



UNIVERSITY OF CAPE TOWN
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UNIVERSITY OF CAPE TOWN

MASTER'S DISSERTATION

**A Hybrid Multi-Modal Recommender System using Neural Collaborative
Filtering and Content Based Filtering**

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A dissertation presented for the degree of
Master of Science Advanced Analytics

from the

Department of Statistical Sciences



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Declaration of Authorship

I, Pavan SINGH, declare that this dissertation titled, “A Hybrid Multi-Modal Recommender System using Neural Collaborative Filtering and Content Based Filtering” and the work presented in it are my own. I confirm that:

- This work was done wholly while in candidature for a research degree at this University.
- The contents of this thesis has not been previously submitted for a degree or any other qualification at this University or any other institution.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.

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Date:

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Abstract

Department of Statistical Sciences

Master of Science Advanced Analytics

A Hybrid Multi-Modal Recommender System using Neural Collaborative Filtering and Content Based Filtering

by Pavan SINGH

Online shopping has become a ubiquitous aspect of modern life and recommender systems have become a crucial tool for e-commerce giants such as Amazon to efficiently sift through vast amounts of data to locate the information that users are seeking. Recommender systems aim to provide users with personalised product recommendations based on their preferences and behaviours. They analyse user data, for example their browsing history, purchase history, and ratings to understand their preferences and make recommendations that align with these preferences. They have become fundamental information retrieval and provide a particularly lucrative landscape for e-commerce platforms, providing suggestions that effectively prune large information spaces so that users are directed toward those items that best meet their needs and preferences.

This paper looks at developing a hybrid recommender system model which incorporates data from multi-modalities, textual data and explicit ratings data. The hybrid model consists of a neural collaborative filtering component to process the numerical ratings data and content based filtering component to process the text features. The primary objectives of this study are twofold. Firstly, the aim is to create and assess the efficacy of the hybrid recommender system model in comparison to other benchmark recommender models including the two collaborative and content based filtering models individually. Secondly, the study seeks to investigate the potential impact of incorporating product review text and review text sentiment in improving the accuracy of recommendations. Our model shall be trained and deployed on the Amazon Reviews dataset, which contains millions of user reviews and feedback on thousands of different products across different categories. The data set also provides a large corpus of metadata making it adequate for exploring both dimensions of filtering approaches. Our methodology is based on a literature analysis and aims to clearly extrapolate on our singular models to develop a well defined hybridised recommender system.

The results of our study show that the hybrid model outperforms the individual models in terms of accuracy and precision. The hybrid model also outperforms the individual models in terms of coverage, which is a measure of the proportion of the product catalogue that the model is able to recommend. The results also show that the inclusion of review text and review text sentiment in the hybrid model improves the accuracy of the model. The results of this study are significant as they demonstrate the potential of hybrid recommender systems in improving the accuracy of recommendations.

The algorithm, models and techniques developed and used in this paper are not problem-specifics and can be applied to different recognition and prediction problems.

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Chapter 1

Introduction

1.1 Background Information

1.2 Research Problem

1.3 Research Objectives and Significance

1.4 Dissertation Outline

Chapter 2

Literature Review and Related Work

We present in this section a brief survey of the state-of-the-art collaborative filtering, content-based filtering as well as hybrid approaches in recommender systems and thoroughly discuss their unique characteristics and subtle differences.

2.1 Recommender Systems in E-Commerce

2.2 Content Based Filtering

2.3 Collaborative Filtering

2.3.1 Neighborhood Methods

2.3.2 Latent Factor Models

2.4 Deep Learning in Recommender Systems

2.5 Text Analysis for Recommender Systems

2.6 Hybrid Models

2.7 Evaluation Methods

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Chapter 3

Data Exploration and Analysis

3.1 Background

3.2 Variable Description

3.3 Data Collection and Preparation

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Chapter 4

Methodology

4.1 Modelling Approach

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4.2.1 Model Specification and Components

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4.6 Model Criteria

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Chapter 5

Application

5.1 Example

5.1.1 Example

5.1.2 Example

5.2 Example

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Chapter 6

Results

6.1 Results

Chapter 7

Discussion

7.1 Example

7.2 Example

7.3 Example

Appendix A

A.1 Example

Appendix B

B.1 Example

B.2 Example