This course is based on the premise that economic and social systems share important properties with other complex systems such as evolution, living cells, the global ecosystem, the human brain, the internet and the weather. It employs scientific theories and innovations to understand complex processes that represent the most challenging policy dilemmas of the twentieth first century: networks, epidemics/crisis management, land use/transport/cities, model validation, public policy, marketing, and the information economy. It explores the proposition that the frontiers of modern science can provide social scientists with a common set of thinking tools for observing and abstracting patterns of social behavior and ultimately for adapting policy mechanisms to address the wickedly hard questions of contemporary, global political economy.

When policy makers confront a complicated problem, they often ask "What do we do first?" or "what is the best solution?" But for problems that are not just complicated, but complex in nature, those are the wrong questions. These problems -- which include everything from state-building to peacemaking to consolidating democracy -- are created by networks of interacting agents influencing each other in a dynamic system. So one cannot isolate a first step from a second, or identify a single optimal solution -- one has to approach the entire landscape of interacting units as a complex system, and identify its feedbacks and interdependencies to understand the effects of different actions. Only then can one build a strategy that is sufficiently dynamic and adaptive to attain desired outcomes in a constantly changing environment. Without understanding the nature of complexity, policy makers will continue to fail -- as they have so often in the last few decades -- to make progress on crucial problems that develop from the dynamic interactions among actors within linked systems.

LEARNING OUTCOMES:
The course will enable students to become familiar with the analytical framework of complex adaptive systems and its application to global public policy. Students will acquire new tools to understand the adaptive processes and possible discontinuities that will shape the emergent global order. Analysis of the military, political, economic and cultural interactions of both Western and non-western societies will illustrate and validate the complex systems approach, challenging conventional conceptions of what the state should do, and the ways in which it can act.

COURSE REQUIREMENTS:
Students are expected to keep up with each week’s required readings and to participate in class discussion.

20%: Class discussion and one class presentation of a title in the syllabus.
20%: Midterm Take Home: A set of questions will be emailed to the class from which students will select their topic and write an essay of 1,000 words.
60%: One term paper, 3,500 words due at the end of the semester or an agent based model revealing a property of a complex social environment.

A) Write a 3,500-word essay in which you explore how the study of complexity can be applied to practical problems of global public policy. Demonstrate potential connections between evolutionary theories of complexity and problems in global management, government or organizations. Students can choose topics in public health, environment, critical infrastructure, global security, cyberwarefare, demographic transitions. As examples consider problems that are inadequately explained; can models of evolutionary complexity be applied to provide a more realistic understandings and better policies than conventional analytical tools? Devise experiments that can reveal laws or patterns that govern how complex institutions, organizations or technologies evolve.

OR:

B) Computationally adept students can construct computer-based simulation models to analyze complex systems. Show how artificial worlds like Sugarscape can be created to capture relevant aspects of the global problems under consideration during the semester. Given all exogenous and endogenous factors, construct model economies that evolve over time so that different scenarios can be analyzed using the models as virtual testbeds for theory generation and exploration.

REQUIRED BOOKS

PART 1: The Basics: Paradigms, Models, and Tools

WEEK 1: JANUARY 20
What is Social Complexity: Building Blocks to examine global political economy and complexity

“Theories of complex social systems are tested on massive scales everyday, when governments implement various policies that often involve substantial resources and ultimately have tremendous impacts on the lives of countless citizens” (Miller and Page 2007: 235). Scholars from many disciplines are applying perspectives from the study of dynamical systems to problems of global and international public policy. How will this affect some of the basic paradigms of governance, development policy, foreign policy and international relations?

Social Complexity 1: Overview: via@YouTube (youtu.be/kkcGr3y70bk?a via @youtube) This module will provide a quick overview to the application theory to the social sciences. See Complexity Academy@Complexityacad


Recommended Reading


WEEK 2: JANUARY 27
Topic: Why Complexity

- Why do all companies, large and small, eventually die but cities generally persist?
- Why does socio-economic complexity accelerate?
- How do selfish agents come to form groups that are not internally selfish?
- How do low-probability events and gradual-unfolding trends have far-reaching influence on the long-term future?
- How can policymaking be made more sensitive to global long-term perspectives?


**Recommended Readings:**


**WEEK 3: FEBRUARY 3**

**Topic: The Economy as a Complex Adaptive System**
- Why do the rich get richer?
  Did complexity cause the demise of central planning and will it cause the reconsideration of neo-classical models of economic development as well?
- How do the global trends of growing economic and social inequalities result from the globalization of resource use, production and consumption?


