

References

- Ackermann, Robert. 1989. The New Experimentalism. *The British Journal for the Philosophy of Science* 40 (2): 185–190.
- Ajelli, Marco, Hu Bruno Gonçalves, Duygu Balcan, Vittoria Colizza, José J. Hao, Stefano Merler Ramasco, and Alessandro Vespignani. 2010. Comparing Large-Scale Computational Approaches to Epidemic Modeling: Agent-Based versus Structured Metapopulation Models. *BMC Infectious Diseases* 10 (190): 1–13.
- Alliance, International Virtual Observatory. 2018. <http://www.ivoa.net>. Accessed 26 Feb 2018.
- Anthonie, Meijers. 2009. *Philosophy of Technology and Engineering Sciences*, Elsevier.
- Appel, Kenneth, and Wolfgang Haken. 1976a. Every Planar Map is Four Colorable. *Bulletin of the American Mathematical Society* 82 (5): 711–712.
- Appel, Kenneth, and Wolfgang Haken. 1976b. A Proof of the Four Color Theorem. *Discrete Mathematics* 16 (2): 179–180.
- Ardourel, Vincent, and Julie Jebeile. 2017. On the Presumed Superiority of Analytical Solutions over Numerical Methods. *European Journal for Philosophy of Science* 7 (2): 201–220.
- Aristotle. 1965. *Historia Animalium*. Harvard University Press.
- Armstrong, Robert K., and Simon J. E. Taylor. 2017. Modeling and Simulation Societies Shaping the Profession. In *The Profession of Modeling and Simulation: Discipline, Ethics, Education, Vocation, Societies, and Economics*, ed. by Andreas Tolk and Tuncer Ören, 131–150. Wiley.
- ASME. 2006. Guide for Verification and Validation in Computational Solid Mechanics. *The American Society of Mechanical Engineers, ASME Standard V&V 10-2006*.
- Atkinson, Kendall E., Weimin Han, and David E. Stewart. 2009. *Numerical Solution of Ordinary Differential Equations*. Wiley.
- Bailer-Jones, Daniela. 2009. *Scientific Models in Philosophy of Science*. University of Pittsburgh Press.
- Balcan, Duygu, Vittoria Colizza, Bruno Gonçalves, Hu Hao, José J. Ramasco, and Alessandro Vespignani. 2009. Multiscale Mobility Networks and the Spatial Spreading of Infectious Diseases. *Proceedings of the National Academy of Sciences of the United States of America* 106 (51): 21484–21489.
- Banks, Jerry, John Carson, Barry L. Nelson, and David Nicol. 2010. *Discrete-Event System Simulation*. Prentice Hall.
- Barberousse, Anouk, and Vorms Marion. 2013. Computer Simulations and Empirical Data. In *Computer Simulations and the Changing Face of Scientific Experimentation*, ed. by Juan M. Durán and Eckhart Arnold. 29–45 Cambridge Scholars Publishing.

- Barberousse, Anouk, Sara Franceschelli, and Cyrille Imbert. 2009. Computer Simulations as Experiments. *Synthese* 169: 557–574.
- Barker, Trish. 2004. Hunt for the supertwister. National Center for Supercomputing Applications—University of Illinois at Urbana-Campaign. <http://www.ncsa.illinois.edu/news/stories/supertwister>.
- Barnes, Eric. 1994. Explaining Brute Facts. *Philosophy of Science* 1: 61–68.
- Barnstorff, Kathy. 2010. X-51A Makes Longest Scramjet Flight. <https://www.nasa.gov/topics/aeronautics/features/X-51A.html>
- Barrett, Jeffrey A., and P. Kyle Stanford. 2006. Prediction. In *The Philosophy, and of Science An Encyclopedia* ed. by S. Sarkar and J. Pfeifer, 585–599. Routledge.
- Baumann, Robert. 2005. Soft Errors in Advanced Computer Systems. *IEEE Design Test of Computers* 22 (3): 258–266.
- Beck, J.D., B.L. Canfield, S.M. Haddock, T.J.H. Chen, M. Kothari, and T.M. Keaveny. 1997. Three-Dimensional Imaging of Trabecular Bone Using the Computer Numerically Controlled Milling Technique. *Bone* 21 (3): 281–287.
- Beisbart, Claus. 2012. How Can Computer Simulations Produce New Knowledge? *European Journal for Philosophy of Science* 2: 395–434.
- Beisbart, Claus. 2017. Are computer simulations experiments? And if not, how are they related to each other? *European Journal for Philosophy of Science* 8(2): 171–204.
- Bentsen, M., I. Bethke, J.B. Debernard, T. Iversen, A. Kirkevåg, Ø. Seland, H. Drange, et al. 2013. The Norwegian Earth System Model, NorESM1-M-Part 1: Description and Basic Evaluation of the Physical Climate. *Geoscientific Model Development* 6 (3): 687–720.
- Béranger, Jérôme. 2016. *Big Data and Ethics: The Medical Datasphere*. Elsevier.
- Berekovic, Mladen, Nikitas Simopoulos, and Stephan Wong (eds.). 2008. *Embedded Computer Systems: Architectures, Modeling, and Simulation*. Springer
- Beyer, Mark, and Douglas Laney. 2012. The Importance of “Big Data”: A Definition. Gartner, G00235055.
- Bidoit, Michel, and Peter D. Mosses. 2004. *CASL User Manual: Introduction to Using the Common Algebraic Specification Language*. Springer.
- Bird, Alexander. 2013. Thomas Kuhn. In *The Stanford Encyclopedia of Philosophy*, (Fall 2013 Edition), ed. by Edward N. Zalta. <https://plato.stanford.edu/archives/fall2013/entries/thomas-kuhn/>.
- Birtwistle, Graham M. 1979. *DEMOS A System for Discrete Event Modelling on Simula*. The Macmillan Press. (Reprint 2003).
- Bjorner, Dines, and Martin C. Henson. 2007. *Logics of Specification Languages*. Springer.
- Blanco, Javier, and Pío García. 2011. A Categorical Mistake in the Formal Verification Debate. In *The Computational Turn: Past, Presents, Futures?*, ed. C. Ess, and R. Hagengruber. 30–33: Mv-Wissenschaft Århus University.
- Blass, Andreas, and Yuri Gurevich. 2003. Algorithms: A Quest for Absolute Definitions. In *Bulletin of European Association for Theoretical Computer Science* 81: 195–225.
- Blass, Andreas, Nachum Dershowitz, and Yuri Gurevich. 2009. When are Two Algorithms the Same? *The Bulletin of Symbolic Logic* 15 (2): 145–168.
- Boehm, C., J.A. Schewtschenko, R.J. Wilkinson, C.M. Baugh, and S. Pascoli. 2014. Using the Milky Way Satellites to Study Interactions between Cold Dark Matter and Radiation. *Monthly Notices of the Royal Astronomical Society* 445: L31–L35.
- Brewer, William F., and Bruce L. Lambert. 2001. The Theory-Ladenness of Observation and the Theory-Ladenness of the Rest of the Scientific Process. *Philosophy of Science* 68: S176–S186.
- Brey, Philip. 1999. The Ethics of Representation and Action in Virtual Reality. *Ethics and Information Technology* 1 (1): 5–14.
- Brey, Philip. 2008. Virtual Reality and Computer Simulation. *The Handbook of Information and Computer Ethics*, ed. by Kenneth Einar Himma and Herman T. Tavani, 361–384. Wiley.
- Briggle, Adam. 2012. *Ethics and Science: An Introduction*. Cambridge: Cambridge University Press.

