Notes from the Margin

Volume X · 2015

What is a p-value, anyway?

by Carolyn Augusta (University of Guelph)

Now that we're past second-year statistics, it might feel a little embarrassing not to have a clear picture of a p-value. But lots of math students don't really remember all that much from second year.

Carolyn Augusta

It's fall, and we're back at the maximum of the sinusoidal function of class attendance! Until, of course, we all remember how early an 8:30 AM lecture really is ...

After all, we were all just wading through assignment after assignment, trying to keep our heads above the paper waves. So for anyone who has forgotten, here's a quick refresher.

A p-value is the probability that you see data as extreme, or more extreme, than what you've seen, given that the null hypothesis is true.

That's got to be the murkiest definition I've ever seen. Let's take an example:

Suppose we have a 2-year-old MacBook Pro, and we want to sell it. Suppose the mean resale value of 2-year-old laptops in general is \$300. So the status quo price, the one we would expect to get if we were to sell the laptop, is \$300. Our null hypothesis (status quo) is that the population mean resale value of a 2-year-old MacBook Pro is equal to \$300. We're poor students, and we want more than that if we can get it.

We want to test if the mean resale value of a 2-year-old MacBook Pro laptop is more than \$300. So our alternative (sometimes called 'research') hypothesis is that the population mean resale value of a 2-year-old MacBook Pro is greater than \$300.

We looked on Kijiji and found that there were 10 2-year-old MacBook Pros sold recently, for \$100, \$200, \$250, \$275, \$300, \$325, \$400, \$550, \$600, and \$650, respectively. The mean resale value based on our sample of 10 is \$3625/10 = \$362.50 and the standard deviation is \$177.27. So we have a sample mean, $\bar{x} = \$362.50$ and a sample standard deviation, $s = \$177.27$. We will use $\bar{x}$ and s to determine whether we can expect to get more than \$300 for our MacBook Pro.

We want to limit the probability of committing a type 1 error to no more than 5% (that is, we choose an α of 0.05). Side note – remember type I error? It's the probability of screwing up and saying the null hypothesis should be rejected when in fact it shouldn't be. So here, that would be the probability of saying the mean resale value of the MacBook Pro is not \$300, when in reality it could be.

Your typical hypothesis test has several steps: state the null and alternative hypotheses, calculate the test statistic, find the p-value, and conclude. In this case, the null and alternative hypotheses are, respectively, that the population mean resale value is \$300, and the population mean resale value is more than \$300. More concretely, $H_0 : \mu = \$300$, $H_a : \mu > \$300$.

If we had more than 30 elements in our sample, we could use a normal distribution to calculate our test statistic, but small samples like ours are too varied for that distribution to be appropriate. Instead, we'll use

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Preamble

by Kyle MacDonald (McMaster University)

As campuses refill and leaves change, we return to the mathematical life. Every autumn is different: some of us may take up teaching duties for the first time or begin new research positions, while others may find themselves digging in for a routine winter of textbooks and departmental commitments.

Nevertheless, September fades predictably into October, and a new crop of theorems needs to be proven and harvested before the frost sets in.

Contributors to this issue of the Margin analyzed and algebraized the mathematical experience of autumn. They review a few key ideas that may have gone rusty, from hypothesis tests to manifolds and locality, and present new variations on such familiar standards as limits and groups. One addresses the fear of inadequacy that grips all of us from time to time, even as our successes accumulate, and its particular effect on women in mathematics. In addition to Tyrone's regular puzzle on the Distractions Page, our longtime editor Kseniya contributed a puzzle that livened up my train ride home for Thanksgiving.

We are pleased to share such a heterogeneous table of contents with you, and as ever we encourage you to send us your work at student-editor@cms.math.ca. Our inbox is always wide open, though as November settles in we may have to contend with a draft or two.

Cover photo courtesy of Brian Zheng Photography.

Correction: In the previous issue of the Margin (Vol. IX), Alex Brandts was identified as a student at the University of Alberta. He is in fact a student at the University of Ottawa.

a t distribution (this might be a good time to dust off your textbook from second year if you're unsure why Studet-t is the correct distribution):

$t^* = (\bar{x} - \mu)/(s/\sqrt{n}) = (362.5 - 300)/(177.26/\sqrt{10}) = 1.11$

(approximately).

