Building Resilient Healthcare

A Case-Based Complexity Approach to Policy Making and Evaluation for Smarter Decision Making

Brian Castellani

Director, Wolfson Research Institute for Health and Wellbeing, Durham University

Director, Durham Research Methods Centre

Director, InSPIRE - research and policy consortium for mitigating the impact of air pollution and the exposome on mental and brain health

RENKEI

Japan-UK Research and Education Network
for Knowledge Economy Initiatives

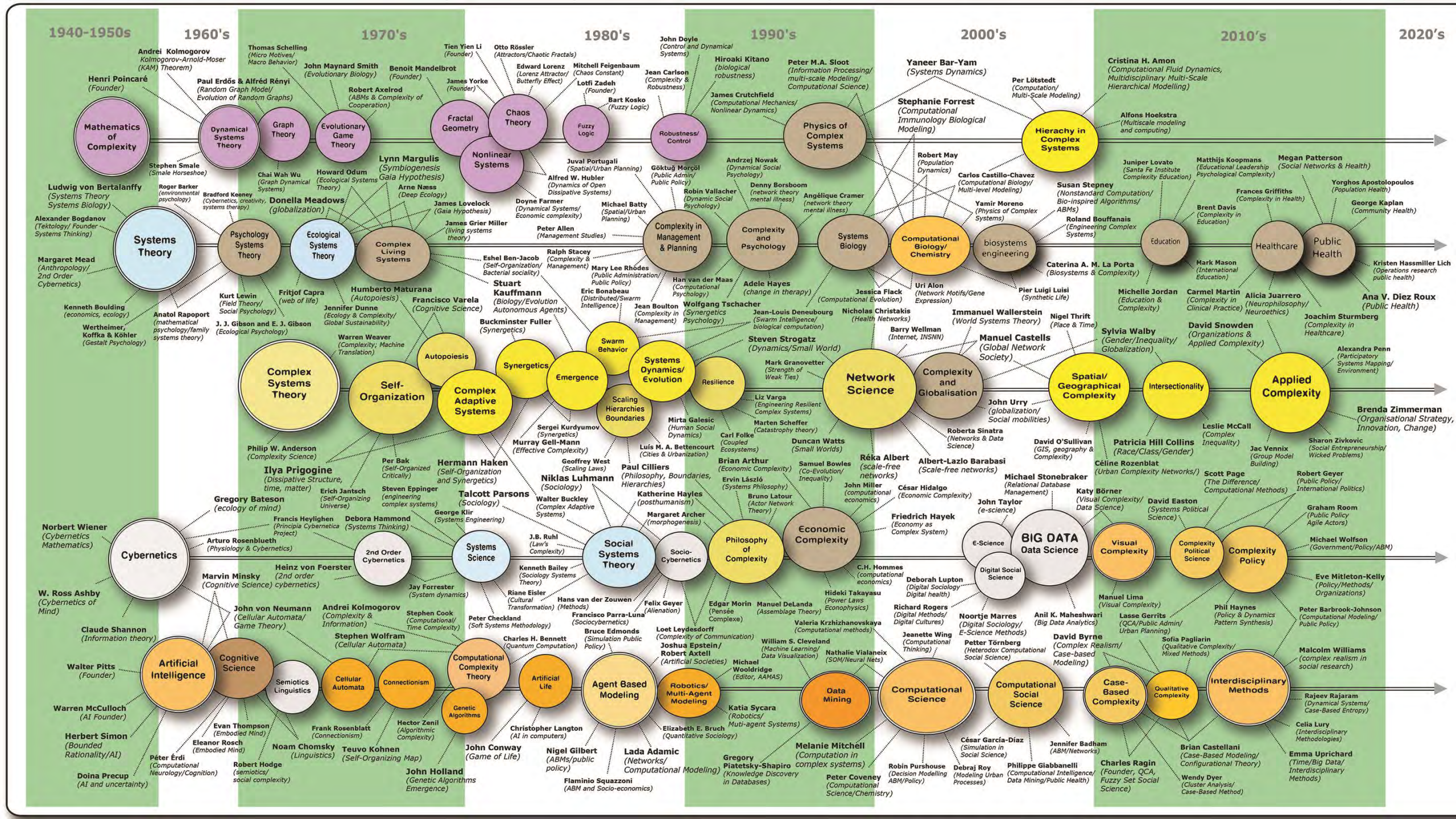
Is healthcare a system?

- We talk about healthcare, particularly in Japan and the UK, as a system.
- But what does that mean to call it a system?
- What type of system is it?
  - Metaphorical, but not really a system?
  - Complicated?
  - Complex?

Is healthcare a system?

- If healthcare is a complex system, how does that inform our understanding of resilience?

- Complexity matters
- The Japanese and UK healthcare systems may have similarities, but they are different. Differences matter.
- They are positioned in different geospatial settings, political climates, economic conditions, cultural arrangements.
- All of which help to identify the ***types of resilience*** they require.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Introduction to Healthcare Systems

- Healthcare systems are complex socio-ecological systems.
- Like ecosystems, healthcare involves interconnected processes.
- Analyzing healthcare resilience is critical in improving system stability and adaptability.
- Feedback loops exist between public health, care delivery, and policy responses.
- Healthcare systems self-regulate through feedback mechanisms (e.g., patient care protocols, triage).
- Example: Hospital capacity management during crises.
- Systems are coupled with their socio-ecological systems, from urban metropolitan areas to local ecological systems.

Decision-Making and Adaptive Governance in Healthcare

- Adaptive governance in healthcare involves flexible policies and system-level adjustments.
- Key areas: crisis management, resource allocation, and response to emerging health threats.
- Building resilient healthcare systems requires forward-thinking policies and responsive governance.

Using case-based complexity

- How to use Case-based Complexity for Policy Making and Evaluation for Smarter Decision Making

