

CLAUDIA d'AMATO
CURRICULUM VITAE
updated at December, 7th 2012

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1 General Information

1.1 Personal Data

Name: Claudia **Surname:** d'Amato

Date of Birth: 16 January 1977 **Place of Birth:** Terlizzi **Nationality:** Italian

1.2 Contact Information

Phone Number: (Office) +39 080 544 2246 **E-mail:** claudia.damato@di.uniba.it

Home Page: www.di.uniba.it/~cdamato

1.3 Current Position

From April 2007 Claudia d'Amato is a research assistant at the computer science department, University of Bari "Aldo Moro"

2 Education

2.1 Doctor of Philosophy

May 2007: PhD in Computer Science, Universtiy of Bari, Italy. Supervisor: Prof. Floriana Esposito.

Dissertation: "Similarity-based Learning Methods for the Semantic Web". Evaluation Rate: Excellent

Full mark evaluation

2.2 PhD Summer Schools

- **July 2005** - Attended SSSW Summer School on Ontological Engineering and the Semantic Web held in Cercedilla (Spain).
- **March 2005** - Attended BISS International Spring School for Graduate Studies in Computer Science held in Bertinoro (Forli).
- **August 2004** - Attended ESSLLI European Summer School in Logic, Language and Information held in Nancy (France).

2.3 Laurea Degree

March 2003 - Laurea Degree in Computer Science with the mark of 110 / 110 CUM LAUDE at University of Bari. Dissertation Title: “*Automatic Classification of Symbolic Objects by O-NN Algorithm with weighted distance*”. Supervisors: Prof. Donato Malerba, Prof. Floriana Esposito

2.4 Secondary School

July 1996: Diploma Degree as Accountant Commercial Expert Programmer with mark 60/60 at I.T.C. “A.M. TANNOIA” di Corato (Bari).

3 Honours and Awards

- Best Paper award at ACM SAC 2010 - SWA Track. F. Esposito, N. Fanizzi, C. d'Amato. [Recovering Uncertain Mappings through Structural Validation and Aggregation with the MoTo System.](#)
- PhD Thesis "[Similarity-based Learning Methods for the Semantic Web](#)" nominated by the Italian Commission for the [AI*IA](#) award 2007 as one of the Best Italian PhD Thesis in Artificial Intelligence
- Best best student paper award at [SEBD 2007](#) offered by Pearson Education. C. d'Amato “Constraint Hardness for Modelling, Matching and Ranking Semantic Web services”.
- Research Grant for three years for being a PhD student at the University of Bari (XIX Round), January 2004

4 Formal Collaboration with other research institutes

- **2012: invited researcher** at University of Oxford – Department of Computer Science for working with Prof. Thomas Lukasiewicz (time slot to be fixed)
- **June 2011: invited researcher** at University of Poznan (Poland) - Laboratory of Operational Research and Artificial Intelligence, Institute of Computing Science working with Dr. Agnieszka Lawrinowicz
- **February – April 2008: visiting researcher** at the University of Koblenz-Landau (Germany) working with Prof. Steffen Staab, head of the Institute of Web Science and Technologies (WeST)
- **February – May 2007: visiting researcher** at the University of Koblenz-Landau (Germany) working with Prof. Steffen Staab, head of the Institute of Web Science and Technologies (WeST)
- **Genauy – June 2006: visiting researcher** at the University of Koblenz-Landau (Germany) working with Prof. Steffen Staab, head of the Institute of Web Science and Technologies (WeST)

Claudia d'Amato also has/had informal scientific collaboration on various titles with other universities and research institutes such as: **George Mason University** - USA (Prof. Paulo Cesar G. Costa, Prof. Kathryn Blackmond Laskey), **MITRE corporation** - USA (Ken Laskey), **University of Bath** - UK (Dr. Matthias Nickles), **Siemens** – Germany (Prof. Volker Tresp), **University of Mannheim** – Germany (Dr. Johanna Volker, Prof. Heiner Stuckenschmidt), **University of Leipzig** (Dr. Jens Lehmann), **Jozef Stefan Institute** – Slovenia (Prof. Marko Grobelnik), **University of Economics** - Czech Republic (Prof. Vojtech Svatek), **Informatics Institute of the Faculty of Economics and Business Engineering (AIFB)** – Germany (Dr. Achim Rettinger), **University of Zurich** - Switzerland (Prof. Abraham Bernstein, Dr. Thomas Scharrenbach), **Swiss Federal Institute for forest, snow and landscape research (WSL)** – Switzerland (Prof. Rolf Grutter, Dr. Bettina Waldvogel), **University of Calabria** – Italy (Dr. Bettina Fazzinga), **Kno.e.sis - Ohio Center of Excellence in Knowledge-enabled Computing** – USA (Prof. Pascal Hitzler), **University of California** – USA (Prof. Krzysztof Janowicz)

5 Research Projects

- ***Semantic-PA: “Tecnologie di Semantic Web per la Pubblica Amministrazione”*** (Regional Project written by Claudia d'Amato and Michele Carulli head of the research division of I&T Servizi S.r.l.)
- ***ASSO “Analysis System of Symbolic Official Data”*** (European Project IST -2000-25161)
- ***“SPIN: Spatial Mining on Data of Public Interest”*** (European Project IST-1999-10536)
- ***“Metodi induttivi per la predizione di relazioni su basi di conoscenza ontologiche”*** (Ateneo Project - Università degli Studi di Bari ex 60% 2010)
- ***“Metodi e Tecniche di Semantic Web Mining”*** (Ateneo Project - Università degli Studi di Bari ex 60% 2009)
- ***“Apprendimento Automatico di conoscenza in forma ontologica in Logiche del primo ordine”*** (Ateneo Project - Università degli Studi di Bari ex 60% 2007)
- ***“Modelli computazionali di Apprendimento Automatico per formalismi ibridi del 1° ordine”*** (Ateneo Project - Università degli Studi di Bari ex 60% 2006)
- ***“Apprendimento induttivo per la annotazione automatica su base semantica di documenti”*** (Ateneo Project - Università degli Studi di Bari ex 60% 2005)
- ***“Astrazione e Logica descrittiva in Apprendimento Automatico”*** (Ateneo Project - Università degli Studi di Bari ex 60% 2004)
- ***DDTA: “Distretto digitale a supporto della filiera produttiva del tessile – abbigliamento”*** (Regional Project)
- ***DIPIS: progetto strategico “Produzione Distribuita come Sistema Innovativo”*** (Regional Project)
- ***“Metodi e Tecniche di apprendimento automatico per il Semantic Web”*** (MIUR Project - PRIN 2003)
- ***“Sintesi automatica di modelli astratti a partire da dati temporali o spaziali”*** (MIUR Project - PRIN 2006)

6 Past work experiences, research and development activities

- April – December 2011: **Collaboration with the Department of Computer Science, University of Bari** as expert researcher for activities related to the Semantic-PA regional project
- November 2006 – March 2007: **Collaboration with the Department of Computer Science, University of Bari** as researcher/analyst for activities related to the DIPIS regional project
- January – March 2004: **Collaboration with the Department of Computer Science, University of Bari** as researcher/analyst for activities related to the COLLATE european project
- June – December 2003: **Collaboration with Omar S.p.A Allaxia group** as analyst and developer in the *Power* project: a system for registry management and associative marketing developed for **Confartigianato**, available on Windows and Unix-like platform; realized with *J2EE (Servlet/JSP)* technology and using IBM *WebSphere Application Server* and *RDBMS*, like *SQLSERVER2000*, *DB2* e *PostgreSQL*
- April - May 2003: **Scientific Collaboration with the Department of Computer Science of the University of Bari** in the context of the ASSO project (Analysis System of Symbolic Official data, IST-2000-25561). Tasks involved: development of a software module for the empiric study of the properties of dissimilarity measures and matching measures between symbolic objects; test of modules which realize matching and dissimilarity measure; definition of a user guide to support user in the choice and estimation of the best dissimilarity measure or the best matching measure. Project Responsible for the Unit of Bari: Prof. Floriana Esposito.
- February - June 2001: **Collaboration with the Department of Computer Science, University of Bari** for the SPIN! Project (SPatial mining on data of public Interest): planning and realization of a package for the support to the Nine Intersection Model which has been integrated into the G.I.S. system developed in the project. Project Responsible: Prof. Donato Malerba.
- September -December 2001; August -December 2000: **Part-time collaboration with the Department of Computer Science, University of Bari** for the analysis and design of the Information System (SIFAS) of the Science Faculty of the University of Bari.

7 Professional Services

7.1 Editorial Board, Co-Chair, Organization, Program Committees, Scientific Interest Groups

- **Editorial Board Member of the Semantic Web Journal ([SWJ](#))**
- **Vice-Chair of the 8th International Semantic Web Conference ([ISWC'09](#))**
- **Workshops and Tutorials Co-Chair at**
 - the 11th International Semantic Web Conference (ISWC 2012)
 - the 18th International Conference on Knowledge Engineering and Knowledge Management ([EKAW'12](#))
- **Track Co-Chair** for the "Machine Learning" track at the 9th Extended Semantic Web Conference ([ESWC'12](#))
- **Workshop Co-Chair** at the 6th IEEE International Conference on Semantic Computing (ICSC 2012)
- **Organizing Committee Member of**
 - the Int. Workshop on Inductive Reasoning and Machine Learning on the Semantic Web at ESCW ([IRMLeS'11](#), [IRMLeS'10](#), [IRMLeS'09](#))
 - the Int. Uncertainty Reasoning Workshop at ISCW ([URSW'11](#), [URSW'10](#), [URSW'09](#), [URSW'08](#), [URSW'07](#))
- **Scientific Interest Groups**
 - **Invited Expert** for the Uncertainty Reasoning for the World Wide Web Incubator Group (2007-2009)
 - **Member** of the IEEE "Semantic Web" Task Force
 - **Member** of the ACM Special Interest Group on Applied Computing (2006, 2010)
 - **Member** of **GULP**: Italian Group of Researchers and Users of Logic Programming (2005)
 - **Member** of **AI*IA**: Italian Association for Artificial Intelligence (2007, 2008, 2010)
 - **Member** of **AICA**: Italian Association for Informatics and Machine Calculus (2004, 2005)
- **Program Committee Member of**
 - the European Conference on Artificial Intelligence (ECAI'12, [ECAI'10](#))
 - the International World Wide Web Conference ([WWW'12](#), [WWW'11](#))
 - the IEEE International Conference on Semantic Computing (ICSC'12)
 - the ACM International Symposium On Applied Computing ([SAC'12](#), [SAC'11](#), [SAC'10](#)) - Semantic Web and Application track ([SWA'12](#), [SWA'11](#), [SWA'10](#))
 - the International Conference on Knowledge Engineering and Knowledge Management by the Masses ([EKAW'12](#), [EKAW'10](#))
 - the International Conference on Business Intelligence and Technology ([BUSTECH 2012](#), [BUSTECH 2011](#))
 - the International Conference on Advanced Collaborative Networks, Systems and Applications ([COLLA 2012](#), [COLLA 2011](#))

