

# CRISTINA CORNELIO

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## RESEARCH INTERESTS

My general research interests lie in the areas of Artificial intelligence and Cognitive Computing. In particular, I have worked on preference reasoning, graphical preference representation, preferences under uncertainty, preference aggregation in a multi agent context, voting rules, computational social choice, recommender systems, matching algorithms, logic of preferences and kidney exchange algorithms.

*More recently* I focused on the research topics of logic and reasoning, inference mechanisms, automated theorem proving, probabilistic logic, knowledge representation and extraction, natural language processing (NLP), neural-symbolic methods, neural embeddings for logic, combination of deep learning techniques with standard reasoning systems and reasoning for scientific discovery.



## EDUCATION

**PhD in Mathematics (Computer Science Area) | University of Padua, Italy**

JANUARY 2013 – MARCH 2016

Supervisor: Francesca Rossi.

PhD Thesis: “Preference reasoning and aggregation over combinatorial domains in uncertain and multi-agent scenarios”.

PhD Thesis reviewers: Barry O’Sullivan and Craig Boutilier.

**Master’s degree in Mathematics | University of Padua, Italy**

OCTOBER 2010 – OCTOBER 2012

Supervisors: Francesca Rossi and K. Brent Venable.

Master Thesis: “Dynamic and Probabilistic CP-nets”.

Master Thesis reviewers: Toby Walsh.

**Bachelor’s Degree in Mathematics | University of Udine, Italy**

SEPTEMBER 2007 – OCTOBER 2010

Bachelor Thesis: “Local search cuts for the maximum satisfiability problem”.

Supervisor: Franca Rinaldi.



## WORK EXPERIENCE

**Research Scientist | IBM Research – Zurich Research Center (Rüschlikon)**

JULY 2019 – PRESENT

Manager: Anika Schumann

Area: Reasoning, NLP and Knowledge Extraction

## Research Staff Member | IBM Research – T.J. Watson Research Center

OCTOBER 2017 – JUNE 2019

*Manager:* Michael Witbrock / Achille Fokoue

Area: AI Foundations - Reasoning

## Post-Doc | IBM – T.J.Watson Research Center

JULY 2016 – OCTOBER 2017

*Manager:* Michael Witbrock

*Mentor:* Vijay Saraswat

## Post-Doc | University of Padua, Italy

JANUARY 2016 – JUNE 2016

*Supervisor:* Francesca Rossi



## SKILLS

- PhD curriculum:
  - Programming Big Data in X10, Quantum Information, Statistical methods, Embedded Real-Time Systems, Preference reasoning in computational social choice, Decision making and social networks, Machine learning for structured domains by kernel methods, Networking Issues and Solutions in Online Games.
- Programming languages:
  - Good: Python, Prolog/Datalog.
  - Basic: Java, C++, C, Mathematica, html.



## PUBLICATIONS

- Journal papers:
  - **“Voting with random classifiers (VORACE): theoretical and experimental analysis”**, C. Cornelio, M. Donini, A. Loreggia, M.S. Pini, F. Rossi, *Autonomous Agents and Multi-Agent Systems*, 2021
  - **“Deceased-donor-initiated chains: first report of a successful deliberate case and its ethical implications”**, L. Furian, C. Cornelio, C. Silvestre, F. Rossi, P. Rigotti, E. Cozzi, F. Neri and A. Nicolò, *Transplantation*, 2019.
  - **“Multi-agent soft constraint aggregation via sequential voting: theoretical and experimental results”**, C. Cornelio, M.S. Pini, F. Rossi, K. B. Venable, *Journal of Autonomous Agents and Multi-Agent Systems (JAAMAS)*, 2019
  - **“Potential gain of utilizing kidneys from deceased donors to initiate “Chain” Kidney Paired donations: quantification of benefit through a real-world retrospective analysis”**, C. Cornelio, L. Furian, F. Neri, A. Nicolò, F. Rossi, P. Rigotti, C. Silvestre., *Transpl Int*, 2017
- Conference papers:

- **“Synthetic Datasets and Evaluation Tools for Inductive Neural Reasoning”**, C. Cornelio and V. Thost, Proceedings of the 30th International Conference of Inductive Logic Programming (ILP21), 2021
- **“A Deep Reinforcement Learning Approach to First-Order Logic Theorem Proving”**, M. Crouse, I. Abdelaziz, B. Makni, S. Whitehead, C. Cornelio, P. Kapanipathi, K. Srinivas, V. Thost, M. Witbrock, A. Fokoue, Proceedings of the Thirty-Fifth AAAI Conference on Artificial Intelligence, AAAI-21.
- **“Using deceased-donor kidneys to initiate chains of living donor kidney paired donations: algorithm and experimentation”**, C. Cornelio, L. Furian, A. Nicolò and F. Rossi, Proceedings of the AAAI/ACM Conference on Artificial Intelligence, Ethics and Society (AIES), 2019.
- **“Reasoning with PCP-nets in a Multi-Agent Context”**, C. Cornelio, U. Grandi, J. Goldsmith, N. Mattei, F. Rossi and K.B. Venable, Proceedings of the International Conference on Autonomous Agents & Multiagent Systems 2015, AAMAS-15.
- **“Updates and Uncertainty in CP-net”**, C. Cornelio, U. Grandi, J. Goldsmith, N. Mattei, F. Rossi and K.B. Venable, Proceedings of the 26th Australasian Joint Conference on Artificial Intelligence, AUAI-13.
- Published research extended abstracts:
  - **“Sequential voting in multi-agent soft constraint aggregation”**, C. Cornelio, M.S. Pini, F. Rossi, K. B. Venable, Proceedings of the International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS) 2020 - JAAMAS track.
  - **“Voting with Random Classifiers (VORACE)”**, C. Cornelio, M. Donini, A. Loreggia, M.S. Pini, F. Rossi, Proceedings of the International Conference on Autonomous Agents & Multiagent Systems 2020 (AAMAS-20).
  - **“Models for Conditional Preferences as extensions of CP-nets”**, C. Cornelio, Proceedings of the Twenty-Fourth International Joint Conference on Artificial Intelligence (extended abstract), IJCAI-15.
  - **“Dynamic and Probabilistic CP-nets”**, C. Cornelio, Proceedings of the Doctoral Program of International Conference on Principles and Practice of Constraint Programming 2013, CP-13.
- Patents:
  - **“Generative Reasoning for Symbolic Discovery”**, C. Cornelio, L. Horesh, V. Pestun, R. Yan, *patent application filed on: 2nd Oct. 2020*
  - **“Symbolic Model Discovery based on a combination of Numerical Learning Methods and Reasoning”**, C. Cornelio, L. Horesh, A. Fokoue-Nkoutche, Sanjeeb Dash, *patent application filed on: 21st Jul. 2020*
  - **“Problem manipulators for language-independent reasoning”**. C. Cornelio, A. Fokoue, A. Pareja, I. Abdelaziz, M. Witbrock, *patent application filed on: 29th Apr. 2020*
  - **“Experimental Design for Symbolic Model Discovery”**. L. Horesh, K. Clarkson, C. Cornelio, S. Magliacane, *patent application filed on: 21st Apr. 2020*

- **“Capturing the global structure logical formulae with graph long short-term memory”**, M. Crouse, I. Abdelaziz, C. Cornelio, V. Thost, L. Wu, B. Makni, K. Srinivas, A. Fokoue, *patent application filed on: 14th Nov. 2019*
- **“Automatic transformation of complex tables in documents into computer understandable structured format and managing dependencies”**, C. Cornelio, M. Canim, R. Musa, M. Rodriguez Muro, A. Iyengar, *patent application filed on: 18th Apr. 2019*
- **“Automatic transformation of complex tables in documents into computer understandable structured format with mapped dependencies and providing schema-less query support for searching table data”**, C. Cornelio, M. Canim, R. Musa, M. Rodriguez Muro, A. Iyengar, *patent application filed on: 18th Apr. 2019*
- **“Method for automatic transformation of complex tables in documents (PDF, Word) into computer understandable structured format and providing schemaless query support Data Extraction”**, C. Cornelio, M. Canim, R. Musa, M. Rodriguez Muro, A. Iyengar, *patent application filed on: 18th Apr. 2019*
- Workshop papers:
  - **“Improving Graph Neural Network Representations of Logical Formulae with Subgraph Pooling”**, M. Crouse, I. Abdelaziz, C. Cornelio, V. Thost, L. Wu, K. Forbus and A. Fokoue, The Second International Workshop on Deep Learning on Graphs: Methods and Applications 2020 (DLG-KDD’20).
  - **“Identifying the Discourse Function of News Article Paragraphs”**, W.V.H. Yarlott, C. Cornelio, T.Gao, M.A. Finlayson, Proceedings of COLING workshop: EventStory 2018.
  - **A Knowledge and Reasoning Toolkit for Cognitive Applications”**, M. Canim, C. Cornelio, R. Farrell, A. Fokoue, K. Gao, J. Gunnels, A. Iyengar, R. Musa, M. Rodriguez-Muro, R. Uceda-Sosa, HotWeb 2017.
  - **“Expressing Probabilistic Graphical Models in RCC”**, C. Cornelio and V. Saraswat, Symbolic Inference and Optimization workshop of AAIL-17.
  - **“Logical conditional preference theories”**, C. Cornelio, A. Loreggia, and V. Saraswat, Proceedings of the MPREF workshop of the International Joint Conference on Artificial Intelligence 2015, IJCAI-15.
  - **“Voting with CP-nets using a Probabilistic Preference Structure**, C. Cornelio, U. Grandi, J. Goldsmith, N. Mattei, F. Rossi and K.B. Venable, 5th International Workshop on Computational Social Choice, ComSoC-14.
  - **“Dynamic Probabilistic CP-nets”**, C. Cornelio, U. Grandi, J. Goldsmith, N. Mattei, F. Rossi and K.B. Venable, Proceedings of the 7th Multidisciplinary Workshop on Advances in Preference Handling, MPREF-13.
- ArXiv papers:
  - **“Integration of Data and Theory for Accelerated Derivable Symbolic Discovery”**, C. Cornelio, S. Dash, V. Austel, T. Josephson, J. Goncalves, K. Clarkson, N. Megiddo, B. El Khadir, L. Horesh, arXiv 2109.01634 , 2021

