

OPERATIONALIZING COMPUTATIONAL TOOLS FOR ANALYSIS AND DECISION SUPPORT

NECESSITY, CAPABILITY, POSSIBILITY

PART 1 OF 2

LTC Tom Pike

25 OCT 18

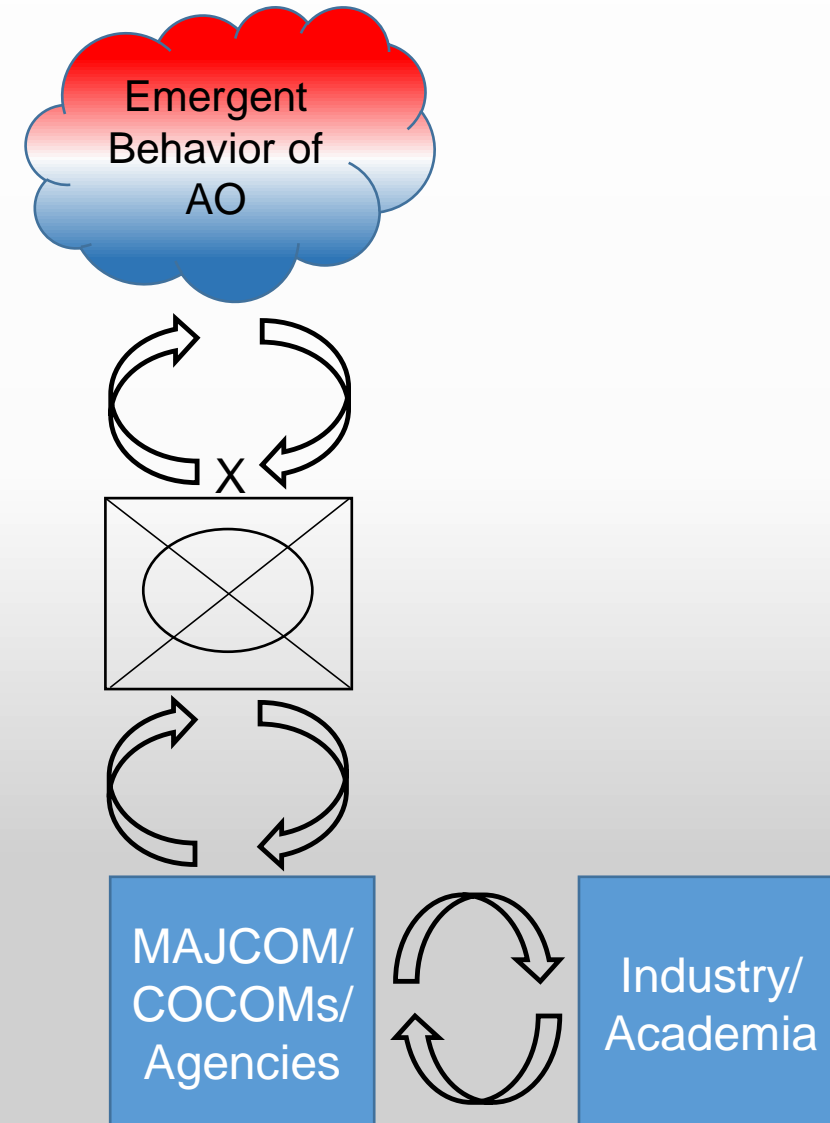
DISCLAIMER: The views expressed in this presentation do not reflect the views of the United States Army, the Department of Defense, or the US Government

AGENDA

- Bottom Line
- Necessity:
 - Clausewitz to Complex Systems
 - On War 2.0
- Capability:
 - Demystifying (a little) Computation
 - The DODs unexploited advances
 - Enable the Team
- Possibility:
 - Expanding the Kitbag
 - Building the Ecosystem

BOTTOM LINE

- It's not the technology it's the integration of the technology (Boot 2006)
 - **Necessity:** Computers are required to explore complex systems
 - **Capability:** To exploit technology, improve Servicemember capability
 - **Possibility:** Distributed AI (Course of Action Simulations)
- A vignette for intuition
 - Increasing the competitiveness of the interdependent community