This is where p-values come in. The p-value is the probability that we see data ($\bar{x} = \$362.50$) as extreme or more extreme than what we see, given that the null hypothesis ($\mu = \$300$) is true.

In English, that's the probability that we see $\bar{x} = \$362.50$ or more if the true population mean selling price is \$300. (Why didn't we say 'or less'? Because our original question was whether the resale value was more than \$300).

Since we calculated a test statistic from the t distribution, we'll use a t table to get that probability. We have 9 degrees of freedom, since we have 1 parameter to estimate (μ) and 10 elements in our sample.

We want $P(t \geq t^*) = P(t \geq 1.11)$, that is, the probability that $\bar{x}$ is \$362.50 or more, given that the null hypothesis is true. $P(t \geq 1.11)$ is the p-value. Looking that up in a t-table, we see the value is 0.15. Our p-value is 0.15.

We compare the p-value to the probability of type I error (α). If the p-value is less than α, then we reject the null hypothesis. Otherwise, we do not reject the null hypothesis.

Here's why:

If the p-value is less than α, then the probability that we see data as extreme or more extreme than what we see, given the null hypothesis is true, is very low. If the probability of seeing $\bar{x} = \$362.50$ is low, given that the true population mean selling price is \$300, then it's unlikely that the true population mean selling price is equal to \$300, so we reject the possibility.

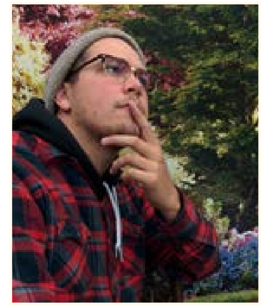
Our conclusion is that since $0.15 > 0.05$ (that is, p-value $> \alpha$), we do not reject the null hypothesis that the true population mean selling price is equal to \$300. Another way of saying this is that we do not have sufficient evidence to reject the null hypothesis.

Final notes: The fact that the p-value is 0.15 means that the probability that you see a sample average of \$362.50 or higher, given that the true population mean selling price is \$300, is 0.15. So if you got another 10 laptop prices from Kijiji, and the next day got another 10, and then another 10, and so on, you would see a mean selling price, each day, of at least \$362.50 if the true population mean selling price is \$300, 15% of the time.

Direct Sequences And Inductive Limits Of Groups

by Dan Hudson (University of Victoria)

Students are often first introduced to sequences and limits of sequences in first year calculus classes. As students go through calculus and analysis, sequences are ubiquitous, being the foundation of many structures.



Dan Hudson

Without question, the best part of doing mathematics in university is the ability to explore a world of abstract nonsense without restraint.

As is the case in many mathematics, one can ask, "Can this be generalized?" The answer in this case is yes.

In this article we define direct sequences and inductive limits of groups with group homomorphisms. We then show that inductive limits exist and prove a theorem on inductive limits of subsequences of a given direct sequence.

1. Direct Sequences and Inductive Limits of Groups

We begin with direct sequences of groups with group homomorphisms, which are so-called categorical colimits.

Definition 1.1 A direct sequence of groups is a sequence

$$A_1 \xrightarrow{\varphi_1} A_2 \xrightarrow{\varphi_2} A_3 \xrightarrow{\varphi_3} \cdots$$

where each A_n is a group and each $\varphi_n : A_n \to A_{n+1}$ is a group homomorphism. In addition, for $m > n$ we define the map $\varphi_{nm} : A_n \to A_m$ by

$$\varphi_{nm} := \varphi_{m-1} \circ \cdots \varphi_{n+1} \circ \varphi_n \text{ and } \varphi_{nn} := \mathrm{id}_{A_n}$$

Given a direct sequence $((A_n), (\varphi_n))$, we wish to associate a "limiting" object in a certain sense. This leads to the definition of a inductive limit.

