Please have your microphones muted.

This presentation will be recorded.

Thank you!
AGENDA

**Introduction:** Adam Kolkiewicz (Associate Dean, Graduate Studies)

**Presenters:**
- Professor Anita Layton (Applied Mathematics)
- Professor Richard Cook (Statistics and Actuarial Science)
- Nikhita Joshi (Computer Science)
- Matthew Lakier (Computer Science)
- Shayla Redlin (Combinatorics & Optimization)
INTRODUCTION

Why is your proposal a key part of the application?

- The evaluation of CGS D applications is based on the following criteria:
  - Research ability and potential  50%
  - Relevant experience and achievements obtained within and beyond academia  50%

Your research proposal is an important part of the assessment of your application. It is also the part that you are in full control at the time when you are preparing your application.
SOME INDICATORS OF...

Research ability and potential:
- Quality of research proposal
  - Specific, focused and feasible research question(s) and objective(s)
  - Clear description of the proposed methodology
  - Significance and expected contributions to research
- Ability or potential to communicate theoretical concepts clearly and logically
- Relevant training
- Research experience
- Quality of contributions
- Demonstration of sound judgment

Relevant experience and achievements:
- Scholarships, awards and distinctions (amount, duration and prestige)
- Academic record
  - Transcripts
  - Duration of previous studies
  - Program requirements and courses pursued
  - Course load
  - Relative standing in program (if available)
- Professional, academic and extracurricular activities
Your proposal should include the following elements:

▪ Background of your proposed research (e.g., key results and developments in the discipline).

▪ Formulation of the problems you want to explore, and why you want to do this.

▪ An outline of the research approach or methods that you believe are suitable for the proposed research. You may briefly discuss pros and cons of some of the approaches.

▪ Stages for developing the research.

▪ A list of references to key articles discussed in your proposal.

Think about your proposal as an opportunity to convince others that:

▪ You have a worthwhile research project

▪ You have the right preparation and skills to accomplish your goals
WHY LISTEN TO ME?

- I came from the US, used to write several grant proposals a year.
- I have won > $15M USD and > $3M CAD in grant funds.
- I am your Associate Dean for Research, which means I review ~50 NSERC Discovery proposals from faculty members every fall.
- And I love writing research proposals!
WHAT TO KNOW BEFORE WRITING

- Write it yourself, sincerity helps
  - DO NOT plagiarize!
- Use an active voice (“I will do this...")
- You can be vague, but not inaccurate
- Think about who is reading your proposal
  - Hint: Not you, not your supervisor
  - The reviewers are smart, but not in your area
  - They are tired and grumpy
  - They will not read between the lines
HOW YOU ARE READY TO WRITE

▪ You need to convince the reviewers that
  ▪ Your work is significant
  ▪ It fits in a bigger context
  ▪ You have a plan that you can execute and succeed
  ▪ You have specific goals
  ▪ Your goals are realistic

▪ Read the requirements for the proposal and address each of them specifically (use the same “buzz” words)
LET’S START WRITING

Thesis: Develop a method to deal with noise in machine learning datasets

- **Why** is your problem important? Set the context for research
  
  Noise can significantly impact ML accuracy, e.g., in medical data

- **What** you are going to do (what isn’t known)
  
  Develop a strategy to understand noisy training labels

- **How** you are going to do it
  
  Extend a method that your supervisor developed

- **Where** you will go: your work’s impact and future work
  
  Method can be applied to electronic medical records
IMPORTANT: WRITE ACCORDING TO THE SELECTION CRITERIA

Research ability and potential:

- Quality of research proposal
  - Specific, focused and feasible research question(s) and objective(s)
  - Clear description of the proposed methodology
  - Significance and expected contributions to research
- Why is your problem important?
- What you are going to do (what isn’t known)
- How you are going to do it
- Where you will go: impact and future work

- Ability or potential to communicate theoretical concepts clearly and logically
- Relevant training
- Research experience
- Quality of contributions
- Demonstration of sound judgment
IMPORTANT: WRITE ACCORDING TO THE SELECTION CRITERIA

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  - Clear description of the proposed methodology
  - Significance and expected contributions to research
- Ability or potential to communicate theoretical concepts clearly and logically
- Relevant training
- Research experience
- Quality of contributions
- Demonstration of sound judgment

- Write clearly, for a smart person not in your field
- Ask your supervisor to read your proposal
- Ask your friends to read your proposal
IMPORTANT: WRITE ACCORDING TO THE SELECTION CRITERIA

Research ability and potential:

