Beyond the Basics: Unleashing the Power of Neural Networks in E-Commerce Analytics

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Introduction

- Amazon as an E-Commerce business
- Hundreds of millions of product offerings
- Utilized a single market list
  - Over two million product offerings
  - Over 300 categories
- 'isBestSeller" category on Amazon
  - Signifies top-selling products
  - Algorithm undisclosed
  - Represents significant sales success

Objective and Goals

- Build a "IsBestSeller" classification model
- Utilize Neural Networks as a model base

```
+----------+----------------+----------------+----------------+-----+-------+--------+---------+--------------------+------------+-----------------+
|      asin|           title|          imgUrl|      productURL|stars|reviews|   price|listPrice|        categoryName|isBestSeller|boughtInLastMonth|
+----------+----------------+----------------+----------------+-----+-------+--------+---------+--------------------+------------+-----------------+
|B07YKQ6KPQ|ECOHOUSEMART | Wo...|https://m.media-a...|https://www.amazo...|  0.0|      0| 40900.0|      0.0|Outdoor Storage   ...|       false|                0|
|B07PBR1P2T|ECOHOUSEMART | Wo...|https://m.media-a...|https://www.amazo...|  0.0|      0| 34552.5|      0.0|Outdoor Storage   ...|       false|                0|
|B086LKXDK2|Panasonic Solutio...|https://m.media-a...|https://www.amazo...|  0.0|      0| 32079.9|      0.0|Television Projec...|       false|                0|
|B0CJT6LS7Z|ZHAOLEI Zero SL-T...|https://m.media-a...|https://www.amazo...|  0.0|      0|29508.95|      0.0|Salon  Spa Equipment|       false|                0|
|B0CKBZRJJL|Projector Project...|https://m.media-a...|https://www.amazo...|  0.0|      0|28012.45|      0.0|Television Projec...|       false|                0|
|B0CKF2M1HW|VENBER Electric M...|https://m.media-a...|https://www.amazo...|  0.0|      0| 27890.8|      0.0|Salon  Spa Equipment|       false|                0|
|B0CKF3C5RB|VENBER Electric M...|https://m.media-a...|https://www.amazo...|  0.0|      0|27504.41|      0.0|Salon  Spa Equipment|       false|                0|
|B0CKF1B4KD|VENBER Electric M...|https://m.media-a...|https://www.amazo...|  0.0|      0|27409.95|      0.0|Salon  Spa Equipment|       false|                0|
|B0CKF1P2RS|VENBER Electric M...|https://m.media-a...|https://www.amazo...|  0.0|      0|26975.67|      0.0|Salon  Spa Equipment|       false|                0|
|B086LKXDJC|PANASONIC Solutio...|https://m.media-a...|https://www.amazo...|  0.0|      0| 26376.3|      0.0|Television Projec...|       false|                0|
|B0C612WC17|DSHGDJF 200/2400m...|https://m.media-a...|https://www.amazo...|  0.0|      0| 26366.2|      0.0|Science Education...|       false|                0|
|B0C98MHYFB|XIEXIUIXA Practic...|https://m.media-a...|https://www.amazo...|  0.0|      0|25926.55|      0.0|Outdoor Storage   ...|       false|                0|
|B0CKDZLJV8|VENBER Electric M...|https://m.media-a...|https://www.amazo...|  0.0|      0|25488.12|      0.0|Salon  Spa Equipment|       false|                0|
|B0CBR7L5SD|Automatic Star Se...|https://m.media-a...|https://www.amazo...|  0.0|      0|25024.64|      0.0|Science Education...|       false|                0|
|B0C6XBNSW1|New in Box 6SL321...|https://m.media-a...|https://www.amazo...|  0.0|      0| 24894.0|      0.0|Computer Uninterr...|       false|                0|
|B0CKF2WL49|VENBER Electric M...|https://m.media-a...|https://www.amazo...|  0.0|      0| 24572.7|      0.0|Salon  Spa Equipment|       false|                0|
|B0CKF2G19L|VENBER Electric M...|https://m.media-a...|https://www.amazo...|  0.0|      0| 24520.8|      0.0|Salon  Spa Equipment|       false|                0|
|B0CKF2FT24|VENBER Electric M...|https://m.media-a...|https://www.amazo...|  0.0|      0|24328.45|      0.0|Salon  Spa Equipment|       false|                0|
|B0CH8DPGVW|Summer Large Infl...|https://m.media-a...|https://www.amazo...|  0.0|      0|23345.98|      0.0|Children's Outdoo...|       false|                0|
|B0CKDZKV1G|VENBER Electric M...|https://m.media-a...|https://www.amazo...|  0.0|      0|23335.23|      0.0|Salon  Spa Equipment|       false|                0|
+----------+----------------+----------------+----------------+-----+-------+--------+---------+--------------------+------------+-----------------+
only showing top 20 rows
```

