

Applications of Machine Learning for Knitting Sweater Pattern Recommendation

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Abstract—This project aims to address a significant challenge often faced by knitters: finding knitting patterns that are similar to sweaters they encounter “in the wild”. This project aims to develop and benchmark machine learning algorithms to provide pattern recommendations based on user-submitted images. It will examine two methods for doing this: classifying images of sweaters based on a predefined set of key attributes (e.g., neckline, texture, construction), followed by a search of the Ravelry API for those attributes, and/or using a nearest neighbor algorithm to identify similar sweater images and their associated pattern.

Keywords—*machine learning, explainable AI, recommendation systems, knitting*

I. INTRODUCTION

Ravelry's database of nearly 200,000 sweater patterns can make it challenging to find the exact pattern a knitter is seeking. Knitters inspired by 'in-the-wild' images (from film, television, on the streets, or even from store catalogs) often struggle to find matching patterns because they must rely on text-based searches that include technical terms or limited knowledge within online communities. While several authors have used machine learning algorithms to classify fashion items like shirts, pants, and shoes, using a CNN for this purpose [1], there is a gap: no one has developed an algorithm for recommending hand-knit sweater patterns through machine learning. The goal of this project is to determine how accurately a machine learning model can identify knitting patterns that closely match in-the-wild sweater images, and if possible, develop a system for recommending knitwear patterns based on an image-based search.

II. PROBLEM

A. Problem Definition

The current process for advanced searching for knitting patterns on Ravelry relies on text-based searches using technical knitting terminology, which limits the scope of recommendations. Otherwise, knitters often rely on members of online communities such as Reddit to help identify similar sweaters. This project aims to simplify this search by developing a system that utilizes machine learning to identify similar patterns in a user-provided image.

B. Significance of Problem

An analysis of posts from the *r/knitting* and *r/knittinghelp* subreddits revealed more than 100 posts from users requesting pattern identification from photos, showing a clear need for this tool. These posts show that knitters frequently look for patterns that match photos of sweaters. This project aims to enable users to search for similar patterns using a photo, finding them among the over 200,000 sweaters on Ravelry.

By allowing users to upload an image to a search, this project also aims to enable knitters who may not be familiar with technical knitting terms to find and purchase patterns on platforms like Ravelry. The system is intended to be a discovery tool that connects customers to creators, not a generative model designed to write patterns and, therefore, replace knitwear patterns and their designers.

III. PRIOR WORK

A significant amount of research exists in the areas of using machine learning models to classify fashion items, from Fashion MNIST – a dataset created to help benchmark machine learning algorithms [2], to fashion and apparel classification benchmarking [1], and a multi-class/hierarchical approach to fashion classification for improved performance [3]. However, no project has been created to classify knitted garments, although some have been developed to classify woven fabrics, such as in [4].

The research thesis in [5] suggests that using images in the wild on a model based on cleaner photos (in this case, high-quality fashion images versus surveillance photos) may be challenging. Still, it offers a few suggestions (training on limited labeled “in-the-wild” data – something that could be done here with the Reddit data) and more robust networks. This work examines two models: AlexNet and ResNet50.

The multi-class/hierarchical approach used in [3] is likely to be very useful in classifying sweaters with multiple levels of features of attributes. This project will also likely examine some of the same models: LeNet5, AlexNet, CNN, ResNet50, and VGG-19.

The Nearest Neighbor Algorithm approach used in [6] involves a two-fold approach: first, a trained neural network processes

the images. Then, a nearest neighbor algorithm (Annoy) and Cosine Similarity are used to find the most relevant products based on the input image's features or embeddings. This approach could be another possible solution to the problem of identifying and recommending knitted sweater patterns.

IV. PROPOSED METHODOLOGY

A. Plan

Figure 1 demonstrates the plan for this project: the project will first gather data from the Ravelry and Reddit APIs, then use several machine learning algorithms to classify existing sweaters based on existing tags in Ravelry's system. It will then use explainable AI models, real-life examples downloaded from the Reddit API, and other methods to benchmark each machine learning algorithm. Once the best-performing algorithm is identified, a web interface will be built so that a user can see the algorithm in action.