- the International Web Rule Symposium: Research Based and Industry Focused ([RuleML'12](#), [RuleML'11](#), [RuleML'10](#), [RuleML'09](#))
- the International Semantic Web Conference ([ISWC'11](#), [ISWC'10](#), [ISWC'09](#), [ISWC'08](#))
- the 22nd International Joint Conference on Artificial Intelligence ([IJCAI'11](#))
- the International Conference on Web Reasoning and Rule Systems ([RR'11](#), [RR'10](#))
- the Joint International Semantic Technology Conference ([JIST'11](#))
- the 8th Extended Semantic Web Conference ([ESWC'11](#)) - Inductive and Probabilistic Approaches Track
- the 8th Extended Semantic Web Conference ([ESWC'11](#)) - Reasoning Track
- the Doctoral consortium at the International Symposium on Rules ([RuleML 2011 Doctoral Consortium](#))
- the [Reasoning Web Summer School 2011](#)
- the International RuleML Challenge ([RuleML Challenge 2011](#), 2010)
- the International Web Rule Symposium ([RuleML@BRF-2011](#))
- the International Workshop on Neural-Symbolic Learning and Reasoning at IJCAI ([NeSy'11](#), [NeSy'10](#), [NeSy'09](#))
- the Int. Workshop on Semantic Media Adaptation and Personalization ([SMAP 2011](#))
- the European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases ([ECML/PKDD'10](#), [ECML/PKDD'09](#))
- the 5h European Starting AI Researcher Symposium ([STAIRS'10](#))
- the International Conference on Web Intelligence ([WI'10](#), [WI'09](#))
- the 24th Conference on Artificial Intelligence ([AAAI'10](#))
- the 1st Int. Workshop on Knowledge Injection to and Extraction from Linked Data at EKAW 2010 ([KIELD'10](#))
- the 2nd International Conference on Advanced Intelligence ([ICAI'10](#))
- the International IEEE Conference on Signal-Image Technology and Internet-based Systems ([SITIS'10](#), [SITIS'09](#))
- the Int. Workshop on Knowledge Acquisition, Reuse and Evaluation at SITIS IEEE conference, ([KARE'10](#), [KARE'09](#))
- the 5th Int. Semantic Web Applications and Perspectives Workshop ([SWAP'08](#))
- the Transactions in GIS [Special Issue on Semantic Similarity Measurement and Geospatial Applications.](#)
- the Int. IFIP Workshop on Semantic Web & Web Semantic ([SWWS'08](#), [SWWS'07](#))

7.2 Editorial Works

- Stefan Brüggemann and **Claudia d'Amato** (Editors). *Collaboration and the Semantic Web: Social Networks, Knowledge Networks and Knowledge Resources*. IGI Global Publisher. (will appear)
- Paulo CG Costa, **Claudia d'Amato**, Nicola Fanizzi, Kathy Laskey, Ken Laskey, Thomas Lukasiewicz, Matthias Nickles, Mike Pool (Editors). *Uncertainty Reasoning for the Semantic Web II*. LNCS/LNAI series, Springer. (will appear)
- Abraham Bernstein, **Claudia d'Amato**, Volker Tresp (Editors). Special Issue on *Induction on the Semantic Web* in the International Journal on Semantic Web and Information Systems. Vol. 7(2). ISSN: 1552-6283.
- **Claudia d'Amato**, Nicola Fanizzi, Marko Grobelnik, Agnieszka Ławrynowicz (Editors). Special Issue on *Inductive Reasoning and Machine Learning for the Semantic Web* in the International Semantic Web Journal. ISSN: 1570-0844 (will appear)

- [Axel Polleres](#), **Claudia d'Amato**, [Marcelo Arenas](#), [Siegfried Handschuh](#), [Paula Kroner](#), [Sascha Ossowski](#), [Peter F. Patel-Schneider](#): Reasoning Web. Semantic Technologies for the Web of Data - 7th International Summer School 2011, Galway, Ireland, August 23-27, 2011, Tutorial Lectures [Springer 2011](#)
- Fernando Bobillo, Paulo C. G. da Costa, Rommel Carvalho, **Claudia d'Amato**, Nicola Fanizzi, Kathryn B. Laskey, Kenneth J. Laskey, Thomas Lukasiewicz, Trevor Martin, Matthias Nickles and Michael Pool (editors) Proc. of the 7th Int. Workshop on Uncertainty Reasoning for the Semantic Web (URSW 2011). Vol-778. CEUR Workshop Proceeding.
- **Claudia d'Amato**, Nicola Fanizzi, Blaz Fortuna, Agnieszka Lawrynowicz and Vojtech Svátek (editors). Proceeding of the 3rd ESWC International Workshop on Inductive Reasoning and Machine Learning on the Semantic Web (IRMLes 2011).
- Fernando Bobillo, Paulo C. G. da Costa, Rommel Carvalho, **Claudia d'Amato**, Nicola Fanizzi, Kathryn B. Laskey, Kenneth J. Laskey, Thomas Lukasiewicz, Trevor Martin, Matthias Nickles and Michael Pool (editors) Proc. of the 6th International Workshop on Uncertainty Reasoning for the Semantic Web (URSW 2010). Vol-654. CEUR Workshop Proceeding.
- **Claudia d'Amato**, Nicola Fanizzi, Marko Grobelnik, Agnieszka Lawrynowicz and Vojtech Svátek (editors) Proc. of the 2nd ESWC Int. Workshop on Inductive Reasoning and Machine Learning on the Semantic Web (IRMLes 2010). Vol. 611 of CEUR Workshop Proc., 2010.
- Fernando Bobillo, Paulo C. G. da Costa, **Claudia d'Amato**, Nicola Fanizzi, Kathryn B. Laskey, Kenneth J. Laskey, Thomas Lukasiewicz, Trevor Martin, Matthias Nickles, Michael Pool, and Pavel Smrz (editors) Proceedings of the 5th International Workshop on Uncertainty Reasoning for the Semantic Web (URSW 2009), Washington DC, USA, October 2009. Volume 527 of CEUR Workshop Proceeding, CEUR-WS.org, 2009
- **Claudia d'Amato**, Nicola Fanizzi, Marko Grobelnik, Agnieszka Lawrynowicz and Vojtech Svátek (editors) Proceeding of the 1st ESWC International Workshop on Inductive Reasoning and Machine Learning on the Semantic Web (IRMLes 2009), Heraklion, Greece, June 1, 2009. Volume 474 of CEUR Workshop Proceeding, CEUR-WS.org, 2009.
- Paulo Cesar G. da Costa, **Claudia d'Amato**, Nicola Fanizzi, Kathryn B. Laskey, Kenneth J. Laskey, Thomas Lukasiewicz, Matthias Nickles, and Michael Pool (editors) Uncertainty Reasoning for the Semantic Web I Volume 5327 of LNCS, Springer, 2008.
- Fernando Bobillo, Paulo C. G. da Costa, **Claudia d'Amato**, Nicola Fanizzi, Kathryn B. Laskey, Kenneth J. Laskey, Thomas Lukasiewicz, Trevor Martin, Matthias Nickles, Michael Pool, and Pavel Smrz (editors) Proceedings of the 4th International Workshop on Uncertainty Reasoning for the Semantic Web (URSW 2008), Karlsruhe, Germany, October 2008. Volume 423 of CEUR Workshop Proceeding, CEUR-WS.org, 2008.
- Fernando Bobillo, Paulo C. G. da Costa, **Claudia d'Amato**, Nicola Fanizzi, Francis Fung, Thomas Lukasiewicz, Trevor Martin, Matthias Nickles, Yun Peng, Michael Pool, Pavel Smrz, and Peter Vojtas (editors) Proceedings of the Third ISWC Workshop on Uncertainty Reasoning for the Semantic Web (URSW 2007), Busan, Korea, November 2007 Volume 327 of CEUR Workshop Proceedings, CEUR-WS.org, 2008.

7.3 Invited Talks

- June 2012 - Dagstuhl Seminar: “Cognitive Approaches for the Semantic Web” - Dagstuhl Schloss (Title of the talk to be announced)
- 22 July 2011 - [\(Dis-\)Similarity Measures for Description Logics Representation](#) - Institute of Computing Science - Poznan University of Technology
- 21 July 2011 - [\(Conceptual\) Clustering methods for the Semantic Web: issues and applications](#) (Jointly with Nicola Fanizzi) - Institute of Computing Science - Poznan University of Technology
- 25 July 2010 - **(Conceptual) Clustering for discovering Concept Drift and Concept Formation from Description Logics Knowledge Bases** - Dagstuhl Seminar: "[Learning Paradigms in Dynamic Environments](#)" - Dagstuhl Schloss
- 22 April 2008 - [Inductive Reasoning on Ontologies: Similarity-Based Approaches](#) - Information Engineering Department - [University of Modena e Reggio Emilia](#)
- 19 December 2007 - **Inductive Reasoning on Ontologies and Rules for the Semantic Web** (jointly with Nicola Fanizzi and Francesca Alessandra Lisi) - SWAP 2007 (Selected tutorial)
- 7 November 2007 - [Ontology: An Introduction](#) - [EMBRACE Workshop "Applied Gene Ontology"](#)
- 15 October 2007 - "[Similarity-based Learning Methods for the Semantic Web](#)" - [IRST](#) - Istituto Trentino di Cultura - Trento
- May 2006 - "[Similarity and Dissimilarity Measures for Concept Descriptions in Ontological Knowledge](#)" - University of Milan – Dept. of Information Technology (Crema)

7.4 Reviewing Activities

International Journal

- JWS: Journal of Web Semantics
- DKE: Journal of Data and Knowledge Engineering
- TIST: ACM Transactions on Intelligent Systems and Technology
- KAIS: Knowledge and Information Systems International Journal
- INS: Journal of Information Sciences
- AAI: Advances in Artificial Intelligence Journal
- PAA: Pattern Analysis and Applications International Journal
- KNOSYS: Knowledge-Based Systems International Journal
- IJITDM: International Journal of Information Technology & Decision Making
- IWET: International Journal of Web Engineering and Technology
- JKE: International Journal of Knowledge Engineering
- JAI: Journal of Applied Intelligence
- IC: IEEE Internet Computing (Magazine)

