



Deep Product Search: Tokenization Methods

Search Labs (A9)

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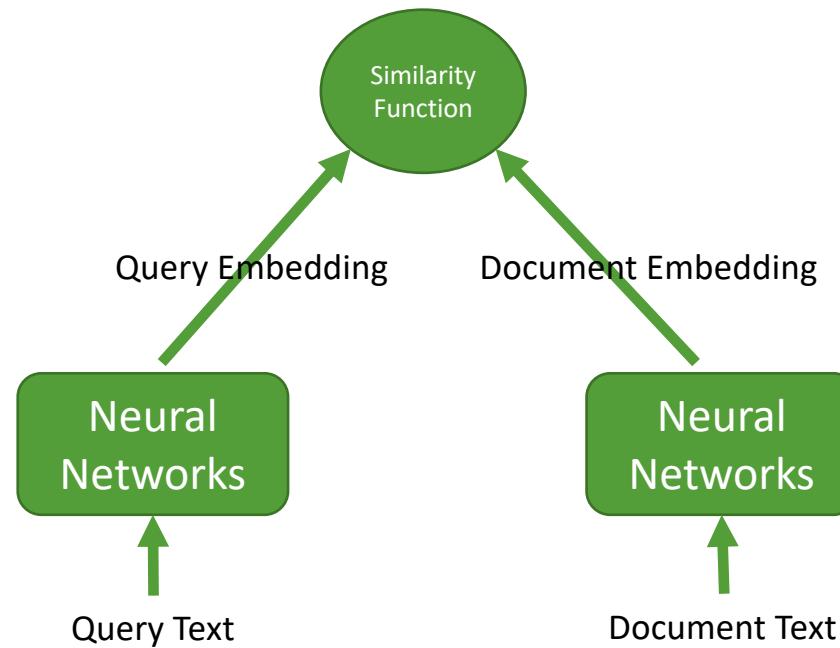
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Huascar Fiorletta

Vijai Mohan

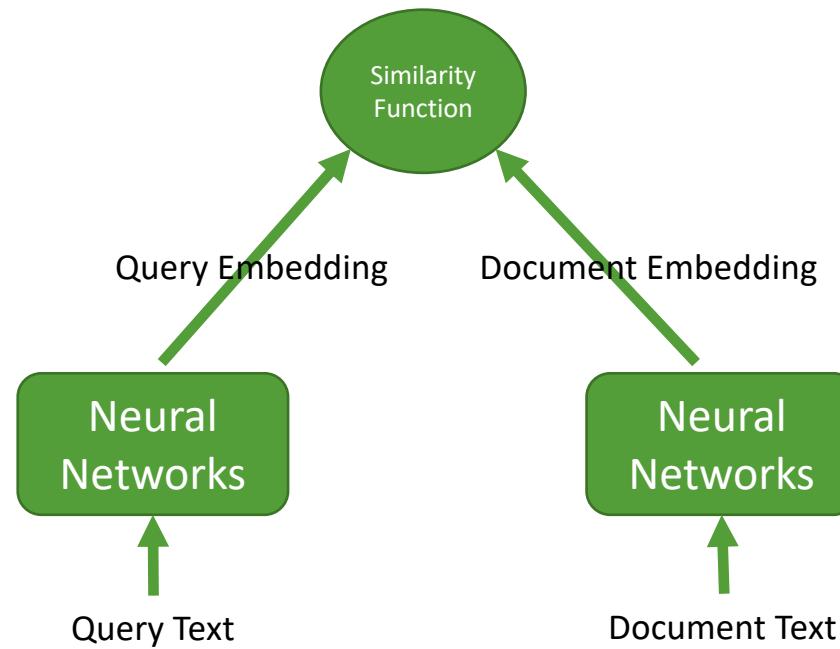
Guy Lebanon

Deep Learning is an Integral Part of Information Retrieval across Industry



- Google's RankBrain, 3rd most important ranking signal
- Microsoft's DSSM
- Baidu's DNN, accounted for 34% of whole year relevance improvement in 2013
- Yahoo
- LinkedIn Job Search

Deep Learning is an Integral Part of Information Retrieval across Industry



- Google's RankBrain, 3rd most important ranking signal
- Microsoft's DSSM
- Baidu's DNN, accounted for 34% of whole year relevance improvement in 2013
- Yahoo
- LinkedIn Job Search
- **Amazon product search?**

Semantic Search

“health shampoo”



[Sulfate Free Sport Swim Shampoo: Aloe & Panthenol Prevents Dry Damaged Hair due to Chlorine & Sun -12 oz](#)

by Zealios

\$13.95 (\$1.16/Fl Oz)

prime

FREE Shipping on eligible orders

More options available:

\$13.60 [Other Sellers](#)

★★★★★ 57 ~ 50

Product Features

... SPORTS AND SWIMMING SHAMPOO: Color treated safe formula revives hairs ...

“collapsible step ladder”



[LavoHome 330lbs Upper Reach Reinforced Metal Folding Step Ladder Stool Household Kitchen Use \(Four Step Ladder\)](#)

by LavoHome

\$74.99

FREE Shipping on eligible orders

Only 10 left in stock - order soon.

★★★★★ 319

“countertop beer fridge”



[DELLA 048-GM-48197 Beverage Center Cool Built-In Cooler Mini Refrigerator w/ Lock- Black/Stainless Steel](#)