**Recommended**

William A. Brock, Karl-Gan Maler, and Charles Perrings “Resilience and Sustainability: The Economic Analysis of Nonlinear Dynamic Systems 261-289

“Economics Focus: Agents of Change.” *The Economist,* July 22, 2010

**WEEK 4: FEBRUARY 10**
**Topic: Modeling Techniques**
Guest Speaker: Steve Scott - MITRE Cooperation

Reading Robert Axtell and Doyne Farmer 
[http://breakthroughs.csmonitor.com/the-economy](http://breakthroughs.csmonitor.com/the-economy), part of a series the “Christian Science Monitor” is doing on complex systems more broadly (e.g., cities, diseases, traffic).

**WEEK 5: FEBRUARY 17**
**Social Networks, Culture, Cognition and Social Evolution**

- How can the global convergence of information and communications technologies work for everyone?
- How can the threat of new and reemerging diseases and immune micro-organisms be reduced?
- Is there any hope of quality in a world where anyone having a Twitter account is an expert?
- What will be the impact of growing interdependence and network density on social movements, protest, social exclusion, social mobility, immigrations, competition between ethnic groups, and on divergent globalising forms of capitalism?


**Recommended**


**PART 2: PROBLEM SOLVING: GREAT TRANSITIONS IN HUMAN HISTORY**

**WEEK 6: FEBRUARY 24**
*The Great Divergence of East and West,*

Reading
Root, “The Gradual Development and Sudden Demise of Social Order” will be sent to students via email

**WEEK 7: MARCH 2**
*Transitions and System Innovations: A Co-evolutionary and Multilevel Perspective*

H. Root “Innovation Systems in Europe and China: Disruptive Innovation in World History” via email


**MARCH 9 SPRING BREAK NO CLASS**

**WEEK 8: MARCH 16**
*Global Diversities Reconsidered:*

International relations continue to exhibit unyielding diversity across nations despite the deepening of globalization and the frequent cross-cultural diffusion of policies and behaviors. While the weight of the global economy is shifting with the economic rise of large, middle-income countries (the so called BRICS), the consequences of this shift for political outcomes remain to be seen. Under what conditions, for example, will global economic institutions reform their structures and decision-making? For scholars of comparative politics, diversities persist within countries, within regions and over time. Despite the spread of democracy to many parts of the world, mixed and authoritarian regimes remain in – or have returned to – many nations. What are the implications of this institutional variation for the quality of governance, for citizens’ well being and, for
economic outcomes? How can complexity studies enable political scientist to define and
conceptualize the persistence of diversities in global political economy

- How will the different local models of social order shape the multi-level context
  of global governance?
- What impact will frameworks designed to fulfil the local search for cultural
  authenticity have on global governance and global stability?
- How will the important example of the successful globalizing economies of East
  Asia and China be diffused?

Root, Hilton "Fast, Slow and Endless Variation Drives Global Development,”
Cambridge Review of International Affairs (In Press, 2016), [copy will be emailed to
class].
Root, “An Evolutionary Theory of Globalization”

Recommended
26, 1 (Jan. 2015): 141-155 and

Larry Diamond and Marc Plattner, 2015 Democracy in Decline? Johns Hopkins
University Press

60(2): 281-314

Inglehart, Ronald, and Christian Welzel. 2007. Modernization, Cultural Change, and
Democracy: The Human Development Sequence. Cambridge Univ. Press. (pp. 15 – 48)

Root, Hilton L. 2013. Dynamics Among Nations: The Evolution of Legitimacy and
Development in Modern States. MIT Press. Chapters 4 – 5, pages 57 - 74

WEEK 10: MARCH 23
Uncertainty, Risk and Institutions
Readings to be posted

March 30
An Ecological Approach to Social Institutions and State Capacity
- Why if most policies fail, do states grow larger?
- How can genuine democracy emerge from authoritarian regimes?
- parallel political modernization – China and Europe.
- How will the models of authoritarian growth impact communities, states and
  international systems?

Reading,
Root, 2013: 112-175.

Recommended


PART III: MANAGERIAL DILEMMAS OF THE TWENTY-FIRST CENTURY

WEEK 12: APRIL 6

Development Assistance and Complexity for Practitioners
- Why do outbreaks of political or economic instability occur?
- How can we separate causes into structural conditions and triggering events?


Ramalingam, Ben. “From Best Practice to Best Fit”

Recommended


**WEEK 13: APRIL 13**

*Managing Complexity: The `New Economy ‘and the New Security Environment and*


Hilton Root, “Opening the Doors of Invention” (download at website: hiltonroot.gmu.edu)

http://hiltonroot.gmu.edu/pdfs/published_articles/opening%20the%20doors%20of%20invention.pdf

**PART 4: THE FUTURE and the END of CERTAINTY**

**WEEK 14: APRIL 20**

Financial Crisis


**WEEK 15: APRIL 27**

*Collapse or Prosperity?*

- How can shared values and new security strategies reduce ethnic conflicts, terrorism, and the use of weapons of mass destruction?
- How can transnational crime and terrorist networks be stopped from becoming more powerful and sophisticated global enterprises?
- What kinds of network-based cooperation are likely to replace the post-hegemonic international order based on liberal world order?