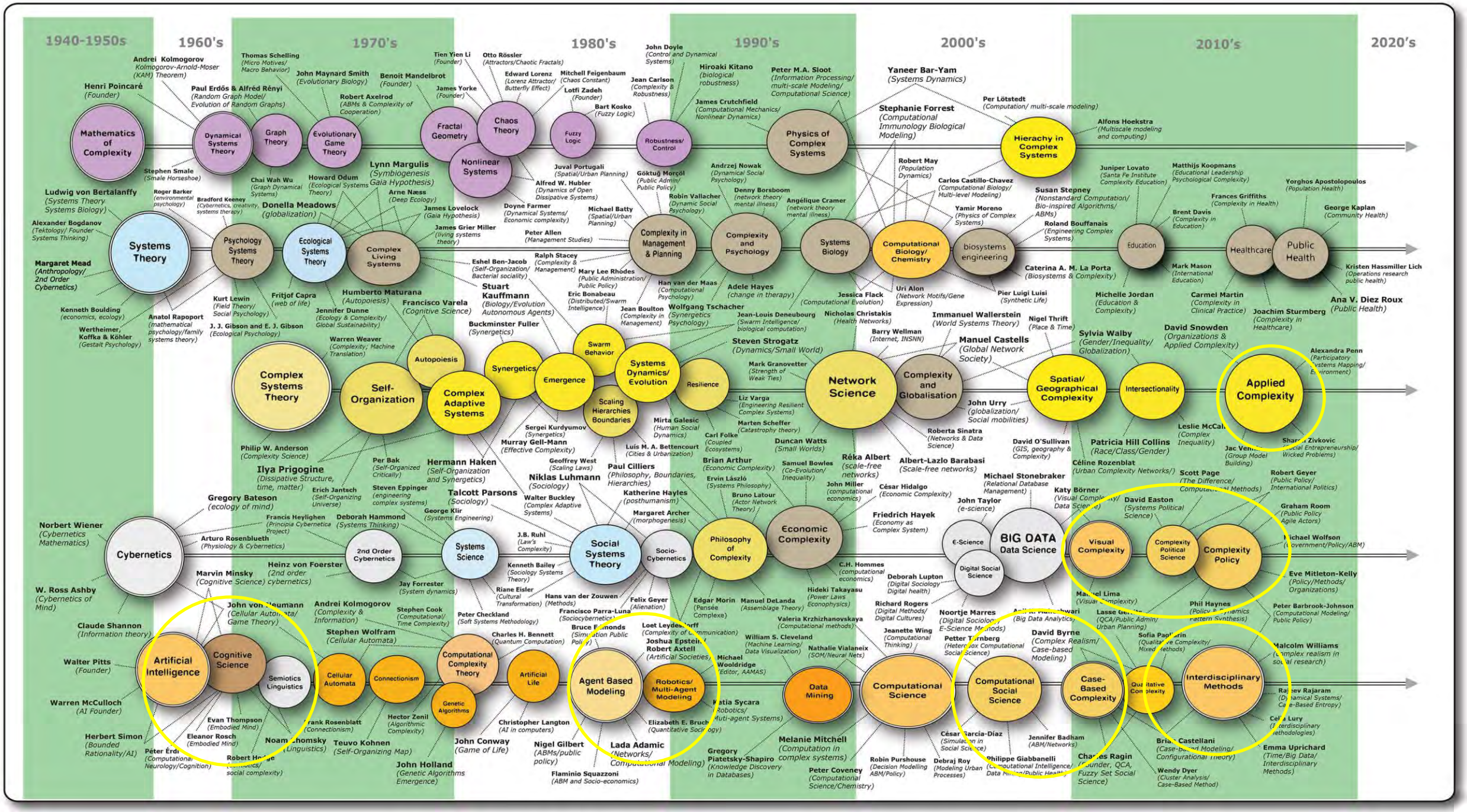
The Field of Case-Based Complexity

Case-based complexity is a suite of interdisciplinary methods first advanced by David Byrne and colleagues as an improvement on the conventions of cased-based qualitative configurational analysis (QCA).

Case-based complexity is an established field of study, particularly in public health, sociology, policy studies, political science, governance, urban planning and public administration.

Case-based complexity is grounded on Byrne's novel insight that cases meet the definitional critique of complex systems.

An excellent introduction to this methodology is Byrne and Ragin's *Sage handbook of case-based methods*.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Matthijs Koopmans (Educational Leadership Psychological Complexity)
Brent Davis (Complexity in Education)
Frances Griffiths (Complexity in Health)
Yorghos Apostolopoulos (Population Health)
George Kaplan (Community Health)
Kristen Hassmiller Lich (Operations research public health)
Ana V. Diez Roux (Public Health)
Joachim Sturmberg (Complexity in Healthcare)
Carmel Martin (Complexity in Clinical Practice)
Mark Mason (International Education)
Michelle Jordan (Education & Complexity)
Caterina A. M. La Porta (Biosystems & Complexity)
Pier Luigi Luisi (Synthetic Life)
Uri Alon (Network Motifs/Gene Expression)
Jessica Flack (Computational Evolution)
Nicholas Christakis (Health Networks)
Barry Wellman (Internet; INSNN)
Immanuel Wallerstein (World Systems Theory)
Nigel Thrift (Place & Time)
Manuel Castells (Global Network Society)
Sylvia Walby (Gender/Inequality/ Globalization)
David Snowden (Organizations & Applied Complexity)
Alexandra Penn (Participatory Systems Mapping/ Environment)
Sharon Zivkovic (Social Entrepreneurship/ Wicked Problems)
Leslie McCall (Complex Inequality)
Patricia Hill Collins (Race/Class/Gender)
Jac Vennix (Group Model Building)
John Urry (globalization/ Social mobilities)
Roberta Sinatra (Networks & Data Science)
David O'Sullivan (GIS, geography & Complexity)
Céline Rozenblat (Urban Complexity Networks)
Liz Varga (Engineering Resilient Complex Systems)
Marten Scheffer (Catastrophy theory)
Mirta Galesic (Human Social Dynamics)
Carl Folke (Coupled Ecosystems)
Luis M. A. Bettencourt (Cities & Urbanization)
Sergei Kurdyumov (Synergetics)
Murray Gell-Mann (Effective Complexity)
Geoffrey West (Scaling Laws)
Niklas Luhmann (Sociology)
Paul Cilliers (Philosophy, Boundaries, Hierarchies)
Duncan Watts (Small Worlds)
Réka Albert (scale-free networks)
Albert-Lazlo Barabasi (Scale-free networks)
Brian Arthur (Economic Complexity)
Samuel Bowles (Co-Evolution/ Inequality)
Ervin László (Systems Philosophy)
John Miller (computational economics)
César Hidalgo (Economic Complexity)
Bruno Latour (Actor Network Theory)
Friedrich Hayek (Economy as Complex System)
Michael Stonebraker (Relational Database Management)
Katy Börner (Visual Complexity/ Data Science)
John Taylor (e-science)
Philip W. Anderson (Complexity Science)
Ilya Prigogine (Dissipative Structure, time, matter)
Per Bak (Self-Organized Criticality)
Erich Jantsch (Self-Organizing Universe)
Hermann Haken (Self-Organization and Synergetics)
Steven Eppinger (engineering complex systems)
Talcott Parsons (Sociology)
Walter Buckley (Complex Adaptive Systems)
George Klir (Systems Engineering)
Katherine Hayles (posthumanism)
Margaret Archer (morphogenesis)
Gregory Bateson (ecology of mind)
Francis Heylighen (Principia Cybernetica Project)
Deborah Hammond (Systems Thinking)
Arturo Rosenblueth (Physiology & Cybernetics)
Norbert Wiener (Cybernetics Mathematics)
W. Ross Ashby (Cybernetics of Mind)
Heinz von Foerster (2nd order cybernetics)
Marvin Minsky (Cognitive Science)
Jay Forrester (System dynamics)
J.B. Ruhl (Law's Complexity)
Kenneth Bailey (Sociology Systems Theory)
Riane Eisler (Cultural Transformation)
Peter Checkland (Soft Systems Methodology)
Hans van der Zouwen (Methods)
Felix Geyer (Alienation)
Francisco Parra-Luna (Sociocybernetics)
Edgar Morin (Pensée Complexe)
Manuel DeLanda (Assemblage Theory)
Hideki Takayasu (Power Laws Econophysics)
Valeria Krzhizhanovskaya (Computational methods)
C.H. Hommes (computational economics)
Deborah Lupton (Digital Sociology Digital health)
Richard Rogers (Digital Methods/ Digital Cultures)
Noortje Marres (Digital Sociology/ E-Science Methods)
Petter Törnberg (Heterodox Computational Social Science)
Jeanette Wing (Computational Thinking)
Aditi Pai (Big Data Analytics)
David Byrne (Complex Realism/ Case-based Modeling)
Manuel Lima (Visual Complexity)
Lasse Gerrits (QCA/Public Admin/ Urban Planning)
Sofia Pagliarin (Qualitative Complexity/ Mixed Methods)
Phil Haynes (Policy & Dynamics Pattern Synthesis)
Peter Barbrook-Johnson (Computational Modeling/ Public Policy)
Malcolm Williams (Complex realism in social research)
Rajeev Rajaram (Dynamical Systems/ Case-Based Entropy)
Celia Lury (Interdisciplinary Methodologies)
Emma Uprichard (Time/Big Data/ Interdisciplinary Methods)
Claude Shannon (Information theory)
Stephen Wolfram (Cellular Automata)
Andrei Kolmogorov (Complexity & Information)
Stephen Cook (Computational/ Time Complexity)
Charles H. Bennett (Quantum Computation)
Bruce Edmonds (Simulation Public Policy)
Loet Leydesdorff (Complexity & Communication)
Joshua Epstein
Robert Axtell (Artificial Societies)
William S. Cleveland (Machine Learning/ Data Visualization)
Michael Wooldridge (Editor, AAMAS)
Nathalie Vialaneix (SOM/Neural Nets)
Katia Sycara (Robotics/ Multi-agent Systems)
Elizabeth E. Bruch (Quantitative Sociology)
Gregory Piatetsky-Shapiro (Knowledge Discovery in Databases)
Melanie Mitchell (Computation in complex systems)
Peter Coveney (Computational Science/Chemistry)
Robin Purshouse (Decision Modelling ABM/Policy)
César García-Díaz (Simulation in Social Science)
Debraj Roy (Modeling Urban Processes)
Jennifer Badham (ABM/Networks)
Philippe Giabbanelli (Computational Intelligence/ Data Mining/Public Health)
Charles Ragin (Founder, QCA, Fuzzy Set Social Science)
Brian Castellani (Case-Based Modeling/ Configurational Theory)
Wendy Dyer (Cluster Analysis/ Case-Based Method)

