

E-Commerce Recommendations

Nina Mishra

Using the electronic trail left by millions to help the next person

Recommendations are Everywhere



Who to follow



Goal of Today's Discussion

- Examples of E-Commerce Recommendations
- Metrics
- Methods
- Pitfalls



Amazon.com Recommendations

Substitutes/Complements

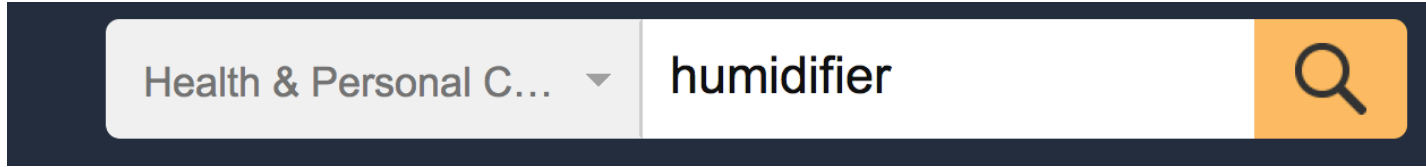
- **Substitutes**

- Similar goods
- Examples: Coke/pepsi, margarine/butter, tea/coffee
- X and Y are substitutes if, when the price of X rises, the demand for Y rises

- **Complements**

- A good often consumed with another
- Examples: Razors/razor blades, Printers/ink cartridges, Pencils/erasers
- Higher demand for X implies higher demand for Y , Lower demand for X implies lower demand for Y

Recommendations



Customers Who Shopped for *Vicks Warm Mist Humidifier with Auto Shut-Off* Also Shopped For



Customers Who Bought *Vicks Warm Mist Humidifier with Auto Shut-Off* Also Bought



Bundles

Frequently Bought Together



Total price: **\$49.46**

Add all three to Cart

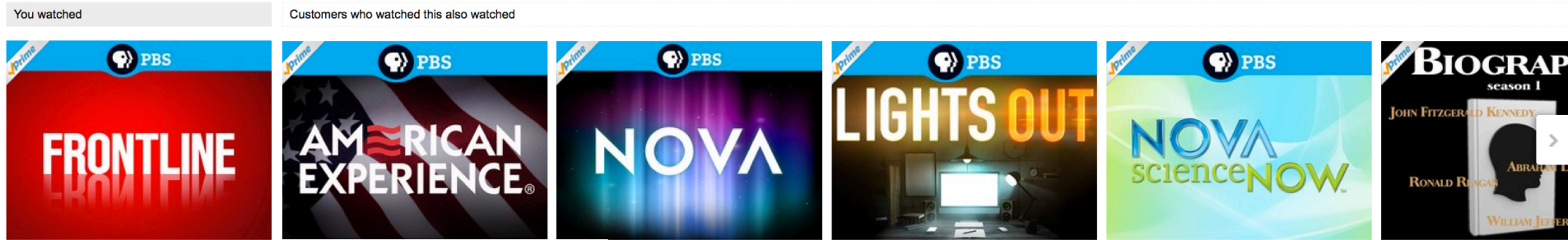
Add all three to Wish List

i These items are shipped from and sold by different sellers. [Show details](#)

- ✓ **This item:** Vicks Warm Mist Humidifier with Auto Shut-Off **\$29.85**
- ✓ Vicks VapoSteam 8 Oz **\$12.66** (\$1.58 / Fl Oz)
- ✓ Kaz Inhalant, 4 oz **\$6.95**

Video Recommendations

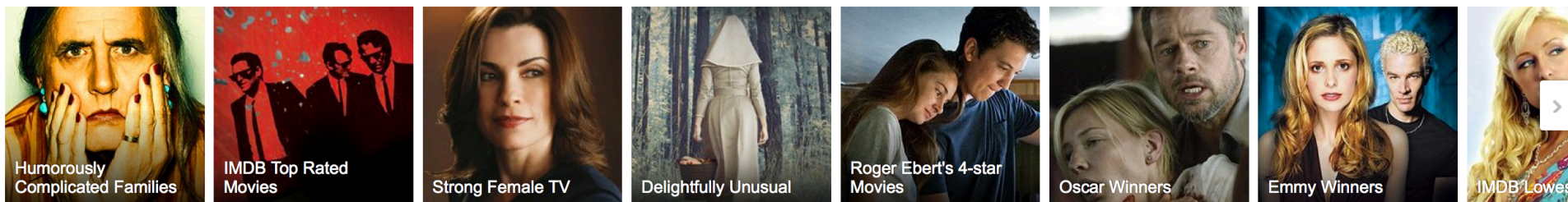
Related to Titles You've Watched



Best of Prime Video



Editor's Picks [View all](#)



Buy it Again

Megan,

Here are some items that you have purchased that other customers have bought repeatedly. We thought that you might be interested in buying them again.

