

Pet Products Taxonomy

Team 6 Dog

Tiancheng Sun, Leona Liu, Sheng Qian,
Jenny Meng, Diantian Fu, Zijue Li

Instructor: Mayank Kejriwal



Table of content

Step 1 Problem Statement

Step 2 Dataset Collection

Step 3 Model Selection & Development

Step 4 Model Evaluation

Step 5 Quantitative Analysis

Step 6 Introspection & Future Improvement

About Our Project



Project Goal

Turn e-commerce's product data, into an accurate pet product taxonomy classification model that can serve as the foundation to benefit platform, seller and customer's interest

Business Value

Our model can produce accurate taxonomy predictions for the pet products. This provides the groundwork to boost platform's operation efficiency, and layout the groundwork for business insight generation for the platform



Problem Statement



Given a set of pet products' title, reviews and related features, we intends to develop a "smart" classification model, that can make accurate **hierarchical predictions** of the category, and sub-categories of the pet product through the product's title, and buyers real time reviews

Data Collection



Dataset Overview

Data Source: huggingface.co

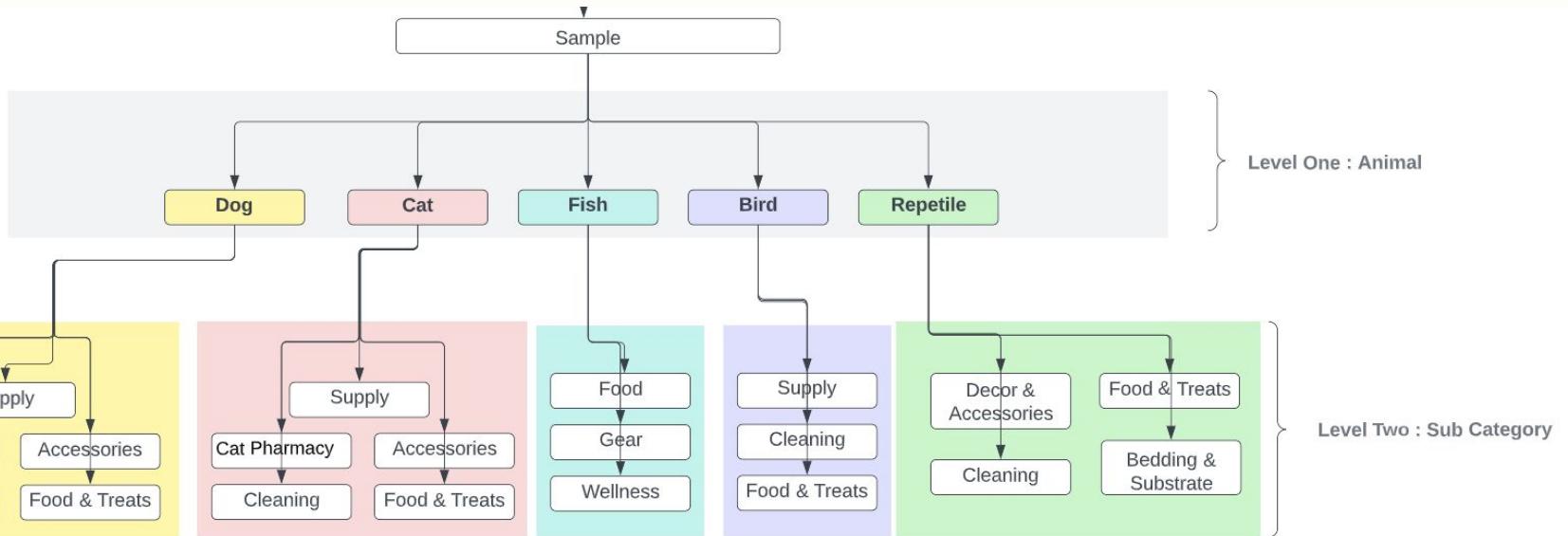
Data Size: 2,643,619 observations

Data contains: 15 columns like product title, review, star rating, helpful votes etc

| marketplace | customer_id | review_id | product_id | product_parent | product_title | product_category | star_rating | helpful_votes | total_votes | vine | verified_purchase | review_headline | review_body | review_date | |
|-------------|-------------|-----------|----------------|----------------|---------------|---|--------------|---------------|-------------|------|-------------------|-----------------|---|---|------------|
| 0 | US | 28794885 | REAKC26P07MDN | B00QOK9604 | 510387886 | (8-Pack) EZwhelp Belly Band/Wrap | Pet Products | 5 | 0 | 0 | 0 | 1 | A great purchase for "dribbly" dogs | Best belly bands on the market! These are a g... | 2015-08-31 |
| 1 | US | 11488901 | R3NU70MZ4HQIEG | B00MBW5O9W | 912374672 | Warren Eckstein's Hugs & Kisses Vitamin Minera... | Pet Products | 2 | 0 | 1 | 0 | 1 | My dogs love Hugs and Kisses | My dogs love Hugs and Kisses. However, the la... | 2015-08-31 |
| 2 | US | 43214993 | R14QJW3XF8QQ1P | B0084OHUJO | 902215727 | Tyson's True Chews Premium Jerky - 12 ounce Ch... | Pet Products | 5 | 0 | 0 | 0 | 1 | I have been purchasing these for a long time. ... | I have been purchasing these for a long time. ... | 2015-08-31 |
| 3 | US | 12835065 | R2HB7AX0394ZGY | B001GS7IK2 | 568880110 | Soft Side Pet Crate, Navy/Tan | Pet Products | 5 | 0 | 0 | 0 | 1 | it is easy to open and close | It is extremely well constructed, it is easy ... | 2015-08-31 |
| 4 | US | 26334022 | RGKMPDQGSahr3 | B004ABH1LG | 692846826 | EliteField 3-Door Folding Soft Dog Crate, Indo... | Pet Products | 5 | 0 | 0 | 0 | 1 | Dog crate | Worked really well. Very pleased with my purc... | 2015-08-31 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| 2643614 | US | 52776499 | R40AVFLMGSX5Q | 1576102793 | 272175353 | Microsoft Office 98 for Mac | Pet Products | 1 | 32 | 34 | 0 | 0 | Not worth the money!! | I feel bad saying this but I think this book i... | 1999-04-06 |
| 2643615 | US | 52064754 | R13RP6H1OP0BFS | 1576102939 | 141604551 | Photoshop 5 Enhanced | Pet Products | 5 | 3 | 3 | 0 | 0 | OUTSTANDING BOOK, BUT!!! | Very good book!! But the CD has a problem with... | 1999-04-04 |
| 2643616 | US | 52050172 | R34ITLN6LBTZN | 0684836483 | 403672048 | 250 Things You Can Do to Make Your Cat Adore You | Pet Products | 3 | 48 | 56 | 0 | 0 | not a waste of money but... | I enjoyed reading most of this book. The info ... | 1999-01-10 |
| 2643617 | US | 52311856 | R30D2N6TX0OFS | 1576102742 | 170629345 | Photoshop 5 3D Textures F/X | Pet Products | 3 | 7 | 7 | 0 | 1 | A good book for someone starting out. | If you are looking to add more realism to the ... | 1998-12-04 |
| 2643618 | US | 52960939 | R2MAGOAOXPFMF1 | 0684836483 | 403672048 | 250 Things You Can Do to Make Your Cat Adore You | Pet Products | 2 | 17 | 20 | 0 | 1 | Goes a little overboard | Although I consider myself a cat lover, I thou... | 1998-08-23 |

