

# Peter Vrancx

*Postdoctoral Researcher Machine Learning*

## SUMMARY

I'm a postdoctoral researcher in the field of machine learning. For my PhD research, I developed methods based on (evolutionary) game theory to analyze decentralized reinforcement learning algorithms. After my PhD, I worked on several research projects aimed at applying reinforcement learning in mechatronic systems and in telecom. My current research focuses on injecting additional knowledge into the reinforcement learning process (through shaping and ensembles), collaborative filtering applications, and the use of deep learning to obtain features for reinforcement learning.

## WORK EXPERIENCE

### **Doctor Assistant, Department of Computer Science, Vrije Universiteit Brussel**

Brussels, Belgium — 2010 - present

As doctor assistant, I have both research and teaching responsibilities. My main research topics include reinforcement learning, recommender systems and deep learning.

#### **Accomplishments**

- Contributing researcher on multiple machine learning projects.
- Co-supervised 4 PhD students and 8 Master's students.
- Co-authored 6 funded research projects.
- Taught machine learning courses at Bachelor's & Master's level.

### **Researcher, AI-lab, Vrije Universiteit Brussel**

Brussels, Belgium — 01/2010 - 10/2010

Researcher on the project *Learning Control for Production Machines* (<http://www.lecopro.org/>).

#### **Accomplishments**

- Developed novel reinforcement learning methods for decentralized control of mechatronic systems.

### **Visiting Researcher, University of Maastricht**

Maastricht, The Netherlands — 09/2007 - 12/2007

Visiting researcher with Dr. Karl Tuyls at the Department of Knowledge Engineering.

#### **Accomplishments**

- Developed a method for analyzing the dynamics of multi-agent reinforcement learning in multi-state systems. Published at AAMAS 2008.

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## Graduate Researcher, Computational Modeling Lab, Vrije Universiteit Brussel

Brussels, Belgium 2004 - 2009

Fellowship funded by the Flemish Agency for Innovation by Science and Technology.

## EDUCATION

### PhD Computer Science, Vrije Universiteit Brussel, Greatest Distinction

Brussels, Belgium — 2004 - 2010

Dissertation: Decentralized Reinforcement Learning in Markov Games.

Supervisors: Ann Nowe & Katja Verbeeck.

Committee members: Gerhard Weiss, Martin Riedmiller, Marco Saerens, Luc Steels, Dirk Vermeir, Bernard Manderick

### M.S. Computer Science, Vrije Universiteit Brussel, Greatest Distinction

Brussels, Belgium, 2000 - 2004

Dissertation: Multi-type Ant Systems. Supervisor: Ann Nowe

## OTHER EXPERIENCE & SKILLS

- Languages: Dutch (native), English (fluent), French (notions)
- Programming: Python, Matlab, Java
- Chair Adaptive and Learning Agents Workshop (2011 & 2012), Belgian-Dutch Reinforcement Learning Workshop (2014)
- Member IEEE Technical Committee on Adaptive Dynamic Programming and Reinforcement Learning.
- I co-organized tutorials on '*Reinforcement Learning and Game Theory*' at the International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS), the European Workshop on Reinforcement Learning (EWRL), and the European Conference on Machine Learning (ECML).
- Program committee member: International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS), European Conference on Artificial Intelligence (ECAI), IEEE Symposium on Adaptive Dynamic Programming and Reinforcement Learning (ADPRL), International Joint Conference on Neural Networks (IJCNN), International Joint Conference on Artificial Intelligence (IJCAI)
- Reviewer for Journal of Autonomous Agents and Multi-Agent Systems, IEEE Transactions on Man, Systems & Cybernetics, Elsevier Theoretical Computer Science, Automatica, ACM Transactions on Autonomous and Adaptive Systems, IEEE Transactions on Neural Networks and Learning Systems.
- Organizer '*Robotics & AI*' workshops for high school students.

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## PUBLICATION LIST

### Edited Volumes

- Howley, E., **Vrancx, P.** & Knudson, M., eds (to appear) *The Knowledge Engineering Review: Special Issue on Learning Agents*, Cambridge University Press.
- **Vrancx, P.**, Knudson, M., & Grzes, M., eds (2012). *Adaptive and Learning Agents. Lecture Notes in Computer Science*. Springer, Berlin, Germany.

