Is Public Health Ready for Complexity?

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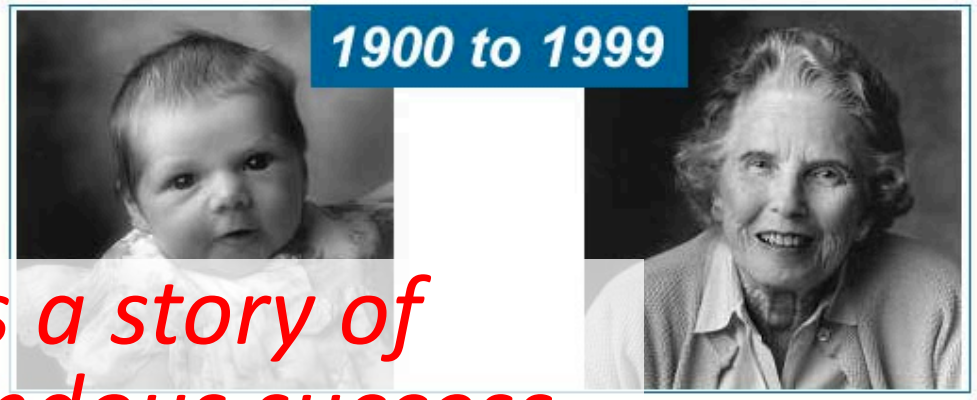
Public Health in the 20th Century

Public health is credited with adding 25 years to the life expectancy of people in the United States in this century. Yet, ask the average person what public health is and their reply might be limited to: "healthcare for low-income families." CDC's Ten Great Public Health Achievements in the 20th Century was created to remind us of how far we've come, how we got here, and exactly what public health is: the active protection of our nation's health and safety, credible information to enhance health decisions, and [illegible] with local minorities and organizations to promote good health.



It is a story of tremendous success

Learn more about how far we've come in the Morbidity and Mortality Weekly Report (MMWR):

Ten Great Public Health Achievements in the 20th Century

- Immunizations
- Motor-Vehicle Safety
- Workplace Safety
- Control of Infectious Diseases
- Declines in Deaths from Heart Disease and Stroke
- Safer and Healthier Foods
- Healthier Mothers and Babies
- Family Planning
- Fluoridation of Drinking Water
- Tobacco as a Health Hazard
- Future Directions of Public Health

CDC Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

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SOURCE: http://www.cdc.gov/about/history/tengpha.htm

Public Health in the 21st Century

- To continue this story of success into the 21st century, however, we need to recognize that things have changed.

- The world in which we live has grown significantly more complex.

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Public Health in the 21st Century

- *The 21st century is different in both quality and quantity.*
- Reasons:
  - globalization
  - cyberinfrastructure and big data
  - global population overload
  - global warming and climate change
  - Increasing ecological challenges – access to water, food, etc.
  - cultural conflict and terrorism
  - global disease transmission – fast moving epidemics, pandemics
  - Importance of health behaviors and access to health care
  - And, significant shifts in the human microbiota and microbiome
    - As a note, the *human microbiota* consists of the trillions of symbiotic microbial cells harbored by each person, primarily bacteria in the gut and colon; in turn, the *human microbiome* consists of the genes these cells harbor.

http://www-personal.umich.edu/~mejn/cartograms/

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Public Health in the 21st Century

SCIENTIFIC AMERICAN™

Stephen Hawking's advice for twenty-first century grads: Embrace complexity

By Ashutosh Jogalekar on April 23, 2013

SOURCE: http://blogs.scientificamerican.com/the-curious-wavefunction/stephen-hawkings-advice-for-twenty-first-century-grads-embrace-complexity/

