

# Muhao Chen

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## Research Interests

*Representation learning for structured data. Data-driven machine learning for knowledge acquisition natural language understanding. Deep learning approaches to computational biology.*

## EDUCATION

### University of California, Los Angeles, USA

*Ph.D. in Computer Science*

2014.9-2019.6

*Dissertation: Multi-relational Representation Learning and Knowledge Acquisition Advisor: Carlo Zaniolo Collaborators: Kai-Wei Chang, Wei Wang, Yizhou Sun*

### Fudan University, Shanghai, China

*B.S. in Computer Science*

2010.9-2014.6

*Advisor: X. Sean Wang*

## PUBLICATIONS

\*Indicating equal contributions. ✉ Indicating contact authors. 👤 Indicating advisee students.

### Refereed Journal Publication

- Guangyu Zhou\*, **Muhao Chen**✉\*, Chelsea J. T. Ju\*, Zheng Wang, Jyun-Yu Jiang, Wei Wang✉. Mutation effect estimation on protein-protein interactions using deep contextualized representation learning. *NAR Genom. Bioinform*, vol. 2 (2). Oxford University Press. 2020.
- Zequn Sun, Qingheng Zhang, Wei Hu✉, Chengming Wang, **Muhao Chen**, Chengkai Li, Yuzhong Qu. A Benchmarking Study of Embedding-based Entity Alignment for Knowledge Graphs. *Proceedings of the VLDB Endowment (PVLDB)*, vol. 13. ACM. 2020
- Muhao Chen**✉\*, Chelsea J. T. Ju\*, Guangyu Zhou, Tianran Zhang, Kai-Wei Chang, Carlo Zaniolo, Wei Wang. Multifaceted Protein-Protein Interaction Prediction Based on Siamese Residual RCNN. *Bioinformatics*, vol. 35 (14) Oxford University Press. Proceedings of ISMB/ECCB, 2019.
- Carlo Zaniolo✉, Shi Gao, Maurizio Atzori, **Muhao Chen**, Jiaqi Gu. User-Friendly Temporal Queries on Historical Knowledge Bases. *Information and Computation*, Vol. 259 (3). Elsevier, 2018.

### Refereed Publication in Conference Proceedings

- Fangyu Liu, **Muhao Chen**, Dan Roth, Nigel Collier. Visual Pivoting for (Unsupervised) Entity Alignment. In *the 35<sup>th</sup> AAAI Conference on Artificial Intelligence (AAAI)*, 2021.
- Cunchao Zhu, **Muhao Chen**, Changjun Fan, Guangquan Cheng, Yan Zhang. Learning from History: Modeling Temporal Knowledge Graphs with Sequential Copy-Generator Networks. In *the 35<sup>th</sup> AAAI Conference on Artificial Intelligence (AAAI)*, 2021.
- Muhao Chen**, Weijia Shi, Ben Zhou, Dan Roth. Cross-lingual Entity Alignment for Knowledge Graphs with Incidental Supervision from Free Text. In *the 16<sup>th</sup> Conference of the European Chapter of the Association for Computational Linguistics (EACL)*, 2021.
- Muhao Chen**, Hongming Zhang, Haoyu Wang👤, Dan Roth. “What Are You Trying to Do?” Semantic Typing of Event Processes. In *Proceedings of the 24<sup>th</sup> SIGNLL Conference on Computational Natural Language Learning (CoNLL)*, 2020. **Best Paper Nomination**
- Zequn Sun, **Muhao Chen**, Wei Hu, Chengming Wang. Knowledge Association with Hyperbolic Representation Learning of Knowledge Graphs. In *Proceedings of the 25<sup>th</sup> Conference on Empirical Methods in Natural Language Processing (EMNLP)* 2020.
- Haoyu Wang👤, **Muhao Chen**, Hongming Zhang, Dan Roth. Joint Constrained Learning for Event-Event Relation Extraction. In *Proceedings of the 25<sup>th</sup> Conference on Empirical Methods in Natural Language Processing (EMNLP)*, 2020.
- Hongming Zhang, **Muhao Chen**, Haoyu Wang👤, Y. Song, Dan Roth. Analogous Process Structure Induction for Sub-event Sequence Prediction. In *Proceedings of the 25<sup>th</sup> Conference on Empirical Methods in Natural Language Processing (EMNLP)*, 2020.