- Buneman, Peter, James Cheney, Wang-Chiew Tan, and Stijn Vansummeren. 2008. Curated Databases. In *Proceedings of the Twenty-Seventh ACM SIGMODSIGACT- SIGART Symposium on Principles of Database Systems*, PODS '08, 1–12. ACM.
- Bunge, Mario. 1979. *Causality and Modern Science*. Dover Publications.
- Bunnik, Anno, Anthony Cawley, Michael Mulqueen, and Andrej Zwitter. 2016. *Big Data Challenges: Society, Security Innovation and Ethics*. Palgrave Macmillan.
- Butcher, James. 2008. Modelling of Neuronal Circuits: The Future is Bright. *The Lancet Neurology* 7 (5): 382–383.
- Cantwell-Smith, and Brian., 1985. The Limits of Correctness. *ACM SIGCAS Computers and Society* 14 (1): 18–26.
- Callebaut, Werner. 2012. “Scientific perspectivism: A philosopher of science’s response to the challenge of big data biology.” *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* 43 (1): 69–80.
- Ceruzzi, Paul E. 1998. *A History of Modern Computing*. MIT Press.
- Chatrchyan, Serguei, V. Khachatryan, A.M. Sirunyan, A. Tumasyan, W. Adam, T. Bergauer, M. Dragicevic, J. Erö, C. Fabjan, M. Friedl, et al. 2014. Measurement of the Properties of a Higgs Boson in the Four-Lepton Final State. *Physical Review D* 89 (9): 1–75.
- Chabert, Jean-Claude (ed.). 1994. *A History of Algorithms.*, From the Pebble to the Microchip. Springer.
- Choudhury, Suparna, Jennifer R. Fishman, Michelle L. McGowan, and Eric T. Juengst. 2014. Big Data, Open Science and the Brain: Lessons Learned from Genomics. *Frontiers in Human Neuroscience* 8 (239). <https://www.frontiersin.org/articles/10.3389/fnhum.2014.00239/full>. Accessed 13 Dec 2017.
- Ciletti, Michael D. 2010. *Advanced Digital Design with Verilog HDL*. Prentice Hall.
- Cohn, Avra. 1989. The Notion of Proof in Hardware Verification. *Journal of Automated Reasoning* 5 (2): 127–139.
- Colburn, Timothy, James H. Fetzer, and Terry L. Rankin (eds.). 1993. *Program Verification: Fundamental Issues in Computer Science*. Springer Science & Business Media.
- Collins, Harry, and Robert Evans. 2007. *Rethinking Expertise*. University of Chicago Press.
- Collmann, Jeff, and Sorin Adam Matei (eds.). 2016. *Ethical Reasoning in Big Data: An Exploratory Analysis*. Springer.
- Copeland, B.Jack. 1996. What is Computation? *Synthese* 108 (3): 335–359.
- Costa, Fabricio F. 2014. Big Data in Biomedicine. *Drug Discovery Today* 19 (4): 433–440.
- Craver, Carl F. 2007. *Explaining the Brain: Mechanisms and the Mosaic Unity of Neuroscience*. Oxford University Press.
- Craver, Carl F. 2001. Role Functions, Mechanisms, and Hierarchy. *Philosophy of Science* 68 (1): 53–74.
- Critchlow, Terence, and Kerstin Kleese van Dam (eds.). 2013. *Data-Intensive Science*. Chapman & Hall/CRC.
- Daston, Lorraine, and Peter Galison. 2007. *Objectivity*. Zone Books.
- De Mol, and Liesbeth, and Giuseppe Primiero. 2014. Facing Computing as Technique: Towards a History and Philosophy of Computing. *Philosophy & Technology* 27 (3): 321–326.
- De Mol, and Liesbeth, and Giuseppe Primiero. 2015. When Logic Meets Engineering: Introduction to Logical Issues in the History and Philosophy of Computer Science. *History and Philosophy of Logic* 36 (3): 195–204.
- De Pierris, Graciela, and Michael Friedman. 2013. Kant and Hume on Causality. In *The Stanford Encyclopedia of Philosophy*, (Winter 2013 Edition), ed. by Edward N. Zalta. <https://plato.stanford.edu/archives/win2013/entries/kant-hume-causality/>.
- Denzin, Norman K. (ed) 2006. *Sociological Methods: A Sourcebook*. Taylor and Francis.
- Deutsche Forschungsgemeinschaft (ed.). 2013. *Sicherung Guter Wissenschaftlicher Praxis—Safeguarding Good Scientific Practice*. Wiley.
- Dijkstra, Edsger W. 1974. Programming as a Discipline of Mathematical Nature. *American Mathematical Monthly* 81 (6): 608–612.

- Douglas, Heather. 2009. *Science, Policy, and the Value-free Ideal*. University of Pittsburgh Press.
- Douglas, Isbell, and Don Savage. 1999. *Mars Climate Orbiter Failure Board Releases Report, Numerous NASA Actions Underway in Response*. <http://sunnyday.mit.edu/accidents/mco991110.html>. Accessed 16 Aug 2018.
- Dowe, Phil. 2000. *Physical Causation*. Cambridge University Press
- Drogoul, Alexis, Jacques Ferber, and Christophe Cambier. 1992. Multi-agent Simulation as a Tool for Modeling Societies: Application to Social Differentiation in Ant Colonies. In *Simulating Societies*, ed. by G. Nigel Gilbert, 49–62. University of Surrey.
- Durán, Juan M. 2013a. A Brief Overview of the Philosophical Study of Computer Simulations. *APA Newsletter on Philosophy and Computers* 13 (1): 38–46.
- Durán, Juan M. 2013b. The Use of the ‘Materiality Argument’ in the Literature on Computer Simulations. In *Computer Simulations and the Changing Face of Scientific Experimentation*, ed. by Juan M. Durán and Eckhart Arnold, 76–98. Cambridge Scholars Publishing.
- Durán, Juan M. 2014. Explaining Simulated Phenomena: A Defense of the Epistemic Power of Computer Simulations. *PhD dissertation, Universität Stuttgart*. <https://elib.unistuttgart.de/handle/11682/5409>.
- Durán, Juan M. 2017a. Varieties of Simulations: From the Analogue to the Digital. In *Science and Art of Simulation 2015*, ed. by M. Resch, A. Kaminski, and P. Gehring. Springer.
- Durán, Juan M. 2017b. Varying the Explanatory Span: Scientific Explanation for Computer Simulations. *International Studies in the Philosophy of Science* 31 (1): 27–45.
- Durán, Juan M. and Nico Formanek 2018a. Essential Epistemic Opacity and Computational Reliabilism: Grounds for Trust. Unpublished.
- Durán, Juan M. 2018b. Ciencia de la computación y filosofía: unidades de análisis del software. *Principia: An International Journal of Epistemology*, 22(2): 203–227.
- Edwards, Kieran, and Mohamed Medhat Gaber (eds.). 2014. *Astronomy and Big Data. A Data Clustering Approach to Identifying Uncertain Galaxy Morphology* Cham: Springer.
- El Skaf, and Rawad, and Cyrille Imbert. 2013. Unfolding in the Empirical Sciences: Experiments. *Thought Experiments and Computer Simulations. Synthese* 190 (16): 3451–3474.
- Elgin, Catherine. 2007. Understanding and the Facts. *Philosophical Studies* 132 (1): 33–42.
- Elgin, Catherine. 2009. Is Understanding Factive? In *Epistemic Value*, ed. by A. Haddock, A. Millar, and D.H. Pritchard, 322–330. Oxford University Press.
- Fahrbach, Ludwig. 2005. Understanding Brute Facts. *Synthese* 145 (3): 449–466.
- Falcon, Andrea. 2015. Aristotle on Causality. In *The Stanford Encyclopedia of Philosophy*, ed. by Edward N. Zalta. Spring 2015 Edition. <https://plato.stanford.edu/archives/spr2015/entries/aristotlecausality/>.
- Fetzer, James H. 1988. Program Verification: The Very Idea. *Communications of the ACM* 37 (9): 1048–1063.
- Feynman, Richard P. 2001. *What Do You Care What Other People Think?*. W.W: Norton & Company.
- Floridi, Luciano. 2012. Big Data and Their Epistemological Challenge. *Philosophy and Technology* 25 (4): 435–437.
- Floridi, Luciano, Nir Fresco, and Giuseppe Primiero. 2015. On Malfunctioning Software. *Synthese* 192 (4): 1199–1220.
- Fox Keller, Evelyn. 2003. Models, Simulations, and “Computer Experiments”. In *The Philosophy of Scientific Experimentation*, ed. by Hans Radder, 198–215. University of Pittsburgh Press.
- Franklin, Allan. 1981. What Makes a ‘Good’ Experiment? *The British Journal for the Philosophy of Science* 32 (4): 367–374.
- Franklin, Allan. 1986. *The Neglect of Experiment*. Cambridge University Press.
- Freedman, David, and Paul W. Humphreys. 1999. Are There Algorithms That Discover Causal Structure? *Synthese* 121 (1): 29–54.
- Fresco, Nir, and Giuseppe Primiero. 2013. Miscomputation. *Philosophy & Technology* 26 (3): 253–272.
- Friedman, Michael. 1974. Explanation and Scientific Understanding. *The Journal of Philosophy* 71 (1): 5–19.