Objective and Goals

Optimization based on dataset schema:

```
root
 |-- asin: string (nullable = true)
 |-- title: string (nullable = true)
 |-- imgUrl: string (nullable = true)
 |-- productURL: string (nullable = true)
 |-- stars: double (nullable = true)
 |-- reviews: integer (nullable = true)
 |-- price: double (nullable = true)
 |-- listPrice: double (nullable = true)
 |-- categoryName: string (nullable = true)
 |-- isBestSeller: boolean (nullable = true)
 |-- boughtInLastMonth: integer (nullable = true)
```

Optimization Strategies

- Pyspark to Parquet dataset to manage 2+ million lines
- Removed url based feature columns
  - Asin, Image URL & Product URL
- Converted title to character length for processing
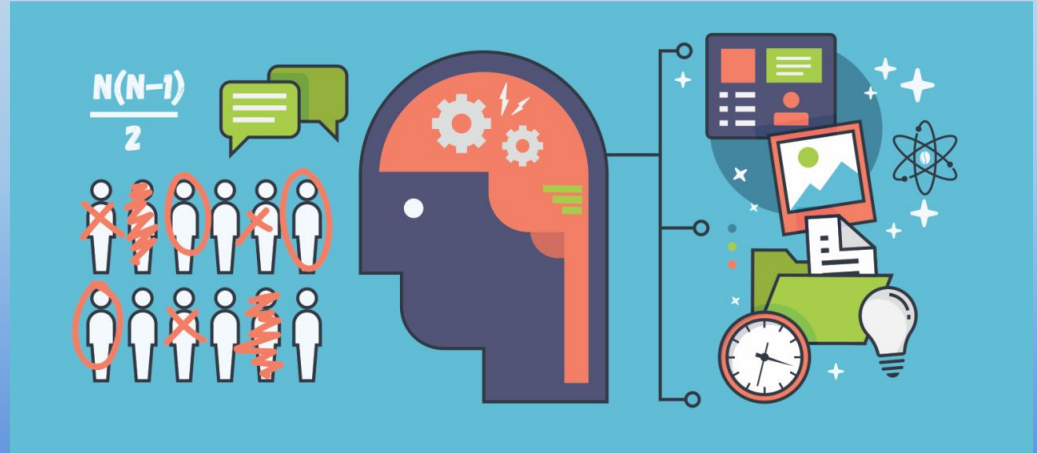
Optimization Strategies

