

Course Overview for PoCS

Last updated: 2025/10/28, 09:33:43 EDT

Principles of Complex Systems, Vols. 1, 2, 3D, 4 Fourever, V for Vendetta

Prof. Peter Sheridan Dodds

Computational Story Lab | Vermont Complex Systems Institute
University of Vermont | Santa Fe Institute



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Sealie & Lambie Productions

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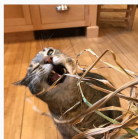
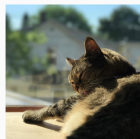
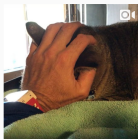
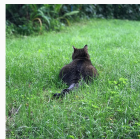
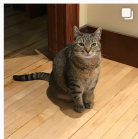
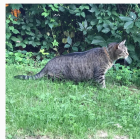
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Special Guest Executive Producer



 On Instagram at [pratchett_the_cat](https://www.instagram.com/pratchett_the_cat) 

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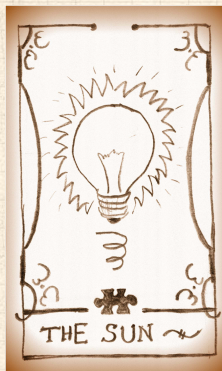
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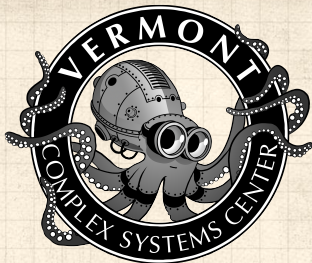
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Describe | Explain | Create | Share | Ethos: Play



vermontcomplexsystems.org 



Vermont Complex Systems Center (2006–):

-  Diverse research and teaching portfolio.
-  Funding from many sources: NSF, NIH, DARPA, Microsoft, MITRE, Computer Associates, MassMutual, Google, foundations.
-  Regular global press coverage: NYT, BBC, WaPo, NatGeo, ...
-  Conferences: “Big Data, Big Stories”, “Big Scale, Big Fail”, “Prediction: the Next Big Thing”, [NetSci 2019](#) , [ALife 2020](#) .
-  Fully developed educational platform in Complex Systems and Data Science.
-  Complex Networks Winter Workshops in Quebec City
-  Faculty hires of true Complex Systems scholars.
-  Numerous NSF CAREER awards (including PECASE).
-  Connecting Graduate and Undergraduate Students across campus (SCRaPS).
-  Paper Shredder, Research Jam, and ComplexiTea.
-  [Talkbocotopus](#) .

Some Major support:



MassMutual Center for Excellence in Complex Systems and Data Science

vermontcomplexsystems.org/partner/MMCOE/



University of Vermont-Google Open-Source Complex Ecosystems And Networks (OCEAN)

vermontcomplexsystems.org/partner/OCEAN/

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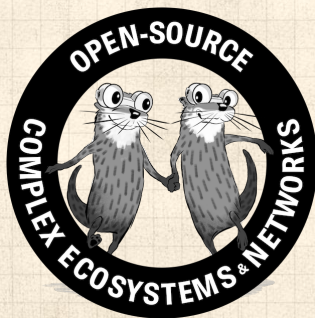
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We're interested in many things:


 Sociotechnical systems


 Social Contagion and Influence


 Happiness and Well-being


 Language and Stories


 Social unrest

 Conflict

 Robotics


 Artificial Intelligence

 Complex Networks


 Climate


 Biology


 Ecology

 Geomorphology


 Space


 Complex Fluids


 (Smart) Power Grids


 Critical infrastructure


 Defense


 Public Policy


 Health and Medicine


 ~~Brainz~~ Brains


 Neuroscience


 Food systems


 Epidemiology

 Pandemics

 Organizations

 Economics

 Wealth inequality

 Financial Systems

Leveling up—Scaffolded educational mission:



Data Science Undergrad.



Graduate Certificate in Complex Systems and Data Science



Fall, 2015–: MS in Complex Systems and Data Science

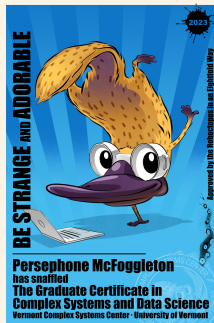


Fall, 2018–: PhD in ~~The Study of Interesting Things~~ Complex Systems and Data Science






All the words: <http://vermontcomplexsystems.org>


Dipoloma-posters:




Graduate Certificate in Complex Systems and Data Science:

 Principles of Complex Systems is one of three core requirements for UVM's five course Certificate of Graduate Study in Complex Systems .