▪ Quality of research proposal
  ▪ Specific, focused and feasible research question(s) and objective(s)
  ▪ Clear description of the proposed methodology
  ▪ Significance and expected contributions to research
▪ Ability or potential to communicate theoretical concepts clearly and logically
▪ Relevant training
▪ Research experience
▪ Quality of contributions
▪ Demonstration of sound judgment

▪ Highlight your publications
▪ No publication? Play up your presentations
FINAL POINTS

- Start early
- Directly address all the selection criteria, write specifically for that scholarship
- Get people to proof-read your proposal (writing style matters!)
- Get your supervisor to read it
- Get your committee members to read it
- Get your favorite professors to read it
- Get your friends to read it
PROFESSOR RICHARD COOK

Department of Statistics and Actuarial Science
MY BACKGROUND

BSc, Statistics, McMaster University, 1988
MMath, Statistics, University of Waterloo, 1989
PhD, Statistics, University of Waterloo, 1993

Medical Research Council of Canada, Scholar Award, 1995 - 2000
Premier's Research Excellence Award, 1997 - 2003
Canadian Institutes for Health Research, Investigator Award, 2000 - 2005
Tier I Canada Research Chair, 2005 – 2019

Currently, I am

Professor of Statistics
Faculty of Mathematics Research Chair
University Professor
WHAT CAN YOU DO LEADING UP TO YOUR NSERC APPLICATION?

Take (or make!) opportunities during graduate studies

- start a Graduate Student Seminar Series
- organize an *invited speaker session at a conference*
- organize a "*Research Day*" in your department to profile graduate student research
  - invite participation from local universities
- get involved in *outreach activities*
EXPERIENCE

Ideally you have some experience from your undergraduate or Master’s program

Describe in detail emphasizing

- relevance of problem
- STEM aspect of research
- what you did and how it addressed the research question
- the impact of the work

*Do not be modest* – this is a very competitive process (but keep it real!)
PROPOSAL

Title
Make the title clear and explicit

Starting Out

Clear statement of problem(s) to be addressed
Give rationale for why the problem is important show your research will have impact

Give a brief overview of how you will address it

Ideally you can point to experience, knowledge or skills that position you to address the challenges
Literature Review

Be sure to cite all relevant work and discuss briefly the most relevant. This demonstrates your familiarity with the area and gives you credibility. It also helps you position your proposed research as meeting a need.

The Research Plan

Consider breaking the problem into sub-problems or consider a staged approach to the research. This enables you to articulate short- and long-term objectives. Get input from as many knowledgeable people as you can. Be ambitious but realistic. Find ways of suggesting you are well-equipped to tackle the planned work.
Make It Professional

Make it logical and coherent and compelling

Polish and perfect the writing

Be enthusiastic but use a scientific writing style

Pay attention to formatting

Use available space – you want to explain as much as possible that you are worthy of the investment so limited space should be a problem for you
GENERAL REMARKS

Get a copy of a successful application if you can

Polish and perfect

Do not leave this to the last minute – it will be evident

You are requesting money to support you while working in your chosen field – it is a privilege to do so, so take the competitive challenge seriously

A challenge is to give the details of what you are working on, but also make it reasonably accessible to readers/reviewers who are outside of your field
ABOUT ME

- 1st year PhD student (CS), in human-computer interaction
- Research focus: using spatial augmented reality to create smarter, everyday objects
- MMath at UW (2017-2020)
- B.Sc at Mount Allison University (2014-2017)
- Originally from New Brunswick!
RESEARCH PROPOSAL

- Find a good “starting point”
  - PhD Personal Statement
  - I focused on depth over breadth

- Extend it in an outline document (bullet points)
  - Problem (why do you want to do this?)
  - Goal (what do you want to do?)
  - Related Work (what has already been done and how is it different?)
  - Methodology (how will you do this?)
  - Significance/Impact (how will this impact the field?)
RESEARCH PROPOSAL

- Write the proposal!
  - Don’t worry about the page limit at first, just write
  - Google Doc with the Zotero plugin

- Find a “buddy”
  - Use the “suggestion” and “comment” features
  - Do multiple edits of each other’s work

- Ask friends if you can read their previous proposals

- Ask your advisor, family members, and friends to provide feedback

- Proofread, edit, proofread, edit, proofread, edit...
CONTRIBUTIONS TO RESEARCH AND DEVELOPMENT

- Follow the outline on NSERC’s website
- Justify the venues
  - Conference papers are preferred over journal articles in computer science
- 1 paragraph summarizing the work and the contributions, 1 paragraph talking about what you did
  - Focus on what YOU did
  - Try to find a way to connect it to your proposal

