













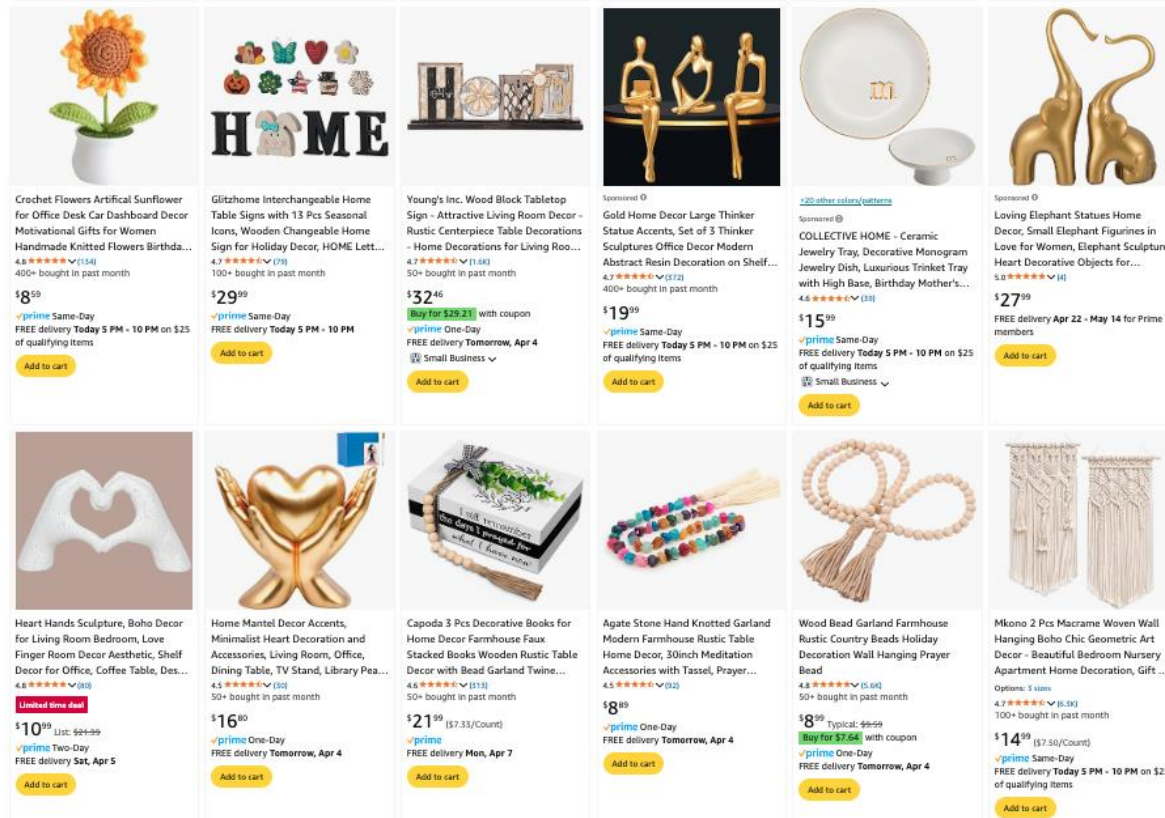
Popularity Prediction and Recommendations with Bayesian Ratings



Brain Station Capstone
Soniya Sharma

| | | | | | |
|---|--|--|---|---|--|
|  <p>Crochet Flowers Artificial Sunflower for Office Desk Car Dashboard Decor Motivational Gifts for Women Handmade Knitted Flowers Birthda...</p> <p>4.8 ★★★★★ (134) 400+ bought in past month</p> <p>\$8⁹⁹</p> <p>✓prime Same-Day FREE delivery Today 5 PM - 10 PM on \$25 of qualifying items</p> <p>Add to cart</p> |  <p>Glitzhome Interchangeable Home Table Signs with 13 Pcs Seasonal Icons, Wooden Changeable Home Sign for Holiday Decor, HOME Lett...</p> <p>4.7 ★★★★★ (79) 100+ bought in past month</p> <p>\$29⁹⁹</p> <p>✓prime Same-Day FREE delivery Today 5 PM - 10 PM</p> <p>Add to cart</p> |  <p>Young's Inc. Wood Block Tabletop Sign - Attractive Living Room Decor - Rustic Centerpiece Table Decorations - Home Decorations for Living Roo...</p> <p>4.7 ★★★★★ (168) 50+ bought in past month</p> <p>\$32⁴⁶ Buy for \$29.21 with coupon</p> <p>✓prime One-Day FREE delivery Tomorrow, Apr 4</p> <p>Add to cart</p> |  <p>Gold Home Decor Large Thinker Statue Accents, Set of 3 Thinker Sculptures Office Decor Modern Abstract Resin Decoration on Shelf...</p> <p>4.7 ★★★★★ (172) 400+ bought in past month</p> <p>\$19⁹⁹</p> <p>✓prime Same-Day FREE delivery Today 5 PM - 10 PM on \$25 of qualifying items</p> <p>Add to cart</p> |  <p>COLLECTIVE HOME - Ceramic Jewelry Tray, Decorative Monogram Jewelry Dish, Luxurious Trinket Tray with High Base, Birthday Mother's...</p> <p>4.6 ★★★★★ (18) 100+ bought in past month</p> <p>\$15⁹⁹</p> <p>✓prime Same-Day FREE delivery Today 5 PM - 10 PM on \$25 of qualifying items</p> <p>Add to cart</p> |  <p>Loving Elephant Statues Home Decor, Small Elephant Figurines in Love for Women, Elephant Sculpture Heart Decorative Objects for...</p> <p>5.0 ★★★★★ (4)</p> <p>\$27⁹⁹</p> <p>FREE delivery Apr 22 - May 14 for Prime members</p> <p>Add to cart</p> |
|  <p>Heart Hands Sculpture, Boho Decor for Living Room Bedroom, Love Finger Room Decor Aesthetic, Shelf Decor for Office, Coffee Table, Des...</p> <p>4.8 ★★★★★ (100)</p> <p>\$10⁹⁹ (List: \$9.99)</p> <p>✓prime Two-Day FREE delivery Sat, Apr 5</p> <p>Add to cart</p> |  <p>Home Mantel Decor Accents, Minimalist Heart Decoration and Accessories, Living Room, Office, Dining Table, TV Stand, Library Pea...</p> <p>4.8 ★★★★★ (10)</p> <p>\$16⁹⁹</p> <p>✓prime One-Day FREE delivery Tomorrow, Apr 4</p> <p>Add to cart</p> |  <p>Capoda 3 Pcs Decorative Books for Home Decor Farmhouse Rustic Table Stacked Books Wooden Rustic Table Decor with Bead Garland Twine...</p> <p>4.8 ★★★★★ (112) 50+ bought in past month</p> <p>\$21⁹⁹ (\$7.33/Count)</p> <p>✓prime FREE delivery Mon, Apr 7</p> <p>Add to cart</p> |  <p>Agate Stone Hand Knotted Garland Modern Farmhouse Rustic Table Home Decor, 30inch Meditation Accessories with Tassel, Prayer...</p> <p>4.8 ★★★★★ (12)</p> <p>\$8⁹⁹</p> <p>✓prime One-Day FREE delivery Tomorrow, Apr 4</p> <p>Add to cart</p> |  <p>Wood Bead Garland Farmhouse Rustic Country Beads Holiday Decoration Wall Hanging Prayer Bead</p> <p>4.8 ★★★★★ (64) 50+ bought in past month</p> <p>\$8⁹⁹ Typical: \$9.99 Buy for \$7.64 with coupon</p> <p>✓prime One-Day FREE delivery Tomorrow, Apr 4</p> <p>Add to cart</p> |  <p>Mkono 2 Pcs Macrame Woven Wall Hanging Boho Chic Geometric Art Decor - Beautiful Bedroom Nursery Apartment Home Decoration, Gift ...</p> <p>Options: 5 sizes 4.7 ★★★★★ (6,16) 100+ bought in past month</p> <p>\$14⁹⁹ (\$7.50/Count)</p> <p>✓prime Same-Day FREE delivery Today 5 PM - 10 PM on \$25 of qualifying items</p> <p>Add to cart</p> |

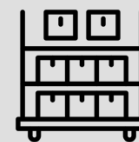
Every day
at
Amazon...