Case-based complexity is anchored in **four core epistemological arguments**:

1. Cases are the methodological equivalent of complex systems – that is, they are emergent, self-organizing, nonlinear, dynamic, etc – and therefore should be studied as such.

2. The case and its trajectory across time/space are the focus of study, not the individual variables or attributes of which it is comprised.

3. Cases and their trajectories are best treated as composites (profiles), comprised of an interdependent, interconnected sets of causal conditions, factors or attributes.

4. The wider social contexts/systems in which cases are situated needs to be considered.

CASE-BASED COMPLEXITY AND CAUSALITY

CASE-BASED COMPLEXITY pushes the researcher to engage in three distinct ways of thinking about complex social causality that are, in combination, theoretically innovative.

The first, and perhaps most original, is ***causal asymmetry***: the idea that the configuration of causal conditions that lead to some outcome may be very different from the configuration of conditions that leads to the absence of that outcome.

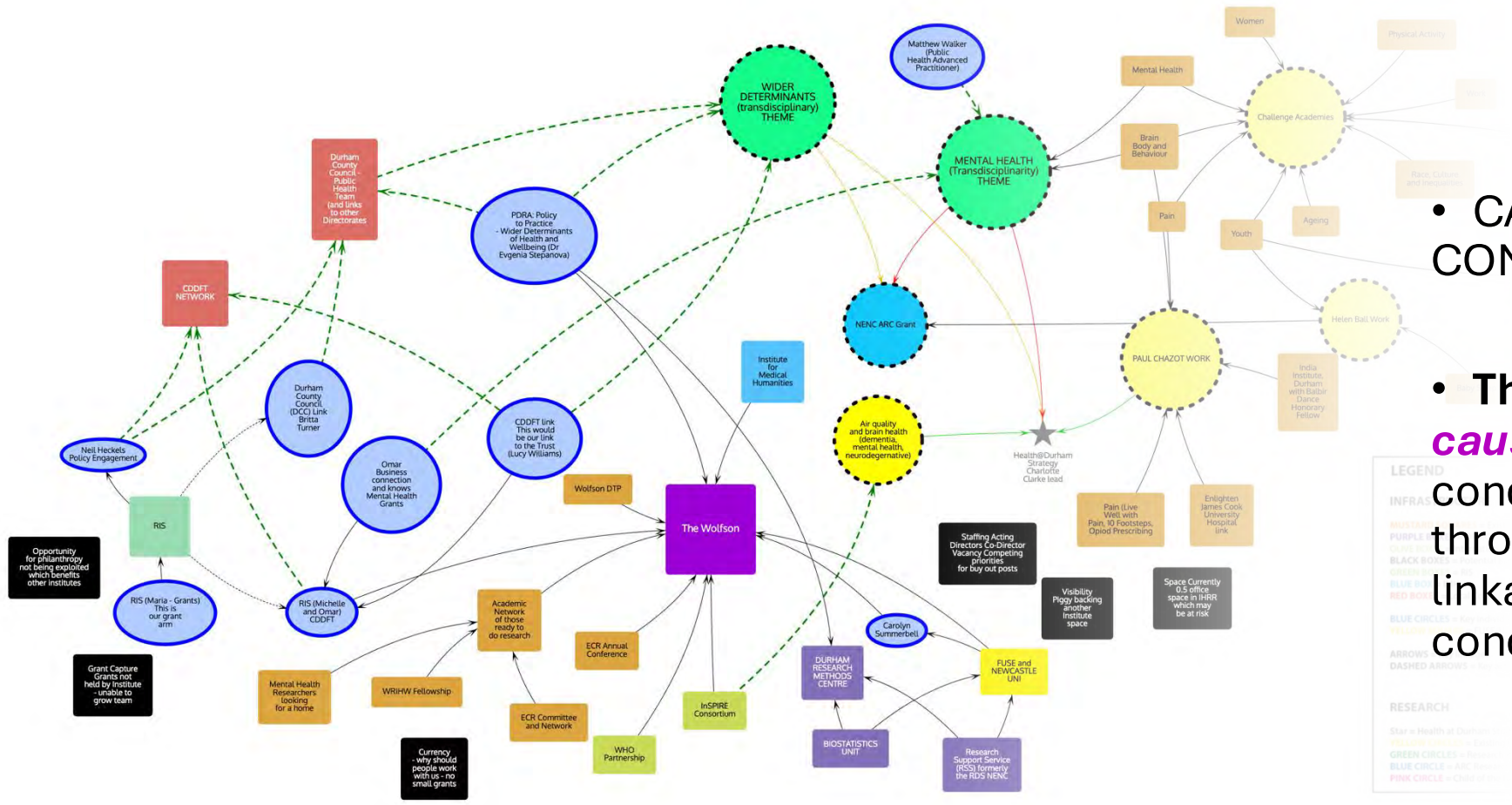
For example, the causal conditions that account for high performing, healthcare systems can differ from those that explain the absence of high performance in economically deprived healthcare systems.

