

# Dmitriy Dligach, Ph.D.

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## Research Interests

Natural language processing, machine learning, data mining, medical informatics.

## Education

Ph.D. Computer Science, University of Colorado, Boulder, 2010.

M.S. Computer Science, State University of New York, Buffalo, 2004.

B.S. Computer Science, Loyola University, Chicago, 1999.

## Professional Experience

Assistant Professor, Loyola University Chicago, 2016 - present.

Assistant Professor, Loyola University School of Medicine, 2016 - present.

Instructor (entry-level faculty appointment), Harvard Medical School, 2014 - 2015.

Associate Scientific Research Staff, Boston Children's Hospital, 2014 - 2015.

Research Fellow, Harvard Medical School, 2011 - 2014.

Research Fellow, Boston Children's Hospital, 2011 - 2014.

Postdoctoral Research Associate, University of Colorado, Boulder, 2010 - 2011.

Research Assistant, University of Colorado, Boulder, 2005 - 2010.

Research Scientist, Pronto Inc., Boulder, CO, 2005.

Teaching Assistant, State University of New York, Buffalo, 2003 - 2005.

Senior Software Engineer, Motorola, Inc., Arlington Heights, IL, 2000 - 2003.

Development Analyst, Commonwealth Edison, Chicago, IL, 1999 - 2000.

Network Administrator, Graver, Bokhof, Goodwin & Sullivan, Chicago, IL, 1997 - 1998.

## Publications

### Conference Proceedings

Majid Afshar, Cara Joyce, Anthony Oakey, Perry Formanek, Philip Yang, Matthew M. Churpek, Richard S. Cooper, Susan Zelisko, Ron Price, Dmitriy Dligach. A Computable Phenotype for Acute Respiratory Distress Syndrome Using Natural Language Processing and Machine Learning. In *Proceedings of American Medical Informatics Association Symposium 2018*. San Francisco, CA. November, 2018.

Dmitriy Dligach and Timothy Miller. Learning Patient Representations from Text. In *\*SEM 2018: Proceedings of the 7th Joint Conference on Lexical and Computational Semantics*. New Orleans, LA. June, 2018.

Natalia Viani, Timothy Miller, Dmitriy Dligach, Steven Bethard, Carlo Napolitano, Silvia Priori, Riccardo Bellazzi, Lucia Sacchi and Guergana Savova. Recurrent Neural Network Architectures for Event Extraction from Italian Medical Reports. In *AIME 2017: Proceedings of the 16th Conference on Artificial Intelligence in Medicine*. Vienna, Austria. June, 2017.

Dmitriy Dligach, Timothy Miller, Chen Lin, Steven Bethard, and Guergana Savova. Neural Temporal Relation Extraction. In *EACL 2017: Proceedings of the 15th Meeting of the European Chapter of the Association for Computational Linguistics*. Valencia, Spain. April, 2017.

Dmitriy Dligach, Timothy Miller, Guergana Savova. Semi-supervised Learning for Phenotyping Tasks. In *Proceedings of American Medical Informatics Association Symposium 2015*. San Francisco, CA. November, 2015.

Chen Lin, Timothy Miller, Alvin Kho, Steven Bethard, Dmitriy Dligach, Sameer Pradhan and Guergana Savova. Descending-Path Convolution Kernel for Syntactic Structures. In *ACL '14: Proceedings of the 52nd Annual Meeting of the Association for Computational Linguistics*. June 22 - 27, 2014, Baltimore, MD.

Dmitriy Dligach and Martha Palmer. Good Seed Makes a Good Crop: Accelerating Active Learning Using Language Modeling. In *ACL '11: Proceedings of the 46th Annual Meeting of the Association for Computational Linguistics: Human Language Technologies*. June 19 - 24, 2011, Portland, OR.

Susan Windisch Brown, Dmitriy Dligach, and Martha Palmer. VerbNet Class Assignment as a WSD Task. In *IWSC 2011: Proceedings of the 9th International Conference on Computational Semantics*. January 12 - 14, 2011, Oxford, UK.

Dmitriy Dligach and Martha Palmer. Improving Verb Sense Disambiguation with Automatically Retrieved Semantic Knowledge. In *ICSC '08: Proceedings of the Second IEEE International Conference on Semantic Computing*. August 4 - 7, 2008, Santa Clara, CA.

