DS 5500 - Fall 2021

Capstone: Applications in Data Science

Walmart Sales Forecasting

Final Presentation

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Agenda

- Summary
- Data Overview
- Methodology
- Project Timeline
- Best Model Benchmarks
- Deployment Demo
- Key Takeaways

Summary

Context :

- Ecommerce has been an ever-growing industry with projected revenue growth of **$4.9 trillion** in 2021.
- Sales forecasting will help businesses understand changing customer demands, manage inventories and create a pricing strategy that reflects demand.

Problem Goals :

- This project will present the right methodologies to analyze time-series sales data and predict **28 days** ahead point forecasts for Walmart to help take strategic decisions.
- We plan to leverage the traditional time series forecasting methods(**Phase 1**) as well as the modern forecasting methods(**Phase 2**), to analyze Walmart's sales data.

Data Overview

The dataset contains **5 year historical sales** from 2011- 2016 for various products and stores.

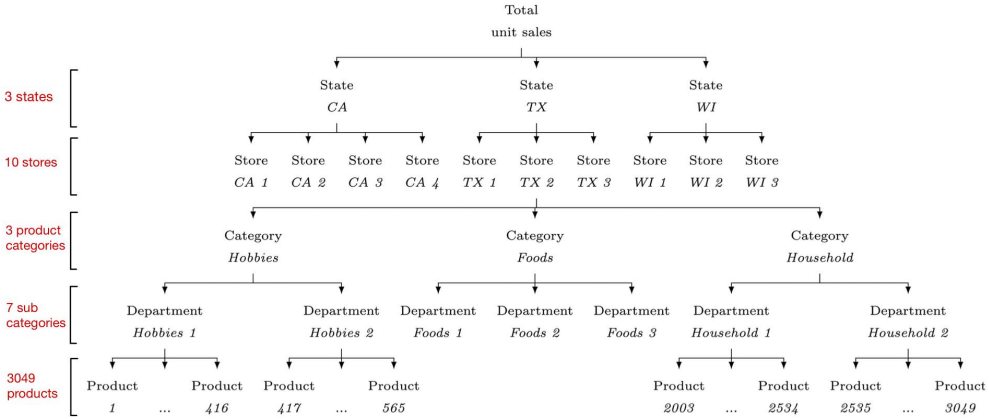
Data is hierarchically organized: stores are divided into 3 states, and products are grouped by categories and sub-categories

The dataset is organized in 3 CSV files :

calendar.csv - Contains dates on which the products are sold and events held on that day.

Sales_train_evaluation.csv: Contains historical daily unit sales of each product on each store

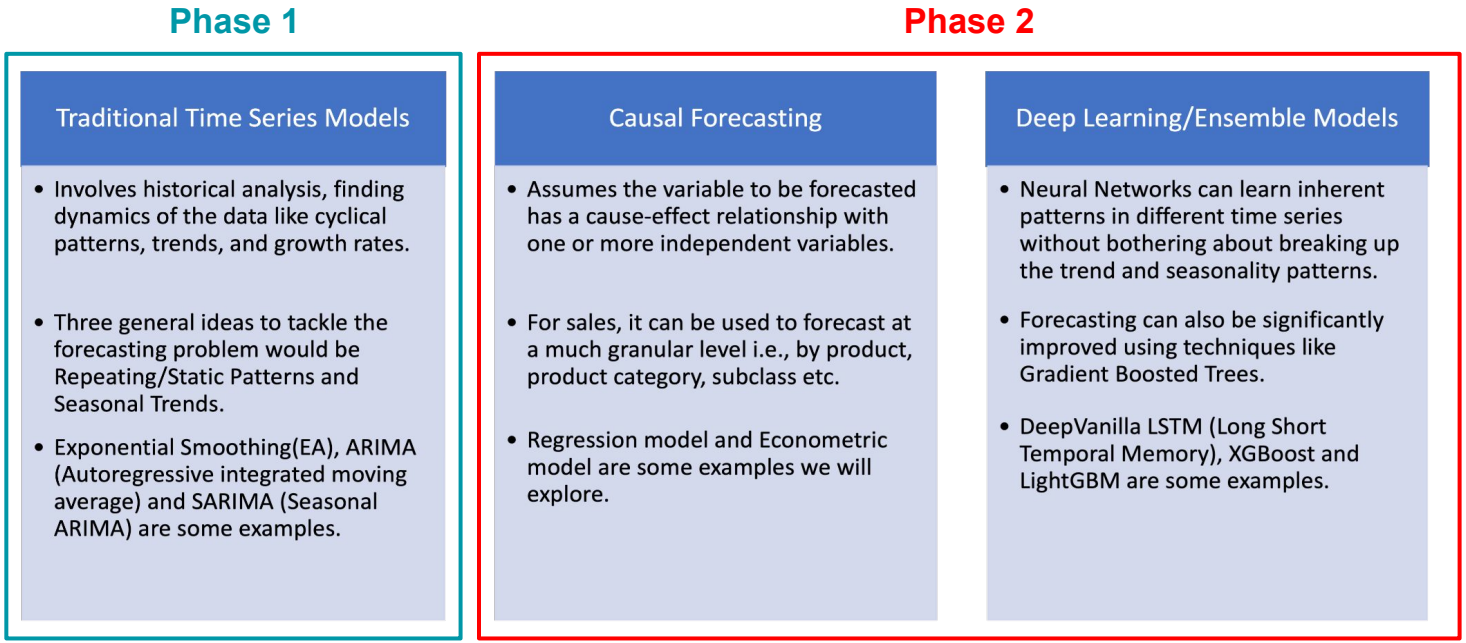
Sell_prices.csv: price of products each week



