

machine learning conference



Semantic Similarity Model using RNN and its Applications in Sponsored Products

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Sr. Machine Learning Scientist | Self-Service Performance Ad STORM



Sourcing Targeting Optimization Research and Modeling

Collaborators



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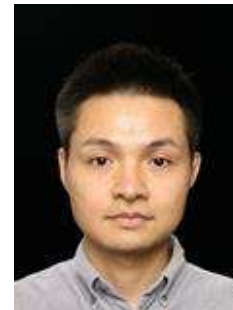
Brian Taylor
(bttaylor@)



Mahsa Maghami
(maghamim@)



Yu Zhang
(yzzhan@)



Keli Zhong
(keliz@)

Background

Search query: pressure cooker

Showing results in **Home & Kitchen**. Show instead results in All Departments.

Best Seller



Sponsored (3)
COSORI 6 Qt Premium 8-in-1 Programmable Multi-Cooker (Pressure Cooker, Rice Cooker, Steamer, Warmer, Etc.), 1000W, Includes Glass Lid, Sealing Ring and Recipe Book
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\$59.99 ~~\$79.99~~ **prime** | FREE One-Day
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Mueller 10-in-1 Pro Series 18 Program 6Q Pressure Cooker with German ThermaV Tech, Cook 2 Dishes at Once, BONUS Tempered Glass Lid incl., Sauté, Steamer, Slow, Rice, Yogurt, Cake, Maker, Sterilizer
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Best Seller



MultiPot 9-in-1 Programmable Pressure Cooker & Quarts by Mealthy - Stainless Steel Pot, steamer basket, instant access to recipe app! Pressure cook, slow cook, sauté, rice cooker, yogurt, steam etc.
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Amazon's Choice




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Presto 01264 6-Quart Aluminum Pressure Cooker
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\$24.00 **prime** | FREE One-Day
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Sponsored ⓘ
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Fastler 6.4 quart Vitaquick Pressure Cooker with Glass Lid Set
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★★★★★ • 55

Best Seller



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Outline

- Motivation
- Model Training/Evaluation
- Weblab Results
- Other Applications
- Future work



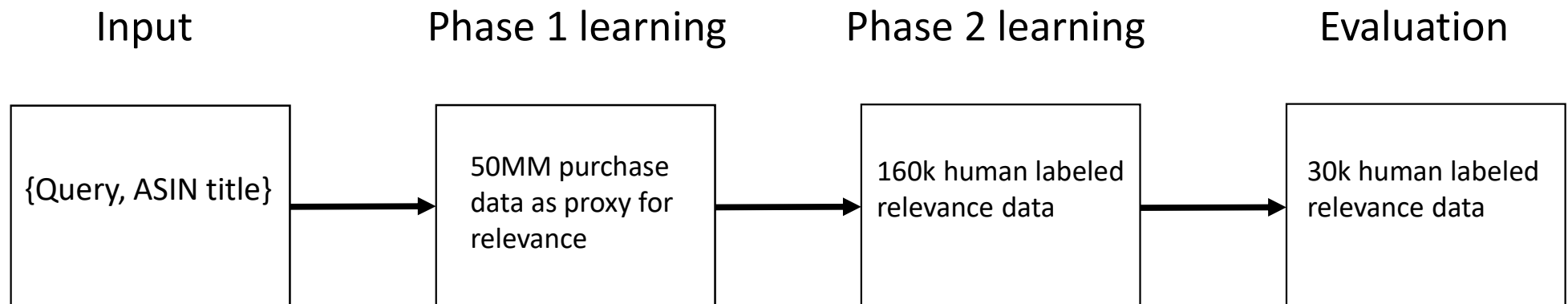
Motivations:

Production relevance model:

- Random Forest model (RF) with 20+ historical performance and lexical matching features
- Does not capture synonyms
- Favor warm ASINs
- Relevance score is not robust when historical performance changes

Two-phase relevance learning with RNN:

Goal: given a query-ASIN pair, estimate the probability they are strictly relevant / exact intent match.





