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mastHEAD

"WHAT ASPECTS OF YOUR LIFE HAS CORONAVIRUS MADE YOU RE-EVALUATE?"

Oh, hi. I didn't see you there. What brings you here? Hm? This is an issue of **mathNEWS**? Issue 2 of volume 143? My goodness — I thought I was somewhere else. How do I get out of here? Actually, scratch that — that's a problem I can deal with later. It's sort of cozy and warm here and it's not so lonely anymore now that you've shown up.

Let me just look ahead this issue to see what's in it, since you've piqued my curiosity. Looks like we have some **mathASKS** on the next page from Professor Gregor Richards. Do you love JavaScript? Hate it? Either way, it's worth giving it a read.

Now just having skimmed through the rest of the issue, it looks like we've got the usual **mathNEWS** content that we all know and love. Of course, there's the expected N-things listicles and playful riffs on PD. This may be a surprise to you, but there's even a small (but quality) collection of **profQUOTES** on page 17. On the last page, there's a Problem of the Issue from PMC. I think I even saw something about a prize.

Well, I don't want to tell you any more things about the issue. You should go read the rest of it on your own without me spoiling it for you. Don't think I'm trying to shoo you away or anything; I'll be sad to see you go. However, don't let that stop you from moving on. This won't be our final farewell — I'm sure we'll meet again on this **mastHEAD** someday.

That is, if I can remember how I ended up here in the first place...

Hmm. I still need to figure out how to get out of here. Do you have any ideas? No? Well that puts me in a pickle. Mmm, pickles. I didn't like pickles as a child but now I do. I could really go for a nice big burger right now — the kind where the patty just melts into indulgent puddles of grease in your mouth — topped with juicy, crunchy slices of pickles. Uh oh. Can you tell I'm hungry? There's no food around here and it's almost supper.

Oh, wait! I've found the exit! It's just further down the page! This is where we must part ways, friend. Goodbye! Adieu!

clarifiED
Editor, **mathNEWS**

George Lambrou	Leaving **mathNEWS** is the greatest mistake I have ever made.
tendstofortytwo	Maybe I'm more of an extrovert than I once thought…
cc	Despite how long some in-person lectures might seem to drag on in the moment, they're downright parties compared to watching lecture videos.
Sandwich Expert	I miss MC.
Finchey	I need to terrorize the donkeys in Waterloo Park by making funny faces at them as they peacefully graze like I need air.
A cool pen name	Can I officially change my star sign? I'm a Leo at heart now.
boldblazer	WP:CRYSTALBALL has never been more clear and evident in why it is in place, and that it can be helpful to also extend it to apply in real life, which probably says a lot.
Cix	I've realized I'll never get back to drawing comics for **mathNEWS** even when I have nothing else to do. I think I literally have no more ideas.
Jeff	I am completely clueless as to what I'm going to do now with the 6 months I had set aside for planning the Great Isogeny Heist. I was so close.
A Mathemagical Psychic And Astrologer	Is Zuko's scar really on the right side?
clarifiED	It's easier to adjust to new things than I thought. Things are less rigid than they really seem.
god ϟ peED	This office chair is not at all comfortable.

ARTICLE OF THE ISSUE

This week's article of the issue goes to *N Positive Vibes from your Past Life in Waterloo*, by royal no.69 milk tea. Thanks for reminding us all of better days gone by, as well as the Sweet Dreams slander and C&D appreciation we always need in our lives.

Unfortunately we've donated your gift card to COVID-19 vaccine research. I'm sure you understand. $25 buys a lot of lab equipment. and the faster this research gets done, the faster all of us can get back on campus and not drink Sweet Dreams bubble tea.

god ϟ peED
Editor, **mathNEWS**

Sayonara, Shadow the Hedgehog.

CLARA XI, mathNEWS EDITOR FOR SPRING 2020
ALONG WITH JAMIE ANDERSON, JOSH RAMPERSAD, AND KEVIN TRIEU

mathASKS 143.2

FEATURING PROFESSOR GREGOR RICHARDS

CIX: BACKSTORY BEHIND THE HATS?

It's extremely boring: When I graduated from elementary school to middle school, my elementary school had had a no-hats policy, but my middle school did not. I decided to take advantage of that, and started wearing a fedora. Then, switching between a fedora and a beret. Then a trilby, then a homburg. After you have three or four hats, hats tend to find you, and suddenly you're a hat guy.

I've always found it amusing that I can make the rest of my attire arbitrarily eccentric, and yet it's still the hats that get focus.

Also, a side benefit to having been a hat person for two decades is that I can bald in peace.

πLLOW PRINCESS: WHERE IS YOUR FAVOURITE WASHROOM ON THE NOW CLOSED CAMPUS?

I have no memory of this place. I hear tales of some place called "The Campus" in the Before Times, but how can the Before Times be real if time isn't real?

CLARIFIED: WHAT'S YOUR FAVOURITE MEAL TO COOK?

I cook most of my own meals, but it would be wrong to suggest that I enjoy cooking. I enjoy good food, and tolerate cooking as the way of getting there. So, my favorite meal to cook would just be my favorite meal to eat, with the cooking being the annoying but necessary task to get there.

My favorite foods are mostly Southeast Asian, and more specifically Thai, and I make an incredible Massuman curry. A lot of Thai restaurants make their curries far too sweet, which is an easy mistake to make since Thai curries use coconut milk as a base. But, good food is about the balance of the basic flavors — sweet, salty, bitter, savory, sour — and getting that balance right is the difference between an acceptable meal and a great meal. Next time you go to a Thai restaurant, if the curry's too sweet, ask for a bottle of fish sauce; your meal will be better and more well-rounded.

I actually come from a family of cooks. My maternal grandfather was a professional chef, and the things I most learned from him are the shortcuts and tricks that would never occur to an amateur cook. You wouldn't want to use bouillion to make a full meal's worth of soup, but there's no reason not to use it to bulk up or add flavor to a soup or sauce. Marinara too sweet? Add soy sauce. Gravy doesn't have the depth you want? Add MSG. I always have a shaker full of a mix of salt, MSG, garlic powder, and pepper, and use that as an almost-universal seasoning.

(Aside: There's nothing wrong with MSG. It's a salt. The various movements against it are fueled principally by racism and stupidity.)

TENDSTOFORTYTWO: WHY JAVASCRIPT?

If you thought my answer to the last question was surprisingly long, buckle up!

There are so many different angles I could take here, so I'm just going to answer this question from four different perspectives, all of which are true:

1. I fell into JavaScript as a platform that was extremely testable and measurable. There are gigabytes of JavaScript code, all of which come with their own execution environment, available constantly and continuously. To someone interested in how programming languages are actually used, it's an invaluable resource. Regardless of one's feelings on the actual design of JavaScript, one cannot deny its utility as a popular language to inspect.

2. In 1991, a paper on the programming language SELF was published with the title "SELF: The Power of Simplicity". People in the programming language design community have this extremely bad habit: when a difficulty is encountered, we think the best solution is another language feature. The result is behemoth languages like C++, that no one could ever hope to fully understand. Unfortunately, the result is also the recent ballooning of JavaScript, but that ballooning has happened largely after I started using it as a target language, so I'll set it to one side for a moment and imagine ECMAScript 5 is the latest specification.

A good programming language needn't have every feature that everyone could possibly use. In fact, a good programming language SHOULDN'T have every feature that everyone could possibly use.

For instance, people describe type systems as "eliminating a class of errors," but the truth is that they just shuffle those errors to a different part of the development process, either in developer brain time required while writing the code, or to errors in compilation that could have been caught with a witness at runtime. Whether that error movement is valuable can only be determined on a case-by-case basis, and the usual response among language design folks is "I don't understand how you're finding this so difficult, a monad is just a monoid in the category of endofunctors!"

What JavaScript has going for it in all this is the power of simplicity. As simple as SELF? No… Well, maybe. In certain ways, it's simpler than SELF, while in other ways, it's more complicated and just more ad hoc. The core of JavaScript is really very few concepts: maps, attributes, prototypes, scalars, closures. But, this small set of features allows great power through metaprogramming. The role of programming

language designers should be to striate features. What features need to be a core concern of the language, and what features can we implement in terms of those? It's not that it's never acceptable to expand the core—personally, I think SOME types are valuable, for example—but there is no golden rule, except that the fact that someone with a PhD finds this easy to use is not an indication that it is an acceptable language feature.

JavaScript has ballooned of late, but, while I take some umbrage with the way that the new features are documented, they are almost without exception syntactic sugar, in the sense that they can be represented in terms of pre-existing features. Some of them I would jettison for that reason—classes, unless they come with types—but it does mean that the language remains relatively small.

In short, JavaScript represents some of the better design intent of language designers, somewhat muddied by the usual layers of crap above that.

3. A good metric of value for a programming language is this: how many correct implementations does the language have? A language with multiple correct implementations must have value, even if just by consensus. This metric is slightly more deep than it seems at first, because it's self-fulfilling: a language which is popular for extrinsic reasons, such as JavaScript, will be improved simply by having its corners hammered out by multiple groups. The JavaScript that was in Netscape was a truly nightmarish programming language, with bizarre corners that make no sense, bizarre scoping rules, and straight-up bugs. Then, Microsoft did their best to implement it too. They failed, but people programmed to the subset of features that both browsers supported. From the ashes of these two failed languages rose ECMAScript, which is better for both failures. Design by committee has many faults, but one of its benefits is that the stupidity and avarice of individuals is softened among a group.

Going back to the metric, how many languages are there with multiple correct implementations? You can probably count them on two hands. C, C++, JavaScript, Common Lisp, Scheme, x86[-64] machine code. ARM doesn't really count since it's multiple licenses of the same implementation. Emulators might count for some other machine languages. The many BASICs weren't and aren't intercompatible, and so aren't actually the same language. Python is nearly there with PyPy, but I can't yet qualify it as more than "nearly" there. Maybe Java, but the degree of useful compatibility between Oracle's canonical JVM and the others is at best dubious. Of course, there are also the category of programming languages defined by their triviality but lack of utility, such as BrainFuck (I wonder how **mathNEWS** will censor this? *[Editor's note: We love BrainFuck here at* **mathNEWS***. Just check out V142i3, V139i2, V137i1, and V132i3.]*), but I'll limit my selection to languages designed for public consumption.

There are at least thousands of programming languages with a single correct implementation, but at most a dozen with two.