### Journal Papers

- Rodriguez, A., **Vrancx P.** & Nowe, A. (to appear). A Reinforcement Learning Approach to Coordinate Exploration with Limited Communication in Continuous Action Games. *The Knowledge Engineering Review*, 31(2).
- **Vrancx, P.**, Gurzi, P., Rodriguez, A., Steenhaut, K., Nowé, A. (2015). A Reinforcement Learning Approach for Inter-Domain Routing with Link Prices. *ACM Transactions on Autonomous and Adaptive Systems* (in press).
- Van Vaerenbergh, K., **Vrancx, P.**, De Hauwere, Y.-M., Nowé, A., Hostens, E., Lauwerys, C. (2014). Tuning hydrostatic two-output drive-train controllers using reinforcement learning. *Mechatronics*, 24(8): 975–985
- De Hauwere, Y.- M., **Vrancx, P.**, & Nowé, A. (2010). Generalized Learning Automata for Multi-agent Reinforcement Learning. *Journal of AI Communications*, 23 (4): 311-324
- **Vrancx, P.**, Verbeeck, K., & Nowé, A. (2010). Analyzing the Dynamics of Stigmergetic Interactions through Pheromone Games. *Theoretical Computer Science*, 411(21): 2116-2126.
- **Vrancx, P.**, Verbeeck, K., & Nowé, A. (2008). Decentralized Learning in Markov Games. *IEEE Transactions on Systems, Man and Cybernetics (Part B: Cybernetics)*, 38: 976-81.
- Bello, R., Nowé, A., **Vrancx, P.**, Caballero, Y., & Gómez, Y. Y. (2005). Using ACO and Rough Set Theory for Feature Selection. *WSEAS Transactions on Information Science and Applications*, volume 2(5): 510-516.

### Book Chapters

- Nowé, A., **Vrancx, P.**, & De Hauwere, Y. - M. (2012). Game Theory and Multi-agent Reinforcement Learning. In M. Wiering & M. van Otterlo (Eds.), *Reinforcement Learning: State of the Art*, p. 441-470.
- De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A. (2010). Multi-agent systems and large state spaces. In A. Hakensson, R. Hartung, & N. T. Nguyen (Eds.), *Multi-agent system technology for Internet and Enterprise Systems*, Vol. 289, p. 181-205.
- Verbeeck, K., Nowé, A., **Vrancx, P.**, & Peeters, M. (2008). Multi-Automata Learning. In C. Weber, M. Elshaw, & N. M. Mayer (Eds.), *Reinforcement Learning: Theory and Applications*, p. 167-185.

### Conference Proceedings

- Harutyunyan, A., Brys, T., **Vrancx, P.**, & Nowe, A. (2015). Multi-Scale Reward Shaping via an Off-Policy Ensemble. In *Proceedings of the 14th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2015)*
- Harutyunyan, A., Devlin, S., **Vrancx, P.**, & Nowe, A. (2015). Expressing Arbitrary Reward Functions as Potential-Based Advice. In *Proceedings Twenty-Ninth AAAI Conference on Artificial Intelligence (AAAI 2015)*.
- Brys, T., Harutyunyan, A., **Vrancx, P.**, Taylor, M. E., Kudenko, D., & Nowé, A. (2014). Multi-Objectivization of Reinforcement Learning Problems by Reward Shaping. In *Proceedings International Joint Conference on Neural Networks (IJCNN 2014)*.
- Harutyunyan, A., Brys, T., **Vrancx, P.**, & Nowe, A. (2014). Off-Policy Shaping Ensembles in Reinforcement Learning. In *Proceedings European Conference on Artificial Intelligence (ECAI 2014)*. IOS Press
- Van Moffaert, K., Van Vaerenbergh, K., **Vrancx, P.** & Nowé, A. (2014) Multi-objective  $\chi$ -Armed bandits. In *Proceedings International Joint Conference on Neural Networks (IJCNN 2014)*.