12. Xuelu Chen , **Muhao Chen**, Changjun Fan, Ankith Uppunda , Yizhou Sun, Carlo Zaniolo. Multilingual Knowledge Graph Completion via Ensemble Knowledge Transfer. In *Proceedings of the 25<sup>th</sup> Conference on Empirical Methods in Natural Language Processing (EMNLP) - Findings*, 2020.
13. Zequn Sun, Chengming Wang, Wei Hu, **Muhao Chen**, Jian Dai, Wei Zhang, Yuzhong Qu. Knowledge Graph Alignment Network with Gated Multi-hop Neighborhood Aggregation. In *the 34<sup>th</sup> AAAI Conference on Artificial Intelligence (AAAI)*, 2020.
14. Changping Meng, **Muhao Chen**, Jie Mao, Jennifer Neville. ReadNet: A Hierarchical Transformer Framework for Readability Analysis. In *the 42<sup>nd</sup> European Conference on Information Retrieval (ECIR)*, 2020.
15. Junheng Hao , Chelsea J. T. Ju, **Muhao Chen**, Yizhou Sun, Carlo Zaniolo, Wei Wang. Bio-JOIE: Joint Representation Learning of Biological Knowledge Bases. In *the 11<sup>th</sup> ACM Conference on Bioinform., Comput. Bio. and Biomed. (ACM BCB)*, 2020 (**Best Student Paper Award**, ~0.8%)
16. Tianran Zhang , **Muhao Chen**, Alex Bui. Diagnostic Prediction with Sequence-of-sets Representation Learning for Clinical Events. In *Proceedings of the 18<sup>th</sup> International Conference on Artificial Intelligence in Medicine (AIME)*, 2020
17. **Muhao Chen**, Yingtao Tian, Haochen Chen, Kai-Wei Chang, Steve Skiena, Carlo Zaniolo. Learning to Represent Bilingual Dictionaries. In *Proceedings of the 23rd SIGNLL Conference on Computational Natural Language Learning (CoNLL)*, 2019
18. Junheng Hao , **Muhao Chen**, Wenchao Yu, Yizhou Sun, Wei Wang. Universal Representation Learning of Knowledge Bases by Jointly Embedding Ontological Concepts and Instances. In *Proceedings of the 25<sup>th</sup> ACM SIGKDD Conference on Knowledge Discovery and Data Mining (KDD)*, 2019.
19. Xuelu Chen , **Muhao Chen**, Weijia Shi , Yizhou Sun, Carlo Zaniolo. Uncertain Knowledge Graphs Embeddings. In *the 33<sup>rd</sup> International Conference on Artificial Intelligence (AAAI)*, 2019.
20. **Muhao Chen**\*, Weijia Shi\* , Pei Zhou , Kai-Wei Chang. Retrofitting Contextualized Word Embeddings with Paraphrases. In *Proceedings of the 24th Conference on Empirical Methods in Natural Language Processing (EMNLP)*, 2019.
21. Pei Zhou , Weijia Shi , Jieyu Zhao, Kuan-Hao Huang, **Muhao Chen**, Ryan Cotterell, Kai-Wei Chang. Examining Gender Bias in Languages with Grammatical Gender. In *Proceedings of the 24th Conference on Empirical Methods in Natural Language Processing (EMNLP)*, 2019.
22. **Muhao Chen**, Chris Quirk. Embedding Edge-attributed Relational Hierarchies. In *Proceedings of the 42<sup>nd</sup> ACM SIGIR Conference on Research and Development in Information Retrieval (SIGIR)*, 2019.
23. Qingheng Zhang, Zequn Sun, Wei Hu, **Muhao Chen**, Lingbing Guo, Yuzhong Qu. Multi-view Knowledge Graph Embedding for Entity Alignment. In *Proceedings of the 28<sup>th</sup> International Joint Conference on Artificial Intelligence (IJCAI)*, 2019. Also in ISWC 2020 Invited Sister Conference Track.
24. Zequn Sun, Jiacheng Huang, Wei Hu, **Muhao Chen**, Yuzhong Qu. TransEdge: Translating Relation-contextualized Embeddings for Knowledge Graphs. In *the 18<sup>th</sup> International Semantic Web Conference (ISWC)*, 2019.
25. Haochen Chen, Syed Fahad Sultan, Yingtao Tian, **Muhao Chen**, Steven Skiena. Fast and Accurate Network Embeddings via Very Sparse Random Projection. In *Proceedings of the 28<sup>th</sup> ACM International Conference on Information and Knowledge Management (CIKM)*, 2019.
26. Changjun Fan, Yuhui Ding, Li Zeng, **Muhao Chen**, Yizhou Sun and Zhong Liu. Learning to Identify High Betweenness Centrality Nodes from Scratch: A Novel Graph Neural Network Approach. In *Proceedings of the 28<sup>th</sup> ACM International Conference on Information and Knowledge Management (CIKM)*, 2019.
27. **Muhao Chen**, Changping Meng, Gang Huang, Carlo Zaniolo. Learning to Differentiate Between Main-articles and Sub-articles in Wikipedia. In *IEEE International Conference on Big Data (BigData)*, 2019.
28. Yingtao Tian, Haochen Chen, Bryan Perozzi, **Muhao Chen**, Xiaofei Sun, Steven Skiena. Social Relation Inference via Label Propagation. In *the 41<sup>st</sup> European Conference on Information Retrieval (ECIR)*, 2019.
29. Qi Zhao, **Muhao Chen**, Pengyuan Du, Tuan Le, Mario Gerla. Towards Efficient Cellular Traffic Offloading via Dynamic MPTCP Path Configuration with SDN. In *IEEE International Conference on Computing, Networking and Communications (ICNC)*, 2019.
30. **Muhao Chen**, Gang Huang, Changping Meng, Carlo Zaniolo. Neural Article Pair Modeling for Wikipedia Sub-article Matching. In *the 29<sup>th</sup> European Conference on Machine Learning (ECML)*, 2018 (**Plenary Presentation**, ~1.7% acceptance rate)
31. **Muhao Chen**, Yingtao Tian, Kai-Wei Chang, Steven Skiena, Carlo Zaniolo. Co-training Embeddings of Knowledge Graphs and Entity Descriptions for Cross-lingual Entity Alignment. In *the 27<sup>th</sup> International Joint Conference on Artificial Intelligence (IJCAI)*, 2018.

