

Introduction

IN ORDINARY TIMES, MATHEMATICIANS may have the luxury of pursuing their passion in “splendid isolation” from the rest of the world. But 2020 and 2021 were not ordinary times. This twelfth edition of *What’s Happening in the Mathematical Sciences* more than ever reflects the tight connection between mathematics and the times that we live in. During the coronavirus pandemic of 2020 and 2021, the world needed mathematicians for objective advice. We needed them to tell us what to expect in the weeks and months ahead; to jar policy makers out of their complacency; to give us road maps for reopening schools and other public spaces; to explain why COVID-19 caused life-threatening illness to some people, while others remained completely asymptomatic; and to evaluate the effectiveness of interventions like masks and vaccines.

The first three chapters of this volume (“Fifty Ways to Beat a Virus, Parts 1–3,” pp. 2, 18, 30) tell the stories of mathematicians who responded to this call. The articles roughly progress from the largest scale to the smallest. Part 1 explains epidemiological models of the whole population and highlights two groups of mathematical modelers who successfully advised local and state authorities. Part 2 investigates COVID-19 in smaller populations—universities and prisons—as well as efforts to forecast the impact of vaccines. Part 3 goes down to the microscopic scale and explains how mathematics can describe the course of infection in individuals, and how it can identify weak spots of the virus that could be targeted with drugs or gene therapy.

Climate change is another looming threat to our way of life that calls for mathematical standards of evidence and reasoning. What is a change, anyway, and how can we tell if we have one? Similarly, what is an extreme? How do climate models work, and how can we improve the parts that currently don’t work? These are some of the questions explored in “A Climate for Math,” page 94.

Even in exceptional times, there is still a place for traditional “pure math.” The remaining four chapters of *What’s Happening* describe progress on a variety of problems from the purely recreational to the highly theoretical. “Square Pegs and Squiggly Holes,” page 64, describes a “folklore” problem that seems as if it should have an easy solution, but has defied the attempts of mathematicians for a century. “Descartes’ Homework,” page 46, tells how an inadvertent discovery by a 17th-century mathematician has led to spectacular (and beautiful) links between number theory and the geometry of foams.

Number theory takes the stage again in “Dancing on the Edge of the Impossible,” page 78. The impossible dream is a foolproof method for finding all the rational-number solutions to a polynomial equation. But for polynomials with only two variables it might just be possible, and this chapter outlines two approaches that might get us there. Finally, “Much Ado About Zero,” page 112, describes an area of mathematics, called zero-forcing, that didn’t even exist twenty years ago. It is a delightful blend of graph theory and linear algebra. Furthermore, this chapter provides an example of how new fields in math can be nourished by facilitating large collaborations and diverse communities.

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"The World is temporarily closed". *A theater marquee aptly sums up life in the pandemic year of 2020—and, to a somewhat lesser extent, 2021. (Courtesy of Edwin Hooper on Unsplash.)*