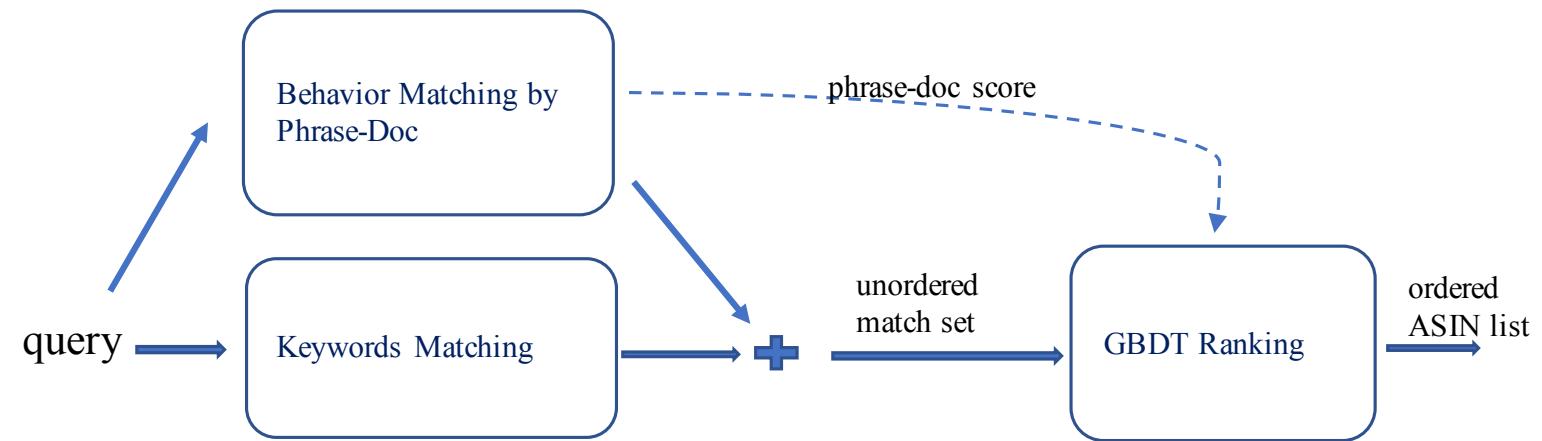
by DELLA

\$219.47

FREE Shipping on eligible orders

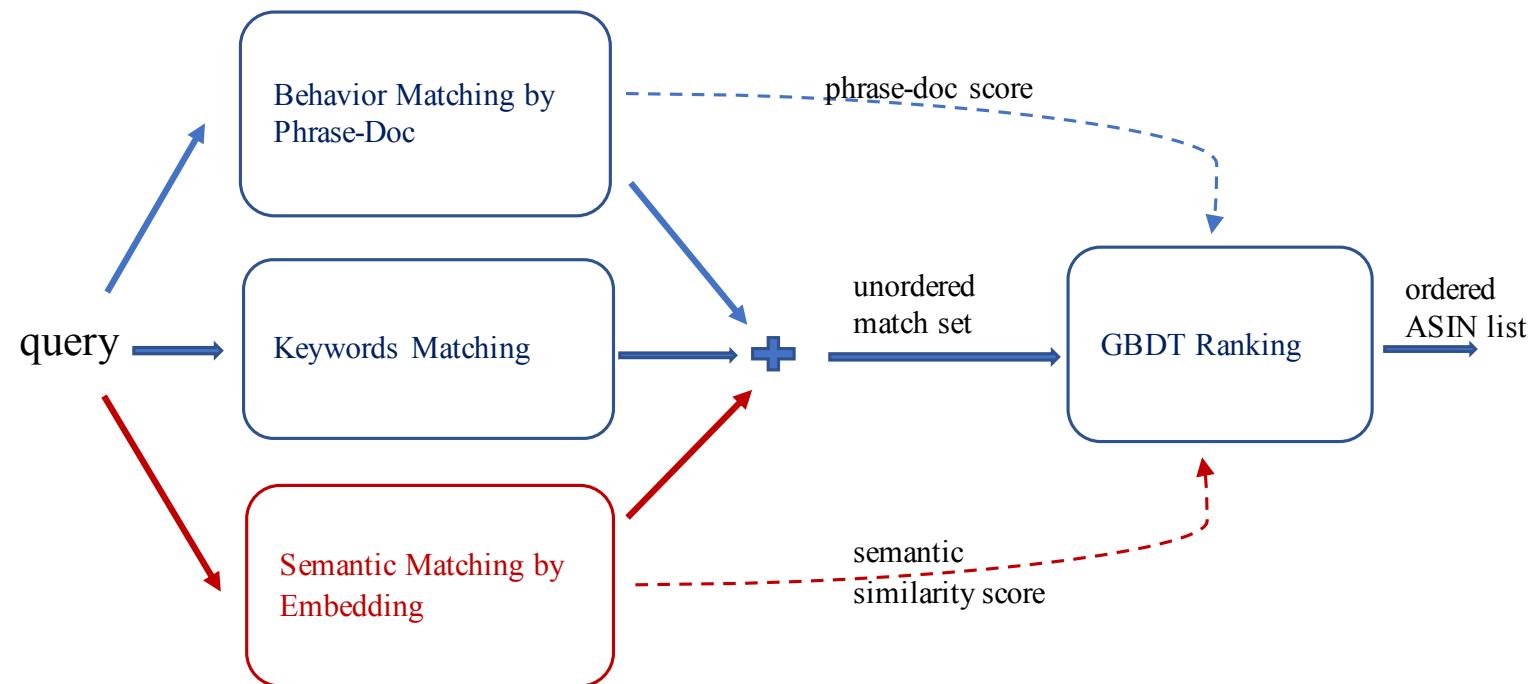
★★★★★ 14

Amazon Product Search



- ASIN has to include all words in query to be returned OR
- It belongs to phrase-doc match which memorized popular ASINs purchased associated with a frequent query

Enhance Amazon Product Search with Semantic Search



- Augment product match set.
- Improve ranking performance for torso and tail queries which do not have phrase-doc coverage.

Data

“artistic iphone 6s case”

Showing most relevant results. See all results for **artistic** (iPhone 6s case).

	<p>iPhone 6s Case Marble, iPhone 6 Case, ULAK Colorful Series Slim Hybrid Dual Layer Scratch Resistant Hard Back Cover Shock Absorbing TPU Bumper Case for Apple iPhone 6/6s 4.7 inch by Freedom Fly</p> <p>\$19.99 prime FREE Shipping on eligible orders More Buying Choices \$2.00 (4 new offers)</p>	<p>★★★★★ 5/5 * 64 Product Features Package:1 iPhone 6s cases</p>
	<p>iPhone 6 Case, iPhone 6 Case, ULAK Slim Fit Dual Layer Soft Silicone & Hard Back Cover Bumper Protective Shock-Absorption & Skid-proof Anti-Scratch Hybrid Case, Artistic/Mint Green Marble by ULAK</p> <p>\$19.99 <small>Subscribe & Save</small> Save more with monthly <small>Subscribe & Save</small> & deliveries.</p> <p>\$19.99 prime FREE Shipping on eligible orders</p>	<p>★★★★★ 5/5 * 1,386 Promotion Available and 1 more promotion ~ Product Features ... iPhone 6s case marble hybrid slim dual layer protective fit for Apple ...</p>
	<p>iPhone 6 Case, [SG] Frame BELK 2nd Gene - 'FLEX Edge' Soft-Gel Shock-absorbing TPU Sided Hard Wood Case [Easy Snap-On] with Durable Reinforced PC Hybrid Back Case, Cherry by Belk</p> <p>\$13.99 prime FREE Shipping on eligible orders Only 10 left in stock - order soon.</p>	<p>★★★★★ 5/5 * 24 Product Features ... Artistic Live Edge Wood, Highly ... Friendly Wood Case with Nature ...</p>
	<p>iPhone 6s Case, iPhone 6 Case, 6s Wallet Case, ULAK Marble Wallet iPhone 6s Leather Case with 9 Card Slots Flip for Apple iPhone 6s/6 4.7 Inch, Artistic-marble pattern by ULAK</p> <p>\$19.99 prime FREE Shipping on eligible orders</p>	<p>★★★★★ 5/5 * 574 Promotion Available See Details Product Features ... iPhone 6s case for women compatible with iPhone 6s 4.7 inch 2015 ...</p>
	<p>iPhone 6 Plus Case, iPhone 6s Plus Case, ULAK Slim Dual Layer Protection Scratch Resistant Hard Back Cover Shock-Absorbing TPU Bumper Case for Apple iPhone 6/6s Plus 5.5 inch, Artistic Marble by ULAK</p> <p>\$19.99 prime FREE Shipping on eligible orders</p>	<p>★★★★★ 4/5 * 975 Promotion Available and 7 more promotions ~ Product Features ... hard PC back cover with cute pattern design marble iPhone 6/6s Plus case ...</p>

Data

“artistic iphone 6s case”

purchased

Showing most relevant results. See all results for artistic iphone 6s case.

iPhone 6s Case Marble, iPhone 6 Case, ULAKE Colorful Series Slim Hybrid Dual Layer Scratch Resistant Hard Back Cover Shock-Absorbent TPU Bumper Case for Apple iPhone 6/6s 4.7 inch(Artistic Marble)
by ULAKE
\$19.99 prime
FREE Shipping on eligible orders
Product Features
... iPhone 6 case, iPhone 6s case designed for Apple iPhone 6 4.7 inch...

6s Case, iPhone 6s Case, iPhone 6 Case, Freedom Fly iPhone 6/6s Protective Case Soft Flexible TPU Transparent Skin Scratch-Proof Case For Apple iPhone 6/6s 4.7 inch by Freedom Fly
\$16.99 prime
FREE Shipping on eligible orders
More Buying Choices
\$2.00 (4 new offers)
★★★★☆ 64
Product Features
Package:1*Phone 6s cases

iPhone 6s Case, iPhone 6 Case, ULAKE Slim Fit Dual Layer Soft Silicone & Hard Back Cover Bumper Protective Shock-Absorption & Skid-proof Anti-Scratch Hybrid Case, Artistic/Mint Green Marble
by ULAKE
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★★★★☆ 24
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Save more with monthly Subscribe & Save deliveries.
\$19.99 prime
FREE Shipping on eligible orders
★★★★★ 1,386
Promotion Available and 1 more promotion •
Product Features
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★★★★★ 975
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Save more with monthly Subscribe & Save deliveries.
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FREE Shipping on eligible orders
★★★★★ 935
Promotion Available and 7 more promotions •
Product Features
... hard PC back cover with cute pattern design marble iPhone 6/6s Plus case ...

Impressed
but not
purchased

Random

Champ Grip. Strongest Grippers Mop Broom Holders with 5 Ball Slots and 6 Hooks. Items Guaranteed Non Slide. Life-time Guarantee.
by CHAMP GRIP®
\$12.99 prime
FREE Shipping on eligible orders
★★★★★ 887
Product Features
... It can also hold heavy items without sliding down. Upon hanging wet ...

