6.867 Project - Milestone 2 Submission

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For our final project we are interested in exploring image segmentation techniques. Specifically, we wish to compare and analyze two different methods for image segmentation [4]: Edge Detection and Clustering. For these implementations we are using the Berkeley Segmentation Dataset and Benchmarks 500 (BSDS500) which consists of 500 natural images. For each image, several people were asked to draw a contour map separating different objects based on their own understanding[1].

Edge Based Segmentation method:

For this method, following the idea from El-Sayed et. al. [2], we will use a Convolutional Neural Network (CNN), which can simplify feature selection and is good at detecting local patterns in images. We partition the data into a training, validation, and test set of 200, 100, and 200 images respectively. For each training example, we preprocess the input, and train on our neural network. We have explored a couple algorithms to remove noise from input images during the preprocessing process: one method to do this is through 1 0 gradient minimization. Following this preprocessing step, the input images will be cropped and trained on our CNN. For data in our validation and test set, we may implement a post-processing step to thin and smooth the edges outputted by the net. Common techniques that me may explore include non-maximum suppression or morphological operations. To find the best parameters for our test set we compare the results of the validation set on different combinations of network structures, data combinations, preprocessing, and postprocessing techniques. We finally choose the best architecture/parameters and evaluate its performance on the test set.

Clustering Based method:

For this method we will use a strict division approach through an existing implemntation of k-means clustering. First the images are converted from RGB to $L * a * b$ color space. Then for a specific k the centers are computed and for each pixel we assign the nearest center using Euclidean distance. This method focuses on minimizing the distance between pixels in the same cluster, and maximizing the distance between pixels in different clusters. The initial centers are chosen randomly and the optimal value for the number of clusters, k, will be the one that minimizes the sum of square distances between the points and their centers.

References

[1] Arbelaez, P.; Maire, M.; Fowlkes, C.; Malik, J. (2011) "Contour Detection and Hierarchical Image Segmentation" *IEEE TPAMI* 33.5: 898-916

[2] El-Sayed, M.; Estaitia, Y.; Khafagy M. (2013) "Automated Edge Detection Using Convolutional Neural Network" *International Journal of Advanced Computer Science and Applications* 4.10

[3] Xu, L.; Lu, C.; Xu, Y.; Jia, J. (2011) "Image Smoothing via L_0 Gradient Minimization" *ACM Trans. Graph.* 30.6

[4] Kaur, D.; Kaur, Y. (2014) "Various Image Segmentation Techniques: A Review" *International Journal of Computer Science and Mobile Computing* 3.5: 809-814