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- Rodriguez, A., **Vrancx P.**, Nowe, A. & Hostens E. (2013). Model-free learning of wire winding control. In Proceedings 9th IEEE Asian Control Conference (ASCC 2013).
- Van Moffaert, K., De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A.. (2013). Reinforcement Learning for Multi-Purpose Schedules. In Proceedings 5th International Conference on Agents and Artificial Intelligence, (ICAART 2013).
- Van Vaerenbergh, K., Rodriguez, A., Gagliolo, M., **Vrancx, P.**, Nowé, A., Stoev, J., Goossens, S., Pinte, G., & Symens, W. (2012). Improving wet clutch engagement with Reinforcement Learning. In Proceedings International Joint Conference on Neural Networks (IJCNN 2012), Brisbane, Australia.
- Rodriguez, A., **Vrancx, P.**, Grau, R., & Nowé, A. (2012). An RL approach to Common-Interest Continuous Action Games. In Proceedings of the 11th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2012). Valencia, Spain.
- De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A. (2011). Adaptive State Representations For Multi-agent Reinforcement Learning. In Proceedings of the 3rd International Conference on Agents and Artificial Intelligence (ICAART 2011). Rome, Italy.
- De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A. (2011). Solving delayed coordination problems in MAS. In Proceedings of the 10th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2011). Taipei, Taiwan.
- De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A. (2011). Adaptive State Representations For Multi-agent Reinforcement Learning. In proceedings of the 23rd Benelux Conference on Artificial Intelligence (BNAIC 2011). Ghent, Belgium.
- **Vrancx, P.**, De Hauwere, Y. - M., & Nowé, A. (2011). Transfer Learning for Multi-agent Coordination. In Proceedings of the 3rd International Conference on Agents and Artificial Intelligence (ICAART 2011). Rome, Italy.
- De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A. (2010). Learning Multi-Agent State Space Representations. In Proceedings of the 9th International Conference on Agents and Multi-Agent Systems (AAMAS 2010). Toronto, Canada.
- **Vrancx, P.**, Verbeeck, K., & Nowé, A. (2010). Taking Turns in General Sum Markov Games. In Proceedings of the 9th International Conference on Agents and Multi-Agent Systems (AAMAS 2010). Toronto, Canada.
- De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A. (2009). Learning what to observe in Multi-agent Systems. In Proceedings of the 21st Benelux Conference on Artificial Intelligence (BNAIC 2009). Eindhoven, The Netherlands.
- De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A. (2009). Multi-Agent state space aggregation using Generalized Learning Automata. In Proceedings of the 21st Benelux Conference on Artificial Intelligence (BNAIC 2009). Eindhoven, The Netherlands.
- **Vrancx, P.**, Tuyls, K., Westra, R., & Nowé, A. (2008). Switching Dynamics of Multi-Agent Learning. In Proceedings International joint conference on Autonomous Agents and Multi-Agent Systems (AAMAS 2008). Estoril, Portugal.
- De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A. (2008). Using Generalized Learning Automata for State Space Aggregation in MAS. in Proceedings Knowledge-Based and Intelligent Information & Engineering Systems 2008. Lecture Notes in Computer Science, Springer, Berlin
- **Vrancx, P.**, Verbeeck, K., & Nowé, A. (2008). Decentralized Learning in Markov Games. In Proceedings 20th Belgian-Dutch Conference on Artificial Intelligence (BNAIC 2008). Enschede, The Netherlands.
- De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A. (2008). Multi-Agent state space aggregation using Generalized Learning Automata. In Proceedings of the Annual Belgian-Dutch Machine Learning Conference (BENELEARN 2008). Spa, Belgium.
- **Vrancx, P.**, Verbeeck, K., & Nowé, A. (2007). Optimal Convergence in Multi-Agent MDPs. In B. Apolloni, R. Howlett, & J. L. (Eds.), Lecture Notes in Computer Science, Proceedings of Knowledge-Based Intelligent Information and Engineering Systems (KES 2007), Vol. 4694. Berlin, Germany.
- **Vrancx, P.**, Verbeeck, K., & Nowé, A. (2007). Optimal Convergence in Multi-Agent MDPs. In Proceedings of the 19th Belgian-Dutch Conference on Artificial Intelligence (BNAIC 2007). Utrecht, The Netherlands.

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- Bello, R., Nowé, A., Caballero, Y., Gómez, Y., & **Vrancx, P.** (2005). Using the Ant colony System meta-heuristic and Rough Set Theory for Feature Selection. In proceedings of the 6th Metaheuristics International Conference (MIC2005). Vienna, Austria.

