About the Editors

Alex Champandard is the founder of AiGameDev.com, the largest online hub for artificial intelligence in games. He has worked in the industry as a senior AI programmer for many years, most notably for Rockstar Games where he also worked on the animation technology of *Max Payne 3*. He regularly consults with leading studios in Europe, most notably at Guerrilla Games on the multiplayer bots for *KillZone 2* & *3*. Alex is also the event director for the Game/AI Conference, the largest independent event dedicated to AI in games.

Kevin Dill is a member of the senior technical staff at Lockheed Martin Rotary & Missions Systems and the chief architect of the Game AI Architecture. He is a veteran of the game and military simulation industries with more than 15 years' experience, and has worked on AI for everything from games (including several major hits, such as *Red Dead Redemption*, *Iron Man*, and *Zoo Tycoon 2*) to military training to emotive avatars. His professional interests include improved techniques for behavior specification, tactical and strategic AI, spatial reasoning, and believable characters. He was the technical editor for *Introduction to Game AI* and *Behavioral Mathematics for Game AI*, and a section editor for "AI Game Programming Wisdom 4" and the "Game AI Pro" series. He is a prolific author and speaker, and has taught at Harvard University, Cambridge, Massachusetts, Boston University, Boston, Massachusetts, and Northeastern University, Boston, Massachusetts.

Damián Isla has been working on and writing about game technology for more than a decade. He is a cofounder of the indie game studio, The Molasses Flood, and was previously the president of Moonshot Games, where he directed *Third Eye Crime*, an innovative AI-based stealth/puzzle/telepathy game. Before joining Moonshot, Damián was the AI and Gameplay engineering lead at Bungie Studios, where he was responsible for the AI in the mega-hit first-person shooters *Halo 2* and *Halo 3*. He also contributed to the AI of *Bioshock: Infinite*, and to the early development of *Destiny*.

Neil Kirby cofounded the IGDA Foundation and serves on its board. He oversees the Eric Dybsand AI Memorial Scholarship to GDC that is awarded each year and works with the IGDA Foundation Scholars and Ambassadors programs.

Neil is a section editor in the "Game AI Pro" book series. He is the author of *An Introduction to Game AI*. His other publications include articles in volumes I, II, and IV of *AI Game Programming Wisdom*. He cowrote "Effective Requirements Traceability: Models, Tools and Practices" for the *Bell Labs Technical Journal*. His 1991 paper, "Artificial Intelligence without AI: An evolutionary Approach," may well show the first use of what is now known as "circle strafing" in a game. His other papers and presentations can be found in the proceedings of the Computer Game Developers Conference from 1991 to present as well as the 2003 Australian Game Developers Conference.

He is a member of technical staff at Nokia. He currently develops .NET solutions used to support requirements traceability. He also provides software architecture consulting services. His previous assignments have included building speech recognition software and teaching at the university level. He has been the head judge of The Ohio State University's Fundamentals of Engineering Honors robot competition for many years.

Neil holds a master's degree in computer science from The Ohio State University, Columbus, Ohio. He lives with his spouse in central Ohio. There he chairs his local village planning commission and volunteers for the historical society.

Steve Rabin has been a key figure in the game AI community for more than a decade and is currently a principal software engineer at Nintendo Technology Development. After initially working as an AI engineer at several Seattle startups, he managed and edited seven game AI books in the "Game AI Pro" series and the "AI Game Programming Wisdom" series. He also edited the book *Introduction to Game Development* and has more than two dozen articles published in the "Game Programming Gems" series. He has been an invited keynote speaker at several AI conferences, founded the AI Game Programmers Guild in 2008, and founded the GDC AI Summit where he has been a summit adviser since 2009. Steve is a principal lecturer at the DigiPen Institute of Technology, Redmond, Washington, where he has taught game AI since 2006. He earned a BS in computer engineering and an MS in computer science, both at the University of Washington, Seattle, Washington.

Nathan R. Sturtevant is an associate professor of computer science at the University of Denver, Denver, Colorado, where he works on AI and games. He began his games career working on shareware games as a college student in the mid-1990s, and returned to the game industry to write the pathfinding engine for *Dragon Age: Origins*. In addition to his work collaborating with the game industry (through work on "Game AI Pro" books, speaking at GDC, and other projects), Nathan guides capstone game projects at the University of Denver and develops games in his free time.

