Acknowledgements

They say it takes a village to raise a child. Imagine how many people it takes to train a Ph.D.! Over the past five years, I have benefited from the solid support of two departments, members of the research community, and my family and friends. I want to thank you all for helping me arrive here at this milestone along my academic journey.

First and foremost, I thank my amazing wife, Katie, for her constant love and support. It certainly was not easy to put up with me while I was stressed about finishing, obsessed over a proof\textsuperscript{1}, or constantly checked computations. Katie took all this in stride, feeding me when I forgot to eat, pulling me away from work when I was frustrated, and convincing me that it would all be OK in the end. I can only hope that I can reciprocate this support as she tackles her own Ph.D. thesis in the coming year.

My most sincere thanks go to my advisors Stephen and Vinod, for taking me in as an over-eager graduate student and putting up with me for the past few years. You have given me more opportunities than I can count and for that I am very grateful.

Thanks to my committee members Jamie Radcliffe, Stephen Scott, and Christina Falci. Jamie, thanks for always being available to answer a question whenever\textsuperscript{1}

\textsuperscript{1}For example, the months of October, November, and December of 2011 were spent obsessing over the proof of Theorem 11.3, which fills 33 pages of this thesis.
I stopped by. It’s a shame we didn’t have the chance to work together more. Stephen (Scott), while you may not be aware of it, your description of the forward/backward algorithm for hidden Markov models during your Pattern Recognition course inspired much of the language used for the tabulation method in Chapter 5. Christina, I hope your experience on my committee has given you a nice view of what pure graph theory is all about.

Steve Goddard and Judy Walker both had significant impacts on my undergraduate career, helped guide me towards graduate school, and mentored me through my Ph.D. experience\(^2\). Steve, thanks for giving me my first research job, which got me hooked even though I had no idea what I was doing. I’ll never forget how you patiently\(^3\) mentored me for my undergraduate thesis, and how that changed my approach to completing this thesis. Judy, your combinatorics course gave me the first taste of what “real” math was like and convinced me to pursue graduate school in mathematics.

I also thank the faculty and staff at the Holland Computing Center, especially David Swanson, Brian Bockleman, and Derek Weitzel for their extremely helpful advice during the design, development, and execution of my software. Thanks to the Holland Computing Center and the Open Science Grid for providing access to significant computational resources, without which some of the results of this thesis would have less impact\(^4\). Further, I apologize for that time I crashed the Prairiefire supercomputer so badly the machines needed to be hard-rebooted\(^5\).

Thanks to Douglas B. West for allowing me to participate in the Combinatorics Research Experience for Graduate Students (REGS) at the University of Illinois at

---

\(^2\) I am also quite proud of being witness to both Steve and Judy’s transitions from humble associate professors to full professors and chairs of their departments.

\(^3\) I believe his first words after my defense were “I’m surprised you got this done.”

\(^4\) If I have seen further it is by standing on the shoulders of giant robots.

\(^5\) At least you have my executable available to test against your safeguards.
Urbana-Champaign. The contents of Chapters 4 and 9 originated as collaborations at REGS. Further, our collaboration provided me with a critical awareness of quality writing and that my writing leaves much to be desired.

To Michael Ferrara, who not only provides good problems but provides excellent company\(^6\). Thanks for inviting me to Denver to work on some truly interesting problems. I was flattered that you asked for my computational expertise towards your “white whale” problem, and I was not surprised that you solved it without my help.

To Paul S. Wenger, whose interests overlap with mine in too many ways to count\(^7\). Thanks for letting me stay with you whenever I’m in town, and know that you’re always welcome at my place. Also, thank you for telling me about unique saturation, where after months of work we know a lot more about the problem, but mostly we now know the problem is even more complicated than previously thought (see Chapter 11).

Thanks to Eric Allender, David Mix Barrington, and Lance Fortnow, three leaders of computational complexity, for treating a lowly, unproven graduate student as a colleague and friend. Sometimes, theoretical computer science can feel like a cutthroat and competitive research area, but you made me feel welcome. I plan to emulate your attitude towards young researchers in the future.

Thanks to my good friend, Joe Geisbauer, for always being available to listen to my problems, provide advice, and facilitate distraction (when appropriate). If anyone asks how to succeed in graduate school while maintaining sanity and focusing on living life in the present-tense, I don’t have the answers but recommend

\(^{6}\) Somehow, whenever Mike visited Lincoln, we ended up having a party at my house. Of course the rule was “do math first, eat wings later.”

\(^{7}\) If Paul and I are in the same town, we find a way to (1) go on a run, (2) do some math, and (3) go out for a beer (and not necessarily in that order).
they talk to Joe, who has the right idea. I must voice my enthusiasm for Joe’s most recent work in applied duck shield research\(^8\).

Almost every UNL math graduate student who attended from 2007 to 2011 should probably thank Zahava Wilstein, and I am no exception. In addition to being a very fun officemate, Zahava was a social catalyst in the department: hosting grad student parties, pursuing interactions with the quietest of grad students, and being an all-around pleasant person.

To my officemate and academic younger brother, James Carraher, who’s calm and quiet demeanor reminds me that you don’t need to be outspoken to have an impact. James is the kind of person that people pursue for help and advice, because he has all the answers, all the patience, and all the humility.

Thanks to all my comrades-at-arms (fellow Mathematics and Computer Science graduate students) that have made the graduate experience much more pleasant than it could have been.

Finally, thanks to all of my collaborators on projects finished and unfinished, written and unwritten, and published, submitted, in preparation, or to be finished another day: Pranav Anand, Chris Bourke, Jane Butterfield, Henry Escuadro, Brady Garvin, Raluca Gera, Ellen Gethner, Adam S. Jobson, Travis Johnston, André Kézdy, Elizabeth Kupin, Timothy D. LeSaulnier, Jared Nishikawa, Kevin G. Milans, Andrew Ray, Ben Reiniger, Tyler Seacrest, Hannah (Kolb) Spinoza, Brendan Stanton, Raghunath Tewari, and Matthew Yancey.

\(^8\)One of Joe’s research problems involved the integral \( \int_{0}^{1} Du(x + she_t)ds. \)