Case Result	Pass

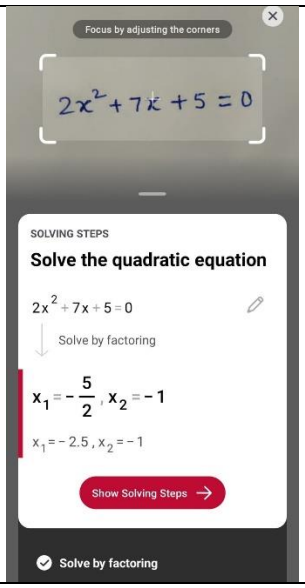
Test Case ID	**57**
Test Topic	Algebra (Polynomial Equations)
Test Description	4^{th} power Equation
AI Context Type	Maths Equation
AI Input Type	Single variable
Test Case Input	$2x^4 - 2x^3 - 14x^2 + 2x + 12 = 0$
Performed By	Harish Marepalli
Execution Date	20^{th} November 2023
AI Output Type	Value-based
Expected Result	x = -2, x = -1, x = 1, x = 3
Actual Result	
Test Case Result	Pass

Test Case ID	58
Test Topic	Algebra (Polynomial Equations)
Test Description	Word Problem
AI Context Type	Non-Maths Equation
AI Input Type	Single variable
Test Case Input	If John has 25 cars, then what will be the new total number of cars if he sells out one from it?
Performed By	Harish Marepalli
Execution Date	20th November 2023
AI Output Type	Value-based
Expected Result	24
Actual Result	Error (Unable to read the word problem)
Test Case Result	Fail

Test Case ID	59
Test Topic	Algebra (Polynomial Equations)
Test Description	Cubic Equation
AI Context Type	Computer Written
AI Input Type	Single variable
Test Case Input	$x^3 - 1 = 0$ 
Performed By	Harish Marepalli
Execution Date	20th November 2023

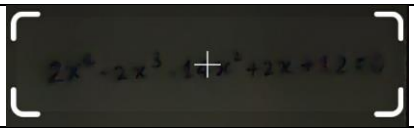
AI Output Type	Value-based
Expected Result	x = 1, x = −1/2 + (sqrt (3)/2)i, x = −1/2 - (sqrt (3)/2)i
Actual Result	
Test Case Result	Pass

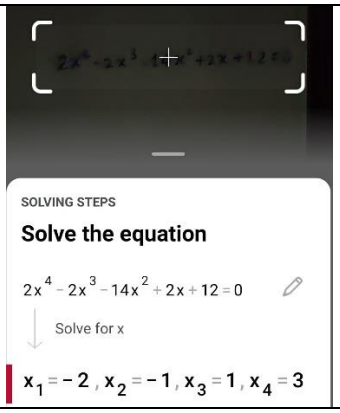
Test Case ID	**60**
Test Topic	Algebra (Polynomial Equations)
Test Description	Quadratic Equation
AI Context Type	Human Written
AI Input Type	Single variable
Test Case Input	
Performed By	Harish Marepalli
Execution Date	20th November 2023
AI Output Type	Value-based
Expected Result	x = -5/2, x = -1

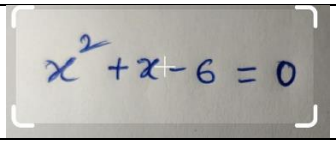
Actual Result	
Test Case Result	Pass

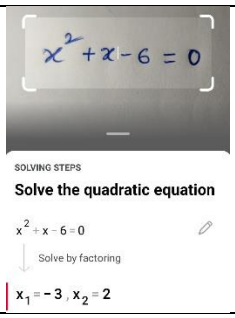
Test Case ID	**61**
Test Topic	Algebra (Polynomial Equations)
Test Description	Word Problem
AI Context Type	English
AI Input Type	Single variable
Test Case Input	If the value of x^2 is 25, what is the value of x^2 - 1?
Performed By	Harish Marepalli
Execution Date	20th November 2023
AI Output Type	Value-based
Expected Result	x = 24
Actual Result	Error (Unable to read the word problem)
Test Case Result	Fail