 Modelling Complex Systems I and II

 Data Science I and II

 Principles of Complex Systems Vols. 1 and 2

Framing (funfully):

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Science = Area of study + Instruments of study

-  Stars and Telescopes = Astronomy
-  Rocks and Hammers = Geology
-  Water and Partial Differential Equations = Fluid Dynamics
-  Brains and Giant Imaging Machines = Neuroscience
-  People and Deception = Social Psychology
-  Mathematics and Mathematics = Pure mathematics
-  Mind and Mind = Psychotherapy, Insight meditation, ...
-  Complex Systems + Data Science = Postdisciplinary Systems Science



Michael Arnold



Jane Adams



Todd DeLuca



Sophie Hodson



Sandhya
Gopchandani



Anne Marie
Stupinski



Summer Jang



Tyler Gray



Aaron Schwartz



Eric Clark



Ben Emery



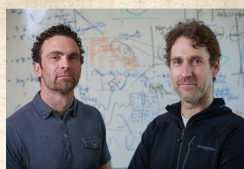
David
Dewhurst



Colin
Van Dort



Laura Jennings



Chris Danforth

Peter Dodds



Abby Ross
Northfield Mount
Hermon School



Chris Fusting
Data Science
Consultant



Ryan Gallagher
Northwestern
PhD student



John Ring



Lindsay Ross



Brendan
Whitney



Henry
Mitchell



Sarah Howerter



Kayla Horak
U of Wisconsin



compstorylab.org



Nick Altshuler
Psychiatry
Res Asst Prof



Dylan Riley
Chobanian Group



Tom Mylindrew
Carisvascular
Research Foundation



Emily Casey
Data Scientist
Adobe



Morgan Fries
MIT Media Lab
PhD Student



Cathy Bliss
UVM Lecturer



Mark Ibrahim
Data Scientist
Insight



Ross Luo
Lappen
Dartmouth PhD
Cold Regions Research
& Engineering Laboratory



Liam Pechemick
Maine School of
Science & Math



Andy Seaman
Data Scientist
MassMutual



Sven McCall
Maps, Apple



Lewis Mitchell
Adelaide Faculty



Jake Williams
Drexel Faculty



Isabel Kleemann
Cornell PhD
Facebook
Data Scientist



Fletcher
Hazlehurst



Sharon Alajajian
Research Scientist
Univ of Pennsylvania



Kameron Harris
U Washington
Postdoc



Paul Lissardi
Colorado
PhD Student



Suma Deva
Apple
Data Scientist



Mike Foley
Northwestern
PhD student



Darcy Green
Climate Science
UC London, MS student



Lindsay Van Lier
VCHiP

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Funding: NSF, NIH, NIDA, NASA, MITRE, James S. McDonnell Foundation, ONR, DARPA, MassMutual, Google, Computer Associates; [YOUR WONDERFUL FUNDING AGENCY HERE]

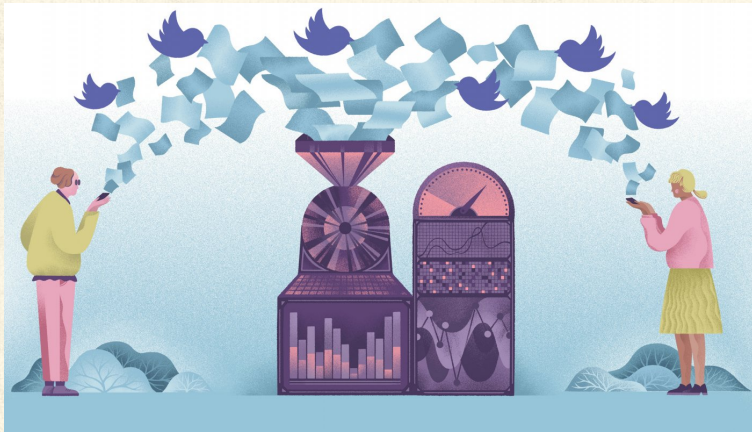


Outside

Inside the Lab that's Quantifying Happiness 

by Rowan Jacobsen, August 2017.

(Reprinted in UVM Quarterly, 2018.)