4. For decades, one of the goals of programming language designers in particular and computer scientists more generally has been the universal software platform. Java's "write once, run everywhere," abstraction layers for GUIs, even C's abstraction of hardware details, all had this laudible goal, and all failed to some extent or another. But, the universal software platform exists. It's come into being, and the CS community barely even acknowledges it. The universal software platform is the web. It has a fully cross-compatible GUI layer which requires zero platform effort, video and audio support, 3D, threads (WebWorkers). It works on every desktop computer that's been made in the last 20 years, and every mobile device that's been made in the last 10. Thanks to Emscripten, it's even backwards-compatible with C and C++. While we've been bickering over how to make the universal software platform, it's already come into fruition. Even native applications are increasingly being written using web frameworks through Electron, for example. Oh, JavaScript isn't the only language of the web, both through compilation and through competition such as WebAssembly, but WebAssembly isn't designed to compete with JavaScript, and languages compiled to JavaScript barely register. The primary programming language of the only true universal software platform is JavaScript. Regardless of your feelings on the language, it's already won.

SANDWICH EXPERT: SHOULD I WRITE THE BACKEND FOR MY SOFTWARE IN JAVASCRIPT?

That depends heavily on the software, doesn't it! For all the love that I have for the web ecosystem, I have a fair amount of revulsion for Node.js, which would be the most popular platform for this. If it had used Promises from day one, it would be an excellent platform; as is, it might be recoverable by shifting things to Promises, but it's just annoying to program in otherwise. Still, I use Node.js all the time, so who am I to talk.

One of the nice things about making backend software in JavaScript is that if your frontend is the web, then you're stuck with JavaScript there anyway, so you may as well use fewer languages and thus eliminate a class of mistakes through semantic mismatches.

I use JavaScript a lot, but I'm not a language zealot at all, and am certainly not a language zealot for JavaScript. The first priority should always be to use whatever language is going to net you the greatest success.

CC: DOES YOUR "GRADUALLY-TYPED SUPERSET OF JAVASCRIPT" LANGUAGE-IN-PROGRESS HAVE A NAME? IF SO, WHY THAT NAME? IF NOT, DO YOU HAVE ANY CANDIDATE NAME IDEAS?

Yes, it's named 𓀀. That's pronounced "WowScript," but I want to be abundantly clear that it is never to be written "WowScript" except to demonstrate the pronunciation. The name is not WowScript, it's 𓀀. The backstory behind the name is complicated, but the short version is this: I was joking about how annoying it is that a prototype programming language in a research publication always needs to have some name, even though that name is meaningless for a prototype, and how it would be amusing to use something extraordinarily annoying to typeset or read as the name. (Hello, **mathNEWS** publishers! Are you enjoying typesetting 𓀀? *[Editor's note: We decline to comment at this time.]*) My original idea was to use a symbol from Chinese, a symbol from Ancient Egyptian, and a symbol from Hebrew, together. We also had the idea of the name being a reverse-indent, so you only know that the name is there because the surrounding text was written over itself. A student of mine, Alexi Turcotte, had drawn this image as part of an unrelated joke about how annoying it is to be a fast walker and constantly stuck behind slow walkers, and we figured, why go with a name that even has Unicode codepoints when we can insist on a symbol as a name, like the Former Artist Formerly Known as the Artist Formerly Known as Prince?

More to the point, whenever a name is needed for a research publication, something dull is invented. StrongScript, ConcreteScript. Bleh.

CC: WHAT DOES GRADUALLY-TYPED EVEN MEAN?

Like so many things, the more precisely you define the term, the more you discover that it is ambiguous and incomplete. This is the fallacy of the heap. But, in short, a gradually typed language is simply a language in which types may be specified and known, but also may be left out. All the interesting behavior happens at the boundaries: what does it mean for half of your program to have specified types, and half of your program to have unspecified types?

There are many different groups working on gradual typing, and you'd probably get a slightly different answer from each of them. They also have different motivations. A lot of people working on gradual typing take the approach "the unwashed heathens are writing code without types, and we need to bring them to the light."I take the approach "types are sometimes useful, and sometimes not, and demanding types everywhere in order to establish their value in some cases is annoying."

ANONYMOUS: WHAT HAT DO YOU WISH EXISTED?

One of my goals, which becomes harder as my hair thins, is that my hair should always be wider than the brim of my hat. I have big hair, so this is achievable for me even with fairly wide-brimmed hats. But, what if the hat could adjust its own brim to assert that this was true…

TC-39: WHAT WOULD YOU PUT IN A LANGUAGE IF YOU ONLY HAD 10 DAYS TO DESIGN IT?

Structural types, closures, objects implemented as maps with the domain being any immutable value, and something akin maybe to Lua's metatables to allow metaprogramming in order to be able to fill in the vast missing feature space in the future… I think I just implemented Lua, actually. The trick is codesign: you want to design something that can support a fast implementation, but can have a quick implementation in 10 days, and doesn't need a bucketload of features to accomplish that. Writing Just-in-Time compilers is what I do, so although I wouldn't actually write a JIT in that 10 days (… Maybe?), I would certainly have that in mind, and choose a minimal but powerful feature set to support that. Closures and map objects with metatables is a really good minimalistic balance for that, and structural types would just be to scratch my typing itch!

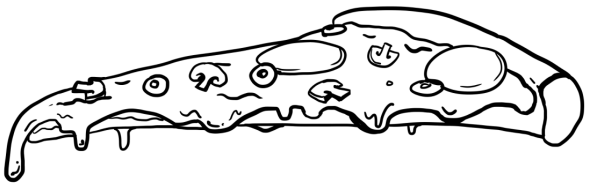
QUANTUM GOOSE: BRENDAN EICH ORIGINALLY WANTED THE WEB TO SCRIPT IN SCHEME. WHERE DO YOU THINK THE WEB WOULD BE TODAY IF HIS WISHES HAD PREVAILED?

Honestly? Pretty same-y. Scheme is also a relatively simple language in which a lot of power is derived from relatively few features, but one of those features, macros, is vastly more powerful for metaprogramming than anything in JavaScript. That's the only feature that Scheme would have going for it with no real comparison in JavaScript, but Microsoft would've found some way to screw it up, so they would be pretty limited in WebScheme. There's far more to the web ecosystem than the language that accidentally fell into place there.

CLARIFIED: WHAT IS YOUR FAVOURITE CLASS AT UW TO TEACH?

Probably CS350. I usually introduce CS350 with something along the lines of "In this course, you will discover that everything we've taught you up to this point about memory and how programs are run has been a lie. But, a convenient and useful lie, invented by a piece of software called the operating system. You'll discover why that lie is there, how it's done, and why it's good." I've always prided myself on being able to straddle lines between very high-level and very low-level understanding of software, and CS350 peers into a level that everyone should understand, even if they never have to work there.

But, I also semi-regularly teach CS842, which is essentially "teach anything you want to in the topic of programming languages," and obviously I find teaching that to be extremely rewarding! But, it's almost meaningless to rank it among favorites, since it's so open-ended.



ON PRIVILEGE AND BAYESIAN PROBABILITY

profTHOUGHTS *143.2*

I was asked to write **profTHOUGHTS** a couple weeks ago, and had started brainstorming a little diatribe on the hacker ethos. But then, my thoughts were forced elsewhere. And, after all, surely the purpose of this is for me to discuss my thoughts, right? Recently my thoughts have been on privilege.

Firstly, let me apologize for (a) writing something grim in a context that calls for levity, and (b) writing something on privilege from my position at the bow of the S.S. Privilege. However, (a) I am an American citizen living in Canada during these times, and for all that I have abandoned my homeland and have exactly zero shame in that fact, I still do feel some connection to it, and (b) it is the duty of those with privilege to recognize it and its consequences. I hope that by the time this is actually published, it will feel a bit late, but I fear that it will not. I am writing my thoughts on privilege in a mathematical way, because this is **mathNEWS**, and also I am a dweeb.

Before getting into the meat of what I want to talk about, let's take a quick refresher on Bayesian probability. But, I'm not going to go into the actual math here, just the concept. In short, the idea of Bayesian probability is that probability is a statement about lack of knowledge, not a fundamental or universal fact. The probability of A given B is different from the probability of A given not B, and so a statement about the probability of A independent of B is measuring as much about our ignorance of B as our knowledge of A. If we learn B, then our stated probability changes, but this doesn't mean we were wrong, it simply means that we've gained more knowledge. Let's not go too much further into the concept than that, because ultimately, I'm actually trying to use Bayesian probability as a basis for a larger point, rather than teach you Bayesian probability, and I have no business teaching you Bayesian probability anyway. And, on that point, apologies to my colleagues in statistics, who are presumably burning effigies of me right now.

By restating and shifting some of the variables in Bayes' theorem, this can also be stated in a different way: the probability of A given B is the independent probability of A, multiplied by a factor determined by B. We can generalize this to say that the probability of A given a set of circumstances is the product of a base probability and many contextual factors, each of which relates to some knowledge about the input system or its evolution. Technically speaking, since each of these probabilities also interrelate, it should be a power-set of factors, but let's not let things spin out of control. The important observation here is that the probability of most things is a product of probability factors, not a sum.

And here's an important point about those factors: some of them are 1, and so learning B may not affect the probability of A. If learning that B is true doesn't affect the probability, then it's intuitive to say that B does not affect A, but that's not correct: B's factor may be 1 when be is true, but it also has a factor when B is false. Our probability of A didn't change when B was true, but it could have changed dramatically if we had learned that B was false.

For a simple demonstration, imagine a video game. I have some degree of skill at the game, and as I continue to practice, my skill will improve. My probability of beating the game on my first attempt may be 50%, but if I play it over and over, my probability will go up. But, most games have random factors. Technically, pseudo-random factors, but since I don't know the input to the pseudo-random number generator, it's as good as random to me. That's Bayesian probability! Let's say that this particular game has some really nasty factors. Certain enemies can spawn in highly obstructed locations; maybe, at the most extreme, in fully obstructed areas, from which they can damage the player but the player cannot damage them. The random factor does not add or subtract from my probability of success; it is a multiplicative factor of my success. If everything loads in sensibly, then the factor is 1, and I feel like my input effort really affected the outcome of the game. If I put in greater effort, or attention, or skill, then I do better. Hey, this game's pretty good! If things load in badly, then that factor is much lower, possibly 0. My input effort still matters, but I'm frustrated by things outside my control. How in Hell was I supposed to beat that boss who appears on an inaccessible dais and shoots fireballs at me when I don't even have a projectile weapon? What a trash game! But in the series of events where everything loaded in sensibly, I have no way of even knowing that this bug exists.

And, that's where I can start to transition to my main point.

Here at the wheel of the S.S. Privilege, I've got a pretty good life. If I define "success" as "get and keep a job doing something you love, in a field you're good at, in a place you are happy to live, with an income that sustains you," then my probability of success was and is clearly quite high. But, that probability can also be stated as a product of many, many factors. What are those factors?

