The Best Jobs of the 21st Century? Mathematicians and STEM Careers

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I have talked with recruiters from over 150 different companies that hire mathematics students. Based upon those discussion, here is my list of the top current careers for mathematics

Data scientist/analytics consultant: Data science deals with analyzing extremely large amounts of data. Think of all the data being created on the internet. In 2011, it was estimated that the Library of Congress had collected about 235 terabytes of data. A few years later, Google estimated that the internet holds about 5,000,000 terabytes of data---20,000 times as much as the Library of Congress. And it is growing. The are many career opportunities for people who have experience in collecting and sifting through large amounts of data in order to analyze it and determine patterns. By large amounts of data, we mean quantities so large that they could not possibly be put into a spreadsheet and examined a person.

A good example of this comes from Prof. Tom Wakefield and his students at Youngstown State University. Youngstown, Ohio has seen a dramatic decline in its city population and a shift in the location of the population over the past forty years. However, the police department was still using a division of the city into police beats that was created decades ago. Students received 2014 crime data from the police department, analyzed the data, and proposed two new models for more equitable divisions of the city into police beats. The police department adopted one of the proposed models.

It is not hard to find examples of how companies have used data analytics to improve their products and services. For instance, Google has used data analytics to improve its internet searching techniques, Netflix has used data science to provide users with recommended new movies based upon a user's ratings of previously watched movies (see the ``Netflix Prize''), Nike has used data analytics to make marketing decisions about their sports apparel, and sports teams from basketball to football use it to improve their chances of winning (as in the movie *Moneyball*).

Software engineer: Programming or coding is an essential skill for any mathematics student who wants a career in industry or business since there are many companies from small start-ups to large international companies that are constantly in need of programmers. Companies that hire mathematics students as programmers include large tech firms such as Amazon, Microsoft, and Google, in addition to lesser known companies like Epic (which creates software for medical records at hospitals and clinics) and FAST Enterprises (which provides software and technology consulting services for government agencies). Some people may think that a student should be a computer science major to be a programmer. That may have been true years ago, but in talking with employers and recruiters, we have learned that they are not as interested in what STEM field students major in or even what courses they have taken as they are in what skills the students have. This is an important message to get across to students.

There is a company that assesses students programming skills not by looking at the students' majors but by giving prospective employees an online programming test. The test consists of a made-up programming language, something that students would not have seen before. The test starts with a list of words, each of which is a specific command in this made-up programming language. The test has a set of questions in which some code in this language is provided, and the examinee is asked to give the output from the code. Next, there is a set of questions in which the examinee is supposed to write code in this made-up language to do specific tasks. This is the coding test the company gives to all prospective software engineers, regardless of what the student's major was or which programming classes the student had taken.

Technology consultant/engineer: Technology and engineering companies such as Raytheon, Boeing, Sandia National Laboratories, Lawrence Livermore National Laboratory, Bell Helicopter, Ford Motor Company, and W. L. Gore (manufacturing) employ mathematicians. In the past, if students wanted to work for companies that specialize in developing engineering projects, they often needed to be engineering majors. Today, these companies hire a significant number of other STEM majors, including mathematics majors. You may think that they would want to hire only engineers and wonder why such companies would employ mathematicians. In answering this question, recruiters from an engineering firm pointed out that they like to form working groups consisting of people with different backgrounds---engineers, programmers, statisticians, and mathematicians. This allows for different perspectives to be used in solving a problem.

Financial analyst: Financial firms that deal with banking, investing, and trading employ mathematicians. These firms include Goldman Sachs, Capital One, RBS, ING, and Jane Street. In 2017, the BYU math department took a group of 18 students to Europe for four weeks to visit companies that hire mathematics students. One of the companies the group visited in London was Jane Street, a quantitative financial trading firm. The group's contact was a mathematician working for Jane Street. During the visit, the students learned about what the company does, what financial trading is, and how mathematics is involved. At the end, the group got to play a simple trading simulation game, then they were able to ask questions as they were treated to pizza. In another instance, we attended a STEM career fair and talked to a representative at RBS, the Royal Bank of Scotland. The RBS representative mentioned that they hired mathematics majors for their number sense and for their ability to pay attention to detail.

Operations researcher: Operations research applies analytical and mathematical methods to help make better decisions. It deals with such questions as ``What is the optimal way to schedule a set of tasks?'' and ``What is the most efficient way to arrange the flow of traffic?'' Examples include the scheduling of a sport team's games, the restocking of large businesses such as Walmart, the scheduling of surgery in hospitals (i.e., arranging physicians, patients, nurses, and operating rooms), the synchronization of stoplights in a city, the evacuation of a building or a stadium in case of a terrorism threat, and the implementation of efficient delivery routes for UPS or airlines. Eric Murphy is a mathematician who did operations research for the U.S. government. He was advising the Joint Chiefs of Staff on how to best move supplies and troops in and out of foreign countries. Sommer Gentry does operations research as a research associate for the John Hopkins University School of Medicine while she is a mathematics professor at the US Naval Academy.

She made national news when she teamed up with her husband, a surgeon, to use operations research to find a more efficient way to match kidney donations with recipients.

Medical scientist: As medical fields become more immersed in data, mathematics can provide more insight in the study of medicine. Helen Moore is a mathematician who has worked for medical companies. Originally, Helen's interest did not lie in the medical field, but after attending some conferences and workshops related to mathematics and medicine, she became interested. Later, she was offered a job with Pharsight (a pharmaceutical company) as a senior scientist. When a pharmaceutical company develops a new drug, they must determine safe and effective dosages to prescribe to patients. Helen used control theory and mathematical modeling to do this. Michael Cannon has a B.S. in mathematics and a Ph.D. in epidemiology and works for the Center for Disease Control and Prevention doing research on the prevention of birth defects.

Government agencies and national laboratories: National laboratories hire students with strong mathematics backgrounds. Robert Berry is a mathematician who worked at Sandia National Labs on energy problems. Carol Meyers has a B.A. in mathematics and a Ph.D. in operations research. She works at Lawrence Livermore National Labs and has solved problems related to nuclear disarmament and emergency disaster preparedness. Emilie Purvine, who has both a B.S. and a Ph.D. in mathematics, works on problems related to cybersecurity and the power grid at Pacific Northwest National Laboratory. Also, the National Security Agency (NSA) is the largest employer of mathematicians in the United States. They employ mathematicians to work on cryptographic problems, complex algorithms, and data science issues.

Computer graphics engineer: Doug Roble at Digital Domain Productions, Inc. has mentioned that mathematics was used in the creation of top money-making movies ranging from *Avatar* to *Toy Story*. Tony DeRose, a research scientist at Pixar Animation Studios, has given talks on how mathematics has changed Hollywood, giving examples of such movies as *The Incredibles*, *Brave*, and *Ratatouille*. Alex McAdams has a Ph.D. in applied mathematics and is a senior software engineer at Walt Disney Animation Studios. He used mathematics to model hair and clothing in such movies as *Frozen* and *Moana*. Ramus Tamstorf, a computer graphics engineer at Walt Disney Animation Studios, and Adam Sidwell, an independent Creature Technical Director, have also voiced this same message of math's importance in movies. They work to make the movement of animated characters, the light shading on characters, the flow of water, and the crashing of objects seem realistic.

Note: This material comes from the soon-to-be-published book “A Mathematician’s Practical Guide to Mentoring Undergraduate Research” by Michael Dorff, Allison Henrich, and Lara Pudwell.