Dmitriy Dligach and Martha Palmer. Novel Semantic Features for Verb Sense Disambiguation. In *ACL '08: Proceedings of the 46th Annual Meeting of the Association for Computational Linguistics: Human Language Technologies*. June 15 - 20, 2008, Columbus, OH.

Jinying Chen, Dmitriy Dligach, and Martha Palmer. Towards Large-scale High-Performance English Verb Sense Disambiguation by Using Linguistically Motivated Features. In *ICSC '07: Proceedings of the First IEEE International Conference on Semantic Computing*. Sep 17 - 19, 2007, Irvine, CA.

Cecily Jill Duffield, Jena D. Hwang, Susan Windisch Brown, Dmitriy Dligach, Sarah E. Vieweg, Jenny Davis, and Martha Palmer. Criteria for the Manual Clustering of Verb Senses. In *CogSci '07: Proceedings of the 29th Annual Conference of the Cognitive Science Society*. August 1-4, 2007, Nashville, TN.

## Workshop Proceedings

Chen Lin, Timothy Miller, Dmitriy Dligach, Hadi Amiri, Steven Bethard and Guergana Savova. Self-training improves Recurrent Neural Networks performance for Temporal Relation Extraction. In *Proceedings of LOUHI 2018: The Ninth International Workshop on Health Text Mining and Information Analysis held in conjunction with EMNLP 2018*. November 2018. Brussels, Belgium.

Chen Lin, Timothy Miller, Dmitriy Dligach, Steven Bethard and Guergana Savova. Representations of Time Expressions for Temporal Relation Extraction with Convolutional Neural Networks. In *Proceedings of the 2017 Workshop on Biomedical Natural Language Processing (BioNLP 2017) held in conjunction with ACL 2017*. August 2017. Vancouver, Canada.

Timothy Miller, Dmitriy Dligach and Guergana Savova. Unsupervised Document Classification with Informed Topic Models. In *Proceedings of the 2016 Workshop on Biomedical Natural Language Processing (BioNLP 2016) held in conjunction with ACL 2016*. August 2016. Berlin, Germany.

Chen Lin, Timothy Miller, Dmitriy Dligach, Steven Bethard and Guergana Savova. Improving Temporal Relation Extraction with Training Instance Augmentation. In *Proceedings of the 2016 Workshop on Biomedical Natural Language Processing (BioNLP 2016) held in conjunction with ACL 2016*. August 2016. Berlin, Germany.

Timothy A. Miller, Steven Bethard, Dmitriy Dligach, Chen Lin, Guergana K. Savova. Extracting Time Expressions from Clinical Text. In *Proceedings of the 2015 Workshop on Biomedical Natural Language Processing (BioNLP 2015) held in conjunction with ACL 2015*. July 2015, Beijing, China.

Dmitriy Dligach, Timothy A. Miller, Guergana K. Savova. Active Learning for Phenotyping Tasks. In *Proceedings of the 2013 NLP for Medicine and Biology workshop held in conjunction with RANLP-2013*. September 2013. Hissar, Bulgaria.

Timothy A. Miller, Steven Bethard, Dmitriy Dligach, Sameer Pradhan, Chen Lin, Guergana K. Savova. Discovering Narrative Containers in Clinical Text. In *Proceedings of the 2013 Workshop on Biomedical Natural Language Processing (BioNLP 2013) held in conjunction with NAACL-2013*. August 2013, Sophia, Bulgaria.

Chen Lin, Timothy Miller, Dmitriy Dligach, Robert M. Plenge, Elizabeth W. Karlson, Guergana Savova. Maximal Information Coefficient for Feature Selection for Clinical Document Classification. In *International Conference on Machine Learning (ICML 2012) Workshop on Machine Learning for Clinical Data Analysis*. June 2012, Edinburgh, Scotland.

Chen Lin, Timothy Miller, Dmitry Dligach, Robert Plenge, Elizabeth Karlson, Guergana Savova. Feature Engineering and Selection for Rheumatoid Arthritis Disease Activity Classification Using Electronic Medical Records. In *International Conference on Machine Learning (ICML 2012) Workshop on Machine Learning for Clinical Data Analysis*. June 2012, Edinburgh, Scotland.

Timothy A. Miller, Dmitriy Dligach, and Guergana K. Savova. Active Learning for Coreference Resolution. In *Proceedings of the 2012 Workshop on Biomedical Natural Language Processing (BioNLP 2012) held in conjunction with NAACL-2012*. June 2012, Montreal, Canada.

