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Handwritten Equation Recognition

Purpose:

Handwriting is a fairly simple method for writing equations but certainly is not efficient for editing. LaTex provides an extremely precise way of typing equations but is not as simple and efficient. Combining these two methods, an artificial neural network was developed in Matlab to recognize handwritten equations in order to print them as LaTex expressions.

Methods:

Preprocessing

Images for training were convolved with 4x4 filter matrix and then resized to 28x28 using bilinear interpolation. A library of each set of outputs was created. Each image was labeled as a letter, digit, or symbol based on its file name. After, matrices containing each images from each subset were grouped together. After grouping, the images were propagated through the network

Segmentation

Segmentation was not performed on training images. During testing equation images were segmented using Matlab's bwlabel function, which finds the connected components of an image. All background is disregarded. The segmented symbols are resized to 28x28 using bilinear interpolation. The dimensions are altered such that a matrix 784x[Number of Segments] represents all symbols contained in the image. In addition, two convolution 3x3 convolution filters are applied.

Training

A backpropagation neural network was used. One hidden layer of 500 units was implemented. Output was compared to the expected and backpropagation was performed based on both inertia and error. The epoch and batch size was determined based on the how large each group of images was. Each set generates a hidden and output weights matrix that can be applied for equation recognition.

Equation Recognition

When feeding the equation segments into the network they are run using each set of hidden and output weights. Three output vectors are generated and the one with the largest maximum is the result. For equations, however, the segments are also combined with the nearest bounding boxes to test whether running the resulting image through the network will produce higher a clearer output, or an output vector with a higher maximum.

Description:

The pipeline MATLAB file should be run by simply typing pipeline in the MATLAB command window. The user will then be prompted for the location of training images. The folder of training images, titled "annotated," is located in in the zip file. After entering the path, all images

will be loaded and training will begin. After training completes, the user will then be prompted for the location of all test images. Again, after entering the folder path, testing will begin. All results will be written to predictions.txt. Testing may take a few minutes, depending on the folder size.