DATA GENIUS: Machine Learning Engineer Test

Test Case Study for ML Engineer: Dr. Thêm Official Store on Shopee
+ Data Description: Sales data over a three-week period (10/03/2024 – 31/03/2024)

+ Issues: Small dataset size, missing information, limited data fields.

+ Requirements: Develop a model that predicts the number of products sold in the upcoming periods.

SOLUTION

1. **Preprocessing to get clean data**
   - Identify and handle missing values: Calculate % missing value in dataframe to fill missing values or remove rows or columns with missing data.
   - Feature selection: Remove feature that are not useful for modeling process => Reduce dimensionality and improve model performance.
   - Feature engineering: Create new features from existing ones that may provide additional information for the model.
     Example: revenue = history_sold*price*(1-discount)
   - Convert relevant feature to datetime format for easier analysis.

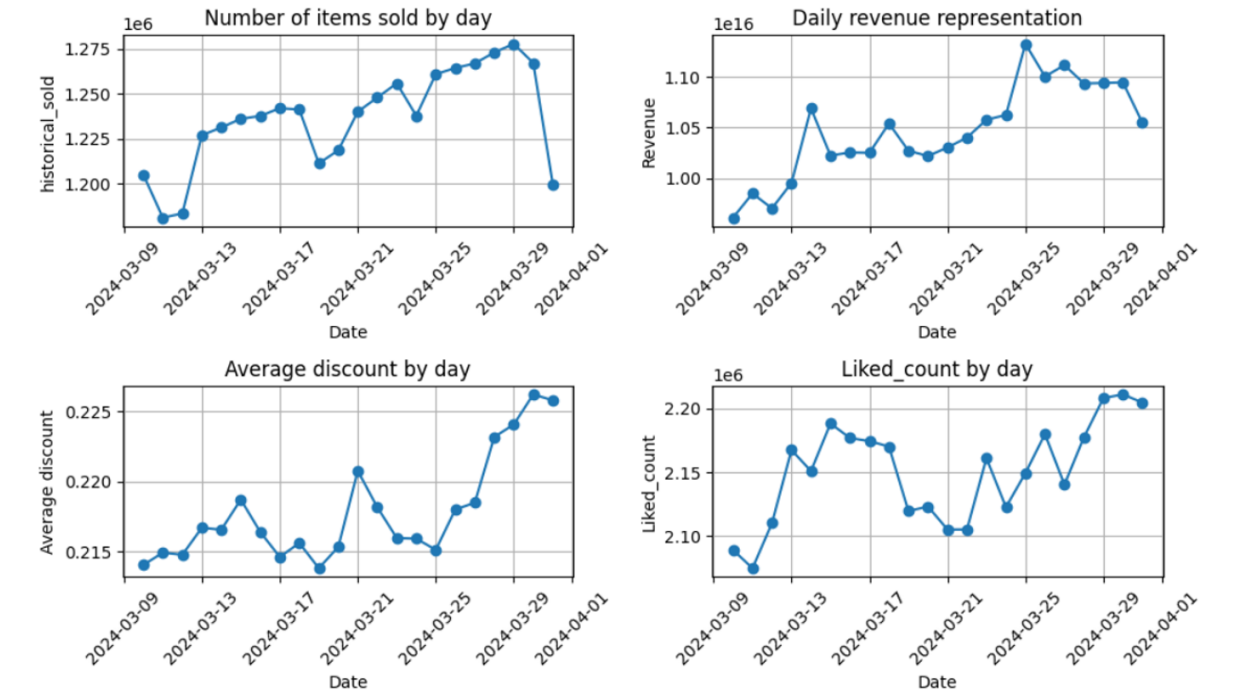
2. Exploratory Data Analysis (EDA) to visualize the data

- Visualize distribution of data with descriptive statistics:

	itemid	liked_count	cmt_count	shop_rating	historical_sold	price	rating_count	rcount_with_context	Date
count	3.867000e+03	3867.000000	3867.000000	3867.000000	3867.000000	3.867000e+03	3867.000000	3867.000000	3867
mean	1.466942e+10	12234.599948	2032.896302	4.931021	7035.889061	2.451592e+10	2032.798293	1210.578485	2024-03-20 16:10:47.944142592
min	1.985670e+09	0.000000	0.000000	4.930905	0.000000	9.000000e+08	0.000000	0.000000	2024-03-10 00:00:00
25%	5.481377e+09	130.000000	55.000000	4.930969	225.000000	1.125000e+10	55.000000	25.000000	2024-03-15 00:00:00
50%	1.823627e+10	16565.000000	198.000000	4.931027	673.000000	2.050000e+10	198.000000	107.000000	2024-03-21 00:00:00
75%	2.215632e+10	18615.500000	909.500000	4.931054	3643.500000	3.490000e+10	909.500000	494.000000	2024-03-26 00:00:00
max	2.591996e+10	71117.000000	106400.000000	4.931238	322223.000000	1.199000e+11	106413.000000	64046.000000	2024-03-31 00:00:00
std	8.170483e+09	10035.877379	8781.247212	0.000066	27425.013404	1.760156e+10	8782.279788	5334.233921	NaN

⇨ Understanding distribution and identify potential outliers or anomalies.

