



Waste Recognition & Classification

Based on Convolutional Neural Networks

1. Inspiration

Before this project, we mainly have two goals: one is to use the current visual recognition technology to create a useful product to solve some specific social issues in our real life, the other is we want to try our best to fully understand the deep learning technology, like how each layer of the convolutional neural network works, and how can we optimize the network models and parameters.

Waste Sorting is a process related to everybody's life. It has perplexed people for a long time. Before we have the recycling system, every kind of waste are put together and the recycling process requires facilities to sort waste by hand, which caused the low efficiency and environment issues.

In modern world, smart people tries to mark different dustbins with different labels (like recycling, organic, and so on). It sounds a very good idea and has already be implemented everywhere. However, the confusion gradually makes it a meaningless invention, people even don't know what is recyclable and what is hazard.

2. Abstract

Based on this situation, my team is going to build an automated visual recognition system for Waste Sorting. Our new system perfectly solves the confusion problem, which lets us only use one dustbin to collect all kinds of waste. The sorting process will happen later. Our vision system helps the mechanical robot to put different waste to different places.

To simplify the model, we currently transform this environmental issue to a specific technology problem: how to do a 2D multi-class object recognition. We try to use the convolutional neural network model to train our classifier to recognize multiple classes: plastics, metal and cigarette butts, etc. We plan to implement different CNN models (like AlexNet, ResNet) and apply different optimization methods, to compare and select a suitable solution for our Waste Sorting vision system.

3. Contribution

Based on the idea we mentioned above, we want to implement a multiclass classifier for garbage, which could be used in waste separation robots someday. Our data set is a bunch of labeled images, more specifically, every image contains one or more kinds of garbage with different backgrounds like lawn, pavement, sands and so on.

The prototype of what we want to design is built on the convolutional neural networks(CNN) technics in general, which could discriminate between garbage and background, and more importantly, classify these garbage into different categories. The specific number of categories that our model could classify will depend on our training data



set, we initially choose four major kinds of trash, like cigarette, paper, mental, and plastic. We might modify our categories according to the performance of our algorithm and our data set.

As dive deeper into our project, what we are going to implement and learn is that we could experience the whole procedure of collecting training data, preprocessing our images, choosing the framework, designing our own training model. We also need to determine the optimization of the initialization, determine the hyper-parameters from the experiential value, toggle the CNN architecture, make tradeoff to choose the Gradient Decent method between the performance and complexity, try to deal with the saddle point when we meet the higher dimension space, attempt to get a better set for our mini-batch and epoch value, consider how to have a better fit if our training data is too small and etc. Lots of theoretical problem become much more serious and knotty when we are coding on a specific platform like PyTorch or Tensorflow.

Since others have done some related projects, like recognize a single trash in one image, firstly, we need to compare the classification accuracy, and analyze why our model and algorithm will have a better performance. Also, we will do plenty of comparison between different CNN architectures, like AlexNet and VGGNet, comparison between different methods of Gradient Decent, like original SGD, adding the momentum and adding some decay rate. We will evaluate the performance and difficulty to make our model more practical, which are common in machine learning and computer vision community.

4. Challenge

In this project, we mainly have two big challenges: one is we don't have enough data set. It's difficult and time-consuming for only us to label the data. So we propose an idea that we will develop an App for user to label the waste in images. Why would the user like to help us do it? We will launch an environmental program named "make city smarter". Every user can share their labeled image to social network (like instagram and facebook) with "#makecitysmarter". It is really an easy way to contribute themselves to public service. People will definitely enjoy it.

The other challenge is about computing power. Up to now, we just have NVIDIA 1050 to run our training process. It is still very slow. We try to resize the images and increase the pooling layers, meanwhile we are looking for more powerful computing center.



Reference

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