See “Collapse of Complex Societies by Dr. Joseph Tainter” youtube.
Jarret Diamond, “Why do Societies Collpase” youtube
Schweller, Randall. 2014. The Age of Entropy or Why the New World Order Won’t be Orderly. *Foreign Affairs*, June 16, 2014

**FINAL – MAY 4**

For Reference, modules of previous years
*Cities as Complex Systems*- 

**Recommended Readings**

[http://www.santafe.edu/media/workingpapers/13-03-008.pdf](http://www.santafe.edu/media/workingpapers/13-03-008.pdf)  
[http://www.complexcity.info/](http://www.complexcity.info/) (A general exploration of this website plus reviews of Michael Batty's, The New Science of Cities)  

*** Students who are taking this course under the CSS course number MUST execute a term project that uses computation in some essential way.

**Policy on Plagiarism**

The profession of scholarship and the intellectual life of a university as well as the field of public policy inquiry depend fundamentally on a foundation of trust. Thus any act of plagiarism strikes at the heart of the meaning of the university and the purpose of a graduate education. It constitutes a serious breach of professional ethics and it is unacceptable.

Plagiarism is the use of another’s words or ideas presented as one’s own. It includes, among other things, the use of specific words, ideas, or frameworks that are the product of another’s work. Honesty and thoroughness in citing sources is essential to professional accountability and personal responsibility. Appropriate citation is necessary so that arguments, evidence, and claims can be critically examined.

Plagiarism is wrong because of the injustice it does to the person whose ideas are stolen. But it is also wrong because it constitutes lying to one’s professional colleagues. From a prudential perspective, it is shortsighted and self-defeating, and it can ruin a professional career.

Any plagiarized assignment will receive an automatic grade of “F.” This may lead to failure for the course.
To help enforce the policy on plagiarism, all written work submitted in partial fulfillment of course or degree requirements must be available in electronic form so that it can be compared with electronic databases, as well as submitted to commercial services.

**Statement on special needs of students**

If you are a student with a disability and you need academic accommodations, please see me.

**Useful Background Sources: (Not Required)**

For a general overview of complexity:

- Acemoglu / Robinson / Verdier. "Can't We All Be More Like Scandinavians? Asymmetric Growth and Institutions in an Interdependent World?"

**General Software, Toolkits, and Hardware**

A website reviewing academic work on evolutionary complexity and social science is

[http://www.econ.iastate.edu/tesfatsi/]
• Ada for Agent-Based Simulation

From Bruce R. Barkstrom (NOAA National Climate Data Center): "Ada, a general purpose programming language originally developed by the U.S. Department of Defence in 1983, appears to provide an appealing tool for developing agent-based software. The language has undergone two major revisions, one in 1995, and a second in 2005. An excellent open-source implementation is available with the GPL license at the AdaCore Site, from which it is possible to download both the GNAT GPL version and the GPS Integrated Development Environment, as well as numerous other libraries and toolkits. The reason Ada would appear to be an attractive language for agent-based simulations is that Ada defines a model for concurrent programming as part of the language itself. A task is an active component encapsulating a light-weight process and it provides a simple model for executing multiple code blocks concurrently - and for allowing different tasks to communicate and synchronize. In cases in which it is necessary for concurrent processes to avoid interference, Ada also provides protected entries and tasks. Because Ada has been designed to handle embedded, distributed systems, it also has excellent exception handling capabilities."

• Brahms: Multi-Agent Discrete-Event Simulation (Java based)

From the developers: "Brahms, developed by the Brahms Team in the Computational Sciences Division at the NASA Ames Research Center, is a multi-agent discrete-event simulation environment. It is also an Agent-Oriented Language for implementing real-time distributed agents. There is an agent language construct that can inherit from multiple group constructs. This permits the modeling of teams of agents either interacting in one model or distributed over multiple models. Agents are belief-based (BDI) activity-oriented, and both deliberative and reactive. Besides agents, the Brahms language also includes constructs for objects and object-class inheritance for modeling of data objects and real world artifacts. Agents and objects are located in a conceptual geography model, enabling agent and object movement in this geography. The Brahms byte-code is XML, which is interpreted by the Brahms Virtual Machine. Each Brahms agent executes in a separate Java thread using a subsumption-based activity and rule execution engine. Multiple Brahms Virtual Machines can interact together via a network using a message- and directory-based communication layer. Agents can publish themselves and locate others on a network, using a distributed directory service. Agents interact via a message-based communication layer that can be based on any low-level communication protocol, such as Corba, UDP, TCP/IP, SOAP."
Brahms can be downloaded at Agent iSolutions. A Tutorial on Brahms is also available.