Definition 1.2 An inductive limit of the direct sequence

$$A_1 \xrightarrow{\varphi_1} A_2 \xrightarrow{\varphi_2} A_3 \xrightarrow{\varphi_3} \cdots,$$

denoted $\varinjlim V_n$, is a system $(A, (\mu_n)_{n=1}^{\infty})$, where A is a group, each $\mu_n : A_n \to A$ is a group homomorphism for all $n \in \mathbb{N}$, and the following two conditions hold

(i) Diagram 1 commutes, that is $\mu_n = \mu_{n+1} \circ \varphi_n$, for all $n \in \mathbb{N}$ and

(ii) if $(B, (\lambda_n)_{n=1}^{\infty})$ is a system where $\lambda_n = \lambda_{n+1} \circ \varphi_n$ for all $n \in \mathbb{N}$, then there is a unique group homomorphism $\lambda : A \to B$ making Diagram 2 commute, that is $\lambda \circ \mu_n = \lambda_n$, for all $n \in \mathbb{N}$.

$$\begin{tikzcd} A_n \arrow[rr, "\varphi_n"] \arrow[dr, "\mu_n"'] & & A_{n+1} \arrow[dl, "\mu_{n+1}"] \\ & A & \end{tikzcd}$$

Diagram 1

$$\begin{tikzcd} & A_n \arrow[dl, "\mu_n"'] \arrow[dr, "\lambda_n"] & \\ A \arrow[rr, "\lambda"'] & & B \end{tikzcd}$$

Diagram 2

It should be noted that inductive limits not only depend on the groups in the direct sequence, but also on the connecting homomorphisms. Observe as well that property (ii) implies that inductive limits, when they exist, are unique up to isomorphism. Indeed, the next proposition shows that they do exist.

Theorem 1.1. If

$$A_1 \xrightarrow{\varphi_1} A_2 \xrightarrow{\varphi_2} A_3 \xrightarrow{\varphi_3} \cdots$$

is a direct sequence of groups, then $\varinjlim A_i$ exists.

Proof. Let $A_1 \xrightarrow{\varphi_1} A_2 \xrightarrow{\varphi_2} A_3 \xrightarrow{\varphi_3} \cdots$ be a direct sequence of groups and define a relation $\sim$ on the disjoint union $\sqcup_{i=1}^{\infty} A_i$ by $a \sim \varphi_{nm}(a)$ for $a \in A_n$, $m \geq n$, and $n \geq 1$. It is easy to check that $\sim$ is an equivalence relation, so we define $A := \sqcup_{i=1}^{\infty} A_i / \sim$. If $a \in A_n$ and $b \in A_m$, then for any $k \geq m, n$, we define their product in A to be the class of $\varphi_{nk}(a)\varphi_{mk}(a)$. This is easily seen to be independent of k, and is therefore a well defined group operation. Thus A is a group.

We claim that $A = \varinjlim A_i$. We define the maps $\mu_n : A_n \to A$ to be the quotient maps. Then, condition (i) of Definition (1.2) holds by definition. Now suppose that $(B, (\lambda_n)_{n=1}^{\infty})$ is a system of groups where $\lambda_n = \lambda_{n+1} \circ \varphi_n$ for all $n \in \mathbb{N}$. For $a \in A_n$, then we define $\lambda : A \to B$ to be the map $\lambda([a]) = \lambda_n(a)$. If we can show that λ is well defined, then it is clearly the unique map so that (ii) holds.

Let $a \in A_n$ and suppose that [a]=[b]. Then, there exists some $m \geq n$ such that $b = \varphi_{nm}(a)$. Therefore,

$$\lambda([b]) = \lambda_m(b) = \lambda_m(\varphi_{nm}(a)) = \lambda_n(a),$$

since $\lambda_n = \lambda_{n+1} \circ \varphi_n$ for all $n \in \mathbb{N}$. Thus λ is well defined, which completes the proof.

We now state and prove a theorem which is analogous to "subsequences of a convergent sequence converge to the same limit".

Theorem 1.1. Let $A_1 \xrightarrow{\varphi_1} A_2 \xrightarrow{\varphi_2} A_3 \xrightarrow{\varphi_3} \cdots$ be a direct sequence of C^*-algebras and (n_k) be a strictly increasing sequence of positive integers. Form a new direct sequence by

$$A_{n_1} \xrightarrow{\varphi_{n_1 n_2}} A_{n_2} \xrightarrow{\varphi_{n_2 n_3}} A_{n_3} \xrightarrow{\varphi_{n_3 n_4}} \cdots.$$

Then, $\varinjlim A_n \simeq \varinjlim A_{n_k}$.

