Course Title: Agent-Based Computing in Education: An Epistemological Arc (Credits: 2)

Instructor: Dr. Pratim Sengupta

Course Dates: February 26, February 27, March 1, March 4, March 5 and March 6, 2019.
Preferred Timings: 09:30 a.m. to 12:30 p.m.

Agent-Based Computing in Education: An Epistemological Arc

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Preferred Meeting Time: 9.30 am - 12.30 pm
Venue: HBCSE

Prolegomenon

What is the relationship between epistemology and technology in the context of educational design? This course attempts to answer this question by tracing an arc through a particular set of histories in educational research, focused on agent-based computing in STEM education. Specifically, we will engage in scholarly conversations about how cognitivist, socio-cultural, democratic and critical theoretical perspectives have shaped (and continue to shape) the design of agent-based computing environments for complex, scientific, disciplinary engagement in educational settings.

Agent-based computing involves the use of virtual agents as computational actors, which can be controlled through simple rules. Agent-based programming languages have been around for a few decades, and have revolutionized educational computing by making it possible for even young children to learn programming (e.g., Logo, SCRATCH, etc.). At the same time, scientists and computer scientists also use agent-based computing for complex disciplinary inquiries. In particular, multi-agent systems - where users can create and control the individual-level behaviors of thousands of agents, which then interact with each other to give rise to complex, emergent patterns (e.g., NetLogo) - have been shown to be very useful for modeling and simulating complex systems that are notoriously challenging to understand otherwise.

Since 2004, I have been studying, designing and developing open-source, agent-based and multi-agent-based computing systems for K-12 science and STEM education. This work has focused on K-12 classrooms as well as public spaces and museums. During our course, in each class (except the final class), we will read three articles, two of which will provide theoretical foundations

and the relevant epistemological anchors. A third paper - a publication from from my research lab - will serve as a "case study" of how these anchors can shape both the design of agent-based computing systems for learning within and across STEM disciplines as well as the conduct of the research study using such systems. Drawing upon my own scholarship will allow us to dive deeper beyond the published article by discussing how the peer-review process and informal epistemological conversations with scholars in the field also shape technology design and research.

No background in computer programming is required for taking this course. The course will introduce you to the basics of agent-based computer modeling, although the focus will be on understanding the relationship between their design and epistemological commitments. We will meet as a class six times and the dates are specified below. Each meeting will last between 2.5 - 3 hours. The goal of the course will be to produce a collective concept map of emerging connections across key concepts and themes that will be identified by the group through discussions and reflections.

Course Project and Expectations

Students taking this course will be required to develop a Reflective Design project throughout the course. This project will have two components:

- Design a rapid prototype of an agent-based computer model or simulation, including physical and/or embodied modeling activities, with specific educational objectives in mind. This can be done either as a group project or an individual project. You do not have to design a new simulation from scratch; you can choose existing, open-source simulations and models from repositories that you will be introduced to. This is also an opportunity to design computational simulations that do not necessarily involve the computer. Class time will be alloted for this work. ***40 Marks***

- Write a reflection paper (5 pages, single-spaced, not including references), that a) describes the epistemological conversations and dilemmas that you experienced *during* the design process, and b) explains the epistemological commitments that are implicit in your designed software, learning environment and/or activities. ***40 Marks***

In addition, students will be expected to contribute actively in class discussions and small group discussions. ***20 Marks***

Feb 26: Intuition, Activity and Conceptual Change

- Papert, S. (1980). Mindstorms: Children, computers, and powerful ideas. Basic Books, Inc. (Chapter 1).

- DiSessa, A. A. (2001). Intuition & activity elaborated. In: Changing minds: Computers, learning, and literacy. (pp 89 - 107). Cambridge, MA: MIT Press.
- Sengupta, P., Krinks, K. D., & Clark, D. B. (2015). Learning to deflect: Conceptual change in physics during digital game play. Journal of the Learning Sciences, 24(4), 638-674.

Feb 27: Computing as *Experience*

- Papert, S. (1987). Computer criticism vs. technocentric thinking. Educational researcher, 16(1), 22-30.
- Levy, S. T., & Wilensky, U. (2008). Inventing a "mid level" to make ends meet: Reasoning between the levels of complexity. Cognition and Instruction, 26(1), 1-47.
- Sengupta, P., Dickes, A.C., & Farris, A. (2018). Toward a Phenomenology of Computational Thinking in STEM Education. In: Khine, M.S. (Ed). Computational Thinking in the STEM Disciplines: Research Highlights. New York, NY: Springer.

Mar 1: Aesthetics, Representation and Objectivity

- Daston, L., & Galison, P. (1992). The image of objectivity. Representations, 81-128.
- Gupta, A., Hammer, D., & Redish, E. F. (2010). The case for dynamic models of learners' ontologies in physics. The Journal of the Learning Sciences,19(3), 285-321.
- Farris, A.V., & Sengupta, P. (2016). Democratizing Children's Computation: Learning Computational Science as Aesthetic Experience. Educational Theory, 66 (1-2), 279–296.

Mar 4: Critical Theory and Educational Computing

- Bang, M., Curley, L., Kessel, A., Marin, A., Suzukovich III, E. S., & Strack, G. (2014). Muskrat theories, tobacco in the streets, and living Chicago as Indigenous land. Environmental Education Research, 20(1), 37-55.

- Philip, T. M., Gupta, A., Elby, A., & Turpen, C. (2018). Why Ideology Matters for Learning: A Case of Ideological Convergence in an Engineering Ethics Classroom Discussion on Drone Warfare. Journal of the Learning Sciences, 27(2), 183-223.
- Hostetler, A. L., Sengupta, P., & Hollett, T. (2018). Unsilencing critical conversations in social studies teacher education using agent-based modeling. Cognition and Instruction, 36(2), 139-170.

Mar 5: Figured Worlds and Public Computing

- Holland, D. (2001). Identity and agency in cultural worlds (pp 49 - 65). Harvard University Press.
- Shanahan, M. C. (2009). Identity in Science Learning: Exploring the Attention Given to Agency and Structure in Studies of Identity. Studies in Science Education, 45(1), 43-64.
- Sengupta, P., & Shanahan, M. C. (2017). Boundary Play and Pivots in Public Computation: New Directions in STEM Education. International Journal of Engineering Education, 33(3), 1124-1134.

March 6: Epilogue

McMahon, L. (2017). Phenomenology as First-Order Perception: Speech, Vision, and Reflection in Merleau-Ponty. In: Jacobson, K., and Russon, J. (Eds.). Perception and Its Development in Merleau-Ponty's Philosophy, Toronto: University of Toronto Press.