International Conferences

- ICAART 2012: International Conference on Agents and Artificial Intelligence
- ILP 2011, 2008: International Conference on Inductive Logic Programming
- IJCNN 2011: International joint Conference on Neural Networks
- PAKDD 2011: 15th Pacific-Asia Conference on Knowledge Discovery and Data Mining

- ECML/PKDD 2011, 2006, 2008: European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases
- KDD 2011, 2009, 2010: ACM SIGKDD Conference on Knowledge Discovery and Data Mining
- DaWaK 2011: International Conference on Data Warehousing and Knowledge Discovery
- KES 2011, 2008, 2007: International Conference on Knowledge-Based and Intelligent Information & Engineering Systems
- AI*IA 2011, 2007, 2005: the 9th Congress of the Italian Association for Artificial Intelligence
- SEBD 2011, 2007: Italian Symposium on Advanced Database Systems
- KDIR 2010: International Conference on Knowledge Discovery and Information Retrieval
- IEA-AIE 2010, 2009, 2008, 2005: International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems
- ICDM 2010, 2008, 2006, 2005: IEEE International Conference on Data Mining
- ESWC 2009, 2008: European Semantic Web Conference
- IIS 2009: 17th International Conference Intelligent Information Systems
- ECDL 2009: 13th European Conference on Digital Libraries
- CIDM 2009: IEEE Symposium on Computational Intelligence and Data Mining
- ADMA 2009: International Conference on Advanced Data Mining and Applications
- SUM 2008: International Conference on Scalable Uncertainty Management
- PAIS 2008: Prestigious Applications of Intelligent Systems
- CIDM 2007: IEEE Symposium on Computational Intelligence and Data Mining
- IRCDL 2007: Italian Research Conference on Digital Library Systems
- AAAI 2006: National Conference on Artificial Intelligence
- WIAMIS 2006: International Workshop on Image Analysis for Multimedia Interactive Services
- SDM 2005, 2006: SIAM International Conference on Data Mining
- SAC 2006: ACM Symposium on Applied Computing
- ISMIS 2006: The 16th International Symposium on Methodologies for Intelligent Systems

International and National Workshops

- MCD 2008 at ICDM: 4th Int. Workshop on Mining Complex Data
- SMR2 2008 at ISWC: 2nd Int. Workshop on Service Matchmaking and Resource Retrieval in the Semantic Web
- SWAP 2007: Italian Workshop on Semantic Web and Perspectives

8 Publications

8.1 Edited Works

1. Stefan Brüggemann and **Claudia d'Amato** (Editors). *Collaboration and the Semantic Web: Social Networks, Knowledge Networks and Knowledge Resources*. IGI Global. (In press)
2. Paulo CG Costa, **Claudia d'Amato**, Nicola Fanizzi, Kathy Laskey, Ken Laskey, Thomas Lukasiewicz, Matthias Nickles, Mike Pool (Editors). *Uncertainty Reasoning for the Semantic Web II*. LNCS/LNAI series, Springer. (In press)
3. Abraham Bernstein, **Claudia d'Amato**, Volker Tresp (Editors). Special Issue on *Induction on the Semantic Web* in the International Journal on Semantic Web and Information Systems. Vol. 7(2). ISSN: 1552-6283.
4. **Claudia d'Amato**, Nicola Fanizzi, Marko Grobelnik, Agnieszka Ławrynowicz (Editors). Special Issue on *Inductive Reasoning and Machine Learning for the Semantic Web* in the International Semantic Web Journal. ISSN: 1570-0844 (In press)
5. [Axel Polleres](#), [Claudia d'Amato](#), [Marcelo Arenas](#), [Siegfried Handschuh](#), [Paula Kroner](#), [Sascha Ossowski](#), [Peter F. Patel-Schneider](#): Reasoning Web. Semantic Technologies for the Web of Data - 7th International Summer School 2011, Galway, Ireland, August 23-27, 2011, Tutorial Lectures [Springer 2011](#)
6. Fernando Bobillo, Paulo C. G. da Costa, Rommel Carvalho, **Claudia d'Amato**, Nicola Fanizzi, Kathryn B. Laskey, Kenneth J. Laskey, Thomas Lukasiewicz, Trevor Martin, Matthias Nickles and Michael Pool (editors) Proc. of the 7th Int. Workshop on Uncertainty Reasoning for the Semantic Web (URSW 2011). Vol-778. CEUR Workshop Proceeding.
7. **Claudia d'Amato**, Nicola Fanizzi, Blaz Fortuna, Agnieszka Lawrynowicz and Vojtech Svátek (editors). Proceeding of the 3rd ESWC International Workshop on Inductive Reasoning and Machine Learning on the Semantic Web (IRMLes 2011).
8. Fernando Bobillo, Paulo C. G. da Costa, Rommel Carvalho, **Claudia d'Amato**, Nicola Fanizzi, Kathryn B. Laskey, Kenneth J. Laskey, Thomas Lukasiewicz, Trevor Martin, Matthias Nickles and Michael Pool (editors) Proc. of the 6th Int. Workshop on Uncertainty Reasoning for the Semantic Web (URSW 2010). Vol-654. CEUR Workshop Proceeding.
9. **Claudia d'Amato**, Nicola Fanizzi, Marko Grobelnik, Agnieszka Lawrynowicz and Vojtech Svátek (editors) Proc. of the 2nd ESWC Int. Workshop on Inductive Reasoning and Machine Learning on the Semantic Web (IRMLes 2010). Vol. 611 of CEUR Workshop Proc., 2010.
10. Fernando Bobillo, Paulo C. G. da Costa, **Claudia d'Amato**, Nicola Fanizzi, Kathryn B. Laskey, Kenneth J. Laskey, Thomas Lukasiewicz, Trevor Martin, Matthias Nickles, Michael Pool, and Pavel Smrz (editors) Proceedings of the 5th International Workshop on Uncertainty Reasoning for the Semantic Web (URSW 2009), Washington DC, USA, October 2009. Volume 527 of CEUR Workshop Proceeding, CEUR-WS.org, 2009
11. **Claudia d'Amato**, Nicola Fanizzi, Marko Grobelnik, Agnieszka Lawrynowicz and Vojtech Svátek (editors) Proceeding of the 1st ESWC International Workshop on Inductive Reasoning and Machine Learning on the Semantic Web (IRMLes 2009), Heraklion, Greece, June 1, 2009. Volume 474 of CEUR Workshop Proceeding, CEUR-WS.org, 2009.
12. Paulo Cesar G. da Costa, **Claudia d'Amato**, Nicola Fanizzi, Kathryn B. Laskey, Kenneth J. Laskey, Thomas Lukasiewicz, Matthias Nickles, and Michael Pool (editors) Uncertainty Reasoning for the Semantic Web I Volume 5327 of LNCS, Springer, 2008.

13. Fernando Bobillo, Paulo C. G. da Costa, **Claudia d'Amato**, Nicola Fanizzi, Kathryn B. Laskey, Kenneth J. Laskey, Thomas Lukasiewicz, Trevor Martin, Matthias Nickles, Michael Pool, and Pavel Smrz (editors) Proceedings of the 4th International Workshop on Uncertainty Reasoning for the Semantic Web (URSW 2008), Karlsruhe, Germany, October 2008. Volume 423 of CEUR Workshop Proceeding, CEUR-WS.org, 2008.
14. Fernando Bobillo, Paulo C. G. da Costa, **Claudia d'Amato**, Nicola Fanizzi, Francis Fung, Thomas Lukasiewicz, Trevor Martin, Matthias Nickles, Yun Peng, Michael Pool, Pavel Smrz, and Peter Vojtas (editors) Proceedings of the Third ISWC Workshop on Uncertainty Reasoning for the Semantic Web (URSW 2007), Busan, Korea, November 2007 Volume 327 of CEUR Workshop Proceedings, CEUR-WS.org, 2008.

8.2 International Journals

1. N. Fanizzi, **C. d'Amato**, F. Esposito. Induction of robust classifiers for web ontologies through kernel machines. International Journal of Web Semantics. Elsevier. (2011) DOI [10.1016/j.websem.2011.11.003](https://doi.org/10.1016/j.websem.2011.11.003) (In press)
2. **C. d'Amato**, N. Fanizzi, B. Fazzinga, G. Gottlob, and T. Lukasiewicz. *Ontology-Based Semantic Search on the Web and its Combination with the Power of Inductive Reasoning*. Special Issue of Annals of Mathematics and Artificial Intelligence (AMAI). (In press) (2011). ISSN: 1012-2443 (print version), ISSN: 1573-7470 (electronic version).
3. **C. d'Amato**, S. Staab, N. Fanizzi, F. Esposito. DL-LINK: A CONCEPTUAL CLUSTERING ALGORITHM FOR INDEXING DESCRIPTION LOGICS KNOWLEDGE BASES. International Journal of Semantic Computing vol.4(4) (2010)
4. **C. d'Amato**, N. Fanizzi, F. Esposito. Inductive Learning for the Semantic Web: What does it buy? Semantic Web Journal. IOS-Press. (2010)
5. N. Fanizzi, **C. d'Amato**, F. Esposito. *Composite Ontology Matching with Uncertain Mappings Recovery*. ACM Applied Computing Review, vol. 11(2); p. 17-29. (2011). ISSN: 1559-6915
6. F. Esposito, **C. d'Amato**, N. Fanizzi. Fuzzy Clustering for Semantic Knowledge Bases. Fundamenta Informaticae Vol. 99(2) pp. 187-205 (2010)
7. N. Fanizzi, **C. d'Amato**, F. Esposito. Inductive Classification of Semantically Annotated Resources through Reduced Coulomb Energy Networks. International Journal of Semantic Web and Information System vol.5(4) (2009) pp. 19-38
8. N. Fanizzi, **C. d'Amato**, F. Esposito. Metric-based Stochastic Conceptual Clustering for Ontologies. Information Systems International Journal Vol. 34(8) (December 2009) pp. 792-806. Elsevier Science.
9. N. Fanizzi, **C. d'Amato**, F. Esposito. Induction of Classifiers through Non-Parametric Methods for Approximate Classification and Retrieval with Ontologies. International Journal of Semantic Computing vol.2(3) (2008) pp. 403 - 423
10. N. Fanizzi, **C. d'Amato**, F. Esposito. Evolutionary Conceptual Clustering Based on Induced Pseudo-Metrics. Int. J. of Semantic Web and Information System vol.4(3) (2008) pp. 44-67
11. **C. d'Amato**, N. Fanizzi, F. Esposito. [Ontologies: An Introduction](#). EMBnet.news vol.14(1) (2008) pp. 28-35 EMBnet Executive Board. ISSN 1023-4144
12. A. Appice **C. d'Amato**, F. Esposito, D. Malerba. Classification of Symbolic Objects: A Lazy Learning Approach. J. of Intelligent Data Analysis vol.10 (2006) pp. 301-324 IOS Press