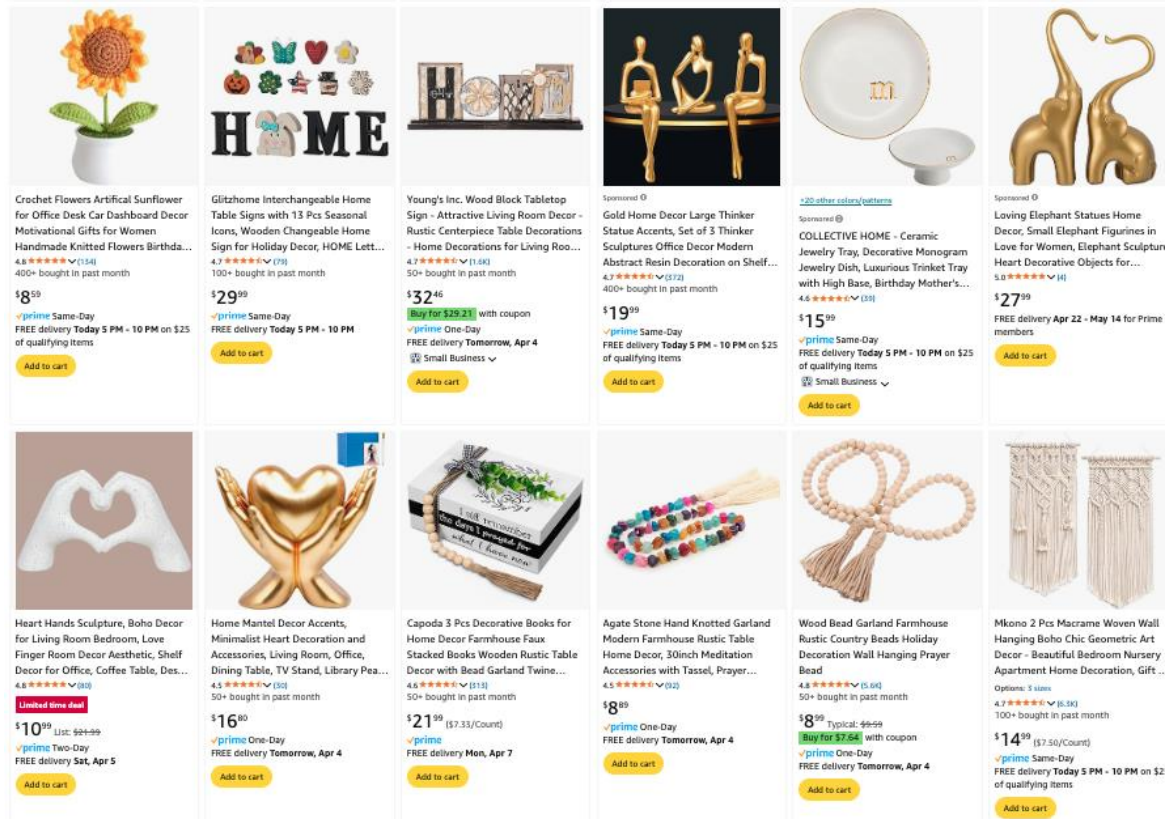
Every day at Amazon...



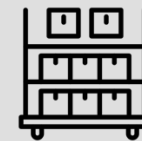
Every day at Amazon...



| | | | | | |
|---|--|--|---|--|---|
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Every day at Amazon...



Home & Kitchen › Home Décor Products › Vases



Roll over image to zoom in



Set of 2 Donut Vase Hollow
Ceramic Vase Handmade
Minimalist Boho ins Style,
Modern Vase for Home Decor
for Wedding Dinner Table Party
Living Room Office Bedroom
(Gold, Large + Small)

Brand: Fulloog

4.5 ★★★★★ (46)

\$19⁹⁹

FREE Returns ▼

Size: Large + Small

Every day at Amazon...



Amazon Reviews'23

Meta Data

- 164k handmade items
- > 3800 sellers
- Product Prices/Age/Category
- Product Title/Descriptions

Data Source: McAuley Lab, collected in 2023 on the category of handmade items.

Part 1

Can we
predict
success
using meta
data?

Amazon Reviews'23

Review Data

- 664k reviews
- 200k reviewers
- Verified Purchases
- Review title/text


Data Source: McAuley Lab, collected in 2023 on the category of handmade items.


Part 2


Can early
ratings refine
predictions?

Part 3


How can we turn ratings into recommend- ations?

 **Settings**

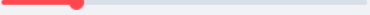
Select a Product: 

Personalized Baby Shark Birthda... 

Number of recommendations:


1 10 20

Minimum ratings:


0 205 1000

Recommend

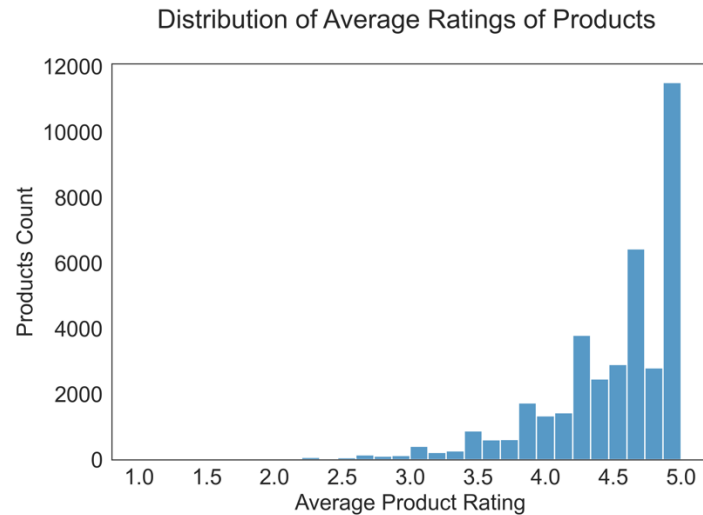
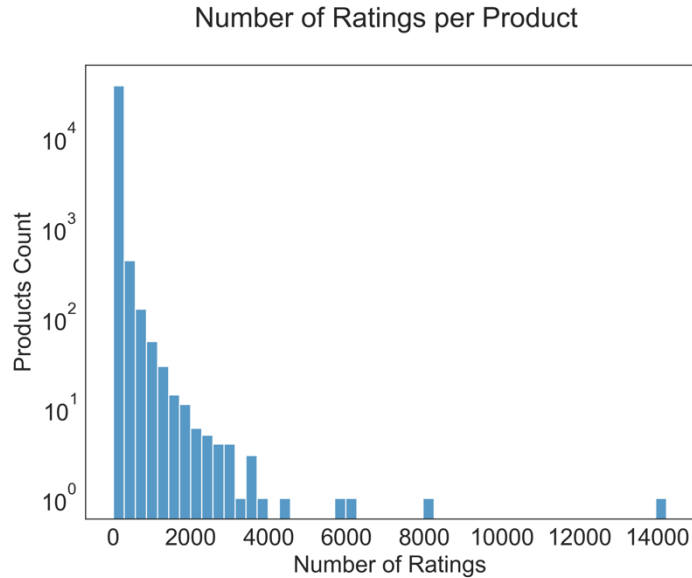
Amazon Product Recommender

Discover Similar Products with Bayesian Ratings and Content-Based Filtering.