Asin, Product URL & Image URL removal:

```
+--------------------+-----+-------+-----+--------------------+------------+----------------+
|               title|stars|reviews|price|        categoryName|isBestSeller|boughtInLastMonth|
+--------------------+-----+-------+-----+--------------------+------------+----------------+
|Green Leaf WW3D W...| 4.4|   2876|47.69|Industrial  Scien...|       false|               0|
|8pcs Toilet Seat ...| 3.8|     55|10.99|Industrial  Scien...|       false|             100|
|YaeCCC 19 Pcs Hol...| 4.0|    126|25.99|Industrial  Scien...|       false|              50|
|LLPT Butyl Putty ...| 4.5|   1936|21.99|Industrial  Scien...|       false|             100|
|Lightbeam 16" Lon...| 4.2|     46|18.99|Industrial  Scien...|       false|             100|
|etguuds White USB...| 4.5|   2505|15.99|Industrial  Scien...|       false|               0|
|REAQER CPAP Hose ...| 4.3|    216|27.99|Industrial  Scien...|       false|              50|
|SAVITA 2pcs Magne...| 4.0|     53| 9.99|Industrial  Scien...|       false|              50|
|Simba Lighting LE...| 4.5|    164|15.95|Industrial  Scien...|       false|               0|
|Knife Sharpening ...| 4.4|    366|29.99|Industrial  Scien...|       false|              50|
|Nelson Wood Shims...| 4.6|    874|12.99|Industrial  Scien...|       false|              50|
|NYXCL 60Pcs 2 Inc...| 4.6|   1219|32.99|Industrial  Scien...|       false|             100|
|Alpine FlyFit - E...| 4.4|   4926|23.99|Industrial  Scien...|       false|              50|
|MIXPOWER Extra Lo...| 4.4|     82|19.97|Industrial  Scien...|       false|               0|
|Party Essentials ...| 4.2|   1242| 9.71|Industrial  Scien...|       false|             100|
|Utiva UTI Test St...| 4.4|    248|53.97|Industrial  Scien...|        true|              50|
|DEWENWILS Outdoor...| 4.1|   2221|81.99|Industrial  Scien...|       false|               0|
|KEMEXC Toilet Sea...| 4.6|     61|66.86|Industrial  Scien...|       false|               0|
|Heat Insulation S...| 4.7|    142|21.99|Industrial  Scien...|       false|              50|
|MulWark 6pc Premi...| 4.5|   3057|20.99|Industrial  Scien...|       false|             100|
+--------------------+-----+-------+-----+--------------------+------------+----------------+
only showing top 20 rows
```

Cleaning Process

Final Table post titleLength conversion:

```
+-----+-------+--------+--------------------------------------------------+-------------+------------------+-----------+
|stars|reviews|price   |categoryName                                      |isBestSeller|boughtInLastMonth|titleLength|
+-----+-------+--------+--------------------------------------------------+-------------+------------------+-----------+
|0.0  |0      |40900.0 |Outdoor Storage  Housing                          |false        |0                 |117        |
|0.0  |0      |34552.5 |Outdoor Storage  Housing                          |false        |0                 |114        |
|0.0  |0      |32079.9 |Television Projectors                             |false        |0                 |55         |
|0.0  |0      |29508.95|Salon  Spa Equipment                              |false        |0                 |73         |
|0.0  |0      |28012.45|Television Projectors                             |false        |0                 |62         |
|0.0  |0      |27890.8 |Salon  Spa Equipment                              |false        |0                 |156        |
|0.0  |0      |27504.41|Salon  Spa Equipment                              |false        |0                 |142        |
|0.0  |0      |27409.95|Salon  Spa Equipment                              |false        |0                 |123        |
|0.0  |0      |26975.67|Salon  Spa Equipment                              |false        |0                 |125        |
|0.0  |0      |26376.3 |Television Projectors                             |false        |0                 |55         |
|0.0  |0      |26366.2 |Science Education Supplies                        |false        |0                 |80         |
|0.0  |0      |25926.55|Outdoor Storage  Housing                          |false        |0                 |103        |
|0.0  |0      |25488.12|Salon  Spa Equipment                              |false        |0                 |120        |
|0.0  |0      |25024.64|Science Education Supplies                        |false        |0                 |125        |
|0.0  |0      |24894.0 |Computer Uninterrupted Power Supply               |false        |0                 |69         |
|0.0  |0      |24572.7 |Salon  Spa Equipment                              |false        |0                 |136        |
|0.0  |0      |24520.8 |Salon  Spa Equipment                              |false        |0                 |144        |
|0.0  |0      |24328.45|Salon  Spa Equipment                              |false        |0                 |140        |
|0.0  |0      |23345.98|Children's Outdoor Inflatable Bouncers  Bouncy Castles|false    |0                 |143        |
|0.0  |0      |23335.23|Salon  Spa Equipment                              |false        |0                 |126        |
+-----+-------+--------+--------------------------------------------------+-------------+------------------+-----------+
only showing top 20 rows
```
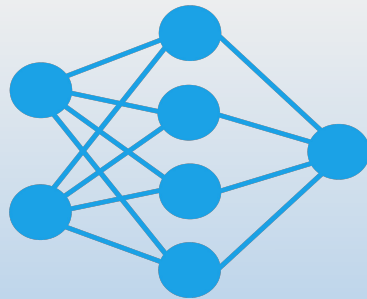
Neural Network Model

