

Recommendation Engine

for the Wholesale Customers

Author: Veronika Zhezhela

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CALVIN KLEIN TOMMY HILFINGER HERITAGE BRANDS



PVH
Stadhouderskade 6
1054 ES Amsterdam

Supervisor:
Alexey Chaplygin



Faculty of Science
Vrije Universiteit Amsterdam
De Boelelaan 1081a
1081 HV Amsterdam

Supervisor:
Prof.dr. Sandjai Bhulai



Thanks

The Master program at Vrije University in Business Analytics is the perfect opportunity to gain necessary theoretical and practical knowledge in complementary yet very different areas of business and technology. Curriculum helps to develop a wide-ranging skill set for further work as a data scientist.

Internship is the most exciting part of the studies, when you can apply all current knowledge on a real business problem and build up new skills. Writing my graduate thesis at PVH Corp gave me an opportunity to learn from highly skilled professionals, gain practical knowledge in a challenging environment.

It was a great 6 month journey and I would like to express my big gratitude to all my former colleagues for such a life-changing experience, especially to my supervisor Alexey Chaplygin, my teammates Josh Chacksfield and Nauman Yousaf, who taught me a lot about the world of applied data science. It was a great privilege to be a part of Business Intelligence and Analytics Department and big challenge at the same time.

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Introduction

0.1 Research question & Hosting Organization

Many fashion brands are constantly experimenting with artificial intelligence and machine learning to increase engagement among shoppers. Although, the fashion industry is moved by the creativity of designers, which is the main engine behind the collections, algorithms can create a personalized experience based on shoppers taste. However, in a domain like fashion it is a very challenging task due to the high level of subjectivity. Also users preferences and product styles change over time; more critically, the meaning of what is fashionable is incredibly complex.

This research is done at PVH Corp, one of the largest apparel companies globally, which operates a diversified portfolio of iconic lifestyle apparel brands. Although PVH owns a number of prosperous heritage brands, this research is focused on Calvin Klein and Tommy Hilfiger, which lead PVH Corp. to record an annual revenue of \$8.9 billion in 2017.

Fashion is an extremely dynamic market. Calvin Klein and Tommy Hilfiger are known for innovative digital and social concepts, second one has launched a digital showroom in Amsterdam, main purpose of which is to transform the traditional buying process for one of the main sales channels - wholesale partners.

The wholesale channel is an important component of the corporation business mix and one of the key ways that the fashion company communicates the brand messaging and positioning to

consumers. Customers sell company's goods in their stores and on their digital commerce sites. For the company it is a way of continually expanding the brand's presence in top doors at both department stores, seeking to maximize sales of key items and upgrade the in-store experience by creating clear and impactful store presentations.

The digital showroom is an innovative digital sales experience which allows sales representatives to showcase the sample of the collection to wholesale clients via an interactive touchscreen table upon which they can create custom orders. Because of the high number of the items in each collection, the sales team prepare proposals with the materials that are most likely to be bought from the new collection by each particular customer. The sales team is dedicated to preparing a proposal for each wholesale partner from scratch. To be specific, sales person needs up to three weeks to create a basket from new collection for a wholesale customer aiming to arouse interest in purchasing.

The recommendation engine will increase sales flow of the company. System will combine two data sources to create master and collection datasets. Master data is historical metadata, which contains customer properties and captures their behaviour. In order to build a more effective recommendation engine, available images and materials' metadata will be included as a 'collection' dataset. In this thesis, we are primarily interested in the second dataset.

There is an old saying "A picture is worth 1,000 words". One of the visual recognition tasks is to prove it. PVH consider images as one of the most valued assets. Visual recognition is based on algorithms that can help analyze images and optimizes tasks such as identifying, tagging and classifying every apparel, thus making customers experience better and brands job much easier.

To explain why using images makes so much sense for recommendation engines, its important to know how the human brain works. Ninety percent of the information transferred to the brain is visual and we process images 60,000 times faster than text-based information. Its no wonder, then, that images and videos are quickly turning into our primary form of communication. Its a lot faster and it better communicates what we are trying to say. Especially

in fashion its difficult to put the style of a product into words. Every detail on the material can influence customer choice.

Brands possess more than millions of high-resolution images in the database. These must be processed by available hardware with least possible memory usage. Based on remarkable success of deep neural networks applied to image processing task, this research is focused on *developing and optimising a network to produce embeddings of materials from their product images, whilst maintaining a manageable and performant network architecture.*

The thesis designs an ensemble of convolutional autoencoder with a pre-trained VGG16 model and generative adversarial network (GAN). The goal is to investigate what is the optimal size of the image embedding which preserve all relevant information of the product. Information that can give us insights and reflect customers' taste. We are mainly interested in color, shape and details (such as presence of the brand's logo, zip etc). We generate the images from the embeddings to visualize the stored information. In this way we perform the evaluation of the network. We experimented with different compression size of the image embedding to conclude which one is sufficient for the recommendation engine. In addition, we explored if adding meta data of the product will influence on the quality of the results.

0.2 Structure of the thesis

The scope of this project included collection of two datasets, clean-up, reduction and manipulation of the data, feature contraction. Next step was to implement autoencoder. It was crucial to define a set of objective indicators and starting points in order to get first sufficient results. We divided the process into steps, accessing the performance of the model on each of them and increasing the complexity respectively.

First, we built a convolutional autoencoder to create embedding for each product and generate images. To achieve better generalization and performance of the model, we included pre-trained VGG16 model as a part of the architecture. Finally, in order to increase the quality of the produced images we included discriminator part of the generative adversarial neural network.

In this thesis, we first introduce neural networks. Chapter 2 presents the theoretical background, related work and different models used in the research. The data is presented in Chapter 2. Then Chapter 3 will explain the architecture of the model and its components, used hyper-parameters. Also, chapter 3 includes results. Finally, Chapter 4 lists conclusions.