Machine Learning assisted Shoe Size Recognition Model

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I. Introduction

A. Related Work

In this section, similar projects that have been conducted shoe recognition or Big Data application on supply chain will be discussed. The main theme of this paper is relevantly new which is using advanced machine learning to detect the presence of shoes and record it, the record will be used to calculate the shoe size and convert into valuable information for decision-making. The papers that related to the study can be partially related, such as object detection or Hadoop framework.

In the past decade, computer vision and data science application in Supply Chain Management (SCM) have gained more attention and the development of these industries are rapid. South Africa is still currently using the traditional way to manage the supply chain, the absence of intelligence in the supply chain makes it very costly.

A paper written by Khosla and Venkataraman [6] proposed that using convolutional neural networks to solve shoe classification and retrieval problems. During the course, Khosla and Venkataraman experimented with different network architecture and fine-tuning for the dataset. In the classification section, the authors prepared three approaches, the first approach follows the general approach of building a Convolutional Neural Network (CNN) which is a select moderately large dataset and train a network from scratch, by tuning the parameters to obtain the best accuracy. This is straightforward to solve the classification problem. The first back approach utilises the transfer learning technique to use an established network and look for the fine-tune for the parameters to obtain the best accuracy. The above two approaches require large computational resources. And in case of failure of both approaches, problem reduction will be applied to reduce the number of classifications, this will allow the model to learn easily.

The second objective of the paper which is retrieval, ti recommend shoes that with similar looking. The performance evaluation for the retrieval problem is much more difficult as it has no absolute answer like the classification problem. The authors planned to calculate significant Confidence Interval (CI) or the result will be evaluated by real humans to determine the success.

After solving limited computational resource and messy dataset issues, 32,000 men's and women's shoe images were collected and each image has its own short description text file which included name, category, brand, label and et al. Three networks were used and compared in both classification and retrieval problem.

	Average Score	Precision
ViggyNet Small	3.64	62.6%
ViggyNet Large	3.71	69.4%
VGGNet	4.12	75.6%

Figure 1: Result of three networks on classification.

Source: Adapted from [6].

	Train Time	Iterations	Accuracy	Loss
Small	119 s	1500	92%	0.2217
Large	1296 s	1500	64%	0.5742
VGGNet	N/A	N/A	N/A	N/A

Figure 2: Result of three networks on retrieval problem.

Source: Adapted from [6].

This project established a good starting for shoe classification problem and demonstrated the feasibility of using Convolutional Neural Network (CNN) to solve shoe classification. The authors advised the future developers to have access to high-quality image dataset to improve the accuracy of the network, the labelling of the dataset also plays an important role in improving the model accuracy. Furthermore, the authors advised that a stronger computational resource can also improve the model.

Unlike the paper of Khosla and Venkataraman, Mottaghi et al. (2014) [7] used a different approach towards object detection. The authors conducted further analysis of the effect of context in detection and segmentation. PASCAL VOC 2010 is chosen, PASCAL VOC 2010 is test dataset which consists of 20 object classes, such as a person, bird cat, cow, dog, bicycle, car, chair, sofa, etc. In Figure 3, as you can observe that PASCAL VOC 2010 is not like the normal training images dataset, every pixel of PASCAL VOC 2010 is labelled as the figure below. The object segmentation in the image is different.

The authors discovered that it is difficult for existing models to deal with PASCAL imagery. To overcome the problem, the authors proposed a novel deformable part-based model, this model can not only exploits the local context around the object candidate but also the global context at the level of the whole picture. This model has significantly improved in object detection, it is able to detect an object in any scale and most effective on the tiny objects.

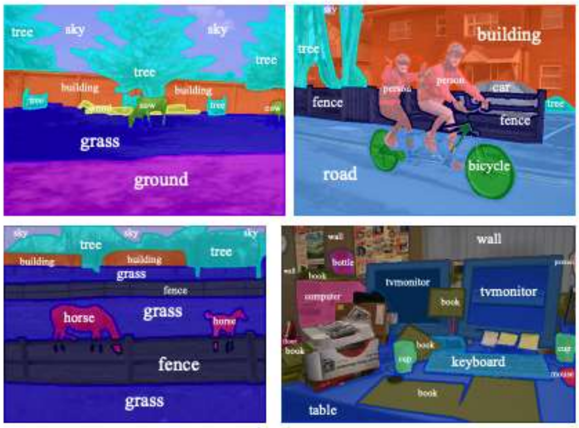

Figure 3: Examples from PASCAL VOC 2010.

