TrendCart: Viral Food Trend Prediction for Grocery Store Inventory Management

Integrating Viral Food Trend Predictions into Grocery Stores Inventory Management

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Motivation

The retail industry is going through a sudden, yet rapid evolution. The exploding popularity of short-form content, and platforms such as TikTok and Instagram, have changed the way people view products and shopping. This new era of digital ‘word of mouth’ has created a new retail ecosystem known as social commerce, whose opportunity is set to grow to $1.2T by 2025 [1]. In the different parts of this social commerce ecosystem, many have already jumped ahead of the curve and created effective ways to take advantage of this new-normal. However, one significant area of it has yet to be fully revolutionized - grocery stores.

In the rapidly evolving landscape of the retail industry, grocery stores are set to be impacted significantly. It is seen that 83% of Americans engage with food or recipe content on social media, a staggering 89% admit that such content influences their cooking and purchasing decisions [2]. Many grocery stores have noticed this, and taken to social media to try and boost their social commerce presence in an attempt to get more customers and generate increased profit [3]. Yet, this attempt to join into the social commerce space is entirely situationally unaware. Grocers are not retailers who need to attract customers, but rather cornerstones of daily life that are going to be impacted by social commerce without actually needing to participate in it. What grocery stores should be focusing on is not who comes in their store, but what they buy.

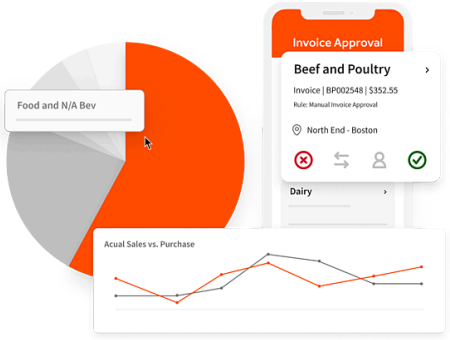
Food and recipe content on social media consists of transitory trends, but these are not just for show. Viral recipes can drive temporary surges in demand for specific ingredients or products that are featured in viral content. Often, the quick burst of demand can cause stores to sell out of those items [4]. Unfortunately, the transient nature of these trends often results in missed opportunities for retailers. When stores sell out of trending items, they are unable to meet consumer demand, leading to potential revenue loss and customer dissatisfaction. To fully take advantage of these trends, grocery stores must be able to react to trends before they explode or as they explode and quickly react. They must also be able to know their position on the trend, as jumping on too late or matching trend demand even as the trend is dying can lead to oversupply and therefore a loss.

Recognizing this, our team aims to develop TrendCart, a grocery store inventory management tool that is able to predict demand based not only on seasonality and historical sales, but also viral food trends as they are growing. The reason we want to build the project as a tool in an inventory management system and not as a standalone system is because trends impact stores differently. Depending on the current sales and inventory patterns, a trend can lead to a different shift in demand than another store.

Traditional inventory systems often rely on historical sales data and seasonality to forecast demand, which cannot handle unpredictable viral trends, creating a cyber-physical gap. Our dashboard, however, is designed to track and respond to these trends before they reach their peak, enabling store owners to adjust their inventory in real-time and avoid stockouts of in-demand items. This not only allows stores to improve inventory waste and turnover, but it also increases profits of store owners. This project provides an innovative blend of traditional retail data with modern social media analysis which can be used as a base for similar concepts.

Related Works

The most obvious related solution to this problem space is traditional Inventory management systems. Two of the main pre-existing solutions are MarkT POS and Toast inventory management. While these do contain some data analytics, they only use internal data. They will predict when you will run out of certain ingredients or dishes based on past and current rate. However, they don't incorporate external data to predict demand for specific ingredients, which is the main advantage of our solution.



There are also other similar solutions that target other areas. For example Kalatzis, et. al surveyed frequent google trend keywords and their correlation to social media to show the correlation between the 2 [5]. They used google trends and social media engagements to extract data and make predictions. Schoen et. al. did similar work in other areas as well. These authors tested the correlation between google trends and real life results [6]. They correlated google trends and twitter engagements with real life ticket sales for a newly released movie.