2643619 rows x 15 columns

Taxonomy



Source of Taxonomy: Chewy: <https://www.chewy.com/>

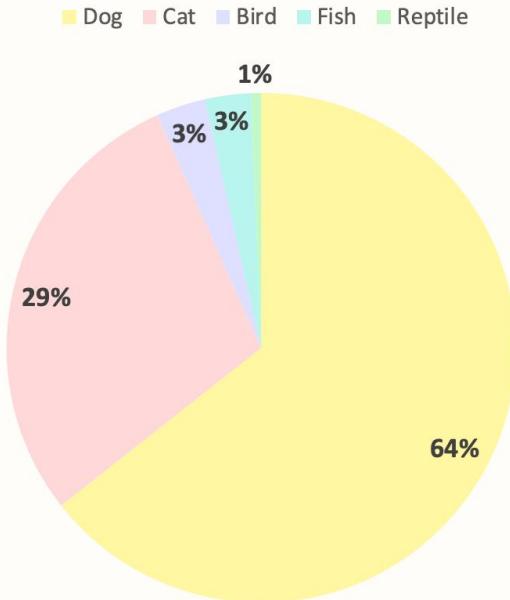
Baseline-Labeling

1,000 manually labeled sampled data

Manual Labeling

| marketplace | customer_id | review_id | product_id | product.parent | product.title | product.category | star_rating | helpful_votes | total_votes | vine | verified_purchase | review_headline | review_body | review_date | Category | level 1 | level 2 |
|-------------|-------------|-----------|----------------|----------------|--|------------------|-------------|---------------|-------------|------|-------------------|---|---|-------------|---------------------------|---------------|---------|
| 4299 | US | 2230831 | READYBUYUSTHQ | B0000EMFW | LitterMaid Universal Cat Privacy Tent (LMT100) | Pet Products | 1 | 0 | 0 | 0 | 1 | One Star | Came broke. Littermaid has said they will repl... | 2015-08-02 | Cat-Litter & Litter Boxes | Cat: Cleaning | |
| 2076 | US | 47508114 | RDTKFB181BPHD | B0000EMFW | LitterMaid Universal Cat Privacy Tent (LMT100) | Pet Products | 2 | 0 | 0 | 0 | 1 | You're better off putting it under a small tab... | The plastic cover is not pliable enough to str... | 2015-08-08 | Cat-Litter & Litter Boxes | Cat: Cleaning | |
| 9334 | US | 48751727 | RZWM0921JJDGV | B0000EMFW | LitterMaid Universal Cat Privacy Tent (LMT100) | Pet Products | 2 | 0 | 0 | 0 | 1 | Not as expected | Great concept. Cheaply made and flimsy. I di... | 2015-04-06 | Cat-Litter & Litter Boxes | Cat: Cleaning | |
| 8796 | US | 3074556 | REYCAV0AZL5 | B0000EMFW | LitterMaid Universal Cat Privacy Tent (LMT100) | Pet Products | 3 | 0 | 0 | 0 | 1 | Three Stars | It is easy to break | 2015-03-22 | Cat-Litter & Litter Boxes | Cat: Cleaning | |
| 5497 | US | 2483183 | R1R7YLQOT01UTM | B0000EMFW | LitterMaid Universal Cat Privacy Tent (LMT100) | Pet Products | 3 | 0 | 0 | 0 | 1 | Not a big fan, but it would work in a pinch. | It serves a purpose, but has a really cheap pl... | 2015-03-13 | Cat-Litter & Litter Boxes | Cat: Cleaning | |

Baseline - Data Cleaning & Processing



- **Stratification & Manual Labeling**
- **Apply Labeled Data to Raw Dataset Based on Product_ID**
 - Total Training Dataset: 51, 319

Segmentation & TFIDF

- Remove non-english word, for example some brand names
- Remove punctuation
- Remove numbers
- Lemmemaization
- String Contains
- TFIDF

LitterMaid Universal Cat Privacy Tent (LMT100)

universal,cat,privacy,tent

PETMATE 26317 Cat Crazies Cat Toy

cat,crazy,cat,toy

| | |
|----------------|---|
| Dog | “Dog”, “Doggie”, “Puppy”, “Puppies” |
| Cat | “Cat”, “Kitten”, “Kitty” |
| Reptile | “Reptile”, “Reptiles”, “Lizard”, “Lizards”, “Bearded” “Dragon” “Pogon” |
| Bird | “Bird”, “Birdie”, “Budgies” |
| Fish | “Fish”, “Betta” |

