Course Overview for PoCS

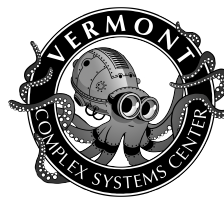Last updated: 2024/09/10, 07:30:42 EDT

Principles of Complex Systems, Vols. 1, 2, & 3D
CSYS/MATH 6701, 6713, & a pretend number, 2024–2025

Prof. Peter Sheridan Dodds

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

Licensed under the Creative Commons Attribution 4.0 International

The PoCSverse
What's the John
Dory?
1 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

Outline

Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects

References

THE SUN

The PoCSverse
What's the John
Dory?
2 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

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.
- Talkboctopus

The PoCSverse
What's the John
Dory?
3 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

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/

The PoCSverse
What's the John
Dory?
4 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

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

The PoCSverse
What's the John
Dory?
5 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

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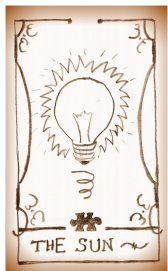- Fall, 2018–: PhD in ~~The Study of Interesting Things~~ Complex Systems and Data Science

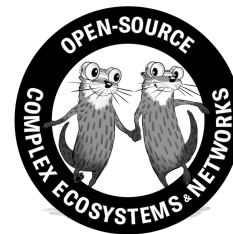All the words: http://vermontcomplexsystems.org.

The PoCSverse
What's the John
Dory?
6 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

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

The PoCSverse
What's the John Dory?
10 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

Outside

Inside the Lab that's Quantifying Happiness ↗
by Rowan Jacobsen, August 2017.
(Reprinted in UVM Quarterly, 2018.)

The PoCSverse
What's the John Dory?
13 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

Framing (funfully):

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

The PoCSverse
What's the John Dory?
11 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
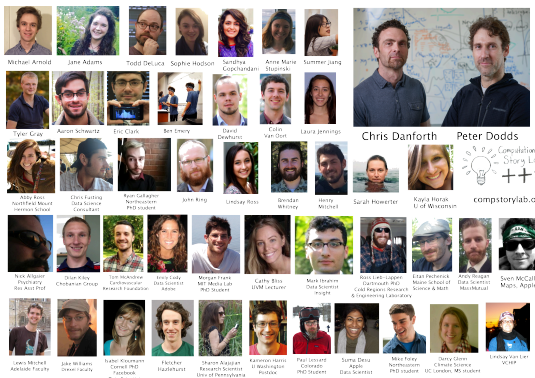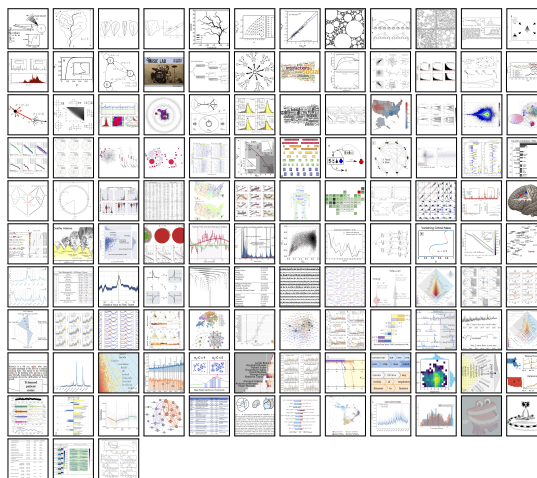Tarot Cards
Projects
References

Courses:
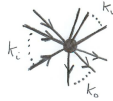
- CSYS/MATH 300: Principles of Complex Systems (@pocsvox ↗)
- CSYS/MATH 303: Complex Networks (@networksvox ↗)
- MATH 124/122: Matrixology (Linear Algebra) (@matrixologyvox and @svdthematrices ↗)
- MATH 237: Numerical Analysis (@MachEps237 ↗)
- MATH 266: Chaos, fractals & dynamical systems (@NonperiodicFlow ↗)
- MATH 330: Ordinary Differential Equations (@dallthethingsdt ↗)
- Courses act as research incubators and have helped generate many papers ↗

The PoCSverse
What's the John Dory?
13 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

Basics:

- Instructor: Prof. Peter Sheridan Dodds
- Lecture room and meeting times:
  Morrill Hall, 010, 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/2024-2025pocsverse ↗
- Course Twitter handle: @pocsvox

The PoCSverse
What's the John Dory?
17 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

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

The PoCSverse
What's the John Dory?
12 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

The PoCSverse
What's the John Dory?
14 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

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).