Source: Adapted from [7].

Girshick [4] introduced Fast R-CNN which is developed to overcome the problem of R-CNN and SPPnet. The training of R-CNN is a multi-stage pipeline, because of that, the training becomes time-consuming and expensive in space, last and most importantly that the object detection of R-CNN is slow. The new Fast R-CNN is not only fast on object detection but also a higher detection quality, the training has become single-stage, using a multi-task loss, training can update all network layers and no disk storage is required.

The architecture of the Fast R-CNN consists of several convolutional and max pooling layers, these layers are used to produce conv feature map. Then pooling layer extracts a feature vector from the feature map. Each feature vectorial then go through fully connected layers that branch into two sibling output layers.

To compare how effective the Fast R-CNN is, Fast R-CNN, R-CNN and SPPnet gone through three testing dataset VOC 2007, VOC 2010 and VOC 2012. The results suggested that Fast R-CNN is clean and fast network, the improvements that were made are very significant.

Ivanov, Dolgui, Sokolov, Werner and Ivanova(2016) [8] proposed using a dynamic model and an algorithm to solve the short-term supply chain scheduling. The study aimed to optimise the short-term supply chain process which is a multi-stage, multi-objective, flexible flow-shop problem. The team created a dynamic scheduling environment which takes factors like unavailability of the machine, fluctuations of processing time and technological constraints. The result of this study provided a theoretical solution for a real-world scheduling problem and this will help the future development for a sophisticated system for smart factory 4.0.

Yan et al. (2014) [10] proposed using Could of Things as a base to create an integrated management system for a supply chain. The objective of this study is to tackle the current supply chain problem which is lacking in real-time information and agility, improving the supply chain process efficiency. The authors also emphasised the importance of information sharing and collaborations between the links in the supply chain, if information sharing and collaboration is poorly done, it lowers the visibility of the supply chain and leads to information delay and distortion, which can result in the expense of the supply chain increases.

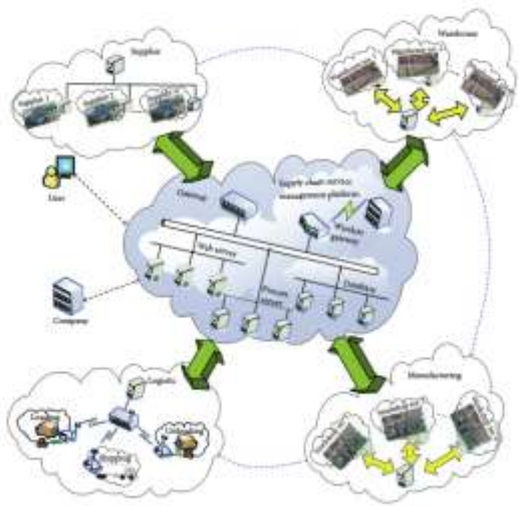

Figure 4: The CoT model for supply chain integration and management.

Source: Adapted from [10].

As shown in Fig4, the study divided the whole supply chain into four sections which includes supplier management, warehouse management, manufacturing management and logistics management. All four sections are connected with each other through CoT, the full connected architecture enable timely communication between each section and allow the tracking of the parcels become much easier.

Each step from manufacturing, warehouse, supplier to client, information about the stocks, communication between different parties are all recorded. These processes created large amount of data, and through CoT to process these data, each party of the integration and management is able to extract relevant information.

However, the traditional non relational database is unable to handle such large heterogeneous data. In order to avoid this situation, Hadoop framework is used to improve data processing. The deployment of Hadoop framework changes the raw data into valuable information which improve the efficiency of the supply chain. Hadoop framework also able to streaming all the data to incorporate with CoT. Hadoop can store large amount of data compare to the traditional database which data storage can be a big problem.

In Figure 5, the whole supply chain is divided into four sections, and using SOA architecture. Each modules are connected with the others. The development of service management platform are based on CoT and the Hadoop which keep producing valuable information and communicating with four main sections.