NECESSITY: CLAUSEWITZ TO COMPLEX SYSTEMS

- The Magnificent Trinity (AKA three-body problem)
 - War is a nonreducible, interdependent system (Clausewitz, Howard, & Paret, 1976)
 - Poincare....difficult by hand
 - Lorenz and the Royal McBee (Gleick, 1987; Peterson, 1993)



[This Photo](#) by Unknown Author is licensed under [CC BY-SA](#)



[This Photo](#) by Unknown Author is licensed under [CC BY-SA](#)



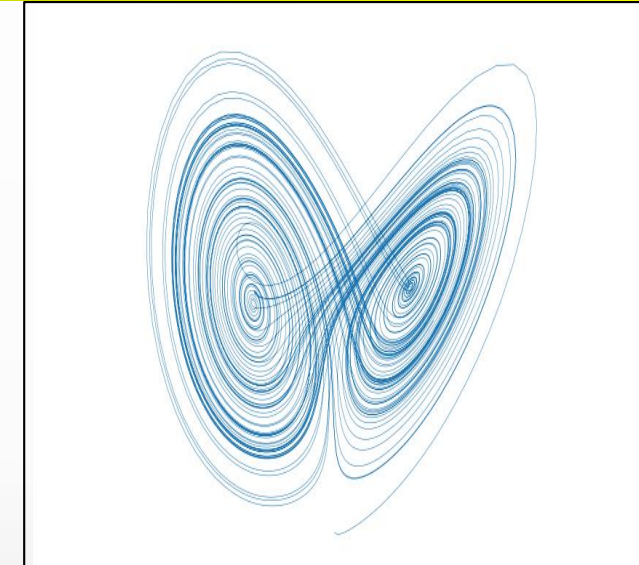
[This Photo](#) by Unknown Author is licensed under [CC BY-SA](#)



[This Photo](#) by Unknown Author is licensed under [CC BY-SA](#)

NECESSITY: ON WAR 2.0

- What's Been Learned and What Hasn't:
 - Sensitivity to initial conditions...the same processes can produce different emergent states (Lorenz, 1963)
 - Emergence...micro-actions may produce counter-intuitive emergent behavior (Prigogine & Stengers, 1984; Schelling, 2006)
 - The Anasazi of Long House Valley...diversity matters (Axtell et al., 2002)
 - Computers are essential! (Cioffi Revilla, 2017; Simon, 1997)
 - STILL NO: universal equations or algorithms
- Implications:
 - Same battle plan, same system of governance... different outcome
 - What may seem obvious could be counter productive
 - Computation will help but its an enabler, not an answer machine
 - Centralization still fails—victory requires the ingenuity and adaptability of Servicemembers throughout the team
 - Challenges with Joint Doctrine – homogenous entities



Lorenz Attractor
(Matplotlib Development Team, 2018)