Buy It Again



Bare Minerals Lasting Long Eyeliner

\$17.95



Bare Minerals Lash Domination 10-in-1

\$17.95



Bare Minerals Original Foundation

\$6.00



Paul Mitchell Super Strong Daily Shampoo

\$3.99

Discuss Data

What data could an e-commerce site collect about its customers to provide effective recommendations?

Quantity of Data (from public sources)

- 88M US customers (1/2015)¹
- 200M US products (12/2013)²
- 2.5M US products added per month³

¹<https://www.internetretailer.com/2015/01/27/45-amazons-us-customers-are-prime-members>

²<https://export-x.com/2013/12/15/many-products-amazon-sell/>

³<https://export-x.com/2014/08/14/many-products-amazon-sell-2/>

Discuss Metrics

How could we evaluate a recommendation engine? Offline? Online?

Offline Evaluation

Netflix Prize: Predicting ratings, Average Error

| Movies \ Users | Matrix | Inception | Titanic | Amélie | Love Actually | Terminator | Elysium | Avatar |
|----------------|--------|-----------|---------|--------|---------------|------------|---------|--------|
| Tom | 4 | 5 | 4 | | | 3 | 1 | 4 |
| Max | 3 | 4 | 5 | 5 | 3 | 3 | 2 | |
| Sam | 2 | | | | | 2 | 4 | 4 |

Average error vs. precision/recall at k, small integer k

Finding content people highly rate vs. watch

Best Rated vs. Most Watched

THE TALE OF THE PRINCESS KAGUYA
Isao Takahata and Yoshiaki Nishimura



AWARDS

MUSEUM

EVENTS

BEST PICTURE

WINNER

BIRDMAN OR (THE UNEXPECTED VIRTUE OF IGNORANCE)

Alejandro G. Iñárritu, John Lesher and James W. Skotchdopole, Producers

NOMINEES

SELMA

Christian Colson, Oprah Winfrey, Dede Gardner and Jeremy Kleiner, Producers

THE THEORY OF EVERYTHING

Tim Bevan, Eric Fellner, Lisa Bruce and Anthony McCarten, Producers

WHIPLASH

Jason Blum, Helen Estabrook and David Lancaster, Producers

AMERICAN SNIPER

Clint Eastwood, Robert Lorenz, Andrew Lazar, Bradley Cooper and Peter Morgan

BOYHOOD

Richard Linklater and Cathleen Sutherland, Producers

THE GRAND BUDAPEST HOTEL

Wes Anderson, Scott Rudin, Steven Rales and Jeremy Dawson, Producers

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Top-US-Grossing Feature Films Released In 2014 With

1-50 of 764 titles.

Next »

Sort by: Popularity | A-Z | User Rating | Num Votes | **US Box Office** | Runtime | Year | US Release Date

-  **American Sniper** (2014) Add to Watchlist \$350M
★ ★ ★ ★ ★ ★ ★ ☆ ☆ ☆ 7.3/10
Navy S.E.A.L. sniper Chris Kyle's pinpoint accuracy saves countless lives on the battlefield and turns him into a legend. Back home to his wife and kids after four tours of duty, however, Chris finds that it is the war he can't leave behind.
Dir: Clint Eastwood With: Bradley Cooper, Sienna Miller, Kyle Gallner
Action | Biography | Drama | History | Thriller | War 133 mins. **R**
-  **The Hunger Games: Mockingjay - Part 1** (2014) Add to Watchlist \$337M
★ ★ ★ ★ ★ ★ ☆ ☆ ☆ ☆ 6.8/10
Katniss Everdeen is in District 13 after she shatters the games forever. Under the leadership of President Coin and the advice of her trusted friends, Katniss spreads her wings as she fights to save Peeta and a nation moved by her courage.
Dir: Francis Lawrence With: Jennifer Lawrence, Josh Hutcherson, Liam Hemsworth
Adventure | Sci-Fi | Thriller 123 mins. **PG-13**
-  **Guardians of the Galaxy** (2014) Add to Watchlist \$333M
★ ★ ★ ★ ★ ★ ☆ ☆ ☆ ☆ 8.1/10
A group of intergalactic criminals are forced to work together to stop a fanatical warrior from taking control of the universe.
Dir: James Gunn With: Chris Pratt, Vin Diesel, Bradley Cooper
Action | Adventure | Sci-Fi 121 mins. **PG-13**
-  **Captain America: The Winter Soldier** (2014) Add to Watchlist \$260M
★ ★ ★ ★ ★ ★ ☆ ☆ ☆ ☆ 7.8/10
As Steve Rogers struggles to embrace his role in the modern world, he teams up with another super soldier, the Black Widow, to battle a new threat from history.