Johnson's Sleepy Time Baby Gift Set, 3 Items
by Johnson's Baby
\$9.97
Add-on Item
FREE Shipping on eligible orders
★★★★★ 805
Product Description
Johnson's Sleepy Time Baby Gift Set, 3 Items

Blind Item Jun 6, 2017
by Kevin Dickson and Jack Ketsosan
Kindle Edition
\$13.99
Get it TODAY, Apr 19
Paperback
\$18.99 prime
FREE Shipping on eligible orders
Available for Pre-order. This item will be released on June 5, 2018.
Audible Audiobook
\$0.00
Free with Audible trial
Other Formats: Hardcover, Audio CD
★★★★★ 72

Amazon.com Gift Card in a Gold Reveal
by Amazon
\$25.00-\$40.00
FREE One-Day Shipping.
★★★★★ 339
Product Features
Gift Card is redeemable towards millions of items storewide at Amazon.com

Butterfly Notebook Dec 14, 2000
by Sovak
Paperback
\$1.66 prime
FREE Shipping on eligible orders
More Buying Choices
\$0.50 (46 used & new offers)
★★★★★ 284

ProCase Toiletry Bag Travel Case with Hanging Hook, Organizer for Accessories, Shampoo, Cosmetic, Personal Items, Healthcare Bag with Handle, Black
by ProCase
\$12.99 prime
FREE Shipping on eligible orders
More options available:
\$11.99 Other Sellers
★★★★★ 266
Product Features
... main storage room for large item organize, zippered pockets for ...

Data

Billions of them!

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★★★★★ 574
Promotion Available See Details
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iPhone 6 Plus Case, iPhone 6s Plus Case, ULAk Slim Dual Layer Protection Scratch Resistant Hard Back Cover Shock-Absorbing TPU Bumper Case for Apple iPhone 6/6s Plus 5.5 inch, Artistic Marble
by ULAk
\$19.99 prime
FREE Shipping on eligible orders
★★★★★ 976
Promotion Available and 7 more promotions •
Product Features
... hard PC back cover with cute pattern design marble iPhone 6/6s Plus case ...

Random

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★★★★★ 887
Product Features
... It can also hold heavy items without sliding down. Upon hanging wet ...

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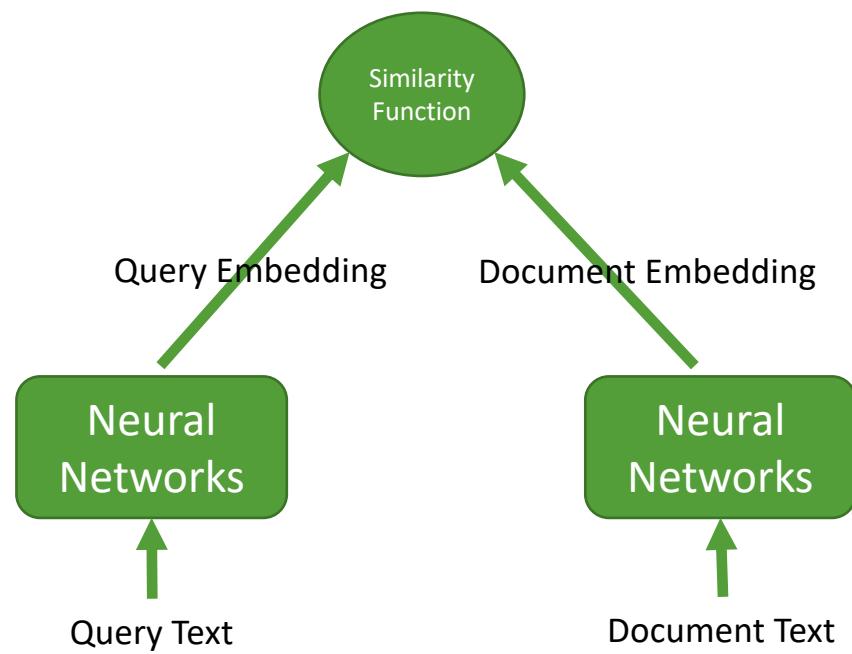
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FREE Shipping on eligible orders
Available for Pre-order. This item will be released on June 5, 2018.
Audible Audiobook
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Free with Audible trial
Other Formats: Hardcover, Audio CD
★★★★★ 72

Amazon.com Gift Card in a Gold Reveal
by Amazon
\$25.00-\$40.00
FREE One-Day Shipping.
★★★★★ 339
Product Features
Gift Card is redeemable towards millions of items storewide at Amazon.com

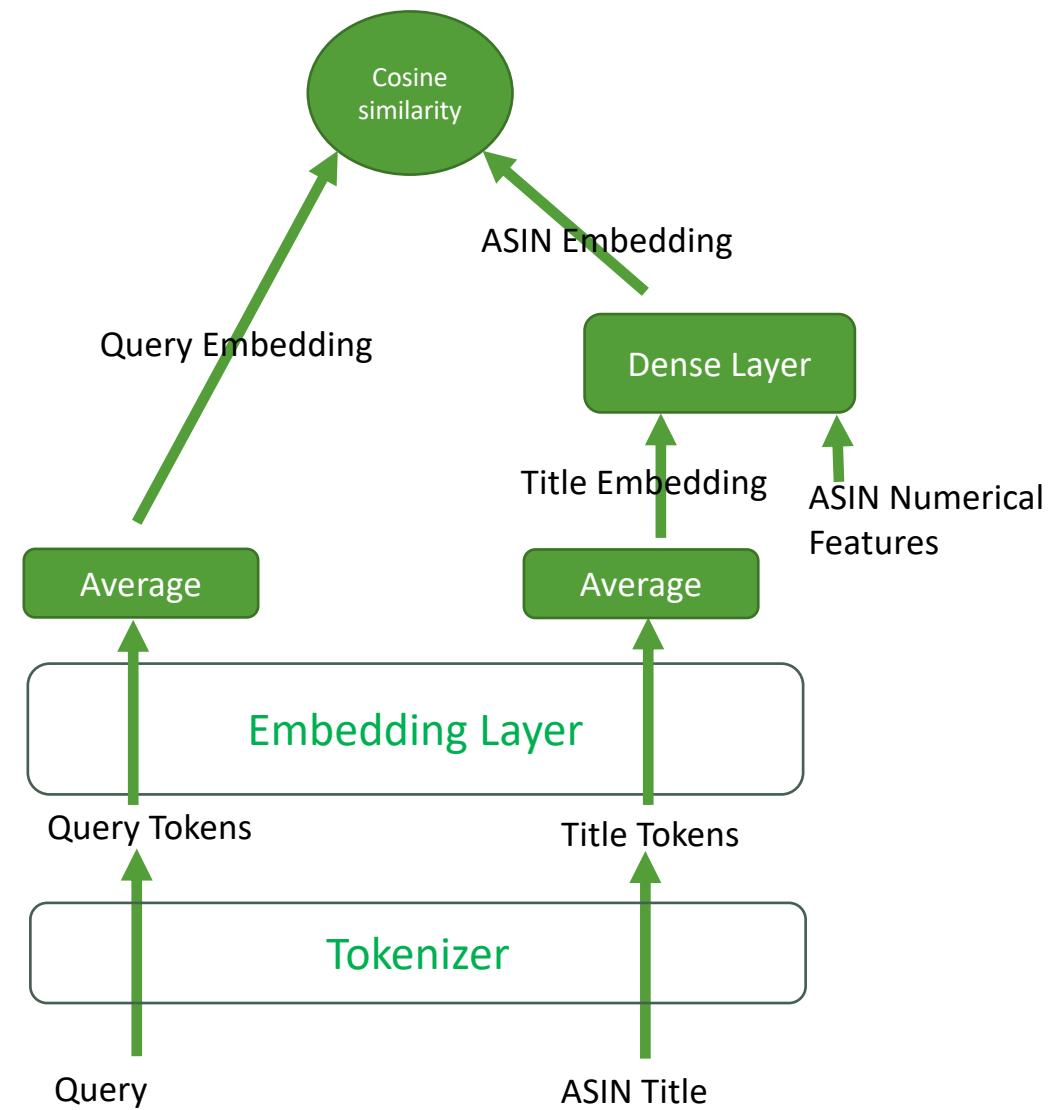
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by ProCase
\$12.99 prime
FREE Shipping on eligible orders
More options available:
\$11.99 Other Sellers
★★★★★ 266
Product Features
... main storage room for large item organize, zippered pockets for ...

Architecture



Architecture



Loss Function

“artistic iphone 6s case”

purchased



6s Case, iPhone 6S Case, iPhone 6 Case, Freedom Fly iPhone 6/6S Protective Case Soft Flexible TPU Transparent Skin Scratch-Proof Case For Apple iPhone 6/6S 4.7 inch

by Freedom Fly

\$6.99

prime

FREE Shipping on eligible orders

More Buying Choices

\$2.00 (4 new offers)

★★★★★ 64

Product Features

Package: 1 iPhone 6S cases

Impressed
but not
purchased



iPhone 6 Plus Case, iPhone 6s Plus Case, ULAKE Slim Dual Layer Protection Scratch Resistant Hard Back Cover Shock-Absorbant TPU Bumper Case for Apple iPhone 6/6S Plus 5.5 inch, Artistic Marble

by ULAKE

\$9.99

prime

FREE Shipping on eligible orders

★★★★★ 1,056

Promotion Available and 7 more promotions

Product Features

... hard PC back cover with cute pattern design marble iPhone 6/6S Plus case ...