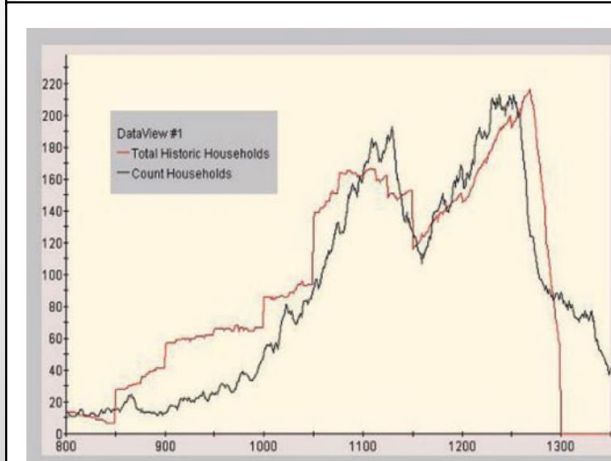
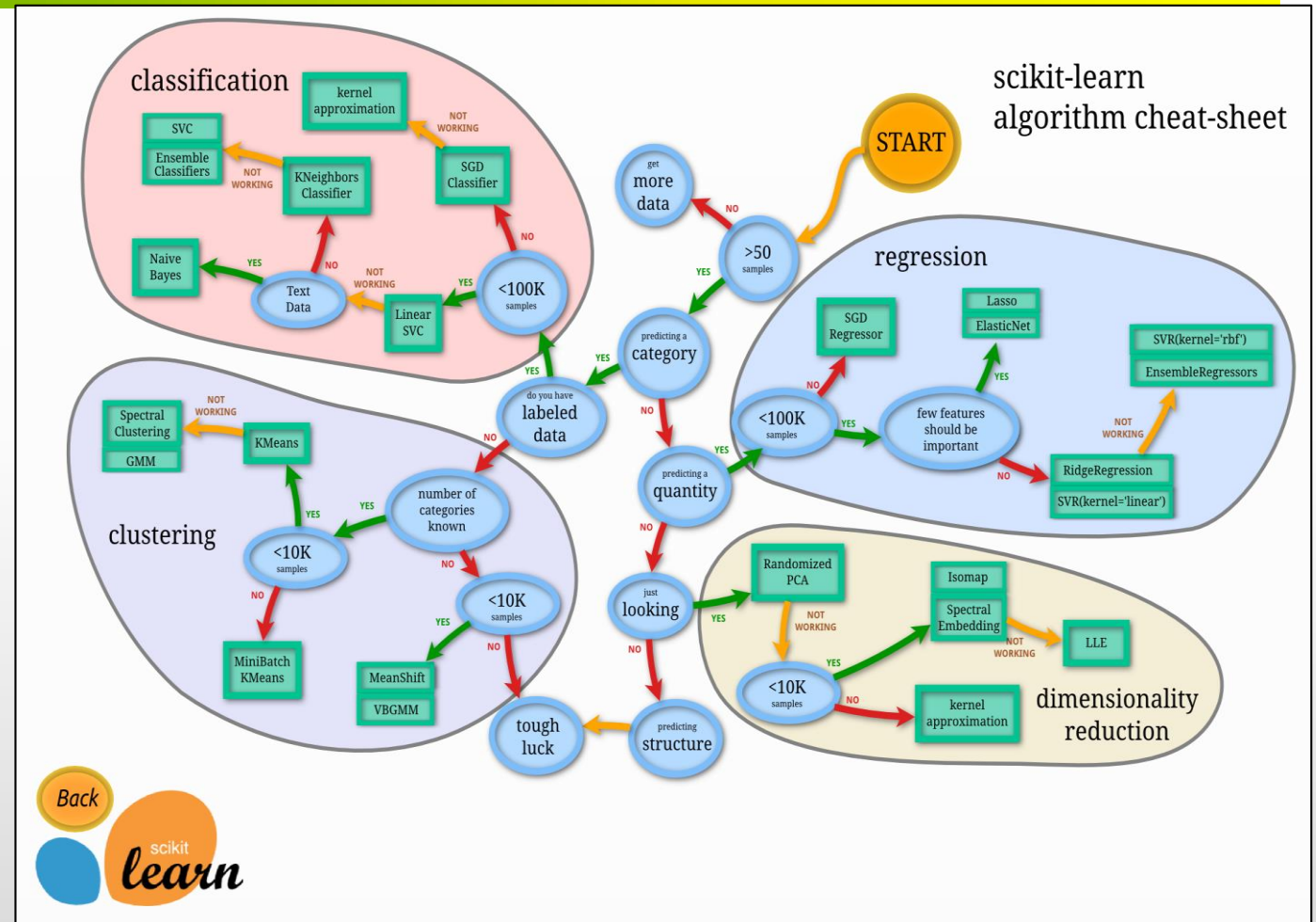


Fig. 2. Best single run of the model according to the L^1 norm. Other best runs based on other norms yield very similar trajectories. The average run, produced by averaging over 15 distinct runs, looks quite similar to this one as well.

CAPABILITY: DEMYSTIFYING (A LITTLE) COMPUTATION

- Artificial Intelligence is a toolbox of computational tools
 - Rich ecosystem of tools
 - Open source improvement



(Scikit-learn Developers 2017)

CAPABILITY: UNEXPLOITED ADVANCES

- Python 2 DARPA Program
 - Youtube, Spotify, Dropbox... vs DOD
- Integrated Conflict Early Warning System (ICEWs)
 - Snapshot of ongoing research for event data
 - User issues
 - With interface
 - Without interface
- Technical Bridges
 - Government funded research

Computer Programming for Everybody (Revised Proposal)