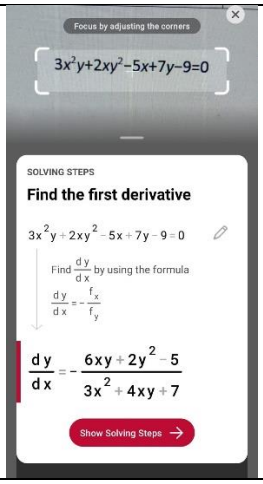
Test Case ID	62
Test Topic	Algebra (Polynomial Equations)
Test Description	Word Problem
AI Context Type	Non-English
AI Input Type	Single variable
Test Case Input	x^3 విలువ 25 అయితే, x^3 మైనస్ 1 విలువ ఎంత?
Performed By	Harish Marepalli
Execution Date	20th November 2023
AI Output Type	Value-based
Expected Result	Cannot recognize the problem
Actual Result	Error (Unable to read the word problem)
Test Case Result	Pass

Test Case ID	63
Test Topic	Algebra (Polynomial Equations)
Test Description	4th power equation
AI Context Type	Under Lowlight
AI Input Type	Single variable
Test Case Input	
Performed By	Harish Marepalli
Execution Date	20th November 2023

AI Output Type	Value-based
Expected Result	x = -2, x = -1, x = 1, x = 3
Actual Result	
Test Case Result	Pass

Test Case ID	**64**
Test Topic	Algebra (Polynomial Equations)
Test Description	4^{th} power equation
AI Context Type	Under Bright light
AI Input Type	Single variable
Test Case Input	
Performed By	Harish Marepalli
Execution Date	20th November 2023
AI Output Type	Value-based
Expected Result	x = -3, x = 2

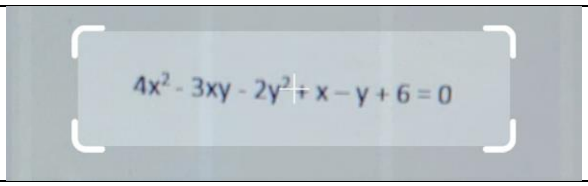
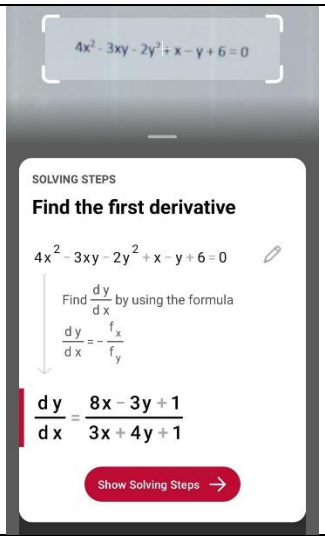
Actual Result	
Test Case Result	Pass

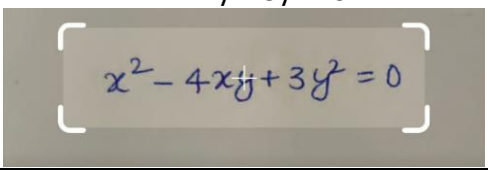
Test Case ID	**65**
Test Topic	Algebra (Polynomial Equations)
Test Description	Quadratic equation
AI Context Type	Maths Equation
AI Input Type	Multi variable
Test Case Input	$3x^2y + 2xy^2 - 5x + 7y - 9=0$
Performed By	Harish Marepalli
Execution Date	20th November 2023
AI Output Type	Value-based
Expected Result	$dy/dx = -(6xy+2y^2-5)/(3x^2+4xy+7)$
Actual Result	

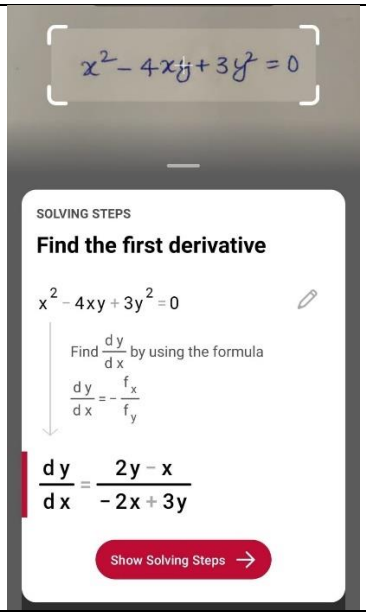
Test Case Result	Pass

Test Case ID	**66**
Test Topic	Algebra (Polynomial Equations)
Test Description	Word problem
AI Context Type	Non-Maths Equation
AI Input Type	Multi variable
Test Case Input	If Steven has 9 pens and 10 pencils, then what will be the new total number of pens and pencils if he sells out one of each?
Performed By	Harish Marepalli
Execution Date	20th November 2023
AI Output Type	Value-based
Expected Result	8, 9
Actual Result	Error (Unable to read the word problem)
Test Case Result	Fail