Some of them are or were under my direct control; I can adjust the probability by adjusting my behavior, and thus changing factors. Do good work. Put in the time. Study. Learn. Grow. Don't use tired clichés when writing things… Oops. The point is, I put active effort into my success, and get success out.

Some of the factors are "luck." In this sense, "luck" is really just all of those factors that you can neither control nor measure. Being in the right place at the right time, mentioning a topic to someone that happened to have the same subject on their mind and thus ingratiating yourself to them, happening upon some piece of information that lets you contextualize more information. Some people use this description of luck to justify the argument that luck isn't real, but the reality is that luck is real, but it's crushingly real and made of real events beyond your sphere of control. We

should never deny the role that luck plays in our successes and failures.

But what of the factors that I cannot control, but could, at least in principle, measure or see to some extent? For me, many of these factors are 1, or very close to 1. Any 1 factors appear transparent; they don't change the probability. Thus, these factors are subjectively almost impossible to see. By definition, they have not affected my life, so I can only see them in comparison to others. What I am arguing in this treatise is that those uncontrollable factors of 1 are privilege, and it is the fact that they're factors of 1 that makes it so difficult for those with privilege to see or acknowledge their privilege.

I don't have a stutter. If I did, then regardless of all attempts by everyone at all levels to be fair and just, it would be almost impossible to be successful in teaching, at least in a conventional, lecture-style teaching job. That's no one's fault, but it means that I have a factor of 1 that's totally transparent to me. People with stutters can often train to minimize it to a greater or lesser extent, and someone with an uncontrollable stutter could be a successful teacher by teaching in a less conventional way—lectures are well known to be a mediocre way of teaching anyway—but that's an extraordinary amount of work without a 100% chance of success. For the stutterer, this factor is not 1, and is largely if not entirely out of their control. For me, it is 1.

I wanted to start with a less obvious source of privilege, because I want to drive home the point of this being a multiplicative process. If I did stutter, it would have affected numerous aspects of my life, almost exclusively serving as a hurdle to overcome. I would have to work harder to accomplish the same likelihood of success as someone without a stutter, because I would have to do all the work they would have to do, and also the work to overcome or work around the stutter. And yet, when I look back at whatever success I've had, I don't typically think, even for a second, "wow, I sure am lucky that I don't stutter." No one remembers the mountains they didn't have to climb.

I'm a white man. Because I am a white man in a part of the world dominated by white men, and in a field of endeavor dominated by white men, no one ever questions my sincerity in anything that I do. No one ever claimed I only got in anywhere because I was filling a quota. No one has ever assumed that I had to fight adversity to get here. Only one person has ever insinuated that my motivation for going into computer science must have been purely financial. No one has ever asked whether I was pressured by my parents to go into a STEM field or if it was my own choice. No one has ever crossed a street to avoid me; well, not until recently. No one has ever assumed that I must speak Hebrew, German, or Russian, or that I don't speak English. No one has ever pondered how my actions reflect my heritage. In this paragraph, I haven't even had to mention any race or gender other than my own, but I'm sure that you can fill in the blanks. A lot of these things aren't even intended to be harmful, but they're sinks of mental effort that I simply have never had to expend.

As anyone who has seen me knows, I'm an eccentric. I dress in bright colors. Why? Because I want to. And also, because from time to time, someone tells me that my chirpy brightness makes them smile. When I lived in a backwards third-world country, the United States, this quirk earned anti-gay pejoratives snarled at me, but it has since been reacted to fairly positively. I honestly believe that I can afford to be so visibly quirky exactly because I am otherwise taken as such a default. Very rarely does anyone assume that my style of dress is a statement, beyond "this is how I like to dress." If I weren't white, would people assume that it was some kind of statement? I suspect so, at least more frequently than as is. Not necessarily a bad statement, and not necessarily anything they or I would be against, but, some statement. If I'm correct in the supposition, then that assumption would cloud anyone's impression of me.

A computer scientist who happens to be black is a black computer scientist. I, on the other hand, am simply a computer scientist. Yes, I'm a white computer scientist, but who has ever bothered with that qualifier? One of the consequences of being a "black computer scientist" is that that indelibly connects your computer-science-ness to your blackness. Recently, a topic that's been trending is visibility for black computer programmers. That's great, and it shouldn't stop, but remember this too: These are real human beings with lives, and they have to put everything into their success that anyone else does, but now also get the extra pressure of being symbols. Every woman in computer science has not only the obstacles that everyone has, but the obstacle of expectation, and of the question of sincerity. Not merely do members of these groups have to prove themselves, but they have to prove that they're not proving themselves just to prove that "X can do it too" for some X. What a hassle. No one would ever claim that Gregor Richards proves that a white guy can code too.

That's one way that lack of privilege manifests. Many little things, and some big things, that are constant companions, affecting everything you do. Multiplying your probability of success by 0.9 here, 0.8 there, 0.4 there.

Up to this point, I haven't even mentioned systemic issues. I don't really see the consequences of systemic racism, because I come from a predominantly white area, and live in a predominantly white area. But then, that's the point, isn't it. During my primary schooling, it was essentially taken as a given that everyone would be going to University, and that everyone could afford to. Also, nearly everyone was white. What an incredible coincidence; definitely no systemic issues here.

I readily admit to bristling at accusations of privilege. Somehow, the gut reaction is always that they seem to come with a sneer of "you haven't earned your success." Particularly since such accusations have, in my experience, come exclusively from people with nearly all if not all the same

advantages as I, which makes the accusation feel like a "more woke than thou" pissing contest. And of course, although I am a golem built out of pure privilege, no one (else) is truly privileged in every conceivable way, so such accusations can also come across as naïve.

But while it would be disingenuous to claim that I haven't worked to get where I am, it would be equally disingenuous to claim that I did not benefit from privilege. These aren't in conflict. They are, in fact, in perfect concordance.

Why would the Captain of the S.S. Privilege write all this at a time when, moreso than ever, oppressed voices must be heard? Because that's not enough. Privilege doesn't equalize when only those without privilege scream, their voices oddly quiet as multiplied by the factor of their lack of privilege. For culture to change, it is the first responsibility of those of us with privilege to understand what that means, because that very same privilege means that often, we're the only ones who can do anything about it.

Prof. Gregor Richards

MATHSOC NOMINATIONS OPEN JUNE 15TH!

And close June 19th!

MathSoc Elections Committee

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UW'S BASTION OF ERUDITE THOUGHT SINCE 1973

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N POSITIVE VIBES FROM YOUR PAST LIFE IN WATERLOO

It has been 87 days since the beginning of the quarantine for me (so close to 100 days, babey!) and ngl I kind of miss Waterloo now. Even the goose poop on the streets and the brutalist interior decor of RCH… sigh. If you also miss loo, here are some good nostalgic vibes that can (hopefully) keep the both of us going:

- You're on SLC first floor, looking for the booth for an event you saw on Facebook. You take a bubble tea from some employer info booth. You secretly wish that the tea was from anywhere else but Sweet Dreams (don't @ me). [*Editor's note: I'm @-ing you.]*
- Walking out of MC after an intense assignment grinding session. It's late at night, you can see the stars in the sky, and the air is fresh and sharp on your face. Yellow light illuminates the trees in the rock garden. You walk in the direction of E5/E7, and you point out to your equally tired homework buddy that the silhouette of the dinosaurs on the entrance of the Earth Sciences museum look like they're having sex.
- You're on the 3rd floor of EV3, grinding for finals with your friends at one of the big tables. It's early April, and your walk from UWP to EV3 was way too humid. You look up from your practice final, and notice that there's a thunderstorm going on outside. Does it usually rain this much in Waterloo? Is this why this place is called WATERloo and not EARTHloo?
- It's late spring, and you're walking through Laurel Creek Conservation Area with an old friend. The trails are muddy, and you have to pay attention to pay attention to not step in a puddle. The moon is rising, and you think to yourself this is what perfect calm feels like.
- Your friend gets lost on his way tunneling from E6 to MC, and you and your other friend in MC need to go pick him up. No one really knows where he is. Adventure ensues.
- It's Math CnD Chili (and Garlic Bread) Friday, and it just so happens that one of the nice booths is empty.
- You're walking from your place on Lester Street to Foodie Fruitie. The sun is warm on your face and the traffic light turns green just as you arrive at the intersection. Covid-19 isn't a thing.

I miss gols please tell me it hasn't closed down or i can and will cry

royal no.69 milk tea

"HOLY FUCK: I JUST REALIZED EVERYONE USES CANVA," AND OTHER RELATED TANGENTS

I'm not a social media or graphic design type of guy, so forgive me if my revelation is a little tardy and this is supposed to be common knowledge. I didn't know what Canva even was until just a few minutes ago, really. I've always assumed that whatever UW student club/organization I've seen on Instagram with pretty announcement posts (you know, the ones that are all tastefully minimal and colourful with dainty vector graphics [usually geometric shapes and "bowling-alley carpet"–esque squiggles] and fonts that either look like calligraphy or that they could be used for the logo of some direct-to-consumer brand whose target market is hip city millennials) has them all made in Adobe Illustrator or some shit, by one member who's *really* into graphic design and social media marketing. Now I realize this is not so.

It all came to a head when I decided to check out the Instagram page of my high school's student council. Their stuff looks exactly the same as whatever graphics MathSoc puts out to remind people about Pi day or mock interviews. The same design sensibilities, the same cutesy backgrounds, all the way down to the same perfectly complementary combination of fonts. My third eye was painfully wrenched open by the ugliness of the truth unraveled before me.

Well, perhaps ugly is too strong a word for Canva. It has its place for small businesses and student clubs who don't have a graphic designer on board and just want to quickly make some good-looking posters or social media posts. Canva's templates are miles better than what an average person could do from scratch, and I state this without malice (so don't take it personally, reader). Nonetheless, when everyone uses Canva, everything becomes so samey. Canva templates are ubiquitious. There's no cohesiveness or unique identity to your page when you use them.

I love the Geocities aesthetic and the Geocities zeitgeist. Y'know, those old DIY static websites from the late 90s to the early 00s? With the animated 3D gifs and patterned backgrounds that made the Times New Roman text unreadable? They were all so fucking ugly. But in a very *alive* way. The fact that I can refer to the look of all these sites underneath the umbrella term "Geocities aesthetic" maybe implies that these websites also had a ubiquity to them, and that is true to an extent. You can only get so far in basic HTML4 with no CSS. But these websites had charm and life behind them because they were built from the ground up by your average Joe. There was a spirit of improvisation, creativity, self-reliance, and fun. No one makes webpages for fun anymore, not even kids. And building a site on Squarespace or Wix just isn't the same. It's a business chore to deal with the necessities of the Internet Age. Once you're done setting things up, you get a minimalist, cookie-cutter user interface with large splash images and a long-scroll homescreen. A polished, shiny clone.

