CS 484, Spring 2019 Term Project: Object Localization and Recognition

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*Abstract*—We propose an object localization and recognition method to classify and localize a set of animals based on a pretrained ResNet-50 on the ImageNet dataset for feature extraction, an SVM to classify the features, and the Edge Boxes method to extract regions of interest. We conclude that this method of object localization is of satisfactory quality and efficiency.

Keywords—localization, classification, SVM, pretrained ResNet-50, edge boxes, thiswastoohard

# Introduction

Object localization and recognition is a widely studied problem in computer vision and image analysis. In this report, we discuss the implementation of the pipeline proposed in the term project specification for the CS484 Image Analysis, Spring 2019. The pipeline provided in the aforementioned specification consists of

* Preprocessing of images through padding, scaling, color normalization
* A pretrained ResNet-50 on the ImageNet dataset for the extraction of features from the preprocessed images
* An SVM trained on the features extracted from the images
* Edge box method to facilitate the localization of objects in an image with objects at multiple scales.
* Evaluation metric to measure the accuracy of the proposed method

We attempt to classify 10 different animals, namely eagle, dog, cat, tiger, starfish, zebra, bison, antelope, chimpanzee, and elephant. We train our SVM classifier over 398 labeled test images in a 1000-dimensional feature space, as per the output of ResNet-50. For testing, we use a dataset of 100 photos and attempt to classify these photos by extracting 50 interesting bounding box via the Edge Box algorithm proposed by Piotr Dollar, then we classify the bounding boxes using the SVM and assign the highest scoring bounding box, with its label, to the entire image. We then compute the classification accuracy of the method through metrics such as precision, recall, and overall accuracy, and for the localization accuracy, we compute the overlap ratio between the bounding box of the ground truth and the bounding box of the correctly labelled object produced by this method. We define the overlap ratio of two bounding boxes as

# Methodology and Approach

## Preprocessing

An image is first loaded into memory and then converted to the RGB color space. The image is then padded so that the resulting image is a square image. For an image with width and in terms of pixels, we desire the size of the padded image to be

where is the length of the sides of the image. In terms of implementation, we create an empty array of integers and try to fit the image to be padded into the middle of the image. After padding the image, we resize the image so that the size of the image is 224x224 pixels. We use a Lanczos interpolation filter to account for the abnormalities resulting from the scaling of the image. We then normalize the image by making the following assignments for the color channels, denoted as respectively for the red, green, and blue channel.

## Feature Extraction

Features are extracted from the preprocessed image by feeding these images to a pretrained ResNet-50, distributed alongside the project data and downloaded through PyTorch. We convert the preprocessed images to a format compatible with PyTorch and then feed the 224x224 RGB image to the neural network, in batch sizes of one image for memory reasons. ResNet-50 outputs a 1000-dimensional feature vector for each image (in the project specification document, it is claimed that the dimensionality of the feature vectors is 2048; however, there is a final layer in ResNet-50 that pools 2048 data points down to 1000 points, hence the dimensionality of the features). We build an in-memory mapping of the images to their feature vectors alongside their labels for SVM training purposes later.

## Training a Classifier

We train a set of SVMs over the space of the features for the classification of features as one of the ten clusters. We use the sklearn SVM library. We feed the samples of a particular object to a binary SVM as positive samples and any samples that are not the same type of that object are fed as negative samples. In total, we train ten SVM classifiers and to classify a feature, we feed that particular feature to all the SVMs and we assume that an image belongs to a cluster if the SVM of that particular cluster outputs a one. The ten SVM classifiers are embedded in the multi-classifier model, and it gives a ten-dimensional vector whose elements sum up to one, and whose entries are the “probabilities” that a feature belongs to a particular class.

## Extraction of Candidate Windows

Edge box method was used to create bounding boxes that represent potential localizations of an object. This method utilizes gradient magnitude and direction to come up with regions of interest that are rich in contours, such that proposed boxes contain high amounts of enclosed contours. The proposed boxes are cropped from the image, and normalized in the same manner to the training images. and used further in the pipeline.

## Classification and Localization

Cropped images that represent the localization proposals were used to extract futures from the pre-trained ResNet-50 network. These features were then normalized in the same way the training image features were normalized. Normalized features extracted from the proposed object regions were classified using the previously trained SVM. Classification outcomes for each bounding box were then compared according to their assignment scores. Bounding box with the highest score were chosen to be the representative bounding box of the object that were aimed to be detected.

## Evaluation

Metrics of the classification accuracy, defined as percentage of correct classifications and localization accuracy were calculated to evaluate the trained SVM. Correctly localized bounding box were defined as 50% overlap between putative and definitive bounding box.

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1. G. Eason, B. Noble, and I. N. Sneddon, “On certain integrals of Lipschitz-Hankel type involving products of Bessel functions,” Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955. *(references)*
2. J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
3. I. S. Jacobs and C. P. Bean, “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.
4. K. Elissa, “Title of paper if known,” unpublished.
5. R. Nicole, “Title of paper with only first word capitalized,” J. Name Stand. Abbrev., in press.
6. Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, “Electron spectroscopy studies on magneto-optical media and plastic substrate interface,” IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].
7. M. Young, The Technical Writer’s Handbook. Mill Valley, CA: University Science, 1989.

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