Multiplex Networks

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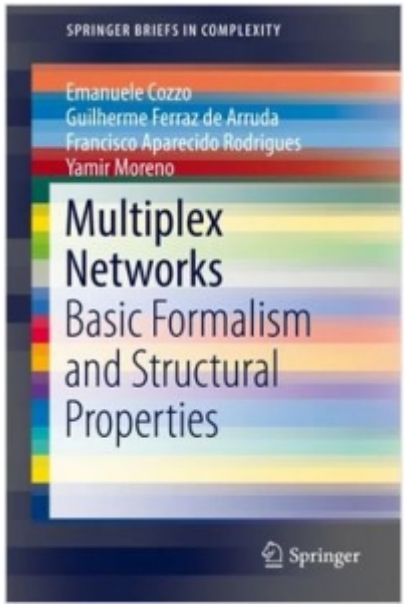

Network representations of natural, technological and social systems allowed researchers to investigate their topological, statistical and dynamical characteristics on a wide scale. For many applications, however, networks with one type of nodes and one type of edges do not suffice. Let us consider for example public transport networks: different modes of transportation imply different sets of stops (i.e. nodes), while edges in the various subnetworks are both qualitatively different from each other and tend to connect in different topologies. Similarly, when one wants to study the diffusion of information, it is important to consider that the same individuals are related to each other by different networks, with the passage of information being non-automatic among the different networks. To address this type of problems, network theorists have recently devoted a growing amount of attention to multiplex networks where different relationships are conceptualised as different and sometimes interconnected layers. Extending concepts and especially analytical results, which are well known in normal networks to a multiplex setup is non-trivial due to the interactions among different layers and their topologies.

This short book, written by four experts that – together – delivered several of the key contributions to the development of this field attempts a partial summary of the recent theoretical literature on multiplex networks. The book is a no-frills book which is quantitative in nature, and that requires a knowledge of mathematics (linear algebra, spectral analysis in particular) beyond one of the typical social scientists. As such, it is a book addressed to network scientists and modellers in particular, with a background in the natural or mathematical sciences. Results and derivations are described clearly and precisely; some efforts to connect the theoretical literature with specific case studies could have significantly enlarged

the readership of this book. This is however not the fault of the authors but rather a consequence of the format of *Springer Briefs in Complexity*, requiring concision.

The book is well structured, with the first three chapters introducing the basic formalism used in most of the book and the extension of basic structural metrics to multiplex networks. These initial chapters are accessible and should be read in sequence. Contrastingly, the remaining chapters can be read and understood independently as they are discussing different approaches and angles through which it is possible to derive results on the structural properties of networks. Chapter 4 deals with the extension of spectral analysis to complex networks. Chapter 5 discusses transitions, i.e. what happens to the structure and functionality of a multiplex network if nodes or edges are progressively being removed. Chapter 6, partially building on the two previous ones, derives further results interpreting the eigenvalue problem. The final chapter illustrates that abandoning the metrical formalism inherited from single-layer networks and adopting a tensor formalism allows investigating, in an agile manner, complex problems such as the degree-degree correlation in multiplex networks.

In several instances throughout the book, the authors propose a parallelism between the results that emerge in multiplex networks and those that are obtained using an aggregate network approach where links are compressed on a single layer. This idea allows the reader to appreciate the advantages of treating the multiplicity of relations in complex systems as a multiplex network.

This book constitutes a handy reference for someone with good previous knowledge of multiplexes and their characteristics, interested in particular in having a go-to book for specific results on the subject. With the recent diffusion of multi-layer networks in agent-based modelling, researchers get a guide throughout the key results that emerge when a system is treated as a multiplex network which is certainly useful.

Further, this book could be the basis for an (advanced) module on the mathematics of multiplex networks as it provides a mindful and clear review of the key results in the field of their interest.