

# NeSy 2007

## 3<sup>rd</sup> International Workshop on Neural-Symbolic Learning and Reasoning

In collaboration with the  
20<sup>th</sup> International Joint Conference on Artificial Intelligence  
IJCAI-07

<http://www.neural-symbolic.org/NeSy07/>

<http://www.ijcai-07.org/>

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# Organising Committee

**Artur Garcez** is a Senior Lecturer at the Department of Computing at City University, London. He has over 50 publications on Machine Learning and the integration of Logics and Neural Networks. His research has evolved from the theoretical foundations of Neural-Symbolic systems to their application in Bioinformatics and Software Engineering. Dr. Garcez is an author of the book Neural-Symbolic Learning Systems: Foundations and Applications, published by Springer-Verlag in 2002, and of the forthcoming book Connectionist Non-Classical Logics, to be published in 2007. He is an area scientific editor (Logics and Neural Networks) of the Journal of Applied Logic, an editor of the Journal of Logic and Computation (reasoning and learning), an associate editor of the International Journal on Artificial Intelligence Tools, an editor of the International Journal on Hybrid Intelligent Systems, and a member of the advisory board of the Cognitive Technologies book series, Springer-Verlag. He has recently organized the First International Workshop on Neural-Symbolic Learning and Reasoning, NeSy'05, at IJCAI-05, and the Second International Workshop on Neural-Symbolic Learning and Reasoning, NeSy'06 at ECAI-06, as well as the special track on Integrated Intelligent Systems at the AAAI International FLAIRS conference, 2005. He has also been successfully organizing and chairing the WITSE workshop series on the application of Artificial Intelligence technologies to Software Engineering, and is a member of the organising committee of the International Joint Conference on Neural Networks IJCNN 2007 – the premier event on neural networks – which will be held in Orlando, USA, August 2007. He has served and serves on the committees of a number of international conferences and workshops, and has acted as a reviewer for a number of international journals on Logic and Artificial Intelligence. He is a member of the British Computer Society, a member of the City and Guilds College Association, and Visiting Research Fellow at the Department of Computer Science, King's College London. He holds an M.Eng. in Computing Engineering, an M.Sc. in Computing and Systems Engineering, and a Ph.D. (D.I.C.) in Computing. For more information, please see <http://www.soi.city.ac.uk/~aag>

**Pascal Hitzler** is assistant professor at the Institute for Applied Informatics and Formal Description Methods at the University of Karlsruhe in Germany. His research record lists over 100 publications in such diverse areas as neural-symbolic integration, knowledge representation and reasoning, lattice and domain theory, denotational semantics, and set-theoretic topology. He was Programme Co-Chair at the 14<sup>th</sup> International Conference on Conceptual Structures, ICCS06, in Aalborg, Denmark, and is also a member of the steering committee of this conference series. He has recently organized the First International Workshop on Neural-Symbolic Learning and Reasoning, NeSy'05 at IJCAI-05, the Second International Workshop on Neural-Symbolic Learning and Reasoning, NeSy'06 at IJCAI-06, the Workshop Reasoning on the Web at WWW2006, the Workshop OWL – Experiences and Directions, OWLED2006 which is collocated with ISWC06, and the Workshop on Applications of Semantic Technologies at Informatik 2007. At ESSLLI'2005, he gave a tutorial on *Integrating logic programs and connectionist systems*. At the Interdisciplinary College Summer School, IK2006 in Günne, Germany, he gave a course on *Neural-Symbolic Learning and Reasoning*. He is co-editor of a book on *Perspectives of Neural-Symbolic Integration* which is to appear in the Springer series on Computational intelligence. He serves on programme committees of international conferences including IJCNN-07, WWW-07, ESWC-07, RuleML2006, and as a reviewer for international journals, conferences, and research project applications. He has also been an organiser of international enhancement programmes for highly skilled students in Mathematics and Computer Science, and has served as an editor for several books in this area. For more information, please see <http://www.pascal-hitzler.de>

