Book Review

Jennifer H. Watkins*
T-10: Theoretical Biology
and Biophysics
Los Alamos National Laboratory
MS K710 Los Alamos, NM 87545
jhw@lanl.gov

Marko A. Rodriguez
STB-RL: Digital Library Research
and Prototyping
Los Alamos National Laboratory
MS P362 Los Alamos, NM 87545
marko@lanl.gov

Weak Links: Stabilizers of Complex Systems from Proteins to Social Networks. Peter Csermely. (2006, Springer.) Hardcover, $64.95, 410 pages.

Following Barabasi's *Linked* [1], network science has become a popular and effective method to study the range of complex systems from molecular interactions to friendship networks. Many measures have been developed to classify and analyze networks. These structural metrics tend to focus on the more permanent connections of a network. Peter Csermely takes a different stance, focusing his book on those connections whose presence does not change the value of these measures in a "statistically discernible way" (p. 3)—the *weak* links. In contrast to the predominant emphasis on the more easily measured connections of a system, *Weak Links* focuses on the effervescent edges that make a network both dynamic and, in his opinion, stable. Csermely advocates a serious exploration of the stabilizing role of weak links in networks at all levels.

Csermely posits the stabilizing effect of weak links to be a general network property of all complex systems. This ambitious claim is substantiated by varied examples from many disciplines as well as through intriguing conjecture in areas that require further research. With a surprising combination of scientific exposition and philosophical reflection, *Weak Links* opens with a biochemical research problem and takes the reader through the breadth of network science studies to conclude with a larger message for humankind.

The first half of the book attempts to fully explain the components of Csermely's hypothesis. This is time well spent, considering the notoriously difficult-to-define topics he tackles—stability, complexity, and weakness. Through a review of other accepted general network properties, such as scale-freeness, clustering, and preferential attachment, Csermely introduces the role of weak links, setting them in a familiar context. In what is anything but a typical review of network science, he includes such diverse asides as fractal geometry, Levy flights in biology, and the scale-free properties of music. What follows is the most technical chapter of the book, exploring the meaning of stability in networks. He concludes that weak links protect networks from perturbations that test network stability. Albeit a difficult subject, the stability definition tends toward the anecdotal.

The second half of the book involves a trip to *Netland*. Here, each chapter is devoted to the description of weak link stabilization in networks of a particular scale. The journey begins with a review of the literature indicating weak link stabilization in macromolecules and continues to cells, organisms, and social networks with each successive chapter. The most unique work ensues as the trip to Netland continues to cultural networks (including language and architecture), the global web

* Corresponding author.

(including the world market), and finally the ecoweb (with a discussion of human dominance in the food chain). All chapters are populated with reviews of a diverse range of studies as well as additional asides and speculations that make the read worthwhile. These speculations, such as the postulation that women stabilize society through their tendency to cultivate many weak social ties, provide enticing questions for further weak link research.

Csermely's inclusion of speculations (which he rates from 1 to 3 for the degree to which they are unsubstantiated) provide some of the most fascinating contributions to the book. For example, it is in these specially formatted sections that he speculates on the fixed dimensionality of our brains, the role of isolation-accelerated innovation in cultural evolution, and that pink noise improves our ability to learn. In fact, *Weak Links* presents a remarkable range of examples, some of which are sure to touch on the reader's discipline as well as some that will be far removed. However, Csermely's hypothesis does not develop sophistication or insight beyond its original formulation. What the author has done is to collect a variety of studies that support the stabilizing effect of weak links and sprinkled their discussion with conjecture of his own.

In all, *Weak Links* should be taken for what it is, a scientifically inclined, but playful account of a fertile research ground. Csermely provides the presentation but not the proof that weakly linked components stabilize the network of any complex system. From observations of weak link stabilization in some networks as well as the plausibility of the phenomenon in other networks, he generalizes the role of weak links to all networks. To his credit, the author is straightforward, even self-conscious, about this generalization, employing frequent side comments to delineate factual text from suggestion. The insight he does provide is the seemingly universal significance of weak links to network dynamics. Csermely convincingly presents a fresh perspective on such well-studied topics as protein structure, psychological health, and market innovation by recasting them as functions stabilized through their weakly linked components.

What Csermely's book contributes is a convincing advocacy for future work in the role of weak links in a network. This is a significant contribution; with Granovetter's 1973 sociological study of the central role of mere associates in finding jobs, weak links entered the research world [2]. Thirty-three years later, Csermely could only provide a smattering of references furthering their research. Weak links, in essence volatile and insubstantial connections, are difficult to study and thus their description in network science has been marginalized. Perhaps, with its enthusiastic tone and inspiring speculations, *Weak Links* will instigate research in this area.

References

1. Barabasi, A. L. (2002). *Linked: The new science of networks*. Cambridge, MA: Perseus.

2. Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology*, *78*, 1360–1380.