

IGME 690 - Seminar on Intelligent Systems in the Arts

3 credits Spring 2021

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Course Description

The use of artificial intelligence and artificial life techniques in the arts have yielded a rich and diverse set of artworks since their earliest iterations in the 1950s. Artists routinely address the questions, challenges and opportunities of these technologies, speculating on their untapped or underexplored possibilities and implications that go beyond the utilitarian in order to provoke us to think about what it means to be human in the age of intelligent machines. This seminar will introduce students to critical issues in AI, Machine Learning and related fields as they pertain to arts, media and culture, with lectures, readings and discussions that explore the work of relevant artists, technologists and theoreticians. This is done in conjunction with project-based work where students will have the opportunity to develop their own artistic or design project or produce original theoretical or philosophical writing. Students will be expected to form their own creative research agendas.

Starting with a historical overview on the origins of new media art (Conceptual Art, Fluxus, and Situationist Art movements) and early AI and Cybernetic artworks, the course will then move toward critical discussions and analysis of contemporary applications of Intelligent Systems in the arts. Numerous examples of creative practices such as visual art, interactive art, music, performing arts, design, architecture, games, robotic art, biological art and net art will be shown. On the technical side, we will start with processes involving chance operations, fractals, stochastic processes and rule-based approaches and see how they can be used in an arts context. We will then study how neural networks, deep learning, clustering, agent-based systems and virtual ecosystems are deployed to produce original artworks and compositions. Students will be expected to present on these topics as well as their own research. Software tools and code libraries will also be introduced, including those specifically designed for artists, musicians and designers to work with AI and Machine Learning

Pre-requisites and course enrollment

This course carries the expectation that students will have a high level of computational literacy (as understood from within the context of their own discipline) and that they will contribute their perspectives to discussions, presentations and projects. While not a formal prerequisite, students will benefit from having completed a foundational multimedia programming computation course (e.g. Processing, P5.js, etc). As is often the case with graduate-level courses, the primary requirement is motivation and willingness to learn.

Upper division undergraduates should contact the instructor prior to enrolling in this course.

Topics

- Machine Learning and evolutionary computing algorithms and their applications in the arts
- Theoretical & Ethical Issues & in Art & Intelligent Machines
- Historical Overview of Intelligent Systems in the Arts

- Critical Analysis of Intelligent Systems
- Formal evaluation of Creative AI & A-life systems
- Philosophy of Science/Philosophy of Mind
- Theories of Creativity

Evaluation and Grading

This section is in draft form and is subject to change.

30% Theoretical research (includes a presentation in class)
 30% Project (10% process, 10% result, 10% presentation)
 30% Research Paper (refining and presenting all of the above together)
 10% Participation

References

In addition to the reference material listed here, actual chapters, journal articles and conference papers will be assigned for reading as the course unfolds.

Students will also be responsible for finding research papers and texts suitable for the work they undertake.

Agre, P. E. (1997). *Computation and Human Experience*. Cambridge University Press.

Akten, M., Fiebrink, R., & Grierson, M. (2018). Deep Meditations: Controlled navigation of latent space. *32nd Conference on Neural Information Processing Systems (NeurIPS 2018)*. 32nd Conference on Neural Information Processing Systems (NeurIPS 2018), Montreal.

Komosinski, M., & Adamatzky, A. (2009). *Artificial Life Models in Software*. Springer Science & Business Media.

Audry, S. (2016). Aesthetics of Adaptive Behaviors in Agent-based Art. *Proceedings of the 22nd International Symposium on Electronic Art ISEA2016 Hong Kong*, 2–9.

Boden, M. A. (2004). Creativity in a Nutshell. In *The Creative Mind: Myths and Mechanisms* (pp. 1–10). Routledge.

Brooks, R. A. (1991). Intelligence Without Representation. *Artificial Intelligence Journal*, 47(1–3), 139–159.

Bureaud, A., Malina, R. F., & Whiteley, L. (Eds.). (2014). *Meta-Life: Biotechnologies, Synthetic Biology, ALife and the Arts*. Leonardo/ISAST and MIT Press.