How it works:

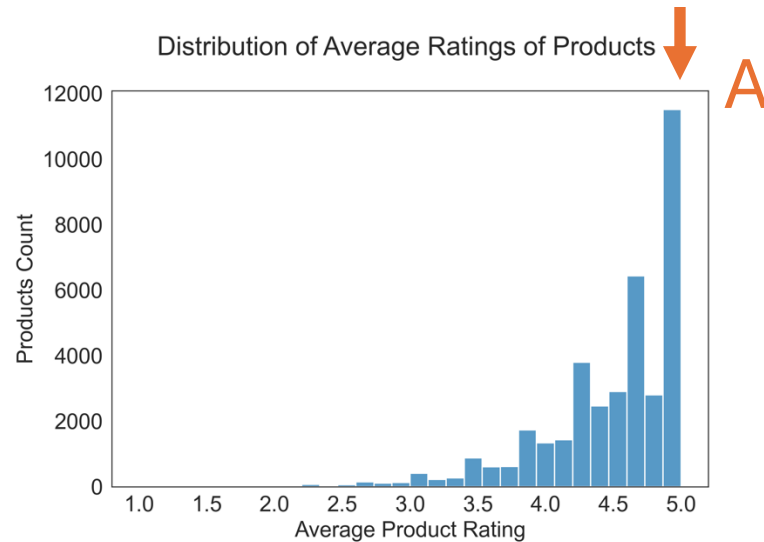
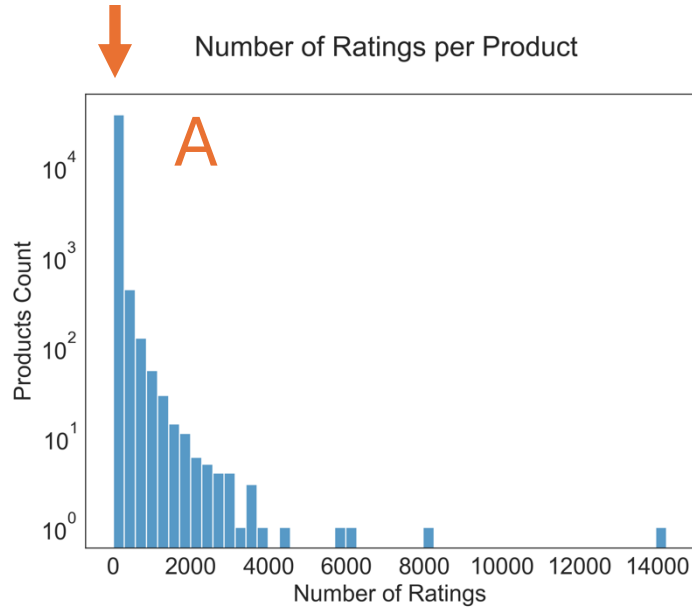
- Enter a product name
- Adjust filters (ratings, number of recs)
- Get instant recommendations!

Done!



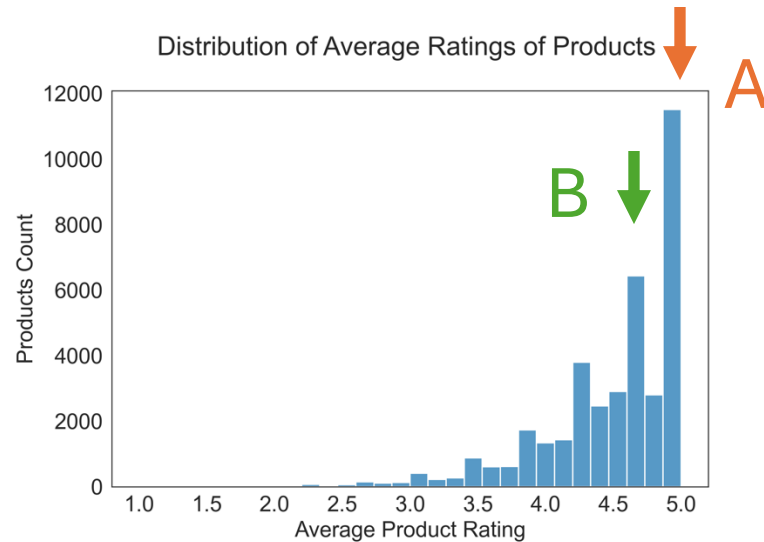
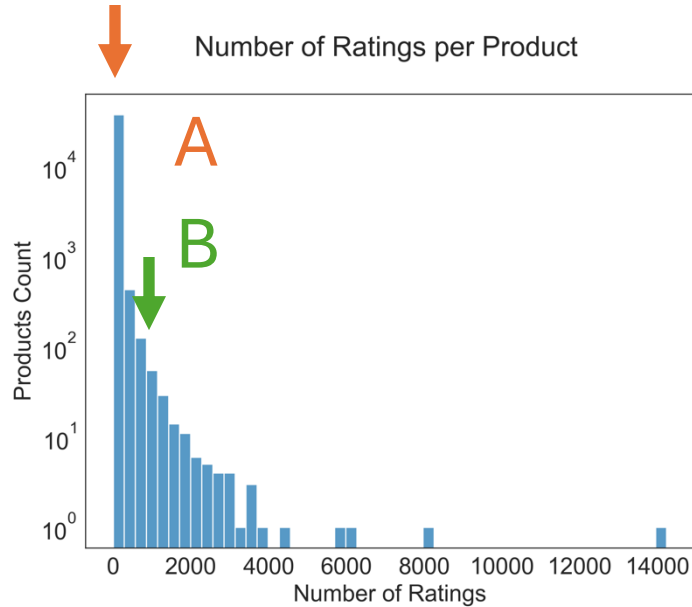
Problem with raw averages

- Raw Averages overvalue sparse ratings
- A new product with one 5★ rating would outrank an established product with 4.8★ from 500 reviews.