CASE-BASED MODELLING AS CONFIGURATIONAL THINKING

The second is that of the pair of ***equifinality*** and ***multifinality***.

Equifinality concerns those instances where different configurations of conditions co-occur with similar outcomes.

Multifinality is the opposite of equifinality. It expresses that similar configurations of causal conditions can co-occur with the outcomes.



- CASE-BASED MODELLING AS CONFIGURATIONAL THINKING

- **The third** is ***conjunctural causation***: the idea that a single condition impacts an outcome through its qualitative causal linkages with the other conditions in a configuration.

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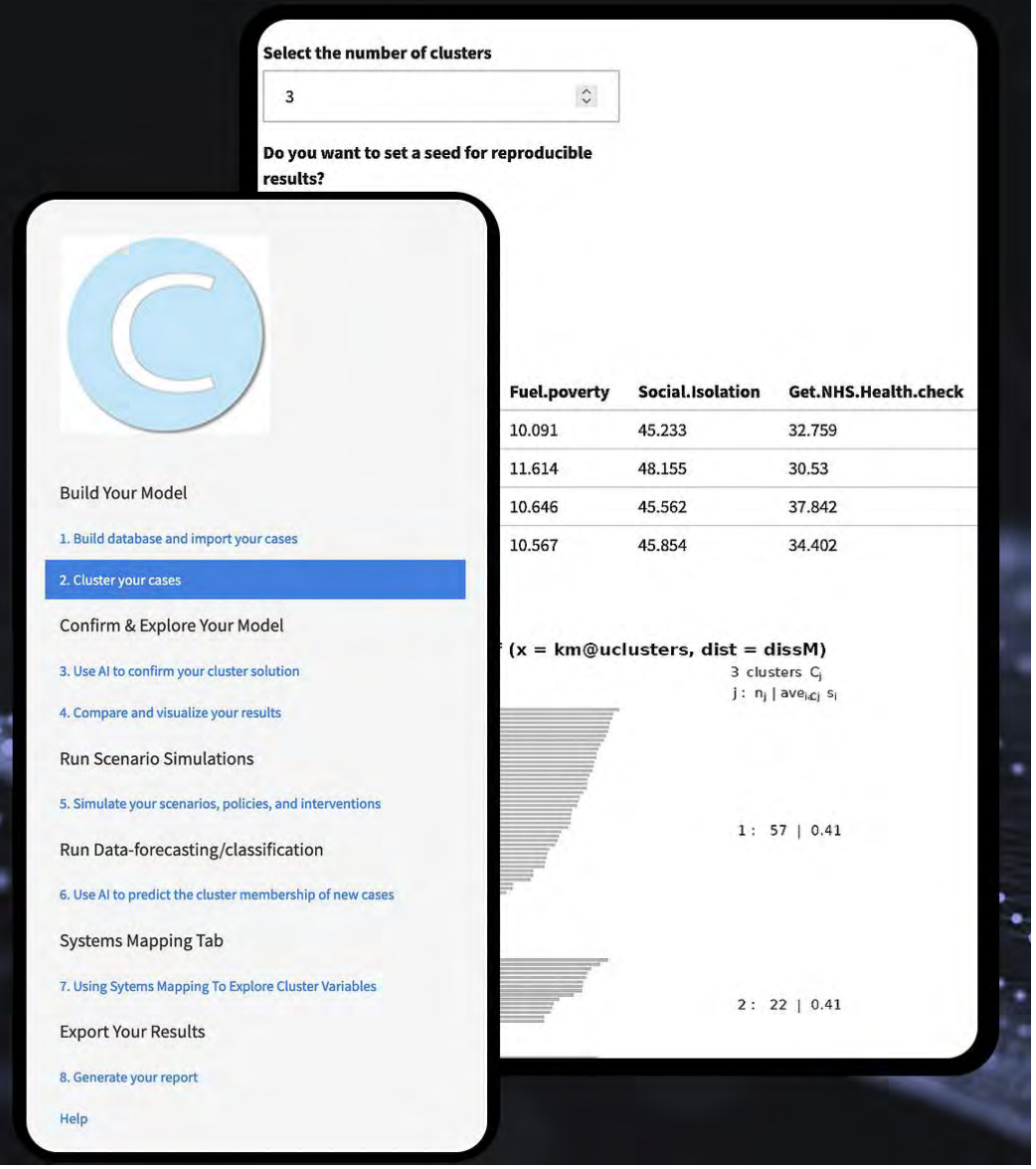
COMPLEX-IT

Run Online or Download for R-Studio

WEB VERSION

DOWNLOAD VERSION

https://www.complex-it-data.org/



COMPLEX-IT

Team

As a team we are committed to advancing a **case-based complexity approach** to research, policy and practice in an effort to advance the study of social complexity and to support decision making. We each bring to the team a wide range of methodological and programming expertise and are proud of the truly transdisciplinary and international makeup of our work.

Brian Castellani
Durham Research Methods Centre
Durham University

Corey Schimpf
Department of Engineering Education
University at Buffalo, SUNY

Peter Barbrook-Johnson
School of Geography and the Environment
Oxford University

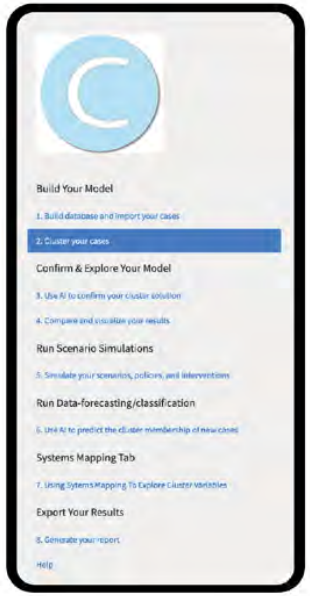
Michael Ball
Computer Services
Kent State University, Ashtabula

