Instructor: Professor Daniel Weiskopf
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Course description
The world is a tapestry of interlocking, multilevel complex systems. The primary task for the sciences is determining how to model these systems in a way that is cognitively and computationally tractable, but that also gives us some predictive and explanatory purchase on them. In this seminar we will discuss some foundational issues concerning the success conditions of such modeling in a range of sciences (physics, ecology, economics, climatology, neuroscience, etc.). Our focus will be on how representation, explanation, and causality work in various real-world modeling contexts. We will consider when models are representationally accurate or veridical, ways in which veridicality and prediction can come apart, and the role of fictions and other simplifying heuristics in modeling. We will also discuss the metaphysics of complex systems, including the prevalence of modularity in living systems, whether complex systems are always mechanisms, what the alternatives to mechanistic modeling might look like, and how to understand causality in distributed systems.

Course objectives
The goal of this course is to acquaint students with a portion of the contemporary philosophical and scientific literature pertaining to modeling complex systems, as well as the skills of philosophical analysis, writing, and argumentation. Students will be expected to know the contents of the readings, and be able to explain and critique them orally and in writing. The aim of the seminar is to equip students to conduct independent research into any of the topics covered.

Prerequisites
Graduate standing or permission of instructor.

Readings
There is one assigned book for the course:

Winsberg, Eric. (2010). *Science in the Age of Computer Simulation*. Chicago: University of Chicago Press.

See the end of this document for the schedule of readings. The readings, as well as other course materials, will be available from the course webpage, which is located on uLearn. The course syllabus provides a general plan for the course; deviations may be necessary.

Assignments

The points available for the class break down as follows (no extra credit):

In-class presentation 15%
Response papers   15%
Final paper   70%

All written work will be uploaded to uLearn in a standard document format (.doc, .docx, .rtf, or .txt). Do not put your name on submitted work; use only your Panther ID number.

The *in-class presentation* is a tightly focused 10-minute discussion of some aspect of one of the required readings. You should *not* aim to summarize the entire article in this time! Rather, you should focus on a particular argument or claim made by the author. Situate the target claim in terms of the larger issues raised in the reading, then analyze and assess it. The point of the presentation is to be a selective, critical, and constructive engagement with one of the problems dealt with in the reading. You will sign up for readings to present during the first class meeting. For more details, consult the separate presentation guidelines sheet.

Response papers (*RP*s) are short (400-800 word) critical discussions focusing on a single claim or argument made in one of the readings. They are not summaries of an entire paper. Rather, they are focused discussions of a very small part of a paper. You are expected to submit three of these during the semester. They may be turned in at any time, subject to the requirements that (1) no more than one RP be turned in per week, and (2) no RP may deal with material that we have discussed in class already. For more details on what is expected from RPs, consult the separate guidelines sheet.

The *final paper* is a research paper of between 4000 and 6000 words. In this paper you are expected to motivate, develop, and defend a substantial philosophical position of your own. The topic may be anything that we have covered in class, or anything that bears a plausible relation to the course content. You must meet with me to discuss your proposed final paper topic no later than 12/1/12.

Lateness policy

Late assignments will not be accepted without prior permission from the instructor. In case of illness, family medical emergency, or other major extenuating circumstances, arrangements can be made to move due dates. These arrangements must be made in advance, where possible. You must also provide adequate documentation when you are requesting permission to turn in an assignment late. If you hand in an assignment late without requesting prior permission, or without providing adequate documentation, I reserve the right not to accept the assignment. Assignments that are turned in late will be graded down by 1/3 of a letter grade per day.

Special accommodations

All efforts will be made to accommodate students with special needs, so long as sufficient notice is given. If you require special accommodations for lectures, papers, exams, or any other course component, you must contact me within the first week of class. You must also notify Disability

Services (Student Center, 2nd floor, Suite 230, 404-463-9044, web: http://www2.gsu.edu/disability).

Attendance
We will meet for the entire scheduled time unless otherwise noted. Sale of recordings or transcripts of lectures and discussions is not permitted, although you may make such recordings for your own personal use. If you need to miss class for religious observances, you must notify me in advance. I expect you to adhere to normal standards of good classroom behavior: cellphones silent, no loud personal conversations, snoring, etc.

Laptops and other electronic devices
Use of laptops and related electronic devices (iPads, Kindles, iPhones and other smartphones, etc.) is not permitted during class.

Contact outside of class
Email is the main means of out-of-class communication. I will be sending updates on readings and assignments to your GSU email account throughout the semester. You are expected to check this account regularly. For in-person meetings I have regular office hours. If you cannot attend my scheduled office hours, email your question or comment, or schedule a meeting at another time. I will try to respond to email within a reasonable amount of time; however, immediate replies aren't guaranteed. If I haven't replied within 48 hours, re-send your message. You must put the course name or number in the subject line of your emails.