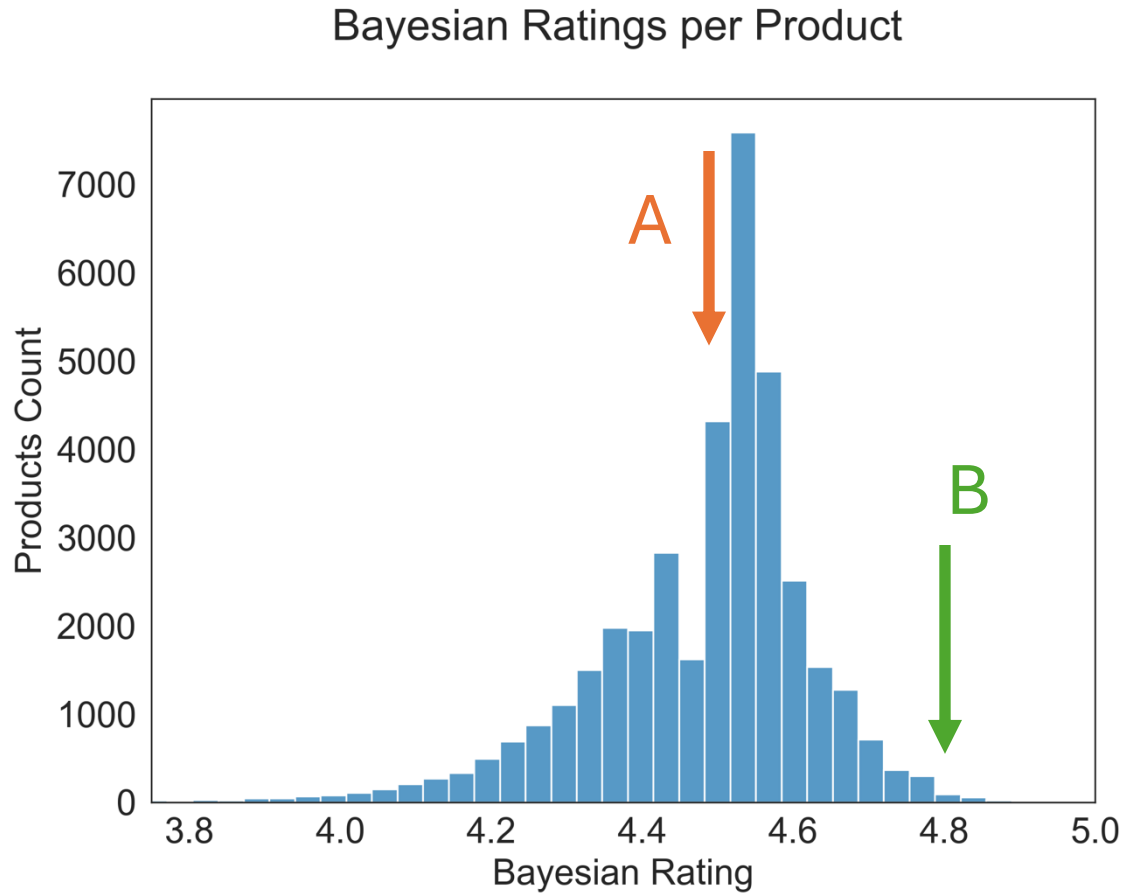
Problem with raw averages

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Problem with raw averages

- Raw Averages overvalue sparse ratings
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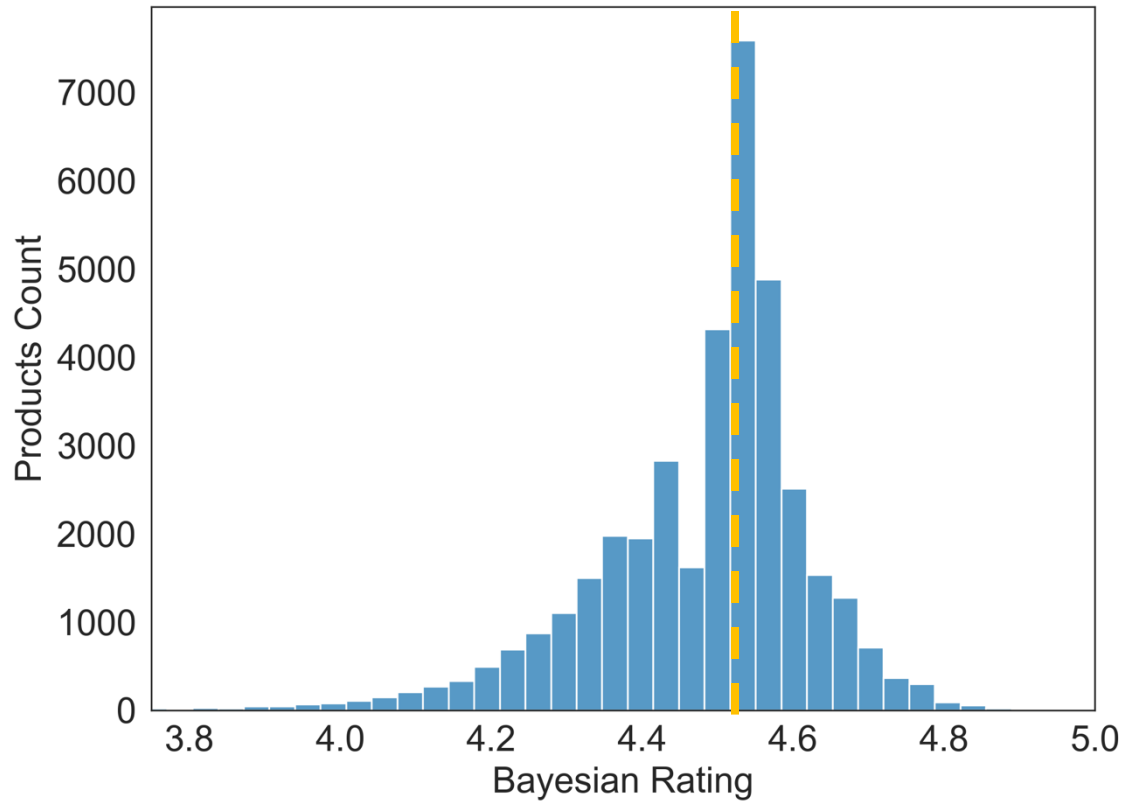
$$\text{Adjusted Rating} = \frac{(\text{avg rating} \times \text{count of ratings}) + (\text{global_avg} \times \text{trust_threshold})}{\text{count of ratings} + \text{trust_threshold}}$$

Bayesian Ratings

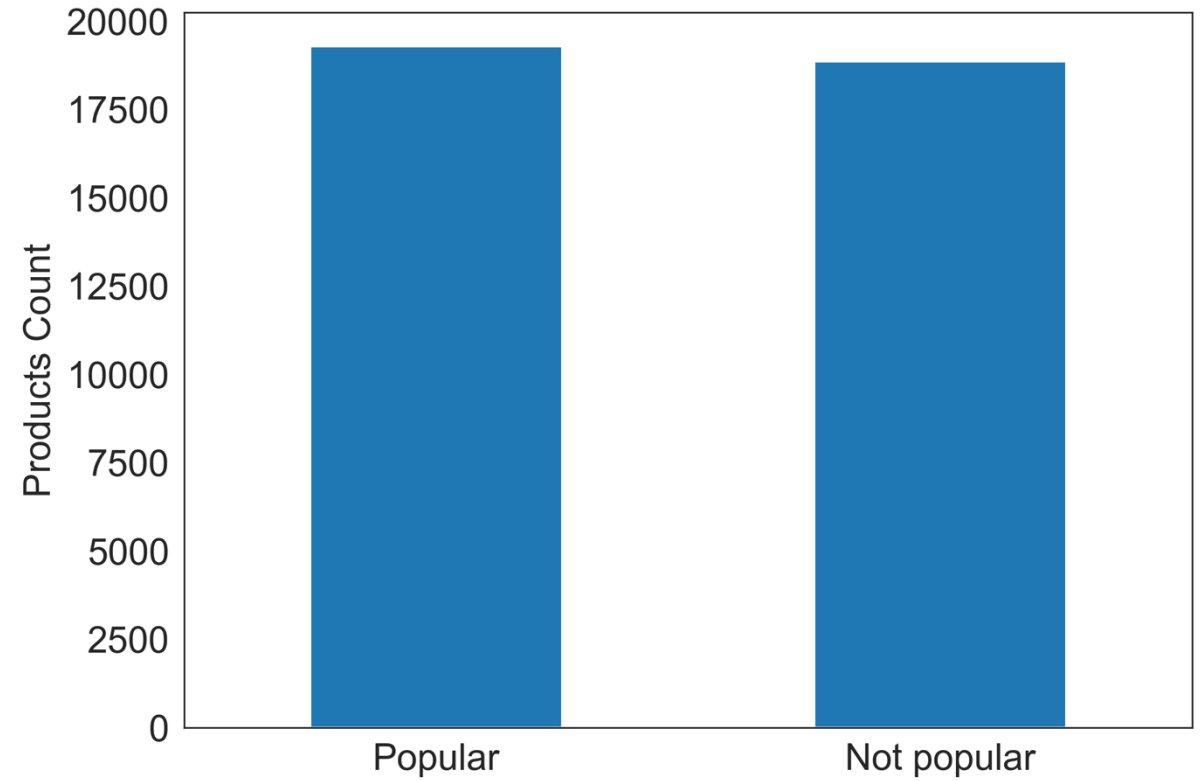
- Confidence weighted ratings for sparse data.
- Create fair popularity thresholds.