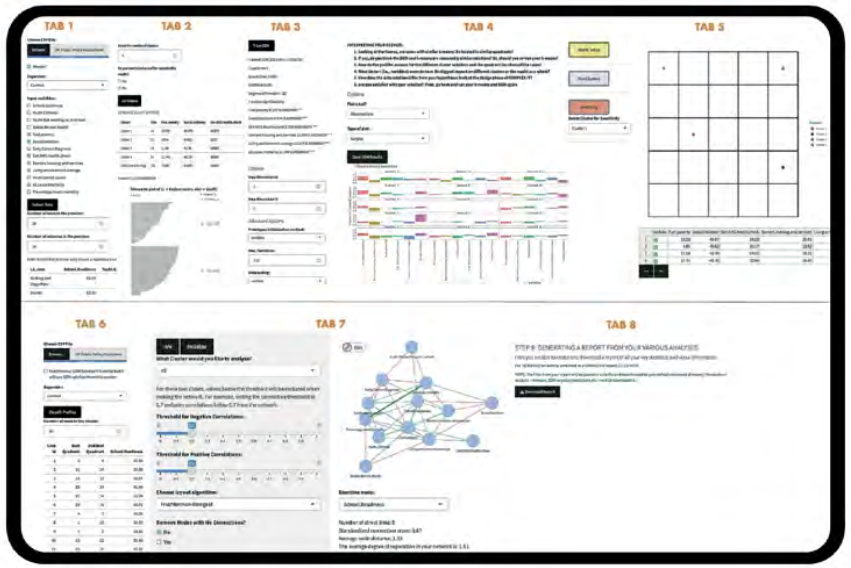
Christopher Caden
Durham Research Methods Centre
Durham University

COMPLEX-IT is a case-based, mixed-methods platform for applied social inquiry to complex data/systems, designed to increase non-expert access to the tools of computational social science.

Presently, the platform is comprised of a bespoke suite of techniques, including:

1. cluster analysis
2. artificial intelligence
3. data visualization
4. data forecasting
5. case-based systems mapping
6. case-based scenario simulation





COMPLEX-IT supports applied social inquiry though a design-based emphasis on learning about the complex data/system under study. It does by

(a) identifying and forecasting major and minor clusters/trends

(b) visualizing their complex causality

(c) mapping and simulating scenarios for potential interventions.

COMPLEX-IT is that it is accessible through the web or can be run locally and is powered by R and the Shiny web framework and includes written and video tutorials.

- Import Your Cases and Map Your Theory
- Build, Confirm and Explore Your Model
- Run Scenario Simulations
- Forecast New Data
- Explore Systems Map
- Export Your Results
- Help

STEP 1: IMPORT YOUR DATABASE AND MAP YOUR THEORY

Here you will upload your data. You can also create a conceptual systems map with of your data with PRSM.

For TUTORIALS on preparing and importing your data for COMPLEX-IT and using the PRSM systems mapping tab CLICK HERE

Your data must be in the form of a csv file. For more on creating csv files CLICK HERE

Import Your Data

Choose CSV File

Browse CaseBasedSystemsMapDat

Upload complete

Header?

Separator:

Comma

Input variables:

First.Time.in.Justice.System
Teens.16.to.17.not.in.education..employe
Percentage.of.people.in.employment
First.time.offenders.per.10k.population

Subset Data

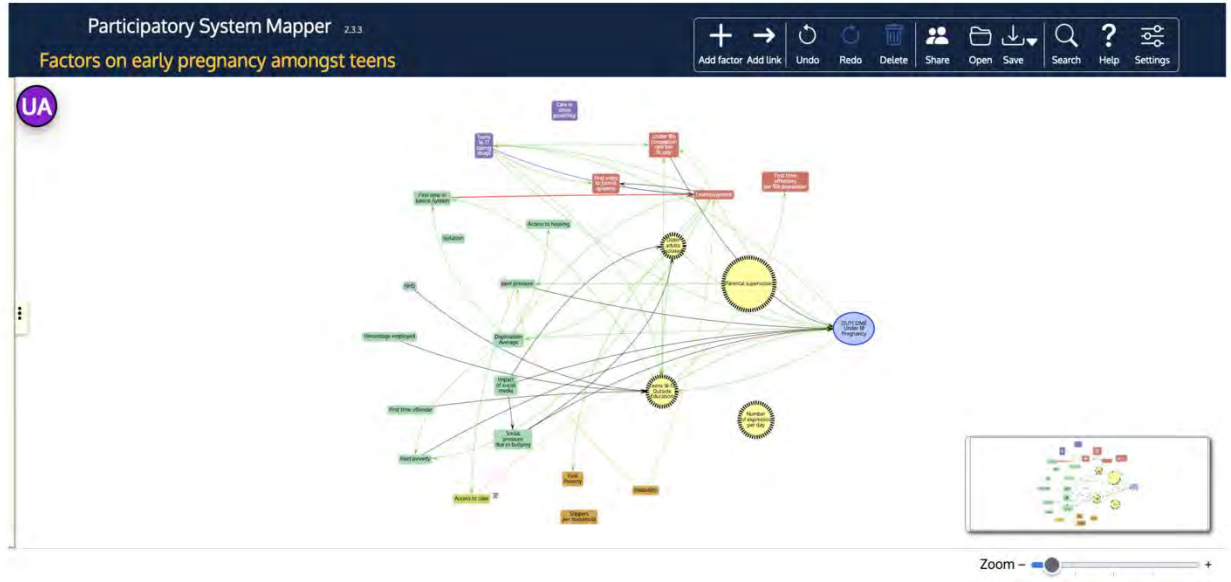
Note: Even if the preview only shows a restricted number of observations, the map will be based on the full dataset.