Cariani, P. (2012). Creating New Informational Primitives in Mind and Machines. In J. McCormack & M. d’Inverno (Eds.), *Computers and Creativity* (pp. 383–417). Springer Berlin Heidelberg.

Dreyfus, H. L. (1992). *What Computers Still Can't Do: A Critique of Artificial Reason*. MIT Press.

Eiben, A. E., & Smith, J. E. (2015). *Introduction to Evolutionary Computing* (2nd ed. 2015 edition). Springer.

Galanter, P. (2007). Complexism and the Role of Evolutionary Art. In *The Art of Artificial Evolution* (pp. 311–332). Springer.

Holland, J. H. (1995). *Hidden Order: How Adaption Builds Complexity*. Addison-Wesley.

Johnson, C., Ciesielski, V., Correia, J., & Machado, P. (Eds.). (2016). *Evolutionary and Biologically Inspired Music, Sound, Art and Design: 5th International Conference, EvoMUSART 2016, Porto, Portugal, March 30 -- April 1, 2016, Proceedings*. Springer.

McCormack, J. (2001). Eden: An Evolutionary Sonic Ecosystem. In J. Kelemen & P. Sosík (Eds.), *Advances in Artificial Life, 6th European Conference, ECAL 2001* (pp. 133–142). Springer.

McCormack, J., & d’Inverno, M. (Eds.). (2012). *Computers and Creativity*. Springer Science & Business Media.

Mitchell, T. M. (1997). *Machine Learning*. McGraw-Hill.

Penny, S. (1999). Agents as Artworks and Agent Design as Artistic Practice. In K. Dautenhahn (Ed.), *Human Cognition and Social Agent Technology* (pp. 395–414). John Benjamins Publishing Company.

Pickering, A. (2010). *The Cybernetic Brain: Sketches of Another Future*. Chicago: University of Chicago Press.

Sommerer, C., & Mignonneau, L. (1997). A-volve, An Evolutionary Artificial Life Environment. In C. G. Langton & K. Shimohara (Eds.), *Artificial Life V* (pp. 167–175). MIT Press.

Varela, F. J., Thompson, E. T., & Rosch, E. (1992). *The Embodied Mind: Cognitive Science and Human Experience* (New Ed). MIT Press.

Whitelaw, M. (2004). *Metacreation: Art and Artificial Life*. MIT Press.

Wilson, S. (2002). *Information Arts: Intersections of Art, Science, and Technology*. MIT Press.

Schedule

(subject to change)

Week 1

Content: Introduction to course, Syllabus, Organization, Theories of Creativity, A Typology of Creative Systems

Videos:

- [Creativity & AI: Asking the Right Questions](#), Margaret Boden, University of Sussex
- [AIART 2020 Keynote: The rise of Creative AI: Computational Creativity and Generative Art at the Metacreation Lab](#), Philippe Pasquier

Readings:

- Boden, Margaret A. 2009. "Computer Models of Creativity." *AI Magazine* 30 (3): 23–34. ([Available online via RIT Library](#))

Week 2

Content: Art and AI: A Semi-Historical Survey, Randomness & Chance Operations, Fractals, Chaos, Rule-based systems

Videos:

- [Music of Changes](#), by John Cage
- [Searcher & Watcher](#), James Seawright

Readings:

- Stephen Wilson, "[Artificial Intelligence Research as Art](#)", SEHR, volume 4, issue 2: Constructions of the Mind, Updated July 22, 1995 (available as part of Stanford Humanities Review) ([alt PDF](#))
- Paul, Christiane. 2016. "Introduction: From Digital to Post-Digital — Evolutions of an Art Form." In *A Companion to Digital Art*. Chichester, edited by Christiane Paul and Dana Arnold, 1-20. [England]: Wiley-Blackwell. ([Available online via RIT Library](#))
- OPTIONAL: Burnham, Jack. 1970. "The Aesthetics of Intelligent Systems." In *On the Future of Art*, 95–122. New York: Viking Press. ([PDF](#))
- OPTIONAL: Sol Lewitt, "[Sentences on Conceptual Art](#)"

