Graph theory, like many fields of mathematics, can provide a more precise way of describing what people in the real world are already doing. For example, a colleague and I are investigating how library catalogers over the years have, at least since the mid 19th century, created graph structures within library catalogs - in their book, index card, and database record forms. Fascinating questions - both abstract and practical - arise. Graph theory combined with key bits from the history of science helps formulate and answer even more fascinating questions: <http://ejournals.bc.edu/ojs/index.php/ital/article/view/1868/0>

They can model many problems that involve state transitions nicely. For example, imagine you have a pulse going through a wall made up of several layers. The signal is attenuated (reduced) by travelling through each material, and partially reflected/transmitted at each boundary. What is the total energy that you receive back at the transceiver? If you try doing the sum you get a very difficult problem. But you can rephrase the problem in terms of a directed weighted graph and make things much easier:

Have vertices representing the start node, each intermediate layer (which gets two: one per direction of travel), and one outgoing node for the signals that are simply lost on the other side. The edges are weighted according to how much the signal is attenuated when going from one state to the other (material attenuation and reflection/transmission combined). Now the result you want can be calculated by performing a simple calculation on the weighted adjacency matrix.

The point is that graphs model "I have stuff, and it's connected to/interacting with other stuff". This is an absurdly general concept, and so applications of graph theory will pop up in all kinds of neat places.

<https://mgoblog.com/diaries/graph-theory-or-alternate-ways-rank-big-ten-year>

I have not progressed in the subject far enough to see it properly applied to real world problems. But this is what I have understood. Graph Theory is the study of **relationships**. Given a set of nodes - which can be used to abstract anything from cities to computer data - Graph Theory studies the relationship between them in a very deep manner and provides answers to many arrangement, networking, optimisation, matching and operational problems. And the strength of it is the the power to be used to abstract such a vast array of real problems. Graph Theory should be renamed Network Theory or something. Because to me that is what it is. It is the study of inter-object relationships where the objects can be pretty much anything. And this study of relationships is useful pretty much everywhere.