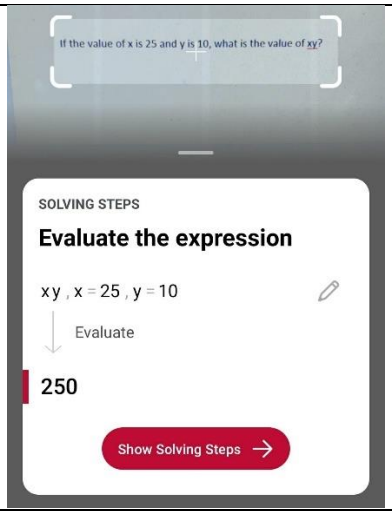
Test Case ID	**67**
Test Topic	Algebra (Polynomial Equations)
Test Description	Word problem
AI Context Type	Computer written
AI Input Type	Multi variable
Test Case Input	$4x^2 - 3xy - 2y^2 + x - y + 6 = 0$

	
Performed By	Harish Marepalli
Execution Date	20th November 2023
AI Output Type	Value-based
Expected Result	dy/dx = (8x-3y+1)/(3x+4y+1)
Actual Result	
Test Case Result	Pass

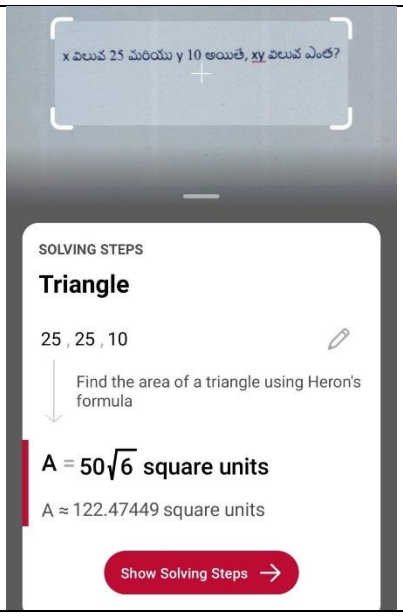
Test Case ID	**68**
Test Topic	Algebra (Polynomial Equations)
Test Description	Word problem
AI Context Type	Human written
AI Input Type	Multi variable
Test Case Input	$x^2 - 4xy + 3y^2 = 0$ 

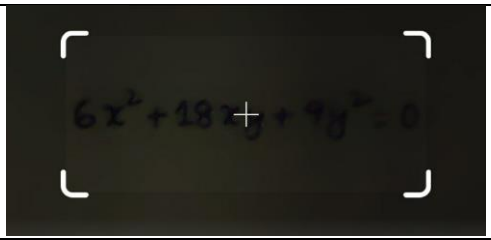
Performed By	Harish Marepalli
Execution Date	20th November 2023
AI Output Type	Value-based
Expected Result	dy/dx = (2y - x)/(-2x + 3y)
Actual Result	
Test Case Result	Pass

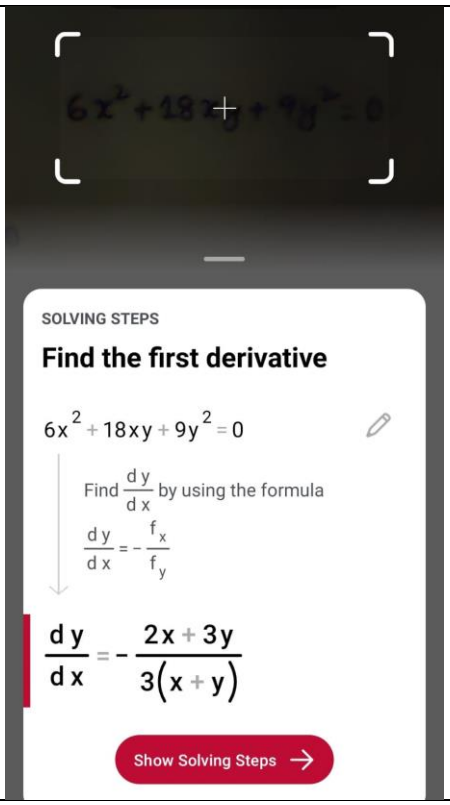
Test Case ID	**69**
Test Topic	Algebra (Polynomial Equations)
Test Description	Word problem
AI Context Type	English
AI Input Type	Multi variable
Test Case Input	If the value of x is 25 and y is 10, what is the value of xy?
Performed By	Harish Marepalli
Execution Date	20th November 2023
AI Output Type	Value-based