- Test Model:
  - 57 input features
  - 1 hidden layer
  - 15 neurons
  - 75 epoch
  - Activation Functions:
    - Input: Relu
    - Output: Sigmoid

Approximately 100% Accuracy Score but 0% Recall Score = Something is wrong
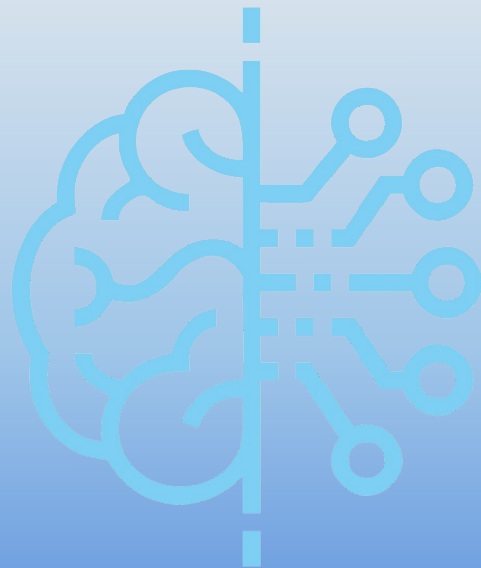
```
5624/5624 [==============================] - 8s 2ms/step
Accuracy: 0.9954879864861861
Recall: 0.0
```

Neural Network Model

- Problem:

```
label_input_ratio = df["isBestSeller"].value_counts().values[0] / df["isBestSeller"].value_counts().values[1]
label_input_ratio
246.97742118716275
```

- The original data had over 246 times more ordinary sellers than best sellers.
- The model became very good at predicting if a target is not a best seller than if a target is a best seller.

Model Tuning - Resampling

Pre-Resampling

- Model only guessing "Zero"
  - High Accuracy
- Accuracy not sufficient for model performance
  - Low Recall

```
0    537493
1      2399
```

```
0    537493
1    537493
```

```
Accuracy: 0.9954879864861861
Recall: 0.0
```

Post-Resampling

- Model accuracy decreased
  - Still within 75% threshold
- Significant Recall increase
  - Overall Model performance improves

```
Accuracy: 0.8068835989420107
Recall: 0.853448275862069
```