32. **Muhao Chen**, Yingtao Tian, Xuelu Chen✉, Zijun Xue, Carlo Zaniolo. On2Vec: Embedding-based Relation Prediction for Ontology Population. In *Proceedings of the 17<sup>th</sup> SIAM International Conference on Data Mining (SDM)*. SIAM, 2018
33. Haochen Chen, Xiaofei Sun, Yingtao Tian, Bryan Perozzi, **Muhao Chen** and Steven Skiena. Enhanced Network Embeddings via Exploiting Edge Labels. In *the 27<sup>th</sup> ACM Conference on Information and Knowledge Management (CIKM)*. ACM 2018.
34. Pengyuan Du, Seunghyun Yoo, Qi Zhao, **Muhao Chen**, Mario Gerla. Towards Opportunistic Resource Sharing in Mobile Social Networks - an Evolutionary Game Theoretic Approach. In *Proceedings of the 19<sup>th</sup> ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc)*, ACM 2018.
35. **Muhao Chen**, Qi Zhao, Pengyuan Du, Carlo Zaniolo, Mario Gerla. Demand-driven Cache Allocation Based on Context-aware Collaborative Filtering. In *Proceedings of the 19<sup>th</sup> ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc)*, ACM 2018.
36. **Muhao Chen**, Yingtao Tian, Mohan Yang, Carlo Zaniolo. Multilingual Knowledge Graph Embeddings for Cross-lingual Knowledge Alignment. In *Proceedings of the 26<sup>th</sup> International Joint Conference on Artificial Intelligence (IJCAI)*. 2017.
37. **Muhao Chen**, Carlo Zaniolo. Learning Multi-faceted Knowledge Graph Embeddings for Natural Language Processing. In *Proceedings of the 26<sup>th</sup> International Joint Conference on Artificial Intelligence (IJCAI)*. 2017 (Extended abstract)
38. **Muhao Chen**, Shi Gao, X. Sean Wang. Converting Spatiotemporal Data Among Heterogeneous Granularity Systems. In *Proceedings of the 25<sup>th</sup> IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)*. IEEE, 2016. Shorter version in *Proceedings of the 31<sup>st</sup> ACM SIGAPP Symposium on Applied Computing (SAC)*. ACM, 2016.