## Workshop Proceedings

- Van Moffaert, K., De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A.. (2013). Learning from Conflicting MDP and Human Reinforcements. In Proceedings Interactive Machine Learning Workshop, International Conference On Intelligent User Interfaces (IUI 2013)
- Van Moffaert, K., De Hauwere, Y.-M, **Vrancx, P.**, & Nowé, A. (2012). Adapting Control Policies to User Preferences. In Proceedings 5th International Workshop on Human-Friendly Robotics (HFR), Brussels, Belgium.
- Rodríguez, A., **Vrancx, P.**, Grau, R. & Nowé., A. (2012). A Reinforcement Learning Approach to Coordinate Exploration with Limited Communication in Continuous Action Games. In Proceedings AAMAS Workshop on Adaptive and Learning Agents (ALA12). Valencia, Spain.
- De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A. (2011). Detecting and Solving Future Multi-Agent Interactions. In Proceedings AAMAS Workshop on Adaptive and Learning Agents (ALA11). Taipei, Taiwan.
- De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A. (2011). Future Sparse Interactions: A MARL approach. In Proceedings of the 9th European Workshop on Reinforcement Learning (EWRL). Athens, Greece.
- Rodriguez, A., Gagliolo, M., **Vrancx, P.**, Grau, R., & Nowé, A. (2011). Improving the performance of Continuous Action Reinforcement Learning Automata. In Proceedings of the 9th European Workshop on Reinforcement Learning (EWRL). Athens, Greece.
- Brys, T., De Hauwere, Y. - M., Nowé, A., & **Vrancx, P.** (2012). Local Coordination in Distributed Constraint Optimization Problems. In Selected and Revised Papers of the 9th European Workshop on Multi-Agent Systems. Springer.
- Gurzi, P., Steenhaut, K., Nowé, A., & **Vrancx, P.** (2011). Learning a Pricing Strategy in Multi-Domain DWDM Networks. In Proceedings IEEE International Workshop on Local and Metropolitan Area Networks. Chapel Hill, USA.
- De Hauwere, Y. - M., **Vrancx, P.**, & Nowé, A. (2010). Learning multi-agent state space representations. In proceedings of the 8th European Workshop on Multi-Agent Systems (EUMAS). Paris, France.
- **Vrancx, P.**, Verbeeck, K., & Nowé, A. (2010). Taking Turns in General Sum Markov Games. In Proceedings AAMAS Adaptive and Learning Agents Workshop 2010 (ALA10). Toronto, Canada.
- De Hauwere, Y. - M., Vrancx, P., & Nowé, A. (2009). Multi-layer learning and knowledge transfer in MAS. In Proceedings 7th European Workshop on Multi-Agent Systems (EUMAS). Ayia Napa, Cyprus.
- **Vrancx, P.**, Verbeeck, K., & Nowé, A. (2008). Networks of learning automata and limiting games. In K. Tuyls, A. Nowé, Z. Guessoum, & D. Kudenko (Eds.), Lecture Notes in Artificial Intelligence, ALAMAS III, Vol. 4865.
- **Vrancx, P.**, Verbeeck, K., & Nowé, A. (2007). Limiting Games of Multi-agent Multi-state Problems. In Proceedings AAMAS Workshop on Adaptive and Learning Agents 2007 (ALAg07), Hawaii, USA.
- Verbeeck, K., **Vrancx, P.**, & Nowé, A. (2007). Networks of learning automata and limiting games. In Proceedings Adaptive Learning Agents and Multi-Agent Systems Workshop 2007 (ALAMAS). Maastricht, The Netherlands.
- **Vrancx, P.**, Verbeeck, K., & Nowé, A. (2007). Analyzing Stigmergetic Algorithms Through Automata Games. In K. Tuyls, R. Westra, Y. Saeys, & A. Nowé (Eds.), Proceedings Knowledge Discovery and Emergent Complexity in Bioinformatics, Lecture Notes in Bioinformatics, Vol. 4366. Berlin, Germany
- **Vrancx, P.**, & Nowé, A. (2006). Using Pheromone Repulsion to Find Disjoint Paths. In M. Dorigo, L. M. Gambardella, M. Birattari, A. Martinoli, R. Poli, & T. Stutzle (Eds.), Lecture Notes in Computer Science, ANTS 2006, Vol. 4150. Brussels, Belgium.
- **Vrancx, P.**, Nowé, A., & Steenhaut, K. (2006). Multi-type ACO for Light Path Protection. In K. Tuyls, P. J. 't Hoen, K. Verbeeck, & S. Sen (Eds.), Lecture Notes in Computer Science, Proceedings of Learning and Adaption in Multi-Agent Systems, Vol. 3898.

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- **Vrancx, P.**, Nowé, A., & Steenhaut, K. (2005). Multi-type ACO for Light Path Protection. In Proceedings 3rd European Workshop on Multi-Agent Systems (EUMAS) Brussels, Belgium.
- Nowé, A., Verbeeck, K., & **Vrancx, P.** (2004). Multi-type Ant Colony: The Edge Disjoint Paths Problem. In M. Dorigo, M. Birattari, C. Blum, L. M. Gambardella, F. Mondada, & T. Stützle, (Eds.), Lecture Notes in Computer Science, Proceedings of ANTS 2004, Brussels, Belgium.

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