

A Complex Systems Manifesto

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Principles of Complex Systems, Vols. 1, 2, & 3D
CSYS/MATH 300, 303, & 394, 2022-2023 | @pocsvox

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References

Definitions

Complicated versus Complex:

- ⚙️ Complicated: Mechanical watches, airplanes, ...
- ⚙️ Engineered systems can be made to be **highly robust but not adaptable**.
- ⚙️ But engineered systems can become complex (power grid, planes).
- ⚙️ They can also **fail spectacularly**.
- ⚙️ Explicit distinction: **Complex Adaptive Systems**.

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Relevant fields:

- ⚙️ Physics
- ⚙️ Economics
- ⚙️ Sociology
- ⚙️ Psychology
- ⚙️ Information Sciences
- ⚙️ Cognitive Sciences
- ⚙️ Biology
- ⚙️ Ecology
- ⚙️ Geosciences
- ⚙️ Geography
- ⚙️ Medical Sciences
- ⚙️ Systems Engineering
- ⚙️ Computer Science
- ⚙️ Data Science
- ⚙️ ...

⚙️ i.e., everything that's interesting ...

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Outline

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Definitions

A working definition of a Complex System:

- ⚙️ Distributed system of many interrelated (possibly networked) parts with no centralized control exhibiting emergent behavior—'More is Different'^[1]

Other features/aspects:

- ⚙️ Explicit nonlinear relationships.
- ⚙️ Presence of feedback loops.
- ⚙️ Being open or driven, opaque boundaries.
- ⚙️ Memory.
- ⚙️ Modular (nested)/multiscale structure.
- ⚙️ Mechanisms range from being purely physical to purely algorithmic in nature.

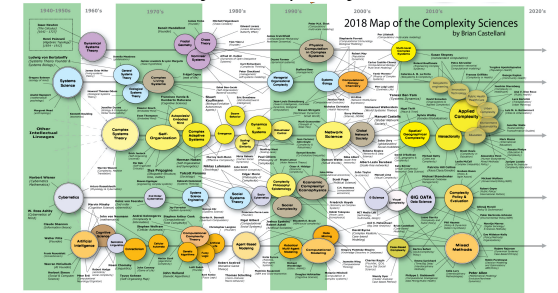


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A visualized history of Complex Systems fields:



"Complexity Map" by Brian Castellani, Kent State

- ⚙️ Online here [at art-sciencefactory.com](https://art-sciencefactory.com)
- ⚙️ Complex Systems is bigger than this (e.g., fluid dynamics; more later).



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Definitions

Complex: (Latin = with + fold/weave (com + plex))



Adjective:

- Made up of multiple parts; intricate or detailed.
- Not simple or straightforward.



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Examples of Complex Systems:

- ⚙️ human societies
- ⚙️ financial systems
- ⚙️ cells
- ⚙️ ant colonies
- ⚙️ fluids, weather systems
- ⚙️ ecosystems
- ⚙️ power grids
- ⚙️ animal societies
- ⚙️ disease ecologies
- ⚙️ brains
- ⚙️ social insects
- ⚙️ geophysical systems
- ⚙️ forests
- ⚙️ Internet + Web

⚙️ i.e., everything that's interesting ...

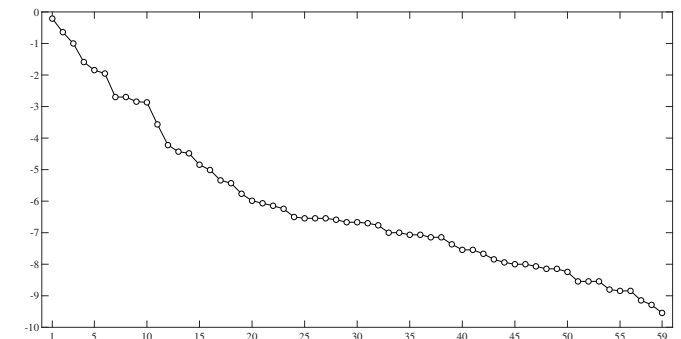


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Cryptograph—What's being plotted here?:



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