Deliverables:

- Proposal for theoretical research (1 page maximum)
- Information about your background and motivations (posted in course Slack)

Week 3

Content: Machine Learning (Pt. 1) - Supervised & Unsupervised Learning, Neural Networks

Videos: Neural Networks for Artists

Readings:

- Machine Learning for Artists (in-progress online book). Read the first three chapters.
- Snyder, Jeff and Ryan, Danny. 2014. "The Birl: An Electronic Wind Instrument Based on an Artificial Neural Network Parameter Mapping Structure". In *Proceedings of the International Conference on New Interfaces for Musical Expression*, 585-88. ([available online](#)).
- Legrady, George. "Pockets Full of Memories." In *Database Aesthetics: Art in the Age of Information Overflow*, edited by Vesna, Victoria, 243-48. University of Minnesota Press, 2007. ([Available online via RIT Library](#))
- OPTIONAL: Andrey Kurenkov, "A Brief History of Neural Nets and Deep Learning", Skynet Today, 2020.
- OPTIONAL: Aggarwal, Charu C. 2018. "An Introduction to Neural Networks." In *Neural Networks and Deep Learning: A Textbook*, edited by Charu C. Aggarwal, 1–52. Cham: Springer International Publishing. ([Available online via RIT library](#))

Deliverables:

- Revised proposal for theoretical research (1 page maximum)

Week 4

Content: Machine Learning (Pt. 2) - Instance-based Learning, Clustering, Bayesian Learning

Readings:

- Castellanos, Carlos, Philippe Pasquier, Luther Thie, and Kyu Che. 2008. "Biometric Tendency Recognition and Classification System: An Artistic Approach." In *Proceedings of the 3rd International Conference on Digital Interactive Media in Entertainment and Arts*, 166–73. Athens, Greece: ACM. ([Available online via RIT Library](#))
- Tatar, K. & Pasquier, P. 2017. "MASOM: A Musical Agent Architecture based on Self-Organizing Maps, Affective Computing, and Variable Markov Models." In *Proceedings of the 5th International Workshop on Musical Metacreation (MuMe 2017)*. ([PDF](#)) ([web page](#))
- OPTIONAL: Aggarwal, Charu C. 2015. "Instance-Based Learning: A Survey." In *Data Classification: Algorithms and Applications*, edited by Charu C. Aggarwal, 157-85. Boca Raton: CRC Press. ([available online](#))

Deliverables:

- Final project proposal (1-2 pages), reflecting the link to your research

Week 5

Content: Machine Learning (Pt. 3) - Deep Learning (Convolutional Neural Networks, Generative Models)

Readings:

- Convolutional neural networks (from Machine Learning for Artists online book).
- Akten, Memo, Rebecca Fiebrink, and Mick Grierson. 2018. "Deep Meditations: Controlled Navigation of Latent Space." In *32nd Conference on Neural Information Processing Systems (NeurIPS 2018)*. Montreal. ([available online](#))
- Salimi, Mahsoo, Nouf Abukhodair, Steve DiPaola, Carlos Castellanos, and Philippe Pasquier. 2020. "Liminal Scape, an Interactive Visual Installation with Expressive AI." In *Proceedings of the 26th International Symposium on Electronic Art (ISEA 2020)*, 365–71. Montreal, Quebec, Canada. ([PDF](#))
- OPTIONAL: McCormack, Jon, and Andy Lomas. 2020. "Deep Learning of Individual Aesthetics." *Neural Computing and Applications*, October. ([Available online via RIT Library](#))
- OPTIONAL: OpenAI, Generative Models
- OPTIONAL: Crawford, Kate, and Trevor Paglen. 2019. "Excavating AI: The Politics of Images in Machine Learning Training Sets." -. 2019. <https://excavatingai.com>.
- OPTIONAL: Zhu, J., T. Park, P. Isola, and A. A. Efros. 2017. "Unpaired Image-to-Image Translation Using Cycle-Consistent Adversarial Networks." In *2017 IEEE International Conference on Computer Vision (ICCV)*, 2242–51. ([Available online via RIT Library](#)) ([web page for paper](#))
- OPTIONAL: Engel, Jesse, Kumar Krishna Agrawal, Shuo Chen, Ishaan Gulrajani, Chris Donahue, and Adam Roberts. 2019. "GANSynth: Adversarial Neural Audio Synthesis." In *International Conference on Learning Representations*. ([available online](#))

