

DEPARTMENT OF MATHEMATICS

VIGRE Funding Report

(due 30 days after semester of support)

Semester/Summer and Year:

Name:

List the graduate courses you have taken this semester (including independent studies), your grades, and the instructors:

Course	Title	Grade	Instructor
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

List the title, date and location of any talks you have given, either here or elsewhere:

None

If you are working on your dissertation, include a one paragraph description of your research progress. If you have not yet begun dissertation research, describe your progress toward finding a dissertation topic and advisor and beginning that research.

I began working with Dr. Bayraksan in Spring 09, covering introductory material for my research. This project was meant to be a small introduction to the field of stochastic programming, and something for which we could generate some results fairly quickly. I like my introduction to the field so far: it combines probability with optimization, and has a good mix of empirical and theoretical work. I have also enjoyed working with Dr. Bayraksan, who I think could be a good candidate for my thesis advisor.

List publications, if any.

None during funding period.

Check all activities you completed during the funded period:

Academics:

- Independent Study
- Oral Comprehensive Exam
- Commence Thesis Research
- Conference attendance
- Conference participation
- Complete PhD

Professional development and outreach:

- AP Calculus Visit
- High School Workshops
- Undergraduate Research Project
- Undergraduate Research Seminar
- Super TA
- Mentoring junior graduate students for the qualifying exams
- RTG (help organize)
- Research Seminar (help organize)

Other (please specify)

Attach a brief statment about your academic progress and professional development during the period of support.

VIGRE Final Narrative Report

Summer 2009

David Love
Program in Applied Mathematics

September 8, 2009

1 Overview

This summer under VIGRE I began working on applying the method of overlapping batches for the estimation of sample variance in simulation output to the method of batches for the estimation of solution quality in stochastic programs. The research focused mostly on showing that this combination creates a useful method for better determining the solution quality in stochastic programming. Additionally, I spent some time working with a test problem, the newsvendor problem, testing our algorithm empirically. As a result of this work, I will be presenting at the INFORMS Annual Meeting in October.

2 Research Progress

During the summer of 2009 my research focused on attempting to combine results from two related fields. The first result, from simulation, is the use of overlapping batches of random variables as a means of reducing the variance of the sample mean point estimator. The output of a simulation run is random and often correlated with previous output. In order to minimize the negative impact of this correlation, the average value of a set of output data is used, so that the correlation of the averages is less than the correlation between data points. The second result, from stochastic programming, uses batches of i.i.d. random variables in order to obtain an estimate on the quality of some potential solution. Using the random samples as input, we solve a series of deterministic optimization problems, and use the results to estimate how close a proposed solution is to the true solution to the problem. In this project, we wish to apply the method of the overlapping batches to this method of assessing solution quality.

Assessing the quality of a solution to a stochastic optimization problem requires constrained optimization of sample means of functions of random variables. These functions often lack nice properties such as differentiability and continuity and the set of constraints can be non-convex. Furthermore, optimization of sample means significantly changes their

statistical properties—for example, the classical central limit theorem no longer applies. To overcome these difficulties, I have introduced non-optimized approximations to the point estimator and its associated variance estimator. The results from simulation can now be applied to these non-optimized approximation. Then I spent a large part of the summer trying to show the convergence of the optimized estimators to the non-optimized estimators, a result that I was able to achieve under fairly general conditions. This allowed us to prove that the technique borrowed from simulation achieves similar asymptotic variance reduction in this setting.

I have also tested this technique empirically on the newsvendor problem, and the results so far are fairly positive. During the fall semester, I will be testing this method on further stochastic programs. On the theory side, I will be working to show that the interval estimators formed by using this technique are asymptotically valid.

3 Professional Development & Outreach Activities

All of the outreach/vertical integration activities that I presented are to be completed during the Fall semester. Thus far, I have been to the organization meeting for the Tucson Math Circle, and accepted responsibility for writing the reports for each meeting.

I will also be presenting at the INFORMS Annual Meeting in San Diego on October 13. For this trip I have been awarded the H. E. Carter travel grant.

4 Conclusion

Over the summer of 2009, I made major headway into accomplishing my major research goals. I will be presenting this research in October, and I have come one step closer to having selected a dissertation advisor.