

Recommended for You: An Algorithmic View into Product Recommendations

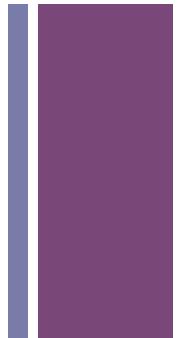
by Josh Janzen



DATA SCIENCE



Outline



- Intro to Recommendations
- Demo (begin)
- Algorithm Deep-dive
 - Collaborative Filtering
 - Bayes' Theorem for Conditional Probability
- Demo (results)
- Questions?



Recommendations

Customers Who Viewed This Item Also Viewed

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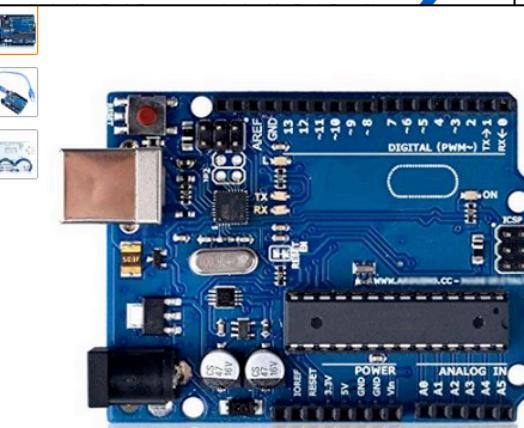


Apple - MacBook® Pro -
Intel Core i5 - 13.3"
Display - 4GB Memory -
500GB Hard Drive -
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 (5824)
On Sale: \$1,044.99

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Intel Core i5 Dual-core (2 Core) 2.40 GHz - Silver

Not Yet Reviewed
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UNO R3 Atmega328p Atmega16u2 2014 Version Board Free USB Cable for Arduino Mkg

by Joybox88

17 customer reviews

List Price: \$19.99

Price: \$10.50 & FREE Shipping on orders over \$35. [Details](#)

You Save: \$9.49 (47%)

Only 1 left in stock.

Sold by NooElec and Fulfilled by Amazon. Gift-wrap available.

Want it Wednesday, Aug. 5? Order within **19 hrs 59 mins** and choose **One Day Delivery** at checkout. [Details](#)

- Atmega 16U2 chip alternative 8U2. Means a higher transfer rate and more pins available.
- increase the SDA and SCL interface
- Size: 75 x 53 x 10mm/ 2.95 x 2.09 x 0.39in
- Package Included: 1 x Development Board 1 x USB Cable
- Trademark Mark: LANMU is a registered trademark,pls do note that LANMU is a trademark of Lanmu Technology Co., Ltd.

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This item: UNO R3 Atmega328p Atmega16u2 2014 Version Board Free USB Cable for Arduino Mkg

Wosang Solderless Flexible Breadboard Jumper Wires M/M 100pcs \$5.30

amazon



YAHOO!

known-user



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[Five Vikings facing a make-or-break season in 2015](#)

The Vikings and Packers tied 26-26. The Minnesota Vikings are a transforming team under second-year head coach Mike Zimmer. Whether it's the result of an upcoming salary-cap hit, impending free agency or waning

[Fox News](#) ▾

[Browns running backs dropping with injuries](#)

Tre

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Live

Onl

YAHOO!

unknown-user

Reunion Island debris confirmed to be from MH370

Malaysia says the fragment discovered more than a year after the jet's disappearance is from the doomed flight. ['Physical evidence'](#) »

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TRENDING

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LIVE

TRENDING

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 **6 Things to Know About Christine Ouzounian, the Nanny at the Center of the Ben Affleck-Jennifer Garner Divorce**
Though Ouzounian maintains no public social media presence, there are a few things we do know for sure about the woman who's alleged to have been

[Yahoo Celebrity](#) 32 mins ago

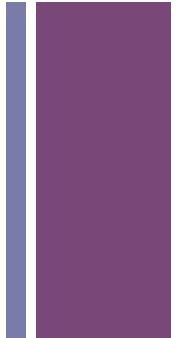
Credit Cards Are Now Offering 0% APR Through 2017

Credit card companies are now offering 0% APR for 21 months for all purchases and balance transfers or 40k bonus miles (\$400 bonus) and double miles.





