References I

Qingyao Ai, Liu Yang, Jiafeng Guo, and W. Bruce Croft. 2016a. Analysis of the Paragraph Vector Model for Information Retrieval. In *ICTIR*. ACM, 133–142.

Qingyao Ai, Liu Yang, Jiafeng Guo, and W Bruce Croft. 2016b. Improving language estimation with the paragraph vector model for ad-hoc retrieval. In *SIGIR*. ACM, 869–872.

Qingyao Ai, Yongfeng Zhang, Keping Bi, Xu Chen, and Bruce W. Croft. 2017. Learning a Hierarchical Embedding Model for Personalized Product Search. In *SIGIR*.

Nima Asadi, Donald Metzler, Tamer Elsayed, and Jimmy Lin. 2011. Pseudo test collections for learning web search ranking functions. In *SIGIR*. ACM, 1073–1082.

K. Balog, L. Azzopardi, and M. de Rijke. 2006. Formal models for expert finding in enterprise corpora. In *SIGIR*. 43–50.

Krisztian Balog, Yi Fang, Maarten de Rijke, Pavel Serdyukov, and Luo Si. 2012. Expertise Retrieval. *Found. & Tr. in Inform. Retr.* 6, 2-3 (2012), 127–256.

Trapit Bansal, David Belanger, and Andrew McCallum. 2016. Ask the GRU: Multi-task Learning for Deep Text Recommendations. In *RecSys*. 107–114.

Marco Baroni, Georgiana Dinu, and Germán Kruszewski. 2014. Don't count, predict! A systematic comparison of context-counting vs. context-predicting semantic vectors.. In *ACL*. 238–247.

Yoshua Bengio and Jean-Sébastien Senécal. 2008. Adaptive importance sampling to accelerate training of a neural probabilistic language model. *Transactions on Neural Networks* 19, 4 (2008), 713–722.

Yoshua Bengio, Jean-Sébastien Senécal, and others. 2003. Quick Training of Probabilistic Neural Nets by Importance Sampling.. In *AISTATS*.

Richard Berendsen, Manos Tsagkias, Wouter Weerkamp, and Maarten de Rijke. 2013. Pseudo test collections for training and tuning microblog rankers. In *SIGIR*. ACM, 53–62.

Alex Beutel, Paul Covington, Sagar Jain, Can Xu, Jia Li, Vince Gatto, and H Chi. 2018. Latent Cross: Making Use of Context in Recurrent Recommender Systems. In *WSDM*.

David M Blei, Andrew Y Ng, and Michael I Jordan. 2003. Latent dirichlet allocation. *JMLR* 3 (2003), 993–1022.

Antoine Bordes, Nicolas Usunier, Alberto Garcia-Duran, Jason Weston, and Oksana Yakhnenko. 2013. Translating embeddings for modeling multi-relational data. In *NIPS*. 2787–2795.

References II

Antoine Bordes and Jason Weston. 2017. Learning end-to-end goal-oriented dialog. *ICLR* (2017).

Alexey Borisov, Ilya Markov, Maarten de Rijke, and Pavel Serdyukov. 2016. A neural click model for web search. In *WWW*. International World Wide Web Conferences Steering Committee, 531–541.

Chris Burges. 2015. RankNet: A ranking retrospective. (2015). `https://www.microsoft.com/en-us/research/blog/ranknet-a-ranking-retrospective/` Accessed July 16, 2017.

Chris Burges, Tal Shaked, Erin Renshaw, Ari Lazier, Matt Deeds, Nicole Hamilton, and Greg Hullender. 2005. Learning to rank using gradient descent. In *ICML*. ACM, 89–96.

Christopher JC Burges. 2010. From ranknet to lambdarank to lambdamart: An overview. *Learning* 11, 23-581 (2010), 81.

Christopher JC Burges, Robert Ragno, and Quoc Viet Le. 2006. Learning to rank with nonsmooth cost functions. In *NIPS*, Vol. 6. 193–200.

Yixin Cao, Lifu Huang, Heng Ji, Xu Chen, and Juanzi Li. 2017. Bridge text and knowledge by learning multi-prototype entity mention embedding. In *ACL*, Vol. 1. 1623–1633.