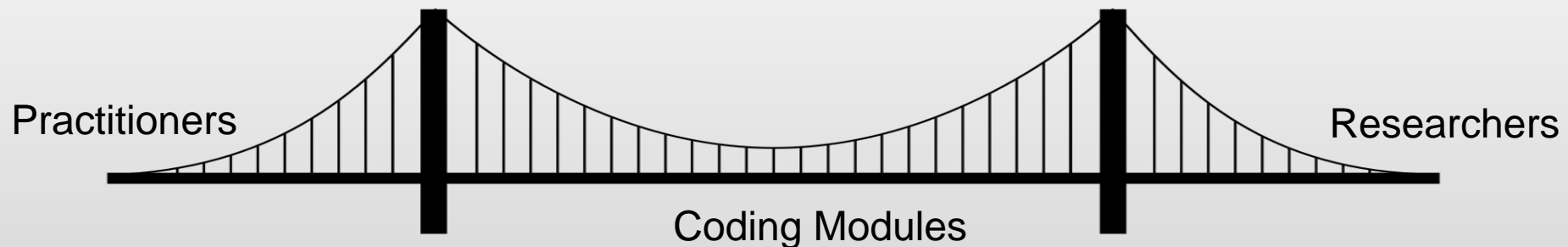
A Scouting Expedition for the Programmers of Tomorrow

Corporation for National Research Initiatives

July 1999

CNRI Proposal # 90120-1a

PI: Guido van Rossum



[This Photo](#) by Unknown Author is licensed under [CC BY-SA](#)

CAPABILITY: ENABLE THE TEAM

- Situation Recap:
 - Unique complex systems
 - Rich ecosystem of tools
 - Unexploited Advances
- Coding vs Other Tools
- Teach Servicemembers to Code
 - Lessons from the 480th and Microbiome
 - Directly
 - How it fails – My lesson from MIBOLC
 - Indirectly
 - school lunches and national security (Rutledge, 2015)

Python, R



[This Photo](#) by Unknown Author is licensed under [CC BY-SA](#)

Spreadsheets



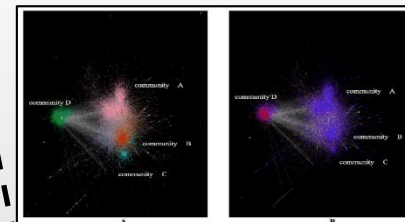
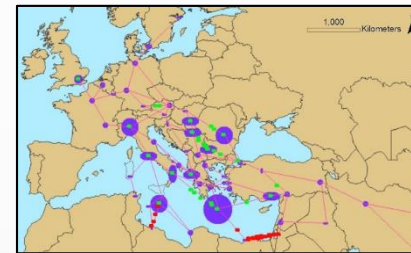
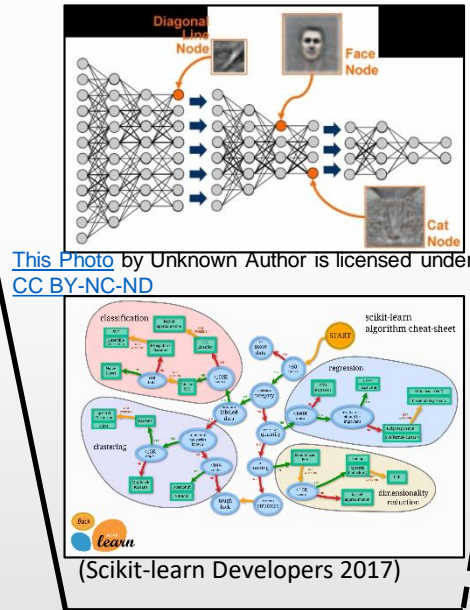
[This Photo](#) by Unknown Author is licensed under [CC BY-SA](#)

POSSIBILITY: EXPANDING THE KITBAG

Situational Awareness:
Machine Learning
Deep Learning

Testing Understanding/ Supporting Decisions:
Simulations
Agent Based Models

- Natural Language Processing
- Image/Video Processing
- Sorting through data
- Basic Behaviors



- Simulating behavior
- Course of Action/ Policy Development

The trovero way:
Preserve privacy as a core principle, automate to slash costs and optimize to enhance effectiveness, and above all let clients fire and forget.

SYNTHESIS ENGINE
Preserves user privacy by estimating communities on the social media without resorting to granular user data.

OPTIMIZATION ENGINE
Optimizes campaign audiences and brings white controlling for platform and influencer spend.