Proof. Clearly, any class $[a] \in \varinjlim A_{n_k}$ can also be considered as a class in $\varinjlim A_n$. Therefore, we define a map $\phi : \varinjlim A_{n_k} \to \varinjlim A_n$ by $\phi([a]) = [a]$. This map is clearly a well defined and injective homomorphism, so we show that it is surjective.

[1]This work was partially funded by NSERC USRA and by Dr. Heath Emereson.

Let $[a]$ be a class in $\varinjlim A_n$. Then, $a \in A_m$ for some m. For any $n_k > m$ we have that $b := \varphi_{mn_k}(a) \in A_{n_k}$, and so $\phi([b]) = [b] = [\varphi_{mn_k}(a)] = [a]$, showing that ϕ is surjective and completing the proof.

2. Further Abstraction

In general, one can talk about direct sequences and inductive limits in any category $\mathscr{C}$ and the definition is the same. A category is a family of objects together with morphisms connecting them. Morphisms act like maps in the sense that

(i) each morphism f has a unique domain A and range B and we f is a morphism from A to B, which we denote by $f : A \to B$,

(ii) if $f : A \to B$ and $g : B \to C$, then we may compose them to get a morphism $g \circ f : A \to C$, and composition is associative in the sense that $h \circ (g \circ f) = (h \circ g) \circ f$.

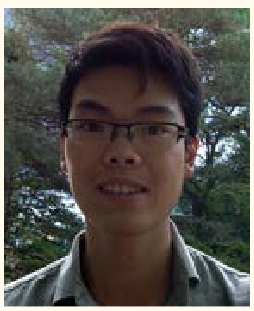
(iii) for every object A in $\mathscr{C}$, there exists an identity morphism $\mathrm{id}_A : A \to A$ such that for and $f : A \to B$ we have $f \circ \mathrm{id}_A = f$ and $\mathrm{id}_B \circ f = f$.

For example, we have defined the category of groups to be the collection of all groups with morphisms being regular group homomorphisms. Another example would be the category of all open intervals of the real line, with morphisms being continuous functions.

Acknowledgments. The author would like to thank Dr. Heath Emerson for helping with the construction of the inductive limits of groups.

References

[1] M. Rørdam, F. Larsen, N. J. Laustsen. An Introduction to K-Theory for C^*-algebras. London Mathematical Society Student Texts 49. 2000.



Raymond Cheng

A new academic year brings forth new mathematical horizons.

Geometry, Locally

by Raymond Cheng (University of Waterloo)

This note will be a short musing on how geometric objects are constructed and studied in modern geometry. Classically, geometric objects were typically given by describing an explicit embedding into some ambient space; in this way, classical geometry was often inundated with formulae describing either parameterizations or else systems of equations corresponding to an object.

Modern geometry theories, on the other hand, tend to view objects as independent: that is, not necessarily embedded in any ambient space, but rather amenable to local study via comparison with some model space. This sentence is bursting with information and is likely vague and overwhelming for the uninitiated; the primary aim of this note is to step toward deciphering this sentence.

One of the favourite words of anyone acquainted with geometry—or at least one who has attempted to do any serious work in geometry! — is certainly the word "local", along with all its derivatives. To a geometer, to say that a property is local means it is sufficient to consider said property on a neighbourhood of each point. Intuitively, local properties are, well, local: only points nearby can affect this property. Notions of proximity are encoded mathematically by a topology, and everything discussed thus far can be made precise with topological language.

A driving philosophy in modern geometry is that geometric properties should be easy, or at least familiar, locally. This principle is precisely realized in the definition of virtually any class of geometric objects. Indeed, almost any geometric object is taken to be a topological space that is locally isomorphic to a model space. The term *model space* basically refers to a simple example of the geometric structure under consideration. Model spaces tend to be simple enough that their geometric properties can be precisely and explicitly understood through technical machinery from algebra and analysis. Global properties of geometric objects are then obtained by carefully patching together local information. How this patching proceeds may be tricky and is peculiar to each geometric field, although general machinery such as sheaves and cohomology do provide a unifying theme to various glueing constructions.