8.3 Book Chapters

1. J. Lehmann, N. Fanizzi, L. Buhmann, **C. d'Amato**. Concept Learning. In: J. Lehmann et al. Editors. *Ontology LEarning*. IOS-Press (In press).
2. **C. d'Amato**, N. Fanizzi, B. Fazzinga, G. Gottlob, T. Lukasiewicz. *Semantic Web Search and Inductive Reasoning*. In P. CG Costa et al. (Editors). *Uncertainty Reasoning for the Semantic Web II*. LNCS/LNAI series, Springer. (In press)
3. G. Rizzo, **C. d'Amato**, N. Fanizzi, F. Esposito. *Inductive Prediction of Assertions on OWL Ontologies through Evidence Combination*. In P. CG Costa, C. d'Amato, N. Fanizzi, K. Laskey, K. Laskey, T. Lukasiewicz, M. Nickles, M. Pool (Editors). *Uncertainty Reasoning for the Semantic Web II*. LNCS/LNAI series, Springer. (In press)
4. **C. d'Amato**, N. Fanizzi, T. Lukasiewicz, F. Esposito. Representing Uncertain Concepts in Rough Description Logics via Contextual Indiscernibility Relations. In P. CG Costa, C. d'Amato, N. Fanizzi, K. Laskey, K. Laskey, T. Lukasiewicz, M. Nickles, M. Pool (Editors). *Uncertainty Reasoning for the Semantic Web II*. LNCS/LNAI series, Springer. (In press)
5. N. Fanizzi, **C. d'Amato**, F. Esposito. Machine Learning Methods for Ontology Mining. In: Phillip Sheu, Heather Yu, C. V. Ramamoorthy, Arvind K. Joshi, Lotfi A. Zadeh. *Semantic Computing*. Wiley/IEEE, ISBN/ISSN: 978-0-470-46495-3 (2010).
6. F. Esposito, **C. d'Amato**, N. Fanizzi. Partitional Conceptual Clustering of Web Resources Annotated with Ontology Languages. In: B. BERENDT, D. MLADENIC, M. DEGEMMIS, G. SEMERARO, M. SPILIOPOULOU, G. STUMME, V. SVATEK, F. ZELEZNY EDS.. *Knowledge Discovery Enhanced with Semantic and Social Information*. Vol. 220, p. 53-70, BERLIN: Springer-Verlag, ISBN/ISSN: 978-3-642-01890-9
7. **C. d'Amato**, N. Fanizzi, F. Esposito. Analogical Reasoning in Description Logics. In Paulo Cesar G. da Costa et al. (Eds.) *Uncertainty Reasoning for the Semantic Web I*, ISWC International Workshops, URSW 2005-2007, Revised Selected and Invited Papers Springer, LNCS Series Vol. 5327 pp. 330-347, 2008
8. N. Fanizzi, **C. d'Amato**, F. Esposito. Approximate Measures of Semantic Dissimilarity under Uncertainty. In Paulo Cesar G. da Costa et al. (Eds.) *Uncertainty Reasoning for the Semantic Web I*, ISWC International Workshops, URSW 2005-2007, Revised Selected and Invited Papers Springer, LNCS Series Vol. 5327 pp. 348-365, 2008
9. F. Esposito, **C. d'Amato**. An Agglomerative Hierarchical Clustering Algorithm for Improving Symbolic Object Retrieval. In Brito, P.; Bertrand, P.; Cucumel, G.; De Carvalho, F. (Eds.) *Selected Contributions in Data Analysis and Classification*. Springer, 2007. *Studies in Classification, Data Analysis, and Knowledge Organization*. 45-54, 2007

8.4 International Conferences

1. P. Minervini, **C. d'Amato**, N. Fanizzi. *Learning Probabilistic Description Logic Concepts Under Different Assumptions on Missing Knowledge*. In Proceedings of the 27th ACM Symposium On Applied Computing (SAC 2012) – SWA Track. (will appear) (2012)
2. N. Fanizzi, **C. d'Amato**. Learning with Semantic Kernels for Clausal Knowledge Bases. *Foundations of Intelligent Systems - 19th International Symposium, ISMIS 2011*. Vol. 6804. pp. 250-259. Springer, (2011).
3. G. Rizzo, N. Fanizzi, **C. d'Amato**, F. Esposito. Prediction of class and property assertions on OWL ontologies through evidence combination. *Proceedings of the International Conference on Web Intelligence, Mining and Semantics, WIMS 2011*. ACM. (2011).
4. **C. d'Amato**, S. Staab, N. Fanizzi, F. Esposito. Efficient Resource Retrieval from Semantic Knowledge Bases. *ICSC 2010, 4th IEEE Int. Conference on Semantic Computing* (2010).

5. N. Fanizzi, **C. d'Amato**, F. Esposito. Induction of Concepts in Web Ontologies through Terminological Decision Trees. ECML/PKDD 2010, European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases (2010).
6. **C. d'Amato**, N. Fanizzi, B. Fazzinga, G. Gottlob, T. Lukasiewicz. Combining semantic web search with the power of inductive reasoning. SUM 2010, 4th International Conference on Scalable Uncertainty Management, September, 27 - 29, 2010, Toulouse, France.
7. N. Fanizzi, **C. d'Amato**, F. Esposito. Learning to Rank Individuals in Description Logics Using Kernel Perceptrons. Proc. of RR 2010, 4th Int. Conf. on Web Reasoning and Rule Systems (2010).
8. A. Lawrynowicz, **C. d'Amato**, N. Fanizzi. A Refinement Operator Based Method for Semantic Grouping of Conjunctive Query Results. KES 2010, 14th Int. Conference on Knowledge-Based and Intelligent Information & Engineering Systems (2010).
9. N. Fanizzi, **C. d'Amato**, F. Esposito. Towards Learning to Rank in Description Logics. ECAI 2010, 19th European Conference on Artificial Intelligence (2010).
10. **C. d'Amato**, N. Fanizzi, A. Lawrynowicz. [Categorize By: Deductive Aggregation of Semantic Web Query Results.](#) ESWC 2010, Extended Semantic Web Conference (2010).
11. F. Esposito, N. Fanizzi, **C. d'Amato**. [Recovering Uncertain Mappings through Structural Validation and Aggregation with the MoTo System.](#) SAC 2010 - SWA Track, 25th ACM International Symposium On Applied Computing, March, 22 - 26, 2010, Sierre, Switzerland.
12. N. Fanizzi, **C. d'Amato**, F. Esposito. [Towards the Induction of Terminological Decision Trees.](#) SAC 2010 - SWA Track, 25th ACM Int. Symposium On Applied Computing (2010).
13. **C. d'Amato**, N. Fanizzi, F. Esposito, T. Lukasiewicz. Inductive Query Answering and Concept Retrieval Exploiting Local Models. ISDA 2009, IEEE International Conference on Intelligent Systems Design and Applications, November, 30 - December, 2, 2009, Pisa, Italy.
14. **C. d'Amato**, N. Fanizzi, F. Esposito, T. Lukasiewicz. Approximate Classification of Semantically Annotated Web Resources Exploiting Pseudo-Metrics Induced by Local Models. WI 2009, IEEE International Conference on Web Intelligence. (2009)
15. N. Fanizzi, **C. d'Amato**, F. Esposito. [ReduceCE: A Reduced Coulomb Energy Network Method for Approximate Classification.](#) European Semantic Web Conference (2009).
16. N. Fanizzi, **C. d'Amato**, F. Esposito. [Fuzzy Clustering for Categorical Spaces: An Application to Semantic Knowledge Bases.](#) ISMIS 2009, International Symposium on Methodologies for Intelligent Systems, September, 14-17, 2009, Prague, Czech Republic.
17. N. Fanizzi, **C. d'Amato**, F. Esposito. [Statistical Learning for Inductive Query Answering on OWL Ontologies.](#) ISWC 2008, International Semantic Web Conference (2008).
18. **C. d'Amato**, N. Fanizzi, T. Lukasiewicz. [Tractable Reasoning with Bayesian Description Logics.](#) SUM 2008, International Conference on Scalable Uncertainty Management (2008).
19. **C. d'Amato**, S. Staab, N. Fanizzi. [On the Influence of Description Logics Ontologies on Conceptual Similarity.](#) EKAW 2008, International Conference on Knowledge Engineering and Knowledge Management Knowledge Patterns (2008).
20. N. Fanizzi, **C. d'Amato**, F. Esposito. [Learning with Kernels in Description Logics.](#) ILP 2008, International Conference on Inductive Logic Programming. (2008).
21. N. Fanizzi, **C. d'Amato**, F. Esposito. [DL-FOIL: Concept Learning in Description Logics.](#) ILP 2008, International Conference on Inductive Logic Programming. (2008).
22. **C. d'Amato**, N. Fanizzi, F. Esposito. [Non-parametric Statistical Learning Methods for Inductive Classifiers in Semantic Knowledge Bases.](#) ICSC 2008, IEEE International Conference on Semantic Computing, August 4-7, 2008, Santa Clara, CA, USA.
23. N. Fanizzi, **C. d'Amato**, F. Esposito. [Evolutionary Clustering in Description Logics: Controlling Concept Formation and Drift in Ontologies.](#) 19th International Conference on Database and Expert Systems Applications - DEXA'08, September 1-5, 2008, Turin, Italy