Target Variable – Product Popularity

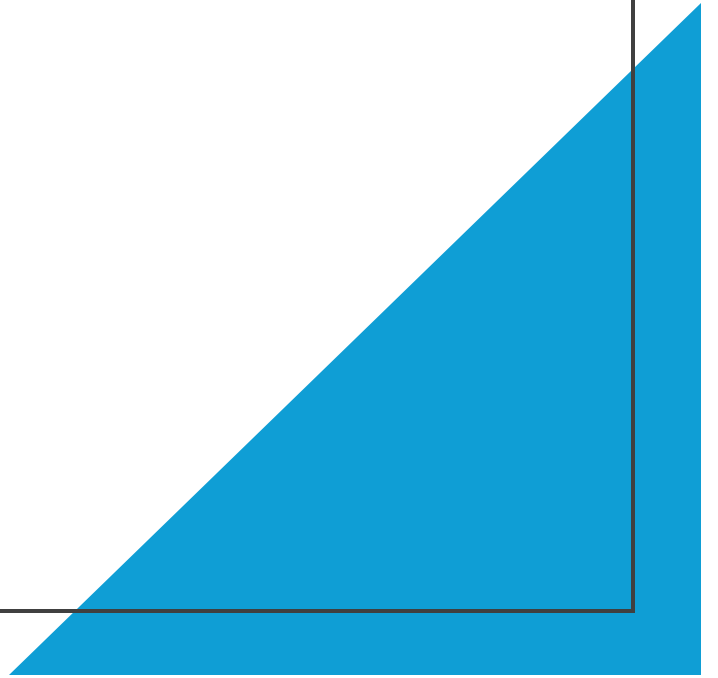
Bayesian Ratings per Product



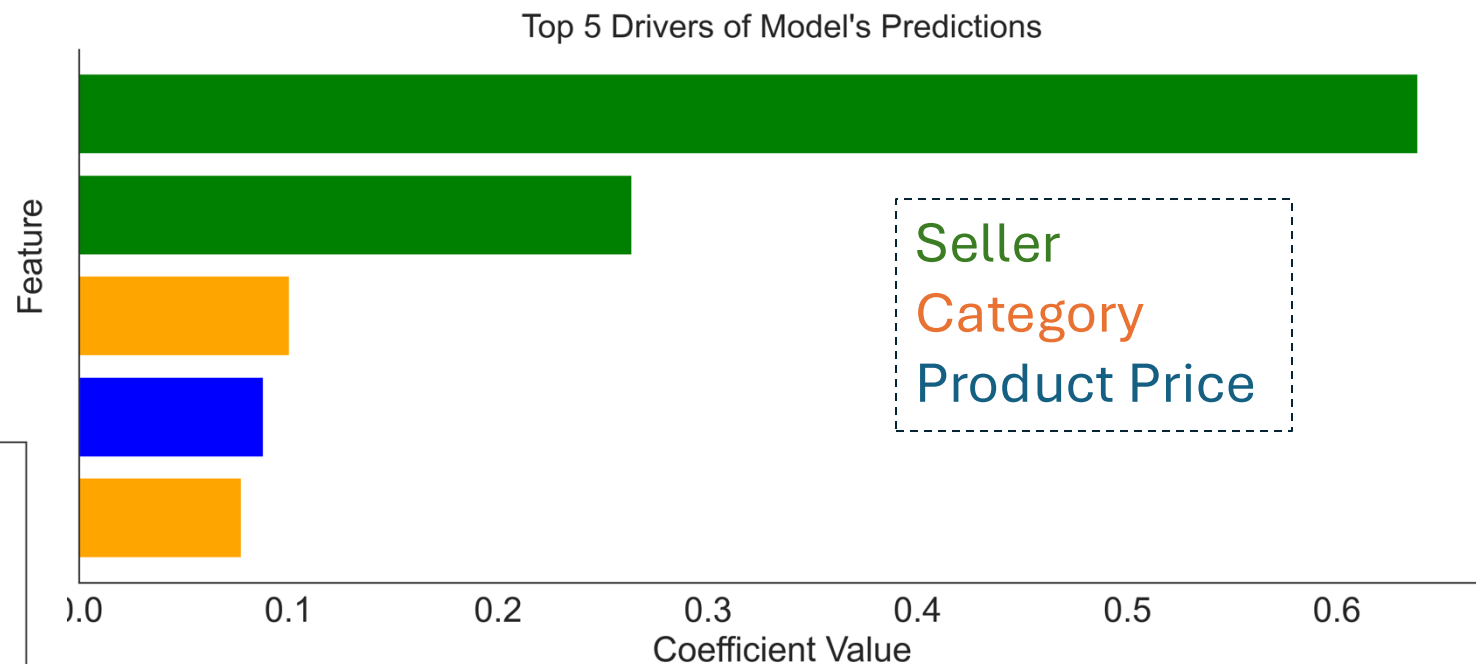
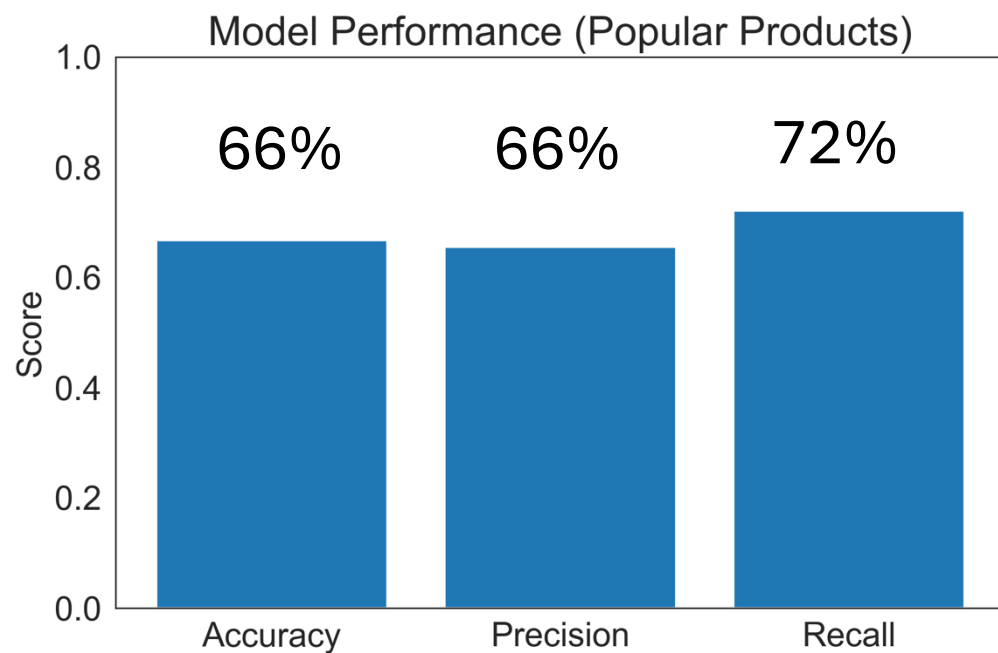
Distribution of Target Variable



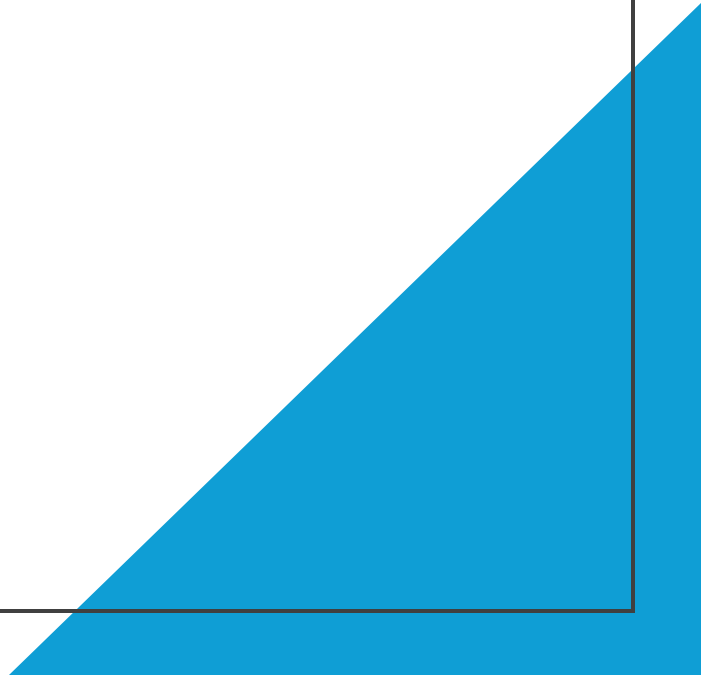
Part1: Can we predict success using meta data?