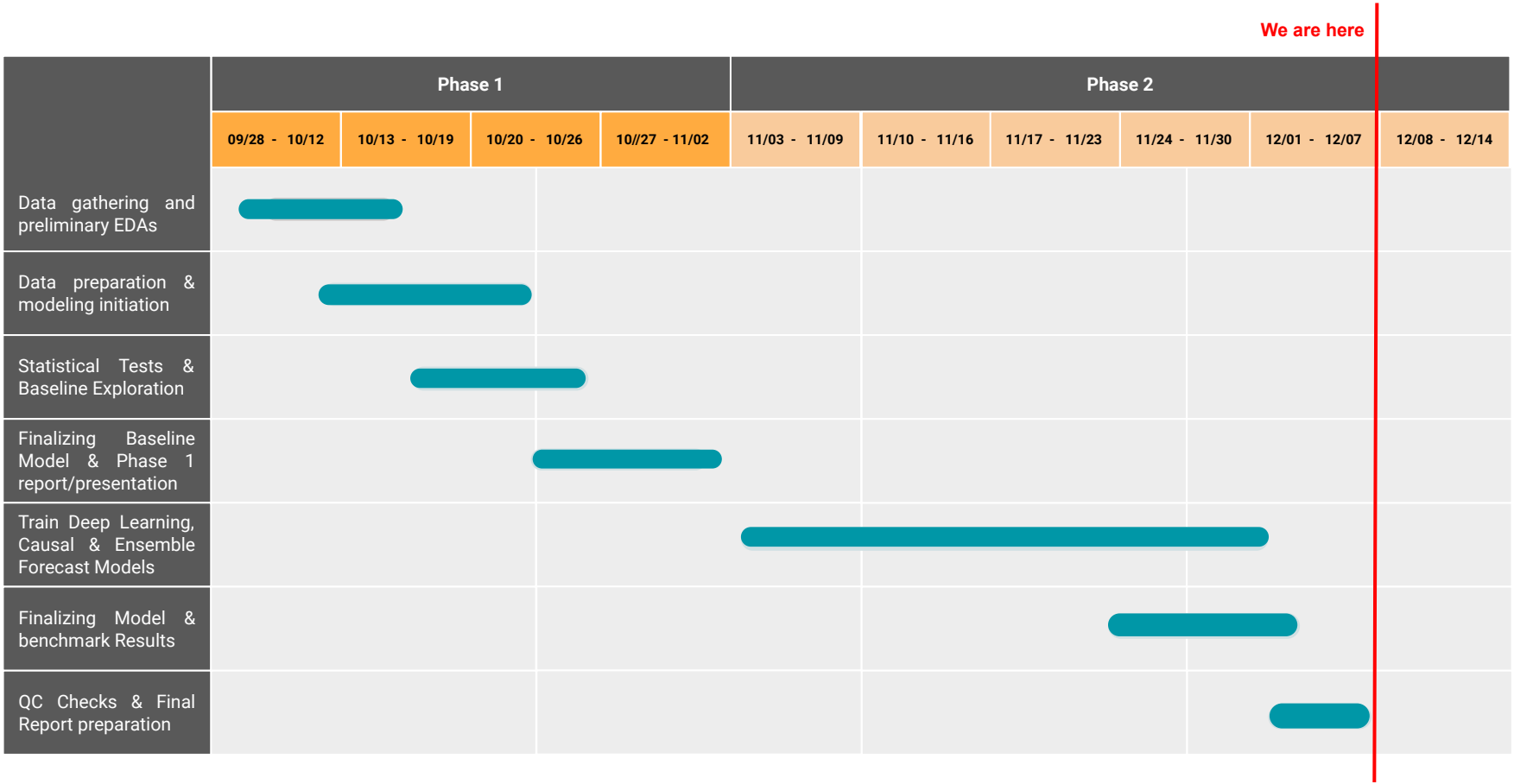
M5 Competition: https://mofc.unic.ac.cy/m5-competition/

