UCL

Project Title

Candidate Number: QMKR4 [1]

Programme: MSc Data Science and Machine Learning

Supervisors: Nadia Berthouze and Temitayo Olugbade

Submission date: 12 September 2022

Abstract

The abstract is a brief summary of the paper, which needs to be written extremely well. Try to address the following points in your abstract, with a single sentence per point. This will naturally keep the abstract compact:

1. Describe the task/problem the paper is going to address (high level)

2. Why is this an interesting/important problem?

3. How does one usually solve this?

4. How (and why) do we do it in this paper (key idea)? Highlight the novelty here.

5. Interpretation of the results (impact and importance)

Contents

Chapter 1

Introduction

1.1 Motivation

The fashion industry is one the most significant contributors to the current climate crisis and is responsible for around 10% of global greenhouse gas emissions and approximately 20% of global wastewater. In addition to its toxic environmental impact, the fast fashion industry has substantial implications on an individual's overall well-being and finances. The fashion industry has recently been channelling digital technology to create a more sustainable and circular economy. Examples such as virtual clothing try-ons and digital clothing for virtual presence aim to lessen consumers' one-time use and return of physical clothing.

This project proposes a novel machine learning approach to infer affect from touch with the end goal of building a smart chatbot that learns how people touch and engage with clothes. The chatbot aims to design a fulfilling clothes shopping experience for the consumer, minimize waste, and create a more circular and sustainable fashion industry.

1.1.1 Fast fashion and its environmental impact

<u>Introduction to fast fashion</u>

'Fast fashion' refers to speedily and mass-produced, low-quality clothing that is quickly circulated through high street stores to satisfy the latest trends and maximise consumer demand. Fast fashion garments are cheaply produced and priced and replicate the latest celebrity or catwalk styles [1, 2, 3]. Fast fashion involves swift design, production, distribution, and marketing. This allows retailers to obtain a larger quantity of assorted designs, and in turn, consumers are presented with a more extensive choice of inexpensive clothing [1, 2].

The term 'Fast fashion' was first coined in the early 1990s by the New York Times to describe how Zara, the Spanish apparel giant, only took 15 days between designing the garment and selling it in their stores. The most prominent names in the current fast fashion industry include Zara,

H&M (Hennes and Mauritz), Uniqlo and Gap. All four apparel manufacturers sold over \$15 billion worth of clothes in the 2021 fiscal year [1, 2, 4].

Include paragraph on how big fast fashion is - stats on how many people buy using fast fashion, proposed trajectories etc

As fast fashion relies on cheap and quick production, it promotes overproduction. Fast fashion also encourages overconsumption because consumers are attracted to cheap and trendy clothing that copies current trends compared to relatively expensive, long-lasting items that fall out of style shortly. This toxic system of constantly buying clothing and almost immediately discarding them due to its low quality is the most significant pitfall of fast fashion. As a result, fast fashion massively harms the environment [2, 3].

Environmental impact of fast fashion

The environmental impact of fast fashion includes large-scale emission of greenhouse gases, the use of massive amounts of water and energy, and the depletion of non-renewable resources. Fast fashion is also one of the world's largest polluters.

According to the United Nations Environment Programme (UNEP), textile production accounts for up to 10% of total global carbon emissions (1.2 billion tonnes). This figure is larger than the emissions from all international flights and maritime shipping combined. Further, according to the UN Framework Convention on Climate Change, global carbon emissions are estimated to skyrocket by more than 60% by 2030 [1, 5, 6].

The fashion industry is also the second largest consumer of the world's water supply. Approximately 700 gallons (3182.26 litres) of water is required to produce a single cotton shirt; this is enough water for an individual to drink at least eight cups per day for three-and-a-half years. Roughly 2 000 gallons (9092.18 litres) of water is used to produce a pair of jeans; this is more than enough for one person to drink eight cups per day for ten years. Further, the United Nations Environment Programme (UNEP) discovered that the fashion industry produces 20% of the world's wastewater and that fabric dyeing is the second largest water polluter because the water leftover from the dyeing process is dumped into rivers, streams, and other water bodies. This severely affects marine life and the aquatic ecosystem [1, 7, 8].

Textile production is also highly energy intensive and requires large quantities of petroleum. According to STAND.earth, the largest component of the fashion supply chain still relies on coal for electricity generation and heat used in apparel manufacturing. Burning coal releases greenhouse gases such as carbon dioxide, and such gases are the leading cause of global warming and climate change. Further, the global textile and apparel industry consumes 98 million tonnes of non-renewable resources [1, 9, 10, 11].