If one thing's for sure, graphic and web design is no different than any other visually-focused area, like fashion or interior design: it follows trends. Templates from Canva and the like just make it easier to keep on top of those trends when you're expected to be promoting your shit on social media. It's one less thing to pay for, one less thing worry about. Are pre-made templates the democratization of graphic design? Or is it contributing to the homogenization and disaccreditation of the field as we know it? This dichotomy is not new, and more creditable, eloquent people than I have probably dissected it before in great detail. In the end, what do I know? I don't study design. You might even disagree with everything I just said so far, and that's fine.

BUT. You know what's *not fine?* Canva resume templates. My heart cries tears for any poor fucker who thinks it's a good idea to use one. They all look like Tumblr blog themes or concert posters. Literally *no one* in any industry should be using a Canva resume template (if you were in graphic design or some other similar creative field, you'd be better off dead than caught using a template anyway). The most common fault in all of them is that you can barely fit in any content: all the space is taken up by massive margins, useless sidebars or headers, and *even more* ditsy graphics. Many templates are also set against a coloured background; if it's a light oatmeal or potato sack greige, I guess it's *passable.* But safety yellow? Or Instagram story gradient? Why not just shoot a laser pointer into the eyes of the HR person who has the misfortune of reading your resume? The most egregious error of all, however, is how a lot of these templates use font colours that don't contrast enough with the background. Like baby blue against white. Or grey against a slightly darker shade of grey. Stick to black, people. Like all four (actually more like three and a half since one is an offshoot of another) of those uninspiring-but-functional LaTeX resume templates.

Doing your resume in LaTeX is only advisable if you already know LaTeX well. What's the best thing to write your resume in, then? Word processors are good, if a little inflexible, and the vast majority of people use them, which has gotta count for something. Publishing software (think InDesign, Scribus, MS Publisher) allows for way more flexibility, but takes time to pick up and learn if you've never used it. Overkill. In the happy middle, we have presentation software. Y'know, Powerpoint, Google Slides, and their ilk. It's basically a stripped-down word processor with textboxes. Sounds kind of batshit to write your resume in Google Slides, but if it looks good in the end (thanks to the magic of snap guides and grouping), no one has to know. But I digress: really, if you're not getting a design-related job, and you don't give a rat's ass about customizing the look of your resume, just write it in Word using a template or something. It's not a social media post — no one but a handful of corporate people are gonna see it.

Finchey

NOT UNLESS YOU LIKE TO DATE COURSES: QUEST AS A DATING SITE

ABSTRACT

In the previous issue of **mathNEWS**, A cool pen name asked in *Hi can someone be my zoom buddy — request from an almost-frosh*,

"How do I use Quest as a dating site to meet my SO?"

This question was prompted by the pandemic forcing most in-person campus activity online, and the resulting dearth of opportunities to find love in-person. And what a question! What innovation! An inquiry into the avenue of using Quest as a dating site had to be conducted at once, and the fruits of exploration published.

Quest. "[T]he University of Waterloo's student information system." Home to personal information, financial data, transcripts, class schedules, and most relevant for a dating site, the AIF application and course selection ("About Quest"). Boring, at first glance. What until-now unseen potential will we discover within when we explore Quest as a dating site?

WELCOME TO QUEST

The homepage of Quest is simple and understated, in the style of many University of Waterloo web pages. A broad banner photo of three students excitedly poring over a laptop catches the eye — and more importantly, the imagination. It asks, what fine, charming, and stunningly handsome prospect has Quest put forth for you to match with?

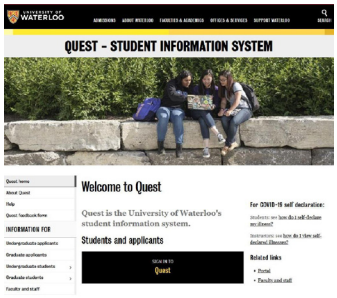

FIG. 1. Quest Homepage // University of Waterloo (https://uwaterloo.ca/quest/)

Signing in to the website itself, one is greeted with a selection of UWaterloo-Yellow navigation buttons.

FIG. 2. Quest Dating Website as a "Current Student" // University of Waterloo (https://uwaterloo.ca/quest/)

Instead of dividing users along traditional lines of gender and sex, Quest splits users into Future Students and Current Students, Programs, and Courses for matchmaking.

Your options will be slightly different depending on your orientation as a student: Future Students will be shown options to match with various UWaterloo programs, and Current Students can find courses to match with. The user interface seems oddly well-suited for mobile devices, but the lack of existence of a Quest mobile dating app puts Quest behind most of its industry competitors, as mobile apps have various advantages such as speed and features (Lusinski 1, 7).

MATCHMAKING AS A FUTURE STUDENT

Unlike regular dating apps, which allow users to match with other humans, Quest offers Future Students the chance to find the UWaterloo Program love of their lives! This feature is offered in conjunction with Ontario Universities' Application Centre, and Future Students must also complete a dating profile and pay a fee on OUAC's site to be included in the pool for matchmaking ("How to Apply").

Future Students fill in a dating profile, then swipe right on the Programs they find most attractive. The Programs can go

through their applicants and match with the most desirable. It's then off to the races for a four-year-or-so relationship between the Student and Program!

YOUR DATING PROFILE AS A FUTURE STUDENT

Building a dating profile on Quest is a long, difficult process for Future Students. Your profile consists of basic personal information such as address, name and phone number. Where Quest sets itself apart from other dating sites is in the AIF, or Admission Information Form. This form consists of various essays, academic courses taken and possibly video interviews (Oh 2.4, 3). It's a long, tough profile to build, from personal experience.

Quest has a disproportionate amount of demand for programs compared to demand for Future Students, and the most attractive Programs are naturally the most difficult for a Future Student to match with. With over 13,000 applicants to the engineering Programs alone—while this is **mathNEWS**, engineering faculty posts more dating statistics—Future Students need to be very tall (grades-wise), and have a *big* academic credential to stand a chance. The most-sought-after Programs pretty much ignore students with a credential shorter than 80% (Bishop), and many expect Future Students with a credential 94%+ long (See Fig. 3).

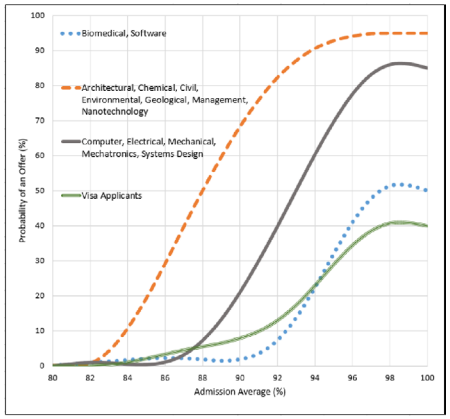

FIG. 3. Quest Future Student Chances of Matching with Engineering Programs // Prof. Willam Bishop (https://theroadtoengineering.com/2018/09/06/chances-of-admission-for-fall-2019/)

Essays, very unconventional for dating sites, make their appearance in Quest's AIF system. Writing love letters of praise to your Program crush is a mistake (those Programs already *know* they're sought after)—instead, a good strategy is to talk about what your aspirations are (Oh 2.1–2.3). Having goals and knowing what you want is sexy.

MATCHMAKING AS A CURRENT STUDENT

In stark contrast to the smaller selection of Programs available to Future Students and the competitive, intensive dating profile creation process where one match will often land you a long-term monogamous relationship, Quest's Current Student matchmaking focuses on polygamous matching—pairing multiple Current Students with multiple Courses.

Instead of making a profile and applying to various Programs, Current Students can simply browse through Courses available, and swipe right on the courses they find attractive. A typical student will date 4–6 Courses a term, though some may overload and date more. At the same time, a Course may be seeing anywhere from a couple to hundreds of students.

Quest for Current Students is like a sampler. Each student typically only dates a Course for a single 4-month term, then moves on to other prospects.

Typically, dating a Course is straightforward for Current Students, but some Courses have low capacity and high demand, and a Current Student may be rejected from a Course (See Fig. 4).

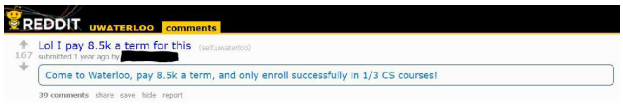

FIG. 4. A Current Student's response after not being matched with two in-demand CS Courses. // University of Waterloo Subreddit

SECURITY & UPTIME

Quest is second-to-none—perhaps even annoyingly so—when it comes to security procedures. With a 10-minute session timeout and mandatory two-factor authentication system every time you log in ("IT campus systems to enable 2FA"), Quest is unparalleled in the dating site industry when it comes to securing your profile.

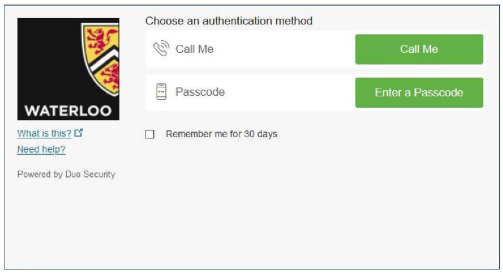

FIG. 5. Quest 2-Factor Authentication // University of Waterloo (https://uwaterloo.ca/quest/)

Curiously, Quest is "available 24 hours a day, 7 days a week," except when it's down from 7:00 a.m. to 8:00 a.m. Wednesday mornings. ("About Quest"). Perhaps Wednesday mornings are the least raunchy time of the week?

PRICING

Quest follows a very unique dating app pricing scheme. It's free to sign up, but once you're matched with an academic program or courses, you'll have to pay to actually meet up!

How much that costs depends on what program you've matched with, and whether you're considered an international Student, as the government of Ontario subsidizes your Quest dating site fee if you're a domestic resident in a relationship with a UWaterloo program ("Tuition FAQ").

Quest charges fees on the same magnitude of ultra-premium dating sites. Typical dating sites and apps cost from $5 to $60 a month (Wilt). Quest charges about $750-$1,700 per month for Domestic Students and $3,800-$6,500 per month for International Students ("Tuition Fee Schedules"). Is dating a UWaterloo Program worth that much money? It seems for Quest users, it is.

IN CONCLUSION

Ultimately, the restriction of only being able to match with programs or courses, and not other humans, is what sets Quest apart from the usual array of dating sites — but this feature also makes Quest impractical for conventional inter-human dating.

