An Approach for Weakly-Supervised Deep Information Retrieval

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(Appeared at neu-IR workshop at SIGIR ’17)

Background

Recent improvements to IR using neural approaches [1-4]

But neural approaches benefit from having lots of data

Recent work [5] generated pseudo-lables using a query log and corpus

[1] Jiafeng Guo, Yixing Fan, Qingyao Ai, and W Bruce Cro . 2016. A deep relevance matching model for ad-hoc retrieval. In Proceedings of the 25th ACM International on Conference on Information and Knowledge Management. ACM, 55–64.

[2] Kai Hui, Andrew Yates, Klaus Berberich, and Gerard de Melo. 2017. A Position- Aware Deep Model for Relevance Matching in Information Retrieval. arXiv preprint arXiv:1704.03940 (2017).

[3] Bhaskar Mitra, Fernando Diaz, and Nick Craswell. 2017. Learning to Match Using Local and Distributed Representations of Text for Web Search. In Proceedings of WWW 2017. ACM.

[4] Liang Pang, Yanyan Lan, Jiafeng Guo, Jun Xu, and Xueqi Cheng. 2016. A Study of MatchPyramid Models on Ad-hoc Retrieval. CoRR abs/1606.04648 (2016).

[5] Mostafa Dehghani, Hamed Zamani, Aliaksei Severyn, Jaap Kamps, and W Bruce Cro . 2017. Neural Ranking Models with Weak Supervision (SIGIR '17).

Motivation

We present an approach that eliminates the need for a query log.

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Main idea: Use news articles, with headlines acting as pseudo-queries, and the article body acting as pseudo-relevant documents.

This can work because headlines are often short descriptions of the article.

Example

May Wedding Set For Laura Myers

Published: January 11, 1987

The engagement of Laura Susan Myers to Steven Hammond Poppe, the son of Mr. and Mrs. Fred C. Poppe of West Islip, L.I., has been announced by Mr. and Mrs. W. Earle Myers of Long Valley, N.J., parents of the bride-to-be. A May wedding is planned.

Ms. Myers, an account executive at the Direct Marketing Association in New York, graduated from Hollins College. She is a granddaughter of the late Ralph Alexander Dickson of Gastonia, N.C., the founder and owner of Genuine Parts Inc. of North Carolina a principal in the electronics firm of Shiflett & Dickson. and of the late O. W. Mvers.

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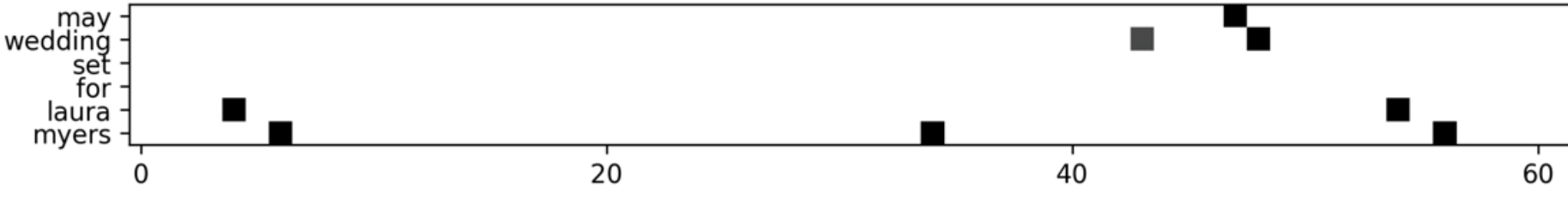

Challenges

Hard-Negative Problem

Mismatched Interaction Problem

Hard-Negative Problem

How to choose *negative* training samples?

Hard-Negative Problem

How to choose *negative* training samples?