## Tutorials


39. **Muhao Chen**, Hongming Zhang, Qiang Ning, Manling Li, Heng Ji, Kathleen McKeown, Dan Roth. Event-centric Natural Language Processing. In *ACL*, 2021.
40. **Muhao Chen**, Hongming Zhang, Qiang Ning, Manling Li, Heng Ji, Dan Roth. Event-centric Natural Language Understanding. In *AAAI*, 2021.
41. **Muhao Chen**, Kai-Wei Chang, Dan Roth. Recent Advances in Transferable Representation Learning. In *AAAI*, 2020.

## Refereed Workshop and System Demonstration Papers

42. Weijia Shi✉, **Muhao Chen**, Yingtao Tian, Kai-Wei Chang. Learning Bilingual Word Embeddings Using Lexical Definitions. In *Proceedings of ACL Workshop on Representation Learning for NLP (RepL4NLP)*, 2019.
43. Zhubo Deng✉, Pei Zhou✉, Weijia Shi✉, **Muhao Chen**, Kai-Wei Chang. Computational Analysis of French-origin Reborrowing Process for English Loanwords. In *ICDM Workshop on Multilingual Cognitive Services (ICDMW)*, 2019
44. Changjun Fan, Yizhou Sun, Li Zeng, Yang-Yu Liu, **Muhao Chen**, Zhong Liu. Dismantle Large Networks through Deep Reinforcement Learning. In *ICLR Workshops*, 2019.
45. Pei Zhou✉, **Muhao Chen**, Kai-Wei Chang, Carlo Zaniolo. Quantification and Analysis of Scientific Language Variation by Research Fields. In *Proceedings of the ICDM Workshops (ICDMW)*, 2018.
46. **Muhao Chen**, Tao Zhou, Pei Zhou✉, Carlo Zaniolo. Multi-graph Affinity Embeddings for Multilingual Knowledge Graphs. **Contributed talk** in the *6<sup>th</sup> Workshop on Automated Knowledge Base Construction at NIPS (AKBC)*. 2017.
47. Tao Zhou, **Muhao Chen**, Demetri Terzopoulos, Jie Yu. Attention-based Natural Language Person Retrieval. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshops (CVPRW)*. IEEE, 2017.
48. Shi Gao, **Muhao Chen**, Maurizio Atzori, Carlo Zaniolo. SPARQL<sup>T</sup> and its User-Friendly Interface for Managing and Querying the History of Knowledge Bases. In *the 14<sup>th</sup> International Semantic Web Conference (ISWC)*, 2015 (demo).

## In Submission

49. Wenxuan Zhou, **Muhao Chen**. Towards Noisy Label Learning for Entity-Centric Information Extraction. In review in *NAACL*, 2021.
50. Xuelu Chen\*, Michael Boratko\*, **Muhao Chen**, Shib Sankar Dasgupta, Xiang Li, Andrew McCallum. Probabilistic Box Embeddings for Uncertain Knowledge Graph Reasoning. In review in *NAACL*, 2021.
51. Dat Duong, Ankith Uppunda✉, Chelsea Ju, James Zhang, **Muhao Chen**, Eleazar Eskin, Jingyi Jessica Li, Kai-Wei Chang. Evaluating Representations for Gene Ontology Terms.

52. Jyun-yu Jiang, Chelsea J. T. Ju, Junheng Hao , **Muhao Chen**, Wei Wang. Circular RNA Prediction based on Junction Encoders and Deep Interaction among Splice Sites.