The PoCSverse
What's the John Dory?
18 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

Exciting details regarding these slides:

The PoCSverse
What's the John
Dory?
19 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

- Three servings (all in pdf):
  1. Fresh: For in-class Deliveration.
  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∃L∀T∃X ⧉, LuaLATEX ⧉, Beamer ⧉, perl ⧉, PerlTeX ⧉, fevered command-line madness ⧉, and an almost fanatical devotion ⧉ to the indomitable emacs ⧉.
  #totallynormal

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

The PoCSverse
What's the John
Dory?
22 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

- "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 ⧉

How grading works:

The PoCSverse
What's the John
Dory?
25 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

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.

More super exciting details:

The PoCSverse
What's the John
Dory?
20 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

- 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 ...

Team PoCS

The PoCSverse
What's the John
Dory?
23 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

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.

 Microsoft Teams   slack

Important things:

The PoCSverse
What's the John
Dory?
26 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

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.

Yet more super exciting details:

The PoCSverse
What's the John
Dory?
21 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

- This is Season 20 of Principles of Complex Systems, Vols. 1, 2, & 3D.
- 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.

Grading breakdown:

The PoCSverse
What's the John
Dory?
24 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

- 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.

Popular Science Books:

The PoCSverse
What's the John
Dory?
28 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

Historical artifact:

 "Complexity: The Emerging Science at the Edge of Order and Chaos" a ⧉ by M. Mitchell Waldrop (1993). [16]

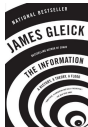Shout-out: Dr. Andrew P. Morokoff ⧉, MBBS PhD FRACS D.Thau (Bug) ⧉

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]

The PoCSverse
What's the John Dory?
29 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

Books on Complexification:
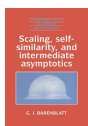
"Scaling, self-similarity, and intermediate asymptotics" 𝐚 ⧉
by G. I. Barenblatt (1996). [3]

"Creation of the Universe" 𝐚 ⧉
by Zhi and Xian (1989). [17]

See Freeman Dyson's ⧉ The Key to Everything ⧉.

The PoCSverse
What's the John Dory?
30 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

On complex sociotechnical systems:

"Human Behaviour and the Principle of Least-Effort" 𝐚 ⧉
by G. K. Zipf (1949). [18]

"Micromotives and Macrobehavior" 𝐚 ⧉
by Thomas C. Schelling (1978). [14]

"Critical Mass: How One Thing Leads to Another" 𝐚 ⧉
by Philip Ball (2004). [2]

The PoCSverse
What's the John Dory?
31 of 56
Orientation
Course Information
Centers, Books, Resources
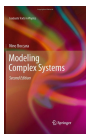Topics
Narrative Arc
Tarot Cards
Projects
References

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]

The PoCSverse
What's the John Dory?
32 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
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"

The PoCSverse
What's the John Dory?
34 of 56
Orientation
Course Information
Centers, Books, Resources
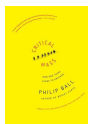Topics
Narrative Arc
Tarot Cards
Projects
References

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 ⧉

Other inputs:

- 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 PoCSverse
What's the John Dory?
35 of 56
Orientation
Course Information
Centers, Books, Resources
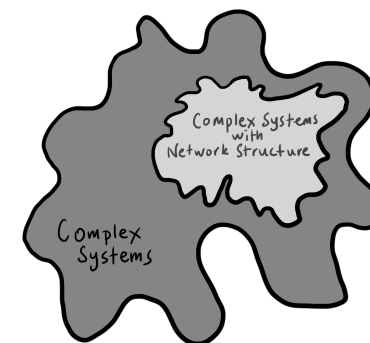Topics
Narrative Arc
Tarot Cards
Projects
References

The nature of PoCS:

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

Major themes:

- The Complexity Manifesto ⧉;
- Complex Systems ≡ 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.