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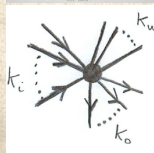
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Projects



References

Computational
Story Lab
++;

Courses:



-  CSYS/MATH 300: Principles of Complex Systems (@pocsvox )
-  CSYS/MATH 303: Complex Networks (@networksvox )
-  MATH 124/122: Matrixology (Linear Algebra) (@matrixologyvox and @svdthematrices )
-  MATH 237: Numerical Analysis (@MachEps237 )
-  MATH 266: Chaos, fractals & dynamical systems (@NonperiodicFlow )
-  MATH 330: Ordinary Differential Equations (@dallthethingsdt )

 Courses act as research incubators and have helped generate many papers 

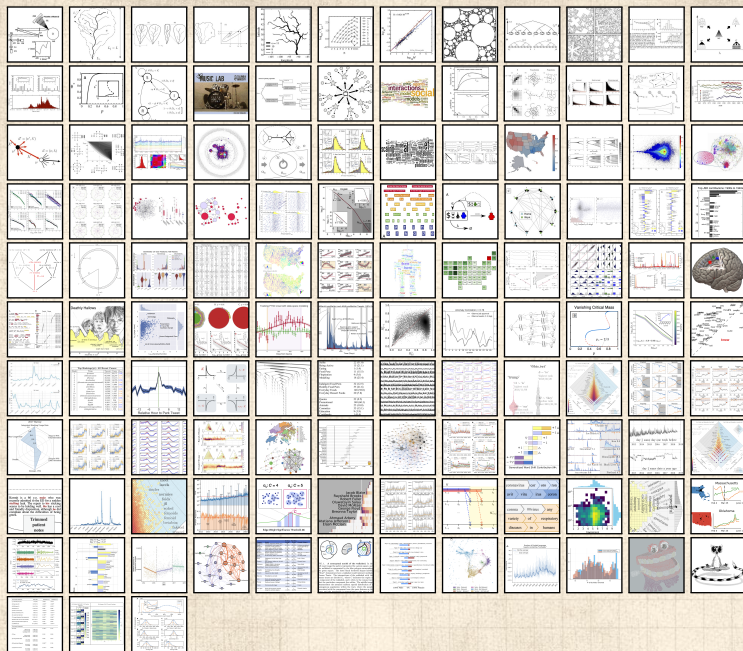
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Instructor: Prof. Peter Sheridan Dodds



Lecture room and meeting times:

Cohen Hall, 10:05 am to 11:20 am




Office: (in theory) The Ether and/or Innovation, fourth floor



email: peter.dodds@uvm.edu



Course Website:

<https://pdodds.w3.uvm.edu/teaching/courses/2025-2026pocsvverse> 




Course Twitter handle: @pocsvox





Potential paper product:

 The Syllabus . and a Poster .



Office hours:

 See Teams calendar,
The Ether and/or Innovation, fourth floor

No laptops in class:

-  Please take notes with pencil/pen and paper.
-  Also okay: Writing on a flat tablet.

Approved etiquette mechanisms:

-  Raise hands for questions (always feel free to ask questions).
-  The class is a G rated environment (of course, sometimes we have to discuss bad things, science-style).



Exciting details regarding these slides:



Three servings (all in pdf):

1. Fresh: For in-class Delivery.
2. On toast: Flattened for page-turning joy.
3. Freeze-dried: Pack-and-go, 3x3 slides per page.



Presentation versions are hyperly navigable:

back + search + forward.



Web links look like this



References in slides link to full citation at end. ^[1]



Citations contain links to pdfs for papers (if available).



Some books will be linked to on Amazon.



Brought to you by a frightening melange of ~~X_YLaTeX~~ ,
Lua~~La~~TeX , Beamer , perl , PerlTeX , fevered
command-line madness , and an almost fanatical
devotion to the indomitable emacs .

#totallynormal



More super exciting details:

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We use ~~Open Sans~~ EB Garamond and make math look good:

```
%% \setmainfont[Ligatures=TeX]{Open Sans}
%% \setsansfont[Ligatures=TeX]{Open Sans}
%% \usefonttheme[onlymath]{serif}
\setmainfont[Ligatures=TeX]{EB Garamond}
\setsansfont[Ligatures=TeX]{EB Garamond}
\usefonttheme[onlymath]{serif}
```














Still working towards putting the course on Github/Gitlab



And finishing writing the books ...