- Frigg, Roman, and Stephan Hartmann. 2006. Scientific Models. In *The Philosophy of Science. An Encyclopedia*, ed. by S. Sarkar, and J. Pfeifer, 740–749. Routledge.
- Frigg, Roman, and Julian Reiss. 2009. The Philosophy of Simulation: Hot New Issues or Same Old Stew? *Synthese* 169 (3): 593–613.
- Fuchs, Norbert E. 1992. Specifications are (Preferably) Executable. *Software Engineering Journal* 7 (5): 323–334.
- Galison, Peter. 1996. Computer Simulations and the Trading Zone. In *The Disunity of Science: Boundaries, Contexts, and Power*, ed. by Peter Galison and David J. Stump, 119–157. Stanford University Press.
- García, Pío, and Marisa Velasco. 2013. Exploratory Strategies: Experiments and Simulations. In *Computer Simulations and the Changing Face of Scientific Experimentation*, ed. by Juan M. Durán and Eckhart Arnold, 99–117. Cambridge Scholars Publishing.
- Gardner, Martin. 1970. The Fantastic Combinations of John Conway’s New Solitaire Game “Life”. *Scientific American* 223 (4): 120–123.
- Gedenk, Eric. 2017. CAVE Visualization Room Immerses Researchers in Simulations. <https://www.hlrs.de/en/solutions-services/service-portfolio/visualization/virtual-reality/>. Accessed 27 Jun 2016.
- Gelfert, Axel. 2016. *How to Do Science with Models*. A Philosophical Primer. Springer Briefs in Philosophy: Springer.
- Gelfert, Axel. 2018. Models in Search of Targets: Exploratory Modelling and the Case of Turing Patterns. In *Philosophy of Science*, ed. by Alexander Christian, David Hommen, Nina Retzlaff, and Gerhard Schurz, 9: 245–269. European Studies in Philosophy of Science, Springer, Cham.
- Giere, Ronald N. 2009. Is Computer Simulation Changing the Face of Experimentation? *Philosophical Studies* 143 (1): 59–62.
- Gilbert, Nigel, and Klaus G. Troitzsch. 2005. *Simulation for the Social Scientist*. 2nd ed. Open University Press.
- Ginsberg, Jeremy, Matthew H. Mohebbi, Rajan S. Patel, Lynnette Brammer, Mark S. Smolinski, and Larry Brilliant. 2009. Detecting Influenza Epidemics Using Search Engine Query Data. *Nature* 457: 1012–1014.
- Goldman, Alvin I. 1979. What is Justified Brief? In *Justification and Knowledge: New Studies in Epistemology*, ed. by George S. Pappas, 1–23. Springer.
- Gorlin, Rena A. 1994. *Codes of Professional Responsibility*. BNA Books.
- Gould, Harvey, Jan Tobochnik and Wolfgang Christian. 2007. *An Introduction to Computer Simulation Methods., Applications to Physical Systems*. Pearson Addison Wesley.
- Gray, Jim. 2009. Jim Gray on eScience: A Transformed Scientific Method. In *Fourth Paradigm Data-Intensive Scientific Discovery* ed by Tony Hey, Stewart Tansley, and Kristin Tolle, xvii–xxxi.
- Grimm, Stephen R. 2010. The Goal of Explanation. *Studies in History and Philosophy of Science* 41: 337–344.
- Guala, Francesco. 2002. Models, Simulations, and Experiments. In *Model-Based Reasoning: Science, Technology, Values*, ed. by Lorenzo Magnani and Nancy J. Nersessian, 59–74. Kluwer Academic.
- Gupta, Anil K., Raj K. Singh, Sudheer Joseph, and Ellen Thomas. 2004. Indian Ocean High-Productivity Event (10–8 Ma): Linked to Global Cooling or to the Initiation of the Indian Monsoons? *Geology* 32 (9): 753–756.
- Hacking, Ian. 1992. The Self-vindication of the Laboratory Sciences. In *Science as Practice and Culture*, ed. by Andrew Pickering, 29–64. University of Chicago Press.
- Haddock, Adrian, Alan Millar, and Duncan Pritchard. 2009. *Epistemic Value*. Oxford University Press.
- Halfhill, Tom R. 1995. The Truth Behind the Pentium Bug: An error in a lookup table created the infamous bug in Intel’s latest processor. *BYTE* (March). <https://web.archive.org/web/20060209005434/http://www.byte.com/art/9503/sec13/art1.htm>. Accessed 17 Oct 2017.

- Halloran, M.Elizabeth, Neil M. Ferguson, Stephen Eubank, Ira M. Longini, Derek A.T. Cummings, Bryan Lewis, Xu Shufu, Christophe Fraser, Anil Vullikanti, Timothy C. Germann, et al. 2008. Modeling Targeted Layered Containment of an Influenza Pandemic in the United States. *Proceedings of the National Academy of Sciences*, ed. by Barry R. Bloom 105 (12): 4639–4644.
- Hanson, Norwood Russell. 1958. *Patterns of Discovery: An Inquiry Into the Conceptual Foundations of Science*. Cambridge University Press.
- Harris Jr, Charles E., Michael S. Pritchard, Michael J. Rabins. 2009. *Engineering Ethics Concepts and Cases*. Cengage Learning.
- Hartmann, Stephan. 1996. The World as a Process: Simulations in the Natural and Social Sciences. In *Modelling and Simulation in the Social Sciences from the Philosophy of Science Point of View*, ed. by R. Hegselmann, Ulrich Mueller, and Klaus G. Troitzsch, 77–100. Kluwer.
- Hartmann, Stephan. 1999. Models and Stories in Hadron Physics. In *Models as Mediators: Perspectives on Natural and Social Science*, ed. by Mary S. Morgan, and Margaret Morrison. 326–246 Cambridge University Press.
- Hasse, Hans, and Johannes Lenhard. 2017. Boon and Bane: On the Role of Adjustable Parameters in Simulation Models. In *Mathematics as a Tool. Tracing New Roles of Mathematics in the Sciences*, ed. by Johannes Lenhard and M. Carrier. 93–116. Boston Studies in the Philosophy and History of Science. Springer.
- Hempel, Carl G., and P. Oppenheim. 1948. Studies in the Logic of Explanation. *Philosophy of Science* 15 (2): 135–175.
- Hempel, Carl G. 1965. *Aspects of Scientific Explanation and Other Essays in the Philosophy of Science*. The Free Press.
- Hey, Tony, Stewart Tansley, and Kristin Tolle (eds.). 2009. *The Fourth Paradigm: Data-Intensive Scientific Discovery*. Microsoft Corporation.
- Hick, Jason, Dick Watson, and Danny Cook. 2010. *HPSS in the Extreme Scale Era: Report to DOE Office of Science on HPSS in 2018–2022*. Report Number: LBNL–3877E.
- Hoare, C.A.R. 1999. *A Theory Of Programming: Denotational, Algebraic and Operational Semantics*. Technical Report, Microsoft Research. https://www.microsoft.com/en-us/research/wpcontent/uploads/2016/02/a_theory_of_programming.pdf. Accessed 16 Aug 2018.
- Hill, Robin K. 2013. What an Algorithm Is, and Is Not. *Communications of the ACM* 56 (6): 8–9.
- Hill, Robin K. 2016. What an Algorithm Is. *Philosophy & Technology* 29 (1): 35–59.
- Himeno, Ryutarō. 2013. Largest Neuronal Network Simulation Achieved Using K Computer. http://www.riken.jp/en/pr/press/2013/20130802_1/. Accessed 16 Aug 2018.
- Hoare, C.A.R. 1971. Computer Science. In *Essays in Computing Science* (1989) ed. by C. B. Jones, 89–102. Prentice Hall International.
- Hoose, Corinna, Jón Egill Kristjánsson, Jen-Ping Chen, and Anupam Hazra. 2010. A Classical-Theory-Based Parameterization of Heterogeneous Ice Nucleation by Mineral Dust, Soot, and Biological Particles in a Global Climate Model. *Journal of the Atmospheric Sciences* 67 (8): 2483–2503.
- Humphreys, Paul, and Cyrille Imbert (eds.). 2012. *Models, Simulations, and Representations*. Routledge Studies in the Philosophy of Science: Routledge.
- Humphreys, Paul W. 1990. PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association. *Computer Simulations* 2: 497–506.
- Humphreys, Paul W. 1997. A Critical Appraisal of Causal Discovery Algorithms. In *Causality in Crisis?: Statistical Methods and the Search for Causal Knowledge in the Social Sciences*, ed. by Vaughn R. McKim and Stephen P. Turner, 249–263. University of Notre Dame Press.
- Humphreys, Paul W. 2004. *Extending Ourselves: Computational Science, Empiricism, and Scientific Method*. Oxford University Press.
- Humphreys, Paul W. 2009. The Philosophical Novelty of Computer Simulation Methods. *Synthese* 169 (3): 615–626.
- Humphreys, Paul W. 2013a. Data Analysis: Models or Techniques? *Foundations of Science* 18 (3): 579–581.