Instructor availability
If you cannot attend my scheduled office hours, feel free to email your question or comment, or schedule a meeting at another time. I will try to respond to email within a reasonable amount of time; however, immediate replies aren't guaranteed. Put the course name or number in the subject line of your emails.

Academic honesty
Plagiarism and other violations of the University's code of academic honesty will not be tolerated. **The penalty for such violations is failure of the course.** Further administrative action may also be pursued. If you are not certain what constitutes a violation of the code of academic honesty, it is *your* responsibility to consult the full text of the code, which is available at: http://www2.gsu.edu/~wwwdos/codeofconduct_conpol.html

Schedule of readings
We won't necessarily discuss all of these readings in a given week, but to help you manage your time and attention they are ordered roughly by how important they are.

Models, theories, and the semantic view (8/24)
Hesse, The function of models: A dialogue
Suppes, A comparison of the meaning and uses of models in mathematics and the empirical sciences
Suppes, What is a scientific theory?
Giere, Models and theories

Data and phenomena (8/31)
Suppes, Models of data
Bogen & Woodward, Saving the phenomena
Harris, Data models and the acquisition and manipulation of data
Portides, Seeking representations of phenomena
Woodward, Data and phenomena

The practice of building models (9/7)
Morgan, Learning from models
Weisberg, Who is a modeler?
Bailer-Jones, Creative strategies employed in modeling
Nersessian, The cognitive basis of model-based reasoning in science

The autonomy of models (9/14)
Morrison, Models as autonomous agents
Cartwright, Fundamentalism vs. the patchwork of laws
Cartwright, Fables and models
Cartwright, Shomar, & Suarez, The tool box of science: Tools for the building of models with a superconductivity example

Models and experiments (9/21)
Guala, Experiments as mediators in the non-laboratory sciences
Morgan, Model experiments and models in experiments
Morgan, Experiments versus models
Odenbaugh, Message in the bottle: The constraints of experimentation on model building
Sugden, Experiments as exhibits and experiments as tests

Simulation and computational modeling (9/28)
Winsberg, *SACS*, Chs. 1-4
Humphreys, Computational modeling
Parker, Does matter really matter?
Morrison, Models, measurement, and computer simulation
Fox Keller, Models, simulations, and 'computer experiments'

Idealization (10/5)
McMullin, Galilean idealization
Laymon, Idealization and the testing of theories by experimentation
Weisberg, Three kinds of idealization
Cartwright, False idealization: A philosophical threat to scientific method
Morrison, Approximating the real: The role of idealizations in physical theory
Shrader-Frechette, Idealized laws, antirealism, and applied science: A case in hydrogeology

Fictions (10/12)
Winsberg, *SACS*, Chs. 5 & 7
Fine, Fictionalism

Wimsatt, False models as means to truer theories
Bokulich, Explanatory fictions
Teller, Fictions, fictionalization, and truth in science
Frigg, Fictions in science

(Dis)unification of models (10/19: to be rescheduled)
Teller, Twilight of the perfect model model
Morrison, One phenomenon, many models
Rueger, Perspectival models and theory unification
Parker, Understanding pluralism in climate modeling

Assessing models: Validation and verification (10/26)
Winsberg, *SACS*, Ch. 6
Morton, Mathematical models: Questions of trustworthiness
Oreskes & Belitz, Philosophical issues in model assessment
Oreskes, Shrader-Frechette, & Belitz, Verification and validation of numerical models in the earth sciences
Bevin, Calibration, validation, and equifinality in hydrological modelling
Rykiel, Testing ecological models
Parker, When climate models agree: The significance of robust model predictions

Complex systems (11/2)
Simon, The architecture of complexity
Wimsatt, The ontology of complex systems
Wimsatt, Complexity and organization
Richerson & Boyd, Simple models of complex phenomena

Mechanistic models (11/9)
Machamer, Darden, & Craver, Thinking about mechanisms
Bechtel & Abrahamson, Explanation: A mechanist alternative
Craver, When mechanistic models explain
Glennan, Modeling mechanisms

Robustness analysis (11/16)
Levins, The strategy of model building in population biology
Wimsatt, Robustness, reliability, and overdetermination
Orzack & Sober, A critical assessment of Levins
Weisberg, Robustness analysis
Odenbaugh & Alexandrova, Buyer beware: Robustness analysis in economics and biology

Beyond mechanism (11/30)
Weiskopf, Models and mechanisms in psychological explanation
Kaplan & Craver, The explanatory force of dynamical and mathematical models in neuroscience
Weiskopf, The reality of cognitive models
Franklin-Hall, The emperor's new mechanisms
Teller, Mechanism, reduction, and emergence in two stories of the human epistemic enterprise