Yet more super exciting details:



-  This is Season 21 of Principles of Complex Systems, Vols. 1 and 2.
-  In-person lectures will be called ~~Stories~~ Episodes (a more elevated framing than “Streams of consciousness”)
-  Slide-specific curated episodes are online, and are broken into clips.
-  ~~Goal for all in-person lectures: Record with ScreenFlow, curate, send to Youtube.~~
-  Office hours will run over Teams and be recorded.
-  Some new clips may be recorded in a pretend studio.
-  All lectures are bottle  episodes .
-  Other tropes  will be involved.





Wonderful foundational support for PoCS Vol. 1, ~~CoNKS~~
~~CocoNutz~~ PoCS Vol. 2, and PoCS Vol. 3D, has come from
the NSF:

 “CAREER: Explorations of Complex Social and
Psychological Phenomena through Multiscale Online
Sociological Experiments, Empirical Studies, and Theoretical
Models.” 2009–2015.







 SES Division of Social and Economic Sciences
SBE Directorate for Social, Behavioral & Economic Sciences

 Abstract is here .

 People have also said nice things about PoCS 





Microsoft Teams + Slack

-  Teams = main place for discussions about all things PoCS including assignments and projects.
-  Slack = main place for students and faculty in Complex Systems and Data Science to talk about everything.
-  Teams—Automatic if enrolled in the course.
-  Slack—Once invited, please sign up here:
<https://csdsgrads.slack.com/>
-  Very good: Install Microsoft and Slack apps on laptops, tablets, phone, cats, dogs. Nothing will go wrong.
-  Everyone will behave wonderfully.




Grading breakdown:

 **Assignments (66%)**—All assignments will be of equal weight and there will be 10 ± 1 of them.

 **Projects/talks (24%)**—Students will work on semester-long projects. Students will develop a proposal in the first few weeks of the course which will be discussed with the instructor for approval.

Details: 8% for the first talk, 8% for the final talk, and 8% for the written project.

 **General attendance/Class participation (10%)**—Everyone is expected to behave well.



How grading works:

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Questions are worth 3 points according to the following scale:

-  3 = correct or very nearly so.
-  2 = acceptable but needs some revisions.
-  1 = needs major revisions.
-  0 = way off.



Important things:

1. Classes run from Monday, August 28 to Friday, December 8.
2. Add/Drop, Audit, Pass/No Pass deadline—Monday, September 11.
3. Last day to withdraw—Monday, October 30 (Sadness!).
4. Reading and Exam period—Saturday, December 9 to Friday, December 15.

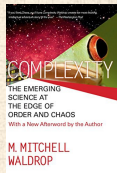
Do check the course Twitter account, @pocsvox, for updates regarding the course (part of the course site).

Academic assistance: Anyone who requires assistance in any way (as per the ACCESS program or due to athletic endeavors), please see or contact me as soon as possible.



Popular Science Books:

Historical artifact:



“Complexity: The Emerging Science at the Edge of Order and Chaos” [a](#) [↗](#)
by M. Mitchell Waldrop (1993). ^[16]

Shout-out: [Dr. Andrew P. Morokoff](#) [↗](#),
[MBBS PhD FRACS D.Thau \(Bug\)](#) [↗](#)



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Popular Science Books:



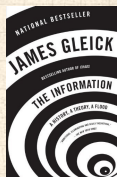
“Simply Complexity: A Clear Guide to Complexity Theory” [a](#) [↗](#)

by Neil F. Johnson (2009). ^[9]



“Complexity: A Guided Tour” [a](#) [↗](#)

by Melanie Mitchell (2009). ^[12]



“The Information: A History, A Theory, A Flood” [a](#) [↗](#)

by James Gleick (2011). ^[6]

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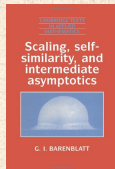
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Books on Complexification:



“Scaling, self-similarity, and intermediate asymptotics” [a](#) [↗](#)
by G. I. Barenblatt (1996). ^[3]



“Creation of the Universe” [a](#) [↗](#)
by Zhi and Xian (1989). ^[17]

See Freeman Dyson’s [↗](#) The Key to Everything [↗](#).