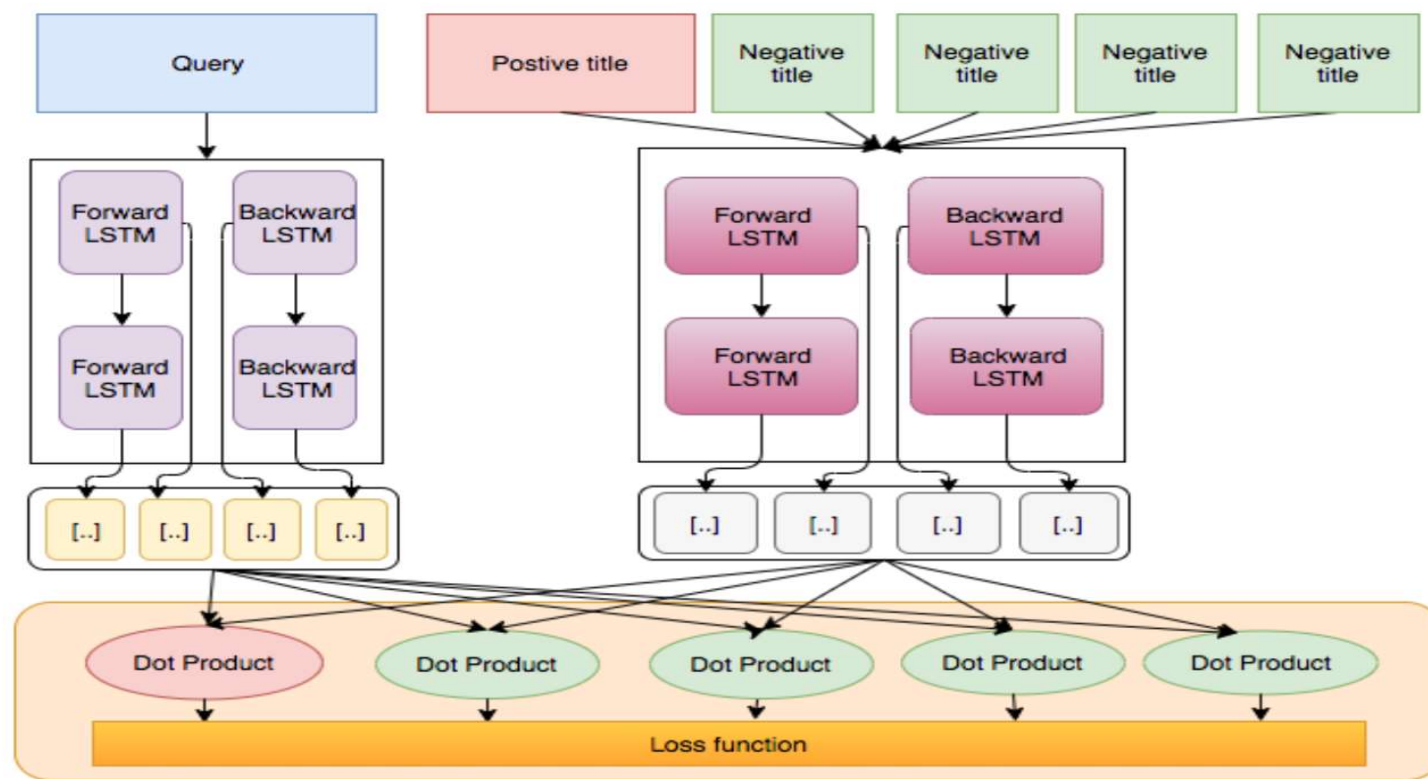
Generic Model Training (Phase 1)

Goal: Use large amount of purchase clickstream data to learn initial weights for the model.

- ~50MM query-purchase pairs from clickstream log
- Generate 4 negative samples for each positive sample through random sampling from Sponsored Products
- Trigram encoding to reduce input dimension (20k)

#cup# → #cu, cup, up#

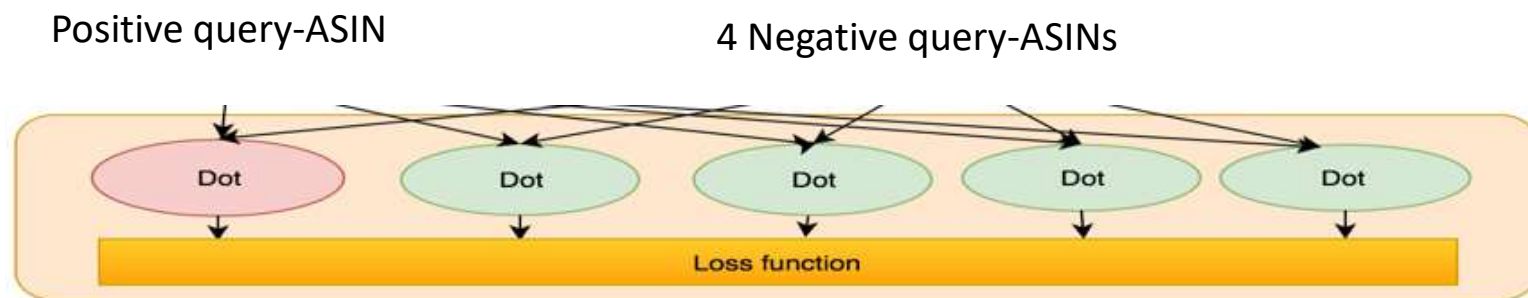
Generic Model Training (Phase 1)