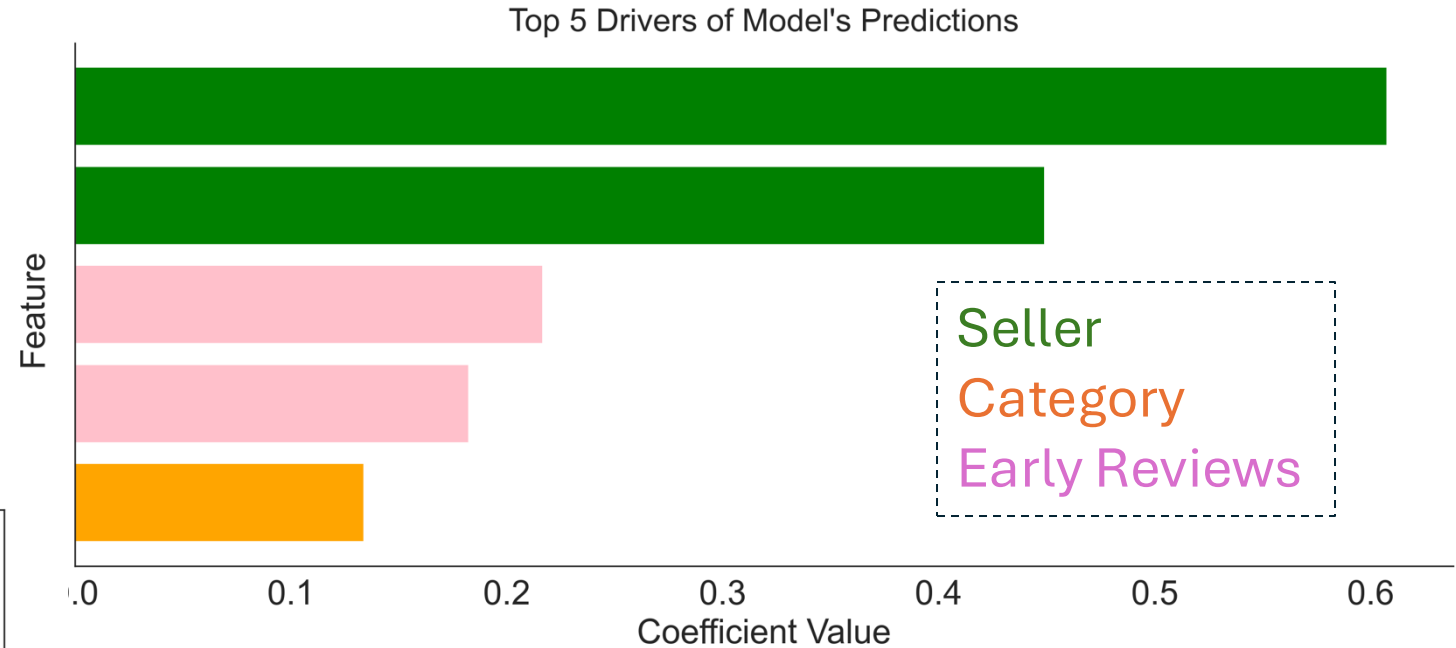
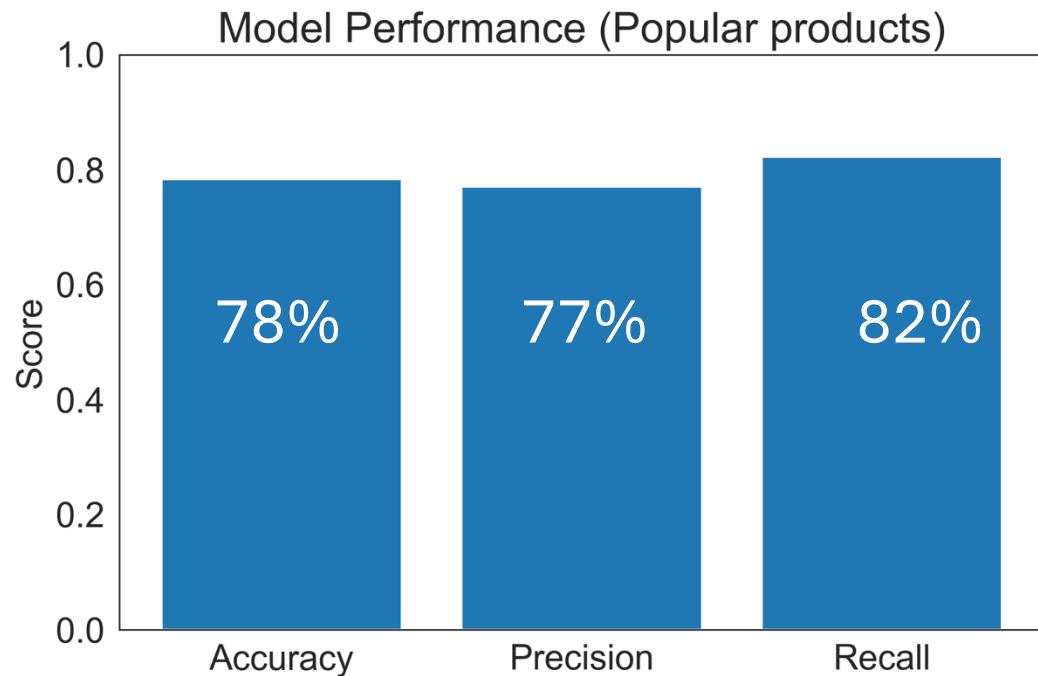
Metadata Based Popularity Prediction (Logistic Regression)



Part2: Can early ratings refine predictions?



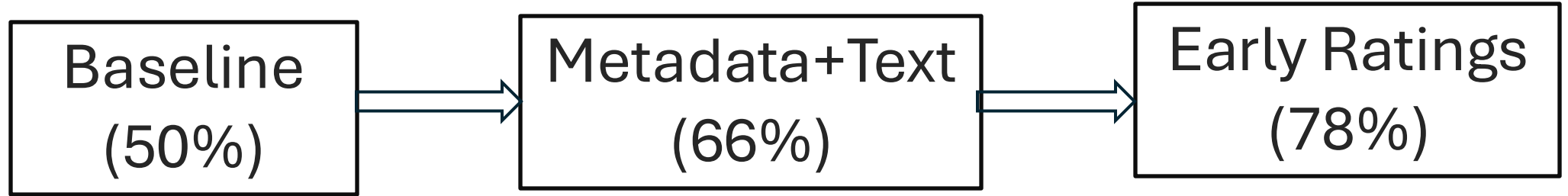
Early Ratings Improve Predictions (Logistic Regression)



Seller Category >> Text based features

How does model compare?

**My
Model**



**Industry
Benchmark**

70-80%

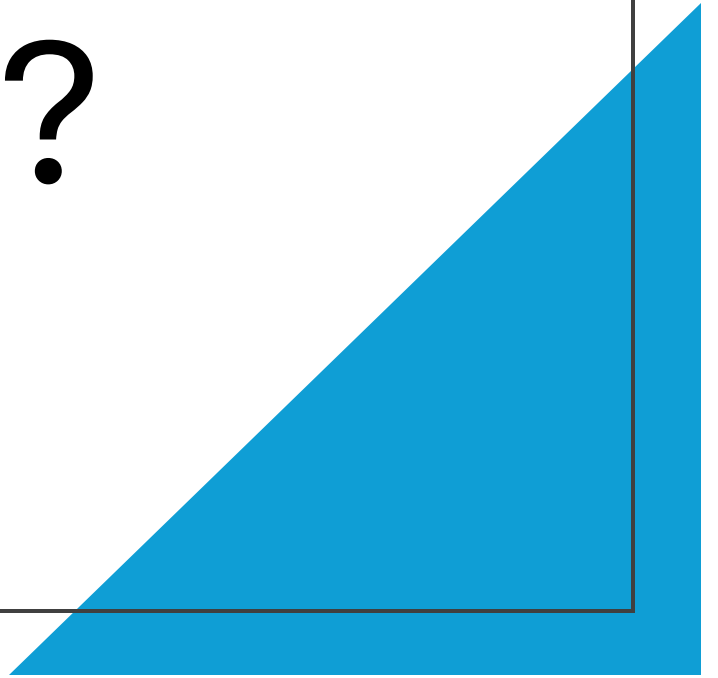
80-90%

Linden et al.2017, Wang et al. 2020, Chen et al 2023.

**Key
Differences**

User Behavior signals (demographics)
Specific Features (Brand/Material)
Brand Reputation from external sources
Image embeddings

Part3: How can we turn ratings into recommendations?




Textual Features


Product Title
Product Category

Numerical Features

Bayesian Rating, Product Price
Rating Counts

 Settings

Select a Product:

Personalized Baby Shark Birthda... 

Number of recommendations:

10

120

Minimum ratings:

10

01000

Recommend

Discover Similar Products with Bayesian Ratings and Content-Based Filtering.