- Humphreys, Paul W. 2013b. What are Data About? In *Computer Simulations, and the Changing Face of Scientific Experimentation*, ed. by M. Juan. Durán and Eckhart Arnold, 12–28. Cambridge Scholars Publishing.
- Ichikawa, Jonathan Jenkins, and Matthias Steup. 2012. The Analysis of Knowledge. In *The Stanford Encyclopedia of Philosophy*, Winter 2012, ed. by Edward N. Zalta. <https://plato.stanford.edu/archives/win2012/entries/knowledge-analysis/>. Accessed 16 Aug 2018.
- IDC. 2014. The Digital Universe of Opportunities: Rich Data and the Increasing Value of the Internet of Things. <https://www.emc.com/leadership/digital-universe/2014iview/executive-summary.htm>. Accessed 11 Dec 2017.
- Interstellar Medium of Isolated GALaxies, AMIGA. 2018. <http://amiga.iaa.es/p/1-homepage.htm>. Accessed 26 Feb 2018.
- Jamieson, Dale. 2008. *Ethics and the Environment: An Introduction*. Cambridge University Press.
- Jason, Gary. 1989. The Role of Error in Computer Science. *Philosophia* 19 (4): 403–416.
- Johnson, Deborah G. 1985. *Computer Ethics*. Englewood Cliffs.
- Kaminski, Andreas, Michael Resch, and Uwe Küster. 2018. Mathematische Opazität. Über Rechtfertigung und Reproduzierbarkeit in der Computersimulation. In *Jahrbuch Technikphilosophie*, ed. by Alexander Friedrich, Petra Gehring, Christoph Hubig, Andreas Kaminski, and Alfred Nordmann, 253–278. Nomos Verlagsgesellschaft.
- Karaca, Koray. 2013. The Strong and Weak Senses of Theory-Ladenness of Experimentation: Theory-Driven versus Exploratory Experiments in the History of High-Energy Particle Physics. *Science in Context* 26 (1): 93–136.
- Keaveny, Tony M., Edward F. Wachtel, X. Edward Guo, and Wilson C. Hayes. 1994. Mechanical Behavior of Damaged Trabecular Bone. *Journal of Biomechanics* 27 (11): 1309–1318.
- Kennedy, Ashley Graham. 2012. A Non Representationalist View of Model Explanation. *Studies in History and Philosophy of Science Part A* 43 (2): 326–332.
- Kennedy, Marc C., and Anthony O’Hagan. 2001. Bayesian Calibration of Computer Models. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)* 63 (3): 425–464.
- Kim, Jaegwon. 1994. Explanatory Knowledge and Metaphysical Dependence. *Philosophical Issues* 5: 51–69.
- Kitcher, Philip. 1981. Explanatory Unification. *Philosophy of Science* 48 (4): 507–531.
- Kitcher, Philip. 1989. Explanatory Unification and the Causal Structure of the World. In *Scientific Explanation*, ed. by Philip Kitcher, and Wesley C. Salmon, 410–505. University of Minnesota Press.
- Kitchin, Rob. 2014. Big Data, New Epistemologies and Paradigm Shifts. *Big Data & Society* 1–12.
- Knupp, Patrick, and Kambiz Salari. 2003. *Verification of Computer Codes in Computational Science and Engineering*. Chapman & Hall/CRC.
- Knuth, Donald E. 1973. *The Art of Computer Programming*. Addison-Wesley.
- Knuth, Donald E. 1974. Computer Science and Its Relation to Mathematics. *The American Mathematical Monthly* 81 (4): 323–343.
- Knuutila, Tarja. 2005. *Models as Epistemic Artefacts: Toward a Non-Representationalist Account of Scientific Representation*. Philosophical Studies from the University of Helsinki 8.
- Kroepelin, S. 2006. Revisiting the Age of the Sahara Desert. *Science* 312(5777): 1138–1139
- Krohs, Ulrich. 2008. How Digital Computer Simulations Explain Real-World Processes. *International Studies in the Philosophy of Science* 22 (3): 277–292.
- Kuhn, Thomas S. 1962. *The Structure of Scientific Revolutions*. University of Chicago Press.
- Kuhn, Thomas S. 1970. Logic of Discovery or Psychology of Research? In *Criticism and the Growth of Knowledge: Proceedings of the International Colloquium in the Philosophy of Science, London, 1965*, vol. ed. by Imre Lakatos and Alan Musgrave, 1–24. Cambridge University Press.
- Küppers, Günter, and Johannes Lenhard. 2005. Validation of Simulation: Patterns in the Social and Natural Sciences. *Journal of Artificial Societies and Social Simulation* 8 (4). <http://jasss.soc.surrey.ac.uk/8/4/3.html>. Accessed 16 Aug 2018.

- Laboratory, Los Alamos National. 2015. *Largest Computational Biology Simulation Mimics Life's Most Essential Nanomachine*. <https://www.sciencedaily.com/releases/2005/11/05110110223046.htm>. Accessed 15 July 2017.
- Laney, Doug. 2001. 3D Data Management: Controlling Data Volume, Velocity, and Variety. *Application Delivery Strategies* File 949. <https://blogs.gartner.com/douglaney/files/2012/01/ad949-3D-Data-Management-Controlling-Data-Volume-Velocity-and-Variety.pdf>. Accessed Feb 2017.
- Latour, Bruno and Steve Woolgar. 1987. *Laboratory Life: The Construction of Scientific Facts*. Princeton University Press.
- Lenhard, Johannes, and Eric Winsberg. 2010. Holism, Entrenchment, and the Future of Climate Model Pluralism. *Studies in History and Philosophy of Modern Physics* 41 (3): 253–262.
- Lenhard, Johannes. 2006. Surprised by a Nanowire: Simulation, Control, and Understanding. *Philosophy of Science* 73 (5): 605–616.
- Lenhard, Johannes. 2007. Computer Simulation: The Cooperation Between Experimenting and Modeling. *Philosophy of Science* 74: 176–194.
- Leonelli, Sabina. 2014. What Difference Does Quantity Make? On the Epistemology of Big Data in Biology. *Big Data & Society* 1: 1–11.
- Lesne, Annick. 2007. The Discrete Versus Continuous Controversy in Physics. *Mathematical Structures in Computer Science* 17 (2): 185–223.
- Lieberman, Mark. 2003. Zettascale Linguistics. <http://itre.cis.upenn.edu/myl/language/og/archives/000087.html>. Accessed 10 March 2016.
- Linder, C. 2012. A Numerical Investigation of the Exponential Electric Displacement Saturation Model in Fracturing Piezoelectric Ceramics. *Technische Mechanik* 32: 53–69.
- Lipton, Peter. 2001. What Good is an Explanation? In *Explanation Theoretical Approaches and Applications*, ed. by Giora Hon and Sam S. Rakover. 43–59. Springer.
- Lloyd, Elisabeth A. 1995. Objectivity and the Double Standard for Feminist Epistemologies. *Synthese* 104 (3): 351–381.
- Longino, Helen E. 1990. *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry*. Princeton University Press.
- Luegenbiehl, Heinz. 1991. Codes of Ethics and the Moral Education of Engineers. In *Ethical Issues in Engineering*, ed. by Deborah Johnson, 4th edn, 137–138. Prentice Hall.
- Lupton, Deborah. 2014. The Commodification of Patient Opinion: The Digital Patient Experience Economy in the Age of Big Data. *Sociology of Health & Illness* 36 (6): 856–869.
- Machamer, Peter, Lindley Darden, and Carl F. Craver. 2000. Thinking about Mechanisms. *Philosophy of Science* 67 (1): 1–25.
- MacKenzie, Donald A. 2001. *Mechanizing Proof: Computing, Risk, and Trust Inside Technology*. MIT Press.
- Mackie, J.L. 1980. *The Cement of the Universe*. Oxford University Press.
- Mahajan, Roop L., Rolf Mueller, Christopher B. Williams, Jeff Reed, Thomas A. Campbell, and Naren Ramakrishnan. 2012. Cultivating Emerging and Black Swan Technologies. *ASME 2012 International Mechanical Engineering Congress and Exposition* 6: 549–557.
- Marr, Bernard. 2016. *Big Data in Practice: How 45 Successful Companies Used Big Data Analytics to Deliver Extraordinary Results*. Wiley.
- Massimi, Michela, and Wahid Bhimji. 2015. Computer Simulations and Experiments: The Case of the Higgs Boson. *Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics* 51: 71–81.
- Mayer-Schönberger, Viktor, and Kenneth Cukier. 2013. *Big Data: A Revolution That Will Transform How We Live, Work, and Think*. Houghton Mifflin Harcourt.
- Mayo, Deborah G., and Aris Spanos, eds. 2010. *Error and Inference. Recent Exchanges on Experimental Reasoning, Reliability, and the Objectivity and Rationality of Science*. Cambridge University Press.
- Mayo, Deborah G. 1994. The New Experimentalism, Topical Hypotheses, and Learning from Error. In *PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association* 1: 270–279.