Feature Importance – Results

Purpose? ⟹ Find the Most Impactful Actionable Features
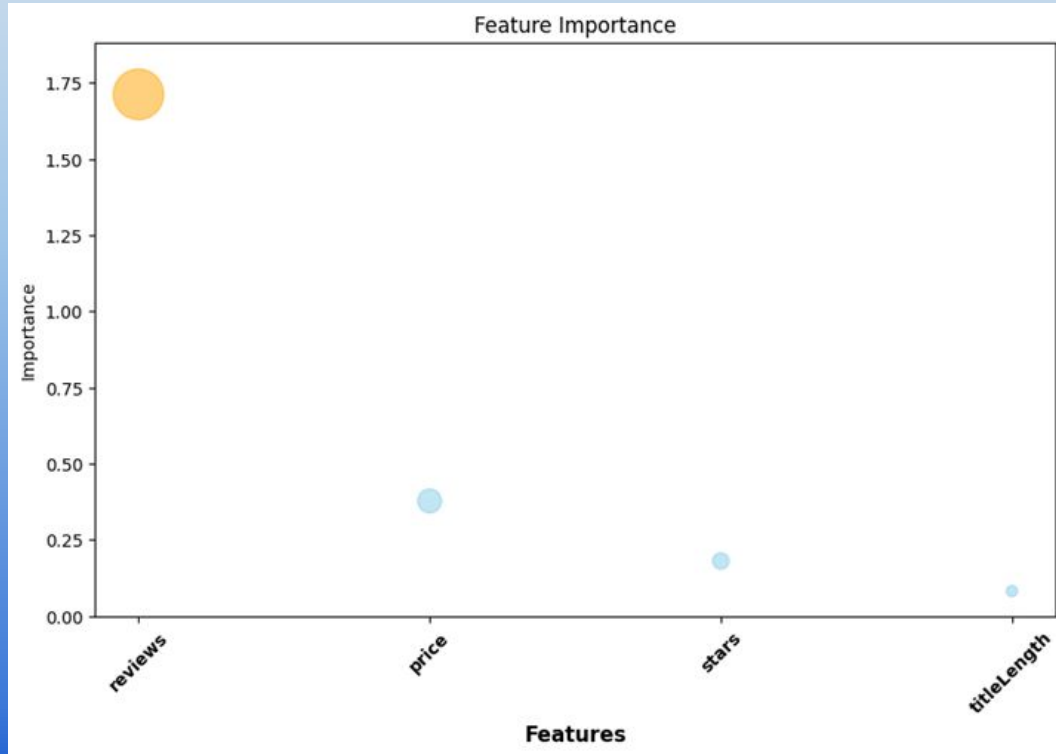
Feature Importance – Next Steps

How? ⟹ How can sellers use this information to make a competitive advantage

Steps

- Financial Review Incentives
  - Discounts, money back, etc.

- Sentimental Strategies
  - Card, personalized email

- Review manipulation
  - Buying reviews

Expanded Analysis – Interaction Terms
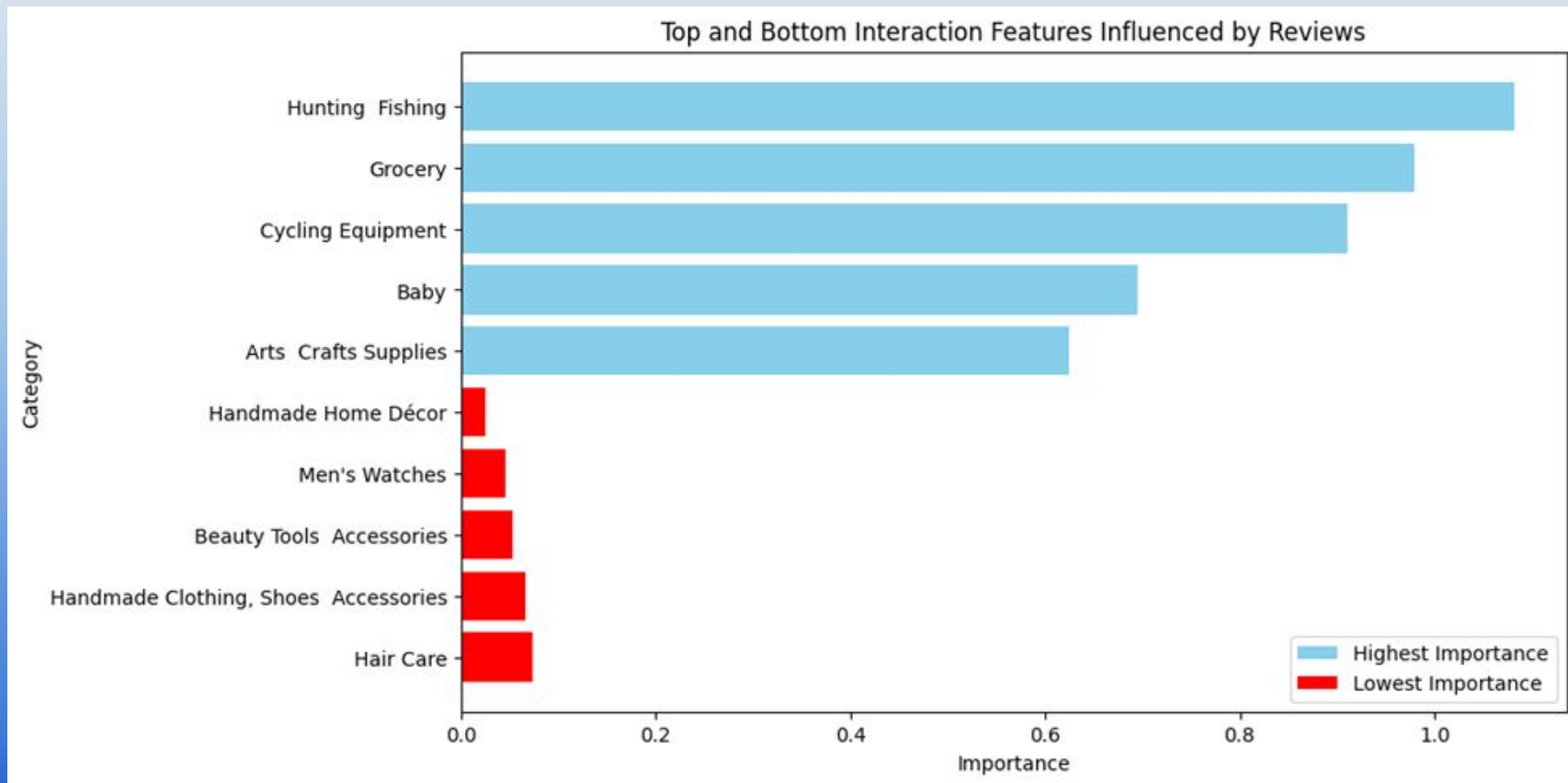
Interaction Terms