Zhe Cao, Tao Qin, Tie-Yan Liu, Ming-Feng Tsai, and Hang Li. 2007. Learning to rank: from pairwise approach to listwise approach. In *ICML*. ACM, 129–136.

Gabriele Capannini, Claudio Lucchese, Franco Maria Nardini, Salvatore Orlando, Raffaele Perego, and Nicola Tonellotto. 2016. Quality versus efficiency in document scoring with learning-to-rank models. *IPM* 52, 6 (2016), 1161–1177.

Ben Carterette and Rosie Jones. 2008. Evaluating search engines by modeling the relationship between relevance and clicks. In *NIPS*. 217–224.

Tianqi Chen and Carlos Guestrin. 2016. Xgboost: A scalable tree boosting system. In *KDD*. ACM, 785–794.

Wei Chen, Tie-Yan Liu, Yanyan Lan, Zhi-Ming Ma, and Hang Li. 2009. Ranking measures and loss functions in learning to rank. In *NIPS*. 315–323.

Heng-Tze Cheng, Levent Koc, Jeremiah Harmsen, Tal Shaked, Tushar Chandra, Hrishi Aradhye, Glen Anderson, Greg Corrado, Wei Chai, Mustafa Ispir, Rohan Anil, Zakaria Haque, Lichan Hong, Vihan Jain, Xiaobing Liu, and Hemal Shah. 2016. Wide & Deep Learning for Recommender Systems. In *DLRS*. 7–10.

Charles LA Clarke, Maheedhar Kolla, Gordon V Cormack, Olga Vechtomova, Azin Ashkan, Stefan Büttcher, and Ian MacKinnon. 2008. Novelty and diversity in information retrieval evaluation. In *SIGIR*. ACM, 659–666.

Ronan Collobert and Jason Weston. 2008. A unified architecture for natural language processing: Deep neural networks with multitask learning. In *ICML*. ACM, 160–167.

References III

Ronan Collobert, Jason Weston, Léon Bottou, Michael Karlen, Koray Kavukcuoglu, and Pavel Kuksa. 2011. Natural language processing (almost) from scratch. *JMLR* 12, Aug (2011), 2493–2537.

David Cossock and Tong Zhang. 2006. Subset ranking using regression. In *COLT*, Vol. 6. Springer, 605–619.

Arjen P. de Vries, Anne-Marie Vercoustre, James A. Thom, Nick Craswell, and Mounia Lalmas. 2007. Overview of the INEX 2007 entity ranking track. In *Focused Access to XML Documents*. Springer, 245–251.

Scott Deerwester, Susan T Dumais, George W Furnas, Thomas K Landauer, and Richard Harshman. 1990. Indexing by latent semantic analysis. *JASIS* 41, 6 (1990), 391–407.

Mostafa Dehghani, Hamed Zamani, Aliaksei Severyn, Jaap Kamps, and W Bruce Croft. 2017. Neural Ranking Models with Weak Supervision. In *SIGIR*.

Gianluca Demartini, Arjen P. de Vries, Tereza Iofciu, and Jianhan Zhu. 2008. Overview of the INEX 2008 Entity Ranking Track. In *Advances in Focused Retrieval*. Springer Berlin Heidelberg, 243–252.

Gianluca Demartini, Tereza Iofciu, and Arjen P De Vries. 2009. Overview of the INEX 2009 entity ranking track. In *International Workshop of the Initiative for the Evaluation of XML Retrieval*. Springer, 254–264.

Gianluca Demartini, Tereza Iofciu, and Arjen P De Vries. 2010. Overview of the INEX 2009 Entity Ranking Track. In *Focused Retrieval and Evaluation*. Springer, 254–264.

Bhuwan Dhingra, Lihong Li, Xiujun Li, Jianfeng Gao, Yun-Nung Chen, Faisal Ahmed, and Li Deng. 2017. Towards End-to-End Reinforcement Learning of Dialogue Agents for Information Access. In *ACL*.

Fernando Diaz, Bhaskar Mitra, and Nick Craswell. 2016. Query expansion with locally-trained word embeddings. In *ACL*.

Laura Dietz, Alexander Kotov, and Edgar Meij. 2017. Utilizing Knowledge Graphs in Text-centric Information Retrieval. In *WSDM*. ACM, 815–816.