24. **C. d'Amato**, N. Fanizzi, F. Esposito. [Query Answering and Ontology Population: an Inductive Approach](#). ESWC 2008, European Semantic Web Conference (2008).
25. N. Fanizzi, **C. d'Amato**, F. Esposito. [Conceptual Clustering and its Application to Concept Drift and Novelty Detection](#). ESWC 2008, European Semantic Web Conference. (2008)
26. **C. d'Amato**, N. Fanizzi, F. Esposito. [Classification and Retrieval through Semantic Kernels](#). KES 2008, International Conference on Knowledge-Based and Intelligent Information & Engineering Systems - SWEA Track, 3-5 September 2008, Zagreb, Croatia.
27. **C. d'Amato**, N. Fanizzi, F. Esposito. [Distance-based Classification in OWL Ontologies](#). KES 2008, International Conference on Knowledge-Based and Intelligent Information & Engineering Systems - AKS Track, 3-5 September 2008, Zagreb, Croatia.
28. N. Fanizzi, **C. d'Amato**, F. Esposito. [A Multi-Relational Hierarchical Clustering Method for DATALOG Knowledge Bases](#). ISMIS 2008, International Symposium on Methodologies for Intelligent Systems, May 20-23, 2008, Toronto, Canada.
29. N. Fanizzi, **C. d'Amato**, F. Esposito. [Randomized Metric Induction and Evolutionary Conceptual Clustering for Semantic Knowledge Bases](#). ACM Sixteenth Conference on Information and Knowledge Management – CIKM'07. (2007).
30. N. Fanizzi, **C. d'Amato**, F. Esposito. [Evolutionary Conceptual Clustering of Semantically Annotated Resources](#). ICSC 2007, IEEE Int. Conference on Semantic Computing (2010)
31. N. Fanizzi, **C. d'Amato**. [Inductive Concept Retrieval and Query Answering with Semantic Knowledge Bases through Kernel Methods](#) KES 2007, the 11th International Conference on Knowledge-Based and Intelligent Information and Engineering Systems. (2007)
32. N. Fanizzi, **C. d'Amato**, F. Esposito. [A Hierarchical Clustering Method for Semantic Knowledge Bases](#) KES 2007, the 11th International Conference on Knowledge-Based and Intelligent Information and Engineering Systems. (2007)
33. **C. d'Amato**, N. Fanizzi, F. Esposito. [Induction of Optimal Semantic Semi-distances for Clausal Knowledge Bases](#) ILP 2007, Int. Conf. on Inductive Logic Programming (2007)
34. N. Fanizzi, **C. d'Amato**, F. Esposito. [Instance Based Retrieval by Analogy](#) SAC 2007 SDRC Track, 11-15 March 2007, Seoul, Korea
35. **C. d'Amato**, N. Fanizzi. Lazy Learning from Terminological Knowledge Bases. 16th International Symposium on Methodologies for Intelligent Systems. (2006)
36. N. Fanizzi, **C. d'Amato**. [A Declarative Kernel for ALC Concept Descriptions](#) 16th International Symposium on Methodologies for Intelligent Systems. (2006)
37. **C. d'Amato**, N. Fanizzi, F. Esposito. A Dissimilarity Measure for ALC Concept Descriptions. SAC 2006 RDRC Track, 23-23 April 2006, Dijon, France.
38. A. Appice **C. d'Amato**, F. Esposito, D. Malerba. Classification of Symbolic Objects: the K-Nearest Neighbour Method *Mathematical Methods for Learning*. (2004).

8.5 International Workshops

1. P. Minervini, **C. d'Amato**, F. Fanizzi. *Learning Terminological Naive Bayesian Classifiers under Different Assumptions on Missing Knowledge*. Proceedings of the International Workshop on Uncertainty Reasoning for the Semantic Web (URSW 2011) co-located at ISWC'11. Vol. 778. CEUR Workshop Proceeding series. CEUR. ISSN: 1613-0073
2. T. Scharrenbach, **C. d'Amato**, N. Fanizzi, R. Grütter, B. Waldvogel, A. Bernstein. Default Logics for Plausible Reasoning with Controversial Axioms. Proc. of the Int. Workshop on Uncertainty Reasoning for the Semantic Web, CEUR Workshop Proceedings. (2010)
3. T. Scharrenbach, **C. d'Amato**, N. Fanizzi, R. Grütter, B. Waldvogel, A. Bernstein. Unsupervised Conflict-Free Ontology Evolution Without Removing Axioms, Proceedings of the 4th International Workshop on Ontology Dynamics. CEUR Workshop Proc.. (2010)

4. N. Fanizzi, **C. d'Amato**, F. Esposito. Uncertainty Reasoning through Similarity in Context. 2nd Workshop on Automated Reasoning about Context and Ontology Evolution (2010).
5. N. Fanizzi, **C. d'Amato**, F. Esposito. Structural Similarity in Expressive Description Logics: An Extended Family of Kernels for OWL. Workshop on Inductive Reasoning and Machine Learning on the Semantic Web IRMLeS 2010, May 31, 2010, Heraklion, Crete (Greece).
6. **C. d'Amato**, N. Fanizzi, B. Fazzinga, G. Gottlob, T. Lukasiewicz. Combining Semantic Web Search with the Power of Inductive Reasoning Workshop on Uncertainty Reasoning for the Semantic Web URSW 2009, October 26, 2009, Washington D.C., USA.
7. N. Fanizzi, **C. d'Amato**, F. Esposito. Evidential Nearest-Neighbors Classification for Inductive ABox Reasoning. Ws. on Uncertainty Reasoning for the Semantic Web (2009).
8. **C. d'Amato**, N. Fanizzi, F. Esposito. A Note on the Evaluation of Inductive Concept Classification Procedures. Works. on Semantic Web Applications and Perspectives (2008)
9. N. Fanizzi, **C. d'Amato**, F. Esposito, T. Lukasiewicz. [Representing Uncertain Concepts in Rough Description Logics via Contextual Indiscernibility Relations](#) Workshop on Uncertainty Reasoning for the Semantic Web URSW 2008. (2008)
10. **C. d'Amato**, S. Staab, N. Fanizzi, F. Esposito. [Efficient Discovery of Services specified in Description Logics Languages.](#) Workshop on Service Matchmaking and Resource Retrieval in the Semantic Web at ISWC 2007, November 11, 2007, Busan, South Korea.
11. N. Fanizzi, **C. d'Amato**, F. Esposito. [Approximate Measures of Semantic Dissimilarity under Uncertainty.](#) Workshop on Uncertainty Reasoning for the Semantic Web (2007)
12. F. Esposito, N. Fanizzi, **C. d'Amato**. [Conceptual Clustering Applied to Ontologies by means of Semantic Discernability](#) Workshop on Prior Conceptual Knowledge in Machine Learning and Knowledge Discovery - PriCKL'07 at ECML/PKDD 2007. (2007)
13. N. Fanizzi, **C. d'Amato**, F. Esposito. [Clustering Individuals in Ontologies: a Distance-based Evolutionary Approach](#) The 3rd International Workshop on Mining Complex Data (2007).
14. **C. d'Amato**, N. Fanizzi, F. Esposito. [Analogical Reasoning in Description Logics](#) 2nd ISWC Workshop on Uncertainty Reasoning for the Semantic Web. (2006).
15. **C. d'Amato**, S. Staab. [Modelling, Matching and Ranking Services Based on Constraint Hardness](#) Advances in Semantics for Web services Workshop (at BPM). (2006)
16. **C. d'Amato**, N. Fanizzi, F. Esposito. [A Semantic Dissimilarity Measure for Concept Descriptions in Ontological Knowledge Bases.](#) The second International Workshop on Knowledge Discovery and Ontologies (at ECML/PKDD), 7 October 2005, Porto, Portugal.
17. **C. d'Amato**, N. Fanizzi, F. Esposito. A Dissimilarity Measure for Concept Descriptions in Expressive Ontology Languages Ontology Management: Searching, Selection, Ranking, and Segmentation (at KCAP), 2 October 2005, Banff, Canada.
18. A. Appice **C. d'Amato**, F. Esposito, D. Malerba. k-Nearest Neighbour Classification of Symbolic Objects. Symbolic and Spatial Data Analysis (at ECML/PKDD). (2004).

8.6 Posters

1. **C. d'Amato**, F. Esposito, N. Fanizzi, B. Fazzinga, G. Gottlob, T. Lukasiewicz. [Inductive Reasoning and Semantic Web Search.](#) SAC 2010 - SWA Track, 25th ACM International Symposium On Applied Computing, March, 22 - 26, 2010, Sierre, Switzerland.
2. N. Fanizzi, **C. d'Amato**, F. Esposito. [Induction of Optimal Semi-distances for Individuals based on Feature Sets](#) DL 2007, International Workshop on Description Logics (2007).
3. B. Taush, **C. d'Amato**, S. Staab, N. Fanizzi. [Efficient Service Matchmaking using Tree-Structured Clustering](#) 5th International Semantic Web Conference (ISWC), 2006.

8.7 National Conferences

1. **C. d'Amato**, N. Fanizzi, F. Esposito, M. Carulli, A. Assab, G. Bux. SEMANTIC-PA: Una Piattaforma per la Gestione Semantica dei Contenuti per la Pubblica Amministrazione. In atti del ILIX Congresso Annuale AICA su Ricerca ed impresa *AICA 2011*. (In press) (2011)
2. N. Fanizzi, **C. d'Amato**, F. Esposito. [A Hierarchical Clustering Procedure for Semantically Annotated Resources](#) 10th Congress of Italian Association for Artificial Intelligence (2007).
3. N. Fanizzi, **C. d'Amato**, F. Esposito. [Instance-based Query Answering with Semantic Knowledge Bases](#) 10th Congress of Italian Association for Artificial Intelligence (2007).
4. N. Fanizzi, **C. d'Amato**. [A Similarity Measure for the ALN Description Logic](#). CILC 2006, Convegno Italiano di Logica Computazionale 26-27 June 2006, Bari, Italy.
5. **C. d'Amato**, N. Fanizzi, F. Esposito. [A semantic similarity measure for expressive Description Logics](#). CILC 2005, Convegno Italiano di Logica Computazionale (2005).
6. N. Fanizzi, L. Iannone, **C. d'Amato**, I. Palmisano, G. Semeraro. Apprendimento di Ontologie nel Web Semantico. AICA 2004, XLII Congresso Annuale (2004).
7. **C. d'Amato**, D. Malerba, F. Esposito, M. Monopoli (2003). [Extending the K-Nearest Neighbour classification algorithm to symbolic objects](#). Convegno Scientifico Intermedio SIS, 9-11 Giugno 2003, Università degli Studi di Napoli "Federico II".

8.8 National Workshops

1. N. Fanizzi, **C. d'Amato**, F. Esposito. [Semantic Nearest Neighbor Search in OWL Ontologies](#). SWAP'07, Italian Workshop on Semantic Web Applications and Perspectives.
2. **C. d'Amato** Constraint hardness for modelling, matching and ranking Semantic Web services SEBD 2007, the 15th Italian Symposium on Advanced Database Systems (2007).
3. N. Fanizzi, **C. d'Amato**, F. Esposito. Approximate query answering and ranking for semantic knowledge bases. Italian Symposium on Advanced Database Systems (2007).
4. **C. d'Amato**, N. Fanizzi, F. Esposito. [Reasoning by Analogy in Description Logics through Instance-based Learning](#) SWAP 2006, the 3rd Italian Semantic Web Workshop (2006).
5. **C. d'Amato**, N. Fanizzi, F. Esposito. [A Dissimilarity Measure for the ALC Description Logic](#). Italian Workshop on Semantic Web Applications and Perspectives (2005).

