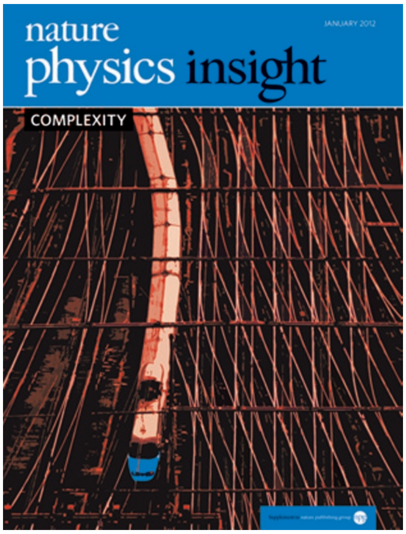

COVER IMAGE

In many large ensembles, the property of the system as a whole cannot be understood by studying the individual entities — neurons in the brain, for example, or transport users in traffic networks. The past decade, however, has seen important progress in our fundamental understanding of what such seemingly disparate 'complex systems' have in common. Image: © Marvin E. Newman/ Getty Images.

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Complexity

A formal definition of what constitutes a complex system is not easy to devise; equally difficult is the delineation of which fields of study fall within the bounds of 'complexity'. An appealing approach — but only one of several possibilities — is to play on the 'more is different' theme, declaring that the properties of a complex system as a whole cannot be understood from the study of its individual constituents. There are many examples, from neurons in the brain, to transport users in traffic networks, to data packages in the Internet.

Large datasets — collected, for example, in proteomic studies, or captured in records of mobile-phone users and Internet traffic — now provide an unprecedented level of information about these systems. Indeed, the availability of these detailed datasets has led to an explosion of activity in the modelling of complex systems. Data-based models can not only provide an understanding of the properties and behaviours of individual systems, but also, beyond that, might lead to the discovery of common properties between seemingly disparate systems.

Much of the progress made during the past decade or so comes under the banner of 'network science'. The representation of complex systems as networks, or graphs, has proved to be a tremendously useful abstraction, and has led to an understanding of how many real-world systems are structured, what kinds of dynamic processes they support and how they interact with each other. This *Nature Physics* Insight is therefore admittedly inclined towards research in complex networks. As Albert-László Barabási argues in his Commentary, the past decade has indeed witnessed a 'network takeover'. On the other hand, James Crutchfield, in his review of the tools for discovering patterns and quantifying their structural complexity, demonstrates beautifully how fundamental theories of information and computation have led to a deeper understanding of just what 'complex systems' are.

For a topic as broad as complexity, it is impossible to do justice to all of the recent developments. The field has been shaped over decades by advances in physics, engineering, computer science, biology and sociology, and its ramifications are equally diverse. But a selection had to be made, and we hope that this Insight will prove inspiring, and a showcase for the pivotal role that physicists are playing — and are bound to play — in the inherently multidisciplinary endeavour of making sense of complexity.

Andreas Trabesinger, Senior Editor

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