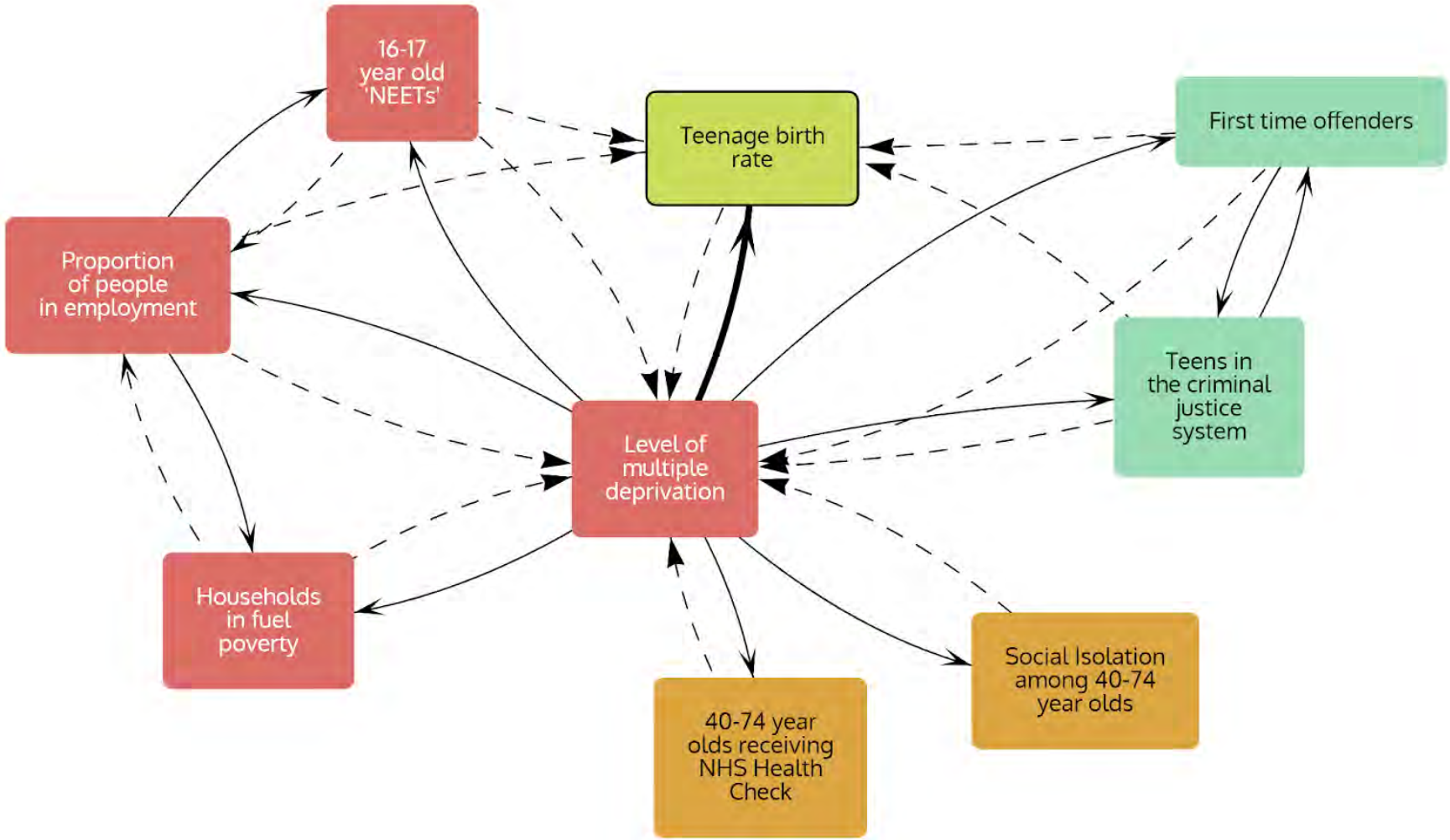
Show 10 **entries**

LA_area	First.Time.in.Justice.System	Teens.16.to.17.not.in.education..employed.or.training	Percentage.of.people.in.employment	I
Barnet	127.1236	1.7114	73	
Bath and North East Somerset	80.8136	8.1428	80.7	
Bexley	225.651	3.2998	76	
Birmingham	267.0717	8.464	65.7	
Blackburn with Darwen	78.8721	3.7755	65.3	
Blackpool	280.1345	8.9058	72.6	
Bolton	120.5525	5.5533	67.7	
Bradford	237.9332	6.6118	70	
Bristol	211.3268	6.8194	75.7	
Bromley	152.6566	2.0225	78	

Showing 1 to 10 of 100 entries Previous 1 2 3 4 5 … 10 Next

Create a Conceptual Systems Map of Your Data




16-17 year old 'NEETs'
Teenage birth rate
First time offenders
Proportion of people in employment
Teens in the criminal justice system
Level of multiple deprivation
Households in fuel poverty
Social Isolation among 40-74 year olds
40-74 year olds receiving NHS Health Check

Import Your Cases and Map Your Theory

Build, Confirm and Explore Your Model

» Cluster Your Cases

» Use AI to Confirm Clusters

» Compare and Visualise Your Results

Run Scenario Simulations

Forecast New Data

Explore Systems Map

Export Your Results

Help

Run the data to explore different cluster solutions in the systems map.

STEP 2: CLUSTER YOUR CASES USING K-MEANS

Here we will use cluster analysis to group your cases based on their different configurations of factors

Get Clusters

Info

Select the number of clusters

4

Do you want to set a seed for reproducible results?

Yes

No

Users can explore different cluster solutions based on the insights from Step 2 of CBSM around different causal flows.

K-Means Clusters | Additional Statistics

Kmeans Cluster Centroids

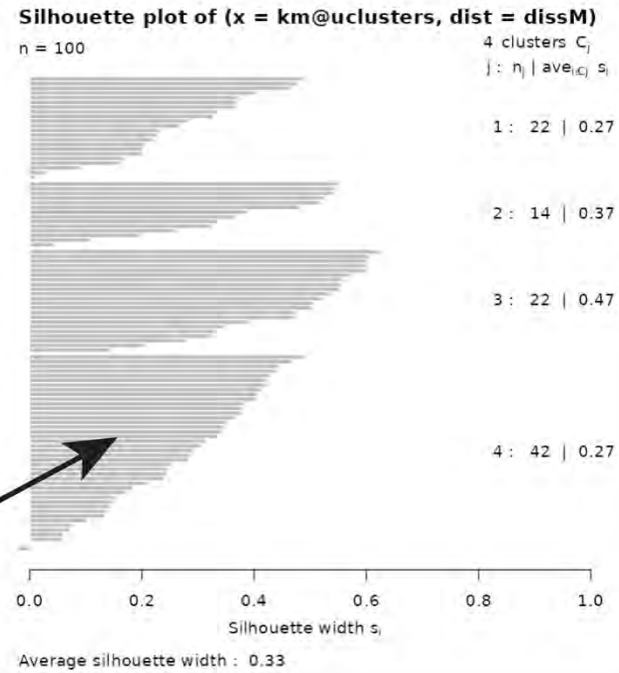
Show 10 entries

Cluster	Size	First.Time.in.Justice.System
Cluster 1	22	226.72
Cluster 2	14	302.317
Cluster 3	22	91.231
Cluster 4	42	159.769
Total Size & Var Avg	100	179.377

Showing 1 to 5 of 5 entries

Users can explore the cluster configurations from the systems map to think through what causal flows might account for different clusters of cases.

Pseudo F: 104.701887650778



The Silhouette plot is a visually useful tool to help users determine how well their cluster solution fits the cases. For those interested in more in-depth statistics, COMPLEX-IT collects results in the background, which can be downloaded in the **Export Your Results** tab.

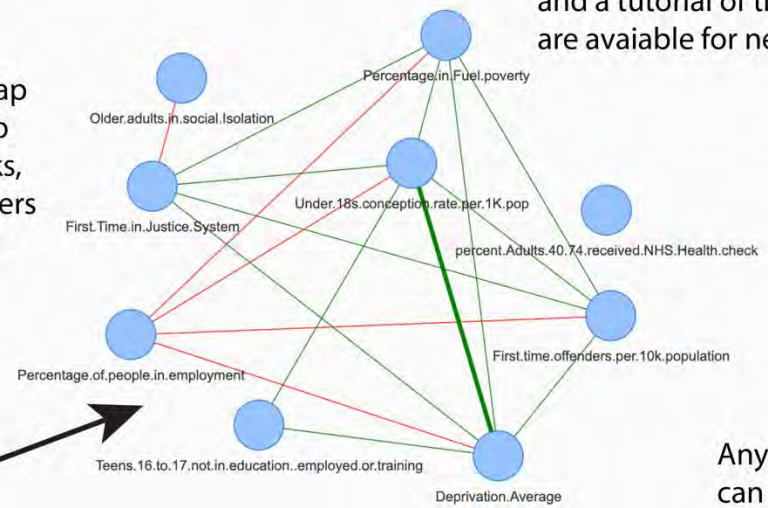
- Import Your Cases and Map Your Theory
- Build, Confirm and Explore Your Model
- Run Scenario Simulations
- Forecast New Data
- Explore Systems Map
  - » Use Systems Mapping to Explore Cluster Variables
- Export Your Results
- Help

STEP 7: USING SYSTEMS MAPPING TO EXPLORE CLUSTER VARIABLES

Here we will use Systems Mapping to visually explore the configuration of variables you used to cluster your data.
The map is generated using the zero-order correlations amongst your variables.