Stephen T. Wu, Vinod C. Kaggal, Guergana K. Savova, Hongfang Liu, Dmitriy Dligach, Jiaping Zheng, Wendy W. Chapman, Christopher G. Chute. Generality and Reuse in a Common Type System for Clinical Natural Language Processing. In *Managing Interoperability and complexiTy in Health Systems (MIXHS-2011)*. October 2011, Glasgow, Scotland, U.K.

Dmitriy Dligach and Martha Palmer. Reducing the Need for Double Annotation. In *Proceedings of the Fifth Linguistic Annotation Workshop (LAW V) held in conjunction with ACL-2011*. June, 2011, Portland, OR.

Dmitriy Dligach, Rodney D. Nielsen, and Martha Palmer. To Annotate More or to Annotate More Accurately. In *Proceedings of the Fourth Linguistic Annotation Workshop (LAW IV) held in conjunction with ACL-2010*. July, 2010, Uppsala, Sweden.

Suresh Manandhar, Ioannis P. Klapaftis, Dmitriy Dligach, and Sameer S. Pradhan. SemEval-2010 Task 14: Word Sense Induction & Disambiguation. In *Proceedings of the Fifth International Workshop on Semantic Evaluations (SemEval-2010) held in conjunction with ACL-2010*. July, 2010, Uppsala, Sweden.

Dmitriy Dligach and Martha Palmer. Using Language Modeling to Select Useful Annotation Data. In *Proceedings of the Student Research Workshop and Doctoral Consortium Held in Conjunction with NAACL-HLT 2009*. May 31 - June 5, 2009. Boulder, Colorado.

Sameer Pradhan, Edward Loper, Dmitriy Dligach, and Martha Palmer. SemEval-2007 Task-17: English Lexical Sample, SRL and All Words. In *Proceedings of the Fourth International Workshop on Semantic Evaluations (SemEval-2007) held in conjunction with ACL-2007*. June, 2007, Prague, the Czech Republic.

Cecily Jill Duffield, Jena D. Hwang, Susan Windisch Brown, Dmitriy Dligach, Sarah E. Vieweg, Jenny Davis, and Martha Palmer. 2007. Criteria for the Manual Grouping of Verb Senses. In *Proceedings of the Linguistic Annotation Workshop held in conjunction with ACL 2007*. June, 2007, Prague, the Czech Republic.

## Journal Articles

Anil Can, Victor M. Castro, Dmitriy Dligach, Sean Finan, Sheng Yu, Vivian Gainer, Nancy A. Shadick, Guergana Savova, Shawn Murphy, Tianxi Cai, Scott T. Weiss, and Rose Du. Elevated International Normalized Ratio is Associated with Ruptured Aneurysms. *Stroke*. 2018.

Anil Can, Robert F Rudy, Victor Castro, Sheng Yu, Dmitriy Dligach, Sean Finan, Vivian S Gainer, Nancy A Shadick, Guergana Savova, Shawn Murphy, Tianxi Cai, Scott Weiss, and Rose Du. Association between Aspirin Dose and Subarachnoid Hemorrhage from Saccular Aneurysms: A Case-Control Study. *Neurology*. 2018.

Anil Can, Victor M. Castro, Dmitriy Dligach, Sean Finan, Sheng Yu, Vivian Gainer, Nancy A. Shadick, Guergana Savova, Shawn Murphy, Tianxi Cai, Scott T. Weiss, Rose Du. Low Serum Calcium and Magnesium Levels and Rupture of Intracranial Aneurysms. *Stroke*. 2018.

Jian Zhang, Anil Can, Srinivasan Mukundan Jr., Michael Steigner, Victor M. Castro, Dmitriy Dligach, Sean Finan, Sheng Yu, Vivian Gainer, Nancy A. Shadick, Guergana Savova, Shawn Murphy, Tianxi Cai, Zhong Wang, Scott T. Weiss, Rose Du. Morphological Variables Associated with Ruptured Middle Cerebral Artery Aneurysms. *Neurosurgery*. 2018.