Methodology

We wanted to improve over the results from standard statistical time-series forecasting strategies from Phase 1, using advanced forecasting strategies which is our **primary goal for Phase 2**.



Timely completion of project resulted in best results



Phase 2 Analysis

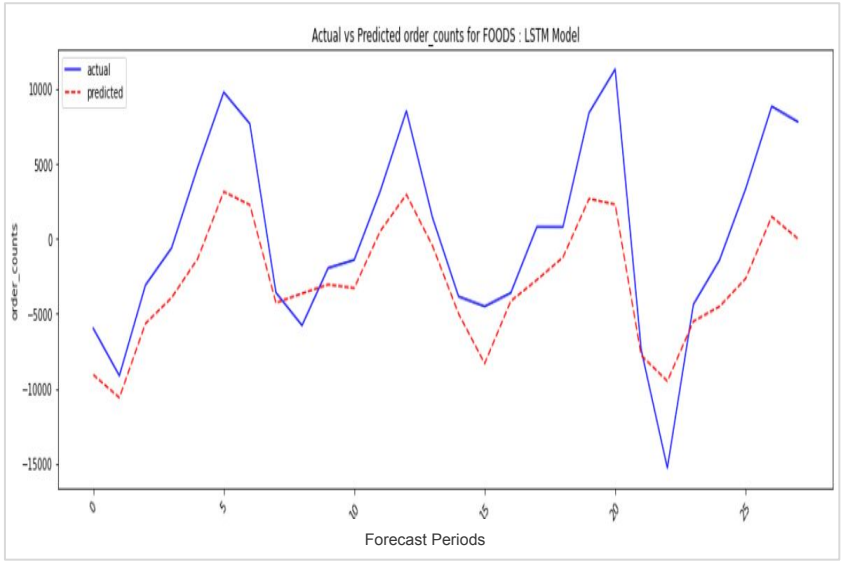
Shortcomings of Phase 1

- Statistical models showed **poor fit when trained on the daily data**
  - Unable to capture the trend/seasonality
  - Data was **aggregated weekly** to smoothen some of underlying volatility
- SARIMAX had **high confidence range**, despite reduction in RMSE wrt baseline