- Mayo, Deborah G. 1996. *Error and the Growth of Experimental Knowledge*. University of Chicago Press.
- Mayo, Deborah G. 2010. Learning from Error, Severe Testing, and the Growth of Theoretical Knowledge. In *Error and Inference. Recent Exchanges on Experimental Reasoning, Reliability, and the Objectivity and Rationality of Science*, ed. by Deborah G. Mayo and Aris Spanos. 28–57. University of Chicago Press.
- McFarland, John, and Sankaran Mahadevan. 2008. Multivariate Significance Testing and Model Calibration under Uncertainty. *Computer Methods in Applied Mechanics and Engineering* 197: 2467–2479.
- McLeod, John. 1986. But, Mr. President—Is it Ethical? In *Proceedings of the 1986 Winter Simulation Conference* ed. by J. Wilson, J. Henriksen, and S. Roberts. 69–71.
- McMillan, Claude, and Richard F. González. 1965. *Systems Analysis: A Computer Approach to Decision Models*. Homewood/Ill: Irwin.
- Meehl, Gerard A., Thomas F. Stocker, William D. Collins, A. T. Friedlingstein, T. Gaye Amadou, M. Gregory Jonathan, Akio Kitoh et al. 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In Chap. *Global Climate Projections*, ed. by S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller, 747–845. Cambridge University Press.
- Millo, De, A. Richard, Richard J. Lipton, and Alan J. Perlis. 1979. Social Processes and Proofs of Theorems and Programs. *Communications of the ACM* 22 (5): 271–280.
- Mittelstadt, Brent Daniel, and Luciano Floridi. 2016a. The Ethics of Big Data: Current and Foreseeable Issues in Biomedical Contexts. *Science and Engineering Ethics* 22 (2): 303–341.
- Mittelstadt, Brent Daniel, and Luciano Floridi. 2016b. *The Ethics of Biomedical Big Data*. Springer.
- Moor, James H. 1985. What Is Computer Ethics? *Metaphilosophy* 16 (4): 266–275.
- Moor, James H. 1988. The Pseudorealization Fallacy and the Chinese Room Argument. In *Aspects of Artificial Intelligence*, ed. by James Fetzer, 35–53. Springer.
- Morgan, Mary S., and Margaret Morrison (eds.). 1999. *Models as Mediators: Perspectives on Natural and Social Sciences*. Cambridge University Press.
- Morgan, Mary S. 2003. Experiments without Material Intervention. In *The Philosophy of Scientific Experimentation*, ed. by Hans Radder, 216–235. University of Pittsburgh Press.
- Morgan, Mary S. 2005. Experiments Versus Models: New Phenomena, Inference and Surprise. *Journal of Economic Methodology* 12 (2): 317–329.
- Morrison, Margaret. 2009. Models, Measurement and Computer Simulation: The Changing Face of Experimentation. *Philosophical Studies* 143 (1): 33–57.
- Morrison, Margaret. 2015. *Reconstructing Reality. Models, Mathematics, and Simulations*. Oxford University Press.
- Müller, Tibor, and Harmund Müller. 2003. *Modelling in Natural Sciences*. Springer.
- Naylor, Thomas H., William H. Wallace, and W. Earl Sasser. 1967a. A Computer Simulation Model of the Textile Industry. *Journal of the American Statistical Association* 62 (320): 1338–1364.
- Naylor, Thomas H., J.M. Finger, James L. McKenney, Williams E. Schrank, and Charles C. Holt. 1967b. Verification of Computer Simulation Models. *Management Science* 14 (2): 92–106.
- Newman, Julian. 2016. Epistemic Opacity, Confirmation Holism and Technical Debt: Computer Simulation in the Light of Empirical Software Engineering. In *History and Philosophy of Computing—Third International Conference, HaPoC 2015*, ed. by Fabio Gadducci and Mirko Tamosanis, 256–272. Springer.
- Niebur, Glen L., Michael J. Feldstein, Jonathan C. Yuen, Tony J. Chen, and Tony M. Keaveny. 2000. High-Resolution Finite Element Models with Tissue Strength Asymmetry Accurately Predict Failure of Trabecular Bone. *Journal of Biomechanics* 33 (12): 1575–1583.
- NSF. 2012. Core Techniques and Technologies for Advancing Big Data Science & Engineering (BIGDATA). NSF 12-499. <https://www.nsf.gov/pubs/2012/nsf12499/nsf12499.htm>. Accessed 17 Oct 2017.

- NSF. 2014. Critical Techniques and Technologies for Advancing Big Data Science & Engineering (BIGDATA). NSF 14-543. <https://www.nsf.gov/pubs/2014/nsf14543/nsf14543.htm>. Accessed 17 Oct 2017.
- NSF. 2016. Critical Techniques, Technologies and Methodologies for Advancing Foundations and Applications of Big Data Sciences and Engineering (BIGDATA). NSF 16-512. <https://www.nsf.gov/pubs/2016/nsf16512/nsf16512.htm>. Accessed 17 Oct 2017.
- Oberkampf, William L., and Christopher J. Roy. 2010. *Verification and Validation in Scientific Computing*. Cambridge University Press.
- Oberkampf, William L., and Timothy G. Trucano. 2002. Verification and Validation in Computational Fluid Dynamics. *Progress in Aerospace Sciences* 38 (3): 209–272.
- Oberkampf, William L., and Timothy G. Trucano. 2008. Verification and Validation Benchmarks. *Nuclear Engineering and Design* 238 (3): 716–743.
- Oberkampf, William L., Timothy G. Trucano, and Charles Hirsch. 2003. *Verification, Validation, and Predictive Capability in Computational Engineering and Physics*. Department of Energy: Sandia National Laboratories. United States.
- Ören, Tuncer, Bernard P. Zeigler, and Maurice S. Elzas (eds.). 1982. In *Proceedings of the NATO Advanced Study Institute on Simulation and Mode-Based Methodologies: An Integrative View*. NATO ASI Series. Springer.
- Ören, Tuncer. 1984. Model-Based Activities: A Paradigm Shift. In *Simulation and Model-Based Methodologies: An Integrative View*, ed. by Tuncer Ören, B.P. Zeigler and M.S. Elzas, 3–40. Springer.
- Ören, Tuncer I. 2000. Responsibility, Ethics, and Simulation. *Transactions of The Society for Computer Simulation International* 17 (4): 165–170.
- Ören, Tuncer I. 2002. Rationale for a Code of Professional Ethics for Simulationists. In *Summer Computer Simulation Conference*, 428–433. Society for Computer Simulation International, 1998.
- Ören, Tuncer. 2011a. A Critical Review of Definitions and About 400 Types of Modeling and Simulation. *SCS M&S Magazine* 2 (3): 142–151.
- Ören, Tuncer. 2011b. The Many Facets of Simulation through a Collection of about 100 Definitions. *SCS M&S Magazine* 2 (2): 82–92.
- Oreskes, Naomi, and Kristin. Shrader-Frechette, and Kenneth Belitz. 1994. Verification, Validation, and Confirmation of Numerical Models in the Earth Sciences. *Science* 263 (5147): 641–646.
- Orf, Leigh, Robert Wilhelmson, Lou Wicker, B.D. Lee, and C.A. Finley. 2014. Talk 3B.3 Genesis and maintenance of a long-track EF5 tornado embedded within a simulated supercell the 27th Conference on Severe Local Storms. <https://ams.confex.com/ams/27SLS/webprogram/Paper255451.html>. Accessed 21 September 2016.
- Parke, Emily C. 2014. Experiments, Simulations, and Epistemic Privilege. *Philosophy of Science* 81 (4): 516–536.
- Parker, Wendy S. 2008. Computer Simulations Through an Error-Statistical Lens. *Synthese* 163 (3): 371–384.
- Parker, Wendy S. 2009. Does Matter Really Matter? Computer Simulations, Experiments, and Materiality. *Synthese* 169 (3): 483–496.
- Parker, Wendy S. 2014. Simulation and Understanding in the Study of Weather and Climate. *Perspectives on Science* 22 (3): 336–356.
- Pearl, Judea. 2000. *Causality. Models, Reasoning, and Inference*. Cambridge University Press.
- Perini, Laura. 2004. Visual Representations and Confirmation. *Philosophy of Science* 72 (5): 913–916.
- Perini, Laura. 2005. The Truth in Pictures. *Philosophy of Science* 72 (1): 262–285.
- Perini, Laura. 2006. Visual Representation. In: *The Philosophy of Science. An Encyclopedia*, ed. by Sahotra Sarkar and Jessica Pfeifer, 863–870. Routledge.
- Pfleeger, Shari Lawrence, and Joanne M. Atlee. 2010. *Software Engineering: Theory and Practice*. Prentice Hall.
- Piccinini, Gualtiero. 2007. Computing Mechanisms. *Philosophy of Science* 74: 501–526.