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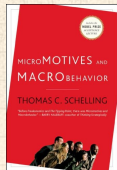
References



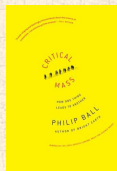
On complex sociotechnical systems:



“Human Behaviour and the Principle of Least-Effort”
by G. K. Zipf (1949). ^[18]



“Micromotives and Macrobehavior”
by Thomas C. Schelling (1978). ^[14]



“Critical Mass: How One Thing Leads to Another”
by Philip Ball (2004). ^[2]

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It's all about algorithms (stories):



“The Engine of Complexity: Evolution as Computation” [a](#) [↗](#)

by John E. Mayfield (2013). ^[10]



“On the Origin of Stories: Evolution, Cognition, and Fiction” [a](#) [↗](#)

by Brian Boyd (2010). ^[5]



“The Storytelling Animal: How Stories Make Us Human” [a](#) [↗](#)

by Jonathan Gottschall (2013). ^[7]

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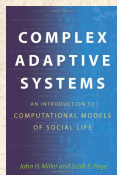
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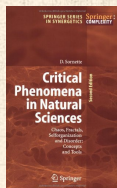
References



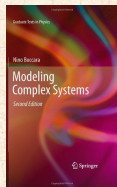
A few textbooky books (dated):



“Complex Adaptive Systems: An introduction to computational models of social life” [a](#) [↗](#)
by Miller and Page (2007). ^[11]



“Critical Phenomena in Natural Sciences” [a](#) [↗](#)
by Didier Sornette (2003). ^[15]



“Modeling Complex Systems” [a](#) [↗](#)
by Nino Boccara (2004). ^[4]

Eventually: “Principles of Complex Systems”

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Centers:

-  Santa Fe Institute (SFI)
-  Networks Institute at Northeastern
-  Northwestern Institute on Complex Systems (NICO )
-  MIT Institute for Data, Systems, AND Society
-  New England Complex Systems Institute (NECSI)
-  Michigan's Center for the Study of Complex Systems (CSCS )
-  Some Data Science groups (highly variable)
-  Also: Indiana, Davis, Brandeis, University of Illinois, Duke, Warsaw, Melbourne, ...,
-  Us!!!: Vermont Complex Systems Center 



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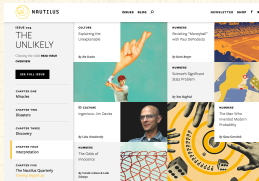
References



Complexity Digest:

<http://www.comdig.org>

<https://twitter.com/@cxdig>



Nautilus Magazine:

<http://nautil.us/>



Aeon: <http://aeon.co/>



Quanta Magazine: <https://www.quantamagazine.org/>



The nature of PoCS:



Transitional from standard coursework to research-focused work. **#alittlescary**

Major themes:



The Complexity Manifesto ;



Complex Systems \equiv Modern, Normal Science;



Roles and limits of Data, Theory, and Experiment;



Emergence;



Universality and Accidents of History;



Structure and Stories: Micro-to-macro Mechanisms;



Elements: Scaling, Surprise, Networks, Robustness, Failure, and Spreading.

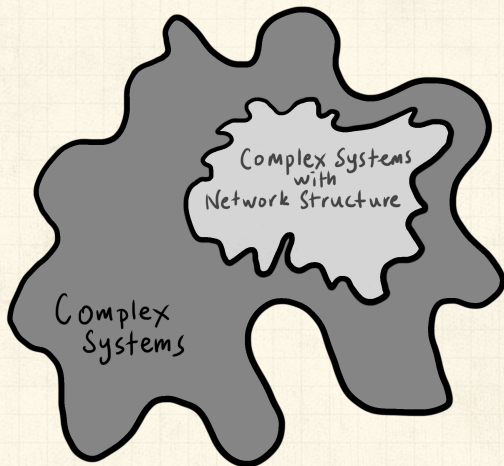


The Theory of Anything: Why Complexify?



It's all about stories.

Complex Systems are the Big Story:



Only a bit networky: Fluids-at-large (the atmosphere, oceans, ...), organism cells, ...

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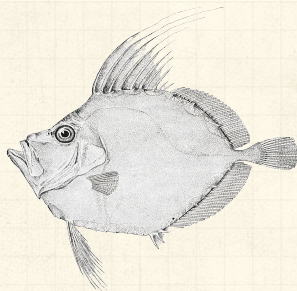
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Cryptolect:

Course mascot:




What's the Story?



What's the John Dory?



What's the John Dory for Rhyming Slang ?



Hemitelea: beers \Rightarrow Edward Lear \Rightarrow Edwards.