- Siamese network, 2 layer Bi-LSTM
- Data parallelism with multiple GPUs
- Similarity through dot product of query/title embedding

Generic Model Training (Phase 1)

Loss function:

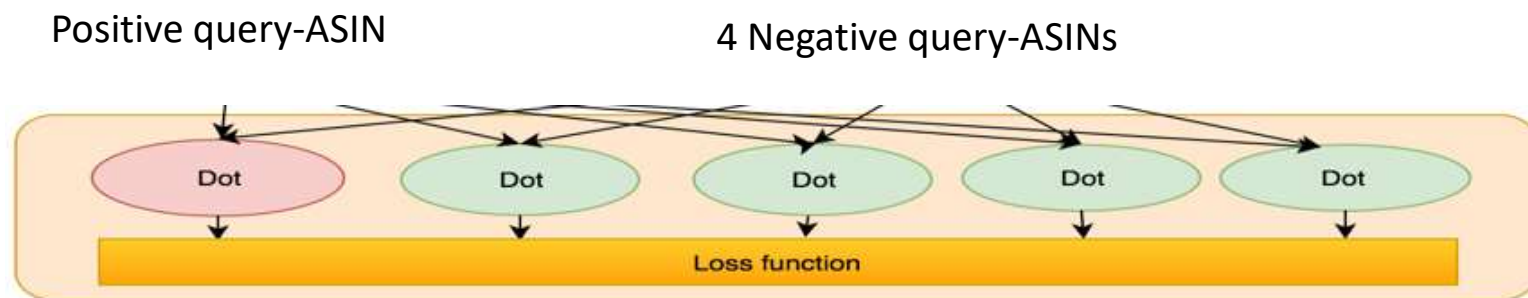


Softmax

→ multi-class classification

Generic Model Training (Phase 1)

Loss function:



Softmax → multi-class classification

VS.

Sigmoid → binary classification

Model Fine-tuning (Phase 2)