Contributors

Kyle Anderson has written games for everything from cell phones and PCs to low-level hardware controllers for motion-activated exergaming equipment. He is currently interested in all things VR. Kyle is the lead programmer at Shikigami Games.

Nicolas A. Barriga is a PhD candidate at the University of Alberta, Edmonton, Canada. He earned BSc (engineering) and MSc degrees in informatics engineering at Universidad Técnica Federico Santa María, Valparaíso, Chile. After a few years working as a software engineer for Gemini and ALMA astronomical observatories, he came back to graduate school and is currently working on state and action abstraction mechanisms for RTS games.

Daniel Brewer graduated from University of Natal Durban, South Africa, in 2000 with a BSc (engineering) in electronic engineering focusing on artificial intelligence, control systems, and data communications. He worked at Cathexis Technologies for six years, as a software engineer writing software for digital surveillance systems, where he was responsible for operating system drivers for PCI video capture cards, image capture scheduling, video compression, and image processing algorithms such as motion detection, people counting, and visual camera tamper detection. He moved to Digital Extremes in 2007 where he is the lead AI programmer and has worked on several titles including *Dark Sector* (March 2008), *BioShock 2* multiplayer (February 2010), and *The Darkness II* (February 2012), *Halo 4* multiplayer DLC packages (2012), and *Warframe* (2013).

Michael Buro is a professor in the computing science department at the University of Alberta, Edmonton, Canada. He received his PhD in 1994 for his work on *Logistello*—an Othello program that defeated the reigning human World champion 6-0. His current research interests include heuristic search, pathfinding, abstraction, state inference, and opponent modeling applied to video games and card games. In these areas, Michael and his students have made numerous contributions, culminating in developing fast geometric pathfinding algorithms and creating the World's best Skat playing program and one of the strongest *StarCraft: Brood War* bots.

David Churchill is the lead AI programmer for Lunarch Studios on the online strategy game, *Prismata*. He completed his PhD in computing science at the University of Alberta, Edmonton, Canada, in the area of artificial intelligence for video games, specifically in real-time heuristic search techniques for *StarCraft*. Since 2011, he has been the organizer of the AIIDE *Starcraft* AI Competition, and won the competition in 2013 with his entry UAlbertaBot.

Christopher Dragert received his PhD in computer science from McGill University, Montréal, Canada. His research focused on the application of software engineering techniques to the development process of game AI, with work being published at top academic conferences, including AIIDE, FDG, FSE, and GAS. Recently, he spoke at GDC 2016 and authored a chapter in the recent book *Computer Games and Software Engineering*. Chris is currently employed at Ubisoft Toronto as an AI programmer on *Watch Dogs 2*.

Anthony Francis, by day, studies human and other minds to create intelligent machines and emotional robots; by night, he writes urban fantasy and draws comic books. His work explores deep learning for robotic control at Google Research. He earned his PhD at Georgia Institute of Technology, Atlanta, Georgia, studying contextual memory for information retrieval, but also worked on emotional long-term memory for robot pets, a project documented on the Google Research blog as "Maybe your computer just needs a hug." Anthony is best known for his "Skindancer" series of urban fantasy novels featuring magical tattoo artist Dakota Frost, including the award-winning *Frost Moon* and its sequels *Blood Rock* and *Liquid Fire*. Anthony lives in San Jose with his wife and cats, but his heart will always belong in Atlanta. You can follow Anthony online at http://www.dresan.com/

David "Rez" Graham is a senior AI programmer currently working independently on a self-funded unannounced project. Before that, he was the director of game programming at the Academy of Art University's School of Game Development, San Francisco, California, where he built the entire game programming curriculum from scratch. He has worked in the game industry as an engineer since 2005, spending most of that time working on various kinds of AI, from platformer enemy AI to full simulation games. Most recently, he was the lead AI programmer on *The Sims 4* at Maxis. Before that, he worked at PlayFirst, Slipgate Ironworks, Planet Moon Studios, and Super-Ego Games. He is the coauthor of *Game Coding Complete* (4th edition), has two articles in *Game AI Pro*, and regularly speaks at the Game Developers Conference. Rez spends his free time acting and running tabletop RPGs.