Random



Johnson's Sleepy Time Baby Gift Set, 3 Items

by Johnson's Baby

\$9.97

Add-on Item

FREE Shipping on eligible orders

★★★★★ 805

Product Description

Johnson's Sleepy Time Baby Gift Set, 3 Items

Loss Function

“artistic iphone 6s case”

purchased



6s Case, iPhone 6S Case, iPhone 6 Case, Freedom Fly iPhone 6/6S Protective Case Soft Flexible TPU Transparent Skin Scratch-Proof Case For Apple iPhone 6/6S 4.7 inch

by Freedom Fly

\$6.99

prime

FREE Shipping on eligible orders

More Buying Choices

\$2.00 (4 new offers)

★★★★★ 64

Product Features

Package: 1 iPhone 6S cases

High

Impressed
but not
purchased



iPhone 6 Plus Case, iPhone 6s Plus Case, ULAKE Slim Dual Layer Protection Scratch Resistant Hard Back Cover Shock-Absorbant TPU Bumper Case for Apple iPhone 6/6S Plus 5.5 inch, Artistic Marble

by ULAKE

\$9.99

prime

FREE Shipping on eligible orders

★★★★★ 1,056

Promotion Available and 7 more promotions

Product Features

... hard PC back cover with cute pattern design marble iPhone 6/6S Plus case ...

Medium

Random



Johnson's Sleepy Time Baby Gift Set, 3 Items

by Johnson's Baby

\$9.97

Add-on Item

FREE Shipping on eligible orders

★★★★★ 805

Product Description

Johnson's Sleepy Time Baby Gift Set, 3 Items

Low

Loss Function

- For purchases:

$$\text{loss}(y, \hat{y}) = \begin{cases} 0, & \hat{y} \geq 0.9 \\ (\hat{y} - 0.9)^2, & \hat{y} < 0.9 \end{cases}$$

- For impressed but not purchased:

$$\text{loss}(y, \hat{y}) = \begin{cases} 0, & \hat{y} \leq 0.55 \\ (\hat{y} - 0.55)^2, & \hat{y} > 0.55 \end{cases}$$

- For randomly-sampled:

$$\text{loss}(y, \hat{y}) = \begin{cases} 0, & \hat{y} \leq 0.2 \\ (\hat{y} - 0.2)^2, & \hat{y} > 0.2 \end{cases}$$

- Point-wise hinge loss for 3 data types
- Matching is to differentiate purchases from randoms
- Ranking is to differentiate purchases from impressed
- Hyper-parameters tuned on our dataset

Tokenization

“artistic
iphone 6s
case”



```
"artistic", "iphone", "6s", "case",  
"artistic#iphone", "iphone#6s", "6s#case",  
"artistic#iphone#6s", "iphone#6s#case",  
"#ar", "art", "rti", ..., "#ca", "cas", "ase", "se#"
```

Tokenization

“artistic
iphone 6s
case”

```
"artistic", "iphone", "6s", "case",  
  
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"artistic#iphone#6s", "iphone#6s#case",  
  
"#ar", "art", "rti", ..., "#ca", "cas", "ase", "se#"
```

- Word-ngrams to capture phrase level information.
 - “chocolate milk” vs “milk chocolate”
 - “for iphone” indicates iphone accessories rather than iphone itself
- Character-trigrams to capture subword information
 - Morphism: “chocolates” vs “chocolate”
 - Compound words: “amazontv”, “firetvstick”
 - Parts number: “36x14” vs “36 x 14”
 - Typos: “iphione”

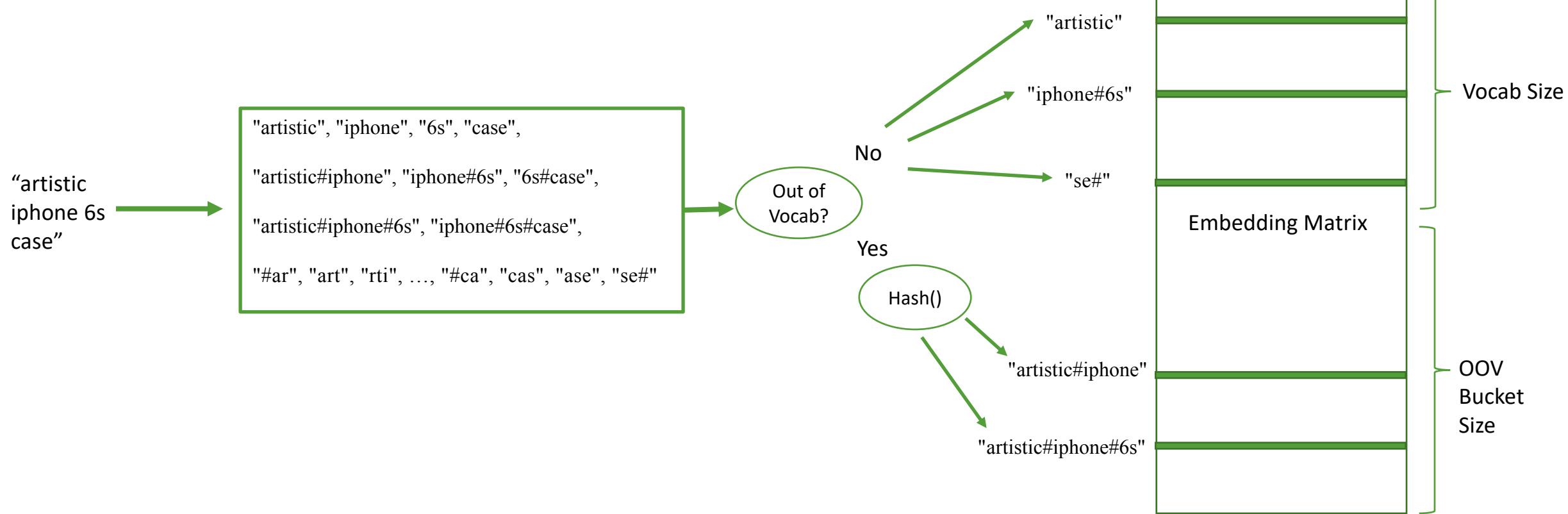
Tokenization

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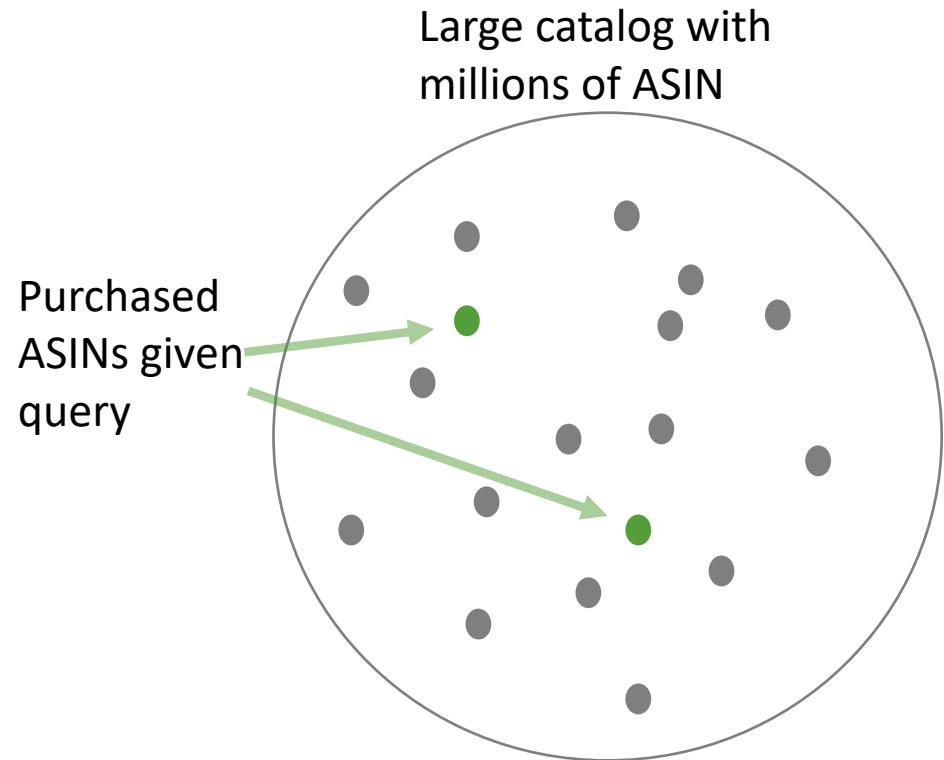
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"artistic", "iphone", "6s", "case",  
  
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"#ar", "art", "rti", ..., "#ca", "cas", "ase", "se#"
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 - Morphism: "chocolates" vs "chocolate"
 - Compound words: "amazontv", "firetvstick"
 - Parts number: "36x14" vs "36 x 14"
 - Typos: "iphione"
- OOV ngrams?
 - Vocab size grows exponentially with n.

