Introduction

In our modern interconnected society, the often ignored world of cybersecurity keeps us protected and productive. Cybersecurity is what allows anyone to safely use a computer, to bank online, to make online purchases, to communicate through phone, email, text, or other applications. Cybersecurity is the backbone of technology. But, who contributes to cybersecurity? One might imagine a hoard of programmers working to stay ahead of hackers, but in reality cybersecurity is a multi-disciplinary *science*, incorporating social science, computer science, programming, information technology science, and especially mathematics.

Cybersecurity issues important to mathematics

Cybersecurity is based upon computer science, of which mathematics is the foundation of. Because of this, mathematics and mathematicians played a critical role in developing the field of cybersecurity, and continue to support cybersecurity. Modern mathematicians work to estimate risk, prevent and model security breaches, develop tools and algorithms to be used in cybersecurity, and more. [1] A 2009 paper posits, "The field of cyber security poses a rich set of new and exciting research opportunities for the mathematical and statistical sciences." [2]

Possible career paths/sectors

One of the key ways in which mathematicians contribute to cybersecurity is through cryptography. Cryptography is the art of sending information so that only the intended recipient can read it. (Note that it is specifically called an art because it requires creativity and innovation.) Cryptographers have two main responsibilities. First, to develop security systems that utilize encryption/decryption algorithms and ciphers so that information can be securely transmitted. Second, to try to break the algorithms and ciphers that they and other cryptographers develop. Modern cryptography requires a strong understanding of mathematics. [3]

If you're not interested in cryptography, you can still be involved in cybersecurity. As a mathematician, you could be involved with penetration testing where you try to break into secure systems and report vulnerabilities, information security research where you work to identify potential threats to your system, security incident responding where you work to forensically identify security incidents, and more.

Main Competencies/Entry Level Experience

If you want to become involved in cybersecurity as a mathematician, you should have competency in: [4]

- Binary Math

- Hexadecimal Math

- Boolean Algebra

- Complex Numbers

- Linear Algebra

- Basic Cryptography

- Programming and Programming Math

If you interested in specializing in cryptography, you should also have competency in: [5]

- Algebraic Theory

- Probability

- Statistics

- Discrete Math

- Algebraic Geometry

- Complex Analysis

- **Number Theory** (especially prime factorization)

- Algorithms

Recommended Coursework

If you are interested in cybersecurity, there are two certificate programs you should look into. The first is the Undergraduate Certificate in Cybersecurity Management through the UCCS College of Business. This program will, "...prepare individuals in High Wage High Demand cybersecurity occupations to fill the job openings anticipated within the next five years." To achieve this certificate you would complete four courses from the table below. [6]

Table 1: Undergraduate Certificate in Cybersecurity Management Courses

Course Number	Course Title	Credit Hours
INFS 2510	Managing Network Interconnections	3
CYSM 3500	Fundamentals of Information Security and Cybersecurity	3
CYSM 3750	Organization Cyber Security	3
CYSM 4100	IT Risk Management	3
CYSM 4300	IT Security Auditing	3
CYSM 4500	Ethical Hacking	3
CYSM 4700	Cloud Computing & Security	3
Approved Cyber Security Elective		3

The second is an Applied Cybersecurity Undergraduate Certificate through the Department of Computer Science (and UCCS College of Engineering and Applied Science). This certificate program "...is designed for learners who work in the cybersecurity career field and those interested in entering the cybersecurity career field. While there are no prerequisites for this certificate, learners will more likely succeed if they have a basic understanding of computer systems and network architectures, have some programming experience, and are proficient in problem solving and algebra." There are four courses in this certificate program. [7]

Table 2: Applied Cybersecurity Undergraduate Certificate Courses

Course Number	Course Title	Credit Hours
CS 3910	System Management & Security	3
CS 4910	Introduction to Computer Security	3
CS 4920	Introduction to Applied Cryptography	3
CS 4950	Homeland Security and Cybersecurity	3

Even if you are not working towards either of these certificates, the classes can give you a significant leg up when entering the cybersecurity industry.

Average Salary Range

Mathematicians in cybersecurity make a significant salary. Here are some example careers gathered from Indeed:

Table 3: Example Jobs with Salary Ranges

Job Title	Company	Salary Range (yearly)
Cryptographer	QuSecure, Inc.	$120,000 – $200,000
Cryptography Engineer	Scratch	$100,000 – $200,000
Information System Security Professional	National Security Administration	$74,682 – $93,062
Research Scientist, CryptoEconLab	Protocol Labs	$88,500 – $112,000
Associate Cyber Information Assurance Analyst	Northrop Grumman	$58,800– $88,200

Conclusion

Bruce Schneier, an American cryptographer, writer, and security specialist, said, "It is insufficient to protect ourselves with laws; we need to protect ourselves with mathematics" [8]. As a mathematician, you can work to be part of this process, helping everyday people protect themselves from malicious actors.

References

[1]

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[2] https://arxiv.org/pdf/0904.1616.pdf

[3] https://cybersecurityguide.org/careers/cryptographer/

[4] https://blog.edx.org/how-is-math-used-in-cybersecurity

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[5]

https://cybersecuritykings.com/2021/05/18/cryptography-math-or-computer-science-must-know-info/

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