Synthetic materials such as nylon, polyester and acrylic are created from fossil fuels and currently comprise over two-thirds of the materials used in the apparel industry. Such materials take over hundreds of years to biodegrade. A 2017 report from the International Union for the Conservation of Nature (IUCN) estimated that 35% of all microplastics (tiny pieces of plastics that never biodegrade) in the ocean came from laundering synthetic textiles like polyester. It is also estimated that microplastics cause up to 31% of plastic pollution in the ocean [1, 7, 12, 9].

There is also massive amounts of monetary and resource wastage resulting from fast fashion. According to Business Insider, 85% of textiles of all textiles go to the landfills each year – this is

enough to fill the Sydney harbour each year. Further, the equivalent of one garbage truck full of clothes is dumped in a landfill or burned every second [7, 13, 14, 15].

Other detrimental effects of fast fashion

There is also a significant human cost resulting from fast fashion. Garment workers in the global South pay a large price so fast fashion brands can keep their profit margins high and price tags low. Garment workers are paid well below the liveable wage and are forced to work long, strenuous hours in abysmal conditions. An Oxfam 2019 report discovered that 0% of Bangladeshi and 1% of Vietnamese garment workers earned a living wage. Nine of 10 Bangladeshi workers starve because they cannot afford food, and three-quarters cannot afford medical treatment. In Vietnam, more than half of workers cannot afford medical treatment, and three-quarters of workers cannot afford to make ends meet in general. Garment workers are often forced to work 14 to 16 hours a day, seven days a week. The devastating Rana Plaza collapse in 2013, which killed 1134 people and injured 2500 others, is a testament to the unacceptable working conditions in the fashion industry. Employees usually work without ventilation and inhale toxic substances such as fibre dust or blasting sand. Accidents, fires, injuries, and diseases frequently occur on apparel production sites. [16, 17, 18, 19]

Animals are also adversely affected by fast fashion. The toxic dyes and microplastics released into waterways are ingested by animals, most often resulting in their deaths. Using animal products such as leather, fur, and wool directly risks animal welfare [3].

Include bridging sentence or paragraph to connect touch and adverse effects of fast fahion

1.1.2 The importance of touch when purchasing clothes

Multiple studies have discovered that consumers heavily rely on affective touch and tactile experience when purchasing clothes. According to [20], affective touch is defined as tactile processing with a hedonic or emotional component; in summary, it is the emotional aspect of touch.

According to [21], touching an object may increase consumer confidence in product assessment and evaluation. Further, tactile input is used more commonly used over macro-spatial characteristics (shape and size, unless there is no way to pass visual judgment) when assessing the physical properties of an item (softness, smoothness, flexibility etc.) [22, 23]. As per a study led by Holbrook [24], tactile cues played a more significant role than visual cues in consumer perception and assessment of sweaters. However, the principal effect of tactile cues may differ from one item to another [25]. For example, consumers will rely more on tactile inputs when assessing a coat with various properties (weight, thickness, texture) than when assessing a standard AAA battery. Therefore, touch is a crucial criterion when assessing items that differ in their textual properties [26]. As a result, it is plausible that conscious or unconscious tactile emotions (affective touch) play a leading role in consumer perception of clothing.

With the expansion of fast fashion and the development of the internet, online clothes shopping has become increasingly popular. However, this comes with the caveat that individuals cannot physically touch the clothes they purchase. Many studies on internet retail [27, 28] show that the main drawback of online shopping is the inability of the consumer to touch the products. Therefore, developing a comprehensive evaluation of the object may be challenging purely through online

shopping. Further, studies have discovered that consumers may feel frustrated or disappointed if they do not have the opportunity to physically touch and examine the products [21, 27]; this is particularly true for consumers who have a higher need for touch (NFT).

Talk about how people don't engage with clothes when they shop fast fashion

1.2 Objective

The long-term aim of this project is to build a chatbot that helps reduce fast fashion's impact. The chatbot aims to transform clothes shopping into a multi-sensory, reflective and recognition-based experience. Firstly, the chatbot will ask individuals to touch new clothes, engage with the fabric, **reflect** on whether they like the garment and if they will wear it. Secondly, the chatbot will have stored information such as what clothes the individual has in their cupboards, what their favourite and most worn clothes are and what type of clothes they like. Based on this data, the chatbot will look at the cloth the individual is looking at and **recognise** if the individual likes it and will wear it.

Past studies have discovered and confirmed that consumers rely heavily on affective touch and tactile experience when purchasing clothes. Therefore, developing a method to comprehensively understand what an individual experiences when touching a textile, how they feel after touching it, and if they like it may help to reduce the impact of fast fashion. Therefore, this study proposes a novel machine learning approach to estimate people's sensations and their liking of the textile being touched.

