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Calculated Moves: Generating Air Combat Behaviour

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List of publications

The work that is presented in this thesis is based on the following publications.

1. A. Toubman, J. J. Roessingh, P. Spronck, A. Plaat and H. J. Van den Herik (2014a). Dynamic Scripting with Team Coordination in Air Combat Simulation. In: *Modern Advances in Applied Intelligence: 27th International Conference on Industrial Engineering and Other Applications of Applied Intelligent Systems, IEA/AIE 2014, Kaohsiung, Taiwan, June 3-6, 2014, Proceedings, Part I*. Ed. by M. Ali, J.-S. Pan, S.-M. Chen and M.-F. Horng. Vol. 8481. Lecture Notes in Computer Science. Kaohsiung, Taiwan: Springer International Publishing, pp. 440–449. ISBN: 978-3-319-07455-9. DOI: 10.1007/978-3-319-07455-9_46
2. A. Toubman, J. J. Roessingh, P. Spronck, A. Plaat and H. J. Van den Herik (2014b). Centralized Versus Decentralized Team Coordination Using Dynamic Scripting. In: *Proceedings of the 28th European Simulation and Modelling Conference - ESM'2014*. Ed. by A. C. Brito, J. M. R. Tavares and C. Braganca de Oliveira. Porto, Portugal: Eurosia, pp. 129–134
3. A. Toubman, J. J. Roessingh, P. Spronck, A. Plaat and H. J. Van den Herik (2015a). Rewarding Air Combat Behavior in Training Simulations. In: *Systems, Man, and Cybernetics (SMC), 2015 IEEE International Conference on*. Hong Kong: IEEE Press, pp. 1397–1402. DOI: 10.1109/SMC.2015.248
4. A. Toubman, J. J. Roessingh, P. Spronck, A. Plaat and H. J. Van den Herik (2015b). Transfer Learning of Air Combat Behavior. In: *2015 IEEE 14th International Conference on Machine Learning and Applications (ICMLA)*. Miami, Florida: IEEE Press, pp. 226–231. DOI: 10.1109/ICMLA.2015.61
5. A. Toubman, J. J. Roessingh, J. Van Oijen, M. Hou, L. Luotsinen, J. Harris, R. A. Løvliid, C. Meyer, R. Rijken and M. Turčaník (2016a). Modeling Behavior of Computer Generated Forces with Machine Learning Techniques, the NATO task group approach. In: *Systems, Man, and Cybernetics (SMC), 2016 IEEE International Conference on*. Budapest, Hungary: IEEE. DOI: 10.1109/SMC.2016.7844517
6. A. Toubman, J. J. Roessingh, P. Spronck, A. Plaat and H. J. Van den Herik (2016b). Rapid Adaptation of Air Combat Behaviour. In: *ECAI 2016 - 22nd European Conference on Artificial Intelligence*. Ed. by G. A. Kaminka, M. Fox, P. Bouquet, E. Hüllermeier, V. Dignum, F. Dignum and F. Van Harmelen. Vol. 285. Frontiers in Artificial Intelligence and Applications. The Hague, The Netherlands: IOS Press, pp. 1791–1796. DOI: 10.3233/978-1-61499-672-9-1791
7. A. Toubman (2019). Validating Air Combat Behaviour Models for Adaptive Training of Teams. In: *Adaptive Instructional Systems*. Ed. by R. A. Sottilare and J. Schwarz. Springer International Publishing, pp. 557–571. DOI: 10.1007/978-3-030-22341-0_44

Curriculum vitae

Armon Toubman was born on October 8, 1988 in Amsterdam, the Netherlands. He attended the Zaanlands Lyceum in Zaandam, where he received his gymnasium diploma in 2006. His love for science fiction, computer programming, and video games led him to start his study of Artificial Intelligence in the same year, at the VU in Amsterdam. He received his bachelor's degree in 2009. During an internship at the Netherlands Organisation for Applied Scientific Research (TNO), he completed his master's thesis on the subject of adaptive autonomy in unmanned ground vehicles. In 2012 he received his master's degree with a specialisation in computational intelligence and self-organisation.

The following year, he joined a collaboration between the Netherlands Aerospace Centre (NLR) and Tilburg University as a PhD candidate. During his research, Armon was supervised by Prof. dr. H.J. van den Herik, Prof. dr. ir. P.H.M. Spronck, Prof. dr. A. Plaat (Tilburg University), and dr. J.J.M. Roessingh (NLR, daily supervision). It is at the NLR that Armon discovered his fourth love, aviation. Midway through his research, he joined professor Van den Herik in his move to establish the Leiden Centre of Data Science (LCDS) at Leiden University. Armon's research has been published at international refereed conferences. At the NLR, he co-supervised four MSc theses together with dr. Roessingh.

Currently, Armon resides in Almere. He works as an R&D engineer at NLR, with a focus on the development of behaviour modelling techniques and machine learning applications. On the web, he can be found at <http://www.armontoubman.com>.

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Writing a PhD thesis is both the most solitary and most collaborative activity I have undertaken so far. I am most grateful to my supervisor Jaap van den Herik for his guidance, reviews, and endless commitment; to Jan Joris Roessingh, for his daily supervision and the enthusiasm by which he helped to solve a continuous stream of puzzles; and to Pieter Spronck, for sharing not only his dynamic scripting algorithm but also his knowledge and experience of everything surrounding it. Here, I also thank Aske Plaat for his support in the early stages of the research.

Most of my time was spent at the department of Training, Simulation, and Operator Performance at NLR. My sincere gratitude goes to the head of the department, Harrie Bohnen, for providing me with the resources that I needed to complete my research. Many thanks also go to the NLR colleagues who graciously shared their expertise with me.

Reaching outside of my own workplaces, I wish to extend my gratitude to the Royal Netherlands Air Force, and in particular to Rich and the 312, 313, and 322 squadrons. I sincerely hope that your support of my research will double the expected pay back in the near future. Also, in my research, only a few things have been more inspiring than preparing my experiments while listening to the roars of F-16s taking off into the skies. Furthermore, I thank the members of the NATO IST-121 panel for the many interesting discussions we have had, and for helping me place my research in an international context.

My roommate Esther Kuindersma deserves special mention. For me, it was invaluable to share the fantastic ups and the devastating downs that come while writing a thesis, with someone going through the same roller coaster. Thanks, Esther.

Finally, this thesis would not have been possible without the unconditional support of the people closest to me: pa, ma, Omri, Tanna, Iet, Hans, and most of all, Marit. Thank you all.

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- 30 Ruud Mattheij (TiU), The Eyes Have It
- 31 Mohammad Khelghati (UT), Deep web content monitoring
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- 50 Yan Wang (TiU), The Bridge of Dreams: Towards a Method for Operational Performance Alignment in IT-enabled Service Supply Chains

2017

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- 17 Daniel Dimov (UL), Crowdsourced Online Dispute Resolution
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- 19 Jeroen Vuurens (UT), Proximity of Terms, Texts and Semantic Vectors in Information Retrieval
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2018

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- 20 Manxia Liu (RUN), Time and Bayesian Networks
- 21 Aad Slootmaker (OU), EMERGO: a generic platform for authoring and playing scenario-based serious games
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2019

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- 04 Ridho Rahmadi (RUN), Finding stable causal structures from clinical data
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2020

- 01 Armon Toubman (UL), Calculated Moves: Generating Air Combat Behaviour