Demo



Will use participants in this room to create a “crowd sourced” Recommender

Step 1: go to www.joshjanzen.com/demo

Step 2: choose activities in MN you ENJOY doing

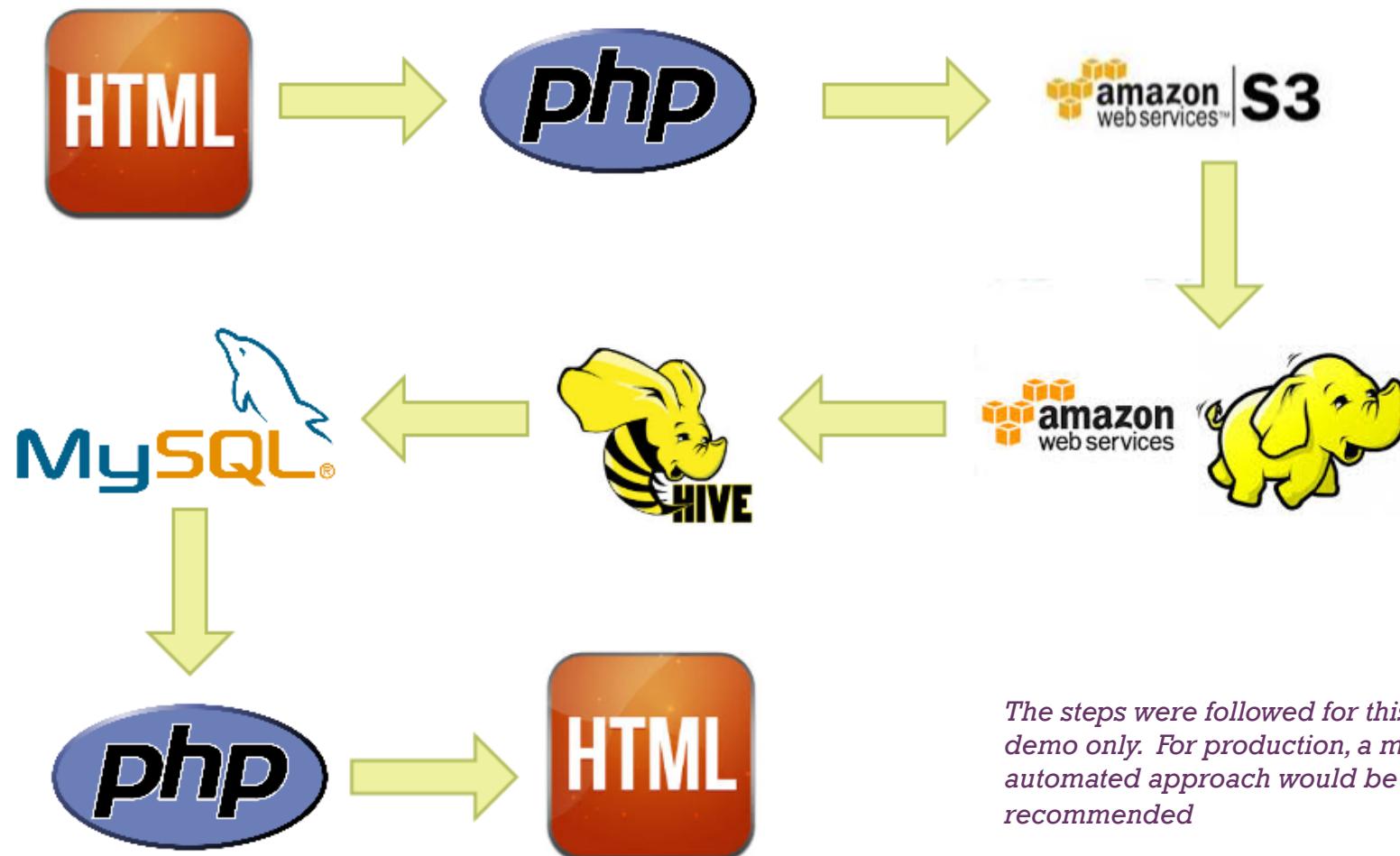
Step 3: enter your email address

Step 4: click ‘Submit’

Let's process the data and make some recommendations!