Anil Can, Victor M. Castro, Sheng Yu, Dmitriy Dligach, Sean Finan, Vivian Gainer, Nancy A. Shadick, Guergana Savova, Shawn Murphy, Tianxi Cai, Guergana Savova, Scott T. Weiss, Rose Du. Antihyperglycemic Agents are Inversely Associated with Intracranial Aneurysm Rupture. *Stroke*. 2017.

Anil Can, Victor M. Castro, Yildirim H. Ozdemir, Sarajune Dagen, Dmitriy Dligach, Sean Finan, Sheng Yu, Vivian Gainer, Nancy A. Shadick, Shawn Murphy, Tianxi Cai, Guergana Savova, Scott T. Weiss, Rose Du. Alcohol Consumption and Aneurysmal Subarachnoid Hemorrhage. *Translational Stroke Research*. 2017.

Anil Can, Victor Castro, Yildirim H Ozdemir, Sarajune Dagen, Sheng Yu, Dmitriy Dligach, Sean Finan, Vivian S Gainer, Nancy Shadick, Shawn Murphy, Tianxi Cai, Guergana Savova, Ruben Dammers, Scott T Weiss, and Rose Du. Association of Intracranial Aneurysm Rupture with Smoking Duration, Intensity, and Cessation. *Neurology*. 2017.

Timothy Miller, Dmitriy Dligach, Steven Bethard, Chen Lin, and Guergana Savovaa. Towards generalizable entity-centric clinical coreference resolution. *Journal of Biomedical Informatics*. 2017. doi: <https://doi.org/10.1016/j.jbi.2017.04.015>.

Victor M Castro, Dmitriy Dligach, Sean Finan, Sheng Yu, Anil Can, Muhammad Abd-El-Barr, Vivian Gainer, Nancy A Shadick, Shawn Murphy, Tianxi Cai, Guergana Savova, Scott T Weiss, and Rose Du. Large-scale Identification of Patients with Cerebral Aneurysms Using Natural Language Processing. *Neurology*. 2017. DOI: 10.1212/WNL.0000000000003490.

\*Chen Lin, \*Dmitriy Dligach, \*Timothy Miller, \*Steven Bethard, Guergana Savova. Multilayered Temporal Modeling for the Clinical Domain. *Journal of American Medical Informatics Association*. 2016. doi: 10.1093/jamia/ocv113. \* Indicates co-first authors

\*Chen Lin, \*Elizabeth W. Karlson, \*Dmitriy Dligach, Monica Ramirez, Timothy A. Miller, Huan Mo, Natalie S. Braggs, Andrew Cagan, Joshua C. Denny, Guergana K. Savova. Automatic Identification of Methotrexate-induced Liver Toxicity in Patients with Rheumatoid Arthritis from the Electronic Medical Record. *Journal of American Medical Informatics Association*. 2015. doi: 10.1136/amiajnl-2014-002642.

\* Indicates co-first authors

Dmitriy Dligach, Steven Bethard, Lee Becker, Timothy A. Miller, Guergana K. Savova. Discovering Body Site and Severity Modifiers in Clinical Texts. *Journal of American Medical Informatics Association*. 2014. 2014;21:438-447. doi:10.1136/amiajnl-2013-001949.

Chen Lin, Elizabeth W. Karlson, Helena Canhao, Timothy A. Miller, Dmitriy Dligach, Pei Jun Chen, Raul Natanael Guzman Perez, Tianxi Cai, Michael E. Weinblatt, Nancy A. Shadick, Robert M. Plenge, Guergana K. Savova. Automatic Prediction of Rheumatoid Arthritis Disease Activity from the Electronic Medical Records. *PLoS ONE*. 2013. 8(8): e69932. doi:10.1371/journal.pone.0069932.

Daniel Albright, Arrick Lanfranchi, Anwen Fredriksen, William F. Styler, Colin Warner, Jena D. Hwang, Jinho D, Choi, Dmitriy Dligach, Rodney D. Nielsen, James Martin, Wayne Ward, Martha Palmer, Guergana K. Savova. Towards comprehensive syntactic and semantic annotations of the clinical narrative. *Journal of American Medical Informatics Association*. 2013. Sep-Oct;20(5):922-30. doi: 10.1136/amiajnl-2012-001317.

Stephen T. Wu, Vinod C. Kaggal, Dmitriy Dligach, James J. Masanz, Pei Chen, Lee Becker, Wendy W. Chapman, Guergana K. Savova, Hongfang Liu and Christopher G. Chute. A common type system for clinical Natural Language Processing. *Journal of Biomedical Semantics*. January 2013, 4:1.