Fabien Gravot made his debut in the game industry in 2011 as an AI researcher with Square Enix. He has worked on a navigation mesh solution for both *FINAL FANTASY XIV: A REALM REBORN* and *FINAL FANTASY XV*. Previously, he had been working on robot AI and autonomous driving. He thought that games were less risky than moving one ton of metal with his program. He received his PhD in computer science from the Paul Sabatier University, Toulouse, France, in 2004.

Ingimar Hólm Guðmundsson is an AI engineer at Square Enix and is focused on character motion, simulations, and workflow tools. His current project is *FINAL FANTASY XV*, a Japanese role-playing game that takes players on a journey of four friends, as their kingdom is threatened and potentially lost. Ingimar has worked on numerous titles in the video game industry, most notably the BAFTA award winning, *Total War: Shogun 2* (2011) by Creative Assembly, where he was the battle AI programmer responsible for the real-time battle strategies. Previously he worked on other *Total War* games, such as *Napoleon: Total War* (2010), and *Empire: Total War* (2009), which was his first foray into the game industry. Ingimar has a master's degree in applied artificial intelligence from the University of Exeter, Exeter, the United Kingdom, and an undergraduate degree in physics from the University of Iceland, Reykjavík, Iceland.

Sebastian Hanlon is a programmer-turned-designer who has been with BioWare Edmonton since 2006. His shipped game credits include *Dragon Age: Origins*, *Dragon Age II*, *Dragon Age: Inquisition*, *Mass Effect 2*, and *Mass Effect 3*. Sebastian holds a BSc and an MSc in computer science from the University of Lethbridge, Lethbridge, Canada.

Jurie Horneman has been programming, designing, and producing games since 1991, at companies such as Rockstar Games, Blue Byte Software, and Thalion Software. He has a strong interest in the intersection of game design, programming, and storytelling.

Ian Horswill is an associate professor of computer science at Northwestern University, Evanston, Illinois, where he teaches and does research on interactive entertainment technologies and cognitive modeling for virtual characters. He received his PhD in computer science from the Massachusetts Institute of Technology, Cambridge, Massachusetts, in 1993, is an associate editor of *IEEE Transactions of Computational Intelligence and AI in Games*, is a past chair of the standing committee of the "AAAI Symposium" series, and has spoken at both the Education and AI Summits at GDC.

Éric Jacopin is a professor at the French Military Academy of Saint-Cyr, Guer, France where he headed the Computer Science Research Laboratory from 1998 to 2012; this includes teaching Turing machines, war games and project management, and the management of international internships for computer science cadets. His research has been in the area of AI Planning for the past 25 years, not only from the viewpoint of artificial intelligence but also from everyday life and gaming perspectives. He received his PhD (1993) and his habilitation to direct research (1999), both from the Pierre and Marie Curie University (Paris VI), Paris, France.

Sumeet Jakatdar is the lead AI engineer at Treyarch/Activision Blizzard, Santa Monica, California, and has been working there for more than 9 years. He has been involved in developing AI for some of the Activision's most popular first-person shooter games. During his years as an AI developer, he has worked on gameplay programming, level design, behavior, animation systems, and networking. Before joining the industry in 2007, he received MS degree in computer science from University of Southern California, Los Angeles, California.

Chris Jenner obtained his PhD in 1998 from the University of Newcastle upon Tyne, the United Kingdom. He has been working as a programmer in the game industry since 1999, in the studio that is now known as Ubisoft Reflections, and have worked on *Driver 2*, *Stuntman*, *Driver 3*, *Driver Parallel Lines*, *Driver San Francisco*, *Just Dance 3*, *Just Dance 4*, *The Crew*, *Assassins Creed: Syndicate*, and *The Division*.

Eric Johnson is a senior AI engineer in the Advanced Technology Division of SQUARE ENIX, developing the AI systems for *KINGDOM HEARTS III*. Before joining the industry in 2008, Eric received his master's degree in artificial intelligence from the Georgia Institute of Technology, Atlanta, Georgia, focusing on case-based reasoning for real-time strategy games. In addition to SQUARE ENIX, Eric has developed AI systems at CCP, KIXEYE, and LucasArts.