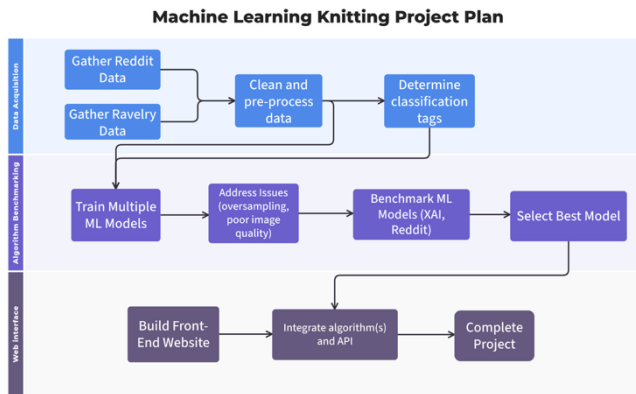


Figure 1: Project Plan in Three Phases

a) *Data Acquisition Phase*: Data will be sourced from the Ravelry API (<https://www.ravelry.com/api>), a popular platform for knitters to share and discover patterns, to build a repository of sweater images and their corresponding metadata, such as construction style, neckline, and texture, using the platform's built-in tags. The Reddit API (<https://www.reddit.com/dev/api/>) will be used to gather real-world examples of user requests for similar patterns to photos they post, and will use subreddits such as r/knitting and r/knittinghelp. This will serve as a real-world test (inference) set to test the model's performance.

The Ravelry data will be cleaned to remove duplicates and non-sweater patterns. The goal is to gather at least 15,000 patterns in each of two main categories: pullovers and cardigans, with a wide variety of other tags. Finally, categories for classification will be determined based on tags downloaded from Ravelry.

b) *Algorithm Testing and Benchmarking*: After the Ravelry data has been downloaded and cleaned, this project will test several machine learning models to identify and classify key features from sweater images and/or use a nearest neighbor

approach to find similar sweaters. This project will explore models previously used in clothing classification to determine which models can effectively classify details of knitted sweaters. These models may include LeNet5, AlexNet, ResNet50, CNN, Annoy, and VGG-19.

Each model's performance will be benchmarked, and XAI models (LIME, SHAP, Grad-CAM) will be used to debug and confirm that models are classifying based on relevant sweater features.

c) *Web Interface*: Finally, this project will use the best-performing model to create a front-end webpage where a user can upload a photo and get a series of recommended patterns pulled from Ravelry. The web interface will integrate the machine learning model and the Ravelry API (using Ravelry's search function).

B. Challenges or Barriers

Ravelry has nearly 200,000 sweater patterns in its database, making it impossible to process them all. This project aims to download as many as possible from the database – approximately 30,000 sweaters to start. Using the "search" function of the API limits the ability to gather a random sample; however, this project will work to ensure a good variety of data points and acquire more sweater samples as needed.

Image quality is also a significant challenge in this project, as images are user-submitted and have a variety of lighting and positioning. Another likely issue will be data imbalance and having a considerable number of images of some sweater features and very few examples of others. Lastly, models may not be able to detect finer sweater features (specific cable patterns, multi-colorwork, etc.)

For image quality issues, this project will use data augmentation techniques such as rotation, flipping, and brightening. To address the issue of data imbalance, this project will first attempt to download more samples in their classes and then investigate oversampling and the application of class weights. Lastly, exploring various models should enable the identification of one that can capture some of the finer details of sweaters.

C. Project Deliverables

This project will deliver an analysis and benchmarking of several machine learning models for classifying knitted sweaters, along with an Explainable AI model that explains "why" the best-performing machine learning model made its classification decisions. This project will also include a web application that allows a user to upload an image of a sweater, which returns several recommended sweater patterns, and a visual display that uses Explainable AI to display the features it used from the uploaded image to recommend the patterns.

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