# Next steps

## Context

I receive applications from more than 250 candidates per year and typically accept 1-3 students per year, of which 1-2 come from those inquiries and 1-2 come from previous summer-interns that have been a good fit in my team. Students take an average of 2-4 years to graduate, which means that I typically have 6-10 students that I directly mentor at any given time within our tight-knit, supportive group of 20-30 IBME students. I develop a mentoring plan that is flexible to the needs of each student, which typically involves a weekly 1-hour one-on-one meeting (which equates to 6-10 hours of my week), in addition to topical group meetings (such as our Controls group meeting), and my own time spent reviewing papers that are foundational for students, working in parallel with students, and reviewing student documents (proposals, theses, conference manuscripts, journal manuscripts, etc…). Mentoring thesis-based graduate students is one of the most important aspects of my research and is a joy to me, but accepting a student accordingly signifies a substantial investment of my time.
 In addition, I typically pay my students a stipend, which must come from finite grant resources that are obtained through a combination of innovative ideas, hard work, persistence, and luck. In summary, efficiently choosing 1-3 students each year to join our team is accordingly a difficult but important process, given the time and financial cost of that student, but also their importance towards furthering our field and its impact on the world.

Over the years I have tried to figure out “*what makes a good graduate student in my team?*” By “*good*”, I mean that supervising them frequently brings joy and a sense of wonder to their life and mine; results in them contributing research that impacts the world; enables them to move on successfully to the next step in their life; and leads to momentum and publications in the area of research, paving the way for the next cycle of students in that area.
 Undergraduate grade-point average is *not* a useful predictor—graduate-based research is different in so many ways, and many high-grade undergrads have never had to deal with failure (which inevitably comes in graduate-based research). Strong endorsements from my close collaborators typically *is* a useful predictor, but in recent years many understandably prefer to keep those students in their own labs. I rely heavily on undergraduate internships (which give me a chance to assess students in a research setting), and typically 1-2 of my 1-3 students per year come from that cohort. For the remaining 1-2 students, I have come to rely on a 3-part process to make decisions that seems to work well for them and me.

## Phases of the process

The first part of the interview process involves a series of questions that I have iterated over time to answer the question “what makes a good graduate student in my team”. The purpose of these questions is to better understand your background and perspective. There are no right or wrong answers for most questions, but the way in which you answer the questions gives me insight into how serious you are about working with me and the way that you are likely to approach research. I have a diverse group of students in my team, many of whom approach life and research differently, and I believe that our research is made stronger and more impactful by recruiting diverse perspectives. So don’t worry if you think your answer is not what I’m looking for – chances are that as long as you were thoughtful and articulate, I’ll be impressed (and in many cases, you might be surprised by what I deem a good answer).
 Answering these questions will likely take 1-3 hours. I realize that is a large commitment. But given that it may result in relocating to do research for the next 2-5 years of your life, I think it is a reasonable level of commitment to expect in this phase.

I often share a subset of those responses with a subset of my research team (staff and students), because I want to make sure that we recruit a diverse group of students (if I was the only one evaluating, I’d likely subconsciously choose those who thought similar to how I think). Although I make the final decision, I find that others are often able to highlight things in ways that sway my decision.

In part 3, based on responses, I invite 3-6 students to have a web-based interview with me, in which we discuss possible areas of research and follow-up on questions (as a two-way dialogue).

Based on those interviews, I invite 1-3 students to work with me, typically offering them a stipend. I am always happy to work with students who have their own funding or are eligible for Canadian scholarships, but this factor does not significantly influence the decision of whom I accept – the largest “cost” of a student is not the stipend, but the investment of time in helping them to perform meaningful research.

Given that context, I invite you to complete Part A, B, and C and return to me for consideration in joining our team. Please remember to include the term PGSJWS in the subject line of your e-mail to ensure that it is appropriately flagged by me. I review submissions in batches, and depending on the time of year it may take several months to warrant reviewing a batch, so please wait patiently and rest assured that I will assess your submission.