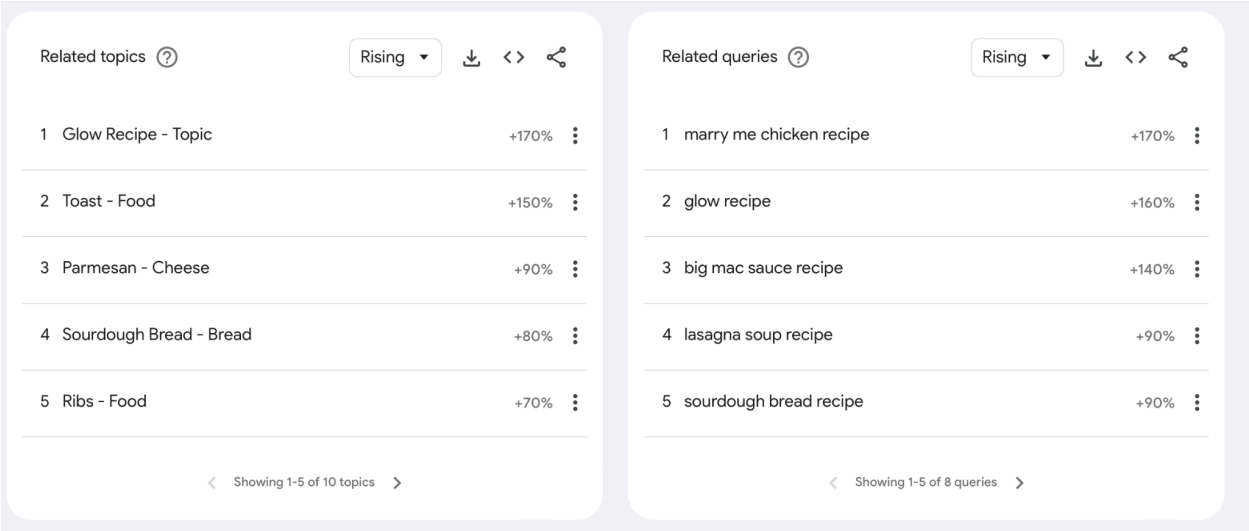
While these concepts are similar in theory to our solution, the main differentiating factor is the application area difference. However, all of these, including ours, aims to bridge the cyber-physical gap between trends on the internet (cyber) and real life (ingredient sales).

Proposed Implementation Details

The foundation of TrendCart relies on an SQL database, which we plan to host on a cloud platform such as AWS or GCP. This database will be structured to track products, sales, and inventory levels. For instance, the database might include a table structure as follows:

This structure allows for tracking of each product's sales performance and inventory status, allowing users to manage products and allowing the system to forecast demand.

To allow for our trend analysis and forecasting abilities, we plan to create an API on AWS/GCP that interfaces directly with Google Trends for real-time evaluation into keywords that trend relative to viral food recipes. An example can be seen in the following [7]:



To ensure the accuracy of these trends, we will attempt to cross-verify with authoritative sources. This includes food magazines, recipe websites/databases, and news sources that track trends. Once a trend is validated, the next step is to check the Spoonacular database for the associated recipe to get its ingredients. In cases where the Spoonacular database doesn't have the recipe, we will find an article online that features the recipe and use the Spoonacular API to scrape the ingredients listed [8].

The core of TrendCart is the inventory predictive model, which will follow an iterative process to reach its full capabilities. The first portion involves exploring the Instacart Market Basket Analysis and Groceries Data datasets from Kaggle to construct a base model [9,10].

This preliminary model will focus on forecasting fundamental inventory needs by analyzing historical sales data. We will then iteratively enhance the model by training on time series data incorporating the detailed ingredients and statistical information derived from our trend analysis. This will allow the model to make inventory predictions in anticipation of viral food trends, optimizing inventory management. The model will be hosted on AWS or GCP to ensure scalability and reliability, and it will be accessible through a dedicated API. By creating independent APIs, we enforce independence across project parts.

Finally, the user facing side will be a frontend created using React. This interface will allow users to easily input products, manage inventory orders, and track sales and inventory levels over time. The key features will be a dashboard for real-time sales and inventory data, predictive forecasts for inventory needs, and alerts for when inventory levels are low or when a viral trend may affect demand for certain products. The frontend will also be hosted on AWS or GCP and will interact with the inventory predictive model and database APIs to create a seamless experience.

Foreseen Issues

There are several limitations of this project that are based on assumptions of conditions. First, we assume that Google Trends captures true virality. Google Trends gauges interest in specific topics over time based on search query volumes. However, some trends may not reflect in search data due to their circulation through other mediums. Additionally, Google Trends data is aggregated and may not capture localized spikes in interest that could significantly impact a single grocery store or geographic area.

