This course exposed me to theoretical Computer Science research in improving and designing algorithms. It is composed of field work at the University of Maryland in summer 2016 and one semester further extension to establish a solid background for my thesis. In my field work, my groupmates and I created a new schema via graph theory and combinatorial approaches, and using this schema, we improved current approximation ratios for multiple online scheduling problems which have direct applications in multiple aspects of real life.

This semester, I carried on my summer field work to complete the writing of our publication. While at the same time, under the guidance of Dianna, this experiences of designing and analyzing algorithms helped me greatly to prepare for my thesis.

**Introduction**

- Obtain experiences in designing and improving algorithms
- Have a deeper understanding in working with and finding out theoretical problems that have great meanings in applications
- Preparing for the theoretical work in my thesis

**Problem Description—An Example**

![Diagram of concurrent open shop scheduling](image)

(a) An instance of concurrent open shop.

(b) The optimal schedule

**Course Objective**

- Obtain experiences in designing and improving algorithms
- Have a deeper understanding in working with and finding out theoretical problems that have great meanings in applications
- Preparing for the theoretical work in my thesis

**Accomplishments**

- Through this work, we obtained the first known competitive ratio for online coflow scheduling and greatly improved previous results on various scheduling problems.
- The publication has been submitted to Integer Programming and Combinatorial Optimization (IPCO 2017)
- This research set up a very solid theoretical background for me to start working on research in my most interested fields.

**Applications**

- Industrial manufacturing
- Distributed computing
- Operation Research
- Scenarios including online shopping, food ordering

**Challenges**

The most significant challenge I have faced in my summer research is that we spent almost seven weeks reading through literature about many problems to get inspiration, grinding various ideas to try to improve current analysis, and running a lot of random cases after implementing current algorithms, but still we had no solid improvements. I was really frustrated at that time and even started to doubt if there could be any improvements. After many active meetings with our mentor about our predicaments and the places we got stuck on analyzing our ideas, Dr. Khuller provided some really meaningful high-level suggestions and intuitions along the way. With his guidance and our experiences from these failures, we eventually got on the right path and made significant improvements.

**Learning**

The most significant learning I gained from this experience is the mentality that I should have toward the frustrations and failures that are inevitable in theoretical research, since people either formally prove a theorem or just spend a lot of time trying to tackle a problem but with no results. This experience let me realize that it is normal to have failures in a theoretical research regardless of the efforts. Yet, it is very important to keep calm and still hold the curiosity along this journey of learning and searching.