AUTOMATION ENGINE
Automatically configures and launches campaigns and tracks their performance, scaling labor costs.

Trovero.io

MEASURING SYSTEMIC RISK*

Getting at Systemic Risk via an Agent-Based Model of the Housing Market*

By JOHN GEANAKOPOLOS, ROBERT AXTELL, DOYNE J. FARMER, PETER HOWITT, BENJAMIN CONLEE, JONATHAN GOLDSTEIN, MATTHEW HENDREY, NATHAN M. PALMER, AND CHUN-YI YANG*



Crooks, A.T. and Hailegiorgis, A.B. (2014)



POSSIBILITY: BUILDING THE ECOSYSTEM

Goal:

- Simulations are part of the decision making process battalion and higher
- Merge multiple echelons of sensors and data
- Integrate multiple echelons of models
- Test understanding *in silico* by growing phenomenon of concern
- Test courses of action/policy in *virtual laboratory*

This Photo by Unknown Author is licensed under [CC BY-SA](#)



This Photo by Unknown Author is licensed under [CC BY-SA-NC](#)



This Photo by Unknown Author is licensed under [CC BY-SA](#)



Mesa Packages
Tom Pike edited this page on Apr 19 · 5 revisions

Economics Agent Resource toolKit

- Field: Economics
- Overview: A library of economic tools to support age
- Author(s): Chris Carroll, Matthew White, Nathan Palm

Bilateral Shapley Value

- Field: Coalition Game Theory
- Overview: An algorithm for forming agents into coal
- Author(s): Tom Pike



This Photo by Unknown Author is licensed under [CC BY-NC-ND](#)

QUESTIONS

REFERENCES

- Axtell, R., Epstein, J. M., Dean, J. S., Gumerman, G. J., Swedlund, A. C., Harburger, J., ... Parker, M. (2002). Population Growth and Collapse in a multiagent model of the Kayenta Anasazi in Long House Valley. *Proceedings of the National Academy of Sciences*, 99(1), 7275–9. <https://doi.org/10.1073/pnas.092080799>
- Boot, M. (2006). *War Made New: Technology, Warfare, and the Course of History 1500 to today*. New York: Gotham.
- Cioffi Revilla, C. (2017). *Introduction to Computational Social Science: Principle and Applications*. (F. B. Schneider, D. Gries, & O. Hazzan, Eds.), *Texts in Computer Science* (2nd ed.). Cham, Switzerland: Springer. <https://doi.org/10.1007/978-3-319-50131-4>
- Clausewitz, C. von, Howard, M., & Paret, P. (1976). *“On War.” What is War, ed. and trans.* Princeton, New Jersey: Princeton University Press.
- Gleick, J. (1987). *Chaos: Making a New Science*. New York: Penguin.
- Hu E (2016) An agent-based model of the European refugee crisis. GitHub repository, <https://github.com/elizabethhu/refugee-abm>. Retrieved on 22 Sept 2017, from <https://tinyurl.com/yd5s6sjc>
- Lorenz, E. N. (1963). Deterministic Nonperiodic Flow. *Journal of the Atmospheric Sciences*. [https://doi.org/10.1175/1520-0469\(1963\)020<0130:DNF>2.0.CO;2](https://doi.org/10.1175/1520-0469(1963)020<0130:DNF>2.0.CO;2)
- Peterson, I. (1993). *Newton’s Clock: Chaos In The Solar System* (Kindle). Henry Holt and Co.
- Prigogine, I., & Stengers, I. (1984). *Order Out of Chaos: Man’s New Dialogue with Nature*. New York: Bantam Books Ltd.
- Rossum, G. (1999). Computer Programming for Everybody (Revised Proposal) A Scouting Expedition for the Programmers of Tomorrow, (August 1999).
- Rutledge, J. G. (2015). From charity to security: The emergence of the national school lunch program. *History of Education*, 44(2), 187–206. <https://doi.org/10.1080/0046760X.2014.979252>
- Schelling, T. C. (2006). *Micromotives and Marcobehavior* (Kindle). New York: W.W. Norton and Company.
- Simon, H. a. (1997). *The Sciences of the Artificial* (3rd, Kindl ed.). Cambridge, Massachusetts: MIT Unviersity Press.