Matthew W. Johnson joined Square Enix in 2013 after completing his PhD in data analytics and data mining. He develops various AI techniques and tools used in the production of *FINAL FANTASY XV*. Before *FINAL FANTASY,* he did research in educational data mining and personalized learning systems known as intelligent tutoring systems.

Tomoki Komatsu graduated from Tohoku University, Sendai, Japan, and completed the master's degree in computer science. Then he started his career as an AI Engineer at SQUARE ENIX in 2014. He developed the Monster AI and supported the development of the tools for *FINAL FANTASY XV*.

Mark Langerak is the principal software engineer at Microsoft, where he works on augmented reality applications and computer vision technologies for the HoloLens platform. Mark has been in the game industry since the early 1990s. Before joining Microsoft, he worked at Microprose, Sony/Psygnosis, Sega, DreamWorks Interactive, Maxis, Electronic Arts, and Pandemic Studios, in graphics engineer, lead programmer, and technical director roles.

Mike Lewis entered the game industry as a programmer in early 2002, and has spent most of the intervening years focusing on game AI and surrounding technologies. He has lectured at the Game Developers Conference and published articles in previous volumes of *Game AI Pro*. Currently, Mike calls ArenaNet, LLC, home, where he tirelessly schemes to bring better AI to the world of massively multiplayer online gaming.

John Manslow started writing games on his Vic-20 as a teenager and gradually became more and more interested in smart AI. Having completed a degree and then a PhD in the subject, he joined Codemasters as the AI specialist in their R&D team, where he worked on several projects to bring the next generation AI to Codemasters' games. Since then, John has worked for several companies outside the industry but has remained focused on AI and statistical analytics.

Eric Martel has been developing games for more than 15 years. He has worked on numerous franchises such as *Far Cry*, *Assassin's Creed*, and *Thief*. He is the published author of "An Analysis of *Far Cry: Instincts*' Anchor System" in AI Game Programming Wisdom 3 and "Tips and Tricks for a Robust Third Person Camera System" in *Game AI Pro*.

He is currently a lead AI programmer at Ubisoft Québec studio where he recently worked on *Assassin's Creed Syndicate*.

Michael Mateas is the codirector of Expressive Intelligence Studio and the director of the Center for Games and Playable Media at the University of California, Santa Cruz, California. His research in game AI focuses on enabling new forms of gameplay through innovative AI solutions. The Expressive Intelligence Studio has ongoing projects in autonomous characters, interactive storytelling, game design support systems, AI models of creativity, and automated game generation. With Andrew Stern, Michael created *Façade*, which uses AI techniques to combine rich autonomous characters with interactive plot control to create the world's first, fully produced, real-time, interactive drama. Michael received his PhD in computer science from Carnegie Mellon University, Pittsburgh, Pennsylvania.

Kousuke Namiki joined FROM SOFTWARE in 2009 and worked on *STEEL BATTALION* and *Monster Hunter Diary: Poka Poka Airou Village*. He has been with SQUARE ENIX since 2012 as an AI programmer developing Luminous Studio. Now he is engaged in the development of enemy character AI for *FINAL FANTASY XV*.

Shintaro Minamino graduated from a game development technical college in Japan in 2005, and has been an engineer at Square Enix Japan since 2012. His most recent work has focused on the asset building pipeline and game metrics system for *FINAL FANTASY XV*. He has been a leader of the Engineering Department of Computer Entertainment Developers Conference (CEDEC) since 2012. Before joining Square Enix, he worked for seven years (2005–2012) on numerous game titles at Polygon Magic, Inc. Japan, where he was also the leader of the R&D section of GeePlus, Inc., Polygon Magic's child company.

Youichiro Miyake is the lead AI researcher at Square Enix, working as the leader of the AI unit for the next-generation game engine Luminous Studio. He is the chairman of the IGDA JAPAN SIG-AI and a board member of DiGRA JAPAN. He has been developing and researching game AI since 2004. He developed the technical design of AI for the following game titles: *Chromehounds* (2006, Xbox 360), *Demon's Souls* (2009, PlayStation 3), and *Armored Core V* (2012, Xbox 360, PlayStation 3), developed by FromSoftware. At Square Enix, he was engaged in the AI development of *FINAL FANTASY XIV: A Realm Reborn*. At present, he is developing AI in *FINAL FANTASY XV* as the lead AI technical architect. He has published papers and books about game AI technologies and has given many lectures at universities and conferences. He was a keynote speaker of GAMEON ASIA 2012 and a game AI course speaker in SIGGRAPH ASIA 2015. His paper "Current Status of Applying Artificial Intelligence in Digital Games" will be published in the *Handbook of Digital Games and Entertainment Technologies* by Springer.