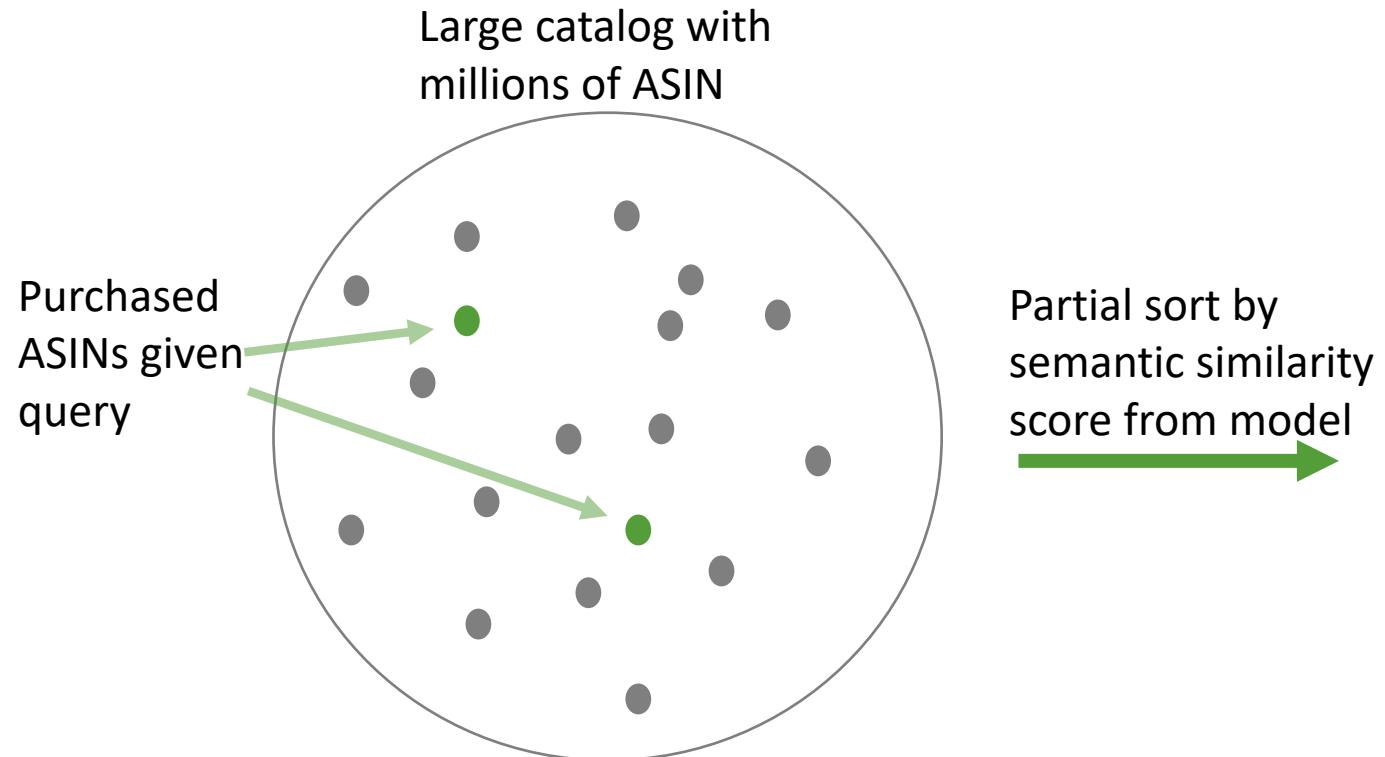
Tokenization



Offline Metrics

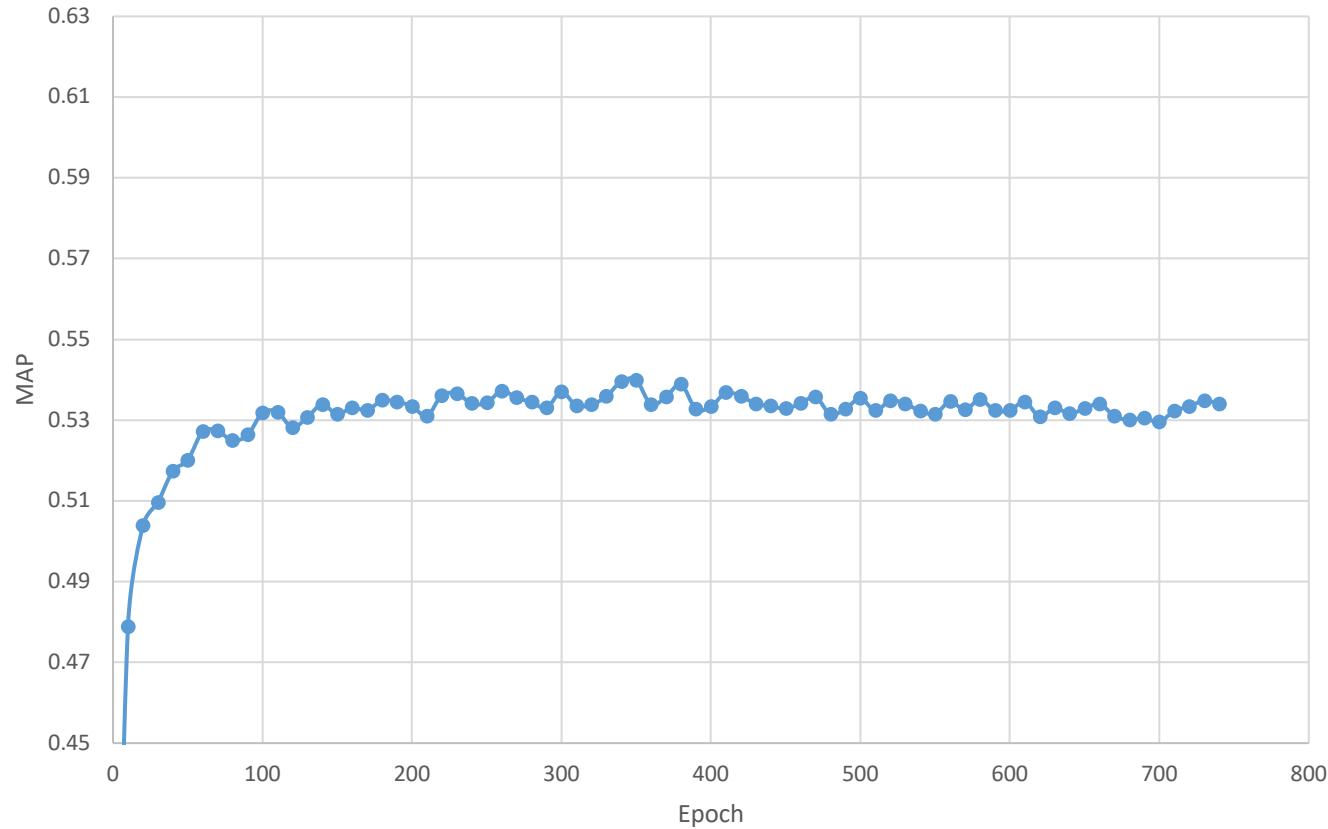


Offline Metrics



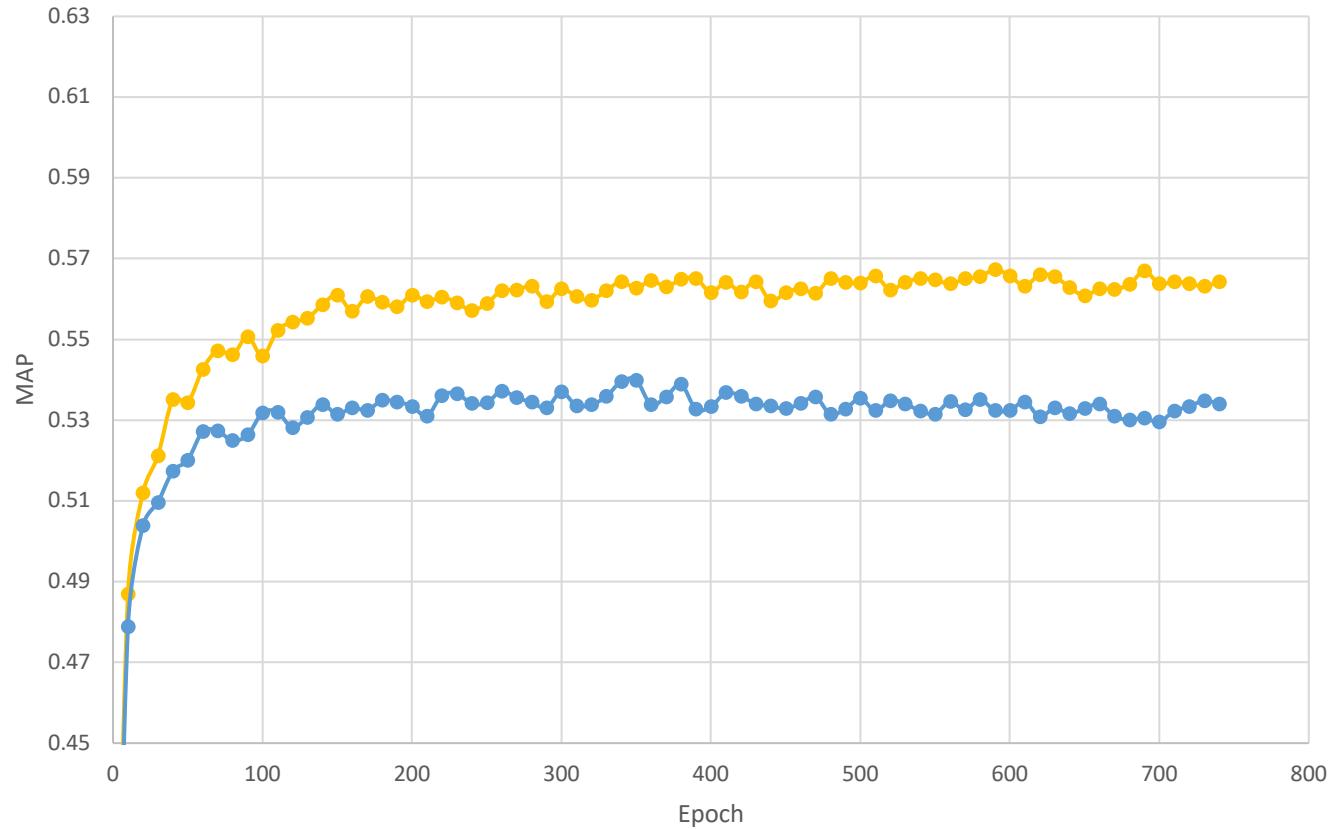
- Average Precision (AP) = $(1 + 0.5)/2 = 0.75$
- Mean Average Precision: mean of AP weighted by query frequency