Demo (how data is processed)



The steps were followed for this demo only. For production, a more automated approach would be recommended



Collaborative Filtering (aka crowdsourcing)

- Crowd based recommender algorithm which aggregates users preferences
- “Customers Who Viewed This Item Also Viewed”
- **Pros**
 - simple to write in SQL
 - deep data-sets
 - favors frequent items, such as “top-selling” or “most-viewed”
- **Cons**
 - difficulty in finding highly unique item-sets
 - significant processing power
 - “cold-start” problem

How Collaborative Filtering Works

All User Activity History

Name	Art Fair	Fishing	Shovel Snow	Wedding
Jon	No	Yes	Yes	No
Jane	Yes	No	No	Yes
Jill	Yes	No	Yes	Yes

How Collaborative Filtering Works

All User Activity History

Name	Art Fair	Fishing	Shovel Snow	Wedding
Jon	No	Yes	Yes	No
Jane	Yes	No	No	Yes
Jill	Yes	No	Yes	Yes

Scenario: a new user, Homer likes **Weddings**, and we need to recommend him other activities he may enjoy.

- Find Wedding in User history above and identify users who also enjoyed Weddings: U{Jane, Jill}
- Identify other activities U{Jane, Jill} enjoyed, and rank by count

Recommendation Output

Activity	Rank	Count of User (co-occurrence)
Art Fair	1	2
Shovel Snow	2	1
Fishing	3	0



Bayes' Theorem for Conditional Probability

- Uses probabilities to classify and rank recommendations
- “Frequently Bought Together”
- **Pros**
 - probability based, easy to understand and tweak
 - depth of data-set can be easily adjusted
- **Cons**
 - more complex SQL statements and processing power

How Bayes' Theorem Works

All User Activity History

Name	Art Fair	Fishing	Shovel Snow	Wedding
Jon	No	Yes	Yes	No
Jane	Yes	No	No	Yes
Jill	Yes	No	Yes	Yes

How Bayes' Theorem Works

All User Activity History

Name	Art Fair	Fishing	Shovel Snow	Wedding
Jon	No	Yes	Yes	No
Jane	Yes	No	No	Yes
Jill	Yes	No	Yes	Yes

Scenario: a new user, Homer likes **Weddings**, and we need to recommend him other activities he may enjoy. We need to calculate probability of an activity occurring with Weddings.

- **Art Fair (AF) & Wedding (W)**
- **Fishing (F) & Wedding (W)**
- **Shovel Snow (SS) & Wedding (W)**

Bayes' Theorem

Name	Art Fair	Fishing	Shovel Snow	Wedding
Jon	No	Yes	Yes	No
Jane	Yes	No	No	Yes
Jill	Yes	No	Yes	Yes

P(Art Fair | Wedding)

- $P(AF) = 2/3 = 67\%$
- $P(W) = 2/3 = 67\%$
- $P(W|AF) = 2/2 = 100\%$
- Posterior Probability = $(67\% * 100\%) / 67\% = 100\%$

P(Fishing | Wedding)

- $P(F) = 1/3 = 33\%$
- $P(W) = 2/3 = 67\%$
- $P(W|F) = 0/1 = 0\%$
- Posterior Probability = $(33\% * 0\%) / 67\% = 0\%$

P(Shovel Snow | Wedding)

- $P(SS) = 2/3 = 67\%$
- $P(W) = 2/3 = 67\%$
- $P(W|SS) = 1/2 = 50\%$
- Posterior Probability = $(67\% * 50\%) / 67\% = 50\%$

Wedding Recommendation (CF vs. BT)