**Guglielmo Tamburrini** is Professor of Logic and Philosophy of Science at Università di Napoli Federico II (Italy). He has recently organized the workshop “Ethics of human interaction with robotic, bionic and AI systems” (Naples, October 2006), and co-organized NeSy06 at ECAI (Riva del Garda, August 2006), the workshop “Models of computation and natural processes” (Bologna, June 2005), and a special session on Epistemology of computing at the First Computability in Europe Conference (Amsterdam, June 2005). He is coordinating a two-year EU project involving research groups from 5 countries. Current research interests concern perception and reasoning systems for cognitive robotics and the philosophy of AI and the cognitive neurosciences. For more information, please see <http://ethicbots.na.infn.it/tamburrini/index.htm>.

# NeSy'07 Programme Committee

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# Introduction

The importance of the efforts to bridge the gap between the connectionist and symbolic paradigms of Artificial Intelligence has been widely recognised. The merging of theory (background knowledge) and data learning (learning from examples) in neural networks has been indicated to provide a learning system that is more effective than purely symbolic or purely connectionist systems, especially when data are noisy.

The above results, which are due also to the massively parallel architecture of neural networks, contributed to the growing interest in developing Neural-Symbolic Learning Systems, i.e. hybrid systems based on neural networks that are capable of learning from examples and background knowledge, and of performing reasoning tasks in a massively parallel fashion. Typically, translation algorithms from a symbolic to a connectionist representation and vice-versa are employed to provide either (i) a neural implementation of a logic, (ii) a logical characterization of a neural system, or (iii) a hybrid system that brings together features from connectionism and symbolic Artificial Intelligence.

However, while symbolic knowledge representation is highly recursive and well understood from a declarative point of view, neural networks encode knowledge implicitly in their weights as a result of learning and generalisation from raw data. The challenge for neural-symbolic systems, therefore, is to combine neural networks' robust learning mechanisms with symbolic knowledge representation, reasoning, and explanation capability in ways that retain the strengths of each paradigm.

This workshop brings together researchers in the fields of neural-symbolic integration, neural computation, logic and artificial intelligence, and computational neuroscience, as well as experts in robotics and semantic web applications of neural-symbolic systems. The workshop aims to focus on principled ways of integrating neural computation and symbolic artificial intelligence w.r.t. knowledge representation, reasoning, learning, and knowledge extraction. Towards this goal, the papers in the workshop address all facets of neural-symbolic integration, including:

- The representation of symbolic knowledge by connectionist systems;
- Integrated neural-symbolic learning approaches;
- Extraction of symbolic knowledge from trained neural networks;
- Integrated neural-symbolic reasoning;
- Biological inspiration for neural-symbolic integration;
- Applications in robotics and semantic web.

The provision of integrated systems for robust learning and expressive reasoning has been identified recently by Leslie Valiant as a key challenge for computer science for the next 50 years (Journal of the ACM, Vol. 50, 2003). Neural-Symbolic integration can rise to this challenge. The area has now reached maturity, as indicated by books recently published in the subject, journals dedicated scientific areas on logic and neural networks, research projects, and a book series dedicated to the integration of symbolic and sub-symbolic computation. There have been isolated workshops in the area in the past, and it is now time for a regular workshop series to serve as a focal point for the community. We hope *Neural-Symbolic Learning and Reasoning* will serve this purpose. We hope it will also become a source for further collaboration between researchers working in the area.

We would like to take this opportunity to thank the members of the programme committee who helped in reviewing and selecting the papers submitted to the workshop, our invited speaker, Prof. Lokendra Shastri, the authors of the papers submitted to the workshop, and the IJCAI-07 workshop chair, Prof. Carles Sierra, for his assistance in the organisation of the workshop.

Hyderabad, January 2007

Artur d'Avila Garcez , Pascal Hitzler, Guglielmo Tamburini