

Introduction

THE DEPTH AND BREADTH OF MATHEMATICS, and its unreasonable effectiveness become more evident every year. Two recent major world events point to the usefulness of mathematics in preventing the loss of life. Mathematics was also a key ingredient behind the scientific discovery dubbed by *Science* the “Breakthrough of the Year 2012”. Advances in pure mathematics continued apace, too. The ninth volume of *What’s Happening in the Mathematical Sciences* presents all these developments, and more, in Dana MacKenzie’s engaging style.

Several major news stories of the last few years have significant mathematical connections. The tsunami that devastated Japan in 2011 showed the need for better warning systems, the best of which employ advanced mathematics. By combining the newest models and better numerical methods, it is possible to give faster estimates of the strength and direction of deadly ocean waves, giving people more time to prepare or to evacuate. The international response to the flu epidemic of 2009 relied heavily on modern mathematical models in several ways, but especially to determine the subset of the population that most needed to be vaccinated to control the outbreak. Meanwhile, in a less publicized development, several police departments began implementing mathematically based “predictive policing”, which reduced crime by telling police where to be *before* the crimes could even be committed.

The biggest science story of the last few years was CERN’s discovery of the Higgs boson. After fifty years and a few billion euros, the physicists confirmed the existence of this fundamental particle that had been predicted in 1964 by means of just two pages of mathematical computations. In a different link to physics, tropical geometry, which has connections to string theory, has become a major topic in diverse areas of both pure and applied mathematics. Meanwhile, the statistical technique known as latent Dirichlet allocation has allowed deep analysis of texts, whether they be literary manuscripts, SMS texts from teenagers, or bits of genetic code. Of course, mathematicians had some serious fun with games, successfully analyzing the minimal solutions of generalized Rubik’s cubes.

We cannot overlook developments in pure mathematics, where some important problems were solved. Once again, deep advances have been the result of combinations of multiple areas of mathematics, whether it is topology and algebra or geometry and analysis.

As with the earlier eight volumes of *What’s Happening in the Mathematical Sciences*, this ninth volume shows how mathematics is lively, practical, and even fun. We hope you enjoy reading this volume as much as we have enjoyed putting it together.

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