1.3 Project outline

This paper is organised as follows.

Include paragraph on paper organisation

Chapter 2

Background and Related Work

Touch is the most advanced sensory function at birth and plays a vital role in emotional, social, cognitive, and cerebral development throughout infancy and childhood [29, 30, 31, 32, 33]. In the words of Michelangelo, 'to touch is to give life'. This statement is further corroborated by a study conducted by Tiffany Field, which observed that premature newborns who received touch therapy for 5-10 days gained almost 50% more weight than preterm newborns who received standard medical treatment [29, 34]. Touch continues to play an essential role through adolescence and adulthood as it is used to express various emotions and manoeuvre various situations [32, 33, 35]. Touch also plays a significant role among nonhuman primates. Nonhuman primates groom each other for 10 to 20 per cent of their day to soothe, reconcile, reinforce reciprocity and build cooperative alliances [34, 36].

Recent studies discovered that touch has incredible health benefits. Touch reduces illness, strengthens the immune system, reduces pain, enhances sleep, soothes, and signals safety and trust [29, 34, 37]. For example, [38] revealed that premenopausal women who received more frequent hugs from their partners had lower blood pressure and heart rates. Hugs have also been found to strengthen the immune system - the gentle pressure applied on the sternum when hugging stimulates the thymus gland, which regulates and balances the production of white blood cells. Further, touch increases levels of dopamine and serotonin (2 neurotransmitters that relieve stress and anxiety) and reduces cardiovascular tension by releasing oxytocin ('the love hormone') and activating the vagus nerve (involved in showing compassion) [34, 39].

2.1 Emotion recognition through touch in social sciences

As humans, we use touch in our daily life for various reasons. We rely on touch to perform actions such as flirting (gently stroking face, hair, or arm), attracting attention (waving hands), offering congratulations (handshake or a pat on the back), and when thanking others (hugging and gently squeezing). We also express emotions such as love (embracing, hugging, and stroking), sympathy (embracing, stroking back), fear (squeezing hand) and anger (gently slapping) through touch.

Touch is such an integral part of our lives that the word stem 'touch' is explicitly and metaphorically used to express emotion. For example, if an individual is 'touched beyond words', they are so overcome by emotion that they cannot speak. The following phrases metaphorically use touch to convey emotion - 'touched their heart' refers to making someone feel sympathy, and 'touched their soul' refers to having a profound effect on someone.

Although touch plays an essential role in human life, it has received less attention in affective science than facial and vocal displays of emotion [33, 40]. Initially, studies regarding touch as an affective modality claimed that it was mainly used to communicate the hedonic tone of emotions (positive and negative) [32, 40, 41, 42, 43, 44] and increase the intensity of emotion-related communication [32, 44]. However, two consecutive studies by Hertenstein in 2006 and 2009 have argued that touch plays a much larger role in emotional communication.

The first study discovered that participants could identify several distinct emotions when they were touched on their forearm by their partner (a stranger), even though they could not communicate visually or verbally [32, 40]. This study observed that the tactile modality could distinguish between the emotions of love, gratitude, sympathy, fear, disgust and anger with accuracy rates between 48% and 83% [32]. The second study confirmed these results and observed that happiness and sadness could also be recognised with accuracy rates higher than chance. Therefore, the recognition performance attained with touch alone was comparable to those observed in studies of facial displays and vocal communication [45, 46].

The second study investigated 23 types of tactile behaviour (ex: squeezing, stroking, pushing) and revealed systematic differences in how touch was used to communicate different emotions [33, 40]. For example, love was associated with stroking; gratitude was associated with shaking of the hand; sympathy was associated with stroking and patting; disgust was associated with a pushing motion; fear was associated with trembling and anger was associated with hitting and squeezing [33]. However, as some types of tactile behaviour were used to communicate multiple emotions (for example, stroking was used to express both love and sympathy), the study concluded that tactile behaviour alone is insufficient to discriminate between different affective emotions [33, 40]. This paper also found that emotions could be categorized according to differences in intensity and duration [33]. For example, love and sympathy were characterized by a moderate-intensity touch for a longer duration, whereas anger was characterized by a vigorous intensity of touch for a moderate duration [33].

Insert paragraph on how we change our muscle activity to signal emotion

The machine learning community commonly uses the psychology behind affective touch and change in muscle activity to perform affective touch to inform the design of features used in machine learning models.