Sergio Ocio Barriales has been working in the game industry since 2005. He received his PhD in 2010 from the University of Oviedo, Asturias, Spain, with his thesis about hinted-execution behavior trees. He has worked on the AI for numerous major titles, such as *Driver San Francisco*, *Splinter Cell: Blacklist*, *DOOM*, and *Watch_Dogs 2*. He joined the team at Hangar 13 as a lead AI engineer in 2016, where he continues pushing character AI forward.

Graham Pentheny is an independent game developer from Cambridge, Massachusetts. He currently runs the local Boston Unity3D user group and does engineering work and consultation with various local studios. Previously, he worked with Dr. Jeff Orkin on conversational AI systems at Giant Otter, led AI and engine development at Subatomic Studios, and is credited on the *Fieldrunners* tower defense games. He received a BS in both computer science and interactive media and game development from Worcester Polytechnic Institute, Worcester, Massachusetts. (grahamboree.com)

Prasert Prasertvithyakarn is the lead game designer for *FINAL FANTASY XV* and is responsible for the game's AI main player characters. He was the leader of the enemy team in *MAJIN AND THE FORSAKEN KINGDOM* (2010, Xbox360, PlayStations3) at GAME REPUBLIC INC. before joining SQUARE ENIX in 2010.

Gijs-Jan Roelofs is the AI and lead programmer at Goldhawk Interactive where he has, among other projects, worked on the "Xenonauts" series. He is also the founder of CodePoKE, an independent game development company aimed at innovative applications of AI in games that cooperates with the Department of Knowledge Engineering at Maastricht University, Maastricht, the Netherlands. His passion for AI was ignited by Professor Mark Winands and the emergence of MCTS during his time in Maastricht. He is currently working on techniques for procedural generation of narratives, and tactical AI using MCTS.

Jeff Rollason is an AI developer who currently heads, and is a cofounder of, AI Factory Ltd, a company with an estimated 200 million users (including more than 129 million Android downloads). AI Factory was founded in 2003 with the premise of creating modular AI and games that would be licensed to third parties. The business has been very successful, with clients such as Microsoft. AI Factory's game engines appear in consoles, PCs, in-flight entertainment, and mobile devices. In addition to his work at AI Factory, Jeff has worked for 17 years in academia, including teaching core computer architecture courses at King's College London, the United Kingdom. He has published in numerous journals and books, including the journal *Artificial Intelligence*. His programs have also competed in computer tournaments for Chess, Go, and particularly Shogi (Japanese Chess), where his program *Shotest* twice ranked third in the world.

James Ryan is a PhD student of computer science at the University of California, Santa Cruz, California, working with the Expressive Intelligence Studio. He earned his BA in linguistics and MS in health informatics (with a minor in cognitive science) at the University of Minnesota, Minneapolis, Minnesota. His current research agenda spans two main topics: building autonomous agents who construct personal narratives out of their subjective experience in simulated worlds, and developing new technologies for freeform conversational interaction in games (by integrating systems for dialog management, natural language generation, and natural language understanding).

Kazuya Shimokawa researched and developed Computer Go AI in his master course at the University of Electro-Communications, Tokyo, Japan. He has been with SQUARE ENIX since 2013. At present, he is developing AI in *FINAL FANTASY XV* and was part of the team that developed Luminous Studio Tools.

Youji Shirakami has worked as a programmer in SQUARE ENIX since 2005. Before that, he worked as an engineer for transportation systems. He was engaged in the development of *Seiken Densetsu FRIENDS of MANA* (Mobile), *KINGDOM HEARTS* (Mobile), and *FINAL FANTASY TYPE-0* (PSP). His current tasks include implementation of the AI Graph Editor and character AI development.