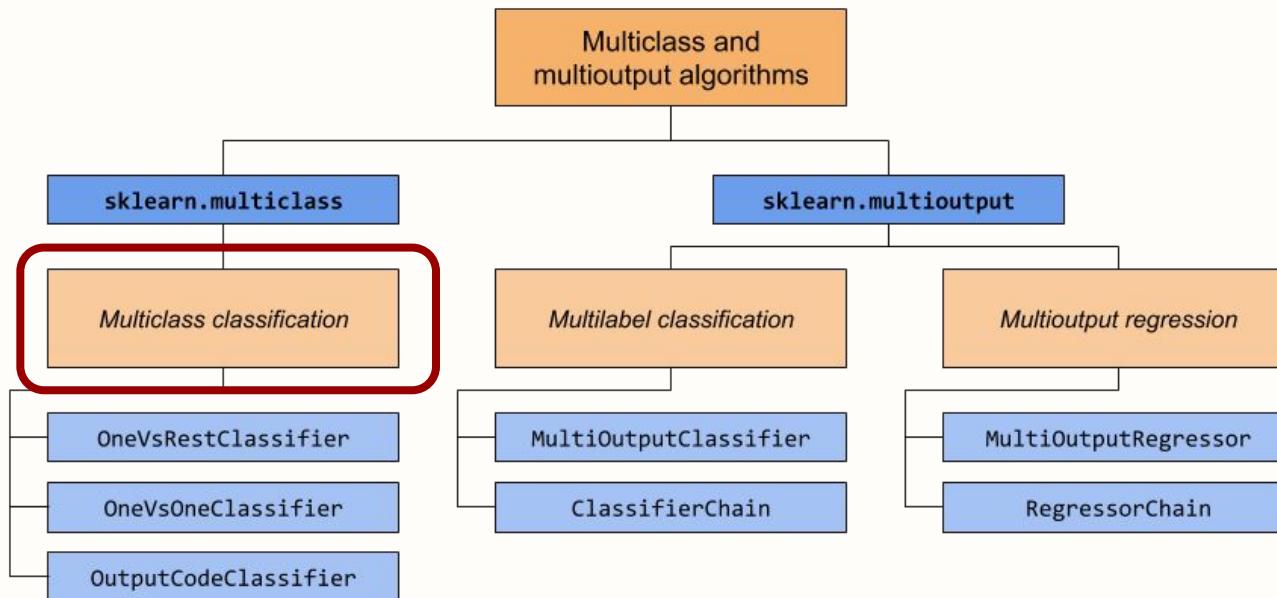
Model Selection & Development



Model Development Overview

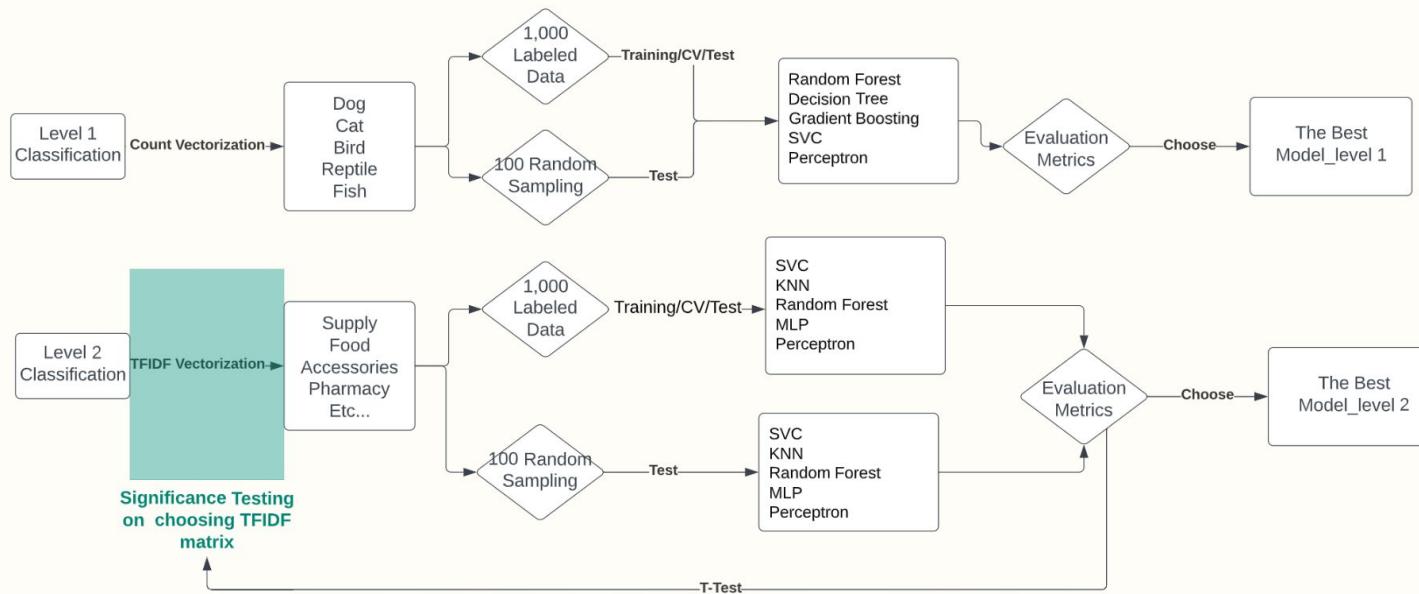


Model Selection

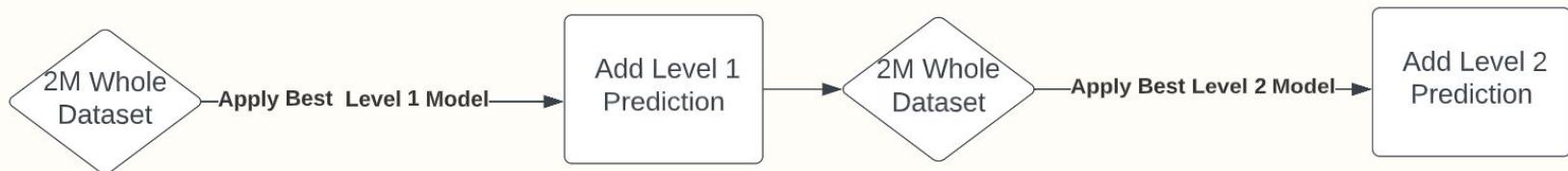


Citation: <https://scikit-learn.org/stable/modules/multiclass.html>

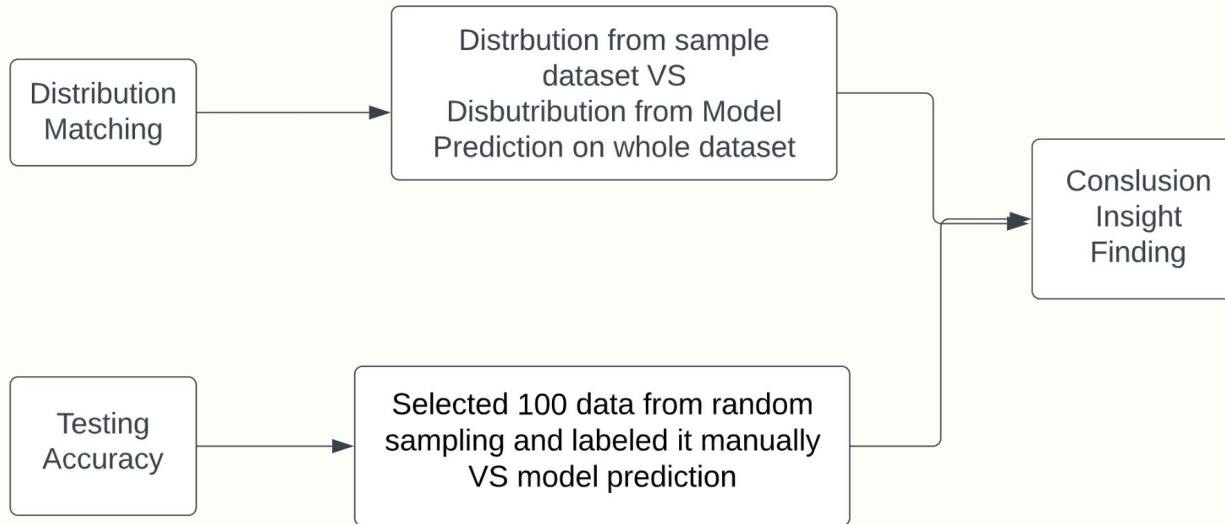
Model Development Flow Chart Step 1 (Model Selection)



Model Development Flow Chart Step 2 (Apply Prediction)



Model Development Flow Chart Step 3 (Verify Prediction)



Model Evaluation



Model Evaluation Metrics

- Average Cross Validation Score (train) / Accuracy (test)
- Macro weighted average Precision
- Macro weighted average Recall
- Macro weighted average F1-score

| | Bird | Cat | Dog | Fish | Reptile | accuracy | macro avg | weighted avg |
|-----------|------------|-------------|-------------|------------|-----------|----------|--------------|--------------|
| precision | 0.969605 | 0.984039 | 0.979516 | 0.996564 | 0.905405 | 0.980417 | 0.967026 | 0.980524 |
| recall | 0.990683 | 0.955204 | 0.991374 | 0.973154 | 1.000000 | 0.980417 | 0.982083 | 0.980417 |
| f1-score | 0.980031 | 0.969407 | 0.985409 | 0.984720 | 0.950355 | 0.980417 | 0.973984 | 0.980363 |
| support | 322.000000 | 2969.000000 | 6608.000000 | 298.000000 | 67.000000 | 0.980417 | 10264.000000 | 10264.000000 |

Level 1 - Model Performance - Train

| | Random Forest | Decision Tree | Gradient Boosting | SVC | Perceptron |
|-------------------------------|---------------|---------------|-------------------|--------|------------|
| Average CV Score | 0.9805 | 0.9804 | 0.9803 | 0.9791 | 0.9269 |
| Macro Weighted Avg. Precision | 0.9806 | 0.9805 | 0.9804 | 0.9794 | 0.9400 |
| Macro Weighted Avg. Recall | 0.9805 | 0.9804 | 0.9803 | 0.9791 | 0.9269 |
| Macro Weighted Avg. F-1 Score | 0.9805 | 0.9804 | 0.9803 | 0.9790 | 0.9288 |

Level 1 - Model Performance - Test

| | Random Forest | Decision Tree | Gradient Boosting | SVC | Perceptron |
|--------------------------------------|---------------|---------------|-------------------|--------|---------------|
| Accuracy | 0.9831 | 0.9830 | 0.9827 | 0.9789 | 0.9693 |
| Macro Weighted Avg. Precision | 0.9867 | 0.9867 | 0.9867 | 0.9881 | 0.9896 |
| Macro Weighted Avg. Recall | 0.9866 | 0.9865 | 0.9865 | 0.9880 | 0.9895 |
| Macro Weighted Avg. F-1 Score | 0.9865 | 0.9865 | 0.9865 | 0.9880 | 0.9895 |

