E-Commerce Recommendations

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Using the electronic trail left by millions to help the next person
Recommendations are Everywhere
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
Recommenda.ons

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

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

You watched

Customers who watched this also watched

Best of Prime Video

Editor's Picks View all

Humorously Complicated Families
IMDB Top Rated Movies
Strong Female TV
Delightfully Unusual
Roger Ebert's 4-star Movies
Oscar Winners
Emmy Winners
IMDB's Lowest
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.

- **Bare Minerals Lasting Long Eyeliner**
- **Bare Minerals Original Foundation**
- **Bare Minerals Lash Domination 10-in-1**
- **Paul Mitchell Super Strong Daily Shampoo**
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 month\(^3\)

\(^1\)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**

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<th>Matrix</th>
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<th>Titanic</th>
<th>Amélie</th>
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Average error vs. precision/recall at k, small integer k

Finding content people highly rate vs. watch
Best Rated vs. Most Watched

Top-US-Grossing Feature Films Released In 2014 With

1-50 of 764 titles.

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

1. **American Sniper** (2014)  
   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.  
   $350M

   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.  
   $337M

   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.  
   $333M

4. **Captain America: The Winter Soldier** (2014)  
   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 $1/popularity$, making less well-known items more relevant.
- To recommend to customer $c$, find other customers $c'$ similar to $c$:
  \[
  \text{similarity}(\vec{A}, \vec{B}) = \cos(\vec{A}, \vec{B}) = \frac{\vec{A} \cdot \vec{B}}{\|\vec{A}\| \cdot \|\vec{B}\|}
  \]
- And recommend according to how many similar customers liked the product.

[Linden, York, Smith], 2003.
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?

[Linden, York, Smith], 2003.
PITFALLS
Incorrect Conclusions about Customers: My TiVo Thinks I’m Gay
Unintentional Bias
Rich get Richer\textsuperscript{1}

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

\textsuperscript{1}[Fieder, Hosanger], Blockbuster Culture's Next Rise or Fall: The Impact of Recommender Systems on Sales Diversity, Management Science
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