Jesse Dodge, Andreea Gane, Xiang Zhang, Antoine Bordes, Sumit Chopra, Alexander H. Miller, Arthur Szlam, and Jason Weston. 2015. Evaluating Prerequisite Qualities for Learning End-to-End Dialog Systems. *CoRR* abs/1511.06931 (2015).

Yixing Fan, Liang Pang, JianPeng Hou, Jiafeng Guo, Yanyan Lan, and Xueqi Cheng. 2017. MatchZoo: A Toolkit for Deep Text Matching. *arXiv preprint arXiv:1707.07270* (2017).

John Rupert Firth. 1957. *Papers in Linguistics 1934-1951*. Oxford University Press.

References IV

Yoav Freund, Raj Iyer, Robert E Schapire, and Yoram Singer. 2003. An efficient boosting algorithm for combining preferences. *JMLR* 4, Nov (2003), 933–969.

Norbert Fuhr. 1989. Optimum polynomial retrieval functions based on the probability ranking principle. *TOIS* 7, 3 (1989), 183–204.

Debasis Ganguly, Dwaipayan Roy, Mandar Mitra, and Gareth JF Jones. 2015. Word embedding based generalized language model for information retrieval. In *SIGIR*. ACM, 795–798.

Yasser Ganjisaffar, Rich Caruana, and Cristina Lopes. 2011. Bagging Gradient-Boosted Trees for High Precision, Low Variance Ranking Models. In *SIGIR*. ACM, 85–94.

Ian Goodfellow, Yoshua Bengio, and Aaron Courville. 2016. *Deep learning*. MIT press.

Ian Goodfellow, Jean Pouget-Abadie, Mehdi Mirza, Bing Xu, David Warde-Farley, Sherjil Ozair, Aaron Courville, and Yoshua Bengio. 2014. Generative adversarial nets. In *NIPS*. 2672–2680.

Joshua Goodman. 2001. Classes for fast maximum entropy training. In *ICASSP*, Vol. 1. IEEE, 561–564.

Mihajlo Grbovic, Vladan Radosavljevic, Nemanja Djuric, Narayan Bhamidipati, Jaikit Savla, Varun Bhagwan, and Doug Sharp. 2015. E-commerce in Your Inbox: Product Recommendations at Scale. In *KDD*. 1809–1818.

Artem Grotov and Maarten de Rijke. 2016. Online Learning to Rank for Information Retrieval: SIGIR 2016 Tutorial. In *SIGIR*. ACM, 1215–1218.

Jiafeng Guo, Yixing Fan, Qingyao Ai, and W Bruce Croft. 2016. A Deep Relevance Matching Model for Ad-hoc Retrieval. ACM, 55–64.

Nitish Gupta, Sameer Singh, and Dan Roth. 2017. Entity linking via joint encoding of types, descriptions, and context. In *EMNLP*. 2681–2690.

Michael Gutmann and Aapo Hyvärinen. 2010. Noise-contrastive estimation: A new estimation principle for unnormalized statistical models.. In *AISTATS*, Vol. 1. 6.

Zellig S Harris. 1954. Distributional structure. *Word* 10, 2-3 (1954), 146–162.

Ruining He and Julian McAuley. 2016. VBPR: Visual Bayesian Personalized Ranking from Implicit Feedback. In *AAAI*. 144–150.

Zhengyan He, Shujie Liu, Mu Li, Ming Zhou, Longkai Zhang, and Houfeng Wang. 2013. Learning entity representation for entity disambiguation. In *ACL*, Vol. 2. 30–34.

Ralf Herbrich, Thore Graepel, and Klaus Obermayer. 2000. Large margin rank boundaries for ordinal regression. (2000).

References V

Karl Moritz Hermann, Tomas Kocisky, Edward Grefenstette, Lasse Espeholt, Will Kay, Mustafa Suleyman, and Phil Blunsom. 2015. Teaching machines to read and comprehend. In *NIPS*.

Daniel Hewlett, Alexandre Lacoste, Llion Jones, Illia Polosukhin, Andrew Fandrianto, Jay Han, Matthew Kelcey, and David Berthelot. 2016. WIKIREADING: A Novel Large-scale Language Understanding Task over Wikipedia. In *ACL*.