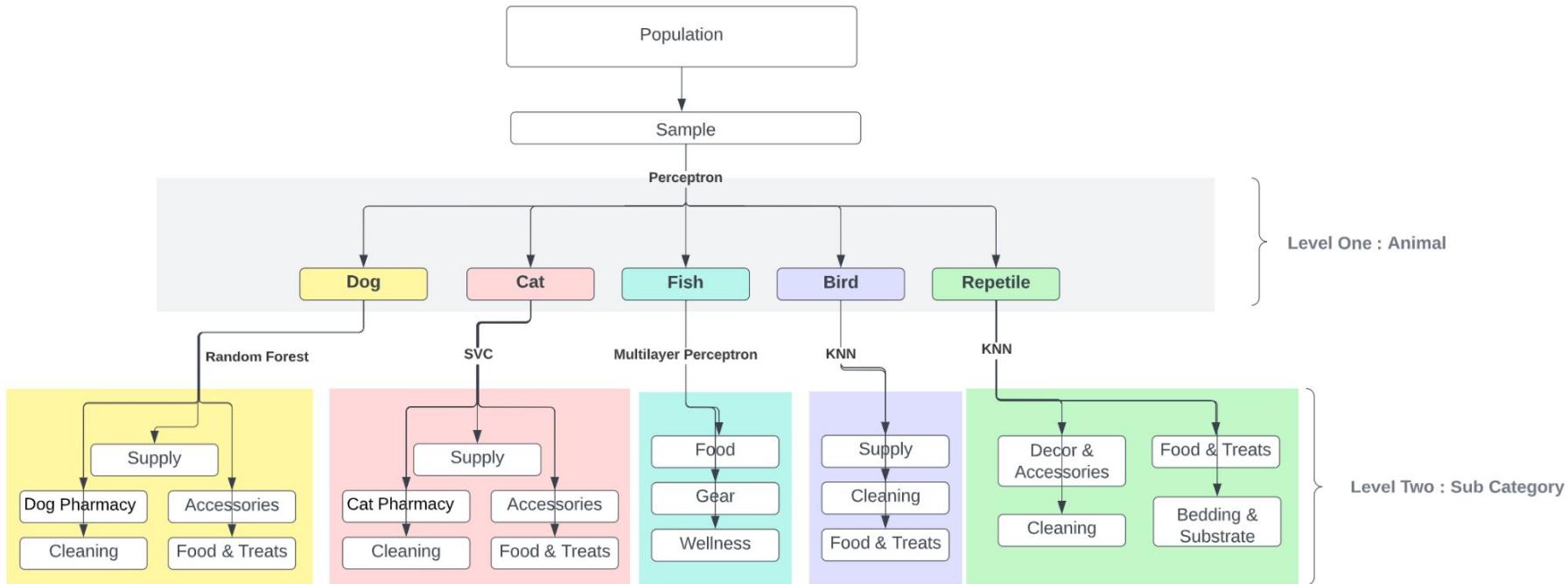
Level 2 - Dog - Model Performance - Train

| | SVC | KNN | Random Forest | Multilayer Perceptron |
|-------------------------------|--------|--------|---------------|-----------------------|
| Average CV Score | 0.9590 | 0.9439 | 0.9606 | 0.9636 |
| Macro Weighted Avg. Precision | 0.9200 | 0.9300 | 0.9500 | 0.9100 |
| Macro Weighted Avg. Recall | 0.9000 | 0.9200 | 0.9600 | 0.9100 |
| Macro Weighted Avg. F-1 Score | 0.9000 | 0.9200 | 0.9500 | 0.9100 |

Level 2 - Dog - Model Performance - Test

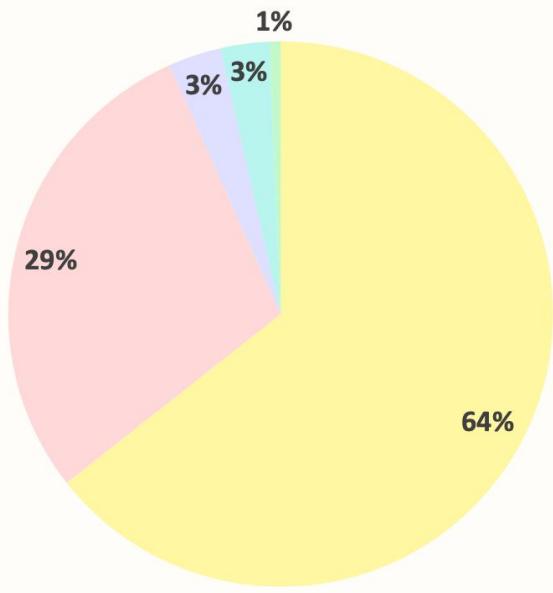
| | SVC | KNN | Random Forest | Multilayer Perceptron |
|-------------------------------|--------|--------|---------------|-----------------------|
| Accuracy | 0.7647 | 0.7500 | 0.8382 | 0.7941 |
| Macro Weighted Avg. Precision | 0.7379 | 0.7199 | 0.7544 | 0.7515 |
| Macro Weighted Avg. Recall | 0.7647 | 0.7500 | 0.7942 | 0.7794 |
| Macro Weighted Avg. F-1 Score | 0.7458 | 0.7312 | 0.7721 | 0.7604 |