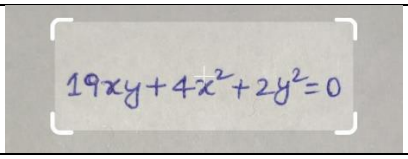
Expected Result	250
Actual Result	
Test Case Result	Pass

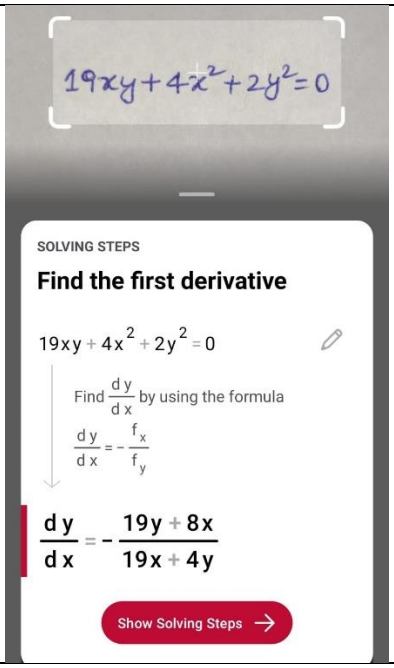
Test Case ID	**70**
Test Topic	Algebra (Polynomial Equations)
Test Description	Word problem
AI Context Type	Non-English
AI Input Type	Multi variable
Test Case Input	x విలువ 25 మరియు y 10 అయితే, xy విలువ ఎంత?
Performed By	Harish Marepalli
Execution Date	20th November 2023
AI Output Type	Value-based
Expected Result	Cannot recognize the problem

Actual Result	
Test Case Result	Fail

Test Case ID	**71**
Test Topic	Algebra (Polynomial Equations)
Test Description	Quadratic Equation
AI Context Type	Under Lowlight
AI Input Type	Multi variable
Test Case Input	
Performed By	Harish Marepalli
Execution Date	20th November 2023
AI Output Type	Value-based
Expected Result	dy/dx = -(2x + 3y)/(3(x + y))

Actual Result	
Test Case Result	Pass

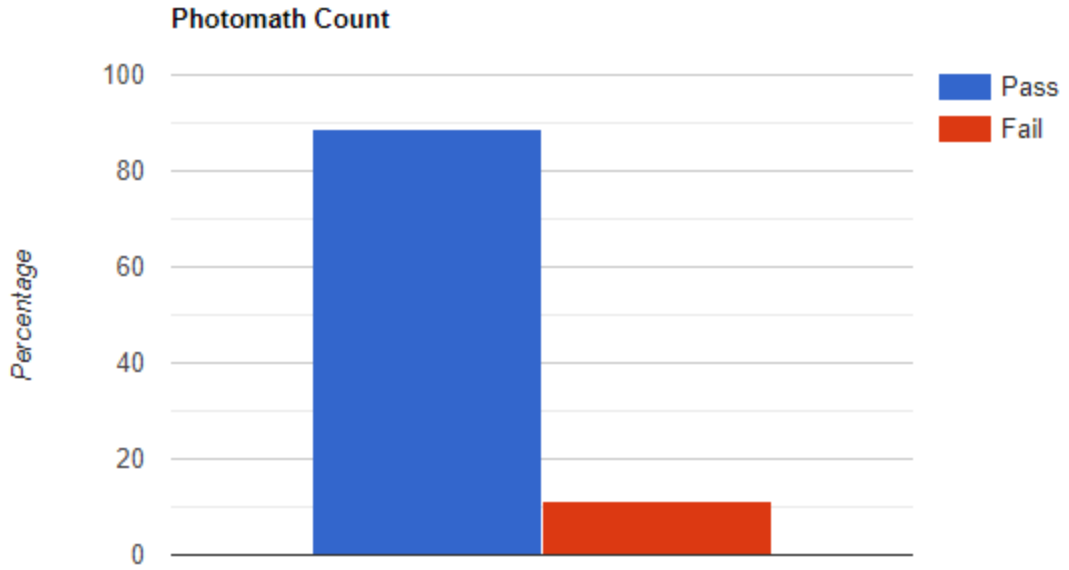
Test Case ID	**72**
Test Topic	Algebra (Polynomial Equations)
Test Description	Quadratic Equation
AI Context Type	Under Bright light
AI Input Type	Multi variable
Test Case Input	
Performed By	Harish Marepalli
Execution Date	20th November 2023
AI Output Type	Value-based

