

# Research Proposal: Kolmogorov Complexity of Graphs

John Hearn

Faculty Advisor: Professor Ran Libeskind-Hadas

## 1 Introduction

I am currently enrolled in Complexity Theory (CSCI 142) and Graph Theory (MATH 104). Coincidentally both classes have allocated two weeks following spring break for an independent research project and I have chosen to integrate the respective requirements in order to dig deeper into a single topic where the subjects intersect. I believe this project will create a good foundation for senior thesis.

Kolmogorov complexity seeks to characterize the compressibility of some string  $s$  by finding the shortest program  $p$  (itself a string) that can generate  $s$ . My hope is to find some interesting implications for graph compression.

## 2 Proposed Research

Kolmogorov complexity is a subject of substantial breadth and depth. I expect the first semester of my thesis research to be spent exploring the field and any necessary prerequisite mathematics absent from my background. My hope is that by the second half of my senior year I will have sufficient mastery of the material to begin working on some known open problem, or to propose one of my own. Both Prof. Orrison and Prof. Ran have interest in the subject and can likely help me find some interesting problems reasonably within my abilities. After some initial research, it appears that very little has been published on the topic of Kolmogorov complexity of graphs, and so it seems quite promising that I will be able to do some original work. However, if after some efforts it seems to Prof. Ran and myself that I will not be able to make any substantial progress in the field in a semester's time, I will instead pursue an expository thesis exploring what work has been done already. In either case, I for see a rewarding experience.

### 3 Prior Research

I understand that Li and Vitányi’s text [2] is considered authoritative and will be my primary source for at least the beginning portion of my thesis research. I have found a dozen or so articles related to Kolmogorov complexity and graphs, but have only had the chance to take more than a cursory glance at one of them. They all appear very specific in focus except the rather generically titled “Graphs and Kolmogorov’s Complexity” by Fujii, *et al* [1]. After first reading that paper seems not to have pursued many topics to substantial depth. However, Fujii’s article does draw on several subjects not very familiar to me, so perhaps the implications of the article’s contents will be more impressive once I’ve had time to look into the necessary background material.

### References

- [1] Masatoshi Fujii, Masahiro Nakamura, Yuki Seo, and Yasuo Watatani. Graphs and Kolmogorov’s complexity. *Math. Japon.*, 44(1):113–117, 1996.
- [2] Ming Li and Paul Vitányi. *An Introduction to Kolmogorov Complexity and Its Applications*. Graduate Texts in Computer Science. Springer-Verlag, New York, second edition, 1997.