- Piccinini, Gualtiero. 2008. Computation without Representation. *Philosophical Studies* 137 (2): 205–241.
- Pietsch, Wolfgang. 2015. The Causal Nature of Modeling with Big Data. *Philosophy & Technology* 29 (2): 137–171.
- Press, William H., Saul A. Teukolsky, William T. Vetterling, and Brian P. Flannery. 2007. *Numerical Recipes. The Art of Scientific Computing*. Cambridge University Press.
- Primiero, Giuseppe. 2014. On the Ontology of the Computing Process and the Epistemology of the Computed. *Philosophy & Technology* 27 (3): 485–489.
- Primiero, Giuseppe. 2016. Information in the Philosophy of Computer Science. In *The Routledge Handbook of Philosophy of Information*, ed. by Luciano Floridi, 90–106. Routledge.
- Pritchard, Duncan. 2010. *What is this Thing Called Knowledge?* Routledge.
- Pritchard, J. 1998. Codes of Ethics. In *Encyclopedia of Applied Ethics (Second Edition)*, ed. by Ruth Chadwick, 494–499. Academic Press.
- Radford, Colin. 1966. Knowledge by Examples. *Analysis* 27 (1): 1–11.
- Ramstein, Gilles, Frédéric Fluteau, Jean Besse, and Sylvie Joussaume. 1997. Effect of Orography, Plate Motion and Land-Sea Distribution on Eurasian Climate Change over the Past 30 Million Years. *Nature* 386: 788–795.
- Rapaport, William J. 1999. Implementation is Semantic Interpretation. *The Monist* 82 (1): 109–130.
- Rapaport, William J. 2005. Implementation is Semantic Interpretation: Further Thoughts. *Journal of Experimental & Theoretical Artificial Intelligence* 17 (4): 385–417.
- Rimoldi, Adele. 2011. Simulation Strategies for the ATLA Experiment at LHC. In *Journal of Physics: Conference Series*, 331: 1–8. IOP Publishing. http://inspirehep.net/record/1117099/files/jpconf11_331_032026.pdf. Accessed 12 July 2018.
- Rohrlich, Fritz. 1990. Computer Simulation in the Physical Sciences. *Philosophy of Science Association* 2: 507–518.
- Rojas, Raúl, and Ulf Hashagen (eds.). 2000. *The First Computers: History and Architectures*. MIT Press.
- Saam, Nicole J. 2016. What is a Computer Simulation? A Review of a Passionate Debate. *Journal for General Philosophy of Science* 48 (2): 293–309.
- Safran, Charles, Meryl Bloomrosen, W. Edward Hammond, Steven Labkoff, Suzanne Markel-Fox, Paul C. Tang, and Don E. Detmer. 2006. Toward a National Framework for the Secondary Use of Health Data: An American Medical Informatics Association White Paper. *Journal of the American Medical Informatics Association* 14 (1): 1–9.
- Salmon, Wesley C. 1984. *Scientific Explanation and the Causal Structure of the World*. Princeton University Press.
- Salmon, Wesley C. 1989. *Four Decades of Scientific Explanation*. University of Pittsburgh Press.
- Salmon, Wesley C. 1998. *Causality and Explanation*. Oxford University Press.
- Sargent, Robert G. 2007. Verification and Validation of Simulation Models. In *Proceedings of the 2007 Winter Simulation Conference* ed. by S. G. Henderson, B. Biller, M.-H. Hsieh, J. Shortle, J. D. Tew, and R. R. Barton, 124–137. IEEE Computer Society Press.
- Schelling, Thomas C. 1971. On the Ecology of Micromotives. *National Affairs* 25 (Fall). https://www.nationalaffairs.com/public_interest/detail/on-the-ecology-of-micromotives. Accessed 12 Aug 2017.
- Schiaffonati, Viola. 2016. Stretching the Traditional Notion of Experiment in Computing: Explorative Experiments. *Science and Engineering Ethics* 22 (3): 647–665.
- Schneider, Ralf, and Michael M Resch. 2014. Calculation of the Discrete Effective Stiffness of Cancellous Bone by Direct Mechanical Simulations. In *Computational Surgery and Dual Training*, ed. by Marc Garbey, Barbara L. Bass, Scott Berceci, Christophe Collet, and Pietro Cerveri, 351–361. Springer.
- Schurz, Gerhard, and Karel Lambert. 1994. Outline of a Theory of Scientific Understanding. *Synthese* 101: 65–120.