NSERC’s outline
APPLICANT’S STATEMENT

- Write this section with your CV/brag document open (more on this later...)
- Focus on aspects that are not as well-captured through your publications
- Ask yourself “so what” often
  - Tie it back to your research proposal
- Once again, swap with your “buddy” often
REFERENCE LETTERS

- Create (and maintain!) a **brag document**
  - I generally edit mine once/month
- Why do this?
  - Lots of little things you will forget about
  - Your references won’t know about everything you’ve done (e.g. staying late to help a friend)
  - Essentially a “cheat sheet” and “evidence” your references can use to create a strong letter
- Use the selection criteria NSERC provides as headers, “evidence” as bullets
MATTHEW LAKIER

School of Computer Science
ABOUT ME

▪ Currently in the Human-Computer Interaction (HCI) Lab

▪ PhD from Bachelor’s
  ▪ Applied to NSERC after 1st PhD year

▪ Graduated from EngSci at UToronto

▪ HCI-related research internships every summer since 1st year undergrad
  ▪ Funded by awards (listed these in NSERC application)
  ▪ Had 1 journal article (1st author), 3 full conference papers (1 as 1st author), 1 short workshop paper when applying
OUTLINE OF PROPOSED RESEARCH

Process

- Pre-existing notes:
  - research ideas
  - summaries of related work
  - partial results from current experiments
  - things I didn't like about “the way things are” or “the way things are going” that I thought I could tackle
- Looked at example proposals to get an idea of content and structure
- Mind-mapping to think about order in which to present research questions and ideas
- Few, long iterations when writing
  - Supervisor gave high-level feedback on early draft
  - My main challenges: integrating enough related work; staying within the page limit
OUTLINE OF PROPOSED RESEARCH

Structure and Content

- Many past proposals had 1 central research question, which was elaborated on and grounded in dedicated background and related work paragraphs
- My ideas were distinct (e.g., a VR project, a longitudinal study); wanted to maintain this level of detail
- Ordered my ideas in sequential way (using mind map) to make a “story”
OUTLINE OF PROPOSED RESEARCH

My structure:

- Motivation and background (1 par)
- General related work (1 par)
- Overall research goals (1 par)
- Research questions in detail (1 for each, 5 total), including:
  - Specific background
  - Related work
  - Hypotheses
  - Methodologies (mostly in-line with past work during internships, and ongoing projects)
- General implications (1 short par)
- Tried to tie in (concepts from) my past projects where possible
MOST SIGNIFICANT CONTRIBUTIONS TO RESEARCH AND DEVELOPMENT

- Discussed two undergrad summer internship projects
- Emphasized related important ideas (e.g., safety in relation to computer based instruction manual)
- Mentioned citation/download counts for publications, and contextualized the venues (“top-tier”, “known for X”, etc.)
APPLICANT’S STATEMENT

Research experience

- Discussed what I learned from my undergrad thesis and research internships

Relevant activities

- Discussed experience as TA, undergrad club leadership involvement, and a leadership award my team won for our undergrad capstone project
ABOUT ME

- 3rd year PhD student in Combinatorics & Optimization
- I won an NSERC CGS-D last year
  - I applied in 2018 right after finishing my Master’s
- I previously won an NSERC CGS-M and an OGS
REFeree REMinder

- If you haven’t already, contact your references now
- Your references can provide evidence for your research ability and other relevant experiences, such as teaching
- Even if they know you very well, send them:
  - CV/transcripts
  - Research Proposal
  - Contributions and Statements
  - NSERC webpages (e.g. “Help for referees” page)
HOW TO CHOOSE A PROPOSAL TOPIC

- Discuss possible topics with your supervisor
- Recall areas of research and open problems from talks or conferences
  - Many are online now, so it should be possible to watch some past talks if necessary
- Discuss possible topics with other faculty or upper year students
- It’s okay if you end up researching a different topic
  - The goal is to show that you can come up with a reasonable and relevant research project
GENERAL ADVICE

Research Proposal

- Get it edited
  - Ask your supervisor, another faculty member, and/or a peer
- Keep the “Instructions for completing an application – Form 201” webpage and selection criteria in mind as you write
- Look at the sample successful proposals that UWaterloo provides
- Look up who will be reviewing your application
  - Mathematical Sciences is Committee 177
Complexity of Colouring Graphs with Forbidden Subgraphs

Graph colouring has been studied since Guthrie proposed the famous Four Colour Conjecture in 1852. The conjecture stumped researchers for over 100 years until it was finally proved in 1977 by Appel and Haken. Graph colouring is known to be computationally intractable; however, significant research has been done regarding the complexity of colouring various graph classes. I propose solving several open problems concerning the colouring problem on classes of graphs defined by forbidding induced subgraphs.