Best Models Summary

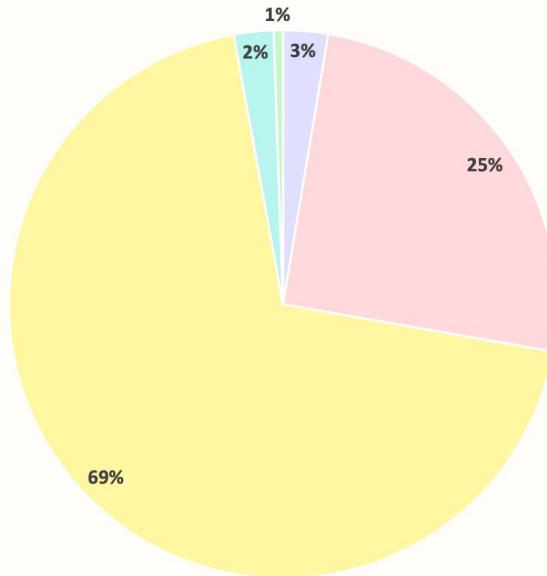


Level One Distribution Evaluation

Dog Cat Bird Fish Reptile



Training



Entire Dataset

Qualitative Analysis





Qualitative Analysis



Dog Sub-Category



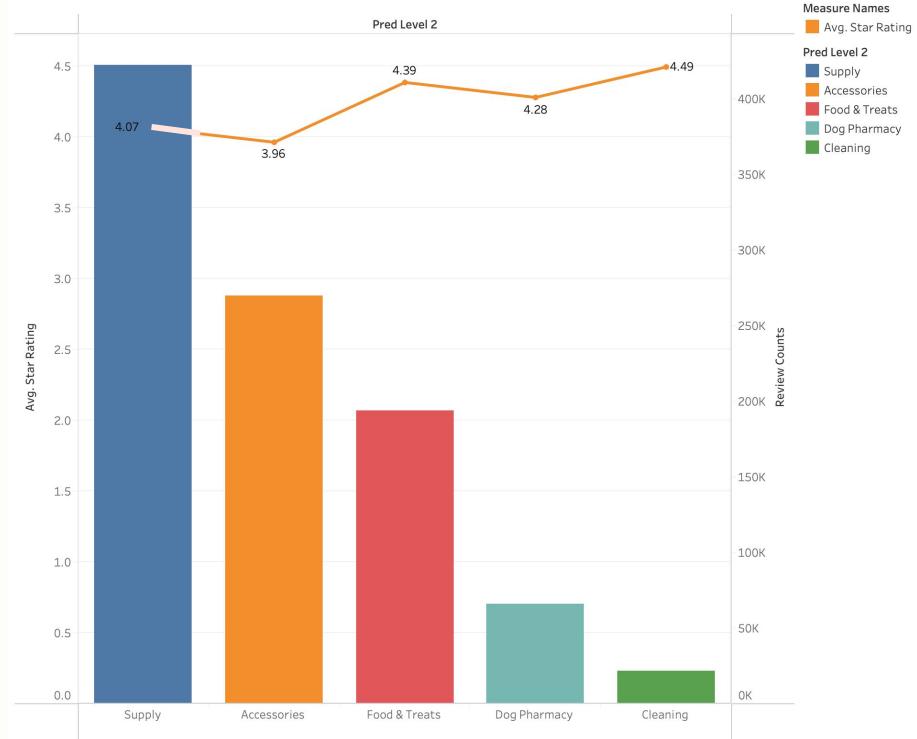
Supply sector has intense competition

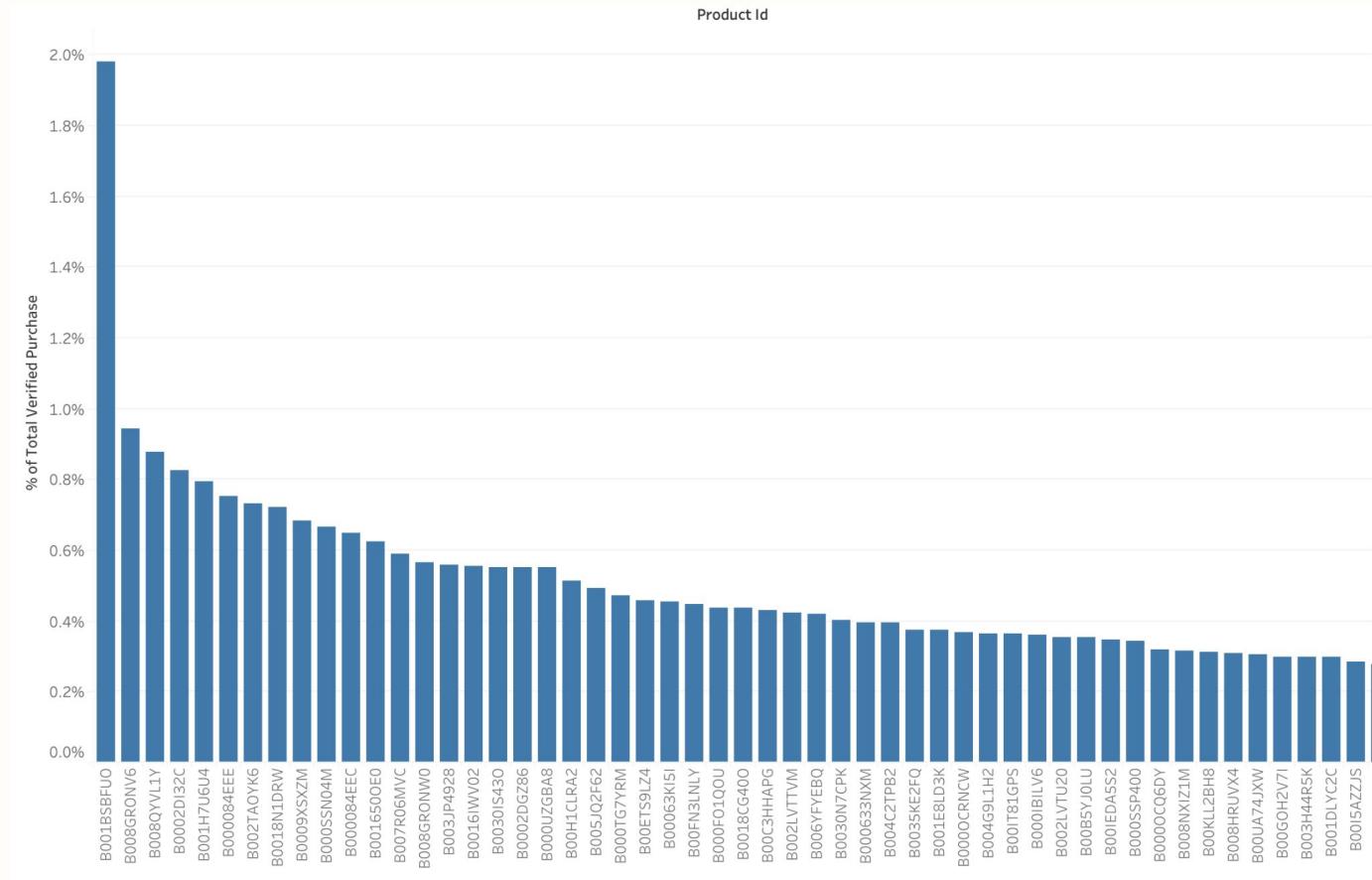


Accessories sector might have business growth opportunities.



Purchase follows a **20/80 distribution** among product





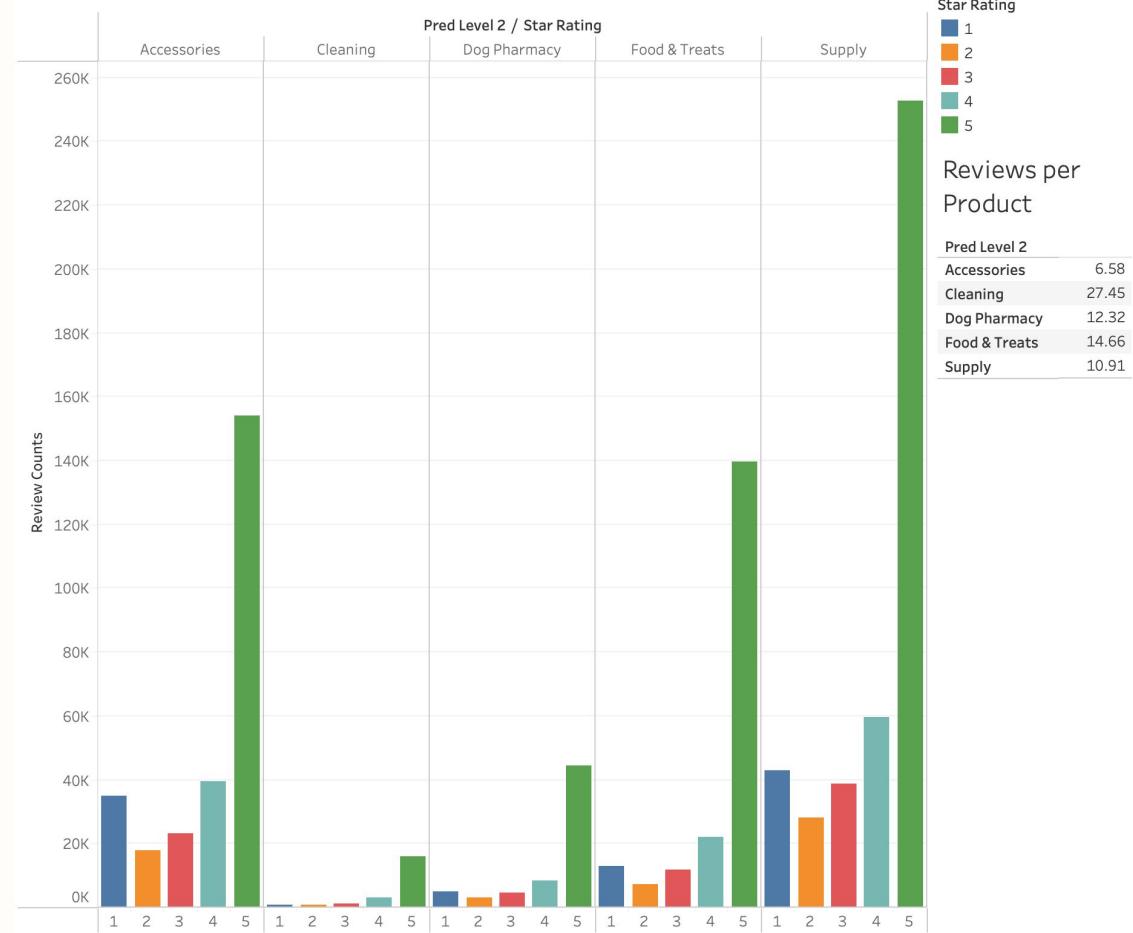
Dog Pharmacy purchase distribution



Customer are more picky
and satisfied at **Cleaning**
Sector



Other sectors in general has
more 5-star rating reviews
and 1-star rating reviews