- Visualize Daily sale metrics:



=> Promotional discounts on Shopee often occur during the last days of the month, particularly from the 25th to the 27th. As a result, there is typically a noticeable increase in the number of items sold, revenue, discount rates, and liked counts on these days. Conversely, the beginning of the month tends to experience lower activity.

- Visulize top 5 most sold items and top 5 least sold items:

Top 5 Most Sold Items

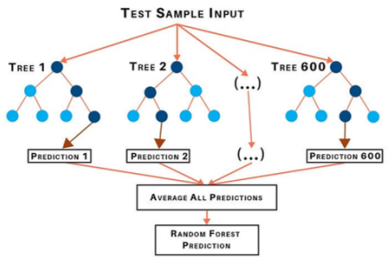
	items	quantity	price
0	2421653980	7043524	9.500000e+09
1	5451541710	2724989	1.270000e+10
2	10001549800	1576811	1.090000e+10
3	23232932577	1318263	6.790000e+09
4	16870222597	1140525	4.200000e+09

Top 5 Least Sold Items

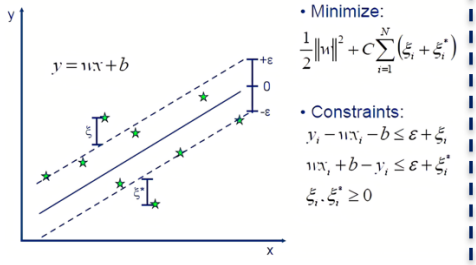
	items	quantity	price
0	25919955014	0	6.500000e+10
1	15689885742	0	7.700000e+10
2	24070912680	0	1.990000e+10
3	25617038549	0	5.000000e+10
4	24320863474	0	1.990000e+10

= > By implementing targeted advertising campaigns and strategies tailored to both the top-selling and least-selling items, we can optimize sales volume and maximize overall revenue for the business.

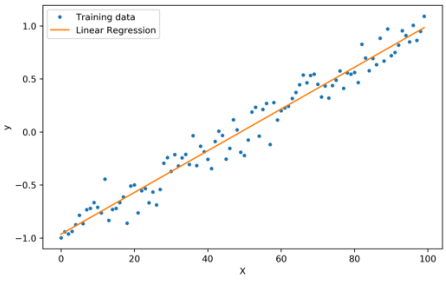
3. Proposing and training three models, follow model evaluation and addressing overfitting issues



Random Forest Regression



Support Vector Regression



Linear Regression

3.1 Random Forest Regression

Training Result	Feature important

```
Train RMSE: 28.882367353420427
Test RMSE: 58.13478817586936
Mean Squared Error: 3379.6535962532
```

```
                    Feature  Importance
             historical_sold    0.463920
rcount_with_context           0.330147
      itemid_2421653980       0.193397
      itemid_5451541710       0.012390
     itemid_16870222597       0.000030
                        ...         ...
     itemid_24320863474       0.000000
     itemid_24070912680       0.000000
     itemid_21094702524       0.000000
     itemid_22159356254       0.000000
     itemid_25919955014       0.000000
```

3.2 Support Vector Regression

Training Result
Mean Squared Error: 885733717.3245064 Train RMSE: 27729.12107954742 Test RMSE: 29761.27882542191

3.3 Linear Regression

4. Training Result	Feature important
Train RMSE: 9.717994879822407e-11 Test RMSE: 1.0465745881020919e-10	historical_sold 0.463920 rcount_with_context 0.330147 itemid_2421653980 0.193397 itemid_5451541710 0.012390 itemid_16870222597 0.000030 ... ... itemid_24320863474 0.000000 itemid_24070912680 0.000000 itemid_21094702524 0.000000 itemid_22159356254 0.000000 itemid_25919955014 0.000000

=> Linear Regression is better than Random forest regression and SVR.

Using Cross-Validation technique to check overfitting:

```
Cross-Validation RMSE Scores: [6.91524811e+02 2.12237437e-10 3.35303403e-11 5.51623611e-11
 4.48795140e+02]
Mean RMSE: 228.06399033514867
```

=> Based on the results of RMSE cross-validation, it can be seen that some folds have a very small RMSE (close to 0) while others have RMSE many times larger. This may be a sign of overfitting.

3.4 Solution to prevent overfitting

Regularization techniques:

Ridge and Lasso regression help prevent overfitting in machine learning models by adding penalty terms to the model's cost function. Ridge regression adds a penalty term proportional to the square of the weights (L2 regularization), while Lasso regression adds a penalty term proportional to the absolute value of the weights (L1 regularization). These penalties help to constrain the magnitude of the weights, reducing the model's complexity and improving its generalization performance on unseen data.

Ridge Regression (L2 regularization)	Lasso Regression (L1 regularization)
RMSE = 0.033	RMSE = 0.030

Summary:

- Small data should use machine learning models for forecasting is reasonable.
- Perform preprocessing to clean data and EDA to visualize data effectively.
- Among three recommended methods (Random forest Regression, SVR and Linear Regression), Linear Regression has the best forecast results.
- Implement overfitting prevention techniques with regularization technique (Ridge and Lasso Regression).
- Besides, some technique such as feature selection, feature important or add data from review data (26/03/2019-16/04/2024) also can improve model learning performance.