9 Supervision and Organization of Research Activities

- **Organizer and Supervisor** of the research activity of Dr. Thomas Scharrenbach – University of Zurich, invited researcher at the University of Bari – Computer Science Dept. on March 2010
- **Co-Supervisor** of the research activity of Dr. Agnieszka Lawrinowicz – Poznan Universtiy, invited researcher at the University of Bari – Computer Science Dept. on November 2009
- **Co-Project Manager** of the Regional Project Semantic-PA
- **Responsible for** most of the workpackages involving the UR-Intelligence for DIPIS Project
- **Co-Supervisor of PhD thesis**
- **Co-Supervisor of Bachelor, Master thesis**

10 Teaching and Tutoring

- **Teacher of** the Informatics course of the Chemical Degree a.a. 2009/2010
- **Expert on the subject for** the courses:
 - Artificial Intelligence Laurea Degree in Informatics **a.a. 2010/2011** (Ontologies and OWL, Description Logics, Reasoning Services in DLs, RDF and SPARQL)
 - Knowledge Engineering and Expert Systems, Master Degree in Informatics **a.a. 2010/2011** (practical exercises for the realization of expert systems in clips language).
 - Artificial Intelligence Laurea Degree in Informatics **a.a. 2009/2010** (Ontologies and OWL, Description Logics, Reasoning Services in DLs)
 - Knowledge Engineering and Expert Systems, Master Degree in Informatics **a.a. 2009/2010** (practical exercises for the realization of expert systems in clips language).
 - Artificial Intelligence Laurea Degree in Informatics **a.a. 2008/2009** (Ontologies and OWL, Description Logics, Reasoning Services in DLs)
 - Programming Languages, bachelor degree in Informatics and technologies for software production **a.a. 2008/2009** (practical exercises with JavaCC)
 - Knowledge Engineering and Expert Systems, Laurea Degree in Informatics **a.a. 2008/2009** (practical exercises for the realization of expert systems in clips language).
- Tutoring for the courses:
 - Algorithms and Structured Data (laboratory), Master Degree in Informatics **Academic year 2004/2005**
 - Knowledge Engineering and Expert Systems course (laboratory), Master Degree in Informatics **Academic year 2000/2001 – 2001/2002 – 2002/2003 – 2003/2004 – 2004/2005**
 - Network Programming course (laboratory), Master Degree in Informatics. **Academic year 2003/2004**
- **Seminars:**
 - “Uncertainty in knowledge representation” for the Knowledge Engineering and Expert Systems course, Master Degree in Informatics **a.a. 2007/2008**
 - “Classification and instance-based learning methods” for the Machine Learning course of the Master degree in Computer Science. **a.a. 2004/2005**
 - “UML 1.4: contents and application” - Omar S.p.A - Allaxia Group. **September 2004**
 - “UML 1.4: contents and application” - Planetek Italy S.r.l. **July 2004**
- **Academic year 2001/2002 - 2002/2003** - Collaboration with the Department of Computer Science of the University of Bari: tutoring for the laboratory of the course of "Knowledge Engineering and Expert Systems" of the degree in Computer Science.
- **Year 2000** - Collaboration with C.I.L.A. (Interdepartmental Center of Logic and Application) and University of Bari: tutoring for lesson concerning Expert Systems in the sphere of INNOVAMEDIA project.

11 Research Activity

Claudia d'Amato's research activity concerns with the study, the analysis and the application of Machine Learning methods (with particular attention to the inductive learning methods) to the Semantic Web (SW) domain. The ultimate goal is to (semi-)automatize the ontology mining tasks that are most of the time manually performed thus resulting to be very time consuming besides of constituting the main bottleneck to the full realization of the SW.

Claudia d'Amato started her research activity on January 2004 when she obtained a grant from the University of Bari for being a PhD student in Computer Science for three years. She ended her PhD on January 2007 and defended her PhD thesis titled “Similarity-based Learning Methods for the Semantic Web” on May 2007 obtaining a full mark evaluation.

From April 2004 Claudia d'Amato is a research assistant at the University of Bari - Computer Science Department. She also collaborated/collaborates with professors and researchers having international creditability. **On January-June 2006, February-May 2007, February-April 2008**, Claudia d'Amato was **visiting researcher** at the University of Koblenz-Landau – Institute WeSt – “Web Science and Technologies” working with **Prof. Steffen Staab** (director of the institute) and maintaining a still active collaboration. **On June 2011**, Claudia d'Amato was **invited researcher** at the University of Poznan (Poland) - Laboratory of Operational Research and Artificial Intelligence, Institute of Computing Science working with **Dr. Agnieszka Lawrinowicz**. Claudia d'Amato is **also invited researcher** (invitation received from **Prof. Thomas Lukasiewicz**) at the University of Oxford – Computer Science Department.

The research activity developed by Claudia d'Amato is articulated along the following three fundamental research lines and finds its application to the Semantic Web field.

1. definition of similarity and dissimilarity measures for Description Logics representation and formalization of their theoretical foundation
2. analysis and formalization of inductive learning methods for Description Logics representation
3. analysis and formalization of methods for managing uncertain knowledge representation and uncertainty reasoning for Description Logics representation

The Semantic Web (SW) is the new vision of the Web proposed by T. Berners Lee [1] whose main goal is to make the Web contents machine readable and processable besides of human readable. To obtain this goal resources are enriched with metadata namely semantic annotations referring to shared ontologies.

An ontology is a “*formal specification of a shared conceptualization*” [2]. It acts as a shared vocabulary where formal definitions are given. The standard representation language is OWL [3] which has Description Logics (DLs) [4] as theoretical foundation.

DLs are a fragment of the First Order Logic. They are characterized by a well defined set-theoretic semantics and a series of reasoning operators. Description Logics are also characterized by the adoption of the Open World Assumption (OWA) which means that the lack of knowledge of a fact does not immediately imply knowledge of the negation of the fact. On the contrary this happens with the Closed World Assumption (CWA) that is generally made in contexts such as Data Bases or Machine Learning.

Given the main peculiarities of the representation of reference and the application domain, the research activity of Claudia d'Amato is briefly illustrated in the following.

11.1 Definition and theoretical foundation of similarity measures for Description Logics representation

The notion of similarity has been active, prominent and seminal in the areas of cognitive psychology [8,21], knowledge acquisition [22], data management and information organization [23,24] for a long time. In the last years, the importance of the notion of similarity has been highlighted also in the SW context. Indeed, most of the ontology related operations such as ontology learning, alignment, ranking, population etc. are grounded on an idea of similarity. However, the definition of similarity or dissimilarity measures¹ in the SW context is a topic that has not been deeply investigated [12]. One of the main problems is the necessity to cope with the high expressive power of DLs and the ability to deal with the semantics of the compared objects (concepts, individuals, ontologies) that is a missing aspect in the existing works.

11.1.1 State of the art

Similarity measures can be classified along with two different dimensions. One is related to the kind of knowledge representation to which they are applied. The other is related to the way in which similarity is computed. Along the dimension of the representation, it is possible to distinguish: measures applied to feature vectors, strings, sets, trees, clauses (see [5] for a complete overview). Along the dimension of the computational model, it is possible to distinguish: measures based on geometric models, measures based on feature matching, measures based on semantic relations, measures based on Information Content, measures based on alignment and transformational models, and measures based on contextual information (following [6,7]).

Here, a brief overview is given. The first distinction is between measures applied to propositional setting and measures applied to relational setting (representation dimension). Hence, for each setting, several computational models for assessing the similarity are analyzed. For each model, the most prominent measures in the literature will be considered.

The best known measures for propositional representation are based on the geometric and the feature-matching models. In the geometric model objects are seen as point in an n-dimensional space. The similarity between a pair of objects is considered to be inversely related to the distance between the two objects points in the space. The best known measures are the Minkowski, Manhattan and Euclidean measures. They are applied to vector representations where features are all continuous. They cannot be applied to vectors with categorical features or vectors with mixed type features (categorical and continuous). In this case measures based on Feature Matching Model are considered. These measures are grounded on counting the common and distinguishing features that characterize the considered objects. The best known measure implementing this model is the Tversky measure [8]. The measures grounded on these two models are not able to capture (expressive) relationships among the data that typically characterize most complex representations. For this reason, similarity measures for relational settings have been defined. In this context, path distance measures and measures based on the notion of Information Content are mainly considered. The best known measure belonging to the first category is the measure proposed by Rada et al. [9]. The objects are represented by means of semantic networks [10] involving concepts and is-a edges. The conceptual distance between two objects (nodes in the network) is the length of the shortest path between their representative nodes in the network. This path length is measured as the sum of the lengths of the paths from each node to their most specific is-a ancestor. This approach is highly sensitive to the predefined hierarchical network and moreover only the is-a relationship can be considered. The measures based on the notion of Information Content (IC) have been introduced. They use an approach that is similar to the path distance approach but the adoption of the notion of IC rather than that of path length avoids the dependency on the predefined structure. However, also

¹ Since a dissimilarity measure could be obtained from a similarity measure [13] only the notion of similarity measure will be considered in the following

in this second approach, the is-a relationship is mainly considered. The most well known measure implementing the approach grounded on IC has been proposed by Resnik [11].

Moving from these works, Borgida et al. [12] proposed a modified version of some of the measures presented² above to allow their applicability to DL concept descriptions. However, a DL allowing for only concept conjunction is considered and as such characterized by a very low expressiveness. Some examples of modifications are: the features to compare are the component of each conjunctive concept expression; the most specific is-a ancestor is mapped to the notion of least common subsumer. Borgida et al. [12] also highlighted a set of open issues that need to be solved for computing concept similarity in expressive DLs while the ability of comparing individuals of a DL knowledge base (KB) has not been taken into account³.

11.1.2 Obtained results

The research activity of Claudia d'Amato has addressed the problems of: a) assessing the similarity between concept descriptions in expressive DLs; b) assessing the similarity between individuals of a DL knowledge base; c) solving the open issues presented by Borgida et al. [12].

In [14], a language independent similarity measure for comparing concept description expressed in any DLs was proposed. An extensional based approach was adopted. Two concepts are highly similar if their concept extensions (the set of individuals that are instance of the considered concepts) largely overlap. The concepts are dissimilar if their extensions are disjoint or weakly overlap. In principle, this measure could be also used for comparing individuals by preliminarily computing the Most Specific Concepts⁴ (MSC) of the individuals to be compared. However in [15], d'Amato et al. proved that the measure was not always able to assess the similarity of individuals that were known to be similar in the considered domain. This was because the MSCs are so specific that most of the time they cover only the considered individuals and do not include any other individuals in their extensions. To cope with this problem, an alternative similarity measure was defined [15,16]. Grounded on the idea that concepts that are defined by almost the same subconcepts are probably similar, the measure assessed the similarity between concept descriptions (MSCs are indeed concept descriptions) by recursively comparing the similarity of the subconcepts. This measure was defined for ALC normal form⁵ concept descriptions and it was based both on the concept structures (since subconcepts are considered) and on the concept semantics (since subconcepts are compared by comparing their extensions). A version of this measure grounded on the notion of Information Content was proposed [17]. Even if these measures were able to assess the similarity between concepts and individuals, they were defined for a particular DL (ALC logic) and were not language independent.