Recommendation Output - Collaborative Filtering

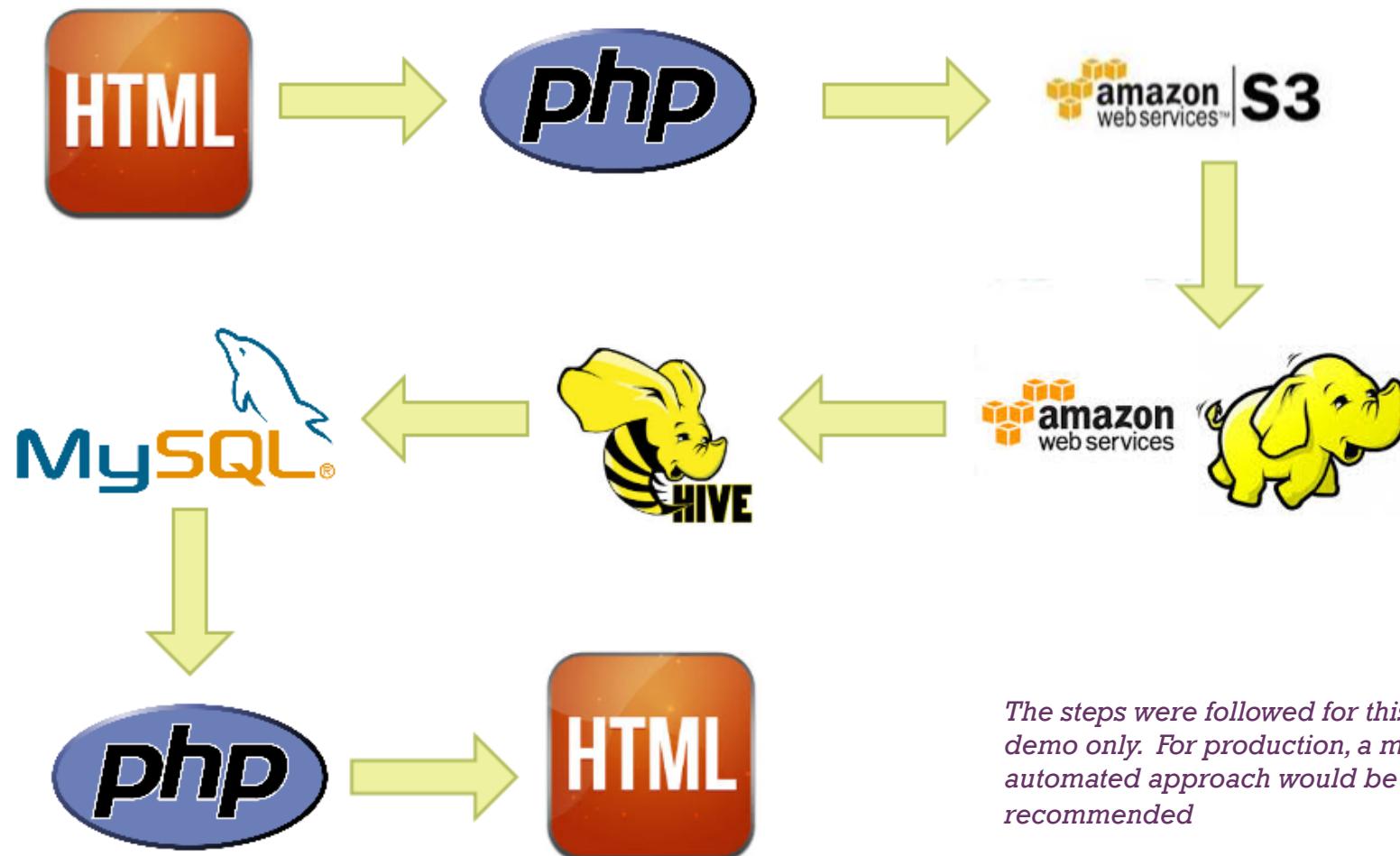
Activity	Rank	Count of User (co-occurrence)
Art Fair	1	2
Shovel Snow	2	1
Fishing	3	0

Recommendation Output - Bayes' Theorem

Activity	Rank	Conditional Probability
Art Fair	1	100%
Shovel Snow	2	50%
Fishing	3	0%



Demo (finish up processing)



The steps were followed for this demo only. For production, a more automated approach would be recommended

Demo Results

All of your (the “crowd”) submissions have been calculated!

Step 1: go to <http://www.joshjanzen.com/demo-results>

Step 2: select any activity you enjoy

Step 3: click ‘Submit’

Step 4: the top 10 recommended activities are listed

Questions?



Appendix: Bayes' Theorem

$$P(c|x) = \frac{P(x|c)P(c)}{P(x)}$$

↑ ↑
Likelihood Class Prior Probability
↓ ↓
Posterior Probability Predictor Prior Probability

$$P(c|X) = P(x_1|c) \times P(x_2|c) \times \cdots \times P(x_n|c) \times P(c)$$

- $P(c|x)$ is the posterior probability of *class (target)* given *predictor (attribute)*.
- $P(c)$ is the prior probability of *class*.
- $P(x|c)$ is the likelihood which is the probability of *predictor given class*.
- $P(x)$ is the prior probability of *predictor*.

Source: http://www.saedsayad.com/naive_bayesian.htm



Appendix: Demo (how data is processed)

- **Step 1:** User submits data through a website form. Using PHP, this is saved as a CSV in AWS S3
- **Step 2:** CSVs on S3 are processed with Hive on AWS EMR Hadoop cluster (any database will work). This is where a series of HQL (SQL) statements in Hive are ran to prepare the data for output. An output CSV is put into S3
- **Step 3:** CSV output is moved from S3 to MySQL
- **Step 4:** the website connects to MySQL via PHP to display recommendations on website

The steps were followed for this demo only. For production, a more automated approach would be recommended