**Motivation.** A k-colouring of a graph is an assignment of k labels or *colours* to its vertices such that no two adjacent vertices are assigned the same colour. We refer to the problem of deciding if a graph has a k-colouring as k-COL. It is well known that k-COL is NP-complete for k \( \geq 3 \) and, in practice, k-COL is computationally hard. In real world applications we often know some structure about the graphs being used, so in order to make progress in these applications, we can exploit the structure that arises. A natural method is to restrict the input graphs in some way, such as by forbidding some induced subgraphs.

**Recent Progress.** We say a graph G is H-free if G does not contain H as an induced subgraph. It is known that k-COL is NP-complete, for each k \( \geq 3 \), on H-free graphs when H contains a cycle or is a forest with a vertex of degree at least 3. The remaining case is when H is a linear forest, so recent research has focused on the case where H is a path. Results from Huang in 2016 almost finish classifying the complexity of k-COL for P_t-free graphs, leaving only the cases where k = 4, t = 6 and k = 3, t \( \geq 8 \). In 2018, Chudnovsky and Stacho made progress in the latter case by showing that there are finitely many “k-critical” P_t-free graphs with certain forbidden cycles. Here, a graph is k-critical if it is not k-colourable, but all proper induced subgraphs are. Since k-COL is in class F, a natural next question is to ask when k-COL is NP-complete for (H_t, H_s)-free graphs, that is, graphs which do not contain H_t or H_s as an induced subgraph. One method is to ask when (H_t, H_s)-free graphs are k-colourable, for k \( \geq 3 \). The case where k = 3 is well studied, but not much is known when k \( \geq 4 \).

**Objectives.** I propose the following research objectives:

1. Determine the complexity of 3-COL for P_t-free graphs when t \( \geq 8 \).
2. Determine the complexity of k-COL for (C_t, H)-free graphs when k = 4, t = 6, and s \( \geq 6 \).
3. Determine all pairs (H_t, H_s) that have the property that every (H_t, H_s)-free graph is 4-colourable.

**Methodology.** Although Objective 1 might be very difficult to solve, I will continue to make progress by using methods similar to that of Chudnovsky and Stacho: studying critical graphs and forbidding more subgraphs. For instance, I will determine the 3-critical (P_t, H)-free graphs where H differs from the other forbidden subgraphs that Chudnovsky and Stacho used. Similarly, I will begin making progress on Objective 2 by forbidding more than two subgraphs and studying 4-critical (C_t, P_t)-free graphs where s \( \geq 6 \). To make progress on Objective 3, I will use variations of the colouring problem, such as list colouring and pre-colouring. From my master’s research, I have experience working with critical graphs. Additionally, my master’s thesis and undergraduate honours paper included complexity results for acyclic colouring and fractional colouring, respectively.

**Impact.** Solving these research objectives will contribute to closing the complexity gap for k-COL on graphs with one or two forbidden subgraphs. Furthermore, conducting this research will greatly contribute to my development as a researcher since complexity theory and colouring are cornerstones of graph theory.

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- Make it clear and easy to read
  - Get right to the point
  - Use headings and white space
  - My headings line up with the selection criteria

- Try to make it self-contained
  - I had a one-page limit, so I assumed the readers knew what a graph was, but I defined graph colouring
GENERAL ADVICE

Contributions and Statements

▪ Get it edited!
  ▪ Mine was read by my partner and my parents

▪ Make it clear and enjoyable to read
  ▪ Use headings and white space
  ▪ Include anecdotes that provide evidence of the selection criteria

▪ Follow all formatting requirements

▪ Have the “Instructions for completing an application – Form 201” webpage and the selection criteria open as you write
  ▪ I started by writing a list of relevant experiences and then condensed it into a few paragraphs so that each criterion was addressed
Contributions and Statements