Edit

The network map can be edited to add factors, links, levers and barriers to change, and so forth.



A visualisation of the systems map for comparison with the original created in Step 1 of CBSM.

Additional information and a tutorial of the tab are avaiable for new users.

Initialise Network

Info

Guided Tour of Inputs

Examine node:

First.Time.in.Justice.System

Number of direct links: 5
Standardised connection score: 0.62
Average node distance: 1.29
The average degree of seperation in your network is: 1.46
The maximum distance (diameter) of your network is: 3

Node Size:

25

Any factor (node) in the network can be chosen for basic network statistics such as # of links, etc.

The systems map can be visualised for the total map, as shown here, and then for each individual cluster.
This is the most important part of process, as it allows for a case-based analysis of the systems map.

What Cluster would you like to analyse?

All

For these two sliders, values below the threshold will be excluded when making the network. For example, setting the correlation threshold to 0.7 excludes correlations below 0.7 from the network.

Threshold for Negative Correlations:

0 0.2 1

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

Threshold for Positive Correlations:

0 0.2 1

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

Choose layout algorithm:

Random

Remove Nodes with No Connections?

- (•) No
- ( ) Yes

The threshold levels for negative and positive correlations amongst the factors can be varied to explore different levels of causal flows in a map/network. The default is set to a .20 correlation coefficient.

Advanced Options — Show / Hide

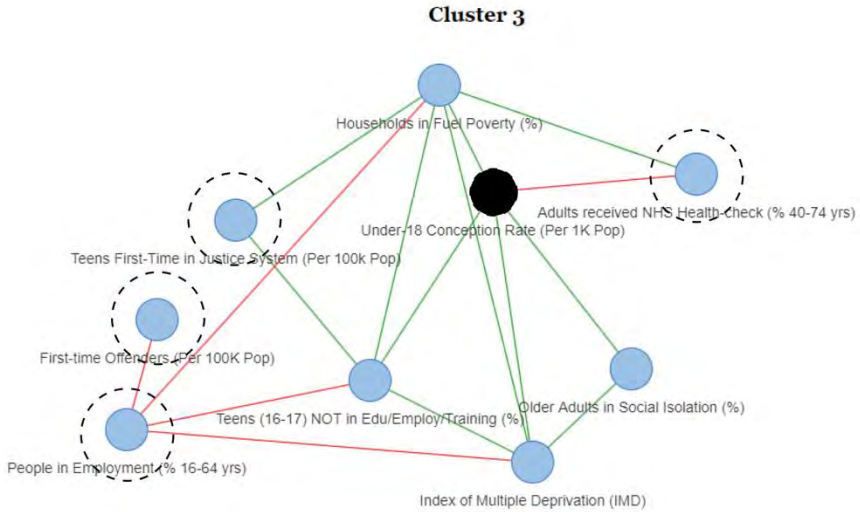
Edge Weights Options — Show / Hide

Ego Network — Show / Hide

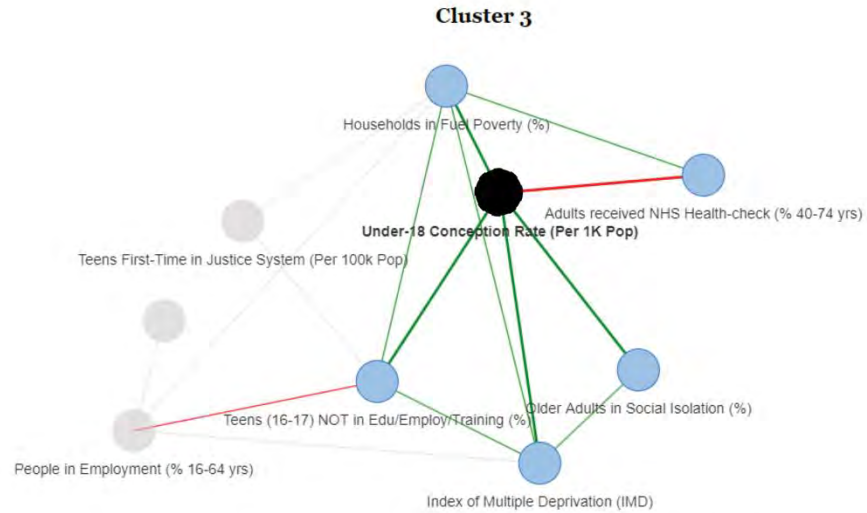
Export Options — Show / Hide

Shortest Paths — Show / Hide

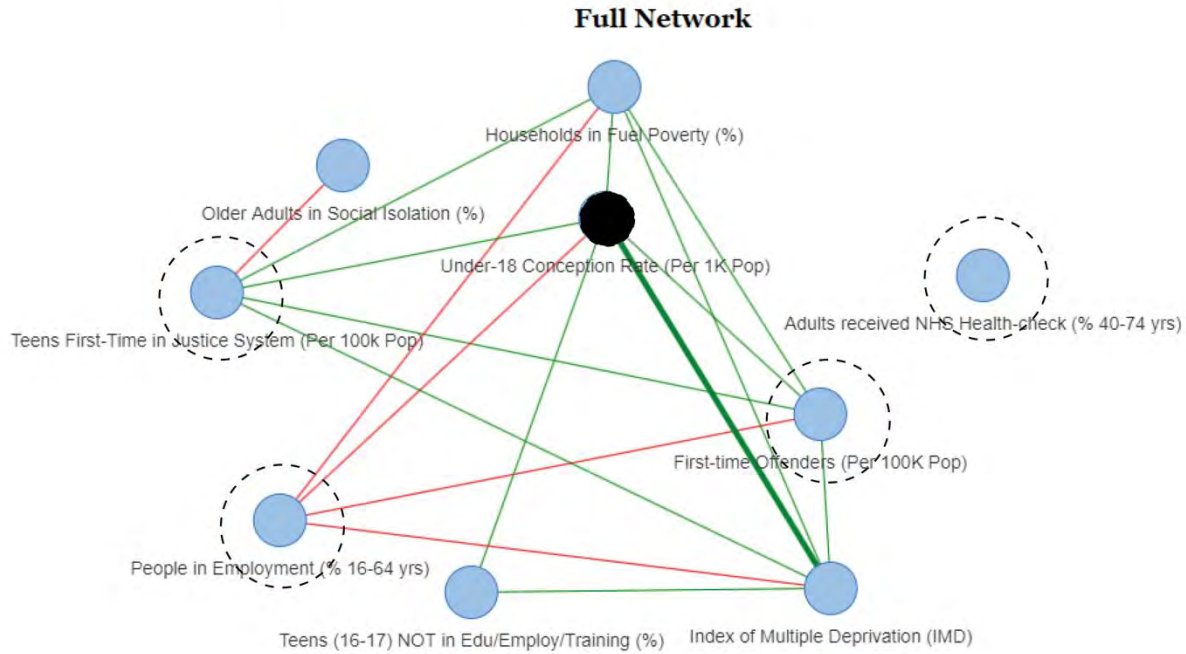
There are a series of advanced network analysis options, such as layout type, path analyses, ego network analyses, etc.

