



# CAPSTONE PROJECT FINAL REPORT

## 1. Introduction

The aim of this capstone project is to create a tutoring assistant which will prove to be effective in helping discrete math students to practice permutation and combination exercises. For the assistant to provide the needed guidance to a student who is struggling, it is needed to take into consideration both mathematical problem that will be solved, as well as the solution that is proposed by the learner.

This tutoring assistant will use a problem generator designed to test the knowledge of the student. This generator is created by another student, Ahmed Fangli, for his capstone project. Fangli's problem generator offers my program with a complete set of exercises prepared into text files, together with a metadata that shows their structure, taking into consideration the agreed on mathematical model which is used commonly in both our projects. My system makes good use of a natural language processing technique in order to parse generated files and further extract the structure of the problems.

## 2. Steeple Analysis

This highly intelligent assistant for discrete math tutoring is actually a prototype which can be later on developed into a more advanced and widely accessible system which helps students in better understanding and practicing various mathematical concepts that they study in a similar manner in order to work with a human tutor. The software may even be extended to other Math fields, such as Probabilities, Calculus, Chemistry and Physics, etc.

The primarily societal impact of this tutoring assistant is to provide support to one of the 14 Grand Challenges of Engineering. This is defined by the National Engineering Academy, particularly personalized learning. This type of learning is a growing field of interest, especially in

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the recent years, as studies keep on advising that learning need to be customized and tailored to different individuals, thus expecting optimum results.

This capstone project belongs to the category of “intelligent” web-based educational systems, with which several advances have already been made. In fact, the Cognitive Tutor Algebra by Carnegie Learning is considered as one of the most successful among these educational systems [1]. There are also other systems in other fields, such as in computer programming, geometry and Physics. There is also a recommender system in the field of languages, especially in learning English as a second language, which is considered as among the systems which has been conceptualized to tailor fit reading lessons for different individuals depending on mistakes that they make [2].

## 2. Methodology

The first step involved in building the tutoring system was to create a mathematical model which embodies the potential structures of the considered domain. In this case, it involves problems on combinations and permutations. This model was also developed in collaboration with Ahmed Fangli, together with his mentor, Dr. Nizar Sing, since are also collaborating towards the creation of a Discrete Math Problem Generator used during the testing phase of my system.

## 3. Mathematical Model

The mathematical model used in this system took into consideration five types of problems which are taught typically in an undergraduate class in discrete math. This includes combinations, permutations,  $r$ -permutations,  $r$ -

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combinations, as well as permutations with restrained repetition [3]. This model was purposed to be in a form of a graph, branching into various types of problems, yet offering links which link one type to another. The reason for this was that the students may become confused between these different types, and the tutoring program can guide them from an answer that is wrong, to one that is correct. This is done without unnecessarily changing their answer completely.

## 4. Conclusion

Working on this advanced system was a memorable and rewarding for me personally. It enabled me to apply what I learned from my computer science curriculum, now on a practical level. It also allowed me to learn new technologies and skills.

## References

- [1] Klinger, Raymond T. "Intelligent Discrete Tutors as Modeling and Instructional Tool for Students." Carnegie Learning. April 2, 1999. <http://www.pact.cmu.edu/klinger/pubs/intelligent.pdf>.
- [2] "Numbering the Challenges in Engineering." Grand Challenges for Engineering. 2016. <http://www.challengesinengineering.org/challenges.aspx>.
- [3] Arphad, Anthony. "Python Web Frameworks". The Python Wiki. November 2, 2014.