- Schuster, Mathieu, Philippe Durringer, and Jean-François Gainé, Patrick Vignaud, Hassan T. Mackaye, Andossa Likius, and Michel Brunet. 2006. The Age of the Sahara Desert. *Science* 311 (5762): 821–821.
- Seibel, Peter. 2009. *Coders at Work: Reflections on the Craft of Programming*. Apress.
- Shackley, Simon, Peter Young, Stuart Parkinson, and Brian Wynne. 1998. Uncertainty, Complexity and Concepts of Good Science in Climate Change Modelling: Are GCMs the Best Tools? *Climatic Change* 38 (2): 159–205.
- Shannon, Robert E. 1975. *Systems Simulation: The Art and Science*. Prentice Hall.
- Shannon, Robert E. 1978. Design and Analysis of Simulation Experiments. In *Proceedings of the 10th Conference on Winter Simulation*, vol. I, 53–61. IEEE Press.
- Shannon, Robert E. 1998. Introduction to the Art and Science of Simulation. In *Proceedings of the 1998 Winter Simulation Conference*, ed. by , D.J. Medeiros, E.F. Watson, J.S. Carson and M.S. Manivannan, 7–14. Los Alamitos: IEEE Computer Society Press.
- Shove, Elizabeth. 2003. *Comfort. Cleanliness and Convenience: The Social Organization of Normality*. Berg Publishers.
- Shubik, Martin. 1960. Simulation of the Industry and The Firm. *The American Economic Review* 50 (5): 908–919.
- Simonite, Tom. 2008. Should Every Computer Chip have a Cosmic Ray Detector? NewScientist. <https://www.newscientist.com/blog/technology/2008/03/do-we-need-cosmic-ray-alerts-for.html>.
- Slayman, C. 2010. Soft Errors-Past History and Recent Discoveries. In 2010. *IEEE International Integrated Reliability Workshop Final Report* 25–30. IEEE Computer Society Press.
- Smith, Reid G., and Randall Davis. 1981. Frameworks for Cooperation in Distributed Problem Solving. *IEEE Transactions on Systems, Man, and Cybernetics* 11 (1): 61–70. ISSN: 0018-9472. <https://doi.org/10.1109/TSMC.1981.4308579>.
- Spier, Raymond E. 2012. Science and Engineering Ethics, Overview. In *Encyclopedia of Applied Ethics* (Second Edition), ed. by Ruth Chadwick, 14–31. Academic Press.
- Spirtes, Peter, Clark Glymour, and Richard Scheines. 1993. *Causation, Prediction, and Search*. MIT Press.
- Spivey, J.M. 2001. *The Z Notation: A Reference Manual*. Prentice Hall.
- Steinle, Friedrich. 1997. Entering New Fields: Exploratory Uses of Experimentation. *Philosophy of Science* 64: S65–S74.
- Steinle, Friedrich. 2002. Experiments in History and Philosophy of Science. *Perspectives on Science* 10 (4): 408–432.
- Steup, Matthias., and Ernest Sosa (eds.). 2005. *Contemporary Debates in Epistemology*. Blackwell Publishing.
- Stuewer, Roger H. 1985. Artificial Disintegration and the Cambridge-Vienna Controversy. In *Observation, Experiment, and Hypothesis in Modern Physical Science*, ed. by Peter Achinstein and Owen Hannaway, 239–307. MIT Press.
- Sun, Ying, Gu Lianhong, Robert E. Dickinson, Richard J. Norby, Stephen G. Pallardy, and Forrest M. Hoffman. 2014. Impact of Mesophyll Diffusion on Estimated Global Land CO₂ Fertilization. *Proceedings of the National Academy of Sciences* 111 (44): 15774–15779.
- Suppe, Frederick (ed.). 1977. *The Structure of Scientific Theories*. University of Illinois Press.
- Tal, Eran. 2011. How Accurate is the Standard Second? *Philosophy of Science* 78 (5): 1082–1096.
- Teichroew, Daniel, and John Francis Lubin. 1966. Computer Simulation—Discussion of the Technique and Comparison of Languages. *Communications of the ACM* 9 (10): 723–741.
- Teller, Paul. 2013. The Concept of Measurement-Precision. *Synthese* 190 (2): 189–202.
- Toffoli, Tommaso. 1984. CAM: A High-Performance Cellular-Automaton Machine. *Physica D: Nonlinear Phenomena* 10 (1–2): 195–204.
- Tolk, Andreas. 2017. Code of Ethics. In *The Profession of Modeling and Simulation: Discipline, Ethics, Education, Vocation, Societies, and Economics*, ed. by Andreas Tolk and Tuncer Ören, 35–51. Wiley.

- Trucano, Timothy G., L.P. Swiler, T. Igusa, W.L. Oberkampf, and M. Pilch. 2006. Calibration, Validation, and Sensitivity Analysis: What's What. *Reliability Engineering and System Safety* 91: 1331–1357.
- Turner, Raymond. 2011. Specification. *Minds and Machines* 21 (2): 135–152.
- U.S. Department of Health and Human Services. 2014. The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General—U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. Atlanta, GA. <https://www.ncbi.nlm.nih.gov/pubmed/24455788>. Accessed 17 Oct 2016.
- Vallverdú, Jordi. 2014. What are Simulations? An Epistemological Approach. *Procedia Technology* 13: 6–15.
- van Helden, Albert. 1974. Saturn and his Anses. *Journal for the History of Astronomy* 5 (2): 105–121.
- van der Poel, Ibo and Lambèr Royakkers 2011. Ethics, Technology, and Engineering. An Introduction. Wiley-Blackwell.
- Vichniac, Gérard Y. 1984. Simulating Physics with Cellular Automata. *Physica D: Nonlinear Phenomena* 10: 96–116.
- Von Neumann, John. 1945. First Draft of a Report on the EDVAC. United States Army Ordnance Department University of Pennsylvania.
- Waters, C.Kenneth. 2007. The Nature and Context of Exploratory Experimentation: An Introduction to Three Case Studies of Exploratory Research. *History and Philosophy of the Life Sciences* 29 (3): 275–284.
- Weber, Marcel. 2005. *Philosophy of Experimental Biology*. Cambridge University Press.
- Weirich, Paul. 2011. The Explanatory Power of Models and Simulations: A Philosophical Exploration. *Simulation & Gaming* 42 (2): 155–176.
- Weisberg, Michael. 2013. *Simulation and Similarity*. Oxford University Press.
- Wenham, C. Lawrence. 2012. *Signs That You're a Bad Programmer*. <http://www.yacoset.com/Home/signs-that-you-re-a-bad-programmer>. Accessed 12 Apr 2016.
- Wilhelmson, Robert, Lou Wicker, Matthew Gilmore, Glen Romine, Lee Counce, Mark Straka, Donna Cox, et al. 2010. Visualization of an F3 Tornado: Storm Chaser Perspective. *Technical report. NCSA'S Advanced Visualization Laboratory*. <http://avl.ncsa.illinois.edu/what-we-do/services/media-downloadswatch?v=EgumU0Ns1YI>. Accessed 10 Aug 2015.
- Wilhelmson, Robert, Mathew Gilmore, Louis Wicker, Glen Romine, Lee Counce, and Mark Straka. 2005. Visualization of an F3 Tornado within a Simulated Supercell Thunderstorm. In *Proceeding SIGGRAPH '05 ACM SIGGRAPH 2005 Electronic Art and Animation Catalog*, 248–249. <http://avl.ncsa.illinois.edu/what-we-do/services/media-downloads> Accessed 10 Aug 2015.
- Williamson, Terence J. 2010. Predicting Building Performance: The Ethics of Computer Simulation. *Building Research & Information* 38 (4): 401–410.
- Wilson, Curtis. 1993. Clairaut's Calculation of the Eighteenth-century Return of Halley's Comet. *Journal for the History of Astronomy* 24: 1–15.
- Winsberg, Eric. 1999. Sanctioning Models: The Epistemology of Simulation. *Science in Context* 12: 275–292.
- Winsberg, Eric. 2001. Simulations, Models, and Theories: Complex Physical Systems and Their Representations. *Philosophy of Science* 68 (3): S442–S454.
- Winsberg, Eric. 2009. A Tale of Two Methods. *Synthese* 169: 575–592.
- Winsberg, Eric. 2010. *Science in the Age of Computer Simulation*. University of Chicago Press.
- Winsberg, Eric. 2015. Computer Simulations in Science. In *The Stanford Encyclopedia of Philosophy*, (Summer 2015 Edition), ed. by Edward N. Zalta. <https://plato.stanford.edu/archives/sum2018/entries/simulations-science/>. Accessed 10 Sept 2015.
- Wittgenstein, Ludwig. 1976. *Zettel*. Ed. by G.E. Anscombe and Georg Henrik Von Wright. University of California Press.
- Wolfram, Stephen. 1984a. Preface. *Physica 10D*: vii–xii.
- Wolfram, Stephen. 1984b. Universality and Complexity in Cellular Automata. *Physica 10D* 1–35.
- Woodward, James. 2003. *Making Things Happen*. Oxford University Press.

- Wolfson, Michael M., and Geoffrey J. Pert. 1999a. *An Introduction to Computer Simulations*. Oxford University Press.
- Wolfson, Michael M., and Geoffrey J. Pert. 1999b. *SATELLIT.FOR. An Introduction to Computer Simulations*. Oxford University Press.
- Wylie, Alison. 2002. *Thinking from Things: Essays in the Philosophy of Archeology*. University of California Press.
- Yoshii, Yuzuru, Kentaro Motohara, Takashi Miyata, and Natsuko Mitani. 2009. The 1 m Telescope at the Atacama Observatory has Started Scientific Operation, Detecting the Hydrogen Emission Line from the Galactic Center in the Infrared Light. <http://www.s.u-tokyo.ac.jp/en/press/2009/15.html>. Accessed 12 Nov 2016.
- Zenil, Hector. 2014. What Is Nature-Like Computation? A Behavioural Approach and a Notion of Programmability. *Philosophy&Technology* 27: 399–421.
- Zhang, Zhongshi, Gilles Ramstein, Mathieu Schuster, Camille Li, Camille Contoux, and Qing Yan. 2014. Aridification of the Sahara Desert Caused by Tethys Sea Shrinkage During the Late Miocene. *Nature* 513 (7518): 401–404.
- Zwitter, Andrej. 2014. Big Data Ethics. *Big Data & Society* 1 (2): 1–6.

