In many ways, a good theory behaves like a rock thrown in a pond: It makes a splash and then its ripples spread. Maria Chudnovsky’s work in graph theory is like that. “A graph is a good model for many practical problems,” she said. “You can think of the Internet as a graph and the computers on it as vertices; some are connected and some are not. Graph theory can tell us about its structure.”

Graph theory does not involve what we normally think of as graphs. Instead, it involves groups of points, or vertices. Sometimes they form geometric objects like squares and pentagons. Other times, they are distributed as randomly as cities or cell phone towers on a map.

Graphs are characterized by the properties of their vertices and the lines, or edges, between them. They can be used to answer problems, from finding the best route for a delivery truck to routing Internet traffic to calculating the shortest itinerary on a GPS.

Chudnovsky works at understanding these attributes. In 2002, her team proved a conjecture about perfect graphs, which are graphs roughly defined as being easy to color. They showed that only two types of defects keep a graph from being perfect, and that all perfect graphs fall into a handful of different categories.

Chudnovsky’s proof makes it possible to determine if a graph is perfect without coloring all its vertices. While this may sound like a strictly cerebral exercise, perfect graphs were originally conceived in order to solve a problem in communications theory. Her work is relevant in other fields as well. Engineers could use her proof to locate wireless towers so their frequencies do not interfere with one another. Knowing whether a graph is perfect or not also helps computer scientists choose efficient algorithms to solve certain problems.

Chudnovsky continues to explore the structure of graphs. Her recent work looked at graphs that did not contain a claw. This structure occurs where three lines, or edges, emanate from a common vertex to form a three-fingered claw.

“We’ve explicitly described all graphs that do not contain a claw,” she said. “Now that our characterization is in place, many problems that seemed to be out of reach can be solved relatively easily.”

While her work is highly abstract, her results promise to solve some of the most practical of problems.