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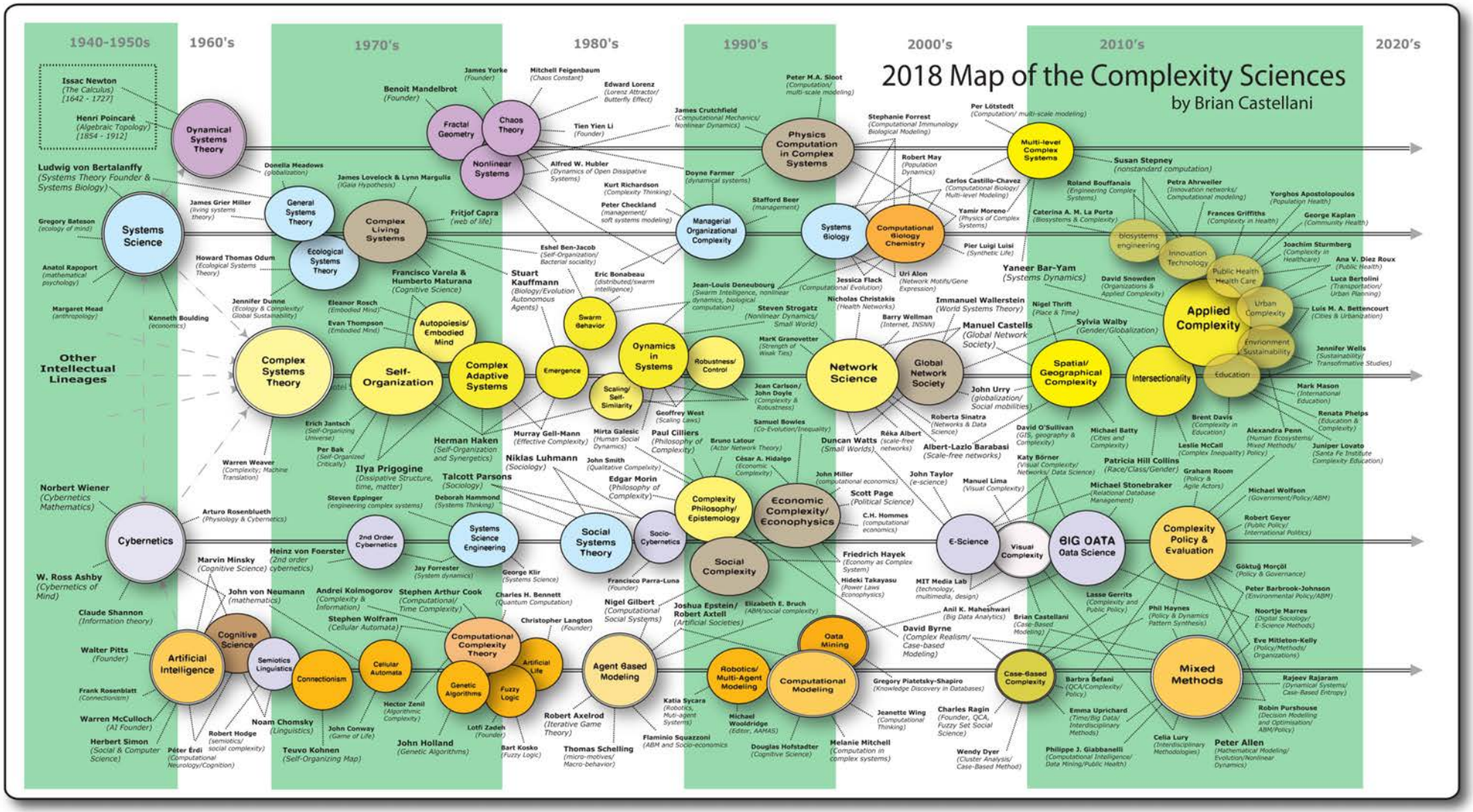

http://www.art-sciencefactory.com/complexity-map_feb09.html

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Is Public Health Ready for Complexity?

There are six key issues that public health needs to address to move forward regarding the issues of complexity:

- 1. Public health is in a difficult position: it realizes its work is more complex, but it is struggling to embrace the tools and concepts of complexity science and computational modelling, as it means doing things differently.
  - This is particularly problematic in terms of funding streams and publishing in journals.
- 2. Related, the best way forward is to employ a mixed-methods approach, as most public health issues require more than one method, including computational modelling.
- 3. Public health needs to adopt a critical approach to complexity, as not all methods or theories are equally useful.
  - For example, while complex network analysis is powerful, it has significant limits.
  - Also, not all complexity methods or ideas apply; or they might require modification to work at the public health level.

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Is Public Health Ready for Complexity?

- 4. Public health also needs to develop its theoretical and conceptual understanding of public health topics as complex.
  - Not all topics need to be modelled as complex. And there are different ways of modelling complexity.
  - Visit Centre for the Evaluation of Complexity Across the Nexus
  - https://www.cecan.ac.uk/
- 5. Public health needs to recognise the important role it plays – both in terms of theory and practical experience – in the development of the complexity sciences, as most of these scholars are trained in other fields.
- 6. Public health needs to adopt a case-based approach to modelling its various complex topics, as health (be it an individual or population) is about cases.
  - In turn, it needs to move away from the strict study of variables and variable-based statistics.
  - Statistics remains very important for complexity modelling; but variables need to be attached to context and cases and their various path-dependent trajectories.

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What Is Complexity?

Given our six points, just how should we make sense of complexity?

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What Is Complexity?

Societal systems – Complex or worse?

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ABSTRACT

The basic observation that we explore in this paper is simple but, we argue, rich in consequences: societal systems combine two qualities that are commonly referred to as *complexity* and *complicatedness*. We address the problem that societal systems remain recalcitrant despite the development of powerful approaches for dealing with both of these qualities. The root of this problem we identify to be that the combination between complexity and complicatedness is *emergent*; i.e. fundamentally and irreducibly different from either quality in isolation. This means that neither class of such approaches can be expected to work well on their own. But it also means that the obvious strategy of *combining* theory for complexity and complicatedness may be much more challenging than envisioned. In short, systems where complexity and complicatedness is mixed ought to be treated as a distinct class of systems. Noting a connection to what has long been called "wicked problems" we hereby outline such a class of systems that we call "wicked systems". We introduce a simple model and heuristic and discuss some implications for theorizing and modeling.