We query articles from the corpus using the headline and pick the top *n* results as negative training samples. (BM25)

Mismatched Interaction Problem

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Headlines do not always act as good queries (e.g. figurative language)

SPORTS OF THE TIMES; When Bird Flies In

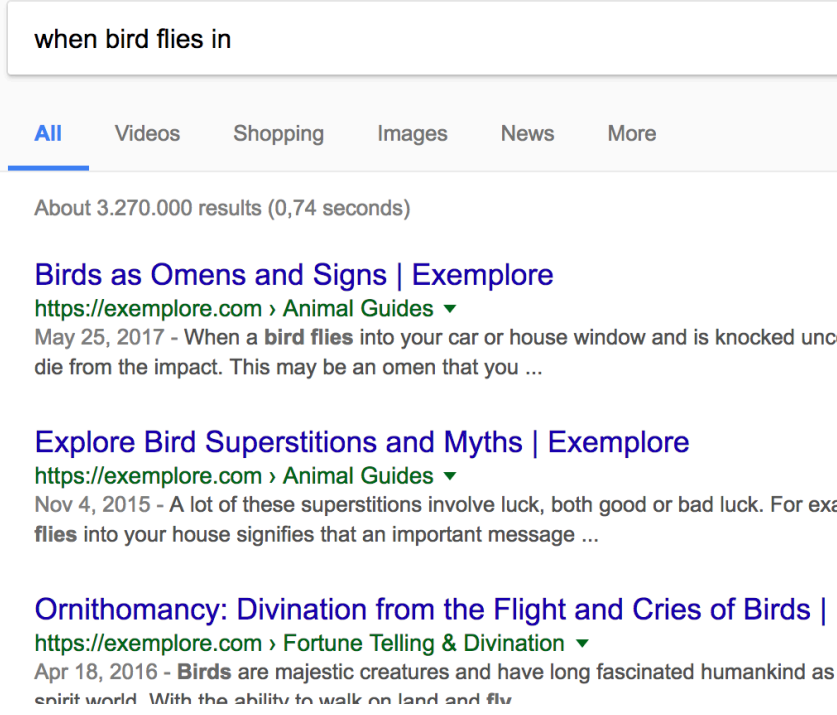
By Ira Berkow
Published: November 12, 1987

LARRY BIRD was in town the other day, and left, but chances are he'll be heard from again.

He didn't arrive in disguise, and he didn't leave in disguise. Not quite. His game's the same - fill the hoop, fill the lane, fill the other team with vexation. The trappings, however, are a little less familiar.

He's sleeker, though not sleek; he's thinner, though not thin; he's more muscular, but not quite muscular.

There's a reason for this physical change in the man many have called the best all-round player to ever heave a ball at a hoop.



Mismatched Interaction Problem

Approach 1: Ranking filter

Discard article if not retrieved in top BM25 results

This eliminates articles like *When Bird Flies In*.

Mismatched Interaction Problem

Approach 2: Interaction filter

Only pick training samples that have similar document interactions to a set of template interactions

Since models “see” the data differently, interaction filters are model-specific

Mismatched Interaction Problem

General interaction filter

1. Use a set of "template" query-document pairs
2. For each template, calculate a *mock interaction embedding* (model-specific function $m(p)$)
3. Keep only the top n most similar articles (given model-specific distance function $d(m_1, m_2)$)

Mismatched Interaction Problem

Example interaction filter (trivial)

$$m(p) = \frac{\text{\# matching query terms in document}}{\text{\# query terms}}$$

$$d(m_1, m_2) = |m_1 - m_2|$$

Mismatched Interaction Problem

PACRR interaction filter

m: maximum value for each query term in query-document similarity matrix

d: “aligned” mean squared error, i.e. minimum MSE over each possible alignment of mock embeddings

Kept
nbc to buy miami tv outlet
state looks to congress again for highway aid
151 new yorkers get science honor

Discarded
when allies don’t see eye to eye
wars can’t be won only from above
diseases common in ashkenazim may be random