• Breve: 3-D Simulation Environment (Open Source)
**Breve** is a free software package that provides a 3-D environment for the simulation of decentralized systems and artificial life. Users define the behaviors of agents in a 3-D world and observe how they interact. Breve includes physical simulation and collision detection for the simulation of realistic creatures, and an OpenGL display engine so that users can visualize their simulated worlds. It is available for Mac OS X, Linux, and Windows platforms.

- **MASON: Multi-Agent Simulator - Latest Release (Java, Open Source)**

The George Mason University Evolutionary Computation Laboratory and Center for Social Complexity has announced a new release (MASON 12) of the **MASON multiagent simulation toolkit**. MASON contains both a model library and an optional suite of visualization tools in 2D and 3D. MASON is a joint effort between George Mason University's ECLab (Evolutionary Computation Laboratory) and the GMU Center for Social Complexity, and was designed by Sean Luke, Gabriel Catalin Balan, and Liviu Panait, with help from Claudio Cioffi-Revilla, Sean Paus, Daniel Kuebrich, and Keith Sullivan. A SwarmFest04 presentation on MASON can be accessed [here](#).

- **Repast Latest Releases (Java, Python, C#; Open Source)**

Repast (REcursive Porous Agent Simulation Toolkit) is an agent-based simulation toolkit specifically designed for social science applications. Originally developed by researchers at the University of Chicago and the Argonne National Laboratory, Repast is now managed by the non-profit volunteer organization ROAD (Repast Organization for Architecture and Development). Repast is currently released in four versions supporting model development in three different languages: RepastJ (Java based); RepastPy (based on the Python scripting language); Repast.Net (implemented in C#, but any .Net language can be used); and Repast S (Symphony, Java-based, developer's alpha release 2). Repast runs on virtually all modern computing platforms (e.g., Windows, Mac OS, and Linux). The latest Repast releases, along with detailed technical information regarding the installation and use of Repast, can be found at the **Repast Sourceforge Website**.

**NetLogo** is a cross-platform multi-agent programmable modeling environment. NetLogo was authored by **Uri Wilensky** in 1999 and is under continuous development at the **CCL** (the people who brought you **StarLogoT**). NetLogo also powers the **HubNet** participatory simulation system. NetLogo is free of charge. For a fuller description, please go to: **http://ccl.northwestern.edu/netlogo/docs/**

**Statement on special needs of students**

If you are a student with a disability and you need academic accommodations, please see me and contact the Disability Resource Center (DRC) at 993-2474. All academic accommodations must be arranged through the DRC.

**Online Student Journal**

New Voices in Public Policy: I will consider nominating the very best papers in this
course for publication in New Voices in Public Policy. New Voices is a student- and faculty-reviewed journal that shares SPP's finest student work with the rest of the world.

**SPP Policy on Plagiarism**
The profession of scholarship and the intellectual life of a university as well as the field of public policy inquiry depend fundamentally on a foundation of trust. Thus any act of plagiarism strikes at the heart of the meaning of the university and the purpose of the School of Public Policy. It constitutes a serious breach of professional ethics and it is unacceptable.

Plagiarism is the use of another’s words or ideas presented as one’s own. It includes, among other things, the use of specific words, ideas, or frameworks that are the product of another’s work. Honesty and thoroughness in citing sources is essential to professional accountability and personal responsibility. Appropriate citation is necessary so that arguments, evidence, and claims can be critically examined.

Plagiarism is wrong because of the injustice it does to the person whose ideas are stolen. But it is also wrong because it constitutes lying to one’s professional colleagues. From a prudential perspective, it is shortsighted and self-defeating, and it can ruin a professional career.

The faculty of the School of Public Policy takes plagiarism seriously and has adopted a zero tolerance policy. Any plagiarized assignment will receive an automatic grade of “F.” This may lead to failure for the course, resulting in dismissal from the University. This dismissal will be noted on the student’s transcript. For foreign students who are on a university-sponsored visa (e.g. F-1, J-1 or J-2), dismissal also results in the revocation of their visa.

To help enforce the SPP policy on plagiarism, all written work submitted in partial fulfillment of course or degree requirements must be available in electronic form so that it can be compared with electronic databases, as well as submitted to commercial services to which the School subscribes. Faculty may at any time submit student’s work without prior permission from the student. Individual instructors may require that written work be submitted in electronic as well as printed form. The SPP policy on plagiarism is supplementary to the George Mason University Honor Code; it is not intended to replace it or substitute for it.