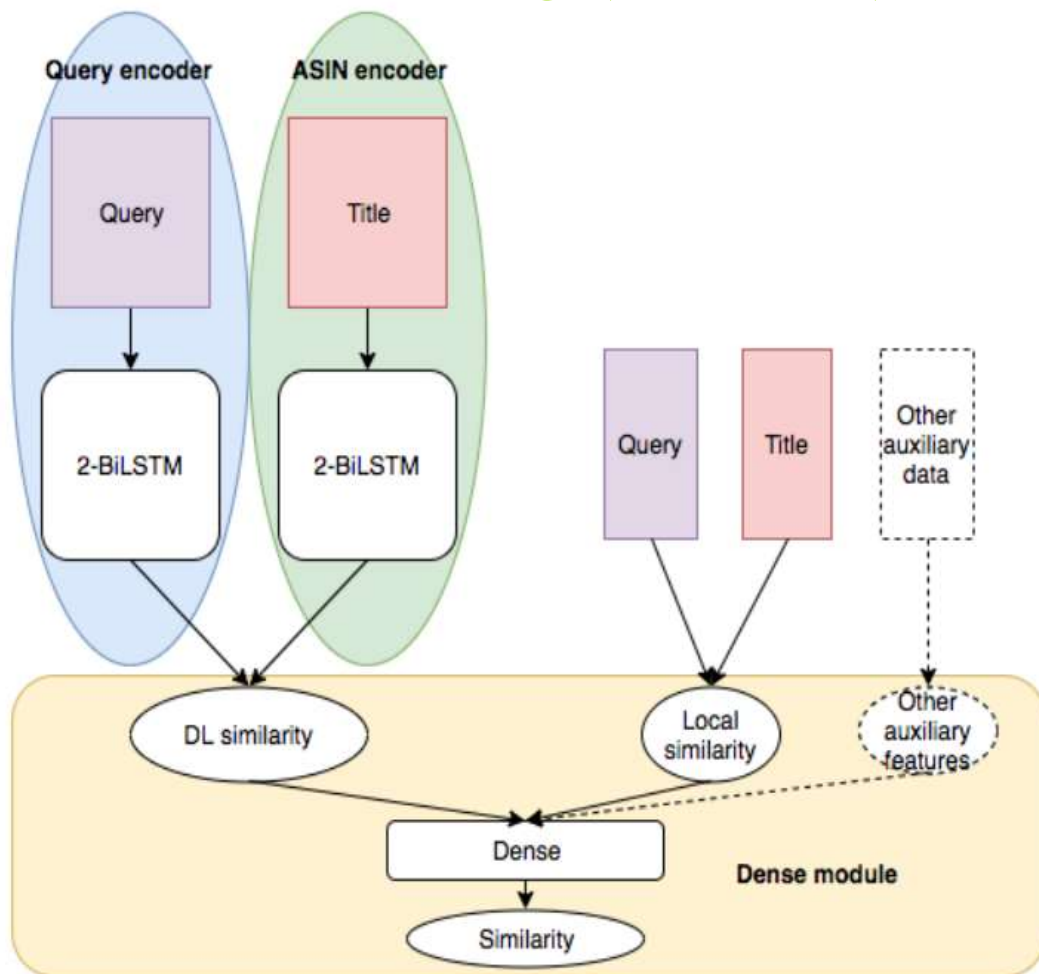
Goal: Achieve better model performance with highly accurate but smaller-scale human labeled data

- ~160K human labeled data
- Contains more closely missed negative samples

| | | |
|---------------------------|---|---|
| iphone 6s cases for girls | Adtechca 3In1 Beautiful Flowers Print Hybrid Case For iPhone 6S - Hotpink | 1 |
| iphone 6 plus refurbished | "OtterBox SYMMETRY SERIES iPhone 6 +/-6s + (5.5" Version) Case - Frustration-Free Packaging - FLORAL POND (TEAL/W FLORAL POND)" | 0 |
| aluminum iphone 6 case | Evershop® Metal Aluminum Case Gundam Aluminum Metal Frame Double Color Oxidation Case for Iphone 6 Plus/6S Plus 5.5 Inch (Orange) | 0 |

- Use same training/testing split as production RF model

Model Fine-tuning (Phase 2)



Auxiliary Features:

Overlap index:

$$O(A, B) = \frac{|A \cap B|}{\min(|A|, |B|)}$$

Offline Evaluation

| Model | AUC |
|---|------|
| Softmax similarity score + train on 50MM purchase data | 0.72 |
| Sigmoid similarity score + train on 50MM purchase data | 0.74 |
| Sigmoid similarity score + train on 160k human labeled data | 0.81 |
| Sigmoid similarity score + 2 phase training | 0.86 |
| Sigmoid similarity score + 2 phase training + overlap index | 0.91 |

