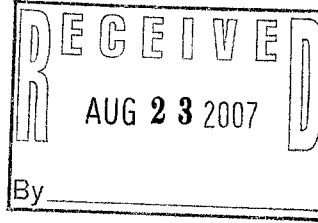


# VIGRE Funding Report

(due 30 days after semester of support)



Semester/Summer and Year:

Summer 2007

Name: Daniel Reich

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

Course	Title	Grade	Instructor

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

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.

Over the course of this past Summer, I made significant progress towards my goal of submitting a paper for publication during this Fall semester. Under the guidance of my advisor Dr. Leo Lopes, I completed a thorough literature review and identified prior publications related to our current research. I then began working on a computational implementation for solving instances of our model. With the assistance of Dr. Robert Indik, I developed a discretization algorithm that utilizes Fast Fourier Transforms. After comparing results from this algorithm to results from Monte Carlo sampling, I discovered inaccuracies present in my implementation. With the help of my advisor, I discovered a mathematical error in my algorithm, which was due to a faulty assumption I had made about the independence of random variables. This lack of independence transformed an equality into an inequality. Consequently, our method is not currently providing exact solutions, but is instead highly efficient in identifying relevant suboptimal solutions. Our central theorem, which guarantees that our problem can be solved in  $n$  steps, where  $n$  is the number of edges in a given graph, remains true. Therefore, we aim to modify and submit our work for publication in the coming weeks.

List publications, if any.

Check all activities you completed during the funded period:

Academics:

Professional development and outreach:

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

- 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 statement about your academic progress and professional development during the period of support.

# VIGRE Summer Report

Daniel Reich

August 22, 2007

My advisor Dr. Leo Lopes and I started this Summer with the goal of submitting a paper for publication by late August or early Fall. I dedicated the first couple of weeks to a thorough literature review and identified publications relevant to our research area. In doing so, I discovered that the model we had been working on over the course of the Spring had previously been identified in 1980 by Sigal et. al. [1]. While their work produced a theoretically interesting result involving a special kind of network cut, it does not make the problem significantly easier from a practical perspective, since at the end of their analysis the computation of a high-dimensional multiple integral is still required. Our contribution, in contrast, is to both identify a significant class of networks on which the problem is tractable and provide a corresponding algorithm.

I then began working on computations. With the assistance of Dr. Robert Indik, I developed a discretization of our algorithm that utilizes Fast Fourier Transforms. To validate our results, I wrote a Monte Carlo simulation. Validation revealed some inconsistencies, which required us to revise the algorithm as well as adjust the extent of our claims. Our research involves stochastic network flows, where some arc-costs have fixed cost and others have random cost. At one step of our algorithm, I made an independence assumption between random variables, which in retrospect I realize does not hold true in all cases. As a result, our current algorithm is no longer exact and is in fact a lower-bound solution, which in some cases provides an optimal solution.

Our central theorem, which guarantees that our problem can be solved in  $n$  steps, where  $n$  is the number of edges in a given graph, remains true, although some of those steps may be expensive. Therefore, we aim to submit our work for publication in the coming weeks. However, the nature of our method will change in one of the following ways: either by us presenting an efficient approximation method; or by us presenting an exact method, where the expensive step is replaced with a heuristic.

In addition to continuing my research in the Fall, I plan to use the continued VIGRE support to take part in undergraduate research and mentoring.

## References

- [1] C.E. Sigal, A.A.B. Pritsker, and J.J. Solberg. The Stochastic Shortest Route Problem. *Operations Research*, 28(5):1122–1129, 1980.