The selection of courses and academic programs available, however, is spectacular, and if that's the way you swing, you'll have an excellent time on Quest finding an SO — Superlative course/program Offering. Quest's popularity as a dating site is ever-growing, with over eight thousand matches made in Fall 2019 (See Fig. 6).

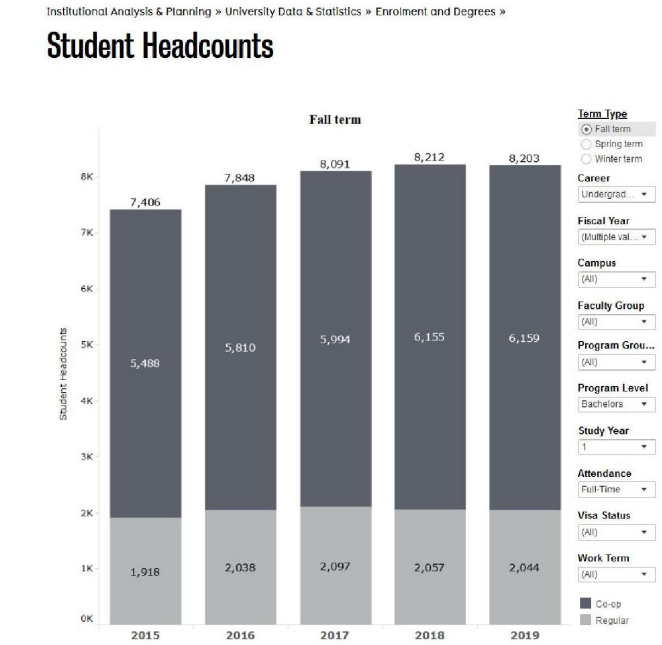

FIG 6. Quest Year-to-Year Future-Student Matchmaking Results // University of Waterloo (https://uwaterloo.ca/institutional-analysis-planning/university-data-and-statistics/student-data/student-headcounts)

For most, though, program applications and course selection are "like doing taxes." (Ayush et al.) Not exciting like dating. Not unless you like to date courses. Hopefully, our fellow writer A cool pen name likes to date courses!

Best of luck in your Quest to find love!

CC

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DOUG FORD GAVE ME COVID-19?! (REAL) [2020]

why the fuck are we already in stage 2 what the hell man fuck off. gonna die to some antsy mall-goers now I guess. man

jeff

PD NOW ASKS STUDENTS TO IMAGINE THAT THEY HAVE A SIGNIFICANT OTHER

WATERLOO — The University of Waterloo has enjoyed unprecedented success with its Professional Development (PD) program, with co-op employers reporting vastly more docile and subdued employees who don't spend time badgering managers about giving them "projects" to work on, instead taking any free time to complete their PD coursework. Now, the university hopes to replicate this success in their students' personal lives as well.

PD69: Relationship Advice is a new mandatory course for all co-op students starting Fall 2020, and will advise the students on the various do's and don'ts of treating their significant other in a relationship. This includes advice on compatibility matching using horoscopes, understanding and implementing Victorian flower language, picking ring sizes for engagement, and more.

However, the university acknowledges that not all of the students in co-op programs — particularly those in the Math and Engineering faculties — may have access to a significant other, due to the ongoing social anxiety pandemic affecting STEM students worldwide, and hitting UW students in particular. In recognition of this, the university has offered "flexible pathways" for completing this vital course. Students will be asked to research online and gather information on the "ideal" romantic partner they hope to have after graduation, and use these attributes of this imaginary partner to complete their coursework.

PD69 is just another addition to the variety of initiatives by the university to increase the success of UW graduates in the real world. With the incorporation of this valuable resource, we hope to see the success of our alum on the various dating platforms like Bumble, OkCupid, Grindr, ChristianMingle, jDate, and others.

tendstofortytwo

N SEQUENCES FROM THE OEIS THAT CONTAIN 1312

- A003336
- A003999
- A004831
- A006036
- A036666
- A045918
- A045987
- A046306
- A055013
- A067945
- A110231
- A117317
- A119461
- A161644
- A174312
- A240763
- A244112
- A258645*
- A258646*
- A259377
- A293873
- A300009*
- A320506
- Honourable Mention: A001312

boldblazer

* Multiple 1312s present

N TYPES OF JOBS ON WATERLOOWORKS THIS TERM

- That perfect job except it's 8 months instead of 4 and you have a 4 month work term
- Like a bazillion web dev jobs
- Software Engineering (Web Development)
- Tree farm labourer
- Backend web dev
- Website development engineering
- Super cool top tier job except it's totally aimed at different faculty
- Web dev
- Apple Cider Engineer
- Front-end web development
- React web developer
- University of Waterloo E-Co-op Entrepreneur
- <Big Prestigious Company in Cali Except it's remote> (1184 Applications)
- PD TA
- University of Calgary is looking for a UWaterloo Student research assistant

CC

UNIVERSITY OF WATERLOO VIOLATING STUDENT PRIVACY WITH ONLINE PROCTORING

This opinion essay is revised from comments I made to WUSA Students' Council after learning that the University of Waterloo is beginning to use online proctoring software. MathSoc and WUSA are both now advocating to ban the use of this software.

According to ProctorU, if you criticize them, you are a security threat. Of course, that's nonsense, yet that didn't stop ProctorU from threatening the UC Santa Barbara Faculty Association after they criticized ProctorU's lack of meaningful privacy protections. According to the law firm that represents ProctorU, using the word "ProctorU" without their permission, quoting from, and linking to their privacy policy amounts to copyright infringement. According to ProctorU's law firm, the mere act of criticizing ProctorU during this pandemic is, and I quote, "directly impacting emergency efforts to mitigate civil disruption." These claims are ridiculous, and have no legal basis.

The University's use of ProctorU and similar software is simply an effort to bully and harass students, infringe on their privacy rights, and make them feel unsafe in their own homes.

This software is trivial to bypass, and accomplishes nothing to ensure academic integrity. Quite frankly, I am sick of this University's pattern of throwing around vague words to confuse critics. Whether it's screaming "academic freedom" and "academic integrity" at students concerned their privacy rights are being violated, or "fiduciary responsibility" at students who are concerned about financial misconduct and environmental degradation, the University of Waterloo administration has demonstrated a continued pattern of ignoring student concerns by throwing around vague phrases that offer no justification of their reprehensible practices.

ProctorU stores student data in the United States of America, which puts student's personal information within reach of the USA PATRIOT Act, an anti-privacy law that allows the United States government to compel companies to hand over data without notifying the person whose private information is being accessed. This alone should require the University to mandate that all instructors provide alternatives to ProctorU for any student who requests it, as is already done with Turnitin. Indeed, the University's existing policy of requiring that students concerned about their privacy are able to use alternatives to Turnitin demonstrates that it is possible to ensure academic integrity without violating student privacy.

Proctortrack, the other application the University is considering using for online proctoring, fails to even list all the personal information that is collected from students in their privacy policy. The list of personal information collected by Proctortrack in their privacy policy is prefaced with the phrase, and I quote, "may include, but is not limited to."

That vague statement means absolutely nothing. ProctorU, Proctortrack, and all similar applications surveil students and incite fear. It is completely immoral for the University to require, or indeed even allow, such spyware to be used at this school. I expect my school to uphold human rights and dignity, not to oppress them. If the University of Waterloo does not immediately reverse their decision to allow the use of online proctoring spyware, I would like to see the Waterloo Undergraduate Student Association without hesitation, and along with the Ontario Undergraduate Student Alliance, proceed with a class action lawsuit against all Ontario universities who are using this pandemic as an excuse to push surveillance and privacy violations onto their students.

The use of this software is not something that is merely being considered for use in final exams this term. At present, the Faculty of Mathematics plans to proceed with privacy violations in CO 342 on June 24th. It is imperative that WUSA act immediately to defend students in this course, as well as the three biology and three engineering courses that are using online proctoring spyware this term.

Anonymous

"THINGS WILL GET BETTER," SAYS MAN WHO WILL BE SHOT IN 2034 OVER A CAN OF CORN

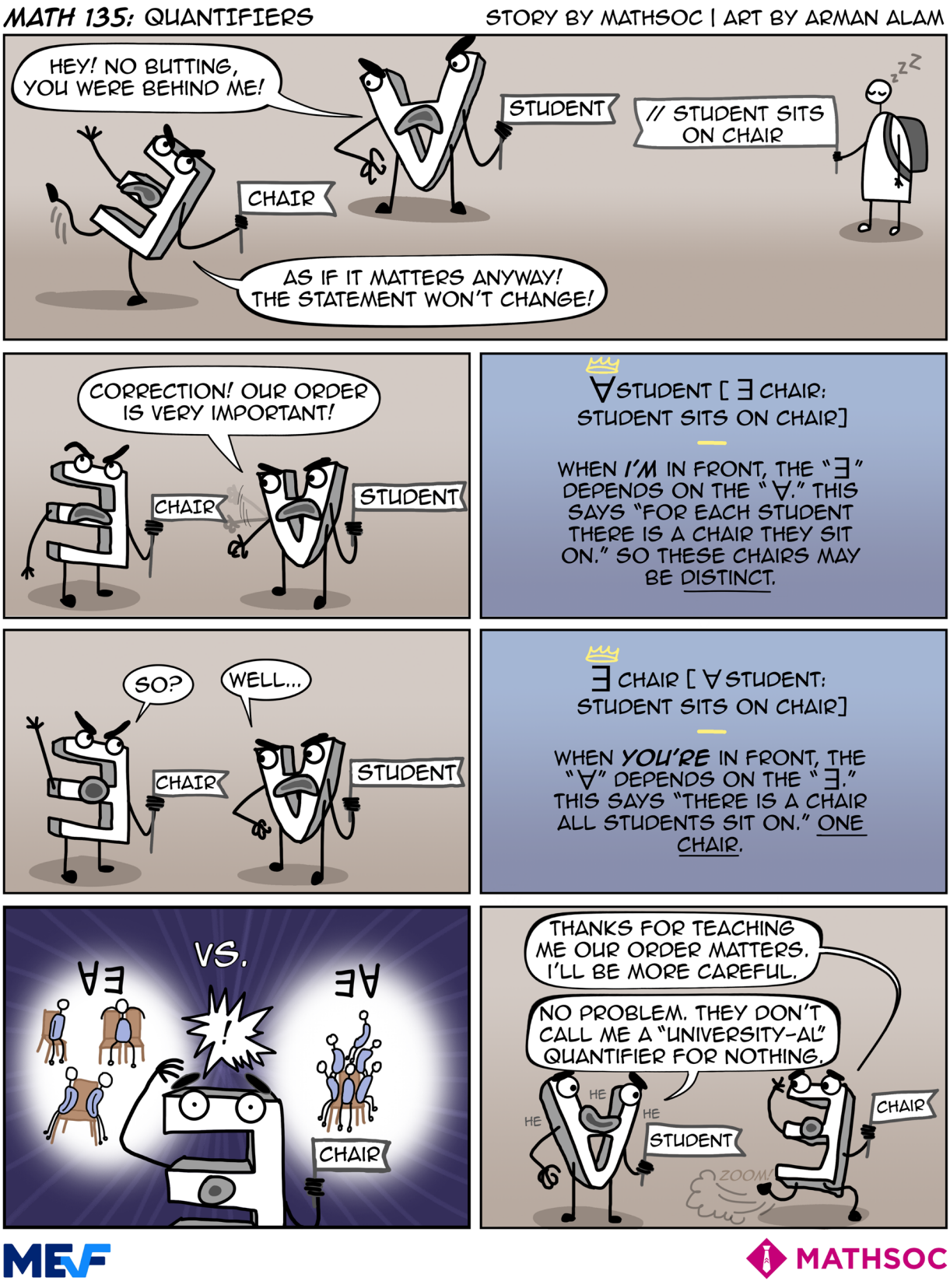
WATERLOO — Amid a world in crisis, **mathNEWS** sources confirmed that Mark Samson, despite claiming that global conditions will improve in the future, will in fact be shot and killed in 2034 over a can of corn.