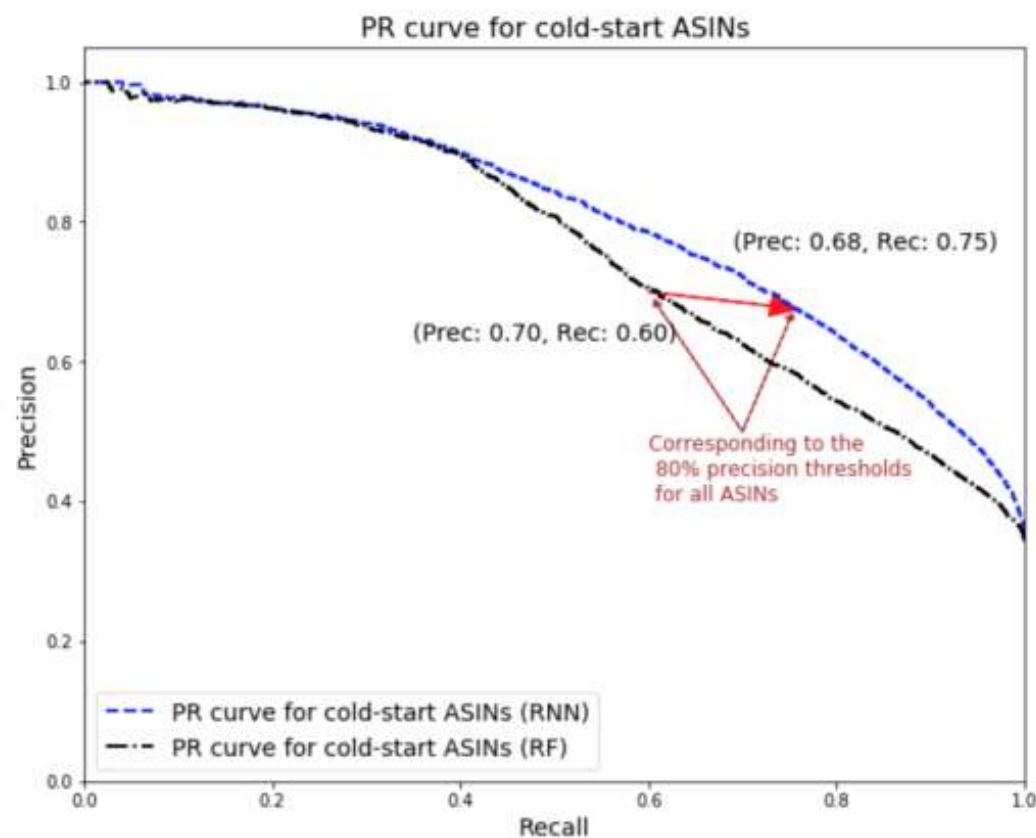
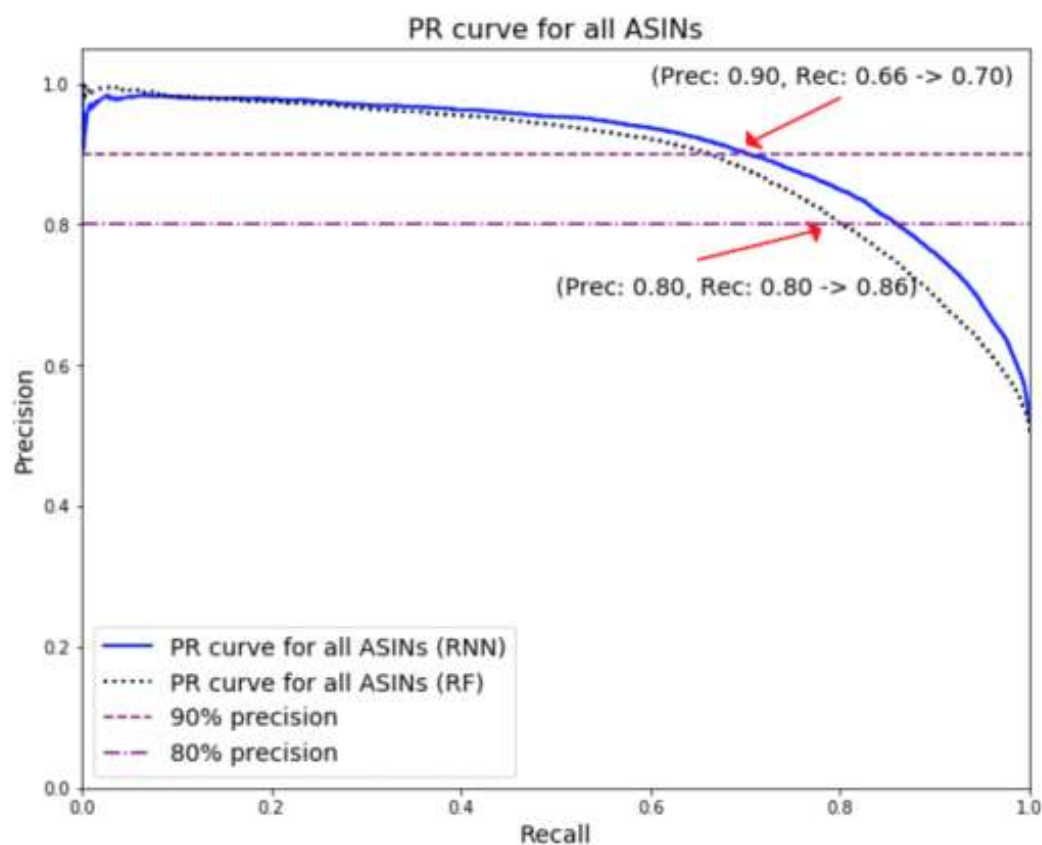
1. Two phase training

