

# Course Overview for PoCS

Last updated: 2025/10/28, 09:29:35 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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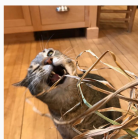
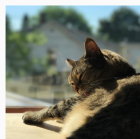
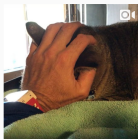
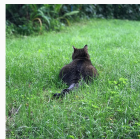
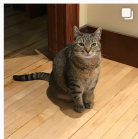
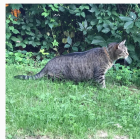
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 On Instagram at [pratchett\\_the\\_cat](https://www.instagram.com/pratchett_the_cat) 



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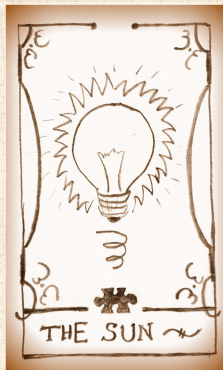
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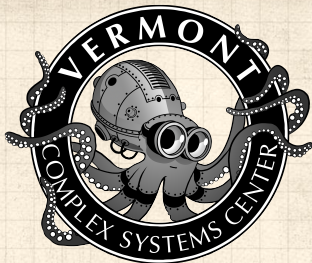
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Describe | Explain | Create | Share | Ethos: Play



[vermontcomplexsystems.org](http://vermontcomplexsystems.org) 





## Vermont Complex Systems Center (2006–):



Diverse research and teaching portfolio.

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-  [Talkbocotopus](#) 

## Some Major support:



MassMutual Center for Excellence in Complex Systems and Data Science

[vermontcomplexsystems.org/partner/MMCOE/](http://vermontcomplexsystems.org/partner/MMCOE/)



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

[vermontcomplexsystems.org/partner/OCEAN/](http://vermontcomplexsystems.org/partner/OCEAN/)

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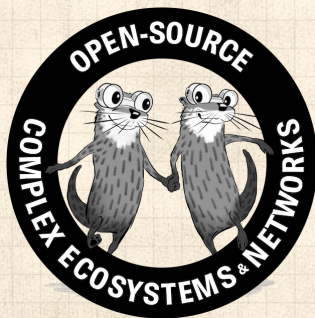
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# We're interested in many things:

 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):

Science = Area of study + Instruments of study



Stars and Telescopes

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# Framing (funfully):

Science = Area of study + Instruments of study



Stars and Telescopes = Astronomy

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Rocks and Hammers

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Stars and Telescopes = Astronomy



Rocks and Hammers = Geology

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# Framing (funfully):

Science = Area of study + Instruments of study



Stars and Telescopes = Astronomy



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Water and Partial Differential Equations

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# Framing (funfully):

Science = Area of study + Instruments of study



Stars and Telescopes = Astronomy



Rocks and Hammers = Geology



Water and Partial Differential Equations = Fluid Dynamics

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Water and Partial Differential Equations = Fluid Dynamics



Brains and Giant Imaging Machines

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Brains and Giant Imaging Machines = Neuroscience

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# Framing (funfully):

Science = Area of study + Instruments of study

-  Stars and Telescopes = Astronomy
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-  Water and Partial Differential Equations = Fluid Dynamics
-  Brains and Giant Imaging Machines = Neuroscience
-  People and Deception

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-  Brains and Giant Imaging Machines = Neuroscience
-  People and Deception = Social Psychology
-  Mathematics and Mathematics








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Science = Area of study + Instruments of study

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-  People and Deception = Social Psychology
-  Mathematics and Mathematics = Pure mathematics

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-  Mind and Mind

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-  Mind and Mind = Psychotherapy, Insight meditation, ...