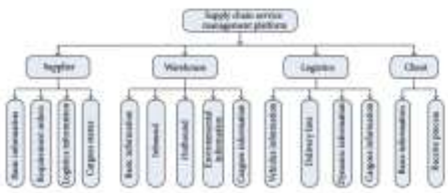

Figure 5: Functional modules of the supply chain service management platform.

Source: Adapted from [10].

Xing et al. (2015) [3] proposed a new platform for Machine Learning on Big Data. This paper is close related to the main theme of our paper which involved both topics Machine Learning and Big Data. Xing et al. suggested in order to fix the space and time bottleneck problem by using Petuum- a system for writing data and model-parallel ML programme.

Jaggi and Kadam (2016) [9] published research paper about Apache spark. In the paper, it indicated that Big data analytics helps the business or an organisation to extract valuable information in vast amount of unstructured data. Big data analytics can help supply chain management become much smoother, and the supply chain will be more intelligent than before. The data generation pace of the supply chain today is super fast, consider the supply chain in a global scale.

In the paper, authors also indicated that the reasons to choose Apache Spark over Hadoop. The three main reasons are computing speed, ease of use and environment. Apache Spark is much faster than Hadoop, in the case of the supply chain, time can be a critical factor. Apache Spark is much easier to operate than Hadoop. Spark can run on different environments even on cloud, also accessible.

Figure 6: Apache Spark logo.

Source: Adapted from [9].

A fast Big Data analytics that capable of processing terabytes of data is very beneficial for an organisation. Today's supply chain management does demand a tool like Apache Spark. Tests have proven that Spark is 100 times faster than Hadoop in memory. This fast data processing engine can help the organisation stay competitive.

In the comparison of Apache Spark, Singh and Kaur (2014) [2] published a paper nohow Hadoop handling the Big Data challenges. The three major challenges of Big Data also as known as the 3V, volume, velocity, variety. MapReduce framework which is one of the main components of Hadoop, it splits the data into small parts, this process is called data segmentation. Data segmentation is able to handle the large volume of data. The Hadoop filesystem is capable of handling any forms of unstructured data.

In conclusion, Hadoop is capable of handling Big Data challenges. It has features such as MapReduce, filesystem and fault tolerant to make it reliable.

Blum, Springenberg, Wülfing and Riedmiller [5] did another work on object recognition in RGB-D data. Another new approach for object recognition by using convolutional k-means descriptor. Unlike the traditional neural network, the descriptor "studies" the interest point and combine all the information. As figure 7 demonstrated below, the descriptor pinpointing both the colour and the depth.

To efficiently process large RGB-D images, the authors made the following modifications in the original algorithm. Since the dimensionality of all images is high, the model will only learn feature responses of the interest point nearby. A fourth channel was added to the response to the RGB-D images. Lastly, to improve the unsupervised algorithm, the pre-processing was modified and bootstrap was introduced. The two modifications were added to help the model to cope with high dimensionality images.

The result of the new descriptor shows that this approach has successfully learnt meaningful features from RGB-D images. The authors suggest that learned feature descriptor can be a valuable tool shortly to improve real-world object recognition application's accuracy.

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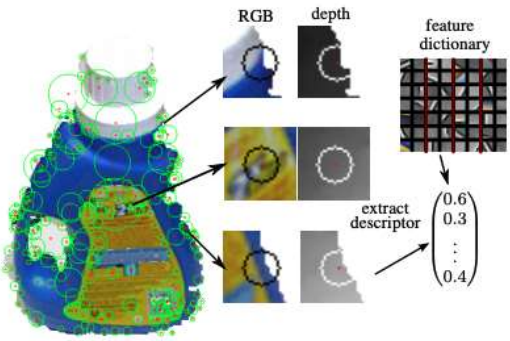

Figure 7: Example of general descriptor extraction procedure.

Source: Adapted from [5].

Suthaharan (2013) [1] proposed that combine both Big Data and Machine Learning to tackle network intrusion traffic problem. Suthaharan first defined that how is network intrusion traffic problem possesses the characterises of Big Data. Then Suthaharan addressed the network topology, communication challenges and security challenges. On the top of the traditional machine learning approach, Suthaharan proposed the application of Representation Learning and Machine Lifelong Learning to tackle the problem.

The result of the study revealed that the feasibility of using Representation Learning and Machine Lifelong Learning on the network intrusion traffic problem.

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