How it works:

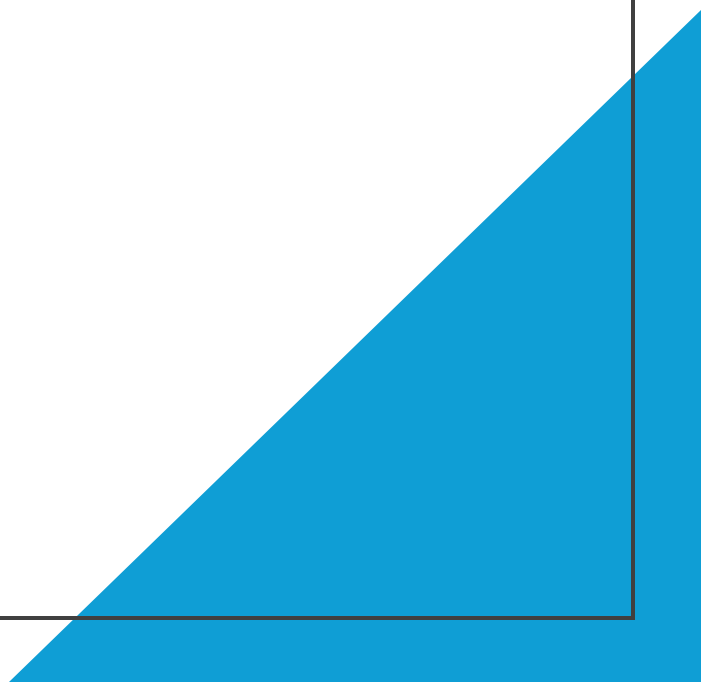
- Enter a product name
- Adjust filters (ratings, number of recs)
- Get instant recommendations!

Done!

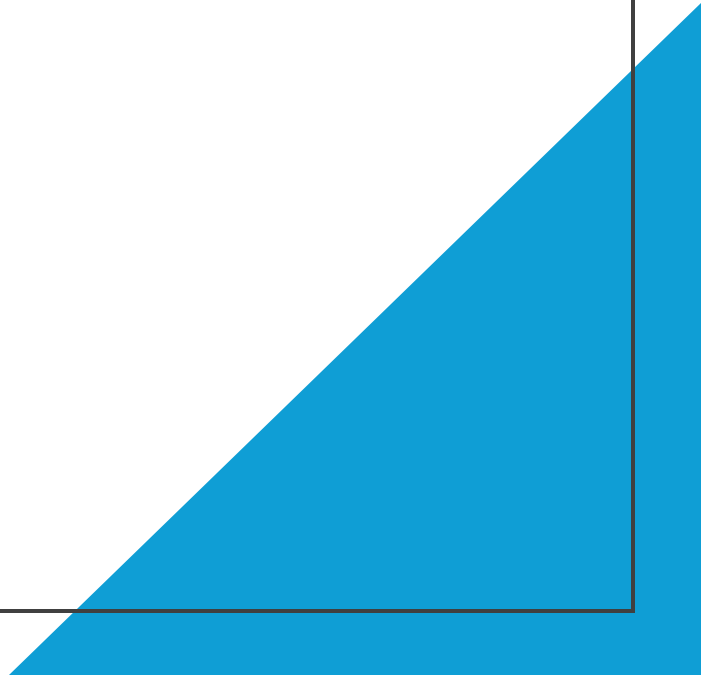
🌟 Recommendations for: Personalized Baby Shark Birthday Outfit Tutu Set

| | product_title | similarity_score | bayesian_rating | rating_number | average_rating | product_age_days |
|-------|---|------------------|-----------------|---------------|----------------|------------------|
| 6339 | Personalized Oona and Molly Birthday Outfit Tutu Set Purple/Turquoise | 0.59 | 4.34 | 16 | 4.1 | 1983 |
| 13589 | Raiders Baby Outfit - Tutus and Touchdowns - Raiders Fan Gift - Raiders Tutu Outfit - Rai | 0.58 | 4.68 | 24 | 4.9 | 1614 |
| 16407 | Personalized Girls Birthday Outfit Tutu Multi Colored Set | 0.57 | 4.43 | 11 | 4.3 | 1983 |
| 15168 | Birthday Outfit Baby Outfit First Birthday Outfit Girl Dress for Toddler Girls Handmade C | 0.52 | 4.59 | 238 | 4.6 | 1812 |
| 16211 | First Birthday Outfit Girl Shirt Rainbow Tutu for Girls Colorful Animal Print 4th 3rd 2nd 1 | 0.52 | 4.57 | 65 | 4.6 | 1812 |
| 12492 | Mouse Birthday Tutu Outfit Set Dress Shirt First Birthday 1st Pink and Gold | 0.5 | 4.43 | 48 | 4.4 | 2390 |
| 950 | Mouse Birthday Number Party Dress 2nd Birthday Tutu Outfit Shirt | 0.48 | 4.38 | 37 | 4.3 | 1683 |
| 11154 | Girls Birthday Shark Personalized Baby Shark Leotard | 0.48 | 4.64 | 26 | 4.8 | 1652 |
| 16345 | Take Home Outfit Baby Girl Outfit Hello World Pink Silver Personalized Name Optional 1 | 0.46 | 4.58 | 12 | 4.8 | 2224 |
| 14420 | Peppa Girl four birthday Outfit Peppa Baby Girl 4th Birthday outfit Pig Birthday outfit Pe | 0.43 | 4.72 | 33 | 4.9 | 832 |

THANK YOU



Backup Slides



$$\text{Adjusted Rating} = \frac{(\text{avg rating} \times \text{count of ratings}) + (\text{global_avg} \times \text{trust_threshold})}{\text{count of ratings} + \text{trust_threshold}}$$

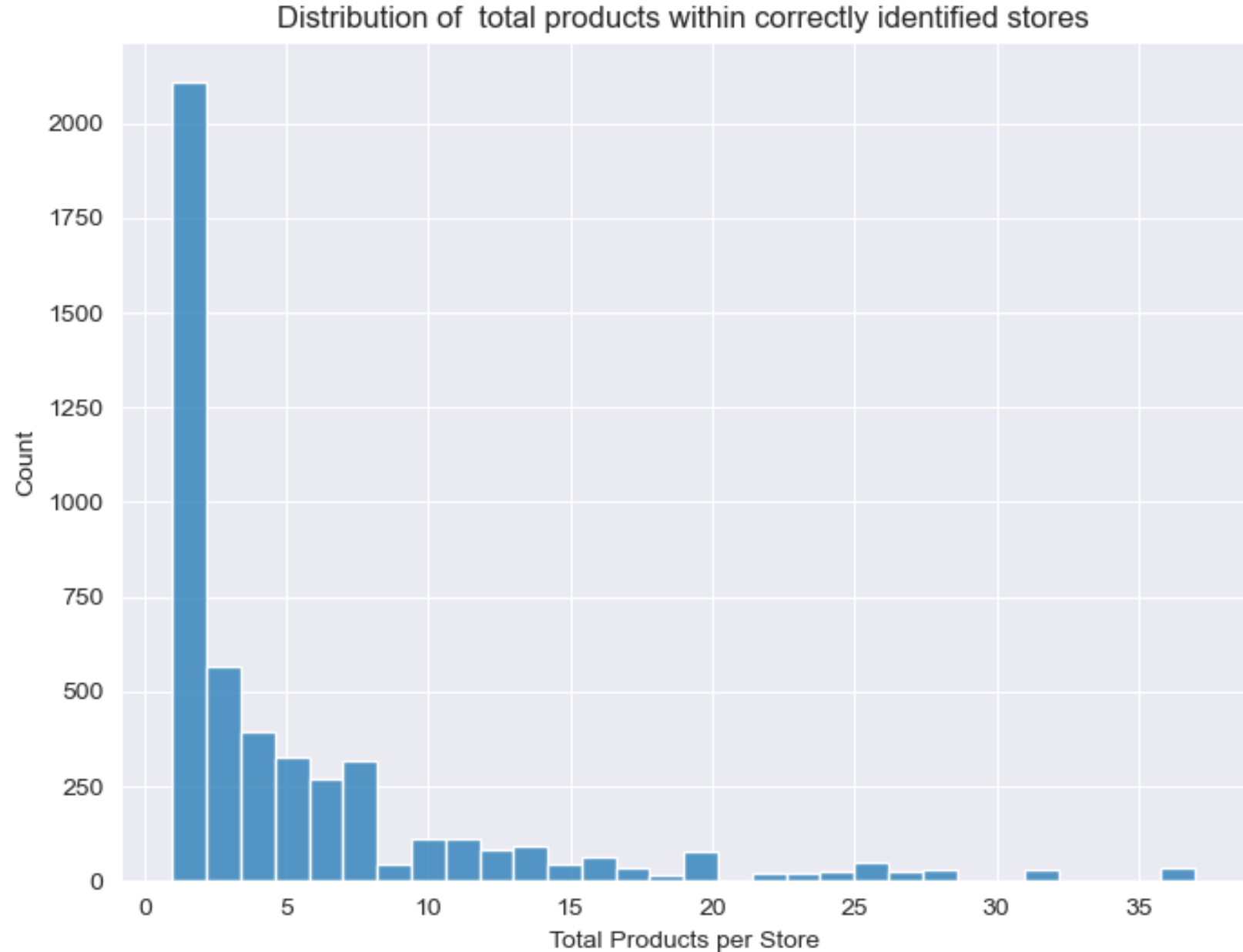
Variables:

| Term | Description |
|-----------------|---|
| Product Avg | The product's current average rating. |
| Rating Count | The number of ratings the product has received. |
| Global Avg | The average rating across <i>all</i> products in the dataset (4.49). |
| Trust Threshold | The minimum number of ratings needed to "trust" the score (75% → 20 reviews). |