# Part A – Getting to know you

1. In 6-8 sentences, tell me about a skill that you obtained that required independent effort on your part (vs. passive education in a classroom). What was the skill? Why did you want it? How did you develop it? How long did it take? What was the hardest part? Are you still learning, or have you mastered it? If you are still learning, how are you actively ensuring that you improve? The subject does not have to be academic; it could be a sport, a musical activity, or something else.
2. Describe a recent non-technical book that you enjoyed reading. How did you choose it? What did you like about it? When did you read it? How many days/weeks did it take to read?
3. Describe the most recent video game you have played. When did you start playing it? How did you choose it? What did you like about it? How many hours per week do you play it?
4. Tell me about a time when you were responsible for taking care of someone or something (e.g., a child, a friend, an elderly person, a pet, a piece of equipment, etc.).
5. Give me an example that shows your ability to be disciplined in doing something.
6. Give me an example that shows your habit of being an active, life-long learner.
7. Give me an example that shows your ability to apply metacognition (thinking about one’s thinking) to your life.
8. Give me an example of something at which you failed (6-8 sentences).
9. Tell me about a time when you disagreed with your supervisor or boss. What happened? What was the root of the problem? What was the resolution?
10. What do you think is your greatest strength pertinent to earning a graduate degree? Please describe a time when this strength was demonstrated in your previous experience.
11. There are many aspects to a graduate degree that you may not have experienced in an undergraduate degree: *Learning the academic culture and pace of a new place; getting insight from others; working independently by yourself; learning the literature; coming up with a good research problem; deriving theories that solve it; designing equipment and experiments to test it; statistically analyzing the results; clearly and succinctly communicating your vision and results to others, etc.* Everyone has strengths and weaknesses. In a 6-8 sentence paragraph, describe the facet that you are the most worried about.
12. Thoughtfully observe the following painting by Colidge for a period of 60 seconds without taking any notes. Then write an observation.



*Painting by Colidge, public domain.*

# Part B – Assessment of skills

1. Let’s start with some basic questions (these have correct answers, but they are not trick questions)
	1. A pencil and ruler cost $1.10 in total. The ruler costs $1.00 more than the pencil. How much does the pencil cost?
	2. If it takes 5 grad students 5 months to write 5 papers, how long would it take 100 grad students to write 100 papers? 100 months OR 5 months?
	3. On an island, there is a patch of wildflowers. Every year the patch doubles in size. If it takes 48 years for the patch to cover the entire island, how long would it take for the patch to cover half of the island? 24 years OR 47 years?
2. Choose your favourite technical journal article and provide the reference. Imagine that you have done your own research, which builds on that work, and that you are writing your own journal paper. Write a 6-8 sentence paragraph that occurs partway through the introduction section of your imaginary paper. The paragraph should not focus on that journal article, but the point you are making in that paragraph should be supported by that journal article and should reference it.
3. *Assessing your ability to think analytically and creatively*. Many different experiences can be modeled as a feedback control diagram. Let’s take an example that most are familiar with – the process of a professor teaching a topic in a classroom setting.
Using a controls framework:
	1. mathematically model this activity across lectures
	2. assess the stability
	3. offer tips to improve performance
4. *Assessing your ability to problem-solve / debug*. You don’t need to spend more than half an hour on this question.

**Framework of the CMC model:**

Imagine that people’s behavior in making ballistic movements with only endpoint feedback can be described as a filter that balances where you expected to land and where you observed that you landed:

Where is the target position, is where you land on trial and is your observation of where you land on trial . Where you land depends on your control signal for that trial (, multiplied by the actual gain of the system and corrupted with Gaussian noise with 0 mean and variance . The observation is corrupted with Gaussian noise with 0 mean and variance . Your posterior estimate of where you landed ( is based on your prior estimate of where you intended to land (), along with the error you observed (, weighted by the filter gain of how much you trust your observation relative to your prior. The uncertainty associate with your posterior estimate is .

Assume that the control signal you generate is based on your estimate of :

where is your estimate of . After every trial, when you realize you didn’t hit the target, you will probably adjust your control signal on the next trial by updating your estimate of . Let’s imagine that your update of that parameter can be modeled as another filter:

Where is the filter gain of your update, and is based off the ratio of a fixed constant that depicts how confident you are in your prior estimate of the parameter, along with the confidence you have in your final estimate of your observation (.

It seems reasonable to assume that the confidence you have in your final estimate of your observation is equal to the uncertainty associated with your sensory measurement plus the uncertainty of your movement: .

**Overview of the CMC model**

This model describes how much you update your parameter each trial. The amount that you update your parameter depends on several factors, such as the amount of error you observed , the amount of control noise in your system , the amount of sensory noise in your system , and the amount of uncertainty in your prior estimate of the parameter . The effect of each of those parameters on how much you adapt should be pretty intuitive.

**CMC Question:**

There is a mistake in this model. It predicts some behaviours that don’t make intuitive sense. Play around with the model, and see if you can spot what doesn’t make sense. You don’t have to fix it, I just want to see if you can spot the problem. Whether you figure it out or not, describe your thought process and the things that you worked on to understand it. Remember – even dead-ends and failures are great ways to learn, and in this exercise I am more interested in your metacognition than your cognition, so talk me through the exercise as if you were thinking out loud, even if it ends in several dead-ends.

# Part C

1. Being mentored in a graduate program is a two-way street. You should be asking tough questions of potential supervisors too, including things like (will I get paid, what is your mentoring philosophy, where do your students typically go after finishing their thesis, what is the environment in your lab, etc). I encourage you to ask some questions along those lines, which we can discuss via an online meeting should the opportunity arise.