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-  Complex Systems + Data Science

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-  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



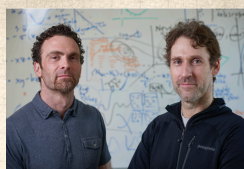
David  
Dewhurst



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 Sengap  
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]

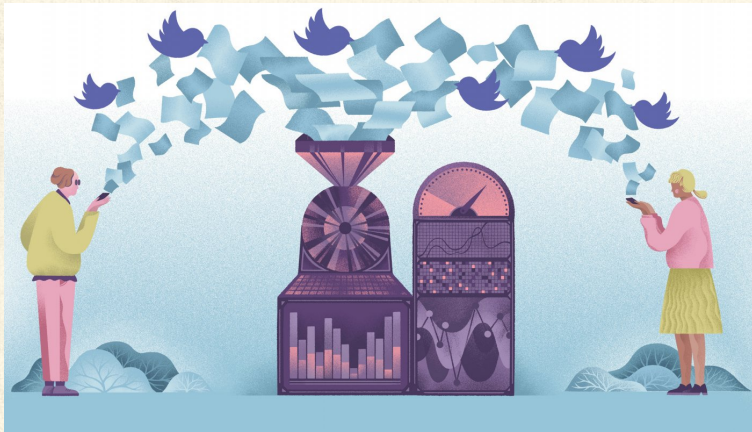


# Outside

Inside the Lab that's Quantifying Happiness 

by Rowan Jacobsen, August 2017.

(Reprinted in UVM Quarterly, 2018.)



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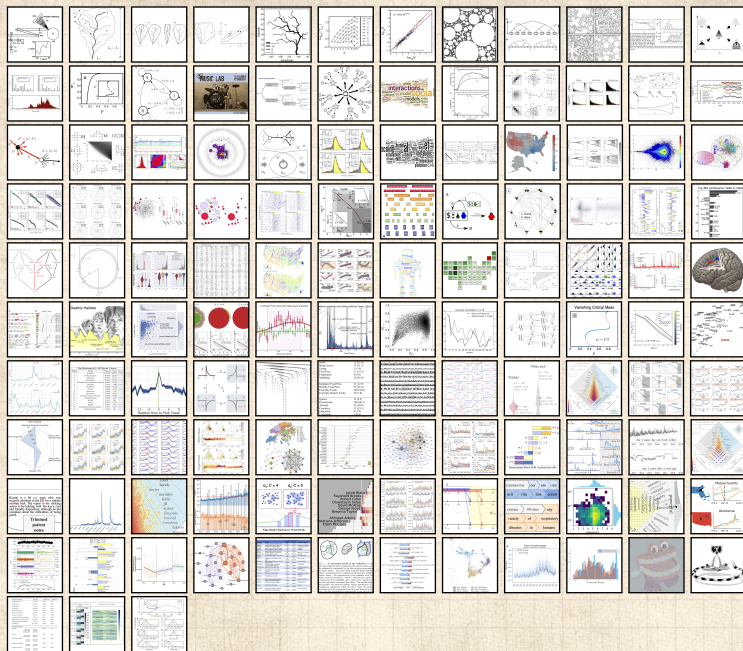
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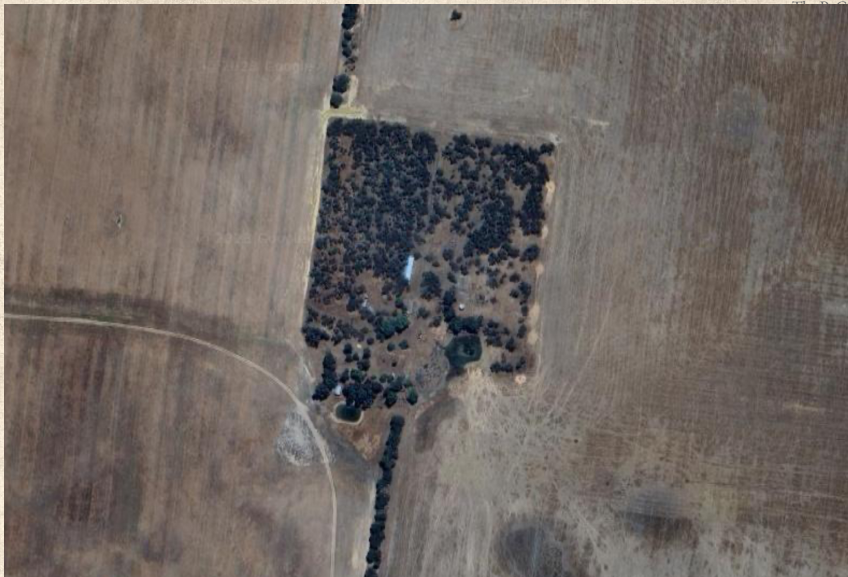
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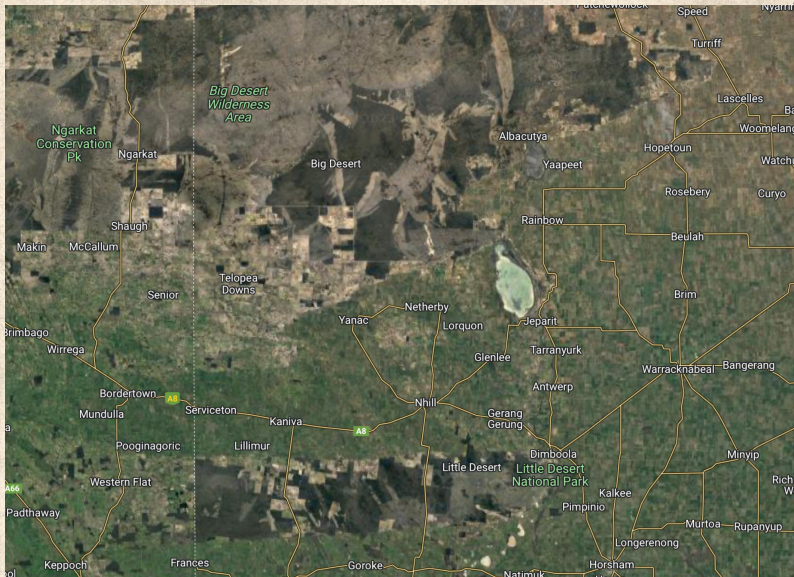
Where  the roads had no names 