Bayesian Ratings

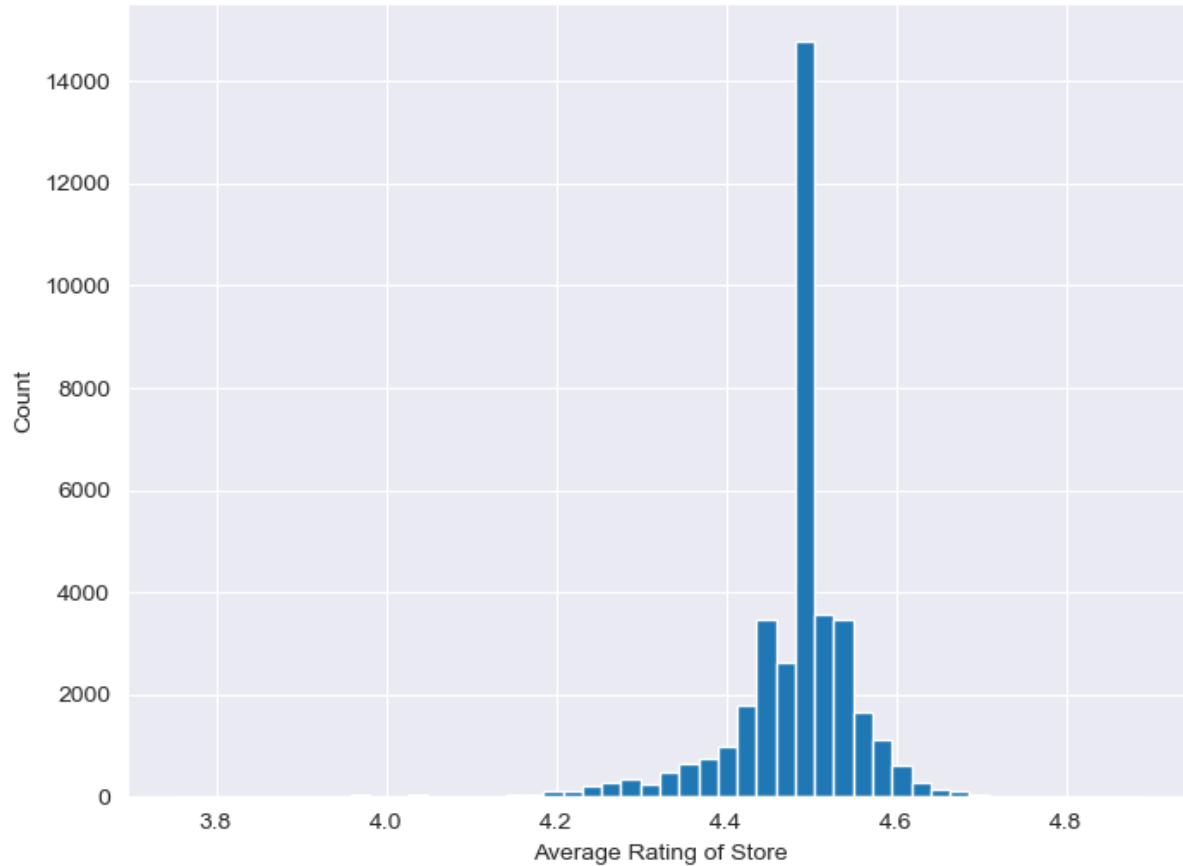
- Weighted Average between products's observed rating and a prior belief.
- As number of ratings increase, weight shifts towards product's actual average.

Product Counts for Correctly predicted stores

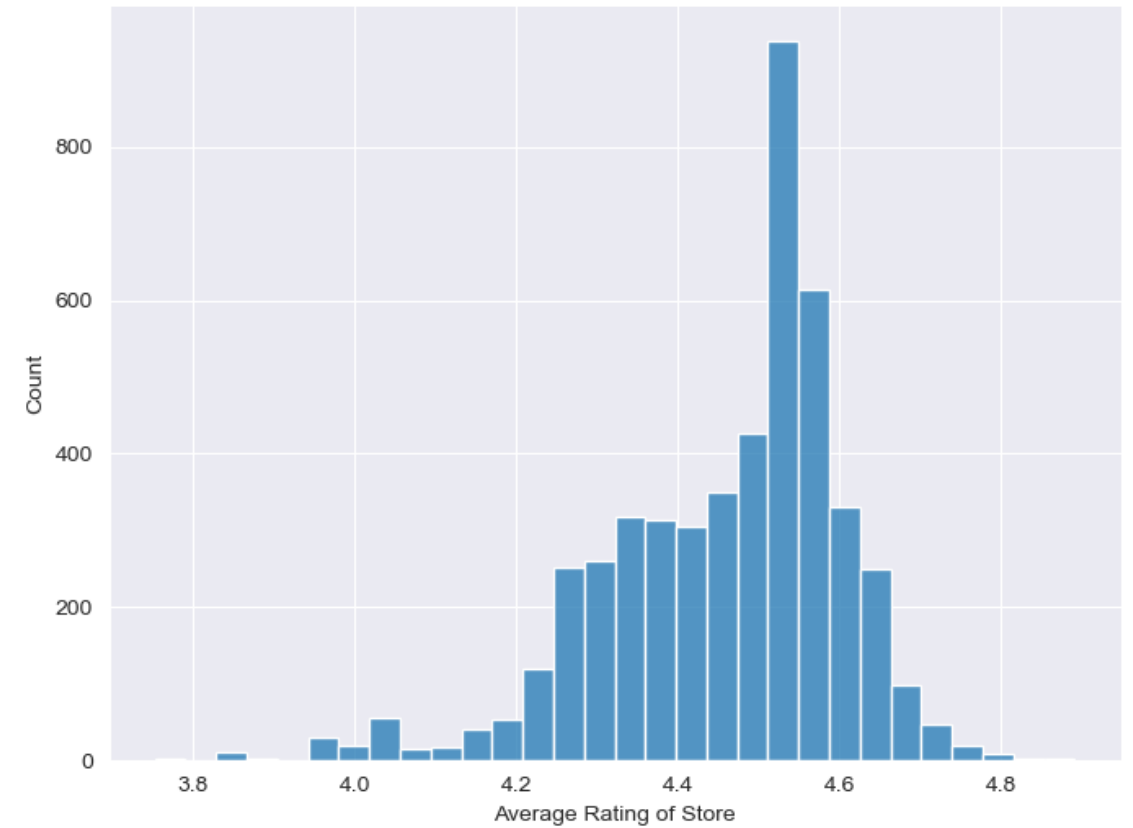


Average Store Ratings

Distribution of Average Store Ratings of All Stores in the dataset



Distribution of Average Store Ratings of Correctly Identified Stores



Better Performance for stores with higher mean ratings i.e. more popular products

Stakeholder Focus

| Stakeholder | Key Metric | Business impact |
|-------------|------------------------------------|---|
| Customer | Precision (Popular) | Ensures recommended products are truly high-quality |
| Seller | Recall (Popular) | Prevents good products from being missed |
| Platforms | Top 5% Precision (Unpopular Class) | Flags low-quality/fraudulent listings |