

Towards 'Flourishing Studies'

A network science lens onto flourishing science commons

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How to read this poster

Read Through the network elements, following the questions that interconnect them. Finish in the Flourishing Studies section, joining the conversation invited there

Add post-its anywhere. Suggest framing your comments in the form of a question to invite conversation

Visit the 'The Flourishing Commons' Github to learn more, find references, and share your resources and to be a part of the living conversation



What this poster is not: A definitive or prescriptive statement. It is an opening and an invitation; the highest hope is that it is the origin of a more robust conception of flourishing as a conversation within science. Finally, it is a question: What does flourishing look like for scientists, science communities, and society?

What this poster is: A view onto how networks as a form of representation and analysis are transforming scientific discovery, scientists and their communities, and science itself and how it is a requisite response to the world we are walking into

What is the world of Earth and Space Science that we are walking into?

Our grand challenges in science are those for which we cannot ignore the complexity of the world--the interconnectedness of our disciplines, systems, and groups.

How do we embrace complexity in the project of scientific discovery?

Complexity

Complexity science is the study of phenomena that emerge from a collection of interacting objects. To understand a complex system requires a plurality of frameworks and we must be able to move between levels (e.g., micro and macro). Complexity science is a paradigm that suggests ways of reconciling the micro and macro scales. It is the collection of methods to understand a system across scales, smaller scale behavior in connection with larger-scale phenomena that emerge from it. The complex systems paradigm transcends the concepts of scale and discipline, providing methods to connect across them.

“The 21st century will be the age of complexity.”
 -Stephen Hawking

The automobile is a complex object, meaning many parts had to come together for it to emerge

Physical phenomena and scientific discoveries are complex objects, too

Self-organization, emergence, and scaling theory

Systems science and cross-scale Information and acknowledging uncertainty

Risk and resilience framework Networks, network science, and collectivity

Learn about the lived and living history of complexity science in space science [McGranaghan; 2023]

Network Science in Wicked Problems

The degree of interconnectivity of our systems means we cannot simply distinguish among the relevant items for a given problem. Moreover, we cannot disentangle physical systems from the social systems that interact with and change them. "Wicked" problems are those that are resistant to final articulation and resolution and that include social complexity. The capacity to make progress on wicked problems is a frontier of science

Global risks landscape: an interconnections map

G: Largest connected nodes fraction in a network, q: fraction of removed nodes, qc: critical fraction causing abrupt fragmentation. Interdependent networks show a "first-order" transition at a smaller qc than isolated networks [Buldyrev et al. 2010]

Vespignani [2010] Discovery: Interdependent networks exhibit a smaller critical threshold than isolated networks, leading to different levels of disruption and a different nature of abrupt "first-order" transitions in system breakdown. This challenges anticipation and control, emphasizing the complexity and difficulty of managing complete breakdowns compared to isolated networks.

Critical infrastructures are complex physical-socio-technical systems for which it is generally impossible to abstract the global behavior from the analysis of single components or divorced from the social component, especially under conditions such as failures and disasters. There is a need to understand the general principles leading to the complex global architecture of these systems and their ability to withstand failures, natural hazards and man-made disasters [Vespignani 2010]

Network Science in the Society of Science

Wicked problems far exceed the cognitive and material capacities of any individual scientist. So, we must understand how communities of scientists function, how they flourish or languish.

Illustration of the manifold inscribing all embeddings and an evaluation of three articles or patents (hyperedges h1-3) in terms of their surprising combinations. Articles/patents h1 and h3 represent projects that combine scientific or technical components near one another in , making each of high probability and low (e) surprise--similar to many related papers from the past. By contrast, paper h2 draws a novel combination of components unlike any paper from the past, making it of low probability and high (e) surprise

Shi and Evans, [2023] Discovery: A hypergraph model of tens of millions of research papers and patents across the life sciences, physical sciences and patented inventions predicts impact based on surprise (within the top 10% of citations) in realized combinations of research contents (article keywords) and contexts (cited journals). Provides a measure of path-breaking surprise in science and technology via the notion of 'research expeditions' (where scientists or inventors travel from their disciplines an unexpected distance or direction to address problems framed by a distant audience)

Our twenty-first-century challenges have a social component and cannot be solved by technology alone. Social network interactions can create social capital such as trust, solidarity, reliability, happiness, social values, norms and culture [Putnam, 2000]. To assess systemic risks fully, a better understanding of social capital is crucial. This is an essential part of the flourishing lens on science, scientific communities, and scientific discovery.

