I am an applied mathematician interested in numerical methods with a specialization in computational methods used in optimization. In the first part of my research, I studied secant update classes with a focus on the BFGS secant method. The foundation of my work is based on the fact the BFGS secant method is the preferred secant method for finite-dimensional unconstrained optimization. I examined the construction of several rank-two secant update classes that had not received much recognition in the literature. My study of the underlying mathematical principles and characterizations inherent in the updates classes led to meaningful theorems and their proofs concerning secant updates.

One class of symmetric rank-two updates that I investigated is the Dennis class. I demonstrated how it can be derived from the general rank-one update formula in a purely algebraic manner and need not utilize Powell's method of iterated projections. I also introduced new characterizations of the Dennis class. Furthermore, I derived what I call the expanded Dennis class and showed how the Davidon class is a special case. This indicated that the Davidon class does not contain all symmetric rank-two secant updates. This discovery motivated me to write the general formula that could be used to represent all symmetric rank-two secant updates. From this, particular parameter choices that yield well-known updates and update classes were presented. I described some known and new characterizations of several secant update classes that are known to contain the BFGS update. I also provided a formal proof of the conjecture made by Schnabel in his 1977 Ph.D. thesis that the BFGS update is in some asymptotic sense the average of the DFP update and the Greenstadt update.

I am also interested in the historical development of mathematical concepts. Therefore, I devoted a significant part of my research to recounting the historical development of secant methods in general and the BFGS secant method in particular. The foundation of this second part of my work is based on the fact that many people believe that the Secant Method arose from Newton's method using a finite difference approximation to the derivative. I compiled historical evidence that reveals that a special case of the Secant Method predated Newton's method by more than 3000 years. I traced the evolution of secant methods from a method (most commonly referred to as the Rule of Double False Position) that can be found in 18th-century B.C. Babylonian clay tablets and the Egyptian Rhind Papyrus. Throughout the years, there has been widespread confusion concerning the origins and the terminology used to refer to the Secant method and the Regula Falsi method. It is interesting that confusion still exists today. I clarified these issues to remove the existing confusion.

I am interested in extending my work in two areas. First, I would like to continue my study of secant update classes. It is expected that further investigation will lead to meaningful conjectures and their proofs. Second, I found learning the historical development of the methods that I had studied enriched the learning experience and added another level of understanding of concepts. I would like to explore the historical development of other mathematical topics so that a historical component can be added when teaching the topic.