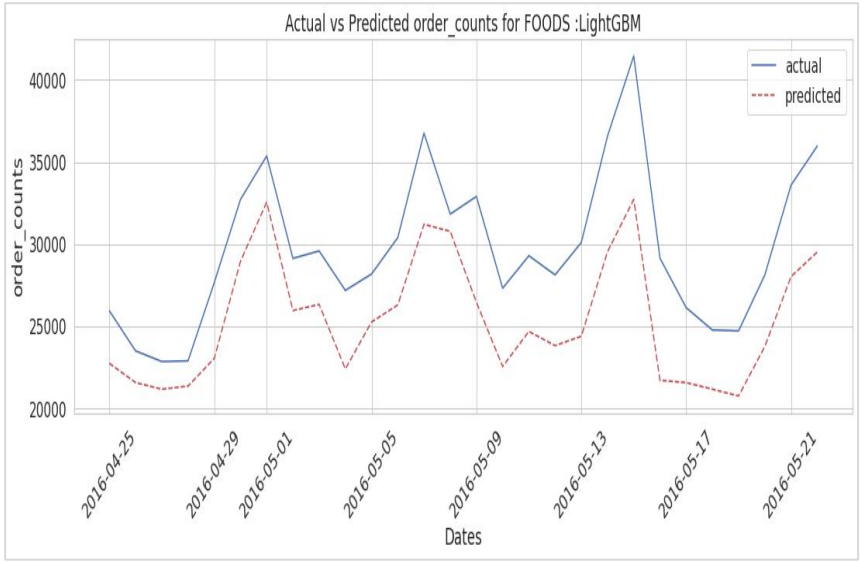
Target for Phase 2

- Train models like RandomForest, **LightGBM** and **LSTM** on daily data
- Causal forecasting to model cause and effect relationship within time series
- Build a **frontend UI** for the complete project and deploy it

LSTM showed ~8.9% improvement wrt SARIMAX [baseline] on FOODS



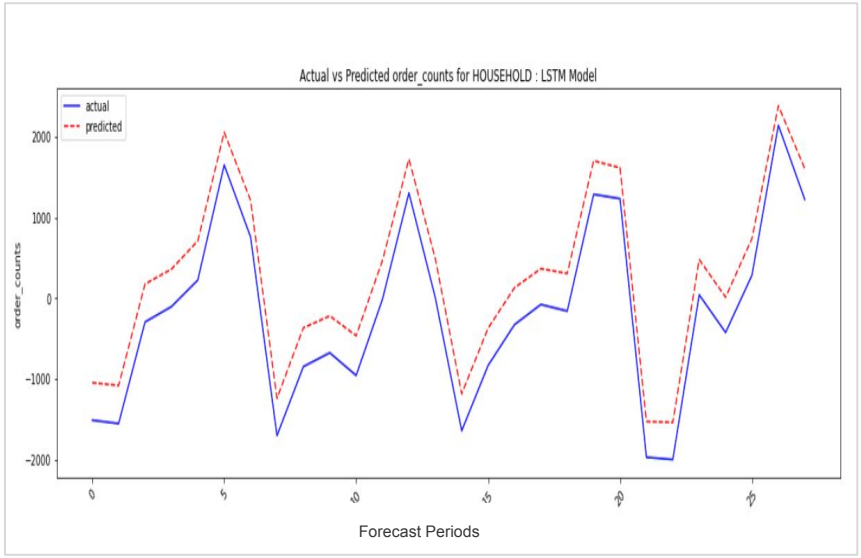
(i) LSTM



(ii) LightGBM

- Unlike Statistical models, advanced models were able to **fit on daily data** and forecast is for **28 days**
- **Exogenous variables** like snap, event v/s no events, paydays and holidays were also considered
- LSTM performed better than LightGBM with **~7.1% improvement** on RMSE Score

LSTM showed ~66.1% improvement wrt SARIMAX [baseline] on HOUSEHOLDS



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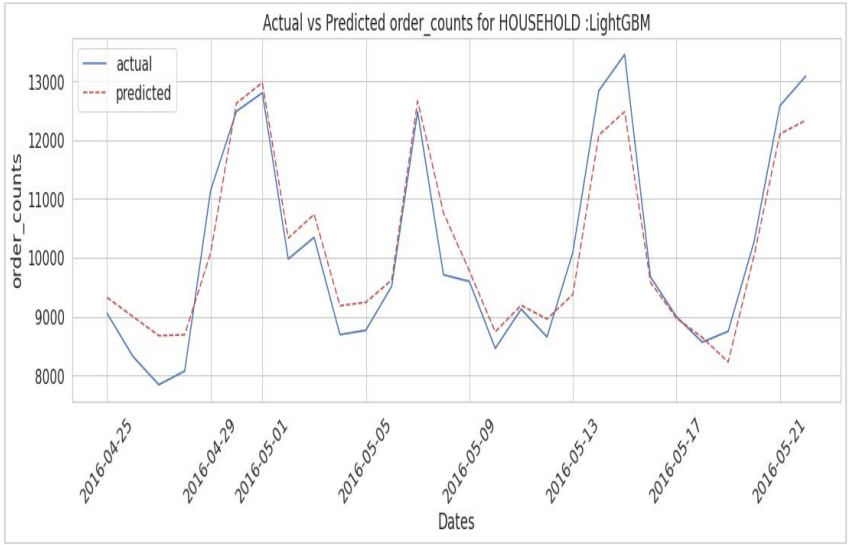