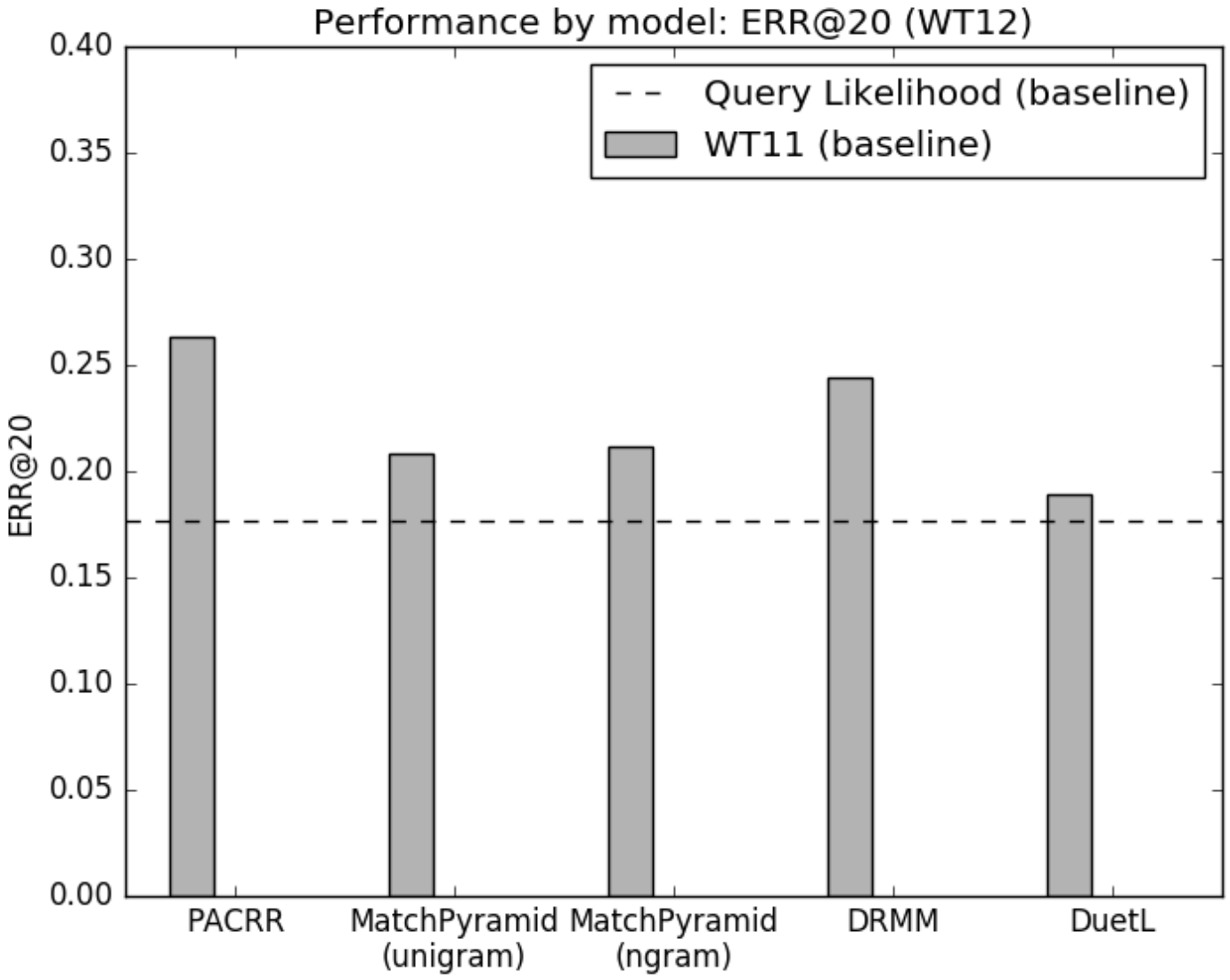
Experiment

Train 5 neural IR models using New York Times Corpus data

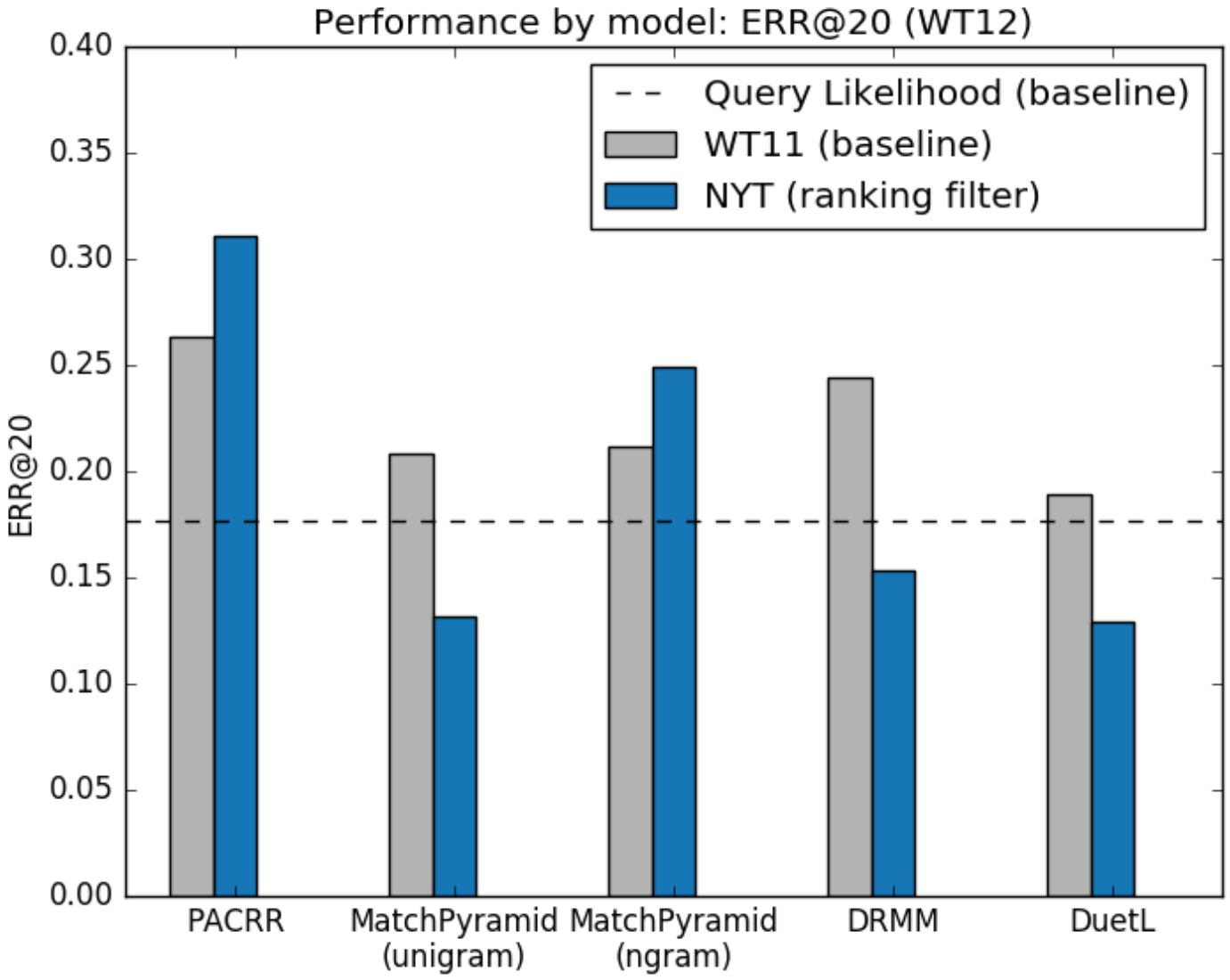
Evaluate on TREC Web 2012-2014 with ERR@20 and nDCG@20

Baselines: Query Likelihood; each model trained on TREC Web 2011 data

Results


Performance by model: ERR@20 (WT12)
Query Likelihood (baseline)
WT11 (baseline)
ERR@20
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
PACRR
MatchPyramid (unigram)
MatchPyramid (ngram)
DRMM
DuetL