Titles in This Series

Quantum Mechanics and Gravity

By Mendel Sachs

Quantum-Classical Correspondence

Dynamical Quantization and the Classical Limit

By A.O. Bolivar

Knowledge and the World: Challenges Beyond the Science Wars

Ed. by M. Carrier, J. Roggenhofer, G. Küppers and P. Blanchard

Quantum-Classical Analogies

By Daniela Dragoman and Mircea Dragoman

Quo Vadis Quantum Mechanics?

Ed. by Avshalom C. Elitzur, Shahar Dolev and Nancy Kolenda

Information and Its Role in Nature

By Juan G. Roederer

Extreme Events in Nature and Society

Ed. by Sergio Albeverio, Volker Jentsch and Holger Kantz

The Thermodynamic Machinery of Life

By Michal Kurzynski

Weak Links

The Universal Key to the Stability of Networks and Complex Systems

By Cserehely Peter

The Emerging Physics of Consciousness

Ed. by Jack A. Tuszynski

Quantum Mechanics at the Crossroads

New Perspectives from History, Philosophy and Physics

Ed. by James Evans and Alan S. Thorndike

Mind, Matter and the Implicate Order

By Paavo T.I. Pylikkanen

Particle Metaphysics

A Critical Account of Subatomic Reality

By Brigitte Falkenburg

The Physical Basis of the Direction of Time

By H. Dieter Zeh

Asymmetry: The Foundation of Information

By Scott J. Muller

Decoherence

and the Quantum-To-Classical Transition

By Maximilian A. Schlosshauer

The Nonlinear Universe

Chaos, Emergence, Life

By Alwyn C. Scott

Quantum Superposition

Counterintuitive Consequences of Coherence, Entanglement, and Interference

By Mark P. Silverman

Symmetry Rules

How Science and Nature are Founded on Symmetry

By Joseph Rosen

Mind, Matter and Quantum Mechanics

By Henry P. Stapp

Entanglement, Information, and the Interpretation of Quantum Mechanics

By Gregg Jaeger

Relativity and the Nature of Spacetime

By Vesselin Petkov

The Biological Evolution of Religious Mind and Behavior

Ed. by Eckart Voland and Wulf Schiefenhövel

Homo Novus-A Human without Illusions

Ed. by Ulrich J. Frey, Charlotte Störmer and Kai P. Willführ

Brain-Computer Interfaces

Revolutionizing Human-Computer Interaction

Ed. by Bernhard Graimann, Brendan Allison and Gert Pfurtscheller

Extreme States of Matter

On Earth and in the Cosmos

By Vladimir E. Fortov

Searching for Extraterrestrial Intelligence

SETI Past, Present, and Future

Ed. by H. Paul Shuch

Essential Building Blocks of Human Nature

Ed. by Ulrich J. Frey, Charlotte Störmer and Kai P. Willführ

Mindful Universe

Quantum Mechanics and the Participating Observer

By Henry P. Stapp

Principles of Evolution

From the Planck Epoch to Complex Multicellular Life

Ed. by Hildegard Meyer-Ortmanns and Stefan Thurner

The Second Law of Economics

Energy, Entropy, and the Origins of Wealth

By Reiner Kümmel

States of Consciousness

Experimental Insights into Meditation, Waking, Sleep and Dreams

Ed. by Dean Cvetkovic and Irena Cosic

Elegance and Enigma

The Quantum Interviews

Ed. by Maximilian Schlosshauer

Humans on Earth

From Origins to Possible Futures

By Filipe Duarte Santos

Evolution 2.0

Implications of Darwinism in Philosophy and the Social and Natural Sciences

Ed. by Martin Brinkworth and Friedel Weinert

Probability in Physics

Ed. by Yemima Ben-Menahem and Meir Hemmo

Chips 2020

A Guide to the Future of Nanoelectronics

Ed. by Bernd Hoefflinger

From the Web to the Grid and Beyond

Computing Paradigms Driven by High-Energy Physics

Ed. by René Brun, Frederico Carminati and Giuliana Galli-Carminati

The Language Phenomenon

Human Communication from Milliseconds to Millennia

Ed. by P.-M. Binder and K. Smith

The Dual Nature of Life

Interplay of the Individual and the Genome

By Gennadiy Zhegunov

Natural Fabrications

Science, Emergence and Consciousness

By William Seager

Ultimate Horizons

Probing the Limits of the Universe

By Helmut Satz

Physics, Nature and Society

A Guide to Order and Complexity in Our World

By Joaquín Marro

Extraterrestrial Altruism

Evolution and Ethics in the Cosmos

Ed. by Douglas A. Vakoch

The Beginning and the End

The Meaning of Life in a Cosmological Perspective

By Clément Vidal

A Brief History of String Theory

From Dual Models to M-Theory

By Dean Rickles

Singularity Hypotheses

A Scientific and Philosophical Assessment

Ed. by Amnon H. Eden, James H. Moor, Johnny H. Søraker and Eric Steinhart

Why More Is Different

Philosophical Issues in Condensed Matter Physics and Complex Systems

Ed. by Brigitte Falkenburg and Margaret Morrison

Questioning the Foundations of Physics

Which of Our Fundamental Assumptions Are Wrong?

Ed. by Anthony Aguirre, Brendan Foster and Zeeya Merali

It From Bit or Bit From It?

On Physics and Information

Ed. by Anthony Aguirre, Brendan Foster and Zeeya Merali

How Should Humanity Steer the Future?

Ed. by Anthony Aguirre, Brendan Foster and Zeeya Merali

Trick or Truth?

The Mysterious Connection Between Physics and Mathematics

Ed. by Anthony Aguirre, Brendan Foster and Zeeya Merali

The Challenge of Chance

A Multidisciplinary Approach from Science and the Humanities

Ed. by Klaas Landsman, Ellen van Wolde

Quantum [Un]Speakables II

Half a Century of Bell's Theorem

Ed. by Reinhold Bertlmann, Anton Zeilinger

Energy, Complexity and Wealth Maximization

Ed. by Robert Ayres

Ancestors, Territoriality and Gods

A Natural History of Religion

By Ina Wunn, Davina Grojnowski

Space, Time and the Limits of Human Understanding

Ed. by Shyam Wuppuluri, Giancarlo Ghirardi

Information and Interaction

Eddington, Wheeler, and the Limits of Knowledge

Ed. by Ian T. Durham, Dean Rickles

The Technological Singularity

Managing the Journey

Ed. by V. Callaghan, J. Miller, R. Yampolskiy, S. Armstrong

How Can Physics Underlie the Mind?

Top-Down Causation in the Human Context

By George Ellis

The Unknown as an Engine for Science

An Essay on the Definite and the Indefinite

Hans J. Pirner

CHIPS 2020 Vol. 2

New Vistas in Nanoelectronics

Ed. by Bernd Hoefflinger

Life—As a Matter of Fat

Lipids in a Membrane Biophysics Perspective

Ole G. Mouritsen, Luis A. Bagatolli

The Quantum World

Philosophical Debates on Quantum Physics

Ed. by Bernard D'Espagnat, Hervé Zwirn

The Seneca Effect

Why Growth is Slow but Collapse is Rapid

By Ugo Bardi

Chemical Complexity

Self-Organization Processes in Molecular Systems

By Alexander S. Mikhailov, Gerhard Ertl

The Essential Tension

Competition, Cooperation and Multilevel Selection in Evolution

By Sonya Bahar

The Computability of the World

How Far Can Science Take Us?

By Bernd-Olaf Küppers

The Map and the Territory

Exploring the Foundations of Science, Thought and Reality

By Shyam Wuppuluri, Francisco A. Doria

Wandering Towards a Goal

How Can Mindless Mathematical Laws Give Rise to Aims and Intention?

Ed. by Anthony Aguirre, Brendan Foster and Zeeya Merali

Computer Simulations in Science and Engineering

Concepts—Practices—Perspectives

By Juan M. Durán

Stepping Stones to Synthetic Biology

By Sergio Carrà