Qualitative Analysis



Cat Sub-Category



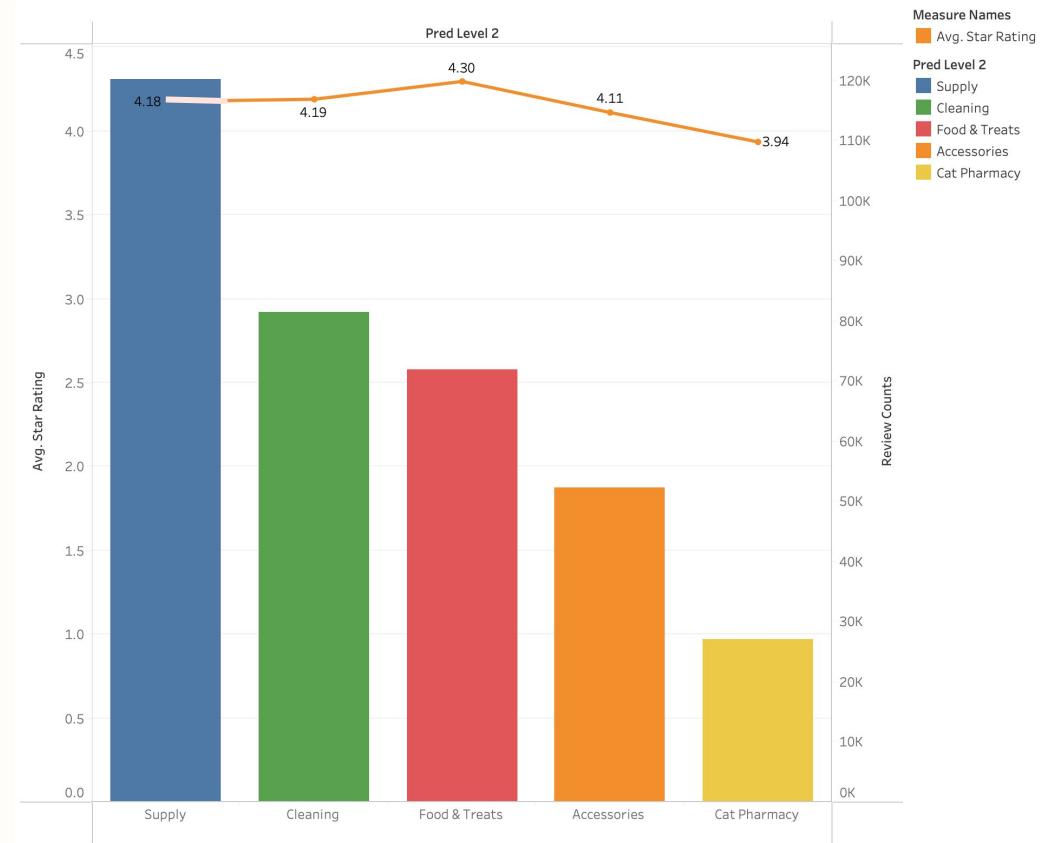
Food & Treats sector has more high-rating products



Cat Pharmacy sector might have business growth opportunities.



Purchase follows a **20/80 distribution** among product





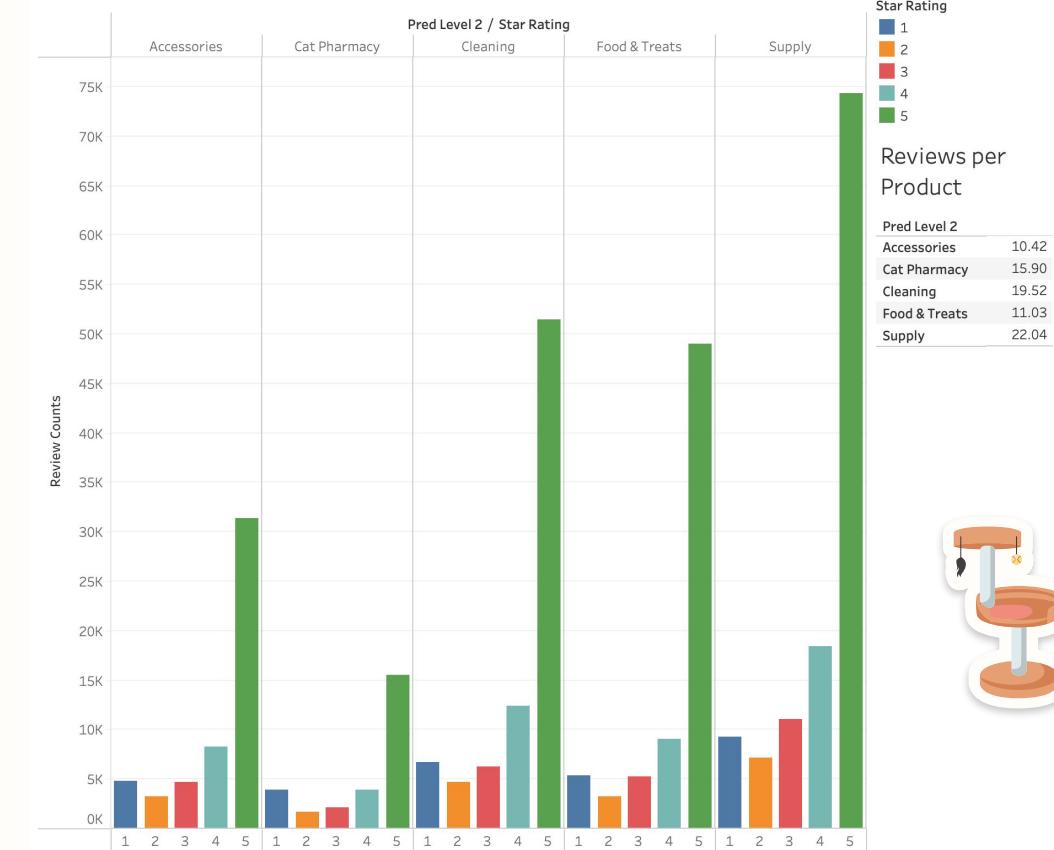
 Customer feels more strongly about expressing their comments on **Supply** products



Accessories and **Food & Treats** sector has less comments per product



Customer satisfaction is high in cat subcategories in general.



Interesting Outliers

| Product_Id | Level 1 | Actual Level 2 | Predicted Level 2 | Review Content |
|--|---------|--------------------------|-------------------|---------------------------------|
|  Bio Spot Active Care Shed Solution Chewable Tablets for Dogs, 60 Count | Dog | Dog Pharmacy | Food & Treats | "Chewable pill" |
|  Innova Large Breed Puppy Food 374g | Fish | Food & Treats | Dog Pharmacy | "Smell like fish " |
|  One for Pets Simply Delicious Dog Food Container, 17.6-Pound, Brown | Dog | Supply | Food & Treats | "food, bag of food, fresh food" |
|  Lixit Animal Care Dog Treat Jar | Dog | Supply | Food & Treats | "dog treat jar" |

Introspection & Future Improvement



Constraint & Challenges

Model Evaluation

Hard to find a complete ground truth to test the performance of model developed

Selection Bias

We stratified the sample based on the distribution by category, which can lead to selection bias. We used 100 randomly selected and manually labeled data as test data to evaluate the model performance.