Results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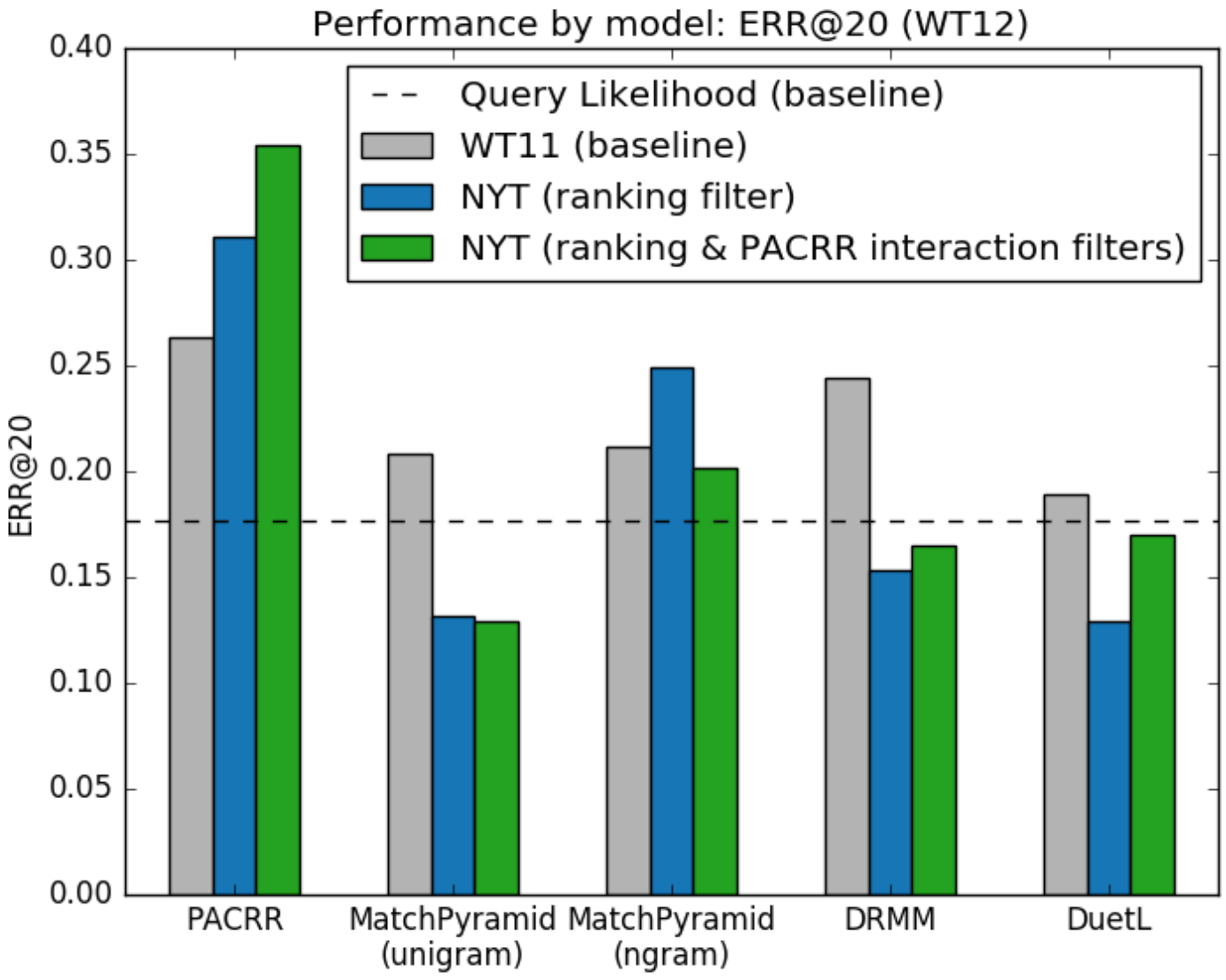
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NYT (ranking & PACRR interaction filters)
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Conclusions

We showed promising results for using news articles for neural IR training

Future Work:

Interaction filters for other models

Use a different source of interaction templates

Questions?

Mismatched Interaction Problem

PACRR