Secondly, we assume that Google Trends virality translates to real world sales. While a spike in Google Trends might indicate increased public interest, it does not guarantee a corresponding increase in product sales. Factors such as seasonality, local preferences, economic conditions, and the difference between interest and purchasing intent can influence the translation of virality into physical sales. This assumption is a form of cyber-physical gap and introduces a risk of overestimating the impact of viral trends on demand, leading to potential overstocking and waste.

Third, we assume good conditions of the world and no black swan events. This assumption fails to account for unforeseen sudden conditions that impacted the likes of Southwest and others. The model will be built on the assumption of static conditions, and may lack the flexibility to adapt to these changes, potentially leading to inaccurate forecasts and recommendations. This in essence means that our project is limited to ‘virtual-time’ to some extent.

Finally, we predict that the models will struggle with knowledge obsolescence. Machine learning models are only as good as the data they are trained on. Long-term changes in consumer preferences can lead to shifts over time. This leads to the risk that the forecasting capabilities will become outdated, leading to suboptimal inventory decisions.

Proposed Schedule

Checkpoints	Feb 12	Feb 19	Feb 26	March 4	March 11	March 18	March 25	April 1	April 8	April 15
Obtain Datasets										
Set up APIs in backend										
Create inventory frontend										
Program the models based on training data										
Integrate suggestions into frontend										
Deploy frontend and backend to AWS/GCP										
Deploy SQL DB to AWS/GCP										

Proposed Responsibilities

Delegation	Sapan Patel	Akaash Dash
Obtain Datasets		Leading
Set up APIs in backend	Leading	
Create inventory frontend		Leading
Program the models based on training data		Leading
Integrate suggestions into frontend	Leading	
Deploy frontend and backend to AWS/GCP	Combined	Combined
Deploy SQL DB to AWS/GCP	Combined	Combined

Project Deliverables

- Research Jupyter notebooks
    - Data exploration and inventory prediction model creation
    - Google trend tracker and recipe ingredient scraper
- Working, intractable webpage
- Source code
    - Database API
    - Trend analysis process and API
    - Inventory predictive model and API
    - Frontend
- Project progress reports and learning reports
- Final project report and video demo

Skills/Learning Outcomes

The implementation of the Grocery Sales Forecasting and Inventory Management Dashboard encompasses a comprehensive skill development plan for us. In the realm of data acquisition and preprocessing, members will refine their abilities in cleaning and integrating diverse datasets, master the art of API integration using tools like `pytrends` and Spoonacular, and gain proficiency in web scraping techniques employing libraries such as BeautifulSoup and Scrapy.

Moving into data analysis and machine learning, we will delve into machine learning model development, experimenting with both traditional approaches like ARIMA and advanced techniques like LSTM and GRU. Feature engineering skills will be honed for extracting meaningful insights, and we will grasp the intricacies of hyperparameter tuning to optimize model performance.

In frontend development, the focus will be on React for creating dynamic user interfaces, coupled with data visualization skills using D3.js or Chart.js to effectively communicate trends and forecasts. On the backend, Python will be the language of choice for developing logic, with either Flask or Django as the framework, providing us with a well-rounded understanding of backend development.

Cloud deployment and services will involve skills in deploying applications on AWS or GCP, managing cloud-based databases (AWS RDS or Google Cloud SQL), and configuring auto-scaling and load balancing for optimal performance. Throughout the development process, we will utilize Git for version control and either Trello or Jira for project management, fostering collaboration, effective communication, and problem-solving skills.

Next, while these skills are all technical, there are some skills that we will obtain that are not explicitly technical. First, we will get valuable experience in relationships between the cyber world and the physical world, namely, the cyber-physical gap. The entire concept of the project pertains to this gap, as we are aiming to bridge the gap between the cyber trends and physical sales. This skill can be extrapolated to other areas of our career. It is applicable, if we can recognize the trends regarding this gap. Trend recognition is an important skill, and implementing this project will allow us to gain exposure to what trends look like and how they can be applied.

Finally, the last skill that we will get experience in from implementing this project is situational awareness. This project relies on being able to identify where in the trend cycle you are in. If you are aware of a trend, then you can take advantage of it on either the rise or the wane. This skill is extremely important to our careers, and implementing this project will allow us to get practice with it.

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