## PRESENTATIONS

1. Understanding Event Processes in Natural Language. *Invited talk at Language Technology Seminar, University of Cambridge*. Nov 2020
2. “What Are You Trying To Do?” Semantic Typing of Event Processes. *Conference talk at CoNLL*. Nov 2020
3. Understanding Event Processes in Natural Language. *Invited talk at Machine Learning and Big Data Seminar, UCLA*. Nov 2020
4. Knowledge Acquisition with Transferable Representation Learning. *CS Research Colloquium, USC*. Nov 2020
5. Event-Centric Commonsense Understanding. *CKG Lunch Talk, USC ISI*. Aug 2020
6. Event Schema Instantiation as Knowledge Graph Alignment. *PI meeting (KAISOS), DARPA*. June 2020.
7. Recent Advances in Transferable Representation Learning. *Half-day tutorial at AAAI*. NYC, NY, Feb 2020.
8. Multi-relational Knowledge Acquisition with Transferable Representation Learning. *AI Seminar, USC ISI*. Los Angeles, Jan 2020.
9. Multi-relational Knowledge Acquisition with Transferable Representation Learning. *IBM Research Almaden*. San Jose, Jan 2020.
10. Multi-relational Knowledge Acquisition with Transferable Representation Learning. *Invited talk at FDSiF, Fudan Univ., Shanghai, China*. Dec 2019.
11. Retrofitting contextualized word embeddings with paraphrases. *Conference talk at EMNLP, Hong Kong, China*. Nov 2019
12. Cross-lingual Dependency Parsing with Unlabeled Auxiliary Languages. *Conference talk at CoNLL, Hong Kong, China*. Nov 2019
13. Multi-relational representation learning and knowledge acquisition. *Invited talk at SNAP Seminar, Stanford University*. Jan 2019
14. Multi-relational representation learning and knowledge acquisition. *Machine Learning and Big Data Seminar, UCLA*. Jan 2019
15. Neural Article Pair Modeling for Wikipedia Sub-article Matching. *Plenary talk at ECML, Dublin, Ireland*. Sept 2018
16. Co-training Embeddings of Knowledge Graphs and Entity Descriptions for Cross-lingual Entity Alignment. *Conference talk at IJCAI, Stockholm, Sweden*. July 2018
17. On2Vec: Embedding-based Relation Prediction for Ontology Population. *Conference talk at SDM, San Diego, CA, USA*. May 2018
18. Multilingual Knowledge Graph Embeddings for Cross-lingual Knowledge Alignment. *Contributed talk at AKBC, Longbeach, CA, USA*. Dec 2017
19. Neural Article Pair Modeling for Wikipedia Sub-article Matching. *Google Search Intelligence Seminar Talk*. Sept 2017
20. Multilingual Knowledge Graph Embeddings for Cross-lingual Knowledge Alignment. *Conference talk at IJCAI, Melbourne, Australia*. Aug 2017
21. Converting Spatiotemporal Data Among Heterogeneous Granularity Systems. *Conference talk at FUZZ-IEEE, Vancouver, Canada*. Aug 2016
22. Reasoning Across Multiple Spatiotemporal Granularity Systems. *Invited talk at Teradata Labs, El Segundo, CA, USA*. Mar 2015

## PROFESSIONAL EXPERIENCE

- |   |               |
|---|---------------|
| <b>Computer Scientist</b> , University of Southern California, Information Science Institute                      | 2020.8-date   |
| <b>Postdoctoral Fellow</b> , University of Pennsylvania, Philadelphia, PA (CogCompGroup) <i>Host: Dan Roth</i>    | 2019.8-2020.7 |
| <b>Research Intern</b> , Microsoft Research, Redmond, WA (NLP Group)  | 2018.6-2018.9 |
| • <i>Embedding Edge-attributed Relational Hierarchies</i> . [22]  |               |
| <b>Research Intern</b> , Google, Mountain View, CA (Google Knowledge Graph)                                       | 2017.6~2017.9 |
| • <i>Neural Article Pair Modeling for Large-scale Sub-article Relation Extraction from Wikipedia</i> . [30,27,14] |               |
| <b>System SDE Intern</b> , Google, Mountain View, CA (ProcCella Real-time Data Infrastructure)                    | 2016.6~2016.9 |
| • <i>Dynamic Shard-partitioning for Large-scale Windowed Event Streams</i> .                                      |               |