Expected Result	dy/dx = -(19y + 8x)/(19x + 4y)
Actual Result	
Test Case Result	Pass

3.3 Test Case Analysis (Statistics)

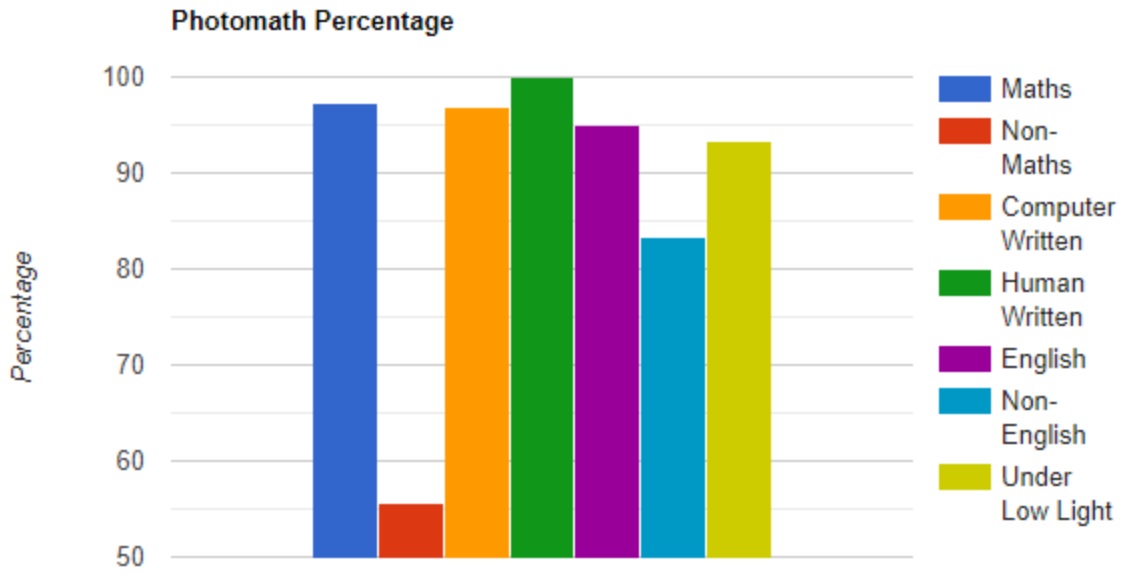
3.3.1 Overall Test Case Results

	PhotoMath
Pass Rate	64/72
Pass Percentage	88.88



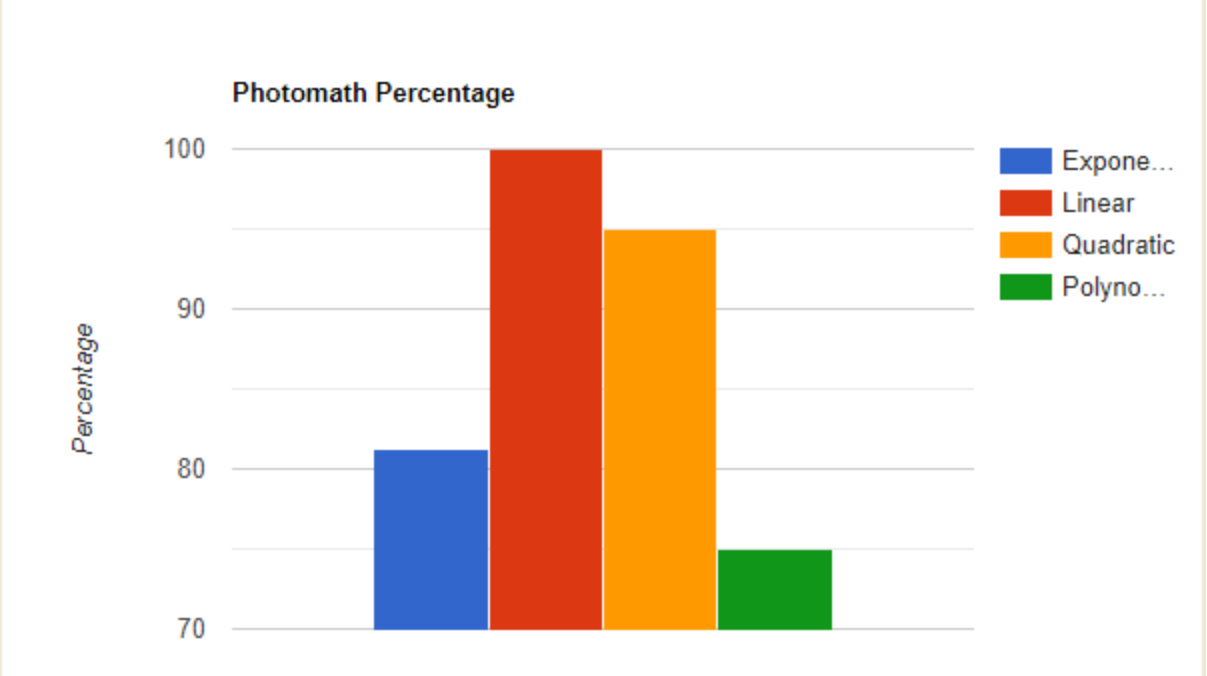
3.3.2 Context Test Case Results

	PhotoMath
Maths Equation	37/38 = 97.36%
Non-Maths Equation	5/9 = 55.55%
Computer Written	32/33 = 96.96%
Human Written	14/14 = 100%
English	38/40 = 95%
Non-English	5/6 = 83.33%
Under Low Light	14/15 = 93.33%
Under Bright Light	30/31 = 96.77%