Offline Comparisons



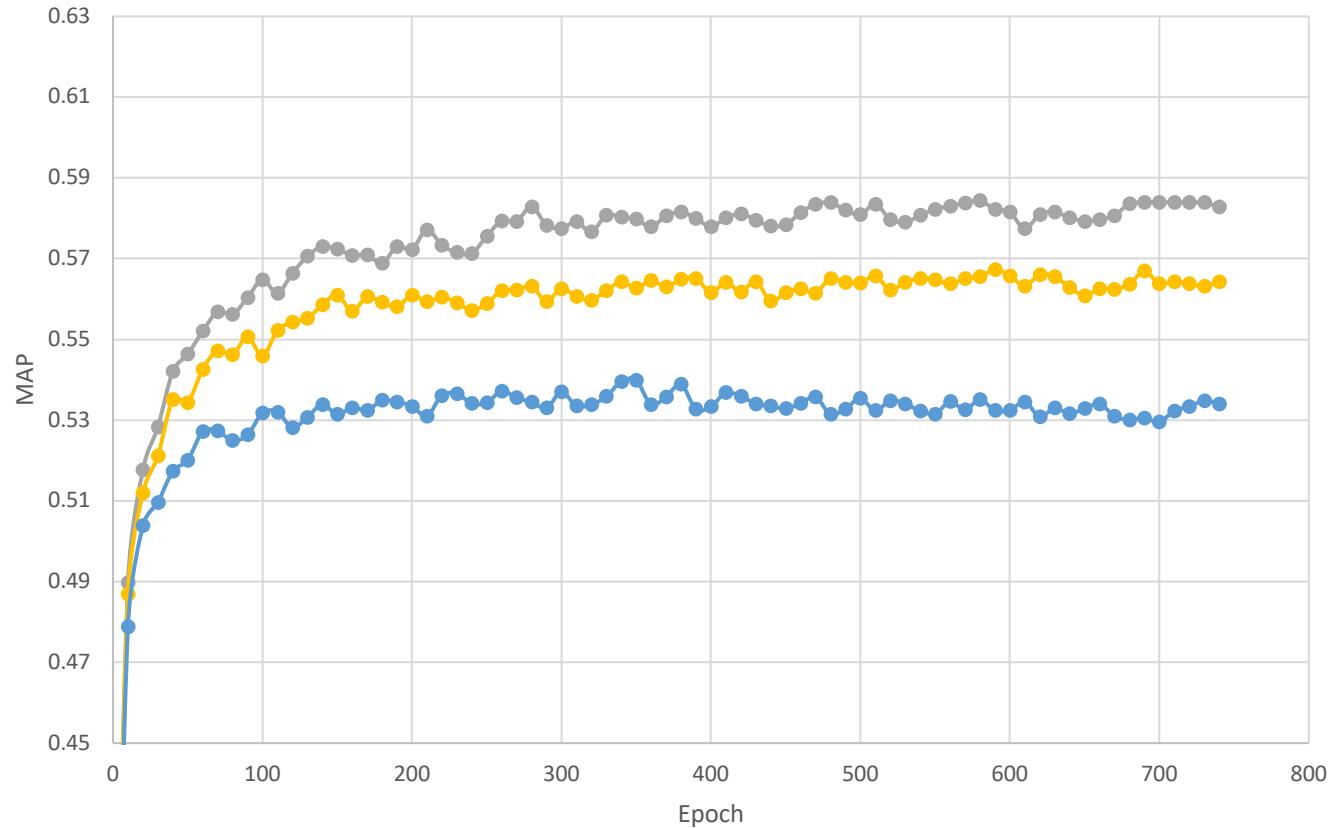
- Word Unigram baseline on small dataset

Offline Comparisons



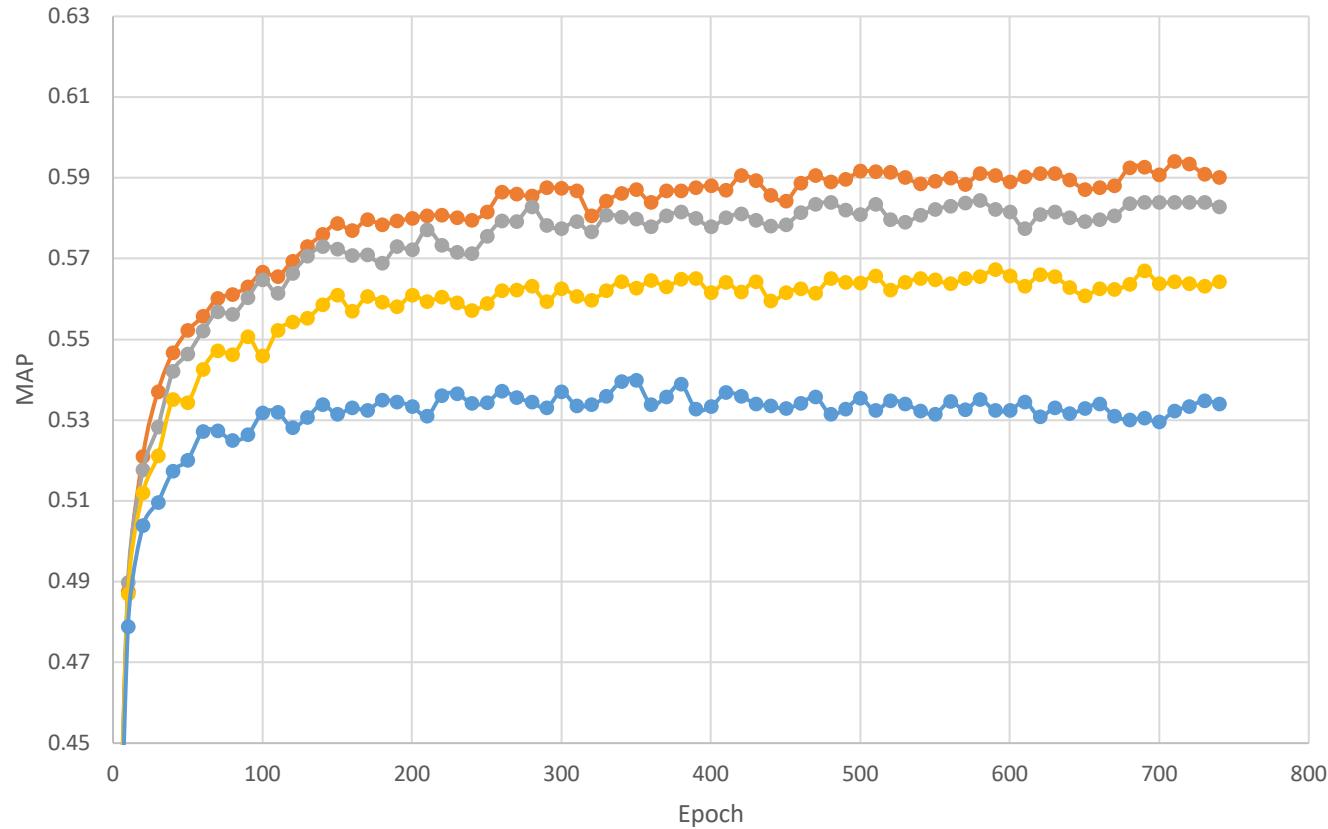
- Word Unigram baseline on small dataset
- Use more data