In [18], a language independent similarity measure for assessing the similarity between individuals was proposed. It was grounded on the intuition that, on a semantic level, similar individuals should behave similarly with respect to the same concepts. Individuals were compared on the grounds of their behavior (being instance of) with respect to a given set of hypotheses, that is a collection of concept descriptions acting as discriminating features expressed in DL language. As such, this measure totally depends on the semantic aspects of the individuals in the KB.

In [20], d'Amato et al. put the influence of the ontological knowledge in assessing the semantic similarities between entities (concepts, individuals) on a solid foundation with objective criteria. The intended behavior of a semantic similarity measure when it is applied to ontological knowledge was discussed, hence a set of criteria that a similarity measure has to satisfy in order to be defined "semantic" were formalized.

2 Specifically, the feature matching model, the path distance model and the IC based model have been considered.

3 Indeed, tasks such as clustering and ranking may preferably focus on the actual resources rather than their conceptual descriptions.

4 The most specific concept of a given individual is the concept most specific with respect to the subsumption relationship of which the individual is instance of.

5 A formulation of this measure for the ALN Description Logic has been also proposed [19].

11.2 Inductive learning methods for Description Logics representation

Most of the research in the SW focuses on deductive-based reasoning methods with the goal of making explicit the knowledge that is implicitly contained in an ontology. The standard and non-standard inference procedures of DLs [4] are the main examples in this direction.

However, important tasks that are likely to be provided by new generation knowledge-based systems, such as classification, ontology construction, ontology revision, ontology population, ontology evolution can be supported also by inductive methods. Moreover, any kind of deductive reasoning can be performed in presence of inconsistent KBs that is a likely case in a distributed context such as the SW.

The main benefit of inductive learning for the SW were presented by d'Amato et al. in [43].

11.2.1 State of the art

To support tasks such as ontology classification, construction, revision etc. and to overcome the inherent complexity of the classic logic-based inference, other forms of reasoning are being investigated, both deductive, such as non-monotonic, paraconsistent [25], approximate [26], case-based reasoning [27] and inductive-analogical forms such as inductive generalization [28] and specialization [29,30].

In general, inductive reasoning and knowledge discovery have received less attention in the SW context [31,32], although inductive reasoning may assist tasks such as clustering (that can be used for managing ontology evolution, for improving the efficiency of the resource discovery process), classification (that can be used to enforce concept retrieval, ontology population, ranking of resources), mapping and alignment of knowledge bases. Moreover, in the perspective of knowledge/functionality sharing and reuse of the SW, new inference services are required, aiming at noise-tolerant and efficient forms of reasoning. These are very interesting characteristics, considered that noise is always harmful in contexts where knowledge is to be acquired from distributed sources. Specifically, two kinds of noise may be identified. The first one may be introduced by inconsistency in the KB. A second kind of noise is due to incorrect knowledge that does not strictly cause inconsistency, nevertheless it may yield incomplete/inconsistent conclusions with respect to the intended meaning of the concepts in the considered domain. From this perspective, clustering methods and instance-based classification methods applied to multi-relational domains appear particularly well suited. Indeed, with special reference to similarity-based methods, they are known to be both very efficient and noise-tolerant [22].

Existing similarity-based methods have been applied to propositional representations [22]. The upgrade of these methods to more complex/multi-relational representations has been defined for symbolic objects[33], clausal/first order logic representation [35,37], relational databases [34,36]. The common factor of these representations is the adoption of the CWA.

The application of similarity-based methods to ontological representation is not straightforward at all. It requires: a) new similarity measures that are able to cope with the high expressive power of DL representations; b) to cope with the OWA adopted by DL representations; c) to take into account, when the considered instances are individuals of the KB, that an individual could be instance of more than one concept at the same time. Furthermore, as regards particularly the clustering methods, many existing algorithms are based on the application of similarity (or density) measures defined over a fixed set of attributes of the domain objects. Classes of objects are taken as collections that exhibit low interclass similarity (density) and high intraclass similarity (density). Clustering methods have aimed at defining groups of objects through conjunctive descriptions based on selected attributes [63]. Often these methods cannot take into account any form of prior knowledge at a conceptual level encoding some semantic relationships. This hinders the interpretation of the outcomes of these methods which is crucial in the SW perspective in which

the expressiveness of the language adopted for describing objects and clusters is extremely important. Specific logic-based approaches, intended for terminological representations [4], have been proposed as language-dependent methods [64, 65]. These methods have been criticized for suffering from noise in the data. This motivates the investigation of Claudia d'Amato also on similarity-based clustering approaches which can be more noise-tolerant, and as language-independent as possible.

In the following the formalization of inductive similarity-based learning methods for DLs representation is briefly illustrated. The ultimate goal of such an investigation is the realization of methods that are able to induce new knowledge that is not logically derivable, making possible to reason on ontologies even in presence of inconsistent and/or noisy knowledge bases. Specifically, Claudia d'Amato has focused on the classification and clustering tasks, besides of inductive learning methods for concept learning with the goal of enriching existing ontologies.

11.2.2 Obtained Results: Classification

In [38,39,40,41,42], the k-Nearest Neighbor (k-NN) [22] algorithm upgraded to DL representation was presented. The learning problem was: given a DL knowledge base, classify all the individuals of the KB a) with respect to the concepts (primitive and defined) declared in the KB [38,39] (with final goal of performing inductive concept retrieval); b) with respect to query concepts generated on the fly starting from the concepts declared in the ontological KB (with the final goal of performing inductive query answering) [40,41].

The k-NN [22] is a lazy learning classification algorithm that classify an instance on the ground of the class that is voted by the (withed) majority of the k training examples that resulted to be most similar to the test example to classify. Generally this algorithm adopts an underlying CWA and a binary classification setting. If a multi-class classification problem is considered, the classes are assumed to be disjoint. These assumptions are not still valid in the considered ontological representation where the OWA is adopted, an individual could be instance of more than one concept (multi-class classification) at the same time and as such classes cannot be assumed to be disjoint. These issues were solved by decomposing the multi-class classification problem into a set of ternary classification problems (one classification for each concept) where the case of unknown information due to the OWA is explicitly treated.

Additionally, the adoption of the OWA does not allow to use the classical metrics (such as predictive accuracy, precision and recall) for the evaluation of the classification results. This is because the new induced knowledge (not logically derivable) was signed as mistakes while this constitutes completely new knowledge extracted from the evidence of data. Hence alternative metrics were also defined [41,42,56].

The realized algorithm was tested with all the similarity measures presented in the previous section with the goal of provide also experimental validity of the proposed measures. Particularly, in [48], the experimental proof of the validity of inductive analogical reasoning (by the use of the upgraded k-NN algorithm) in presence of inconsistent/noisy knowledge bases was presented.

In [44,45] an extension of the realized k-NN algorithm was presented by embedding intentional descriptions of the local models built from the selected k nearest training examples. The underlying idea was to enforce the similarity-based classification with intentional descriptions coming from the available KB.

In [46] a classification method grounded on the Reduced Coulomb Energy (RCE) network [47] approach is presented. The essentials of this learning scheme have been extended to be applied to the standard representations of the SW via semantic similarity measures for individual resources. As with the other similarity-based methods, a retrieval procedure may seek for individuals belonging to query concepts, exploiting the analogy with other training instances, namely the classification of the nearest ones (with respect to the measure of choice). Differently from other lazy-learning approaches such as the k-NN algorithm which does not require a real training, this alternative method is organized in two phases: in the training phase, an RCE network based on

prototypical individuals (parameterized for each prototype) is trained to detect the membership of further individuals with respect to some query concept. The network is then exploited by the classifier, during the classification phase, to make a decision on the class-membership of an individual with respect to the query concept on the grounds of a likelihood estimate.

The exploitation of a classification problem has been further studied in order to predict not only class membership assertions (namely if an individual is instance of a concept) but also for predicting object properties and data-type properties assertions [49]. In this case the Dempster-Shafer evidence theory customized for DL representations has been adopted.

The exploitation of kernel methods [50,51], and specifically Support Vector Machine (SVM) [52] for performing class membership classification was also considered. The reasons of this choice are many. First of all kernel methods, and particularly SVMs, are well known efficient inductive learning methods. They can be developed in a modular way. Two components of the kernel methods have to be distinguished: the kernel machine and the kernel function. The kernel machine encapsulates the learning task and the way in which a solution is looked for, the kernel function encapsulates the hypothesis language, i.e., how the set of possible solutions is made up. Different kernel functions implement different hypothesis spaces or even different knowledge representations. Kernel functions can be informally defined as similarity functions that are able to work with high dimensional feature spaces. From a computational point of view, the attractiveness of kernel methods comes from the fact that they map, by means of the kernel function, the original feature space of the considered data set into a high dimensional feature space where the execution of the learning task is easier. This is done without suffering the high cost of explicitly computing the mapped data. The kernel trick is to define a *positive definite kernel* on any feature set. For such functions it is known that there exists an embedding of the feature set in a linear space such that the kernel on the elements of the set corresponds to the inner product in this space. Particularly, SVMs are classifiers that, by the use of a mapping function, map the training data into a higher dimensional feature space where they can be classified using a linear classifier. This is done by constructing a separating hyperplane with the maximum margin in such new feature space, which yields a nonlinear decision boundary in input space. By the use of a kernel function, it is possible to compute the separating hyperplane without explicitly carrying out the map into the feature space.

Moving from this consideration, and exploiting the theoretical result on convolution kernel for composite objects proposed by Haussler [53], different kernel functions for DLs having different expressiveness have been defined [54,55,57,58] and plugged in a SVM for performing inductive concept retrieval and query answering [42,58].

The experience matured in the similarity-based classification and kernel methods was exploited for focusing on the problem of resource ranking. In [59], a method for ranking retrieved resources on the ground of the similarity of their semantic descriptions (expressed also distinguishing between hard and soft constraints, namely mandatory and optional necessities) with respect to the formulated request is proposed. In [60], the results of a the classification process by the use of the upgraded k-NN algorithm were further ranked on the ground of the strength of the exploited voting process. In [61, 62] a ranking method based on kernel perceptron was proposed while in [83] some of the developed classification methods were exploited for assessing the nature of uncertain mapping in the ontology matching process.