Not all things complex require us to model them as such; and there are also different ways to model complexity!

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What Is Complexity?

- Generally speaking, by complex we mean that
  - a disease or public health issue is . . .
    - » emergent, self-organizing, nonlinear, chaotic, etc.

  - But, more important, I mean it is . . .

1. situated within different systems and factors, as such, it is causally complex.
2. evolves differently across time-space.
3. resulting in different major and minor trends, different sub-types and sub-trajectories.
4. requires different clinical, community-level and population health approaches to treatment
5. demands different methods, specifically those grounded in the computational and complexity sciences.

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So, what makes these theories so different?

- These theories:
- Focus on the intersection of factors.
  - Example: Patricia Hill-Collins's intersectionality theory
- Study social complexity in systems terms.
  - Example: Wallerstein's world systems theory.
- See the structure of these systems in network terms.
  - Example: Castell's global network society.
- Interested in how social complexity evolves across time.
  - Here the focus is on dynamics, emergence, self-organisation, etc
- Interdisciplinary focused

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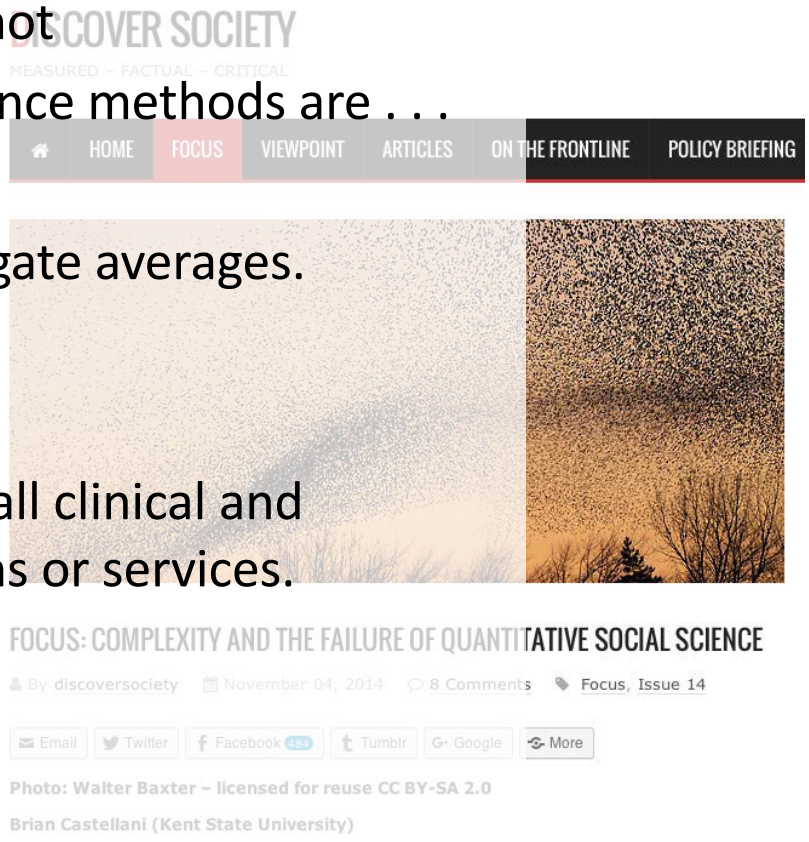
So, what makes these methods so different?

- First, we can talk about what they are not
  - Computational and complexity science methods are . . .
    1. Not focused on variables.
    2. Not focused on simple aggregate averages.
    3. Not reductionist
    4. Not static
    5. Not focused on one-size-fits-all clinical and community level interventions or services.



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So, what makes these methods so different?

- Second, we can talk about what they are:
  - From genetic algorithms and agent-based modeling to network analysis and geospatial modeling . . .
  - These methods all contain a combination of the old and new
    - The new is the usage of computation, machine intelligence and high-powered computing.
    - The old is a focus on cases! The core of medicine, public health and health services research
      - Be it movie preferences on NetFlix, item interests on Amazon, or credit card purchasing patterns, the focus in all of these methods is on mapping cases and their differences.

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"According to case-based complexity, cases are complex profiles comprised of a set of inter-dependent variables, which are contextually dependent, nonlinear, dynamic, evolving, self-organizing, emergent, etc. in short, cases have the same characteristics as a complex system. Theoretically speaking, then, cases can be treated and modeled as complex system..."

BACKGROUND: Building on the case-comparative methods of Charles Ragin and, more recently, the case-based complexity theory of David Byrne a new set of methodological techniques and arguments have emerged for the study of complex systems, called case-based complexity science and case-based modeling---for more information, click here to see Byrne and Ragin's 2009, Sage Handbook of Case-Based Method.

For more on computational and complexity methods, see the map in an earlier slide. Also, to learn more about COMPLEX-IT, which is our free software package for modelling complex systems, designed specifically for those without a background in these methods, you can go to: http://www.art-sciencefactory.com/complexit.html

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