2.2 Human activity recognition using machine learning

2. How is this this knowledge used to inform ML techniques (automatic recognition, feature base etc)

Chapter 3

Methodology

Describe your method in detail and with great clarity, distinguishing it from other works (if it is indeed a novel idea). It is very important to clearly motivate your method. Describe the results of your method here in this chapter.

3.1 Data Collection

3.2 Feature Analysis

3.3 Models

3.4 Results

Chapter 4

Extensions of methodology

It is unlikely that everything you tried worked well, so in this chapter you may wish to describe a modified version of your method and the associated results. Explain why you were motivated to try this extension and how you think it might help to address some of the shortcomings of the method is Chapter 3.

Chapter 5

Conclusion

Summarise what you have achieved and evaluate honestly if you feel the approach has been largely successful. Explain what could be improved still and perhaps why the method is not working well (if that is the case).

Bibliography

[1] Rashmila Maiti. Fast fashion and its environmental impact. https://earth.org/fast-fashions-detrimental-effect-on-the-environment/. (accessed: 07/08/2022).

[2] Olivia Lai. What is fast fashion. https://earth.org/what-is-fast-fashion/. (accessed: 07/08/2022).

[3] Solene Rauturier. What is fast fashion and why is it so bad? https://goodonyou.eco/what-is-fast-fashion/. (accessed: 07/08/2022).

[4] Paul Smith. Sales of selected fashion manufacturers/retailers worldwide in 2021. https://www.statista.com/statistics/242114/sales-of-the-leading-10-apparel-retailers-worldwide/. (accessed: 08/08/2022).

[5] Rachael Dottle and Jackie Gu. The global gut of clothing is an environmental crisis. https://www.bloomberg.com/graphics/2022-fashion-industry-environmental-impact/xj4y7vzkg. (accessed: 08/08/2022).

[6] United Nations. Fashion industry, un pursue climate action for sustainable development. https://unfccc.int/news/fashion-industry-un-pursue-climate-action-for-sustainable-development. (accessed: 08/08/2022).

[7] Morgan McFall-Johnsen. The fashion industry emits more carbon than international flights and maritime shipping combined. here are the biggest ways it impacts the planet. https://www.businessinsider.com/fast-fashion-environmental-impact-pollution-emissions-waste-water-2019-10?r=USIR=T. (accessed: 07/08/2022).

[8] Waste2Fresh. Dye pollution in the textile industry. https://waste2fresh.eu/dye-pollution-in-the-textile-industry/. (accessed: 07/08/2022).

[9] Gary Cook and Maya Rommwatt. Fashion forward: A roadmap to fossil free fashion. https://www.stand.earth/sites/stand/files/standearth-fashionforward-roadmaptofossilfreefashion.pdf. (accessed: 16/08/2022).

[10] Outlook for a new textile economy in china. https://www.switch-asia.eu/resource/make-fashion-circular/. (accessed: 16/08/2022).

[11] The issues: Energy. https://www.commonobjective.co/article/the-issues-energy. (accessed: 16/08/2022).

[12] Julien Boucher and Damien Friot. *Primary Microplastics in the Oceans: A Global Evaluation of Sources.* 01 2017.

[13] UN Environment Programme. Putting the brakes on fast fashion. https://www.unep.org/news-and-stories/story/putting-brakes-fast-fashion. (accessed: 07/08/2022).

[14] UNECE. Fashion and the sdgs: what role for the un? https://unece.org/fileadmin/DAM/RCM$_W ebsite/RFSD_2018_side_event_sustainable_f ashion.pdf.(accessed$: 16/08/2022).

[15] Elizabeth Reichart and Deborah Drew. By the numbers: The economic, social and environmental impacts of "fast fashion". https://www.wri.org/insights/numbers-economic-social-and-environmental-impacts-fast-fashion. (accessed: 16/08/2022).

[16] Martyna Lesniak. The human cost of cheap, fast fashion: 8 years after rana plaza. https://europeandme.eu/the-human-cost-of-cheap-fast-fashion-8-years-after-rana-plaza/. (accessed: 16/08/2022).

[17] Jaclyn McCosker. The impact of fast fashion on garment workers. https://goodonyou.eco/impact-fast-fashion-garment-workers/. (accessed: 16/08/2022).

[18] Oxfam. https://www.oxfam.org.au/what-she-makes/. (accessed: 16/08/2022).

[19] The Borgen Project. How oxfam is creating a fair fashion industry. https://borgenproject.org/fair-fashion-industry/. (accessed: 16/08/2022).

[20] India Morrison. Ale meta-analysis reveals dissociable networks for affective and discriminative aspects of touch. *Human Brain Mapping*, 37, 02 2016.