Training Imbalance

Uneven distribution of pet product purchasing records can lead to inaccurate prediction. We decided to use 'SMOTE' methodology to oversample the training dataset.

Multilabel Problem

Some pet products can be used by both dogs and cats

How to Improve in the Future



Training Optimization

- The process of training the model is long. Optimize the code efficiency to enable well-trained model with better performance



Multilabel Classification

- To enable model with more complicated structure



Increase scale

- Add more depth of hierarchy to group similar product to build recommendation system



Ambiguous Reviews Analysis

- Bert model to understand meaning of ambiguous reviews to further improve the accuracy of classification model (mitigate issue of too many products under Other category, or enable multilable classification)

How we Benefit the E-commerce Ecosystem?



Seller: easy inventory management

Platform can auto populate the product category and subcategory to save time for inventory management

Platform: locate business insights

The category taxonomy will drive business insights. Eg, platform can locate underdeveloped categories, find alternative use method of product



Customer: recommend related product

If we have enough labeled data with more level of hierarchy, we will be able to group similar product together and build recommendation algorithm

Thank You!

Question?



References

Data Source

- Hugging Face
- https://huggingface.co/datasets/amazon_us_reviews/viewer/Pet_Products_v1_00/train

Validation Taxonomy

- Chewy
- <https://www.chewy.com/>

Tips and Tricks for Multi-Class Classification

- <https://medium.com/@b.terryjack/tips-and-tricks-for-multi-class-classification-c184ae1c8ffc>

Appendix



Level 2- Cat Model Performance - Train

| | SVC | KNN | Random Forest | Multilayer Perceptron |
|------------------------------|--------|--------|---------------|-----------------------|
| Average CV Score | 0.997 | 0.9971 | 0.9963 | 0.9998 |
| Macro weighted avg Precision | 0.9419 | 0.9419 | 0.9836 | 0.9967 |
| Macro weighted avg Recall | 0.9350 | 0.9350 | 0.9833 | 0.9967 |
| Macro weighted avg F1 | 0.9303 | 0.9304 | 0.9830 | 0.9966 |



Level 2- Cat Model Performance - Test

| | SVC | KNN | Random Forest | Multilayer Perceptron |
|------------------------------|----------|----------|---------------|-----------------------|
| Accuracy | 0.9117 | 0.8235 | 0.8529 | 0.9117 |
| Macro weighted avg Precision | 0.938971 | 0.870722 | 0.884867 | 0.944491 |
| Macro weighted avg Recall | 0.911765 | 0.823529 | 0.852941 | 0.911765 |
| Macro weighted avg F1 | 0.916457 | 0.823529 | 0.840338 | 0.929314 |



Level 2- Fish model performance - Train

| | SVC | KNN | Multilayer Perceptron | Perceptron |
|------------------------------|--------|--------|-----------------------|------------|
| Average CV Score | 0.9833 | 0.9666 | 1.0 | 0.9967 |
| Macro weighted avg Precision | 0.9836 | 0.9728 | 1.0 | 0.9967 |
| Macro weighted avg Recall | 0.9832 | 0.9666 | 1.0 | 0.9967 |
| Macro weighted avg F1 | 0.9823 | 0.9680 | 1.0 | 0.9967 |



Level 2- Fish Model Performance - Test

| | SVC | KNN | Random Forest | Multilayer Perceptron |
|------------------------------|--------|--------|---------------|-----------------------|
| Accuracy | 0.7857 | 0.7333 | 0.7809 | 0.8285 |
| Macro weighted avg Precision | 0.8519 | 0.8571 | 0.8571 | 0.8603 |
| Macro weighted avg Recall | 0.7857 | 0.7333 | 0.7810 | 0.8286 |
| Macro weighted avg F1 | 0.7397 | 0.7190 | 0.7846 | 0.8482 |



Level 2- Bird Model performance - Train

| | SVC | KNN | Random Forest | Multilayer Perceptron |
|------------------------------|--------|--------|---------------|-----------------------|
| Average CV Score | 0.9441 | 0.9379 | 0.9938 | 0.9907 |
| Macro weighted avg Precision | 0.9486 | 0.9553 | 0.9938 | 0.9908 |
| Macro weighted avg Recall | 0.9441 | 0.9379 | 0.9938 | 0.9907 |
| Macro weighted avg F1 | 0.9423 | 0.9414 | 0.9938 | 0.9906 |



Level 2- Bird Model performance - Test

| | SVC | KNN | Random Forest | Multilayer Perceptron |
|------------------------------|--------|---------------|---------------|-----------------------|
| Accuracy | 0.9047 | 0.9285 | 0.9047 | 0.9047 |
| Macro weighted avg Precision | 0.9569 | 0.9299 | 0.9569 | 0.9569 |
| Macro weighted avg Recall | 0.9048 | 0.9286 | 0.9048 | 0.9048 |
| Macro weighted avg F1 | 0.9237 | 0.9279 | 0.9237 | 0.9237 |



Level 2- Reptile Model Performance - Train

| | SVC | KNN | Multilayer Perceptron | Perceptron |
|------------------------------|--------|-----|-----------------------|------------|
| Average CV Score | 0.9853 | 1.0 | 1.0 | 1.0 |
| Macro weighted avg Precision | 0.9856 | 1.0 | 1.0 | 1.0 |
| Macro weighted avg Recall | 0.9853 | 1.0 | 1.0 | 1.0 |
| Macro weighted avg F1 | 0.9851 | 1.0 | 1.0 | 1.0 |



Level 2- Reptile Model Performance - Test

| | SVC | KNN | Random Forest | Multilayer Perceptron |
|------------------------------|--------|---------------|---------------|-----------------------|
| Accuracy | 0.8000 | 0.8500 | 0.8000 | 0.7000 |
| Macro weighted avg Precision | 0.7643 | 0.8981 | 0.7643 | 0.7143 |
| Macro weighted avg Recall | 0.7000 | 0.8500 | 0.7000 | 0.7000 |
| Macro weighted avg F1 | 0.7972 | 0.8543 | 0.7972 | 0.7639 |



T-Test

| | Accessories | Cleaning | og Pharma | ood & Treat | Supply | accuracy | macro avg | weighted avg |
|-----------|-------------|----------|-----------|-------------|----------|----------|-----------|--------------|
| precision | 0.84 | 0 | 0 | 0.666667 | 0.75 | 0.761905 | 0.451333 | 0.667672 |
| recall | 0.954545 | 0 | 0 | 0.857143 | 0.789474 | 0.761905 | 0.520232 | 0.761905 |
| f1-score | 0.893617 | 0 | 0 | 0.75 | 0.769231 | 0.761905 | 0.48257 | 0.710714 |
| support | 22 | 3 | 5 | 14 | 19 | 0.761905 | 63 | 63 |
| | Accessories | Cleaning | og Pharma | ood & Treat | Supply | accuracy | macro avg | weighted avg |
| precision | 0.782609 | 0 | 1 | 0.8125 | 0.666667 | 0.761905 | 0.652355 | 0.734271 |
| recall | 0.818182 | 0 | 0.6 | 0.928571 | 0.736842 | 0.761905 | 0.616719 | 0.761905 |
| f1-score | 0.8 | 0 | 0.75 | 0.866667 | 0.7 | 0.761905 | 0.623333 | 0.742593 |
| support | 22 | 3 | 5 | 14 | 19 | 0.761905 | 63 | 63 |
| | | | | | | T-Value | | |
| precision | 0.173509 | 0.14731 | 0.253306 | -0.20102 | -0.0666 | -0.79359 | 45.05% | |
| recall | 0.228978 | 0.133223 | 0.269147 | -0.09649 | 0 | -0.35849 | 72.99% | |
| f1-score | 0.1971 | 0.125222 | 0.253899 | -0.14076 | -0.03188 | -0.55441 | 59.52% | |

