

# Introduction

THE AMS IS HAPPY TO PRESENT a new volume of *What's Happening in the Mathematical Sciences*. Like all ten previous volumes, this book is intended to provide a reader-friendly, not too technical introduction to a variety of topics in mathematics, both pure and applied, which have been of particular interest in the last five years.

At the easier end of the spectrum, the popular card game “Set<sup>®</sup>” leads to a fascinating problem in combinatorics known as the Cap Set Conjecture. In 2016, mathematicians discovered an unexpectedly simple solution, which is presented in “The ‘Set<sup>®</sup>’ Game Has Met Its Match,” **page 62**. “Expanding Horizons,” **page 90**, explains how expanding graphs, or expanders, are used in coding, knot theory, and nearest-neighbor search. “Needles in an Infinite Haystack,” **page 122**, describes the “asymptotic Fermat’s last theorem” problem and its connection to a seemingly much simpler equation called the  $S$ -unit equation. In many cases this reduces the problem (metaphorically speaking) from a futile search through an infinitely large haystack to a much simpler search through a modestly sized hay basket.

“The Shape of Data,” **page 46**, and “Quantum Computers and Golden Gates,” **page 106**, feature recent advances in theoretical computer science and related areas of data science. “When Black Holes Collide,” **page 30**, discusses one of the most fascinating recent developments in physics, the discovery of gravitational waves. The biggest roadblock in the way of this discovery, for many years, was the purely mathematical problem of solving the equations of general relativity that describe two colliding black holes.

While math can be used to predict how stars collide and the tiniest particles behave, it also has fundamental impacts on our everyday lives. “The Mathematics of Commuting,” **page 74**, describes how bike-sharing services make sure you always can get a bike when you need one, and explores how these services can integrate with ride-sharing systems (like Lyft and Uber) to make our cities less congested. “The Calculus of Calories,” **page 18**, explores the world of weight control, and why those pounds are always so hard to keep off. Last, and certainly not least, mathematicians have made extraordinary progress in recent years at detecting unfair apportionment of legislative seats. “Gerrymandering: Mathematics on Trial,” **page 2**, explains the not-too-difficult concepts behind these methods. One might well wish that the Supreme Court had read this chapter before deciding some of their recent cases.

The brief abstracts in the Table of Contents will tell you more about each of these chapters and, of course, you can learn much more by diving into the articles themselves. We hope that we have included something in this volume for every mathematical taste!

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