- Relationship between Reviews and the individual categories

Model Adjustment

- Double neurons 15 ⇸ 30
- Increase epochs 75 ⇸ 100

Accuracy: 0.825859616367718
Recall: 0.8115763546798029

Expanded Analysis – Results

Top and Bottom Interaction Features Influenced by Reviews

Next Steps?

Premium Members

- Interaction terms with ALL actionable features

- Online technical support

- Guided model customization

Results and Findings

- Explored factors influencing Amazon best seller status
- Identified crucial attributes, with a focus on review count impact
- Highlighted the need to adjust sales and marketing strategies for increased reviews
- Examined interaction terms to understand category influences
- Discovered review sensitivity in categories like hunting, fishing, grocery, and baby products

- Proposed targeted review campaigns for substantial benefits in these segments
- Emphasized the model's overall value in optimizing product listings
- Provides insights for sellers to enhance competitiveness on Amazon

Thank You

Appendix

Citations

https://stptrans.com/ecommerce-is-booming-in-the-nordic-markets/

https://pixelfy.me/blog/amazon-choice-vs-best-seller/#:~:text=As%20obvious%20from%20the%20name,Best%20Seller%20Rank%20(BSR)

https://www.threecolts.com/blog-articles/amazon-best-seller-rank

https://sell.amazon.com/blog/amazon-best-sellers-rank

https://www.shutterstock.com/search/data-insights-icon

https://www.flaticon.com/free-icon/insight_10179168

https://www.mindmingles.com/amazon-listing-optimization/
https://www.linkedin.com/pulse/unlocking-workforce-optimization-data-driven-staffing-vitor-mesquita/

Cleaning Process

Final Table prior to titleLength conversion:

```
+--------------------+-----+-------+-----+--------------------+------------+----------------+
|               title|stars|reviews|price|        categoryName|isBestSeller|boughtInLastMonth|
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|KEMEXC Toilet Sea...|  4.6|     61|66.86|Industrial  Scien...|       false|               0|
|Heat Insulation S...|  4.7|    142|21.99|Industrial  Scien...|       false|              50|
|MulWark 6pc Premi...|  4.5|   3057|20.99|Industrial  Scien...|       false|             100|
+--------------------+-----+-------+-----+--------------------+------------+----------------+
only showing top 20 rows
```