| | Accessories | Cleaning | Dog | Pharmacy | Food & Treat | Supply | accuracy | macro avg | weighted avg |
|-----------|-------------|-----------|-----------|-----------|--------------|-----------|-----------|-----------|--------------|
| precision | 0.8461538 | 0 | 0.1764706 | 0.7857143 | 1 | 0.5555556 | 0.5616677 | 0.785678 | |
| recall | 0.5 | 0 | 0.6 | 0.7857143 | 0.5263158 | 0.5555556 | 0.482406 | 0.555555 | |
| f1-score | 0.6285714 | 0 | 0.2727273 | 0.7857143 | 0.6896552 | 0.5555556 | 0.4753336 | 0.623740 | |
| support | 22 | 3 | 5 | 14 | 19 | 0.5555556 | 63 | 6 | |
| | Accessories | Cleaning | Dog | Pharmacy | Food & Treat | Supply | accuracy | macro avg | weighted avg |
| precision | 0.76 | 0 | 0.6 | 0.75 | 0.7647059 | 0.7460317 | 0.5749412 | 0.710308 | |
| recall | 0.8636364 | 0 | 0.6 | 0.8571429 | 0.6842105 | 0.7460317 | 0.6009979 | 0.746031 | |
| f1-score | 0.8085106 | 0 | 0.6 | 0.8 | 0.7222222 | 0.7460317 | 0.5861466 | 0.725546 | |
| support | 22 | 3 | 5 | 14 | 19 | 0.7460317 | 63 | 6 | |
| | | | | | | T-Value | | | |
| precision | 0.196778 | 0.1080221 | 0.2469008 | -0.013273 | 0.0753703 | -0.05376 | 95.86% | | |
| recall | 0.0851944 | 0.1256783 | 0.2053644 | -0.118592 | -0.190476 | -0.577471 | 58.01% | | |



| | Accessories | Cleaning | og Pharma | ood & Treat | Supply | accuracy | macro avg | weighted avg |
|-----------|-------------|----------|-----------|-------------|----------|----------|-----------|--------------|
| precision | 0.913043 | 0 | 1 | 0.769231 | 0.615385 | 0.761905 | 0.659532 | 0.754738 |
| recall | 0.954545 | 0 | 0.2 | 0.714286 | 0.842105 | 0.761905 | 0.542187 | 0.761905 |
| f1-score | 0.933333 | 0 | 0.333333 | 0.740741 | 0.711111 | 0.761905 | 0.543704 | 0.731452 |
| support | 22 | 3 | 5 | 14 | 19 | 0.761905 | 63 | 63 |
| | Accessories | Cleaning | og Pharma | ood & Treat | Supply | accuracy | macro avg | weighted avg |
| precision | 0.913043 | 0 | 0.5 | 0.8 | 0.789474 | 0.809524 | 0.600503 | 0.774396 |
| recall | 0.954545 | 0 | 0.6 | 0.857143 | 0.789474 | 0.809524 | 0.640232 | 0.809524 |
| f1-score | 0.933333 | 0 | 0.545455 | 0.827586 | 0.789474 | 0.809524 | 0.61917 | 0.791219 |
| support | 22 | 3 | 5 | 14 | 19 | 0.809524 | 63 | 63 |
| | | | | | | T-Value | | |
| precision | 0.157288 | 0.135974 | 0.242182 | 0.059028 | -0.01966 | 0.243735 | 81.36% | |
| recall | 0.175167 | 0.144908 | 0.253012 | -0.09805 | -0.04762 | -0.38751 | 70.86% | |
| f1-score | 0.139632 | 0.139986 | 0.236482 | -0.07547 | -0.05977 | -0.31912 | 75.78% | |



| | Accessories | Cleaning | Dog | Pharmaco | Food & Treat | Supply | accuracy | macro avg | weighted avg |
|-----------|-------------|----------|----------|----------|--------------|----------|----------|-----------|--------------|
| precision | 0.826087 | 0 | 0.75 | 0.75 | 0.7 | 0.761905 | 0.605217 | 0.725776 | |
| recall | 0.863636 | 0 | 0.6 | 0.857143 | 0.736842 | 0.761905 | 0.611524 | 0.761905 | |
| f1-score | 0.844444 | 0 | 0.666667 | 0.8 | 0.717949 | 0.761905 | 0.605812 | 0.742097 | |
| support | 22 | 3 | 5 | 14 | 19 | 0.761905 | 63 | 63 | |
| | Accessories | Cleaning | Dog | Pharmaco | Food & Treat | Supply | accuracy | macro avg | weighted avg |
| precision | 0.76 | 0 | 1 | 0.764706 | 0.736842 | 0.761905 | 0.65231 | 0.736919 | |
| recall | 0.863636 | 0 | 0.4 | 0.928571 | 0.736842 | 0.761905 | 0.58581 | 0.761905 | |
| f1-score | 0.808511 | 0 | 0.571429 | 0.83871 | 0.736842 | 0.761905 | 0.591098 | 0.736291 | |
| support | 22 | 3 | 5 | 14 | 19 | 0.761905 | 63 | 63 | |
| | | | | | | T-Value | | | |
| precision | 0.116495 | 0.144443 | 0.228446 | -0.04709 | -0.01114 | -0.20614 | 84.19% | | |
| recall | 0.128422 | 0.148796 | 0.235464 | 0.025714 | 0 | 0.109207 | 91.57% | | |
| f1-score | 0.119485 | 0.119901 | 0.218809 | 0.014714 | 0.005807 | 0.067245 | 94.80% | | |



| | Accessories | Cleaning | log Pharma | ood & Treat | Supply | accuracy | macro avg | weighted avg |
|-----------|-------------|----------|------------|-------------|----------|----------|-----------|--------------|
| precision | 0.826087 | 0 | 0.75 | 0.75 | 0.7 | 0.761905 | 0.605217 | 0.725776 |
| recall | 0.863636 | 0 | 0.6 | 0.857143 | 0.736842 | 0.761905 | 0.611524 | 0.761905 |
| f1-score | 0.844444 | 0 | 0.666667 | 0.8 | 0.717949 | 0.761905 | 0.605812 | 0.742097 |
| support | 22 | 3 | 5 | 14 | 19 | 0.761905 | 63 | 63 |

| | Accessories | Cleaning | log Pharma | ood & Treat | Supply | accuracy | macro avg | weighted avg |
|-----------|-------------|----------|------------|-------------|----------|----------|-----------|--------------|
| precision | 0.76 | 0 | 1 | 0.764706 | 0.736842 | 0.761905 | 0.65231 | 0.736919 |
| recall | 0.863636 | 0 | 0.4 | 0.928571 | 0.736842 | 0.761905 | 0.58581 | 0.761905 |
| f1-score | 0.808511 | 0 | 0.571429 | 0.83871 | 0.736842 | 0.761905 | 0.591098 | 0.736291 |
| support | 22 | 3 | 5 | 14 | 19 | 0.761905 | 63 | 63 |

| | T-Value | | | | | | |
|-----------|----------|----------|----------|-----------|-----------|-----------|--------|
| precision | 0.116495 | 0.144443 | 0.228446 | -0.047092 | -0.011142 | -0.206142 | 84.19% |
| recall | 0.128422 | 0.148796 | 0.235464 | 0.025714 | 0 | 0.109207 | 91.57% |
| f1-score | 0.119485 | 0.119901 | 0.218809 | 0.014714 | 0.005807 | 0.067245 | 94.80% |