Functional Specification

Handwritten Mathematical Expressions

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1. Background

As one of the most important subjects in school, math plays a crucial role in helping students develop logical thinking and strengthening their understanding of many other subjects. However, people often find it difficult to calculate math by hand, especially when facing complicated expressions. Although there are many calculators available, formatting math into text can be boring and a minor mistake will lead to a big difference in the result.

In this project, we aim to alleviate people's pain of doing mathematically heavy calculations by building a full stack web application system that takes users' handwritten image (.png format) as input and returns the calculated result as output. Specifically, we will first use machine learning and computer vision to build a model that can recognize numbers and operators in the expression. The expression will then be calculated in the background and the returned result will be displayed on the web page.

2. Functional Requirements

2.1 Users

2.1.1 User Profile

Our target users are STEM students of all grades and faculties in the education industry who are interested in:

1. Checking a previous math expression that they calculated by hand
2. Getting the result of a handwritten math expression from the calculator

Computer experience requirement:

1. The users should have basic knowledge of browsing a website
2. The users should be able to convert their image into .png format if the original one doesn't meet the requirement
3. The users should have basic knowledge of uploading images from local computer
4. The users should be able to follow the instruction to click corresponding buttons

Domain knowledge requirement:

1. The users should have basic knowledge of algebra in case they want to check the results returned by the page
2. The users should have some experience in machine learning and computer vision if they are interested in understanding how we recognize the expression

2.1.2 Use Cases

Use Case 1

John is a seventh-year-old student who is doing his math homework. He is confident about his answers but just wants to double check one of them for the homework question. To interact with our web application, John needs to first write down his expression and make it into a .png file. Then he will need to go to the website and click on the 'Choose File' button to upload his file. If the file is uploaded successfully, the application will start to recognize the expression and run the calculation in the background. Once the process is done, the web will notify John that calculation is finished and he will be able to see the returned result after clicking on 'OK'. Lastly, he needs to check if the returned result is the same as his answer.

Use Case 2

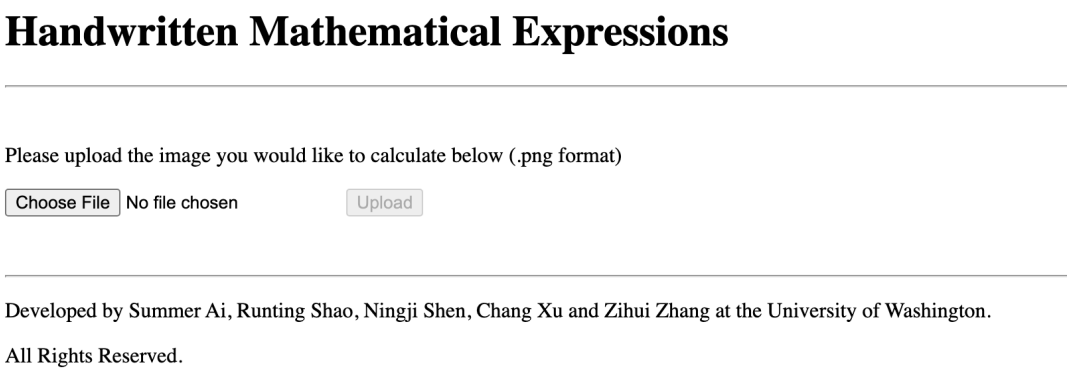
Jennifer is an elementary school teacher who is trying to calculate the average score of each student across ten quizzes. She has all the scores by hand and hopes to calculate them in an easy way. She will need to write down an expression for the first student and upload it to the web as John does. If the file is uploaded successfully, the application will start to recognize the expression and run the calculation in the background. Once the process is done, the web will notify Jennifer that calculation is finished and he will be able to see the returned result after clicking on 'OK'. Because she needs to calculate the average score for each student, she needs to click on the 'Start Over' button to repeat this process iteratively until finishing calculating the score for the last student.

2.2 Software Requirements

Our system requires python3.5 - 3.7 pre-installed. Please refer to README for detailed instructions.

3. User Interface

3.1 Home page



3.2 User interface attributes

User input:

A PNG image that contains a full length mathematical expression.

System output:

Print-friendly version of the expression (in LaTeX);

Calculated result.