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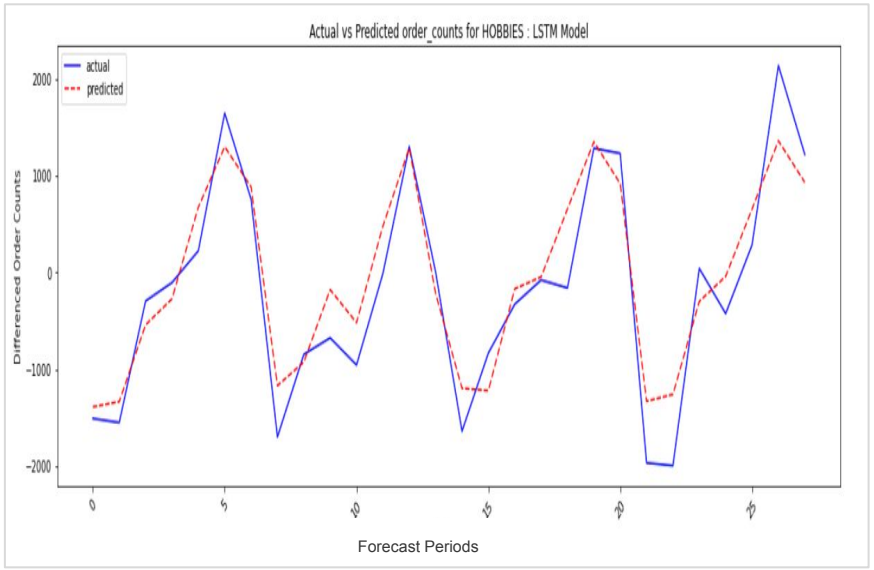
- Unlike Statistical models, advanced models were able to **fit on daily data** and forecast is for **28 days**
- **Exogenous variables** like snap, event v/s no events, paydays and holidays were also considered
- LSTM performed better than LightGBM with **~16.9% improvement** on RMSE Score

No improvement on RMSE score for HOBBIES wrt SARIMAX [baseline]



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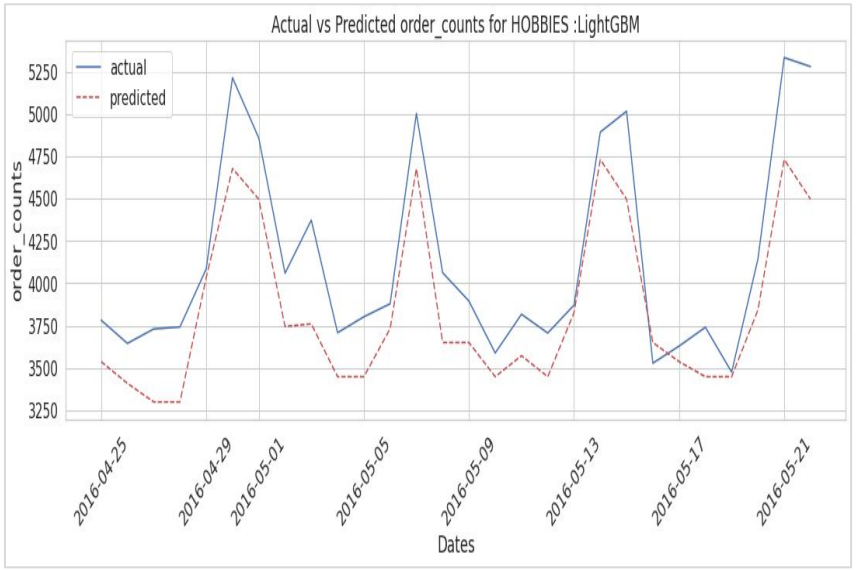

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Model Benchmarks - RMSE Score Evaluation

MODELS / CATEGORIES	FOODS	HOUSEHOLD	HOBBIES
ARIMA	9,802.53	2,532.63	712.39
ARIMA with Gridsearch	6,217.83	2,130.08	466.83
SARIMAX with Gridsearch	4,802.55	1,314.61	215.28
Random Forest	6,514.09	2,704.61	988.62
LightGBM	4,705.59	536.88	356.64
Deep Vanilla LSTM	4,373.36	446.29	646.36