Balázs Hidasi, Alexandros Karatzoglou, Linas Baltrunas, and Domonkos Tikk. 2016. Session-based recommendations with recurrent neural networks. *ICLR* (2016).

S. Hochreiter and J. Schmidhuber. 1997. Long short-term memory. *Neural Computation* 9, 8 (1997), 1735–1780.

Thomas Hofmann. 1999. Probabilistic latent semantic indexing. In *SIGIR*. ACM, 50–57.

Baotian Hu, Zhengdong Lu, Hang Li, and Qingcai Chen. 2014. Convolutional neural network architectures for matching natural language sentences. In *NIPS*. 2042–2050.

Po-Sen Huang, Xiaodong He, Jianfeng Gao, Li Deng, Alex Acero, and Larry Heck. 2013. Learning deep structured semantic models for web search using clickthrough data. In *CIKM*. ACM, 2333–2338.

Zhiheng Huang, Wei Xu, and Kai Yu. 2015. Bidirectional LSTM-CRF models for sequence tagging. *arXiv preprint arXiv:1508.01991* (2015).

Phillip Isola, Jun-Yan Zhu, Tinghui Zhou, and Alexei A Efros. 2016. Image-to-Image Translation with Conditional Adversarial Networks. *arXiv preprint arXiv:1611.07004* (2016).

Rolf Jagerman, Julia Kiseleva, and Maarten de Rijke. 2017. Modeling Label Ambiguity for Neural List-Wise Learning to Rank. In *Neu-IR SIGIR Workshop*.

Kalervo Järvelin and Jaana Kekäläinen. 2000. IR Evaluation Methods for Retrieving Highly Relevant Documents. In *SIGIR*. ACM, 41–48.

Sébastien Jean, Kyunghyun Cho, Roland Memisevic, and Yoshua Bengio. 2014. On Using Very Large Target Vocabulary for Neural Machine Translation. *arXiv preprint arXiv:1412.2007* (2014).

Shihao Ji, SVN Vishwanathan, Nadathur Satish, Michael J Anderson, and Pradeep Dubey. 2015. Blackout: Speeding up recurrent neural network language models with very large vocabularies. *arXiv preprint arXiv:1511.06909* (2015).

Thorsten Joachims. 2003. Evaluating Retrieval Performance Using Clickthrough Data. In *Text Mining*. 79–96.

Thorsten Joachims. 2006. Training linear SVMs in linear time. In *KDD*. ACM, 217–226.

Thorsten Joachims, Dayne Freitag, and Tom Mitchell. 1997. Webwatcher: A tour guide for the world wide web. In *IJCAI*. 770–777.

References VI

Rafal Jozefowicz, Oriol Vinyals, Mike Schuster, Noam Shazeer, and Yonghui Wu. 2016. Exploring the limits of language modeling. *arXiv preprint arXiv:1602.02410* (2016).

Nal Kalchbrenner, Lasse Espeholt, Karen Simonyan, Aaron van den Oord, Alex Graves, and Koray Kavukcuoglu. 2016. Neural Machine Translation in Linear Time. *arXiv preprint arXiv:1610.10099* (2016).

Anjuli Kannan, Karol Kurach, Sujith Ravi, Tobias Kaufmann, Andrew Tomkins, Balint Miklos, Greg Corrado, László Lukács, Marina Ganea, Peter Young, and others. 2016. Smart Reply: Automated response suggestion for email. In *KDD*. ACM, 955–964.

Tom Kenter, Alexey Borisov, and Maarten de Rijke. 2016. Siamese CBOW: Optimizing Word Embeddings for Sentence Representations. In *ACL*. 941–951.

Tom Kenter and Maarten de Rijke. 2017. Attentive Memory Networks: Efficient Machine Reading for Conversational Search. In *The First International Workshop on Conversational Approaches to Information Retrieval (CAIR'17)*.

Tom Kenter, Llion Jones, and Daniel Hewlett. 2018. Byte-level Machine Reading across Morphologically Varied Languages. In *AAAI*.

Quoc V Le and Tomas Mikolov. 2014. Distributed Representations of Sentences and Documents. In *ICML*. 1188–1196.

Yu Lei, Wenjie Li, Ziyu Lu, and Miao Zhao. 2017. Alternating Pointwise-Pairwise Learning for Personalized Item Ranking. In *CIKM*. ACM, 2155–2158.