Offline Comparisons



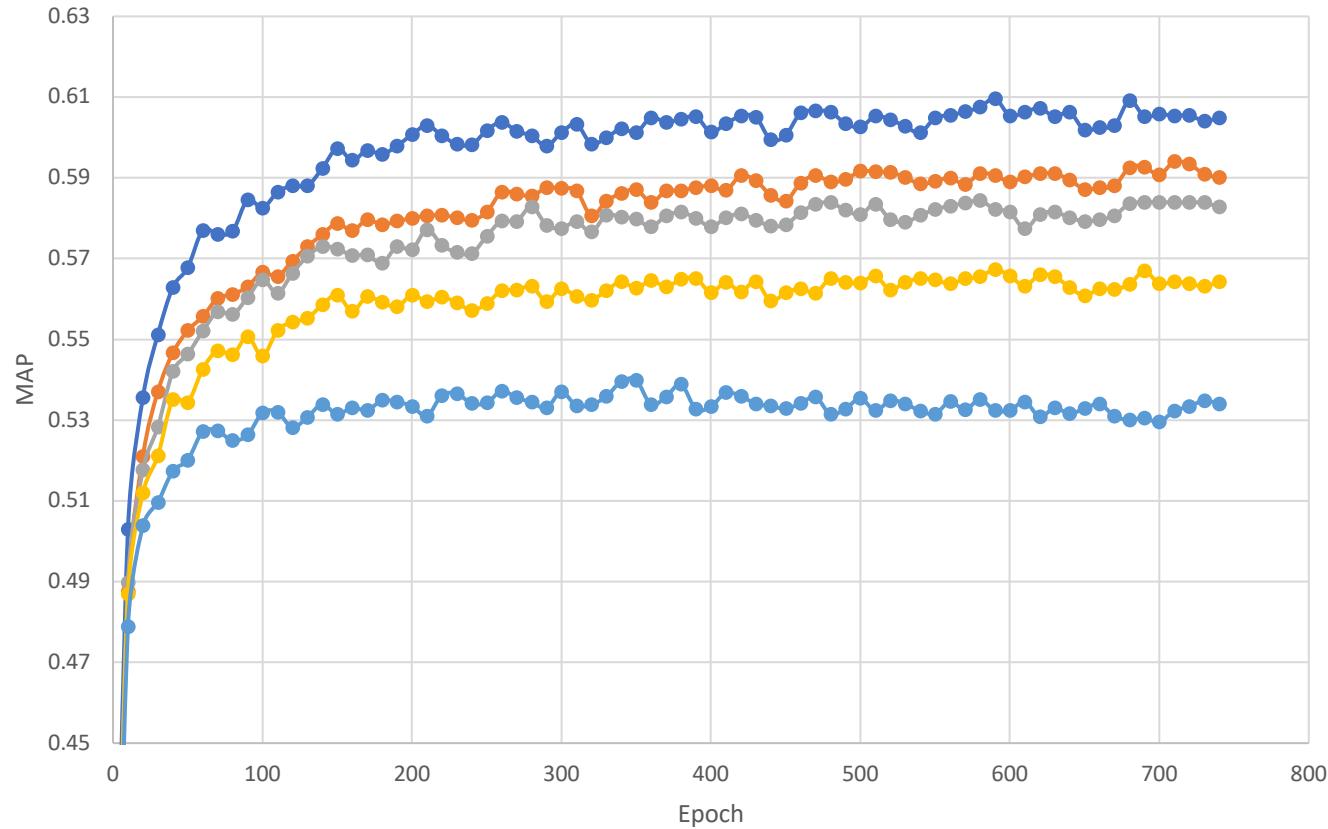
- Word Unigram baseline
- Use more data
- Add Word Bigram

Offline Comparisons



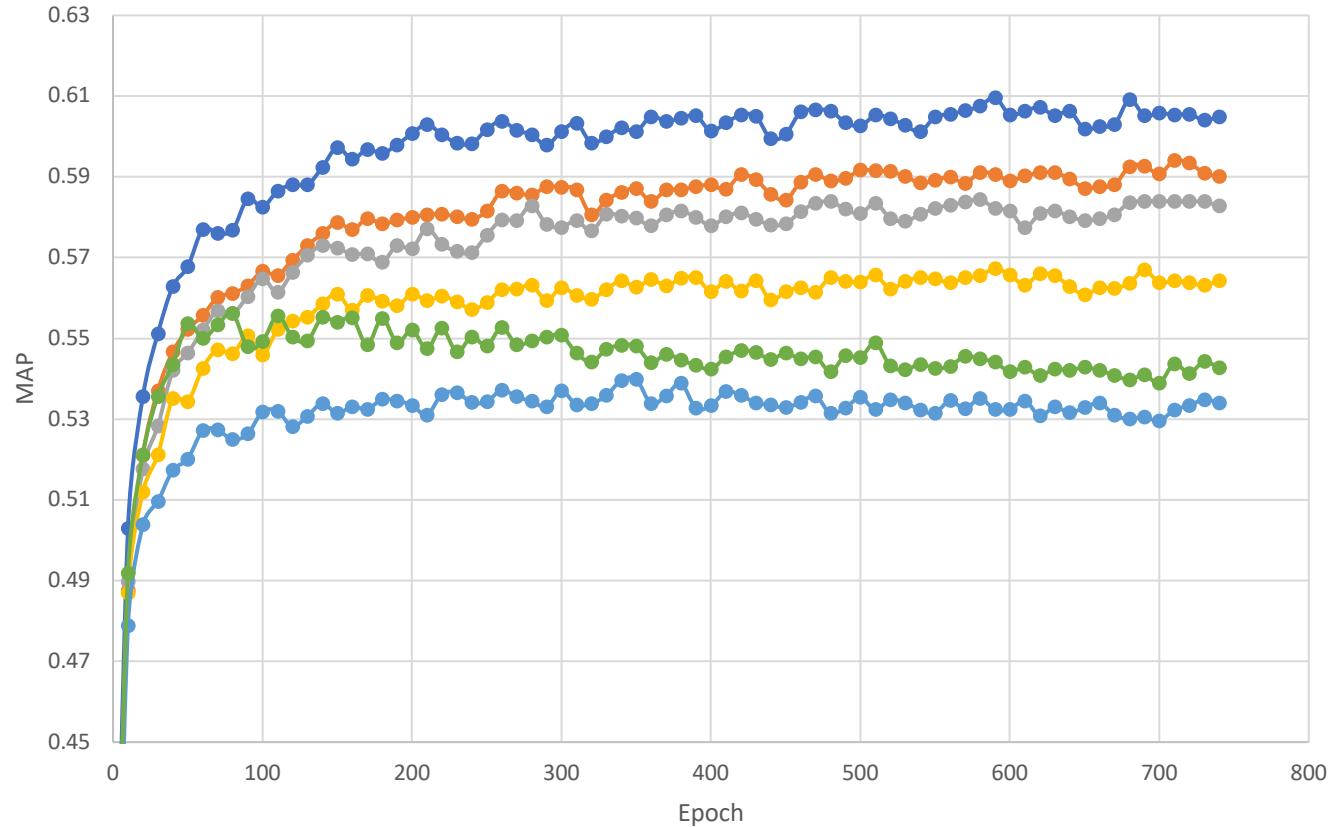
- Word Unigram baseline on small dataset
- Use more data
- Add Word Bigram
- Add Character Trigram

