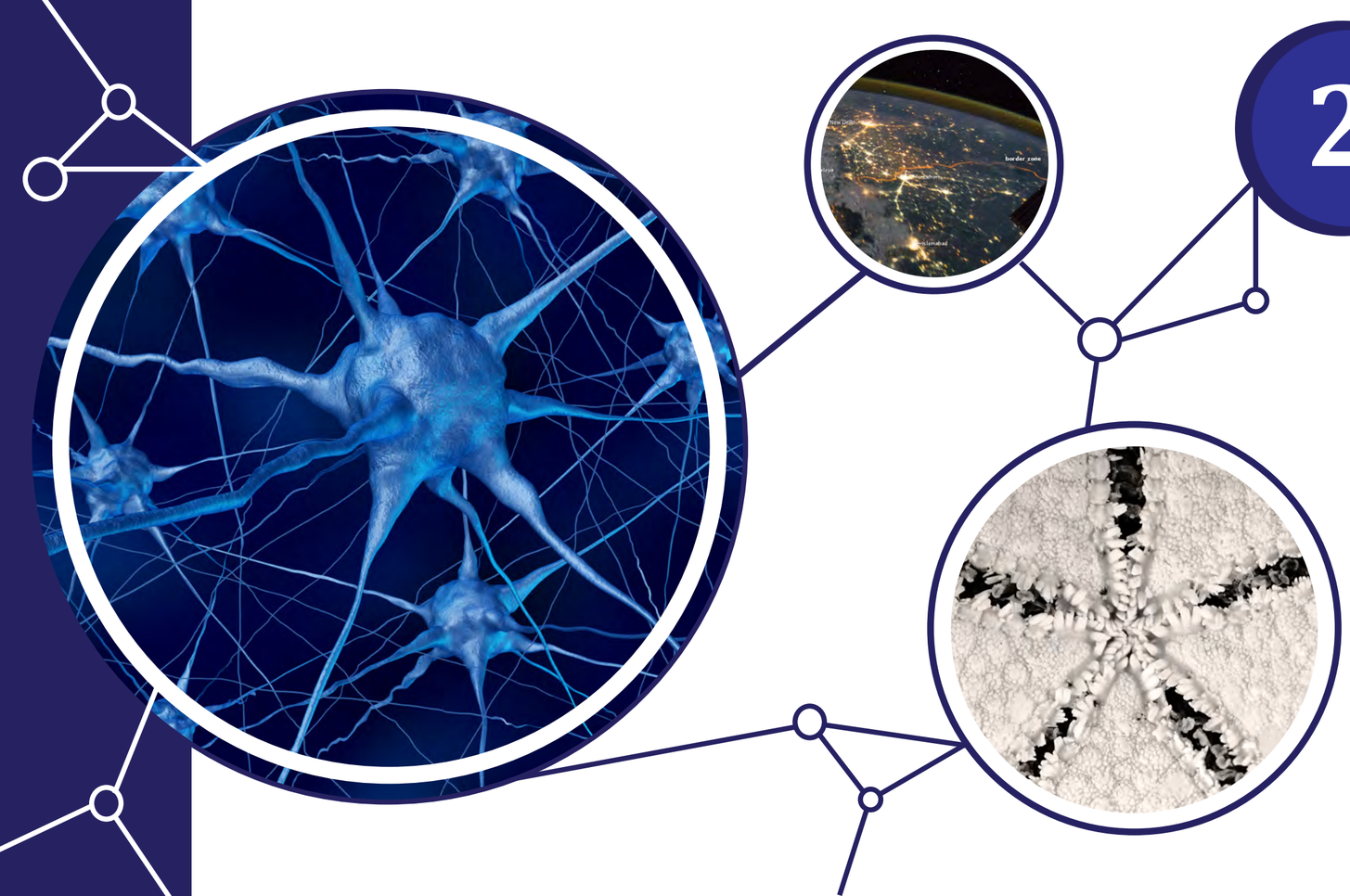

2 networks

How do you plan a journey from a small village in Kerala to one in Arunachal Pradesh? How does an email reach from the computer on which it is typed to the one on which it is read? How does your hand recoil from a very hot pot? How does overfishing in a river affect coral reefs in an ocean? All these questions can fruitfully be analysed by understanding the network underlying these systems. The connection, pun intended, between these varied questions and networks may not be obvious at first glance, so let us look at it in detail. The above questions are naturally related to, respectively, railway network that connects distant places together by railway lines and trains running on them; the internet network that connects computers together and moves data over optical fibers and copper wires to deliver emails and webpages; the neurons that are connected in a dazzling network which carries signals back and forth between our organs and the brain, which itself is one of the most complex networks yet known; the eco-systems of which food webs are a part, are also a complex network of interdependence between animals, plants, bacteria, and all living beings, and their interactions with the environment in which they live.

Simply put, the most basic description of a network is in terms of a collection of nodes (places, computers, organs and brain, species, in the examples above) joined by links called edges (railway lines, optical and copper fibers, neurons, predator-prey links, respectively, in those

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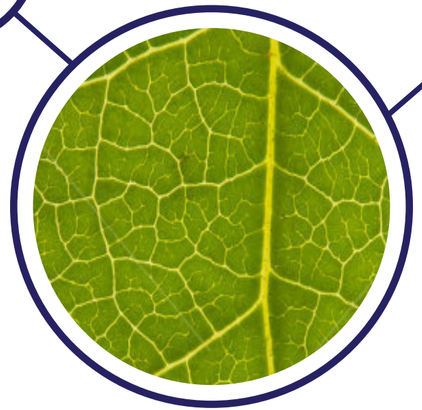

examples).

What is the math? One of the simplest ways to represent a network is by a matrix each row represents a node and so does each column. When one node (station) is connected to another node (station) by an edge (railway line), we put the number 1 in the corresponding row and column location. Such a matrix is called the “adjacency matrix”. Combining such a description in terms of a matrix with the powerful mathematical ideas from linear algebra and other fields helps us answer many questions about networks, connectivity. The whole field of graph and network theory is devoted to such study and is now an indispensable tool in many subjects such as biology, economics, computer science, and many others.

Can you try to write down the adjacency matrix of the different localities in Bangalore or your own city or nearby villages with edges indicating whether there is a direct bus service from one locality or village to another? Can you draw such a network on a map? What do you learn about the connectivity?

The above description has hopefully made it amply clear that networks occur everywhere literally! Just like waves , networks are ubiquitous: a family tree is a vast network of humans, especially if you include both paternal and maternal links; the chemical reactions linking our genes and proteins inside our cells forms a network with different chemicals as nodes and the chemical reactions forming the links; the mobile phones connecting so many of us together.