Our correspondents confirmed that Samson will be killed by a bandit in the ruins of Waterloo while trying to defend his hoard of canned vegetables, a valuable commodity at the time of his death.

The killer, who is currently an optometrist, will be killed the day after in an attempt to steal bottled water from an army encampment.

Our sources also confirmed that most doomsday preppers, instead of being post-apocalyptic survivalists, as they envision, will instead be used as living room furniture by Jeff Bezos Jr.

UW Unprint



Enjoy episode three of MathSoc's educational cartoons series: MATH 135 Quantifiers! This cartoon attempts to help explain why the order of universal and existential quantifiers is important. If you have any feedback please email Gavin Orok at gjorok@uwaterloo.ca or fill out the following survey: https://bit.ly/cartoon_feedback. For each unique educational cartoon we produce that you give feedback on through this survey, your name will be entered in a draw. At the end of the term one person from this draw will be chosen to win a $25 gift card prize!

Gavin Orok

THE TRAITOR-PROOF ARMY THAT RUNS BLOCKCHAIN: A LOOK AT THE BYZANTINE GENERALS PROBLEM

My first co-op is a position not many dream of, but I will certainly covet in the future — I'm a research intern for an ECE professor here at Waterloo! While this means suboptimal pay and working with grad students, it also means that a lot of my work had background reading that I had to read and understand, could reach out to my supervisor about if I had questions, and would spend the next four months applying in practice. For the first few weeks of the term, I was effectively learning and getting paid for it! Take that, people paying full tuition for online courses.

Now, the work I am doing is in the field of fault-tolerant distributed computing, where a bunch of computers work together as part of a larger system to perform some computations, but some of the computers are prone to failure or untrustworthy. Fault-tolerant distributed computing is the backbone of almost all blockchain and cryptocurrencies, since the computers doing all the mining or sharing the common ledger are inherently untrustworthy — none of the computers belong to the same entity and any one of them would like to "game the system" for their own advantage. They also tend to randomly go offline when you turn off the Bitcoin miner on your computer to play Fortnite. A fault-tolerant network should be able to make progress in computation despite all of these issues.

One paper that I read, not strictly related to my current work but good background, is titled "The Byzantine Generals Problem" (Lamport et al., 1982). The authors consider the problem of creating a reliable computing system, one that can handle a certain number of its components not working properly. And when we say "not working properly," we don't just mean they crash and turn off. The component might go completely berserk, sending wrong data to the rest of the system, and even sending *different* wrong data to different parts of the system. Or it might work just fine most of the time, but spew garbage every other Friday between 1–3PM. Or it might be malicious, and report incorrect data for its own personal gain. How do you deal with such arbitrary, hard-to-identify failure? To discuss strategies to solve this problem, the authors abstract away the existence of computers and components and all this modern gizmos, and instead tell a story. So shut your eyes and lie down on your bed, and I'll tell you what the story is.

Once upon a time, there was an army, that of the great Byzantine Empire! The army was camped outside an enemy city, and in the army were many generals, each commanding a legion of soldiers. These generals had to make a simple decision — given their their forces and the strength of the enemy, was it wise to attack the city, or to retreat back home? If they decided to attack when they couldn't handle it, their forces would perish and their work so far would go to waste. But if they retreated when they could have attacked they would leave the enemy with a valuable base intact. The decision had to be made, and it had to be correct. The only problem: they had traitors among them. These traitors could give correct advice to gain trust, or incorrect advice to lead the army astray. And there was no way to identify these traitors, at least immediately. The loyal generals had to come up with a way of doing the right thing, even in the presence of such traitors. What could they do?

This is the Byzantine Generals Problem, and if you can solve this, you can solve the problem of reliable computing with some unreliable parts, because they are the same problem — to generate a correct result (attack vs. retreat) on some input (the enemy status) despite some components (generals) being faulty (traitorous).

Now, the actual details of the problem — specific constraints about the problem and the authors' proposed solution, are in the paper, and I highly encourage you to check it out if you're interested. There's no background required, except for one section that requires some knowledge of graph theory (and can be skipped). That said, I will talk about some of the highlights.

The authors, through logic magic and arcane assumptions, were able to break down the Byzantine Generals Problem into an equivalent one: where one general must send his opinion to all other generals, in a way that all loyal generals receive the same opinion, and if the one general sending the message is loyal, then every other loyal general receives the opinion that he actually sent, not something else. The authors have shown that if you can devise a way for the generals to communicate such that these constraints are met, the generals will be able to make the right call.

The authors then go on to show two results — if there are only three generals and even one of them is a traitor, it is impossible to solve the Byzantine Generals Problem. They also extend the result to show that in any scenario, if one-third of the generals or more are traitorous, the Byzantine Generals Problem cannot be solved. The proof is not very rigorous, and the authors acknowledge this:

> *This argument may appear convincing, but we strongly advise the reader to be very suspicious of such nonrigorous reasoning. Although this result is indeed correct, we have seen equally plausible "proofs" of invalid results.*

Uh… sure, guys. We totally believe your result now. (They link to a more rigorous proof in the citations.)

They then go on to prove (more rigorously, but still using generals and lieutenants and now there's Albanians involved…?) that it is, in fact, possible to solve the Byzantine Generals Problem if the number of traitors are less than one third of the total number of generals — that is, for f traitors, the total number of generals is at least $3f+1$. They present two algorithms for doing so, one that is slower but allows

for message forgery, another that is faster but requires that every message transmitted with an unforgeable signature. This "unforgeable signature" is something that we can do with cryptography, but it has its own cost in terms of computation.

Thanks to this paper, in modern distributed computing research, an arbitrary and potentially malicious failure of one of the components of a system is called a "Byzantine fault," and the various algorithms that solve the Byzantine Generals Problem in more efficient and scalable ways are called BFT (Byzantine fault tolerant) algorithms. I don't know if that name is very fitting — after all, the Byzantines were never the traitors, they had traitors among them. It seems kinda harsh to name all the traitorous nodes after them. But hey, what is the English language if not bastardization of terms pulled out of context?

Byzantine fault tolerance, as I said previously, is a very big deal for blockchain and cryptocurrencies, though that is not its only purpose. One example my supervisor gave was that of cooperative electricity generation. When you get a power connection for your house, you not only take power from the grid, but also pour *in* any power you might generate using something like a solar farm. So at the end of the day, your power bill is what you used, minus what you provided — if you create more energy than you use, you might even end up earning money! Now, we need computers to keep track of who is generating how much power, and we need to keep an accurate account of this information, despite a few people who might claim that they generated 1.21 gigawatts even though what they actually supplied to the grid was like 97 kilowatts. (That is the difference between the power consumption of a *Back to the Future* DeLorean vs. the power output of real life DeLorean made in 1981. But I digress.) So we need a system that keeps an accurate track of power supplied by each person even though there may be a few bad actors trying to abuse the system and get incorrect results. Sound familiar?

This was an introduction into one of the most basic building blocks of distributed computing — Byzantine fault tolerance. I hope I was able to excite you enough to at least take a look at the paper I talked about here, because the field itself is really interesting, from the limited experience I've had it with so far. If you read the paper and really enjoy it, and feel like this is something you could spend four months studying, check out CS 454 or ECE 454.

tendstofortytwo

Citations

LAMPORT, L., SHOSTAK, R., & PEASE, M. (1982). The Byzantine Generals Problem. ACM Transactions on Programming Languages and Systems, 4(3), 382–401.

SURVIVING PRODUCTION NIGHT: ROUND 2

It is my second night infiltrating production night and, luckily, no one has figured out that I have no idea what I'm doing. But it's only a matter of time before they notice me, so before it is too late, I would like to reveal to you, dear readers, exclusive insider information of what it's like to be a **mathNEWS** writer.

First, I've now heard the phrase "someone give me an article idea" 57 times. I am convinced that someone has recorded their own voice saying that and set it on playback every three minutes to fuck with everyone else. Although, the repetition of it is actually just hypnotic enough to stimulate me to write this…. Is this how Waterloo students motivate themselves to do work? Hypnosis??

Second, there's something people keep saying about some free **mathNEWS** pizza… But I don't see any pizza, so I still haven't figured that part out. Honestly, this "pizza" is brought up so much that it's got to be some magic pizza. Magic pizza that fills your soul, not just your stomach, when you eat it. Magic pizza that will make you divorce your wife to pursue a life of travel — and as you're in India searching for Gandhi's legacy you meet the ghost of Dwayne the Rock Johnson, who tells you that he's always believed in you and your destiny is to take the bags of gold he's brought you to create an orphanage for kids and your orphanage is so successful that you win the Nobel Peace Prize that Malala presents to you while the United Nations leader decides that you have so much potential that you shall become the democratically elected monarch of a small third world country which you quickly make the most powerful and joyful place in the world that all of humanity praises to be the superior human race, pledging their allegiance to you and only you — you who is then offered immortality by the Gods which you must reject because of your responsibility to your people so that the Gods think that you are so morally pure that they hang an everlasting portrait of you in front of the Gates of the afterlife so that every good human being may gaze and wonder upon your deep eyes which for some becomes an even greater joy than actual Heaven so crowds gather outside the Gates to spend eternity with you. Yeah, so where's my pizza?