- “**Schemaless Queries over Document Tables with Dependencies**”, M. Canim, C. Cornelio, A. Iyengar, R. Musa, M. Rodriguez Muro, 2019, arXiv:1911.09356
- “**Improving Graph Neural Network Representations of Logical Formulae with Subgraph Pooling**”, M. Crouse, I. Abdelaziz, C. Cornelio, V. Thost, L. Wu, K. Forbus, A. Fokoue, 2019, arXiv:1911.06904
- “**Logical conditional preference theories**”, C. Cornelio, A. Loreggia, V. Saraswat, 2015, arXiv:1504.06374.



## TALKS

- Conference talks:
  - “**Sequential voting in multi-agent soft constraint aggregation**”, International Conference on Autonomous Agents and Multi-Agent Systems, 2020.
  - “**Reasoning with PCP-net in a Multi-Agent Context**”, International Conference on Autonomous Agents and Multi-Agents Systems 2015, AAMAS-15, Istanbul, Turkey.
  - “**Using deceased-donor kidneys to initiate chains of living donor kidney paired donations: algorithm and experimentation**”, AAI/ACM Conference on Artificial Intelligence, Ethics and Society (AIES), 2019. Honolulu, Hawaii, USA
- Workshop talks:
  - “**Logical conditional preference theories**”, MPREF, workshop of the International Joint Conference on Artificial Intelligence 2015, IJCAI-15, Buenos Aires, Argentina.
  - “**Expressing Probabilistic Graphical Models in RCC**”, C. Cornelio and V. Saraswat, Symbolic Inference and Optimization workshop of AAI-17
- Poster presentations:
  - “**Dynamic and Probabilistic CP-nets**”, International Conference on Principles and Practice of Constraint Programming 2013, CP-13, Uppsala, Sweden.
  - “**Models for Conditional Preferences as extensions of CP-nets**”, International Joint Conference on Artificial Intelligence 2015, IJCAI-15, Buenos Aires, Argentina.
  - “**Expressing Probabilistic Graphical Models in RCC**”, C. Cornelio and V. Saraswat, Symbolic Inference and Optimization workshop of AAI-17
  - “**Using deceased-donor kidneys to initiate chains of living donor kidney paired donations: algorithm and experimentation**”, C. Cornelio, L. Furian, A. Nicolò, F. Rossi, Proceedings of the AAI/ACM Conference on Artificial Intelligence, Ethics and Society, 2019. Honolulu, Hawaii, USA
- Doctoral consortium talks:
  - “**Dynamic and Probabilistic CP-nets**”, Doctoral Consortium of the International Conference on Principles and Practice of Constraint Programming 2013, CP-13, Uppsala, Sweden.
  - “**Models for Conditional Preferences as extensions of CP-nets**”, Doctoral Consortium of the International Joint Conference on Artificial Intelligence 2015, IJCAI-15, Buenos Aires, Argentina.