Deliverables:

- Refine Final Project Proposal:
 - Add a technical specification (1 page minimum)
 - Send me a 2-3 pages (min), PDF; good idea to include images, diagrams, etc (if appropriate)

Week 6

Content: Machine Learning (Pt. 4) - Deep Learning (Recurrent Neural Networks)

Readings:

- Rajcic, Nina, and Jon McCormack. 2020. "Mirror Ritual: An Affective Interface for Emotional Self-Reflection." In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–13. CHI '20. New York, NY, USA: Association for Computing Machinery. ([Available online via RIT Library](#)) ([video](#))
- Karpathy, Andrej. 2015. "The Unreasonable Effectiveness of Recurrent Neural Networks." ([Available online](#))
- OPTIONAL: Perlman, Ellen. 2021. "AIBO - A Sicko AI Brainwave Opera". In *IEEE 4th International Conference on Multimedia Information Processing and Retrieval (MIPR)*. ([Available online via RIT Library](#))
- OPTIONAL: Alec Radford, Jeffrey Wu, Rewon Child, David Luan, Dario Amodei, and Ilya Sutskever. 2019. Language models are unsupervised multitask learners. ([available online](#)) ([web page for paper](#))

Deliverables:

Week 7

Content: Machine Learning (Pt. 5) - Reinforcement Learning

Readings:

- Chan, M. T. K., R. Gorbet, P. Beesley, and D. Kulić. 2016. "Interacting with Curious Agents: User Experience with Interactive Sculptural Systems." In *2016 25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 151–58. ([Available online via RIT Library](#))
- Ha, David, and Jürgen Schmidhuber. 2018. "World Models." *ArXiv:1803.10122 [Cs, Stat]*, March. ([available online](#)) ([web page for paper](#))
- Mance E. Harmon, Stephanie S. Harmon, *Reinforcement Learning: A Tutorial*, 1996. ([available online](#))
- OPTIONAL: Collins, Nick. 2008. "Reinforcement Learning for Live Musical Agents." In *Proceedings of the International Computer Music Conference*. Belfast, Northern Ireland. ([available online](#))
- OPTIONAL: Huang, Z., S. Zhou, and W. Heng. 2019. "Learning to Paint With Model-Based Deep Reinforcement Learning." In *2019 IEEE/CVF International Conference on Computer Vision (ICCV)*, 8708–17. ([Available online via RIT Library](#))

Deliverables:

Week 8

Research Presentations

Week 9

Content: Cybernetics, Emergence and Adaptation in Media Art

Readings:

- Audry, Sofian. 2021. "Behavior Morphologies of Machine Learning Agents in Media Artworks." *Leonardo* 54(3) 269–73. ([Available online via RIT Library](#))
- Cariani, Peter. 1993. "To Evolve an Ear: Epistemological Implications of Gordon Pask's Electrochemical Devices." *Systems Research* 10 (3): 19–33. ([PDF](#))
- Burnham, Jack. 1968. "Systems Esthetics." *Artforum* 7, no. 1: 30–35. ([PDF](#))
- OPTIONAL: Galanter, Philip. 2003. "What is generative art? Complexity theory as a context for art theory." In *GA2003 – 6th Generative Art Conference*. ([PDF](#))
- OPTIONAL: Galanter, Philip. 2008. "What is Complexism? Generative Art and the Cultures of Science and the Humanities. In *GA2008 – 11th Generative Art Conference*. ([PDF](#))
- OPTIONAL: Audry, Sofian. 2016. "Aesthetics of Adaptive Behaviors in Agent-based Art." in *Proceedings of the 22nd International Symposium on Electronic Art (ISEA2016)*, Hong Kong. ([PDF](#))
- OPTIONAL: Davis, Tom. 2012. "Complexity as Practice: A Reflection on the Creative Outcomes of a Sustained Engagement with Complexity." *Leonardo* 45 (2). 106–112. ([Available online via RIT Library](#))