2. Loss function

3. Auxiliary local similarity feature

Production RF model
AUC: 0.88

Offline Evaluation



Offline Evaluation

| Query | ASIN Title | RF score | RNN score | Label |
|-------------------------|---|----------|-----------|-------|
| trash bags construction | Honeydew Extra Strong Contractor Garbage Bags, 42 Gallon-20 Count | 0.318 | 0.948 | 1 |
| v8 drink | V8 V-Fusion + Energy Orange Pineapple Vegetable & Fruit Juice, 8 fl oz, 6 pack(Case of 2) | 0.163 | 0.888 | 1 |
| dr who merchandise | Doctor Who Don't Blink Weeping Angel Juniors Black T-shirt S | 0.466 | 0.962 | 1 |

- Capture semantic meaning
- Robust against misspelling, abbreviation etc.
- Base on textual feature only

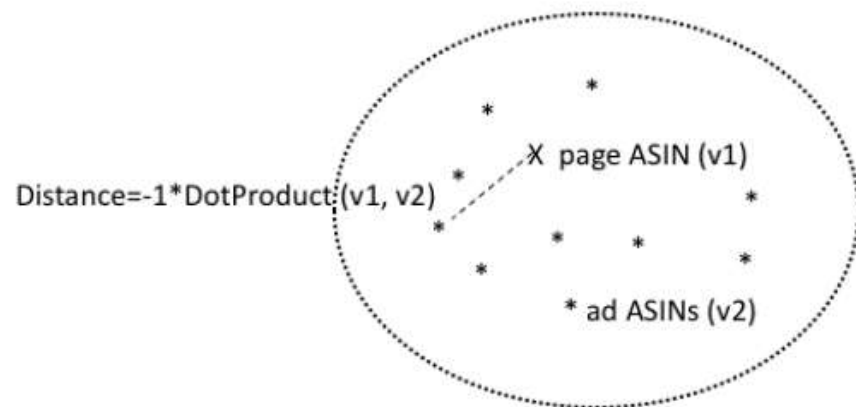
Weblab results

5 week 50%-50% weblab comparing RNN semantic model with RF model:

| Business metrics | RNN semantic model treatment |
|------------------------------------|------------------------------|
| Overall auction value | +0.9% |
| Amazon ads revenue | +1.0% |
| Top ads coverage | +0.4% |
| Clicks | +0.4% |
| CTR | +0.3% |
| CVR | +0.1% |
| Annualized ads revenue | +20MM (p-value = 0.0000) |
| Annualized net contribution profit | +18.7MM (p-value =0.003) |
| Unique impression | 5% |

Other applications

- ASIN-ASIN sourcing for Detail page:



(a)



Page ASIN

Title: Maxi-Cosi Pria 85 Max Convertible Car Seat, Nomad Purple

GL: gl_baby_product

Sourced ad ASINs





Other applications

- **Keywords recommendation:**

Table 3: Example k-Nearest Queries Given ASIN Title

| ASIN Title | k-Nearest Queries |
|---|---|
| Childrens Protective Sunglasses | "children sunglasses", "children sports sunglasses", "kid sunglasses" |
| Defway Travel Wallet Neck RFID Blocking Passport Holder Waterproof Hidden Pouch | "travel wallets passport", "travel rfid wallet", "travel wallets rfid" |
| Chew King Premium Treat Dog Toy,Medium, Extremely Durable Natural Rubber Toy | "anti chew dog toys", "dog chew training toy", "rubber dog chew toys" |
| Kellogg's Favorites Single Serve Breakfast Cereal Cups Variety Pack, 60 Count | "kelloggs cereal cups", "kellogg's fruit flavored snacks", "cereal variety pack cups" |

Conclusions and future work

- A productionalized query-ASIN relevance model based on textual data only
 - ❖ Two phase training (purchase data + human labeled data)
 - ❖ Loss function
 - ❖ Auxiliary feature
- Robust in relevance estimation and helps surfacing cold-start ad ASINs
- Extracting keywords in ASIN title then match [Guo et al 2016, Xiong et al 2017]
 - ❖ Zero-shot training AUC 0.86 vs. RNN 0.74

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Thank you!

Questions or scoring request, email sp-storm@