Hendrik Skubch joined Square Enix in Japan in 2013 as an AI researcher, where he develops generic AI technologies for all aspects of game AI. In 2014, he joined a focused effort on *FINAL FANTASY XV* as a senior AI engineer. Before entering the game industry, he researched cooperative robotics and led a robotic soccer team within the RoboCup initiative. He received his PhD for work on robotic teams in 2012 from the University of Kassel, Kassel, Germany.

Marius Stanescu is a PhD candidate at the University of Alberta, Edmonton, Canada. He completed his MSc in artificial intelligence at University of Edinburgh, Edinburgh, the United Kingdom, in 2011, and became a researcher at the Center of Nanosciences for Renewable & Alternative Energy Sources of University of Bucharest, Bucharest, Romania, in 2012. Since 2013, he has been helping organize the AIIDE StarCraft Competition. Marius' main areas of research include machine learning, AI, and RTS games.

Ben Sunshine-Hill is the lead developer of Havok AI. He holds a PhD in computer science from the University of Pennsylvania, Philadelphia, Pennsylvania, for his work in perceptually driven simulation. He once saw a really cool-looking cow.

Joudan Tatsuhiro has been with SQUARE ENIX since 2011. He was engaged in the development at Luminous Studio, especially for tools. He has been developing buddy AI within the *FINAL FANTASY XV* team, especially for the meta-AI system that controls them.

Matthew Viglione is a cofounder of SomaSim, a Chicago-based indie studio founded in 2013 to create simulation games. He has extensive experience in creative direction, writing, and graphic design. Before starting SomaSim, Matthew was the director of communications for Catholic Charities in San Francisco, California.

Cody Watts is a programmer and professional game developer. Since 2010, he has been working at BioWare Edmonton, where he is variously described by his coworkers as "a freaking genius" and "a space wizard ninja." While at BioWare, Cody has contributed to such AAA titles as *Dragon Age: Origins*, *Dragon Age II*, *Dragon Age: Inquisition* and *Mass Effect: Andromeda*. Cody holds a BSc and an MSc in computer science from the University of Calgary, Calgary, Canada, but more importantly, he beat *SpaceChem*—and that is *way* harder than defending a master's thesis. Follow Cody's latest adventures at www.codywatts.com.

Ben G. Weber is a senior data scientist at Electronic Arts (EA), where his current focus is on improving the computing infrastructure and workflows used by the data science and analytics teams. He received his PhD in computer science from University of California, Santa Cruz, California, where he studied Game AI and machine learning. Before

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Baylor Wetzel has degrees in psychology and computer science and until recently taught artificial intelligence and English at a major university. When not making NPCs behave properly for others, he enjoys designing and writing dialog for his own story-rich indie games. Baylor currently works as a game designer at indie game studio Shikigami Games.

Takanori Yokoyama has worked as a game programmer in the game industry since 2004. He has been especially interested in game AI and implemented it for many game titles including *ENCHANT ARMS* (2006, Xbox360), *CHROME HOUNDS* (2006, Xbox360), and *Demon's Souls* (2009, PlayStation3) developed by FROM SOFTWARE. He is now working as an AI engineer at SQUARE ENIX.

David Young is a senior software engineer at Activision Treyarch, specializing in AI and animation systems, and he previously shipped both *Call of Duty Black Ops II* and *Black Ops III*. Before working in the game industry, David started his career at the NASA (National Aeronautics and Space Administration) Deep Space Network and later went on to work on the Curiosity rover mission at the NASA Jet Propulsion Laboratory, Pasadena, California. Currently, David is simultaneously pursuing a PhD at the University of Southern California, Los Angeles, California, focusing on real-time hair simulation techniques.

Mieszko Zieliński has worked in the game industry throughout his professional life—that is close to 13 years at the time of writing—most of which focused on game AI. For the past eight years, he has been with Epic Games, with the past five spent on leading the AI system development in Unreal Engine 4. He has recently been micromanaging Paragon bots, which he found a very refreshing activity after the time spent on working for generic AI systems.

Robert Zubek is a game developer and cofounder at SomaSim, a Chicago-based indie studio founded in 2013 to create simulation games. Previously, he built large-scale online social games at Zynga, MMO game and analytics infrastructure at Three Rings Design, and console games at Electronic Arts/Maxis. Before joining the industry, he specialized in artificial intelligence and robotics research. Robert holds a PhD in computer science from Northwestern University, Evanston, Illinois, where he also received his previous computer science degrees.