Third, there are some really good writers in **mathNEWS**, and then there's the person who wrote a run-on sentence about how pizza gives you god-like powers.

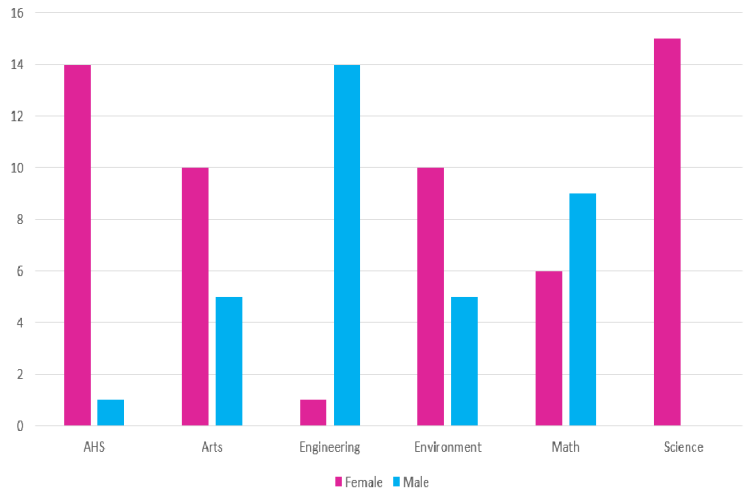
Lastly, can someone give me an article idea?

A cool pen name

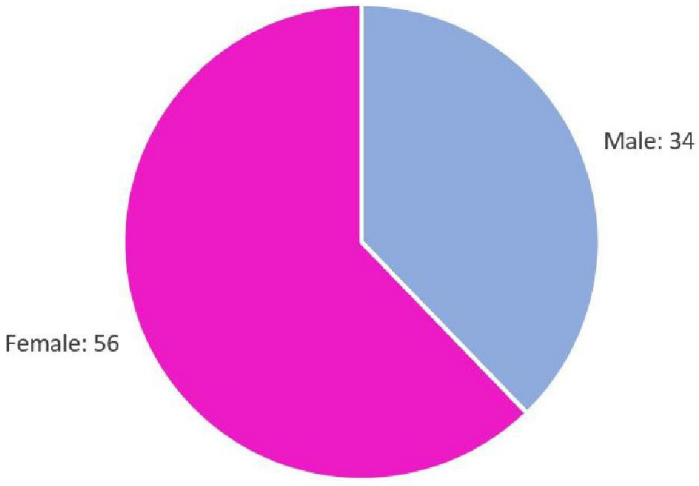
"CO-OP STUDENT OF THE YEAR AWARD" RECIPENTS OVER THE PAST FIFTEEN YEARS AS A FUNCTION OF:

Every year, one student from each faculty (six in total) is selected for the Co-op Student of the Year Award, based on exceptional contributions during a co-op work term. This writer has collected data on past recipients of the award from University of Waterloo's website and published them here.

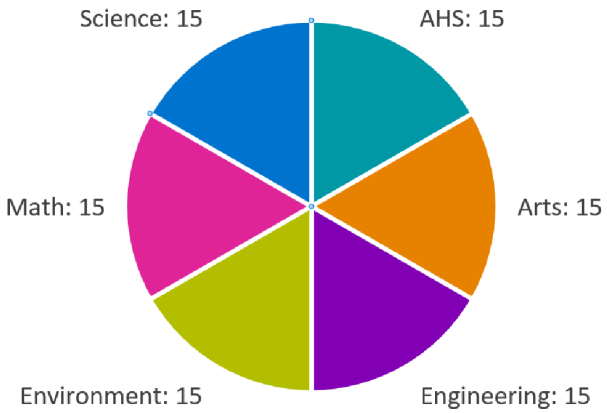
SEX (BY FACULTY)



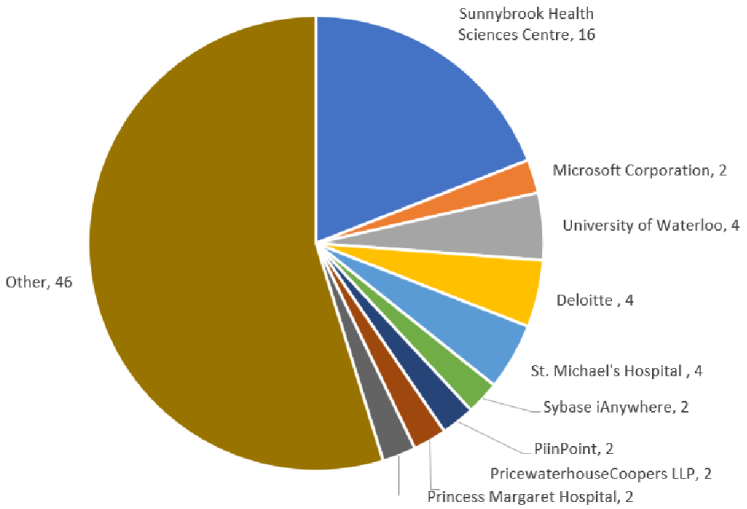
SEX (TOTAL COUNT)



FACULTY



EMPLOYER



Math undergrads already know too much about me.

PROF. JIM GEELEN

CC

Data collected from 2005–2019 articles at https://uwaterloo.ca/co-operative-education/co-op-student-awards/co-op-student-year-award-recipients/previous-award-recipients. Whether a recipient was male or female was determined based on their published name and photo; there is a small possibility of mischaracterization.

profQUOTES 143.2

CO 380: IAN VANDERBURGH

❝ I'm beginning to feel like this must have something to do with Goldilocks and the Three Bears.

❝ Now, a little bit of full disclosure—I was slightly mean here since x=99 is actually a solution. So I asked you to start at 100, just for fun.

CS 241: GREGOR RICHARDS

❝ [The exams] of course, will be take-home… Where else are you supposed to do them, when we're all stuck?

❝ I was born in a third-world country, the United States.

PMATH 320: BEN WEBSTER

❝ [The Greeks] were upset that the irrational numbers existed.

❝ Then you would have to have a whole discussion about what computers are and that would be very, very problematic.

❝ You know it wasn't easy to comunicate [in the 19th century]. They didn't have email.

STAT 231: SURYA BANERJEE

❝ There's a joke in my STAT 231 class, when we used to see each other in real life… I used to say that the way to think of likelihood functions and MLE is like choosing the smartest Kardashian. In other words, you are choosing a maximum value, but each value is incredibly small.

INTERVIEWER DOESN'T KNOW WHY YOU'D WANT TO WORK HERE EITHER

UW Unprint

A VARIED COLLECTION OF QUOTES FROM INTERIM DEAN KEVIN HARE

All from Alumni Day on June 5. Starring yours truly, alongside Ina Wang, MathSoc President.

- [When asked about how he transferred from the regular program into co-op] "My trick to get into co-op was a bit extreme. I wrote an letter to the Dean, and I had an average in the top 2% of the Faculty. (I'm pretty sure it was an actual physical letter anyways, as I don't think I got my first email account until the next term)."
- "I was president of the PMC, twice. (The first time was because I impeached the current president… The second time I was elected legitimately.) I was mathletics (sp?) director once for MathSoc, (but I spent too much money so I wasn't invited to do it again). For reasons that still baffle me, I ended up as president of the Slavic Society. I think my qualification for that was that I was taking Russian 101 and I didn't say no quickly enough."
- "We had elected a president for the PMC. Unfortunately he didn't do anything for the first couple of weeks. At some point I needed a key to the office I felt the easiest way to do it was to impeach the president and take over."
- IW: "I got the following question from a student […]: Why does Math [keep] asking to look for my ex?"
- KH: "It is the last letter of the previous line, just before the question mark. I'm not sure why it is so hard to find."
- CX: "What is your favourite math-related joke?"
- KH: "What is a good anagram of Banach Tarski? Banach Tarski Banach Tarski. Okay, this might be [a] joke only a Pure Mathie could love. Sorry."

clarifiED

AN ASTROLOGER'S THOUGHTS ON ASTROLOGY

"I don't believe in astrology; I'm a Sagittarius and we're skeptical."

Arthur C. Clarke

A Mathemagical Psychic and Astrologer

GEORGE'S QUARANTINE DIARY

The following diary entries came from a long-term residence of the University of Waterloo.

FEBRUARY 28, 2020

Shelly and I finally arrived back at Waterloo today. Despite my protests of not wanting to leave the warmth of Cali so early in the year, Shelly decided for the two of us to fly back to Waterloo. To no goose's surprise, it is absolutely freezing here and there isn't even any fresh grass. There is just snow, snow everywhere. Sometimes she makes a decision so bad that I wonder why we are married. Should have asked her sister Susan instead.

MARCH 11, 2020

A bunch of our friends joined us today, which is a good thing because Shelly and I are tired of eating the grass by RCH by ourselves, and because there is always some idiot trying to sneak up to try and scare us. Now that our friends are back, we have once again regained our strength in numbers. There are now enough of us to fight off those pesky students in swarms.

I heard that Alice and Bob are planning to have children this year. Maybe it's time for Shelly and I to do the same.

MARCH 24, 2020

Something is off.

At first, we thought that it was just a snow day or something, but the students have begun to disappear over the past ten days. At first, we thought that they were staying inside because the weather was bad. But no, we haven't seen many students coming and going between the buildings. Shelly thinks that it's because they've all decided to go Cali, Carl thinks that they are all dead in their dorms, and Alice thinks that the aliens has finally got to them.

APRIL 13, 2020

Today Shelly and I had a rare sighting of a student trekking between V1 and REV and we decided to welcome it with a loving honk and a gentle peck at the ankle.

It ran away screaming.

MAY 09, 2020

Alice and Bob are standing guard by their eggs everyday, not that they need much guarding now that the students are mostly gone, and no one is trying to steal them. Bob keeps telling me that they are going to hatch soon. I cannot wait to see their babies.

All of our friends are back now, and we spend most of our time chilling on the V1 greens in the shade and eating the grass there. We have eaten lots of grass and we always agree that the best ones are the ones at V1 green.

JUNE 02, 2020

We are getting used to not having any of those students around. Though, I do kind of miss them, not their presence, but the ones that used to feed us bread.

Bob and Alice's kids are really grown up. Every time I see them, I get a little bit jealous because I really want to walk around like I own the place with my family.

Maybe we will never find out what happened to those students three months ago, but one thing is for sure. We are the sole rulers of the school now.

DuckDuckGoose

PROPOSAL 1205-69B: PURCHASE OF BIT.LY URL SHORTENER FOR mathNEWS

[Editor's Note: This was meant for V143i1, but was omitted from the final draft after an egregious layout mistake. We're sorry CC!]