Deliverables:

Week 10

Content: Autonomous Agents & Multi-agent Systems (Pt. 1) - Cognitive Agents, Reactive Agents

Readings:

- Dorri, A., S. S. Kanhere, and R. Jurdak. 2018. "Multi-Agent Systems: A Survey." *IEEE Access* 6: 28573–93. ([Available online via RIT Library](#))
- Boersen, Ronald, Aaron Liu-Rosenbaum, Kivanç Tatar, and Philippe Pasquier. 2020. "Chatterbox: An Interactive System of Gibberish Agents." In *International Symposium on Electronic Art (ISEA 2020)*. Montreal. ([available online](#))
- OPTIONAL: Pasquier, Philippe, Eunjung Han, Kirak Kim, and Keechul Jung. 2008. "Shadow Agent: A New Type of Virtual Agent." In *ACM International Conference on Advances in Computer Entertainment Technologies (ACE 2008)*, 71–75. Yokohama: ACM. ([available online](#))
- OPTIONAL: Tatar, Kivanç, Mirjana Prpa, and Philippe Pasquier. 2019. "Respire: Virtual Reality Art with Musical Agent Guided by Respiratory Interaction." *Leonardo Music Journal* 29 (September): 19–24. ([Available online via RIT Library](#))
- OPTIONAL: Brooks, Rodney A. 1991. "Intelligence Without Representation." *Artificial Intelligence Journal* 47 (1–3): 139–59. ([PDF](#))
- OPTIONAL: Brooks, Rodney A. 1986. "A Robust Layered Control System for a Mobile Robot." *IEEE Journal of Robotics and Automation* 2 (1): 14–23. ([Available online via RIT Library](#))

Deliverables:

Week 11

Content: Autonomous Agents & Multi-agent Systems (Pt. 2) - Cellular Automata, Swarm Intelligence

Readings:

- Greenfield, Gary, and Penousal Machado. 2015. "Ant- and Ant-Colony-Inspired ALife Visual Art." *Artificial Life* 21 (3): 293–306. ([Available online via RIT Library](#))
- Miranda, Eduardo Reck. 1995. "Granular Synthesis of Sounds by Means of a Cellular Automaton." *Leonardo* 28 (4): 297–300. ([Available online via RIT Library](#))
- OPTIONAL: Langton, Christopher G. 1986. "Studying Artificial Life with Cellular Automata." *Physica D: Nonlinear Phenomena*, Proceedings of the Fifth Annual International Conference, 22 (1): 120–49. ([available online](#))
- OPTIONAL: Correll, N., Farrow, N., Sugawara, K., & Theodore, M. 2013. "The Swarm-Wall: Toward Life's Uncanny Valley". In *IEEE International Conference on Robotics and Automation*. ([available online](#))
- OPTIONAL: Reynolds, C. W. 1987. "Flocks, Herds, and Schools: A Distributed Behavioral Model". *Computer Graphics* 21(4) (SIGGRAPH '87 Conference Proceedings). 25-34. ([available online](#))

Deliverables:

Week 12

Content: Evolutionary Computing and Artificial Life - Genetic Algorithms, Genetic Programming, Creative Ecosystems

Readings:

