**Scene Segmentation Using Unsupervised Learning**

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#### Abstract

The project aims to investigate the use of Unsupervised learning techniques for the problem of image segmentation. We aim to investigate the use of both K means and convolutional neural networks mainly for the task. We aim to improve the existing K means techniques and also apply a CNN-based approach for improving feature extraction and clustering functions so that pixels with comparable features, spatially continuous pixels be allocated to the same label, and the number of unique clusters can be increase

**Index Terms—** Unsupervised Learning, KMeans, CNN, OpenCV

**1. MOTIVATION**

Image processing is a critical part in many recent machine learning technologies. Segmentation is the process of extracting or identification of distinguishable regions in an image and partitioning it. This is performed based on the properties of pixels such a color, proximity, intensity and so on. Segmentation using supervised learning works on a dataset of trained features here any fault in segmentation will led to inaccurate extraction of features which results in wrong prediction of the decision support systems. Hence, our project will focus on an investigation of various latest unsupervised image segmentation techniques performed in the field of deep learning.

**2. Technical Description**

We aim to develop a end-to-end network of unsupervised image segmentation for differentiable clustering. A CNN-based algorithm to optimize feature extraction functions and clustering functions so that pixels of similar features can be assigned to same label, spatially continuous pixels be assigned to same label and making the number of unique clusters large**. Develop a loss function** that mitigates the limitations of fixed segment boundaries. The we aim to test the effectiveness of the proposed approach on several benchmark datasets of image segmentation

**3. Description of Data**

We identified the following datasets for our problem statement

**Pascal** **VOC**: Provides standardized image data sets for object class recognition

**BSDS500**: The Berkeley Segmentation Dataset has about12,000 hand-labeled segmentations of 1,000 Corel dataset images

**COCO**: A large-scale object detection, segmentation, and captioning dataset.

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**4. KMeans Clustering**

So far, we have tried implementing the K-means clustering algorithm for unsupervised image classification. Since we are dealing with colored images that have 3 dimensions based on RGB, we don’t treat them the same way as conventional data points. We convert this into 2-dimensional data. Then we convert it into float values as k-means algorithm only takes that as an input in OpenCV. We convert the image into data frame before passing it to the model.

We observed with an increase in the value of K, the image captures more minute details because the K-means algorithm can classify more classes or clusters of colors.

**Libraries Used:**

NumPy, Matplotlib and OpenCV

**Dataset Used:**

**BSDS500**: The Berkeley Segmentation Dataset has about12,000 hand-labeled segmentations of 1,000 Corel dataset images

**Challenges Encountered:**

* Finding the optimal k- value for clustering using the elbow method
* Since image data in the format of pixels is huge, we must wait for the centroids to stabilize to find the optimal centroid in such a manner that the desired object is segmented
* Even after Segmentation the image consists or some unwanted region or noise

**Future Improvements:**

* Using image enhancement techniques to improve the quality of the image
* Using the elbow method to find the optimal value of k for the k-means algorithm
* Using OpenCV library to perform digital image processing to finally remove the noise present after k means clustering
* Running edge detection algorithms after segmentation to get the proper outline of the image

**5. Unsupervised CNN**

Model architecture follows the method proposed by Kanezaki et al. Convolutional filters for feature extraction and differentiable processes for feature clustering are used in the proposed CNN architecture, which allows for end-to-end network training. Using backpropagation of the suggested loss to the normalized responses of convolutional layers, the proposed CNN provided cluster labels to image pixels and modified the convolutional filters to achieve better cluster separation.

**Model Improvements:**

* Used weighted average for cross entropy loss and discontinuity loss.
* Used Xavier initialization improve the initialization of neural network weighted inputs,
* Implemented Learning rate scheduler with a scheduling rate per 10 epoch.

**6.. Team Contribution**

* **Meghana**: working on pre-processing the image using OpenCV and K- means approach. Also, looking into K-Medoids and other techniques for clustering.
* **Rohan**: working on K- means approach and improving the CNN of the model.
* **Saumya**: working on unsupervised CNN techniques. Research on Gaussian Mixture models, which can be potentially implemented in the further scope of this project.

**6. References**

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