

# Spencer Krieger

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spencerkrieger.com

## EDUCATION

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- August 2016 - Present* **PhD student in Computer Science**  
University of Arizona  
PhD Advisor: John Kececioglu
- May 2020* **MS in Computer Science**  
University of Arizona
- April 2016* **BS in Biochemistry**  
Brigham Young University  
Computer Science minor

## POSITIONS HELD

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- June 2016 – present* **Research Assistant**  
University of Arizona, Computer Science  
Research Advisor: John Kececioglu
- January 2014 – April 2016* **Research Assitant**  
Brigham Young University, Chemistry and Biochemistry  
Research Advisor: Roger Harrison

## RESEARCH INTERESTS

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Algorithms in bioinformatics (network biology, cell-signaling pathway analysis, shortest path in hypergraphs; structural bioinformatics, protein secondary structure prediction); personal medicine (genomics, personal genomics)

## RESEARCH PROJECTS

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**Protein Secondary Structure Prediction** (2016-present, University of Arizona, Department of Computer Science) - We have developed a fast and accurate protein secondary-structure predictor that uses dynamic programming and a variant of nearest-neighbor classification on a learned distance function, which avoids a conventional sequence-database homology search. Our method achieves 86.0% accuracy on benchmark datasets and runs in half the time of state-of-the-art tools (which achieve 84.0% or less accuracy on the same datasets).

**Shortest Hyperpaths in Cell-Signaling Networks** (2017-present, University of Arizona, Department of Computer Science) - We model cell-signaling pathways as directed hypergraphs, and find the shortest hyperpath from a set of receptors to a set of transcription factors to assist biologists in finding the proteins involved in disease pathways. We proved that in our new formulation of shortest hyperpaths as an integer linear program (ILP), that for ordinary directed graphs, the number of constraints is linear in the size of the graph.

**Multi-Level Vertex-Weighted Steiner Tree Problem** (2018-2019, University of Arizona, Department of Computer Science) - The multi-level vertex-weighted steiner tree problem (MLVST) is a generalization of the vertex-weighted steiner tree problem (VST). VST is approximable within  $2 \ln |T|$ , where  $T$  is the number of terminals, given a reduction from the set cover problem. Surprisingly, we developed an approximation algorithm that approximates the seemingly harder MLVST within the same factor ( $2 \ln |T|$ ).

**Separation and Preconcentration of Perrhenate From Ionic Solutions Using Ion Chromatography** (2014-2016, Brigham Young University, Department of Chemistry and Biochemistry) - Using large macrocyclic molecules, we were able to separate perrhenate, a safe analog of pertechnetate, a common ingredient in cancer treatments, from ionic solutions.

## PAPERS

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Spencer Krieger and John Kececioglu, "Fast approximate shortest hyperpaths for inferring pathways in cell signaling hypergraphs." (Accepted for publication in the proceedings of the Workshop for Algorithms in Bioinformatics (WABI 2021))

Wim L Cuypers, Handan Melike Dönertaş, Jasleen K. Grewal, Chase Donnelly, Arvind Singh Mer, Spencer Krieger, Bart Cuypers. Highlights from the 16th International Society for Computational Biology Student Council Symposium 2020. F1000Research 2021, 10(ISCB Comm J):443 doi.org/10.12688/f1000research.53408.1

Wai Ning Chan, Jacob P. Warren, Spencer P. Krieger, Benjamin L. Vestal, Roger G. Harrison, "Separation and preconcentration of perrhenate from ionic solutions by ion exchange chromatography", *Journal of Chromatography A* 1631, 461588, 2020, doi.org/10.1016/j.chroma.2020.461588

Spencer Krieger and John Kececioglu, "Predicting protein secondary structure by an ensemble through feature-based accuracy estimation", Proceedings of the 11th ACM Conference on Bioinformatics, Computational Biology, and Health Informatics (ACM-BCB 2020), Atlanta, GA, Article 29, 1-10, doi.org/10.1145/3388440.3412425

Spencer Krieger and John Kececioglu, "Boosting the Accuracy of Protein Secondary Structure Prediction Through Nearest Neighbor Search and Method Hybridization", Proceedings of the 28th International Conference on Intelligent Systems in Molecular Biology (ISMB), *Bioinformatics* 36, i317-i325, 2020, doi.org/10.1093/bioinformatics/btaa336

Faryad Darabi Sahneh, Alon Efrat, Stephen Kobourov, Spencer Krieger and Richard Spence, "An Approximation Algorithm for the Grade-of-Service Node-Weighted Steiner Tree Problem." November 2018, preprint at arxiv.org/abs/1811.11700

## PAPERS IN PREPARATION

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Spencer Krieger and John Kececioglu, "Predicting protein secondary structure by an ensemble through feature-based accuracy estimation" (In Preparation for Plos: Computational Biology)