Hang Li and Zhengdong Lu. 2016. Deep learning for information retrieval. In *SIGIR*. ACM, 1203–1206.

Hang Li, Jun Xu, and others. 2014. Semantic matching in search. *Foundations and Trends® in Information Retrieval* 7, 5 (2014), 343–469.

Jiwei Li, Michel Galley, Chris Brockett, Jianfeng Gao, and Bill Dolan. 2015. A diversity-promoting objective function for neural conversation models. In *NAACL-HLT 2016*. 110–119.

Jiwei Li, Will Monroe, Tianlin Shi, Alan Ritter, and Dan Jurafsky. 2017. Adversarial learning for neural dialogue generation. *arXiv preprint arXiv:1701.06547* (2017).

Ping Li, Qiang Wu, and Christopher J Burges. 2008. Mcrank: Learning to rank using multiple classification and gradient boosting. In *NIPS*. 897–904.

Dawen Liang, Jaan Altosaar, Laurent Charlin, and David M. Blei. 2016. Factorization Meets the Item Embedding: Regularizing Matrix Factorization with Item Co-occurrence. In *RecSys '16*. 59–66.

Yankai Lin, Zhiyuan Liu, Maosong Sun, Yang Liu, and Xuan Zhu. 2015. Learning Entity and Relation Embeddings for Knowledge Graph Completion.. In *AAAI*. 2181–2187.

References VII

Chia-Wei Liu, Ryan Lowe, Iulian V Serban, Michael Noseworthy, Laurent Charlin, and Joelle Pineau. 2016. How NOT to evaluate your dialogue system: An empirical study of unsupervised evaluation metrics for dialogue response generation. In *EMNLP*.

Qiang Liu, Feng Yu, Shu Wu, and Liang Wang. 2015. A convolutional click prediction model. In *CIKM*. ACM, 1743–1746.

Tie-Yan Liu. 2009. Learning to rank for information retrieval. *Foundations and Trends® in Information Retrieval* 3, 3 (2009), 225–331.

Ryan Lowe, Nissan Pow, Iulian Serban, and Joelle Pineau. 2015. The ubuntu dialogue corpus: A large dataset for research in unstructured multi-turn dialogue systems. In *SIGDIAL*. 285–294.

R Duncan Luce. 2005. *Individual choice behavior: A theoretical analysis*. Courier Corporation.

S. MacAvaney, K. Hui, and A. Yates. 2017. An Approach for Weakly-Supervised Deep Information Retrieval. arXiv 1707.00189. (2017).

Tomas Mikolov, Ilya Sutskever, Kai Chen, Greg S Corrado, and Jeff Dean. 2013. Distributed representations of words and phrases and their compositionality. 3111–3119.

Alexander Miller, Adam Fisch, Jesse Dodge, Amir-Hossein Karimi, Antoine Bordes, and Jason Weston. 2016. Key-Value Memory Networks for Directly Reading Documents. In *EMNLP*.

Bhaskar Mitra. 2015. Exploring session context using distributed representations of queries and reformulations. In *SIGIR*. ACM, 3–12.

Bhaskar Mitra and Nick Craswell. 2017. An introduction to neural information retrieval. *Foundations and Trends® in Information Retrieval (to appear)* (2017).

Bhaskar Mitra, Fernando Diaz, and Nick Craswell. 2017. Learning to Match Using Local and Distributed Representations of Text for Web Search. 1291–1299.

Andriy Mnih and Geoffrey E Hinton. 2009. A scalable hierarchical distributed language model. In *NIPS*. 1081–1088.

Andriy Mnih and Yee Whye Teh. 2012. A fast and simple algorithm for training neural probabilistic language models. *arXiv preprint arXiv:1206.6426* (2012).

Frederic Morin and Yoshua Bengio. 2005. Hierarchical Probabilistic Neural Network Language Model.. In *AISTATS*, Vol. 5. 246–252.

Eric Nalisnick, Bhaskar Mitra, Nick Craswell, and Rich Caruana. 2016. Improving Document Ranking with Dual Word Embeddings. In *WWW*.

Thomas Nedelec, Elena Smirnova, and Flavian Vasile. 2016. Content2vec: Specializing joint representations of product images and text for the task of product recommendation. (2016).