Where  the roads had no names 





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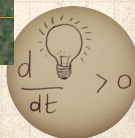
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**Instructor:** Prof. Peter Sheridan Dodds



**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 .

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## Office hours:

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

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## 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.

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


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Presentation versions are **hyperly navigable**:

 ~~back + search + forward.~~

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


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 .



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


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


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Some books will be linked to on Amazon.





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Brought to you by a frightening melange of ~~X<sub>Y</sub>LaTeX~~ ,  
LuaLaTeX , Beamer , perl , PerlTeX , fevered  
command-line madness , and an almost fanatical  
devotion to the indomitable emacs .



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**#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:

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# Yet more super exciting details:



This is Season 21 of Principles of Complex Systems, Vols. 1 and 2.

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 In-person lectures will be called ~~Stories~~ Episodes (a more elevated framing than “Streams of consciousness”)

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-  Slide-specific curated episodes are online, and are broken into clips.
-  ~~Goal for all in-person lectures: Record with ScreenFlow, curate, send to Youtube.~~
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-  All lectures are bottle  episodes .





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-  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~~  
~~CocoNut~~ 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](#) .









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 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 



# Team PoCS

## Microsoft Teams + Slack

 Teams = main place for discussions about all things PoCS including assignments and projects.



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-  Very good: Install Microsoft and Slack apps on laptops, tablets, phone, cats, dogs. Nothing will go wrong.





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<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  $10 \pm 1$  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.



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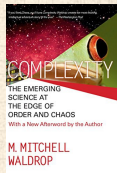
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# Popular Science Books:

## Historical artifact:



“Complexity: The Emerging Science at the Edge of  
Order and Chaos”   
by M. Mitchell Waldrop (1993). <sup>[16]</sup>

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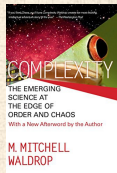
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# Popular Science Books:

Historical artifact:



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by M. Mitchell Waldrop (1993). <sup>[16]</sup>

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



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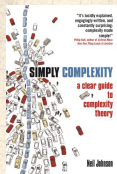
[Tarot Cards](#)

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# Popular Science Books:



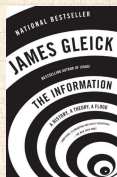
“Simply Complexity: A Clear Guide to Complexity Theory” [a](#) [↗](#)

by Neil F. Johnson (2009). <sup>[9]</sup>



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

by Melanie Mitchell (2009). <sup>[12]</sup>



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

by James Gleick (2011). <sup>[6]</sup>

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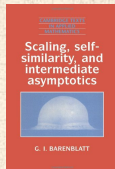
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# Books on Complexification:



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



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

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

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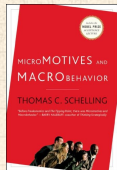
References



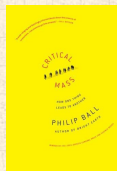
# On complex sociotechnical systems:



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



“Micromotives and Macrobehavior”   
by Thomas C. Schelling (1978). <sup>[14]</sup>



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

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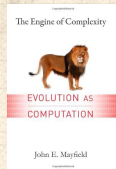
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# It's all about algorithms (stories):



“The Engine of Complexity: Evolution as Computation” [!\[\]\(919a2cb85b99741a73c0c31a427236a8\_img.jpg\)](#)  
by John E. Mayfield (2013). <sup>[10]</sup>



“On the Origin of Stories: Evolution, Cognition, and Fiction” [!\[\]\(c3d993ca47bfe2a953c700506ce31fa0\_img.jpg\)](#)  
by Brian Boyd (2010). <sup>[5]</sup>



“The Storytelling Animal: How Stories Make Us Human” [!\[\]\(e3f8612927870f2e0f9f5989e6dd3064\_img.jpg\)](#)  
by Jonathan Gottschall (2013). <sup>[7]</sup>

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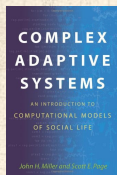
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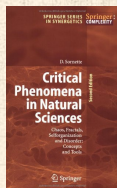
References



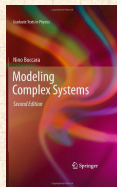
# A few textbooky books (dated):



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



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



“Modeling Complex Systems” [a](#) [↗](#)  
by Nino Boccara (2004). <sup>[4]</sup>

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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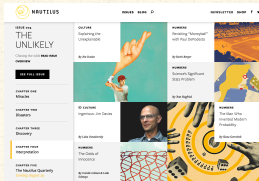
## References



### 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/>





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# The nature of PoCS:



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# The nature of PoCS:



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

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## The nature of PoCS:



Transitional from standard coursework to research-focused work. [#alittlescary](#)

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

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The Complexity Manifesto ;

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The Complexity Manifesto ;



Complex Systems  $\equiv$  Modern, Normal Science;

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Roles and limits of Data, Theory, and Experiment;

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

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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?



## 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.

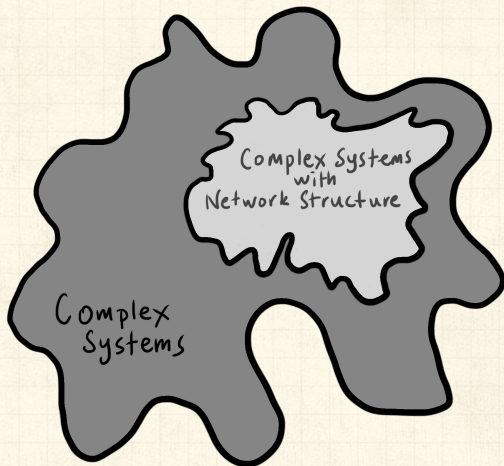


The Theory of Anything: Why Complexify?