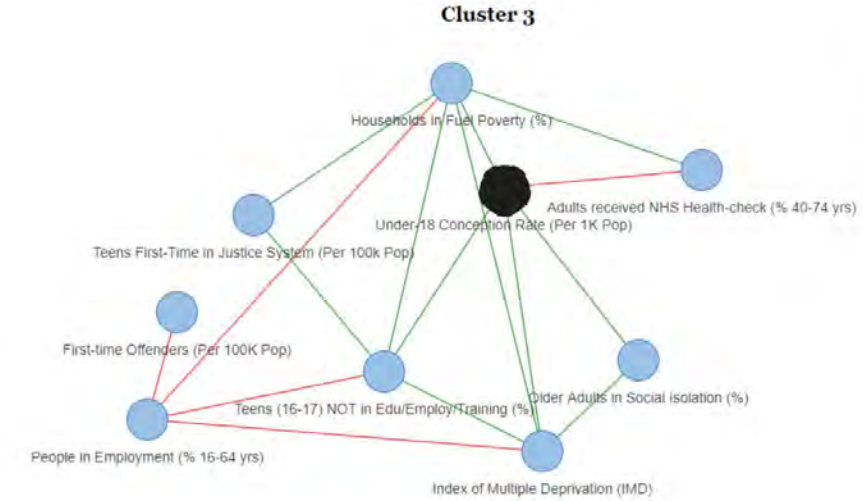


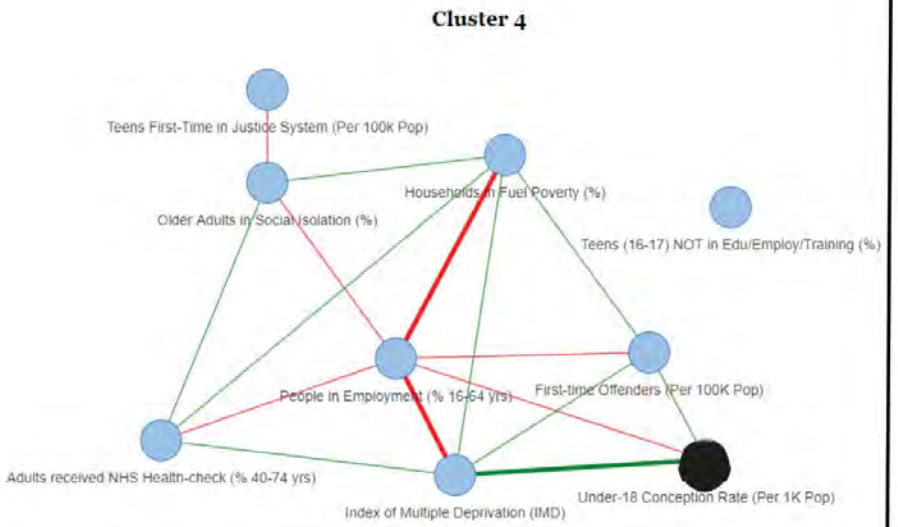
Cluster 3 Systems Map with all links shown



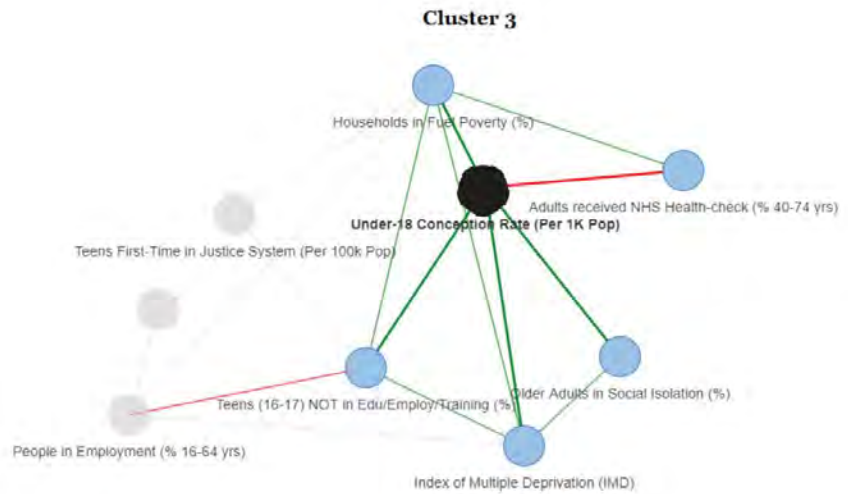
Cluster 3 Systems Map with only first degree links highlighted

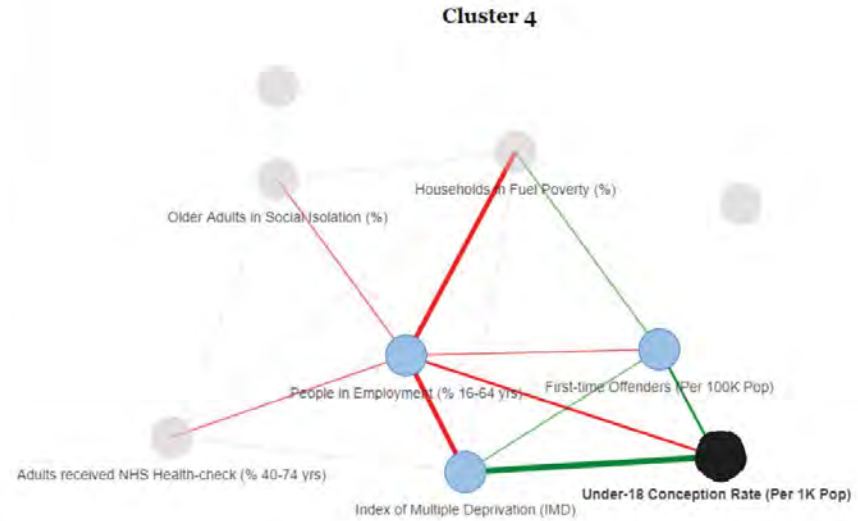






Cluster 3 and 4, the complete network shown for their respective sub-maps.





Cluster 3 and 4, highlighting the most important links to teenage pregenancy rates.