Phase 1

Phase 2

Learning and Outcomes

Deprioritized Cloud Architecture

- Was incurring extra cost to us
- Streamlit, an open Source app was used for deployment (will be demoed)

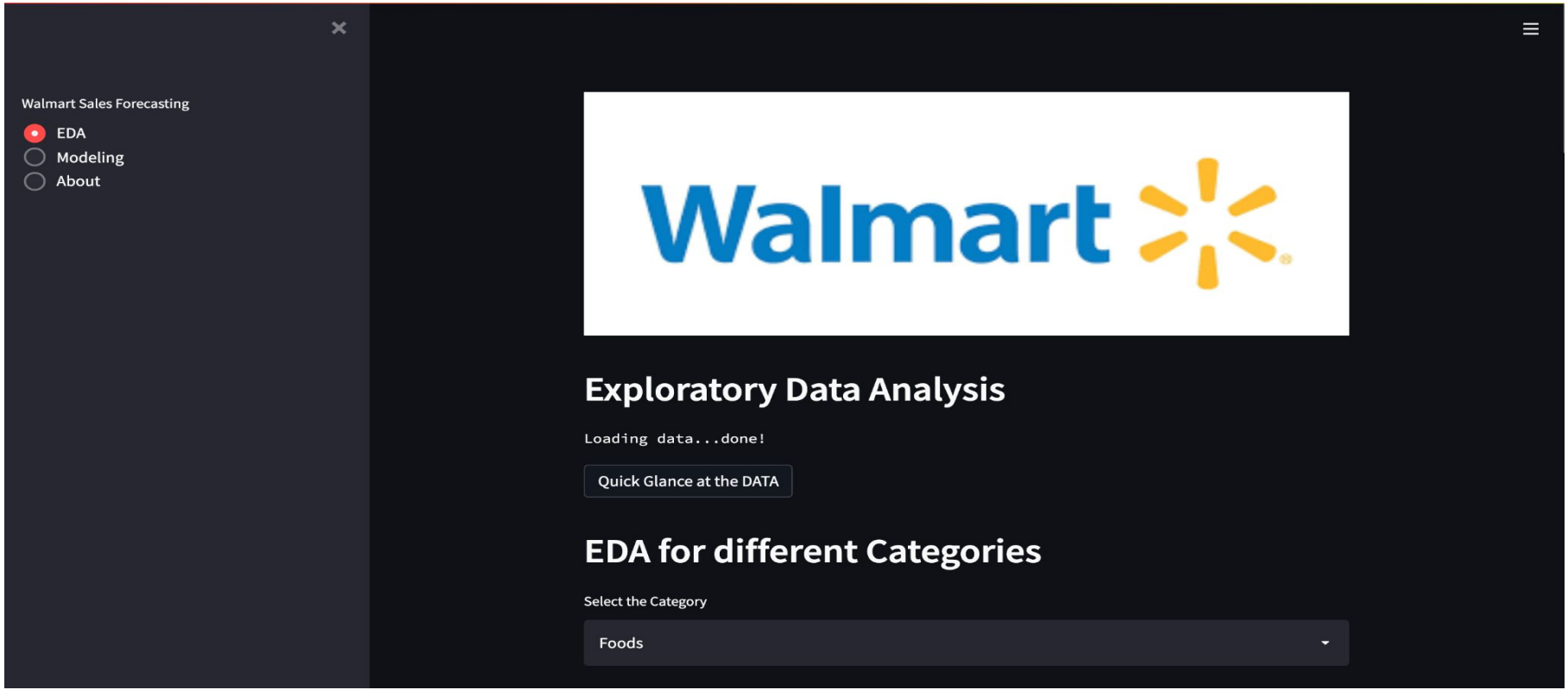
LSTM Outperformed on all categories

- Models were able to fit on daily sampled data
- For HOBBIES the RMSE was higher but showed better trend capture

Causal Forecasting wasn't possible

- Data was masked and Econometric fields like CPI was missing for Granger Causality tests
- State-wise CPI data was not easily feasible as it's purposely created with a focus on buying habits of urban customers

Application UI - A Quick Glance



Thank you!