**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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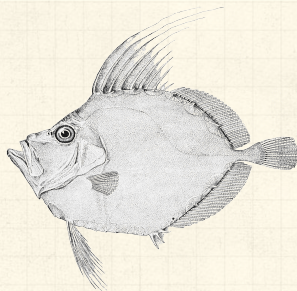
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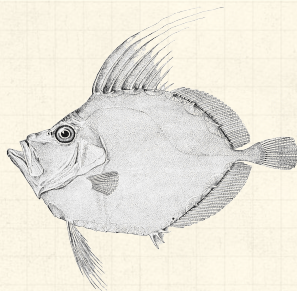
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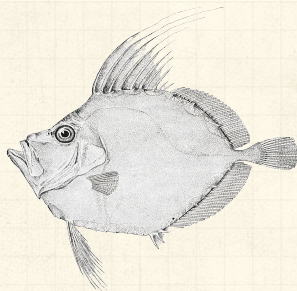
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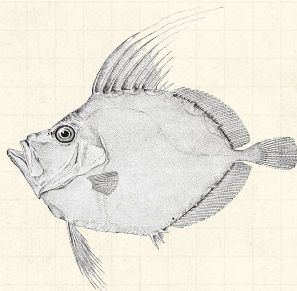
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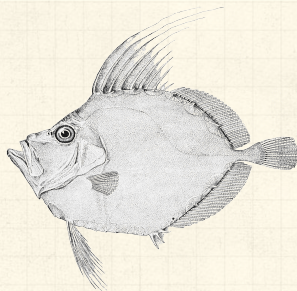
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Hemitelea: beers  $\Rightarrow$  Edward Lears  $\Rightarrow$  Edwards.



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.



# 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.

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# Topics:

## Robustness—Integrity of complex systems:

-  Generic failure mechanisms.
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-  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<sup>[17]</sup>).

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# 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 <sup>[13]</sup>
-  Granovetter's model of imitation <sup>[8]</sup>
-  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.

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# Topics:

## Collective decision making:

-  Wisdom and madness of crowds.
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-  The paradox of unpredictable global fame.
-  Bonus knowledge: How to make things spread.

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-  Bonus knowledge: Fate does not exist in a world of fame.

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## Collective decision making:

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-  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





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



Overview of Complex Systems with bonus Manifesto .

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Overview of Complex Systems with bonus Manifesto .



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

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 Thread of Understanding Sociotechnical Systems.


 Allometric scaling in complex systems.







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

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 Allometric scaling in complex systems.


 Size distributions of system elements:





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

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 Size distributions of system elements:


 Power-law size distributions.





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 Size distributions of system elements:


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 Description and Mechanisms of Becoming.





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 Description and Mechanisms of Becoming.

 Robustness of Complex Systems.















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  -  Power-law size distributions.
  -  Description and Mechanisms of Becoming.
-  Robustness of Complex Systems.
-  Complex networks—how system elements are connected:














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-  Complex networks—how system elements are connected:
  -  Structure, Growth Mechanisms, Processes on Networks.















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-  Complexification: The Theory of Anything and the Rise of Algorithms





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# Projects



Semester-long projects, teams.

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# Projects



Semester-long projects, teams.



Develop proposal in first few weeks.

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# 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.

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-  Massive data sets available, including Twitter.

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


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-  Possible: Work with Twitter data and Story Lab on socially meaningful problems.



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-  Academic output (journal papers) resulting from Principles of Complex Systems and Complex Networks can be found here . Add more!

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-  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,



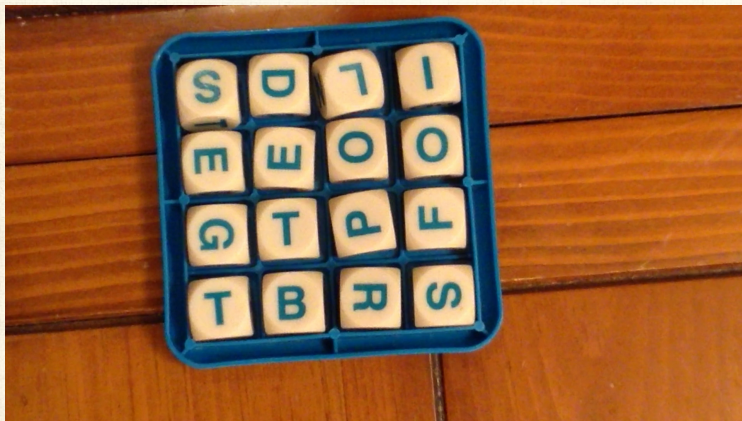
book,



...



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