The PoCSverse
What's the John Dory?
37 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

## Complex Systems are the Big Story:

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

The PoCSverse
What's the John Dory?
38 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

Cryptolect:

Course mascot:

The PoCSverse
What's the John Dory?
39 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References
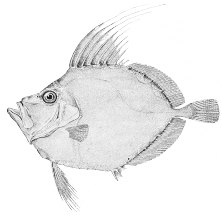
- What's the Story?
- What's the John Dory?
- What's the John Dory for Rhyming Slang ⎘?
- Hemiteleia: beers ⇒ Edward Lears ⇒ Edwards.
- Also: Taxis ⇒ Boris Spasskies ⎘ ⇒ Borises

Topics:

Scaling phenomena:

The PoCSverse
What's the John Dory?
40 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

- 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:

The PoCSverse
What's the John Dory?
41 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

- 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:

The PoCSverse
What's the John Dory?
42 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

- 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.~~

Topics:

Sociotechnical Systems:

The PoCSverse
What's the John Dory?
43 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

- 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

Topics:

Collective decision making:

The PoCSverse
What's the John Dory?
44 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

- 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):

The PoCSverse
What's the John Dory?
46 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

- 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

The PoCSverse
What's the John Dory?
50 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

- 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.

The narrative hierarchy—Stories and Storytelling on all Scales: ⎘

The PoCSverse
What's the John Dory?
51 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

- 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,
- ...

References I

[1] P. W. Anderson.
More is different.
Science, 177(4047):393–396, 1972. pdf

[2] P. Ball.
Critical Mass: How One Thing Leads to Another.
Farra, Straus, and Giroux, New York, 2004.

[3] G. I. Barenblatt.
Scaling, self-similarity, and intermediate asymptotics,
volume 14 of Cambridge Texts in Applied Mathematics.
Cambridge University Press, 1996.

[4] N. Boccara.
Modeling Complex Systems.
Springer-Verlag, New York, 2nd edition, 2004.

References II

[5] B. Boyd.
On the Origin of Stories: Evolution, Cognition, and Fiction.
Belknap Press, 2010.

[6] J. Gleick.
The Information: A History, A Theory, A Flood.
Pantheon, 2011.

[7] J. Gottschall.
The Storytelling Animal: How Stories Make Us Human.
Mariner Books, 2013.

[8] M. Granovetter.
Threshold models of collective behavior.
Am. J. Sociol., 83(6):1420–1443, 1978. pdf

References III

[9] N. F. Johnson.
Simply Complexity: A Clear Guide to Complexity Theory.
Oneworld Publications, London, UK, 2009. pdf

[10] J. E. Mayfield.
The Engine of Complexity: Evolution as Computation.
Columbia University Press, New York, 2013.

[11] J. H. Miller and S. E. Page.
Complex Adaptive Systems: An introduction to
computational models of social life.
Princeton University Press, Princeton, NJ, 2007.

[12] M. Mitchell.
Complexity: A Guided Tour.
Oxford University Press, New York, NY, 2009. pdf

References IV

[13] T. C. Schelling.
Dynamic models of segregation.
J. Math. Sociol., 1:143–186, 1971. pdf

[14] T. C. Schelling.
Micromotives and Macrobehavior.
Norton, New York, 1978.

[15] D. Sornette.
Critical Phenomena in Natural Sciences.
Springer-Verlag, Berlin, 2nd edition, 2003.

[16] M. M. Waldrop.
Complexity: The Emerging Science at the Edge of Order and
Chaos.
Simon & Schuster, New York, NY, 1993.

References V

[17] F. L. Zhi and L. S. Xian.
Creation of the Universe.
World Scientific Publishing Company, 1989.

[18] G. K. Zipf.
Human Behaviour and the Principle of Least-Effort.
Addison-Wesley, Cambridge, MA, 1949.

The PoCSverse
What's the John
Dory?
52 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

The PoCSverse
What's the John
Dory?
54 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

The PoCSverse
What's the John
Dory?
56 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References

The PoCSverse
What's the John
Dory?
55 of 56
Orientation
Course Information
Centers, Books, Resources
Topics
Narrative Arc
Tarot Cards
Projects
References