Marketing and advertising is a critical aspect of the success of publications both physical and digital. **mathNEWS** falls into both of these categories, and today, I will be presenting a disruptive proposal to skyrocket **mathNEWS**'s popularity and readership to stratospheric heights.

Let me introduce `bit.ly` (pronounced bit-ly): a URL shortener used by millions of users to redirect billions of clicks. Shortened URLs are ubiquitous and appear everywhere from company websites to forums to physical posters.

The proposal I am putting forth is to purchase the company `bit.ly`.

After we own the company, we will make every `bit.ly` link ever created cease to point to wherever they were created to point to, and redirect to `mathnews.uwaterloo.ca` instead. Our page hits will expand million-fold, and everyone who uses `bit.ly` links will now know about **mathNEWS**, which will usher in a new golden age for the publication!

For this, we're asking for a sum of $100,000,000 USD to make an offer to Spectrum Equity to purchase `bit.ly`. Thank you for your time, and your support of free journalism!

CC

A gridWORD FROM MY YOUTH

gridCOMMENT *143.2*

The **gridWORD** in this issue is from V138i2, published on October 5, 2018. That was during my 1A term! How fleeting time is. I feel for the incoming first-years who will have an online Fall term — they've lost the chance to take part in a typical, "movie"–like if you will, postsecondary experience. Real life is always more mundane than Hollywood, I'll concur, but the transition to university is still a big change for many. You learn things about yourself, step out of your comfort zone, and do many a regrettable thing. I'll always have a place in my heart for all the memories I made last year, happy and sad.

Well, enough shumucking around. The **gridQUESTION** this time is: "If you were chosen to be part of the initial colony on Mars, what would you take with you to remind you of Earth?" Send in an answer to mathnews@gmail.com to get featured in the **gridWORD** next issue. Just for kicks, you know? The solutions for this **gridWORD** are on the next page, since there are no prizes this term. See you in a fortnight,

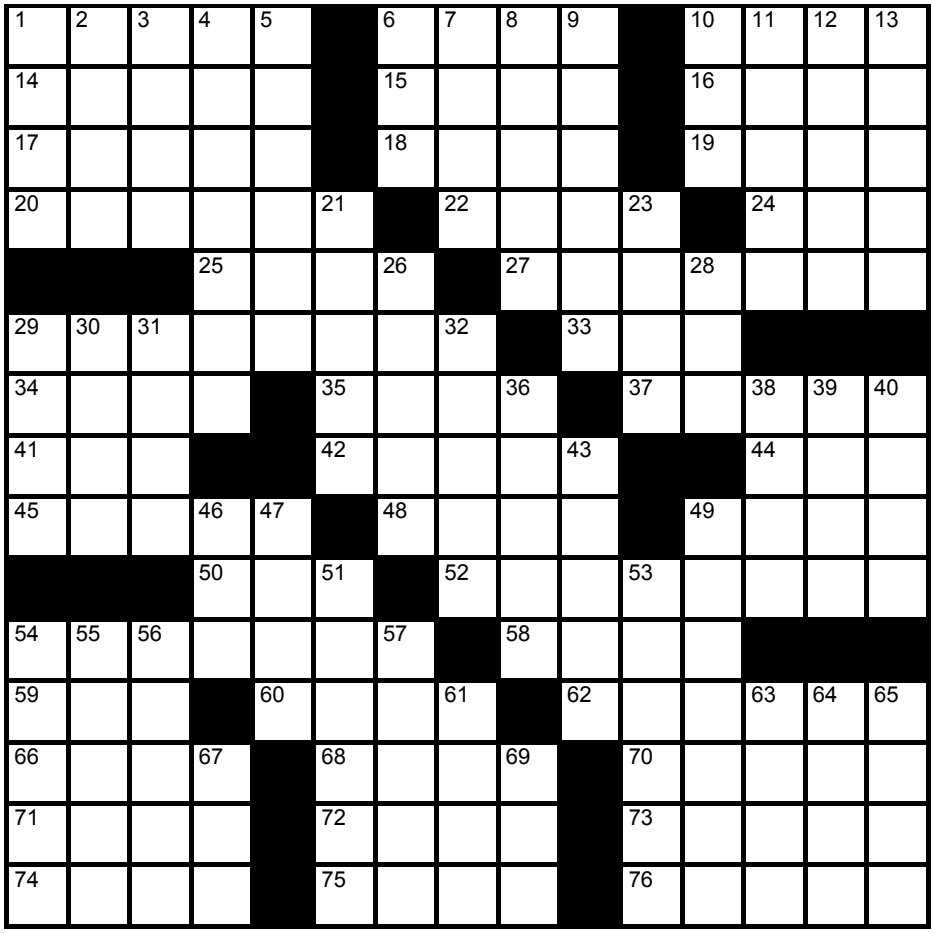
clarifiED

ACROSS

1. An infinitely connected cycle free graph: The ____ Lattice
6. Safecracker
10. It's sometimes golden
14. Related to spiritual energy
15. Eye layer
16. Aroma
17. Voice lesson topic
18. Equal
19. Canceled
20. "What a shame"
22. Litter member
24. Alternative to OCT or HEX
25. Cork's country
27. 496 or 28 could be described this way
29. A von Neumann algebra, for example
33. Free from, with "of"
34. Parsnip, e.g.
35. "Picture it. Silicy. Mount ____ erupts everywhere!"
37. Player
41. It's sometimes full around Christmas
42. Everybody at UW wants to be on the ___ list
44. Cute nickname for Darth Vader
45. Chaotic
48. Common request
49. Auspices
50. "___ the fields we go"
52. Summer music festival in Guelph
54. A very important optimization algorithm
58. Big name in chips
59. Toronto-to-Montreal dir.
60. Agenda
62. Aftershock
66. One way to stand by
68. x, y or z, for example
70. Absurd
71. A 10-Across, all grown up
72. It's good for forking with
73. Money substitute
74. Final, e.g.
75. Biblical birthright seller
76. Books

DOWN

1. Insulation
2. 100 cents
3. Not quite a quartet
4. Curator of 23 unsolved math problems
5. Bakery buy
6. "Uh-huh"
7. "... happily ___ after"
8. HYPE!
9. Actor James
10. Swindler
11. Software giant
12. It can be predicate or propositional
13. Attack locale
21. Preserved, in a way
23. High school math topic
26. "Come in!"
28. Kind of approval
29. Cup part
30. Bang-up
31. A long, long time
32. Grind, as teeth
36. Blacksmith's block
38. O. Henry's "The Gift of the ___"
39. Early Barenaked Ladies song
40. Acclivity
43. Comics sound
46. Absorb, with "up"
47. Canine cry
49. Core
51. Empathize
53. King David was one, famously
54. Capture
55. Cardinality, kind of
56. Kind of toast
57. An instance of 68-Across
61. A girl from Granada
63. 80s crooner Richard
64. "Don't bet ___!"
65. Gym set
67. "Dee-lish!"
69. Space Invaders and Defender are early examples (abbr.)



lookAHEAD

SUN JUNE 14	MON JUNE 15	TUE JUNE 16	WED JUNE 17	THU JUNE 18	FRI JUNE 19	SAT JUNE 20
Alonzo Church's 117th birthday				WaterlooWorks student rankings open @ 12PM	WaterlooWorks student rankings close @ 2PM Blaise Pascal's 397th birthday	First day of summer

SUN JUNE 21	MON JUNE 22	TUE JUNE 23	WED JUNE 24	THU JUNE 25	FRI JUNE 26	SAT JUNE 27
National Selfie Day	**mathNEWS** 143.3 production night	Continuous interview cycle begins Alan Turing's 108th birthday			**mathNEWS** 143.3 published Tuition and fee refund deadline — 50% Course selection for returning students begins	

THE PURE MATH, APPLIED MATH, AND COMBINATORICS & OPTIMIZATION CLUB'S PROBLEM OF THE ISSUE

Hello friends,

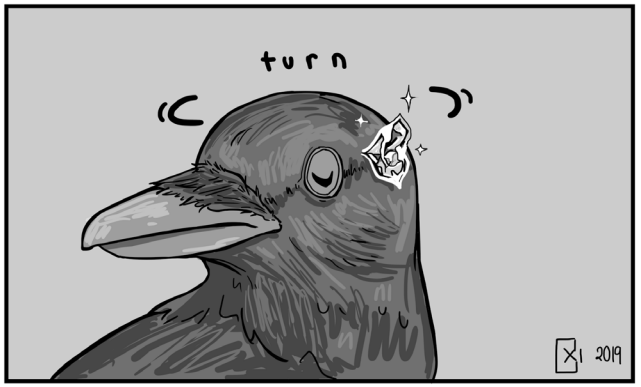
Here is a nice light exercise to while away the quarantine hours—and possibly win you a prize.

Let k and n be positive integers. Derive, with proof, a formula for the number of non-trivial arithmetic progressions* of length k whose members are all positive integers at most n.

*We shall define a non-trivial arithmetic progression of length k whose members are all positive integers at most n to be a k - element subset $S \subseteq \{1, 2, \ldots, n\}$ such that if $S = \{a_1, a_2, \ldots, a_k\}$ with $a_1 < a_2 < \cdots < a_k$, then $a_2 - a_1 = a_3 - a_2 = \cdots = a_k - a_{k-1}$.

Submit your solution to pmclub@gmail.com.

PMC



THIS WEEK'S gridSOLUTION

B	E	T	H	E	■	Y	E	G	G	■	C	A	L	F
A	U	R	I	C	■	U	V	E	A	■	O	D	O	R
T	R	I	L	L	■	P	E	E	R	■	N	O	G	O
T	O	O	B	A	D	■	R	U	N	T	■	B	I	N
■	■	■	E	I	R	E	■	P	E	R	F	E	C	T
B	A	E	R	R	I	N	G	■	R	I	D	■	■	■
R	O	O	T	■	E	T	N	A	■	G	A	M	E	R
I	N	N	■	■	D	E	A	N	S	■	■	A	N	I
M	E	S	S	Y	■	R	S	V	P	■	E	G	I	S
■	■	■	O	E	R	■	H	I	L	L	S	I	D	E
S	I	M	P	L	E	X	■	L	A	Y	S	■	■	■
E	N	E	■	P	L	A	N	■	T	R	E	M	O	R
I	D	L	Y	■	A	X	I	S	■	I	N	A	N	E
Z	E	B	U	■	T	I	N	E	■	S	C	R	I	P
E	X	A	M	■	E	S	A	U	■	T	E	X	T	S