11.2.3 Obtained Results: Clustering

The benefits of clustering in the context of semantically annotated knowledge bases are manifold. Clustering enables the definition of new emerging categories (concept formation) on the grounds of the concepts asserted in a knowledge base; supervised methods can exploit these clusters to induce new concept definitions or to refining existing ones (ontology evolution); intensionally defined groupings may speedup the task of discovery and search in general.

Claudia d'Amato focused on the multi-relational extensions of effective clustering techniques intended for grouping similar resources with respect to a semantic similarity measure

which is tailored for the DL representations. Several clustering algorithms were studied and applied for the purpose.

In [66] a method for clustering semantically annotated resources was presented. Specifically, a hierarchical agglomerative conceptual clustering method exploiting the complete-link approach was proposed and intensional cluster descriptions were generated by computing the Good Common Subsumer [68] of the semantic descriptions of the grouped resources in a cluster. The ultimate goal was to improve the efficiency of the resource retrieval task. This was obtained by clustering the semantic descriptions of the available resources and by exploiting the hierarchical structure that comes as output of the clustering process as an index for making faster the retrieval process (similarly to what is generally done in the database context with indexing methods such as B-Tree, B+-Tree etc.). In [67], it is proved as an approach similar to the one presented in [66] can be exploited for decreasing the complexity of the deductive concept retrieval procedure by recurring, as much as possible, to the computation of the subsumption relationship and minimizing the number of instance checking (which has a higher computational complexity with respect to subsumption for expressive DLs) [4] that are necessary for assessing the concept extension.

An alternative hierarchical partitional clustering algorithm was proposed in [68,69]. Particularly, an extension of the effective *Bisecting k-means* algorithm [70] to the multi-relational SW setting is proposed. It is intended for grouping similar resources with respect to a semantic similarity measure which allows for discovering new concepts. The clustering procedure works topdown, starting with one universal cluster grouping all instances. Then it iteratively finds two clusters bisecting an existing one up to the desired number of clusters is reached, producing a dendrogram. Each cluster is represented by the *center* of the cluster. As for the original method, a fixed number k of clusters could be defined. Yet this may be hard when scarce knowledge about the domain is available. As an alternative, here it was proposed to adopt a partitional method up to reaching a minimal threshold value for cluster quality [70] which makes any further bisection useless. Moreover, instead of the notion of means for representing the cluster center (characterizing the *k-means* algorithm) that is defined for numeric (or just ordinal) features, in [68,69] the notion of medoid⁶ [71] as central individual in a cluster is adopted.

Additionally, to cope with the problem of assessing the required number of clusters, clustering methods for the SW setting grounded on the genetic algorithms [72] and stochastic search [73] were also proposed. These approaches automatically converge towards the optimal number of clusters without predefining it and also without using any threshold.

All the clustering methods presented above return clusters (groups of resources) that are assumed to be mutually disjoint. However, as highlighted above, in ontological representation and individual could be instance of more than one concept at the same time, namely a resource could be instance/member of more than a group. In order to take into account this aspect a fuzzy clustering method for DL representation was proposed [74].

In [75] the application of clustering methods for detecting concept drift and new emerging concepts in an ontology was studied. Indeed an ontology is not a static entity, it may evolve over the time because new concepts are added or because new instances are added. In [75] this latter phenomenon is analyzed. Specifically, the insertion of new individuals and assertions could provoke the drift of an existing concept in an ontology towards a more general or a more specific concept (with respect to its original definition) or may introduce a completely new concept that is only extensionally asserted and no intensional definition for it is given. By clustering the available instances this phenomenon could be discovered.

6 The medoid is the element of the cluster having the highest average similarity with respect to all the others individuals in the cluster

11.2.4 Obtained results: Concepts Learning

Conceptual clustering algorithms could be fruitfully exploited for the concept learning task, with the ultimate goal of enriching/refining existing ontologies. In [75], intentional cluster descriptions of discovered new groups that are candidate new concepts were learnt and the new descriptions were added to the existing ontology, thus semi-automatizing the ontology refinement task. The intensional descriptions were learnt by computing the *least common subsumer* of the *most specific concepts* describing the resources (individuals) in a given cluster. For expressive DLs, the adoption of suitable refinement operators [30,64] for learning cluster descriptions was suggested.

Further approaches were investigated with the final goal of semi-automatizing the ontology learning and refinement⁷ task. In [77] the problem of learning concept descriptions expressed in DLs was focused. A FOIL-like algorithm [80] was presented to be applied to general DL languages. The theoretical aspects of learning with the inherent incompleteness underlying the OWA characterizing the semantics of DL was also studied. The focused learning problem was: given an ontological knowledge base of reference, a concept name (target concept) and a set of positive and negative examples for the target concept (namely the individuals that are respectively known to be instance of the target concept and individuals that are known to be instance of the negated target concept) the goal is to learn a concept description such that all positive examples are also instance of the learnt concept description and all negative examples are not instance of the learnt concept description. In [78,79], the problem of learning a concept description for a given target concept and a set of positive and negative examples was solved by setting up a method for learning decision trees [22] customized for DL representation, again with particular attention to the issue of learning with the inherent incompleteness underlying the OWA. The advantage of this second approach was that the DL-Tree obtained as an output of the learning process could be also exploited for a further classification task, namely for inductively classifying the individuals that are instance of the learnt concept or the target concept.

A different problem was analyzed in [81,82]. The semantic aggregation of the query answering results was studied. Indeed, query answering on a wide and heterogeneous environment such as the Web can return a large number of results that can be hardly manageable by users/agents. The adoption of grouping criteria of the results could be of great help. Most of the proposed methods for aggregating results on the (Semantic) Web are mainly grounded on syntactic approaches and they cannot be of significant help when the values instantiating a grouping criterion are all equal (thus creating a unique group) or when the values instantiating a grouping criterion are almost all different (thus creating one group for each answer). In [81,82] d'Amato et al. proposed a novel approach that is able to overcome such drawbacks. Given a query in the form of a conjunctive query, grouping is grounded on the exploitation of the semantics of background ontologies during the aggregation of the query results. Specifically, a solution where, in a deductive modality, answers are grouped taking into account the subsumption hierarchy of the underlying knowledge base was proposed. Furthermore, the inspection and navigation of the results similarly to a faceted search was also introduced.

⁷ Usually with “Ontology Learning” it is intended the task of automatically building (a sketch of) an ontology having documents as source of information [76]. In this context, for ontology learning it is meant the automatic construction of (a sketch of) an ontology having semantic annotated resources as input data.

11.3 Uncertain knowledge and uncertainty reasoning in Description Logics representation

Another important problem that is emerged in the last few years is concerning how to manage the inherent uncertainty of the Web. The importance of the problem has been particularly highlighted by the formation of a W3C incubator group⁸. Here, with the term "uncertainty", a variety of aspects are meant such as incompleteness, vagueness, ambiguity.

11.3.1 State of the Art

To face the problem of managing uncertainty in the (Semantic) Web, several proposals have been formulated. They mainly concern with: how to represent uncertain knowledge [90, 85,89] and how to reason in presence of uncertain knowledge [91,92].

As regards the first issue, proposals are basically towards representing uncertainty by extending standard SW representation languages with probability or fuzzy logic. Paulo Da Costa et al. [84] formalized PR-OWL, a probabilistic extension of OWL that allows legacy ontologies to interoperate with new probabilistic ontologies. Lukasiewicz [85] formalized an extension of the SHIQ e SHOIN DLs so that probabilistic knowledge can be expressed (for instance if an inclusion axiom occurs). Straccia [86] proposed an extensions of the more expressive DLs by including a fuzzy semantics. Schloback et al. [89] proposed Rough-DLs that is an extension of the DL semantics by exploiting rough set theory for represent vague and uncertain knowledge.

All these approaches generally assume that probabilistic and/or fuzzy information is usually available. However, this resulted to be a quite strong assumption with respect to the reality. Only very recently some effort in learning probabilistic ontologies have been done [96,97,98]. Nevertheless, these works do not take into account the underlying OWA characterizing the DL representation, rather an implicit CWA is adopted.

As regards reasoning in presence of uncertain knowledge, different reasoner that are able to support some of the frameworks for representing uncertain knowledge mentioned have been realized [87,88]. Their main drawback is its inability to scale on large set of data.

11.3.2 Obtained Results

Uncertain knowledge representation and uncertainty reasoning for the SW is the topic to which Claudia d'Amato started to focus on in the last years. In this context she contributed with the formalization of a new framework for representing uncertain knowledge by the integrating Bayesian Networks [22] with DL representation [93]. Specifically, a probabilistic generalization of the *DL-Lite*⁹ description logic [94] integrating Bayesian networks was presented. The new probabilistic description logics allow for flexibly combining terminological and assertional pieces of probabilistic knowledge. This work shows that the new probabilistic description logics are rich enough to properly extend both the *DL-Lite* description logics as well as Bayesian networks. Furthermore the complexity of the main reasoning operators such as satisfiability checking and query processing was also analyzed.

Claudia d'Amato also investigated the Rough-DLs framework for representing uncertain knowledge and enriched this framework by defining two contextual discernibility relations [95]. Indeed in the Rough-DL framework the discernibility relations are mentioned but any practical and/or formal definition is given for them.

Claudia d'Amato also investigated how to build probabilistic knowledge bases automatically. Inductive learning methods could be fruitfully exploited for for the purpose, for instance by learning the probability that: an inclusion axiom, a relationship between two individuals, a concept assertion hold. Indeed, since the conclusions drawn from inductive reasoning are typically uncertain, this can

⁸ <http://www.w3.org/2005/Incubator/urw3/>

⁹ *DL-Lite* is a family of tractable description logics lying between the semantic web languages RDFS and OWL Lite.

be explicitly treated, that is the probability of an inductive result (for instance an individual belonging to a certain concept) could be computed. The explicit treatment of the uncertain results gives several advantages: 1) users or applications can have a measure of the reliability of the inductive results; 2) computed probabilities can be exploited for ranking the answers of a query; 3) a new way of formulating queries which include the chance of requiring likely information/event can be considered [31]; 4) probabilistic ontologies can be automatically built.

In [48,41] a way for assessing the probability that a certain concept membership assertion hold was presented, thus setting up a possible way for building (assertional) probabilistic knowledge bases by simply exploiting available data. In [99], a Statistical Relational Learning method designed for learning terminological naive Bayesian classifiers was defined. This method estimates the probability that a generic individual belongs to a given target concept given its membership to a set of DL concepts. The novelty of this approach is given by the explicit treatment of the lack of knowledge (due to the OWA) that is consistently handle during the learning process by considering different models about the varying nature of the missing knowledge itself.

11.4 References

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