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New Applications of the Container Method

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Title: New Applications of the Container Method

Objective

Pursue new applications of the recently-developed container method in extremal combinatorics.

Summary of results

During the funded period I began an investigation into a new area of research: the so-called container method. The original plan of the proposal was to prove several new applications of this method and to collaborate with one of the method's inventors. Ultimately, we did not produce new research via the container method. However, as is often the case in mathematics, our pursuits lead in unplanned directions and the funded period ended up being very productive in two different (although related) research areas.

In October 2017 I visited Dr. Craig Timmons for a three-day visit to continue some of our previous work on extremal numbers in hypergraphs. We also used this short visit as an opportunity to discuss a number of potential future projects. This is an ongoing collaboration that has already produced one publication.

In November 2017 I hosted Dr. Daniel Gerbner of the Alfred Renyi Institute of Mathematics and Abhishek Methuku of Central European University for a two-week visit. During this visit we began a new investigation into Berge-Turan hypergraph problems. In the following summer I travelled to Budapest, Hungary to continue working with Gerbner and Methuku on this project. This travel was partially-supported by the UGP grant. Ultimately, this collaboration lead to a new manuscript titled "General lemmas for Berge-Turan hypergraph problems." In this manuscript we were able to give new short proofs and extensions of several previous results given by different authors. This paper is likely to be one of my strongest of the past few years and will be submitted to a top journal in combinatorics.

In August 2018 I hosted Dan Johnston of Grand Valley State University for a weeklong visit. During this visit we continued work begun when Dan was a visiting assistant professor at University of Montana. This is a joint project with my UM colleague Mark Kayll. In this project we are investigating a generalization of the so called hat-check problem. This project is still in progress, but our early results are exciting and lead to a particularly beautiful theorem. We are considering publishing this work in The American Mathematical Monthly which is a widely-read journal that is especially focused on results of broad appeal.