Also: Taxis \Rightarrow Boris Spasskies  \Rightarrow Borises

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Topics:

Scaling phenomena:

-  Allometry.
-  Scaling of social phenomena: crime, creativity, and consumption.
-  Scaling in biology (elephants and platypuses).
-  Dimensional Analysis and Renormalization.
-  Power law size distributions and non-Gaussian statistics.
-  The 80/20 rule, the 1%.
-  Zipf's law.
-  Order from randomness.
-  Fundamental mechanisms for generating power law size distributions.
-  The rich-get-richer mechanism.

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Topics:

Robustness—Integrity of complex systems:









-  Generic failure mechanisms.
-  Highly Optimized Tolerance (HOT): Robustness and fragility.
-  How to build optimal forests.
-  Minimization of risk as a driver of heterogeneous structures in complex systems.
-  How to optimally locate facilities: hospitals, schools, and coffee shops.

Fundamentals of Complexity:

-  Emergence: More is Different.
-  Measurement and mismeasurement.
-  Universality versus path dependence.
-  Complexification (it all starts with gravity^[17]).

Topics:

Complex networks:

-  Statistical Mechanics
-  Structure and Dynamics
-  Phase transitions
-  Random Networks
-  Scale-free Networks
-  Small-world Networks
-  Why your friends are better than you.
-  More in PoCS, Vol. 2 in the spring.

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Topics:

Sociotechnical Systems:

-  Biological and social spreading models
-  Schelling's model of segregation ^[13]
-  Granovetter's model of imitation ^[8]
-  Collective behavior and synchrony
-  Global cooperation from bad actors
-  Global conflicts from good actors
-  Stories (Homo Narrativus)
-  The Sociotechnocene

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Topics:

Collective decision making:













-  Wisdom and madness of crowds.
-  Systems of voting.
-  The role of randomness and chance.
-  Success inequality.
-  The paradox of unpredictable global fame.
-  Bonus knowledge: How to make things spread.
-  Bonus knowledge: Fate does not exist in a world of fame.

Large-scale social patterns (maybe):

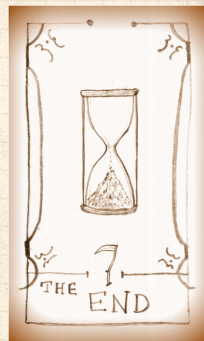
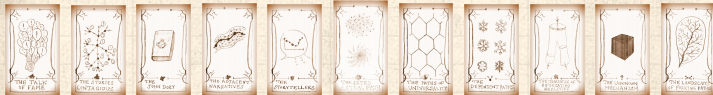
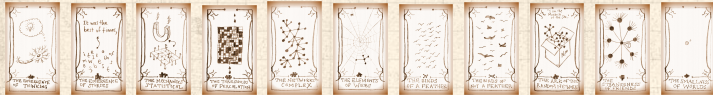
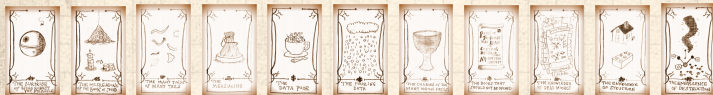
-  Movement
-  Cities
-  Happiness
-  Social media














Season's Narrative Arc (or Places We Will Go):

-  Overview of Complex Systems with bonus Manifesto .
-  Thread of Understanding Sociotechnical Systems.
-  Allometric scaling in complex systems.
-  Size distributions of system elements:
 -  Power-law size distributions.
 -  Description and Mechanisms of Becoming.
-  Robustness of Complex Systems.
-  Complex networks—how system elements are connected:
 -  Structure, Growth Mechanisms, Processes on Networks.
-  Social Contagion, Voting, Fame and Fate, Stories.
-  Complexification: The Theory of Anything and the Rise of Algorithms





Projects

-  Semester-long projects, teams.
-  Develop proposal in first few weeks.
-  May range from novel research to investigation of an established area of complex systems.
-  Two talks + written piece.
-  Usage of the VACC  is encouraged (ability to code well = super powers).
-  Massive data sets available, including Twitter.
-  Possible: Work with Twitter data and Story Lab on socially meaningful problems.
-  Academic output (journal papers) resulting from Principles of Complex Systems and Complex Networks can be found here . Add more!
-  We'll go through a list of possible projects soon.

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The narrative hierarchy—Stories and Storytelling on all

Scales: ↗



1 to 3 word encapsulation = a soundbite
= a buzzframe,



1 sentence, title,



few sentences, a haiku,



a paragraph, abstract,



short paper, essay,



long paper,



chapter,



book,



...

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


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