Offline Comparisons



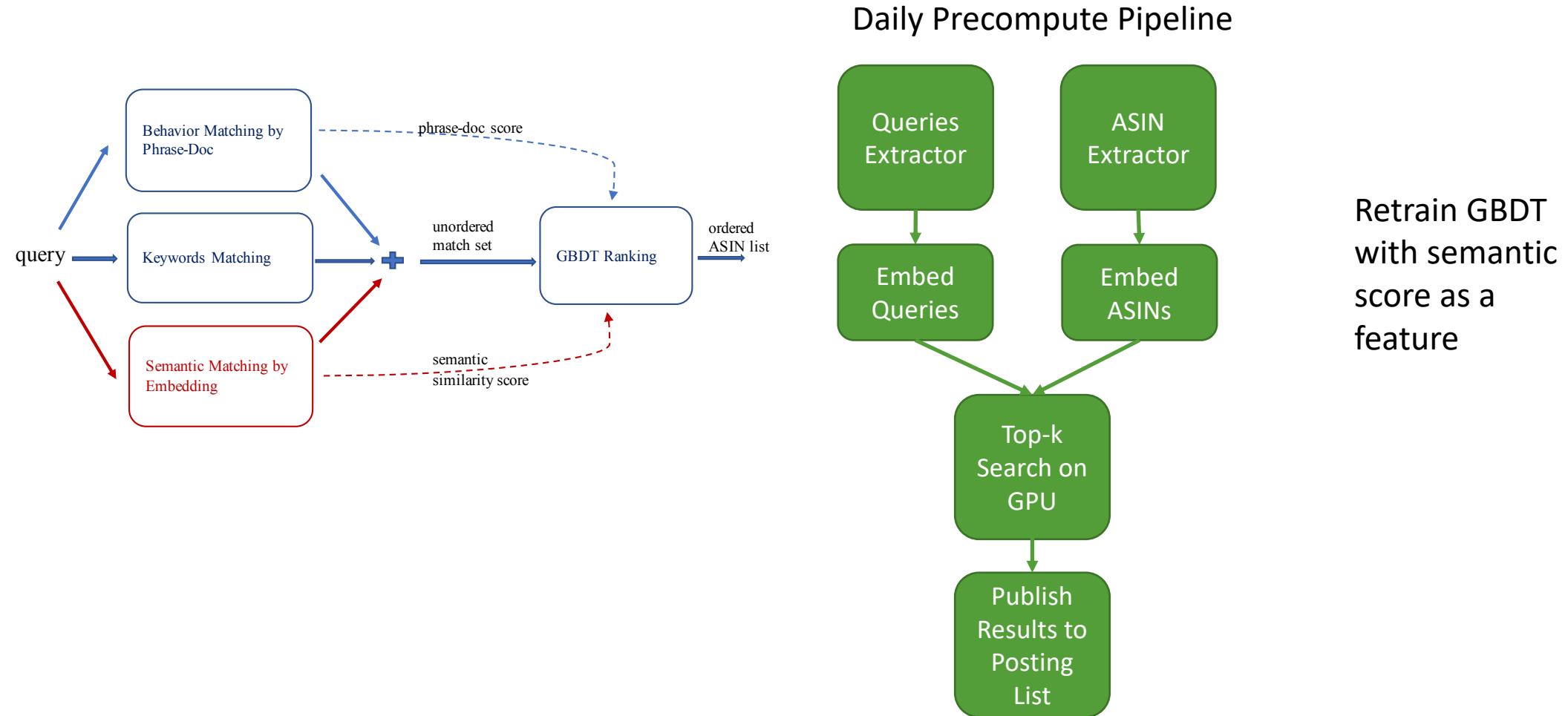
- Word Unigram baseline on small dataset
- Use more data
- Add Word Bigram
- Add Character Trigram
- Add OOV hashing for ngrams

Offline Comparisons



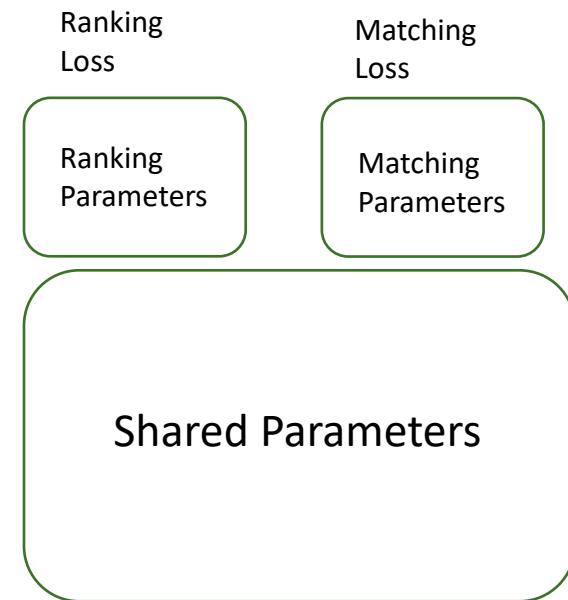
- Word Unigram baseline on small dataset
- Use more data
- Add Word Bigram
- Add Character Trigram
- Add OOV hashing for ngrams
- More tokens/parameters will overfit on small dataset

Online Deployment



Future Improvements

- Multi-tasks Model
 - Separate Ranking and Matching



Future Improvements

- Multi-tasks Model
 - Separate Ranking and Matching
- Richer Text Features
 - User Reviews and descriptions
 - Combine multiple text fields

 fisherman
★★★★★ It is a fantastic product. Very nice.
August 22, 2017
Verified Purchase
Very nice toys for kids. It has so many pieces that can build lots of 3D constructs. The magnet is powerful. It can attached each other together tightly. So all the constructs can stand firmly. It is very creative toys. My son initially followed the booklet to build all the models, then he can try to assemble it by himself. This toy is very helpful for kid development for imagination creativity and practical ability. He played this every day. It is very easy to clean up and won't mess the room. Good. Recommended.



[Comment](#) | One person found this helpful. Was this review helpful to you? [Report abuse](#)

 Gene Penn
★★★★★ Great toy for young kids and parents
August 23, 2017
Verified Purchase
This is really a great toy for toddlers and young children. My daughter love it and would spend hours with it to make different staffs with my help. Her favorite is "ice cream" we made so far. IF you have time you could spend with your kid and use the manual to make more complex things like air plane or vehicles. The best part for parents is those magnetic blocks could easily put on refrigerators surface and make variety shapes as pictures you kid made. That said those things are easy to put away and keep around without losing and missing. That saves a lot time and energy when kids loose attention and interest with it and leave a mess for parents to clean. Just put all to stick to the refrigerators surface then could get all pieces next round.



[Comment](#) | Was this review helpful to you? [Report abuse](#)

 Careful Customer
★★★★★ The magnets make them magical for little kids!
February 3, 2018
Verified Purchase
My grandson at three loves these! They allow him to design wonderful looking creations without having to be frustrated by trying to fit things together that require more strength and agility at his age. The magnets solve all of this and he is endlessly thrilled with his clever creations! It taught me that kids his age can create objects that far exceed what they can do with harder to use blocks and plastics that are harder to use! They're relatively expensive but looking back at his use of them, they are among the best toys I've seen for kids his age (and maybe, older too)!



Future Improvements

- Multi-tasks Model
 - Separate Ranking and Matching
- Richer Text Features
 - User Reviews and descriptions
 - Combine multiple text fields
- Balance between exact match and semantic match



Future Improvements

- Multi-tasks Model
 - Separate Ranking and Matching
- Richer Text Features
 - User Reviews and descriptions
 - Combine multiple text fields
- Balance between exact match and semantic match
- Multiple Categories Blending



Future Improvements

- Multi-tasks Model
 - Separate Ranking and Matching
- Richer Text Features
 - User Reviews and descriptions
 - Combine multiple text fields
- Balance between exact match and semantic match
- Multiple Categories Blending
- Engineering Infrastructure