- McCormack, Jon. 2019. "Creative Systems: A Biological Perspective." In *Computational Creativity: The Philosophy and Engineering of Autonomously Creative Systems*, edited by Tony Veale and Amilcar Cardoso, 327–52. Computational Synthesis and Creative Systems. Springer International Publishing. ([Available online via RIT Library](#))
- Penny, Simon. 1996. "The Darwin Machine: Artificial Life and Interactive Art". *New Formations* 29, 59-68. ([Available online](#))
- OPTIONAL: McCormack, Jon. 2003. "Evolving Sonic Ecosystems." *Kybernetes* 32 (1/2): 184–202. ([Available online via RIT Library](#))
- OPTIONAL: Whitelaw, Mitchell. 2004. *Metacreation: Art and Artificial Life*. Cambridge, MA: MIT Press.
- OPTIONAL: Sommerer, Christa, and Laurent Mignonneau. 1998. "The Application of Artificial Life to Interactive Computer Installations." *Artificial Life and Robotics* 2 (4): 151–56. ([Available online via RIT Library](#))
- OPTIONAL: Holland, John H. 1995. *Hidden Order: How Adaption Builds Complexity*. Reading, MA: Addison-Wesley.

Deliverables:

Week 13

Content: Methods, Evaluation & Validation in Art and AI

Video: Jürgen Schmidhuber: The Algorithmic Principle Behind Curiosity and Creativity

Readings:

- Candy, Linda, and Ernest Edmonds. 2018. "Practice-Based Research in the Creative Arts: Foundations and Futures from the Front Line." *Leonardo* 51 (1): 63–69. ([Available online via RIT Library](#))
- Galanter, Philip. 2012. "Computational Aesthetic Evaluation: Past and Future." In *Computers and Creativity*, edited by Jon McCormack and Mark d’Inverno, 255–93. Berlin, Heidelberg: Springer. ([available online via RIT Library](#))
- OPTIONAL: Ritchie, Graeme. 2019. "The Evaluation of Creative Systems." In *Computational Creativity: The Philosophy and Engineering of Autonomously Creative Systems*, edited by Tony Veale and F. Amílcar Cardoso, 159–94. Computational Synthesis and Creative Systems. Cham: Springer International Publishing. ([Available online via RIT Library](#))
- OPTIONAL: Wiggins, Geraint A. 2019. "A Framework for Description, Analysis and Comparison of Creative Systems." In *Computational Creativity: The Philosophy and Engineering of Autonomously Creative Systems*, edited by Tony Veale and F. Amílcar Cardoso, 21–47. Computational Synthesis and Creative Systems. Cham: Springer International Publishing. ([Available online via RIT Library](#))
- OPTIONAL: Cariani, Peter. 2012. "Creating New Informational Primitives in Mind and Machines." In *Computers and Creativity*, edited by Jon McCormack and Mark d’Inverno, 383–417. Berlin, Heidelberg: Springer. ([available online via RIT Library](#))
- OPTIONAL: Cohen, Harold, Frieder Nake, David C. Brown, Paul Brown, Philip Galanter, Jon McCormack, and Mark d’Inverno. 2012. "Evaluation of Creative Aesthetics." In *Computers and Creativity*, edited by Jon McCormack and Mark d’Inverno, 95–111. Berlin, Heidelberg: Springer. ([available online via RIT Library](#))

Deliverables:

Week 14

Content: Critical Analysis of Art & AI, Ethical Implications of AI

Readings:

- Adam, Alison. 2000. "Deleting the Subject: A Feminist Reading of Epistemology in Artificial Intelligence." *Minds and Machines* 10 (2): 231–53. ([Available online via RIT Library](#))
- Sengers, Phoebe. 2002. "Schizophrenia and Narrative in Artificial Agents." *Leonardo* 35 (2): 427–31. ([Available online via RIT Library](#))
- OPTIONAL: Adam, Alison. 1998. *Artificial Knowing: Gender and the Thinking Machine*. Routledge. ([Available online via RIT Library](#))
- OPTIONAL: Dreyfus, Hubert L. 1992. *What Computers Still Can't Do: A Critique of Artificial Reason*. Cambridge, MA: MIT Press. (physical copy in RIT Library)
- OPTIONAL: Brooks, Rodney A. 1990. "Elephants Don't Play Chess." In *Designing Autonomous Agents: Theory and Practice from Biology to Engineering and Back*, edited by P. Maes, 3–15. Cambridge, MA: The MIT Press. ([PDF](#))

Deliverables:

Demo In-progress projects

Week 15

Final Papers Due

Week 16

Content:

Presentation of student projects.