Spencer Krieger and John Kececioglu, "Fast optimal shortest hyperpaths in cell-signaling hypergraphs." (In Preparation for RECOMB 2021)

## SOFTWARE RELEASED

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**Hyperpaths:** Finding short hyperpaths in directed cell-signalling hypergraphs, version 0.1, January 2021.  
<http://hyperpaths.cs.arizona.edu>

**Nnessy:** Nearest-neighbor-based prediction of protein secondary structure without searching for homology, version 1.0, July 2020.  
<http://nnessy.cs.arizona.edu>

**Ssylla:** Protein secondary structure prediction by an ensemble leveraging accuracy estimation, version 0.1, July 2020.  
<http://ssylla.cs.arizona.edu>

## TALKS

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"Predicting protein secondary structure by an ensemble through feature-based accuracy estimation", Proceedings talk in the 11th ACM Conference on Bioinformatics, Computational Biology, and Health Informatics (ACM-BCB 2020), September 22, 2020

"Boosting the Accuracy of Protein Secondary Structure Prediction Through Nearest Neighbor Search and Method Hybridization", Highlights talk in the 11th ACM Conference on Bioinformatics, Computational Biology, and Health Informatics (ACM-BCB 2020), September 22, 2020

"Boosting the Accuracy of Protein Secondary Structure Prediction Through Nearest Neighbor Search and Method Hybridization", 28th International Conference on Intelligent Systems in Molecular Biology (ISMB 2020), July 15, 2020

"Predicting Protein Secondary Structure Through Nearest Neighbor Search and Method Hybridization", 16th Student Council Symposium preceding ISMB 2020 (SCS 2020), July 10, 2020

"Making Data Structures Persistent", CSC 630 (Great Results in Discrete Algorithms), Department of Computer Science, University of Arizona, April 25, 2019

"Breaking Through the Accuracy and Speed Barrier for Protein Secondary Structure Prediction Without Homology Search", A Peer Organized Student Seminar (POSSE), Department of Computer Science, University of Arizona, February 1, 2019

"A Cutting Planes, Integer Linear Programming Method to Solve the Multi-level Node-Weighted Steiner Tree Problem Exactly", CSC 620 (Multilevel Graph Representation), Department of Computer Science, University of Arizona, April 2, 2018

"Separation of Pertechnetate From Nuclear Waste", Spring Research Conference, Brigham Young University, March 19, 2016

"Selective Preconcentration of Perrhenate Using Ion Chromatography", Spring Research Conference, Brigham Young University, March 21, 2015

## POSTERS

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"Boosting the Accuracy of Protein Secondary Structure Prediction Through Nearest Neighbor Search and Method Hybridization", 28th International Conference on Intelligent Systems in Molecular Biology (ISMB 2020), July 15-16, 2020

"Predicting Protein Secondary Structure Through Nearest Neighbor Search and Method Hybridization", 16th Student Council Symposium preceding ISMB 2020, July 10-11, 2020

"Separation of Pertechnetate From Nuclear Waste", Spring Research Conference, Brigham Young University, March 19, 2016

"Selective Preconcentration of Perrhenate Using Ion Chromatography", Spring Research Conference, Brigham Young University, March 21, 2015

## AWARDS

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Departmental Fellowship Award, Department of Computer Science, University of Arizona, May 2021, \$773

Galileo Circle Scholar Award, College of Science, University of Arizona, August 2020 - May 2021, \$1,000

Best talk for "Predicting Protein Secondary Structure Through Nearest Neighbor Search and Method Hybridization", 16th Student Council Symposium preceding ISMB 2020 (SCS 2020), July 10, 2020, \$250

Graduate Student Service Award, Department of Computer Science, University of Arizona, April, 2020, \$100

Galileo Circle Scholar Award, College of Science, University of Arizona, August 2018 - May 2019, \$2,000

Undergraduate Research Award, College of Physical and Mathematical Sciences, Brigham Young University, April 2014 - April 2016, \$10,000

**PROFESSIONAL SERVICE**

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Web Committee Chair, Student Council, International Society for Computational Biology (ISCB), 2018 - Present

Web Chair, Student Council Symposium directly preceding ISMB 2020, International Society for Computational Biology (ISCB)

Web Committee Member, Student Council, International Society for Computational Biology (ISCB), 2017-2018

**DEPARTMENT AND UNIVERSITY SERVICE**

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Vice President (and Cofounder), Graduate Student Council, Department of Computer Science, University of Arizona, September 2018 - September 2020

Graduate Affairs Committee Member, Department of Computer Science, University of Arizona, September 2018 - September 2020

Faculty Recruiting Committee Graduate Student Liaison, Department of Computer Science, University of Arizona, January 2019 - September 2020