References VIII

Kezban Dilek Onal, Ye Zhang, Ismail Sengor Altingovde, Md Mustafizur Rahman, Pinar Karagoz, Alex Braylan, Brandon Dang, Heng-Lu Chang, Henna Kim, Quinten McNamara, and others. 2017. Neural information retrieval: At the end of the early years. *Information Retrieval Journal* (2017), 1–72.

Liang Pang, Yanyan Lan, Jiafeng Guo, Jun Xu, Shengxian Wan, and Xueqi Cheng. 2016. Text Matching as Image Recognition.. In *AAAI*. 2793–2799.

Liang Pang, Yanyan Lan, Jiafeng Guo, Jun Xu, Jingfang Xu, and Xueqi Cheng. 2017. DeepRank: A New Deep Architecture for Relevance Ranking in Information Retrieval. In *CIKM*. ACM, 257–266.

Filip Radlinski and Thorsten Joachims. 2005. Query chains: learning to rank from implicit feedback. In *KDD*. ACM, 239–248.

Filip Radlinski, Madhu Kurup, and Thorsten Joachims. 2008. How does clickthrough data reflect retrieval quality?. In *CIKM*. ACM, 43–52.

Radim Řehůřek and Petr Sojka. 2010. Software Framework for Topic Modelling with Large Corpora. In *LREC Workshop on New Challenges for NLP Frameworks*. ELRA, Valletta, Malta, 45–50. `http://is.muni.cz/publication/884893/en`.

Jennifer Rowley. 2000. Product search in e-shopping: a review and research propositions. *Journal of consumer marketing* 17, 1 (2000), 20–35.

Dwaipayan Roy, Debjyoti Paul, Mandar Mitra, and Utpal Garain. 2016. Using Word Embeddings for Automatic Query Expansion. *arXiv preprint arXiv:1606.07608* (2016).

Ruslan Salakhutdinov and Geoffrey Hinton. 2009. Semantic hashing. *Int. J. Approximate Reasoning* 50, 7 (2009), 969–978.

Ruslan Salakhutdinov, Andriy Mnih, and Geoffrey Hinton. 2007. Restricted Boltzmann Machines for Collaborative Filtering. In *ICML*. 791–798.

Tobias Schnabel, Adith Swaminathan, Ashudeep Singh, Navin Chandak, and Thorsten Joachims. 2016. Recommendations as Treatments: Debiasing Learning and Evaluation. *CoRR* abs/1602.05352 (2016).

D. Sculley. 2009. Large scale learning to rank. In *NIPS Workshop on Advances in Ranking*.

Iulian Vlad Serban, Alessandro Sordoni, Yoshua Bengio, Aaron C Courville, and Joelle Pineau. 2016. Building End-To-End Dialogue Systems Using Generative Hierarchical Neural Network Models.. In *AAAI*. 3776–3784.

Pararth Shah, Dilek Hakkani-Tür, and Larry Heck. 2016. Interactive reinforcement learning for task-oriented dialogue management. In *NIPS Workshop on Deep Learning for Action and Interaction*.

Lifeng Shang, Zhengdong Lu, and Hang Li. 2015. Neural responding machine for short-text conversation. In *ACL*.

Yelong Shen, Xiaodong He, Jianfeng Gao, Li Deng, and Grégoire Mesnil. 2014. A latent semantic model with convolutional-pooling structure for information retrieval. In *CIKM*. ACM, 101–110.

References IX

Alessandro Sordoni, Yoshua Bengio, Hossein Vahabi, Christina Lioma, Jakob G. Simonson, and Jian-Yun Nie. 2015a. A Hierarchical Recurrent Encoder-Decoder for Generative Context-Aware Query Suggestion. In *CIKM*.

Alessandro Sordoni, Michel Galley, Michael Auli, Chris Brockett, Yangfeng Ji, Meg Mitchell, Jian-Yun Nie, Jianfeng Gao, and Bill Dolan. 2015b. A Neural Network Approach to Context-Sensitive Generation of Conversational Responses. In *ACL HLT*.

K. Sparck Jones and C.J. van Rijsbergen. 1976. *Report on the need for and provision of an 'ideal' information retrieval test collection.* Technical Report. Computer Laboratory, Cambridge University.