[21] Joann Peck and Terry Childers. To have and to hold: The influence of haptic information on product judgments. *Journal of Marketing - J MARKETING*, 67:35–48, 04 2003.

[22] Lederman Susan. and Klatzky, Roberta L. There's more to touch than meets the eye: The salience of object attributes for haptics with and without vision. *Journal of Experimental Psychology*, 116 4:356–369, 1987.

[23] Susan J. Lederman, Gary L Thorne, and B Jones. Perception of texture by vision and touch: multidimensionality and intersensory integration. *Journal of experimental psychology. Human perception and performance*, 12 2:169–80, 1986.

[24] Morris B. Holbrook. Aims, concepts, and methods for the representation of individual differences in esthetic responses to design features. *Journal of Consumer Research*, 13 4:337–347, 1986.

[25] Deborah Brown Mccabe and Stephen M. Nowlis. The effect of examining actual products or product descriptions on consumer preference. *Journal of Consumer Psychology*, 13:431–439, 2003.

[26] Bianca Grohmann, Eric Spangenberg, and David Sprott. The influence of tactile input on the evaluation of retail product offerings. *Journal of Retailing - J RETAIL*, 83:237–245, 04 2007.

[27] Alka Varma Citrin, Donald E. Stem, Eric R. Spangenberg, and Michael J. Clark. Consumer need for tactile input: An internet retailing challenge. *Journal of Business Research*, 56(11):915–922, 2003. Strategy in e-marketing.

[28] Deborah H. Lester, Andrew M. Forman, and Dolly Loyd. Internet shopping and buying behavior of college students. *Services Marketing Quarterly*, 27:123 – 138, 2005.

[29] Tiffany Field. *Touch*. MIT Press, 1st edition, 2001.

[30] Matthew J. Hertenstein. Touch: Its communicative functions in infancy.

[31] Dale M Stack. The salience of touch and physical contact during infancy: Unraveling some of the mysteries of the somesthetic sense. 2007.

[32] Matthew J. Hertenstein, Dacher Keltner, Betsy App, Brittany A Bulleit, and Ariane R Jaskolka. Touch communicates distinct emotions. *Emotion*, 6 3:528–33, 2006.

[33] Matthew J. Hertenstein, Rachel Holmes, Margaret E. McCullough, and Dacher Keltner. The communication of emotion via touch. *Emotion*, 9 4:566–73, 2009.

[34] Dacher Keltner. Hands on research: The science of touch. https://greatergood.berkeley.edu/article/item/hands$_o$n$_r$esearch.(accessed : 26/08/2022).

[35] Iren Eibl-Eibesfeldt. *Human Ethology*. 1989.

[36] Frans B. M. de Waal. *Peacemaking among Primates*. Harvard University Press, 1989.

[37] Janette Neuwahl Tannen. Scholar touts the advantages of touch. https://news.miami.edu/stories/2020/04/scholar-touts-the-advantages-of-touch.html. (accessed: 26/08/2022).

[38] Kathleen C. Light, Karen M. Grewen, and Janet A. Amico. More frequent partner hugs and higher oxytocin levels are linked to lower blood pressure and heart rate in premenopausal women. *Biological Psychology*, 69(1):5–21, 2005. Current Trends in Women's Health Research.

[39] Sara Menges. Sthe 3 biggest advantages of human touch may surprise you. https://news.miami.edu/stories/2020/04/scholar-touts-the-advantages-of-touch.html. (accessed: 26/08/2022).

[40] Yuan Gao, Nadia Bianchi-Berthouze, and Hongying Meng. What does touch tell us about emotions in touchscreen-based gameplay? *ACM Trans. Comput.-Hum. Interact.*, 19(4):31:1–31:30, December 2012.

[41] Matthew J. Hertenstein. *Touch*, volume 3. Sage Publications, 2005.

[42] Matthew Hertenstein and Joseph Campos. Emotion regulation via maternal touch. *Infancy*, 2:549 – 566, 10 2001.

[43] Stanley E. Jones and A. Elaine Yarbrough. A naturalistic study of the meanings of touch. 1985.

[44] Mark L. Knapp and Judith A. Hall. *Nonverbal Communication in Human Interaction*. 1997.

[45] Hillary Elfenbein and Nalini Ambady. On the universality and cultural specificity of emotion recognition: A meta-analysis. *Psychological bulletin*, 128:203–35, 04 2002.

[46] Klaus R. Scherer, Tom Johnstone, and Gundrun Klasmeyer. *Vocal expression of emotion*. Oxford University Press, 2003.