Dmitriy Dligach and Martha Palmer. Word Sense Disambiguation with Automatically Retrieved Semantic Knowledge. *International Journal of Semantic Computing (IJSC)*. 2:3, pp. 365-380, 2008.

## Book Chapters

Susan Windisch Brown, Dmitriy Dligach, and Martha Palmer. VerbNet Class Assignment as a WSD Task. 2014. *Computing Meaning Vol. 4*. Springer. pp 203-216.

## Conference Abstracts

Anthony Oakey, Dmitry Dligach, Philip Yang, Perry Formanek, Susan Zelisko, Ron Price, Cara Joyce, Richard Cooper, Majid Afshar. Natural language processing and machine learning for identification of Acute Respiratory Distress Syndrome. The American Thoracic Society (ATS) 2018. San Diego, CA. May, 2018.

Dmitriy Dligach, Timothy Miller, Chen Lin, Steven Bethard, and Guergana Savova. Neural Models for Clinical Temporal Relation Extraction. Midwest Speech and Language Days & Midwest Computational Linguistics Colloquium 2017. Chicago, IL. May, 2017.

Timothy A. Miller, Dmitriy Dligach, Chen Lin, Steven Bethard, Guergana K. Savova. Cross-domain Coreference Feature Exploration. AMIA Annual Symposium. Chicago, IL. November, 2016.

Elena Rodina and Dmitriy Dligach. An on-line dictator; A Textual Analysis of the Instagram Account of Ramzan Kadyrov, President of the Chechen Republic. Amsterdam Text Analysis Conference. Amsterdam, Netherlands. June 2016.

Timothy A. Miller, Sean Finan, Dmitriy Dligach, Guergana Savova. Robust Sentence Segmentation for Clinical Text. AMIA Annual Symposium. San-Francisco, CA. November, 2015.

Dmitriy Dligach, Steven Bethard, Lee Becker, Timothy A. Miller, Guergana K. Savova. Discovering Body Site and Severity Modifiers in Clinical Texts. In *American Medical Informatics Association Symposium*. Washington DC, November, 2013.

Chen Lin, Elizabeth W. Karlson, Helena Canhao, Timothy A. Miller, Dmitriy Dligach, Pei Jun Chen, Raul Natanael Guzman Perez, Tianxi Cai, Michael E. Weinblatt, Nancy A. Shadick, Robert M. Plenge, Guergana K. Savova. Automatic Prediction of Rheumatoid Arthritis Disease Activity from the Electronic Medical Records. In *American Medical Informatics Association Symposium*. Washington DC, November, 2013.

Timothy Miller, Dmitriy Dligach, Steven Bethard, Sameer Pradhan, Chen Lin, Guergana K. Savova. Discovering Time Expressions in Clinical Text. In *American Medical Informatics Association Symposium*. Washington DC, November, 2013.

Susan Windisch Brown, Cecily Jill Duffield, Jena D. Hwang, Dmitriy Dligach, Sarah E. Vieweg, Jenny Davis, Martha Palmer. The role of functional nouns in manual grouping of verb senses. In *Poster Session of Concept Types and Frames in Language, Cognition, and Science*. August 20-22, 2007, Dusseldorf, Germany.

### *Invited Talks*

Neural Models for Temporal Relation Extraction. Northwestern University, Department of Computer Science. Chicago, IL. May 2017.

Semantic Processing of Clinical Texts. Loyola University Stritch School of Medicine. Chicago, IL. March 2016.

Semantic Analysis of Clinical Texts. Northwestern University Feinberg School of Medicine. Chicago, IL. June 2015.

Semantic Analysis of Clinical Narratives. NorthShore University Health System Research Institute. Evanston, IL. June 2014.

Active Learning for Phenotyping Tasks. i2b2 3rd Annual Academic User Group Conference and NLP Workshop. Boston, MA. June 2013.

Discovering Body Site and Severity Modifiers in Rheumatoid Arthritis Data. i2b2 2nd Annual Academic User Group Conference and NLP Workshop. Boston, MA. June 2012.

Discovering Severity and Body Site Modifiers: A Relation Extraction Task. Strategic Health IT Advanced Research Project Annual Meeting. Rochester, MN. June, 2012.