Textbooks exist.

RECOMMENDATION ALGORITHMS

Traditional Recommendation Approach

- Represent customer c by vector over items, e.g., +1 positively rated, -1 negatively rated
- Scale vector by $1/\text{popularity}$, making less well-known items more relevant
- To recommend to customer c , find other customers c' similar to c
$$\text{similarity}(\vec{A}, \vec{B}) = \cos(\vec{A}, \vec{B}) = \frac{\vec{A} \bullet \vec{B}}{\|\vec{A}\| * \|\vec{B}\|}$$
- And recommend according to how many similar customers liked the product

Item-to-Item Collaborative Filtering

```
For each item in product catalog,  $I_1$ 
  For each customer  $C$  who purchased  $I_1$ 
    For each item  $I_2$  purchased by
      customer  $C$ 
        Record that a customer purchased  $I_1$ 
          and  $I_2$ 
  For each item  $I_2$ 
    Compute the similarity between  $I_1$  and  $I_2$ 
```

Substitute vs. complement?
Bundles?

PITFALLS

Incorrect Conclusions about Customers: My TiVo Thinks I'm Gay



Unintentional Bias

You are here: [Home Page](#) > [Movies](#) > [DVD](#) > [DVD Box Sets](#) > [Action & Adventure](#)

Planet Of The Apes: The Complete TV Series



⊕ Click image to enlarge it

NOT
RATED



Starring: [Roddy McDowall](#), [Ron Harper](#), [James Naughton](#)

Director: [Ralph Senensky](#)

Format: DVD

\$43.87

List Price: ~~\$49.98~~

You Save: \$6.11 (12%)

[Add to Cart](#)

Add to: [Wish List](#) [Registry](#)

IN STOCK

Usually takes 24 to 48 hours to process.
[See estimated arrival date.](#)

✓ **Dallas-Fort Worth, TX Customers:**
Free Shipping: Site to Store™
Arrives in 7-10 business days.
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Information below:

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Similar Items



[Introducing Dorothy Dandridge](#)
\$5.50



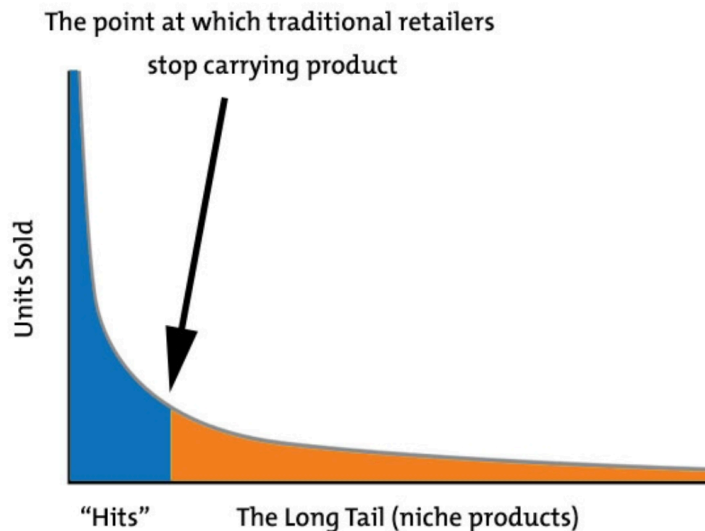
[Martin Luther King: I Have A Dream / Assassination Of MLK](#)
\$16.87

↓ [See more below](#)

Rich get Richer¹

More Sales Diversity?

Customers exposed to products they cannot easily find



Less Sales Diversity?

Reinforce popularity of already popular products

If recommending based on sales and ratings, cannot recommend products with limited history

→ Greater individual diversity but less aggregate diversity

¹[Fieder, Hosanger], Blockbuster Culture's Next Rise or Fall: The Impact of Recommender Systems on Sales Diversity, Management Science http://papers.ssrn.com/sol3/papers.cfm?abstract_id=955984

Goal of Discussion

- Examples of E-Commerce Recommendations
 - People who buy X buy Y
 - People who shop for X shop for Y
 - Movie Recommendations
 - Buy It Again
- Metrics
 - Predict ratings
 - Predict purchases
 - Online Evaluation: A/B testing
- Methods
 - Recommend what similar customers purchase
 - Recommend items similar to current item
 - Supervised, time-dependent methods
- Pitfalls
 - Incorrect Customer Conclusions
 - Unintended Bias
 - Rich get richer