- **Invited talks:**
  - **“Affable Knowledge Elicitation”**, Rensselaer Polytechnic Institute (RPI), Troy (NY), USA, October 2017.
  - **“Potential gain of utilizing kidneys from deceased donors to initiate “Chain” Kidney Paired donations: quantification of benefit through a real-world retrospective analysis”**, Workshop on Matching Theory and Applications, University of Padua, Padua, Italy, December 2017.
- **Other talks:**
  - **“Probabilistic and Dynamic CP-Nets”**, (PRANA Seminar Series), University of Padua, Padua, Italy.
  - **“Reasoning with PCP-net in a Multi-Agent Context: Optimality and Dominance”**, (Insight Seminar Series), Insight Centre for Data Analytics, Cork, Ireland.
  - **“Preferences in AI”**, (Doctoral Seminar Series), University of Padua, Padua, Italy.



## ATTENDED CONFERENCES

- 2013: International Conference on Principles and Practice of Constraint Programming 2013, CP-13, Uppsala, Sweden.
- 2013: AI\*IA, Turin, Italy. Workshop on Iterative Voting and Voting Games, Padua, Italy.
- 2014: Workshop on Iterative Voting and Voting Games, Padua, Italy.
- 2015: International Conference on Autonomous Agents and Multi-Agents Systems 2015, AAMAS-15, Istanbul, Turkey.
- 2015: International Joint Conference on Artificial Intelligence 2015, IJCAI-15, Buenos Aires, Argentina.
- 2016: International Conference on Logic Programming, ICLP-16, New York, USA.
- 2017: AAIL-17, San Francisco, USA.
- 2019: AAIL-19, Honolulu, Hawaii, USA
- 2019: AIES-19, Honolulu, Hawaii, USA
- 2019: Dagstuhl seminar: “Application-Oriented Computational Social Choice”
- 2020: AAMAS-20 (Online conference)



## AWARDS

- Special mention for “Premio per NeoLaureati” (Italian national award for recent graduates) AI\*IA-2013, Italian Association of Artificial Intelligence.
- Paper “Updates and Uncertainty in CP-nets”: nomination for the best paper at the 26th Australasian Joint Conference on Artificial Intelligence.
- “Patent issuance award”: IBM patent & invention program (on Acclaim), 2020.
- “Plateau”: IBM patent & invention program (on Acclaim), 2020.



## PROFESSIONAL ACTIVITIES AND ACHIEVEMENTS

- 2013-2014: [Project “Incorporating patients’ preferences in kidney transplant decision protocols”](#): From January 2018 the system is piloted in Padova (involving NITp - Nord Italia Transplant program) and it started recently to be adopted nationally. It received national media and press attentions.
- 2013-2014: PhD representative for the Department of Mathematics of the University of Padua (Computer Science Area).
- 2014: Co-Organization of “Workshop on Iterative Voting and Voting Games” and realization of the corresponding web site.
- 2014 SEPTEMBER-DECEMBER:
  - Internship at “Insight Centre for Data Analytics” (Cork, Ireland) under the supervision of Nic Wilson and Barry O’Sullivan.
  - Co-Internship at *Avego*: optimization of the car-sharing algorithms for the application “CARMA”.
- 2014: Co-supervision of a Computer Science Master thesis: “A Personalized Recommender System for the Financial Domain”.
- 2015: IJCAI-15 Student Volunteer Program in Buenos Aires, Argentina.
- 2015: Post-Doc representative for the Department of Mathematics of the University of Padua.
- Supervision of summer interns/externs at IBM Research: 2017-2018-2019-2020
- 2019: Co-author of the proposal [“Accelerated Scientific Discovery via Globally Optimal Symbolic Regression”](#), accepted by DARPA for the call [AIRA \(Artificial Intelligence Research Associate\)](#)
- 2019-2021: participation in the [DARPA project AIRA](#)
- **REVIEWING FOR CONFERENCES:**
  - European Conference of Artificial Intelligence (**ECAI**): 2014, 2015, 2016.
  - International Conference on Algorithmic Decision Theory (**ADT**): 2017.
  - International Joint Conference on Artificial Intelligence (**IJCAI**): 2015, 2016, 2017,2018, 2020, 2021.
  - Conference on Artificial Intelligence, Ethics and Society (**AIES**): 2018, 2019, 2020.
  - International Conference on Autonomous Agents and Multi-agent Systems (**AAMAS**): 2018, 2019.
  - International Conference on Artificial Intelligence (**AAAI**): 2018, 2019, 2020, 2021.
  - International Conference on Artificial Intelligence (**AAAI**)-**Demo** track: 2020, 2021.
  - Neural Information Processing Systems (**NeurIPS**) – 2020.