Sainbayar Sukhbaatar, Arthur Szlam, Jason Weston, and Rob Fergus. 2015. End-To-End Memory Networks. In *NIPS*.

Yaming Sun, Lei Lin, Duyu Tang, Nan Yang, Zhenzhou Ji, and Xiaolong Wang. 2015. Modeling Mention, Context and Entity with Neural Networks for Entity Disambiguation.. In *IJCAI*.

Paul Thomas, Daniel McDuff, Mary Czerwinski, and Nick Craswell. 2017. MISC: A data set of information-seeking conversations. In *The First International Workshop on Conversational Approaches to Information Retrieval (CAIR'17)*.

Jörg Tiedemann. 2009. News from OPUS-A collection of multilingual parallel corpora with tools and interfaces. In *ACL RANLP*, Vol. 5. 237–248.

Aäron van den Oord, Sander Dieleman, Heiga Zen, Karen Simonyan, Oriol Vinyals, Alexander Graves, Nal Kalchbrenner, Andrew Senior, and Koray Kavukcuoglu. 2016. WaveNet: A Generative Model for Raw Audio. In *Arxiv*. `https://arxiv.org/abs/1609.03499`

Christophe Van Gysel, Maarten de Rijke, and Evangelos Kanoulas. 2016. Learning Latent Vector Spaces for Product Search. In *CIKM*. ACM, 165–174.

Christophe Van Gysel, Maarten de Rijke, and Evangelos Kanoulas. 2017a. Neural Vector Spaces for Unsupervised Information Retrieval. *arXiv preprint arXiv:1708.02702* (2017).

Christophe Van Gysel, Maarten de Rijke, and Evangelos Kanoulas. 2017b. Semantic Entity Retrieval Toolkit. In *Neu-IR SIGIR Workshop*.

Christophe Van Gysel, Maarten de Rijke, and Evangelos Kanoulas. 2017c. Structural Regularities in Expert Vector Spaces. In *ICTIR*. ACM.

Christophe Van Gysel, Maarten de Rijke, and Marcel Worring. 2016. Unsupervised, Efficient and Semantic Expertise Retrieval. In *WWW*. ACM, 1069–1079.

Ashish Vaswani, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N Gomez, Łukasz Kaiser, and Illia Polosukhin. 2017. Attention is all you need. In *NIPS*. 6000–6010.

References X

Ashish Vaswani, Yinggong Zhao, Victoria Fossum, and David Chiang. 2013. Decoding with Large-Scale Neural Language Models Improves Translation.. In *EMNLP*. 1387–1392.

Oriol Vinyals and Quoc Le. 2015. A neural conversational model. In *ICML Workshop on Deep Learning*.

Ivan Vulić and Marie-Francine Moens. 2015. Monolingual and cross-lingual information retrieval models based on (bilingual) word embeddings. In *SIGIR*. ACM, 363–372.

Shengxian Wan, Yanyan Lan, Jiafeng Guo, Jun Xu, Liang Pang, and Xueqi Cheng. 2016a. A Deep Architecture for Semantic Matching with Multiple Positional Sentence Representations.. In *AAAI*.

Shengxian Wan, Yanyan Lan, Jun Xu, Jiafeng Guo, Liang Pang, and Xueqi Cheng. 2016b. Match-SRNN: Modeling the Recursive Matching Structure with Spatial RNN. In *IJCAI*. AAAI Press, 2922–2928.

Jun Wang, Lantao Yu, Weinan Zhang, Yu Gong, Yinghui Xu, Benyou Wang, Peng Zhang, and Dell Zhang. 2017. IRGAN: A Minimax Game for Unifying Generative and Discriminative Information Retrieval Models. In *SIGIR*. ACM, 515–524.

Zhen Wang, Jianwen Zhang, Jianlin Feng, and Zheng Chen. 2014. Knowledge Graph Embedding by Translating on Hyperplanes.. In *AAAI*. 1112–1119.

Tsung-Hsien Wen, David Vandyke, Nikola Mrksic, Milica Gasic, Lina M Rojas-Barahona, Pei-Hao Su, Stefan Ultes, and Steve Young. 2017. A network-based end-to-end trainable task-oriented dialogue system. In *EACL*.