Part I – Contributions to research and development

b. Articles submitted to peer-reviewed journals


d. Non-peer-reviewed contributions

Oral Presentations - International


Oral Presentations - National


Poster Presentations - Institutional


Part II – Most significant contributions to research and development

1. The oral presentation entitled “The Firefighter Problem for All Orientations of the Hexagonal Grid.”

In 2014, I was nominated for a Jamie Cassels Undergraduate Research Award (JCURA) by Dr. Gary MacGillivray. The nomination was successful and we researched the firefighter problem from September 2014 until March 2015 in preparation for the JCURA research fair. In addition to presenting a poster at the fair, Dr. MacGillivray and I co-wrote a paper and I also presented in the research at the 2016 Canadian Undergraduate Mathematics Conference (CUMC). I chose to present this research at CUMC 2016 because of the audience: undergraduates. Our result is interesting, but easy to state and explain, so my talk was accessible to my fellow undergraduates. The proof strategy relies on a paper by Gavenčik, Kratochvíl, and Pulář to avoid excessive case work. The idea of how to use the result from this paper was particularly exciting since it came to me in the middle of the night, as I was falling asleep. This research is important because it answers an open question in the area and demonstrates the impact of a directed grid (as opposed to an undirected grid) on the firefighter problem.

2. The paper entitled “Complexity of Proper Frugal Colouring.”

From September 2015 to May 2016, I researched frugal colouring with Dr. Gary MacGillivray as part of my Honours Degree requirements. This resulted in my honours paper and a seminar presentation. Dr. MacGillivray continued the research we had done with his PhD student, Stefan Bard. Stefan used some of my work to write the paper that we submitted earlier this year. Luckily, Dr. MacGillivray, Stefan, and I were all able to meet in person before the paper was submitted, so I was also able to assist in editing the paper. We chose to submit the paper to the Journal of Combinatorial Mathematics and Combinatorial Computing because our results align with the focus of the journal. Frugal colouring is a generalization of the well studied topic of injective colouring. Our paper contributes to the math community by answering several questions about frugal colouring that have already been studied for injective colouring.

3. The oral presentation entitled “Acyclic Colouring of Graphs on Surfaces.”

This presentation was on the topic of my Master’s thesis, so in order to avoid repeating information from the Thesis Summary, I will not include much detail here. However, I feel a list of my most significant contributions would be incomplete without mentioning my most significant result. The main result of my thesis is important because it is a non-trivial acyclic analog of a well-studied and impactful colouring theorem and the proof uses a clever reduction. I chose to present this research at the 2018 SIAM Conference on Discrete Mathematics because it is a well-known, high caliber conference and because I was invited to by Dr. Debra Boutin, one of the mini-symposium organizers.

Part III – Applicant’s statement

Research Experience

I have completed three major research projects: two as an undergraduate student, and one as a Master’s student. Two of the most important research skills I have developed from these experiences are writing and critical analysis. More specifically, I gained experience studying topics in graph theory, graph colouring, and complexity theory which will be useful when conducting my proposed research.

In addition to these research projects, I participated in two co-op work terms, one of which was as a Research Assistant for the Canadian Centre for Climate Modelling and Analysis (CCMa) division of Environment Canada. A large portion of my time with CCMa was spent creating and developing a tool that retrieves the output of a climate model and presents the data in a collection of graphs. I developed my programming and algorithm analysis skills while creating this tool and I practiced my technical writing skills while creating the documentation for the tool and completing my work term report.

Relevant Activities

One of my favorite parts of being a university student is being able to teach and mentor younger students. As a Teaching Assistant, I have developed strong communication, interpersonal, and leadership skills by leading tutorials, marking, and assisting students in small groups during office or tutorial centre hours. I have also mentored students as a high school math and science tutor. Each term of my undergraduate degree, I tutored between one and six high school students weekly. Two students in particular I tutored and mentored for four years each. I am proud to say that both are now in university and one is studying computer science, despite saying that she disliked math when she was in grade 9. In fact, supporting women in math has become a recent passion of mine and I have recently joined the Women in Mathematics committee at the University of Waterloo.

I believe it is important to recognize the help I have received from my communities and give back to those communities as often as possible. One way I have done this is by serving as Computer Science Course Union (CSCU) member at the University of Victoria for one year. As a CSCU member, I used my organizational and communication skills to help plan and advertise events for computer science undergraduates. I was also a member of the 2016 Canadian Undergraduate Mathematics Conference (CUMC) organizing committee. Using my interpersonal and research skills, I worked in a group of about 15 students to plan and oversee the conference. Another way I gave back to my University of Victoria community was to volunteer as a note-taker for the Resource Centre for Students with Disabilities for several terms. After rowing competitively for five years in high school, I worked and volunteered as a rowing coach for three years, which greatly contributed to my leadership skills. More recently, I gave back to the larger mathematics community and developed my written communication skills when I reviewed a paper for the journal “Discrete Mathematics” earlier this year.
Thank you and good luck!