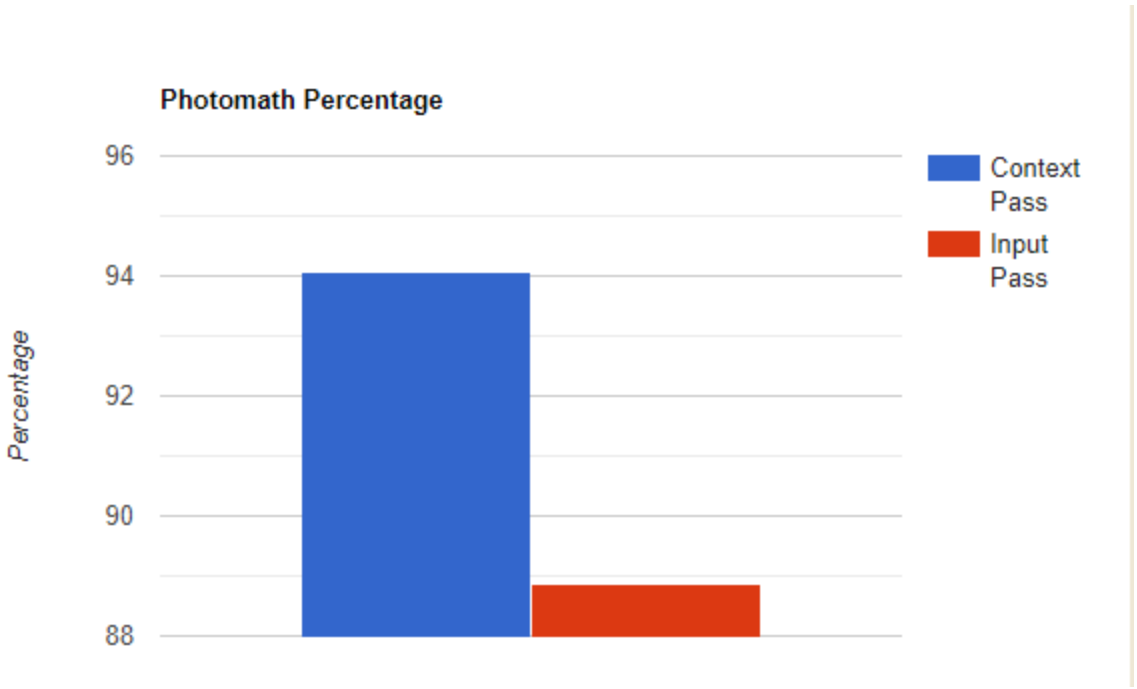
3.3.3 Input Test Case Results

	PhotoMath
Exponential	13/16 = 81.25%
Linear	20/20 = 100%
Quadratic	19/20 = 95%
Polynomial	12/16 = 75%



3.3.4 Context and Input Test Case Results

	PhotoMath
Context Pass Percentage	175/186 = 94.08
Input Pass Percentage	64/72 = 88.88



3.3.5 Test Report

- We used Photomath application to test and solve few math problems. We took several context features into consideration such as clarity, language, and various types of content.
- We believe accuracy as an important parameter when solving mathematical equations irrespective of the application used.
- While testing based on context test cases, the application fails to detect the problem when input is given in any language other than English.
- While testing the application with input having word-based problem, Photomath application failed to detect the equations.
- After looking at the results of the testing, Photomath needs a lot of work in solving word-based equations under different context conditions.

4. AI Function Test Results and Test Criteria

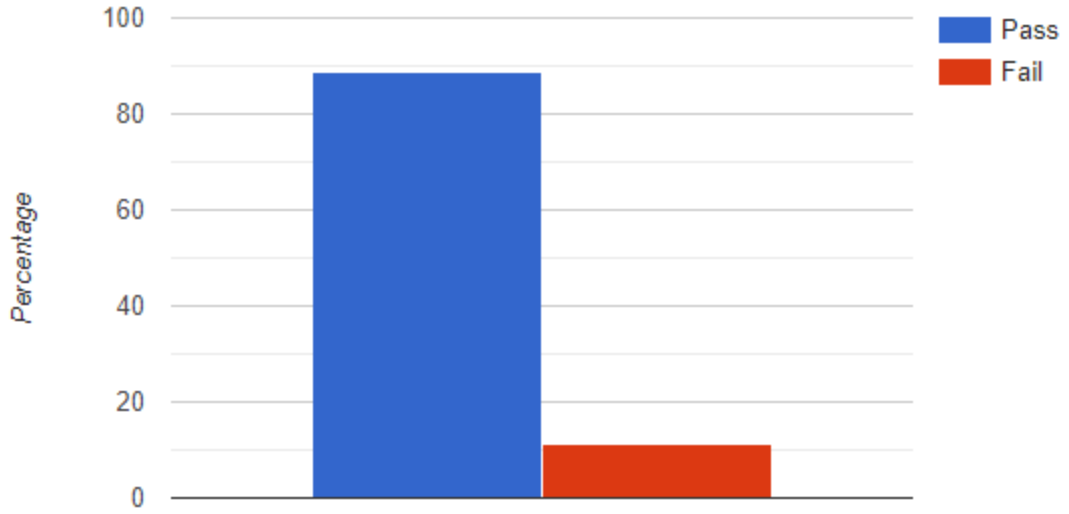
4.1 AI Model Based Test Complexity

We used black box testing techniques like Boundary value testing, category based testing, scenario-based testing, and equivalence partitioning testing for conventional testing. In regard of AI testing, we used an AI tool for generating various test cases

based on various context features.

Test Method	Photo math
Boundary Value Testing	100%
Category Partition Testing	78.62%
Scenario Testing	100%

4.2 AI Function Bug Analysis



With the AI tool generated test cases, we can see above that the pass percentage is good but needs a little improvement.

4.3 AI Function Test Quality Assessment

The testing method we used here is category partition testing. After the test cases were separated based on the various input and context criteria. We selected at least one input from each category.

4.3.1 Test Criteria

- At Least one test case from each input and context criteria are tested and solutions are displayed for problems which can be solved and error message for problems which can't be solved.

4.3.2 Test Coverage

- All input, context and output classifications were covered by testing at least one test case from each domain.