Jason Williams, Kavosh Asadi, and Geoffrey Zweig. 2017. Hybrid Code Networks: Practical and Efficient End-To-End Dialog Control With Supervised and Reinforcement Learning. In *ACL*.

Yao Wu, Christopher DuBois, Alice X. Zheng, and Martin Ester. 2016. Collaborative Denoising Auto-Encoders for Top-N Recommender Systems. In *WSDM*. 153–162.

Fen Xia, Tie-Yan Liu, Jue Wang, Wensheng Zhang, and Hang Li. 2008. Listwise approach to learning to rank: theory and algorithm. In *ICML*. ACM, 1192–1199.

Chenyan Xiong, Jamie Callan, and Tie-Yan Liu. 2017a. Word-Entity Duet Representations for Document Ranking. In *SIGIR*.

Chenyan Xiong, Zhuyun Dai, Jamie Callan, Zhiyuan Liu, and Russell Power. 2017b. End-to-End Neural Ad-hoc Ranking with Kernel Pooling. In *SIGIR*. ACM, 55–64.

Bo Xu, Hongfei Lin, Yuan Lin, and Kan Xu. 2017. Learning to Rank with Query-level Semi-supervised Autoencoders. In *CIKM*. ACM, 2395–2398.

References XI

Liu Yang, Qingyao Ai, Jiafeng Guo, and W Bruce Croft. 2016. aNMM: Ranking short answer texts with attention-based neural matching model. In *CIKM*. ACM, 287–296.

Emine Yilmaz and Stephen Robertson. 2009. Deep Versus Shallow Judgments in Learning to Rank. In *SIGIR*. ACM, 662–663.

Hamed Zamani and W. Bruce Croft. 2016a. Embedding-based Query Language Models. In *ICTIR*. ACM, 147–156.

Hamed Zamani and W. Bruce Croft. 2016b. Estimating Embedding Vectors for Queries. In *ICTIR*. ACM, 123–132.

Hamed Zamani and W Bruce Croft. 2017. Relevance-based Word Embedding. In *SIGIR*.

Yuyu Zhang, Hanjun Dai, Chang Xu, Jun Feng, Taifeng Wang, Jiang Bian, Bin Wang, and Tie-Yan Liu. 2014. Sequential Click Prediction for Sponsored Search with Recurrent Neural Networks.. In *AAAI*. 1369–1375.

Xiangyu Zhao, Liang Zhang, Zhuoye Ding, Dawei Yin, Yihong Zhao, and Jiliang Tang. 2017. Deep Reinforcement Learning for List-wise Recommendations. *CoRR* abs/1801.00209 (2017).

Guoqing Zheng and Jamie Callan. 2015. Learning to reweight terms with distributed representations. In *SIGIR*. ACM, 575–584.

Zhaohui Zheng, Keke Chen, Gordon Sun, and Hongyuan Zha. 2007. A regression framework for learning ranking functions using relative relevance judgments. In *SIGIR*. ACM, 287–294.

Guido Zuccon, Bevan Koopman, Peter Bruza, and Leif Azzopardi. 2015. Integrating and Evaluating Neural Word Embeddings in Information Retrieval. In *20th Australasian Document Computing Symposium*. ACM, Article 12, 8 pages.

Notation

Meaning	Notation
Single query	q
Single document	d
Set of queries	Q
Collection of documents	D
Term in query q	t_q
Term in document d	t_d
Full vocabulary of all terms	T
Set of ranked results retrieved for query q	R_q
Result tuple (document d at rank i)	$\langle i, d \rangle$, where $\langle i, d \rangle \in R_q$
Relevance label of document d for query q	$rel_q(d)$
d_i is more relevant than d_j for query q	$rel_q(d_i) > rel_q(d_j)$, or $d_i \succ_q d_j$
Frequency of term t in document d	$tf(t, d)$
Number of documents that contain term t	$df(t)$
Vector representation of text z	$\vec{z}$
Probability function for an event $\mathcal{E}$	$p(\mathcal{E})$
$\mathbb{R}$	The set of real numbers

We adopt some neural network related notation from [Goodfellow et al., 2016] and IR related notation from [Mitra and Craswell, 2017]

Acknowledgments


All content represents the opinion of the author(s), which is not necessarily shared or endorsed by their employers and/or sponsors.