### *Ph.D. Thesis*

Dmitriy Dligach. High-performance Word Sense Disambiguation with Less Manual Effort. Ph.D. thesis, University of Colorado at Boulder, August 2010.

### *Minor Contributions*

William J. Rapaport. Philosophy of Computer Science: An Introductory Course. In *Teaching Philosophy* 28(4): 319-341. 2005.

### *Courses Taught*

COMP 388/488: Introduction to Natural Language Processing. Loyola University Chicago. Spring 2018.

COMP 379/479: Introduction to Machine Learning. Loyola University Chicago. Fall 2016-2017.

COMP 170: Introduction to Object-Oriented Programming. Loyola University Chicago. 2016-2017.

CSCI 3202: Introduction to Artificial Intelligence. University of Colorado, Boulder, Invited lecture, Fall 2008.

LING 7800: Advanced Computational Linguistics: Lexical Semantics. University of Colorado, Boulder, Invited lecture, Spring 2007.

LING 5200: Computational Corpus Linguistics. University of Colorado, Boulder, Invited lecture, Spring 2006

CSE/PHI 510: Philosophy of Computer Science. State University of New York, Buffalo, Teaching Assistant, Fall 2004.

CSE 116 : Introduction To Computer Science for Majors II. State University of New York, Buffalo, Teaching Assistant, Fall 2003, Spring 2004.

### *Courses Prepared to Teach*

Natural Language Processing / Computational Linguistics

Machine Learning

Artificial Intelligence

Data Mining

### *Honors*

Presidential Fellowship, State University of New York, Buffalo.

Fr. Gerst Memorial Award ("presented to a single graduating senior who has displayed outstanding academic achievement in mathematics or computer science"), Loyola University, Chicago, 1999.

Graduated Magna Cum Laude, Loyola University, Chicago, 1999.

Loyola University scholarship, Loyola University, Chicago, 1996.

## *Service*

International Conference on Computational Linguistics (COLING). Paper Reviewer. April 2018.  
Association for Computational Linguistics (ACL) conference. Program Committee. March 2018.  
Association for Computational Linguistics (ACL) conference. Paper Reviewer. February 2018.  
American Medical Informatics Association (AMIA) Symposium. Paper Reviewer. March 2017.  
Association for Computational Linguistics (ACL) conference. Paper Reviewer. February 2017.  
Clinical NLP Workshop at COLING 2016. Program Committee. December 2016.  
Clinical NLP Workshop at COLING 2016. Paper Reviewer. December 2016.  
American Medical Informatics Association (AMIA) Symposium. Paper Reviewer. April 2016.  
Association for Computational Linguistics (ACL) conference. Paper Reviewer. March 2016.  
American Medical Informatics Association (AMIA) Symposium. Paper Reviewer. April 2015.  
Association for Computational Linguistics (ACL) conference. Program Committee. February 2015.  
Association for Computational Linguistics (ACL) conference. Paper Reviewer. February 2015.  
SemEval 2015. Paper Reviewer. February 2015.  
International Conference on Computational Semantics (IWCS). Program Committee. January 2015.  
International Conference on Computational Semantics (IWCS). Paper Reviewer. January 2015.  
RANLP NLP for Medicine and Biology Workshop. Paper Reviewer. September 2013.  
American Medical Informatics Association (AMIA) Symposium. Paper Reviewer. May 2013.  
International Conference on Computational Semantics (IWCS). Program Committee. March 2013.  
International Conference on Computational Semantics (IWCS). Paper Reviewer. March 2013.  
i2b2/VA/Cincinnati 2011 Shared Task and Workshop. Paper Reviewer. September 2011.  
Computational Linguistics. Paper Reviewer. May 2011.  
SemEval 2010. Program Committee. April 2010.  
SemEval 2010. Paper Reviewer. April 2010.  
SemEval 2010 Tasks 14: Word Sense Induction & Disambiguation Task. Organizing Committee. April 2010.

## *Funding*

Loyola University Chicago, Research Support Grant. "Natural Language Processing for Phenotyping Tasks". PI: Dmitriy Dligach. May 2017. \$4,998.  
NVIDIA Hardware Grant Program. Titan X GPU. July 2016. About \$1,200 value.  
Boston Children's Hospital, The Program for Patient Safety and Quality. "Natural Language Processing for Quality Metrics". PI: Dmitriy Dligach. July 2015. \$19,388.