Chen, Muhao – CV (Jan. 11, 2021)

**R&D Intern**, Teradata Labs, Los Angeles, CA (Optimizer Group)

2015.6~2015.9

- *Multi-task Learning for Cost-based Database Optimizers.*

## SELECTED AWARDS

*SIGBio ACM-BCB Best Student Paper Award* 2020

*UCLA Dissertation Fellowship.* 2018-2019

*Google Research & Travel Support Archimedes Program.* 2018

*NSF Travel Grants.* 2016, 2017, 2018, 2019

*Research Grant of the National University Student Innovation Program.* Ministry of Education of China. 2014

*Tung OOCL Scholarships.* Tung's Foundation of Hong Kong & The Oriental Overseas Container Line. 2012, 2013

*Wang-Dao Fellowship.* President of Fudan University. 2013

*EMC Scholarship.* EMC Inc. 2013

*Chun-Tsung Fellowship.* Hui-Chun Chin and Tsung-Dao Lee Chinese Undergraduate Research Endowment. 2012

## TEACHING AND MENTORING EXPERIENCE

**Mentoring** (Publications by undergraduate and masters mentees are highlighted)

Fei Wang, USC MS Student in Computer Science. **Research mentor** 2020.9-date

Haoyu Wang, UPenn MS Student in Computer and Information Science. **Research mentor** (First author publication in EMNLP'20, co-authored another two EMNLP'20 and CoNLL'20 papers) 2019.9-date

Xuelu (Shirley) Chen, UCLA PhD student in Computer Science. **Research mentor** 2017.10-2020.11

Junheng Hao, UCLA PhD student in Computer Science. **Research mentor** 2017.10-date

Tianran Zhang, UCLA PhD student in Bioengineering. **Research mentor** 2019.6-date

Pei Zhou, UCLA undergraduate student (Now PhD student at USC CS). **Research mentor** (First-author publications in EMNLP'19 and ICDMW'18. Coauthored paper in AKBC'18) 2019.12-2019.6

Weijia Shi, UCLA undergraduate student (Now PhD student at UW CSE). **Research mentor** (First-author publications in EMNLP'19 and RepL4NLP'19. Coauthored paper in AAAI'19) 2018.6-2019.12

Ankith Uppunda, UCLA undergraduate student. **Research mentor.** (Published in Findings of EMNLP 2020) 2019.3-2019.6.

Zhubo Deng, UCLA undergraduate student. **Research mentor** (First-author publication in ICDMW'19). 2019.1-2019.6

Xiaoshuang Wei, UCLA MS student in Computer Science (Now software engineer at Google). **Thesis mentor** 2016.10-2017.3

### Teaching

Teaching assistant (2015.9-2016.6), associate (2016.9-2017.6), fellow (2017.9-2018.6) at UCLA (Data Structures and Algorithms; Introduction to Computer Science).

## ACADEMIC SERVICES

### Organization Committee:

2021: AAAI (Senior PC), IJCAI (Senior PC)

2019: IEEE AIKE (Doctoral Consortium Co-chair)

### PC Member:

2021: EACL, NAACL, WSDM, WWW.

Chen, Muhao – CV (Jan. 11, 2021)

2020: AAAI, AACL-IJCNLP, AKBC, COLING, EMNLP, IJCAI, ISWC, KDD, SIGIR, WSDM, \*SEM.

2019: AAAI, AKBC, NAACL, ACL, EMNLP-IJCNLP, BigData, NLPCC, WISE, ICSC.

2018: AAAI, EMNLP, BigData, NLPCC, SoCal NLP.

**Journal Reviewer:** TPAMI, TNNLS, TKDD, TOIS, W3J, PLOS Computational Biology, Clinical and Translational Medicine, Comput. & Struct. Biotechnol., TKDE, TII, BMC Genomics, BMC Medical Genomics, Evolutionary Intelligence, Frontiers of Computer Science, Information Sciences.