Optical Linear Equation Solver Using Support Vector Machines

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This project proposal presents the motivation, goal, and intended approach for implementing an optical linear equation solver.

1 Motivation

Anyone in a mathematics-related field comes in contact with linear equations on a daily basis. It would be convenient to have a means of solving and/or graphing these equations without having to enter them into a computer manually. Optical character recognition (OCR) of standard English text is already in wide usage [1].

2 Goal

The goal of this project is to create an algorithm capable of detecting and extracting characters in a linear equation using standard image processing techniques. The extracted equation can then be exported using external API's to the Mathematica database to be solved. These API's will then return the solution(s) to the equation, which can then be displayed to the user.

3 Intended Approach

The incoming image will be binarized using locally adaptive Otsu's method. Next, we will perform region labeling to find all blobs in the image. The

pixels in the image can then be filtered according to centroid locations of the blobs they belong to. If a pixel belongs to a blob whose centroid is too far vertically from the center of the mass of all the white pixels in the image, then it will be discarded as an unwanted artifact. Next, a bounding box will be computed for each remaining blob in order to shrink each blob down to a standardized size of, say, 12x12 pixels.

The standardized blobs will then be passed into n trained SVM's for text classification, where n is the number of characters in the dictionary of our recognition algorithm [2]. It is planned that n one-vs-all SVM's will be used instead of $\binom{n}{2}$ one-vs-one SVM's [3]. Additional postprocessing can be executed to distinguish if a matched character is a superscript, subscript, numerator, denominator, etc.

Once every blob in the image is characterized, the constructed equation can be sent to a service like Mathematica. The external service will return the zeros, graphs, and other interesting facts about the provided equation.

References

[1] D. Chen, J.M. Odobez, H. Bourlard. Text detection and recognition in images and video frames. *Pattern Recognition* 37:595608, 2004.

[2] T. Joachims. Text categorization with support vector machines. *European Conference on Machine Learning*, 1998.

[3] C. Hsu, C. Lin. A comparison of methods for multi-class support vector machines. *IEEE Transactions on Neural Networks*, 13:415-425, 2002.