The considerations of the **society of science** are not yet in the realm of computation (e.g., beyond the science of science) and are more accurately a part of the philosophy and sociology of science

How does science advance? How do we know what to focus on as individuals, as a community?

Intellectual playfulness [Nguyen, 2023]

An experiment in fostering community and the flourishing of individual scientists and scientific knowledge in a given domain

Why is network science a core element of complexity science?

Network Science

A 'node' (or vertex)
 An 'edge' (or link)

A graph represents the relations (edges) between a collection of entities (nodes)

The edges could be...

who talked to who at a party
 Lines in the power grid
 Co-citations between science papers

The emergence of network science at the dawn of the 21st century is a vivid demonstration that science can live up to the challenges of complexity [http://networksciencebook.com/]

The common nature of the network structure of many of the systems we study, from social to physical, as well as the way networks allow information from multiple domains to be seamlessly integrated means that network science offers a language through which different disciplines can seamlessly interact with each other

What is the potential of network science to transform the way we do science?

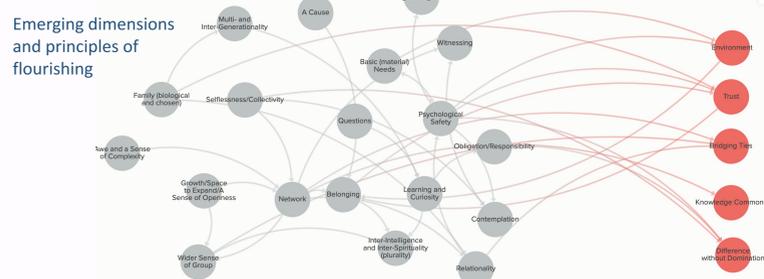
How do we discover principles of flourishing in scientific discovery and scientific communities?

“Justice consists of those forms of human interaction and social organization necessary to support human flourishing. The design principles necessary to implement justice will flow from our understanding of human flourishing.”
 -Danielle Allen (*Justice by Means of Democracy*)

Flourishing Studies

We need a more robust conception of flourishing for the world we are walking into, a conception furnishing of new multiscale and multi-medium interactions, the ways of making legible when a system is flourishing, and new groups and institutions capable of responding to the call to flourishing. These groups will not fit within any departmental or institutional boundaries, nor within the boundaries of any single or few worldviews.

As flourishing is something we must practice and, in that experience, understand, we believe the exploration must be situated within the research domain now. We must have it as the philosophy undergirding how we do research and as the focus of research. We call this sensibility 'Flourishing Studies' and its instantiation a 'Flourishing Commons.'



Interactive and living version

What is the potential of network science to transform physical science?

Network Science in Physical Science

Networks are the lingua franca of complex systems and are revealing fundamental discoveries about the physical world and across the physical sciences

Evolution of oceanic network clusters over a 20-year period, derived from atmospheric variables. Notable patterns include cohesive clusters in sea-level pressure (SLP) and more dispersed clusters in vertical wind shear (VWS)

Steinhaeuser et al., [2012] Discovery: Networks can unveil climate insights, extracting valuable information from well-predicted variables (e.g., temperature) to enhance understanding and predictions of critical, less-predicted factors like precipitation, potentially complementing physics-based climate models

Hines et al., [2015] Discovery: Power grid line outages exhibit distant and non-local cascades, both geographically and topologically, akin to the random fuse model in statistical physics

Conclusions

We articulated why a lens of flourishing is vital for science

Identified a need for a synthesis into what flourishing is and what it means for scientists, science communities, and scientific discovery

This synthesis will be complex and will require network science

We have identified areas ripe for development and collaboration, calling the new field 'Flourishing Studies'

What to do now?

How do we build research groups/networks capable of studying flourishing and practicing science in a way that creates flourishing?

What might be metrics of flourishing?

What additional literacies for scientists and science communities does the lens of flourishing suggest?

Contribute to the 'Flourishing Commons'

Github Substack

Be a part of 'Open Science,' one place where flourishing in science is playing out