Time to move from philosophy to mathematics. Smooth manifolds are geometric objects on which we should be able to do calculus. Euclidean space $\mathbb{R}^n$ is where differentiation and integration makes sense, so unsurprisingly, such are the model spaces in this context. In other words, smooth manifolds are generally

We are happy to announce that the Canadian Undergraduate Mathematics Conference will be hosted next year at the University of Victoria in beautiful British Columbia. CUMC 2016 at UVic will be an exciting five days of sharing ideas, networking, and celebrating the vast diversity within the field of mathematics and within the community of mathematicians. Victoria BC in the summer is a vacation destination. Delegates will have the opportunity to experience all that it has to offer, from spectacular beaches and parks to the charming Inner Harbour in the center of downtown. Furthermore, UVic boasts an active Department of Mathematics and Statistics whose faculty are engaged in exploring a wide range of fields, including graph theory, mathematical biology, and operator algebras. Our organizing committee is dedicated to ensuring that the event runs smoothly and is enjoyable for every participant. We hope to see you there!

topological spaces X which are locally homeomorphic to $\mathbb{R}^n$—for simplicity, I shall ignore the technical point-set topology requirements here. If $U \subseteq X$ is an open subset which is locally homeomorphic to $\mathbb{R}^n$, then we can think of U as possessing a system of local coordinates; the homeomorphism allows us to import the standard coordinates in $\mathbb{R}^n$ to U. We are now able to do calculus on X locally by using these local coordinates on each open set. In order for these analytic notions to make sense globally, we need to impose a compatibility condition on these local homeomorphisms which says that smooth functions on one local patch are the same as those on another local patch. Specifically, if $U, V \subseteq X$ are open subsets which can be equipped with local coordinates, then there is a change of coordinate map φ which relates the two open sets; the required compatibility condition is for φ to be a smooth---that is, infinitely differentiable—map.

For a second example of the philosophy explained, let us discuss varieties over an algebraically closed field k. The simplest varieties are those that are given as the zero loci in k^n of a set of polynomials $(f_i)_{i\in I}$ in n-variables; such varieties are called *affine varieties* and each such variety is a model space for general varieties. Geometric properties of affine varieties, and hence local properties of general varieties, are understood through correspondence between algebra and geometry promised by the Nullstellensatz. This magnificent theorem basically says that all geometric properties of an affine variety V are encoded as algebraic properties of its coordinate ring k[V], which is algebra of polynomial functions not vanishing on V. More precisely, k[V] is the quotient of the n-variate polynomial over k by the ideal generated by the polynomials f_i defining V. In this fashion, local properties of varieties in general are understood through the tools of commutative algebra applied to the coordinate rings of local affine patches.

As an aside, notice that the rings that appear as coordinate rings of affine varieties are severely constrained; for instance, coordinate rings of affine varieties contain no nilpotent elements. Such constraints are removed in the theory of schemes, so that any commutative ring can be realized as the coordinate ring of some affine scheme. A scheme is then a topological space that looks locally like an affine scheme. Though these sentences are easy to state, much effort is required to make everything precise.

So far, geometric objects are viewed as topological spaces that are locally isomorphic to model spaces. Rather than starting with a prefabricated space, we can construct objects by glueing together model spaces. To see what is meant by this, it is useful to nonetheless start with a ready-made example and construct a copy of it from scratch. For illustration, consider a smooth manifold X. Cover X with local coordinate patches $\{U_\alpha\}$. Reconstruct X by taking the disjoint union of the U_α and then by glueing U_α with U_β along their intersection $U_\alpha \cap U_\beta$ using the change of coordinate map relating the local coordinates on U_α with those of U_β. Doing this for all pairs of coordinate patches gives a topological space which is homeomorphic to X and local coordinates on this resultant space are obtained through the U_α again.

Ask Ada

Advice for math grads–Valentine's edition!

by Jane Butterfield (University of Victoria)

Dear Ada, I've always loved math. That's why I came to grad school. I thought I had found the one! The subject area, the potential adviser. But I'm in my second year now and as I slog my way through comps and more advanced material, I feel like the heat is gone from my relationship with math. I think I might have committed too soon. Now I want to play the field but it seems too late. I don't want to end up in my fourth year with 10 cats for an adviser. How do I rekindle that spark? How do I find out if its the subject area I picked, or the stress of comps? Is it time to say, "Sorry, math: it's not you, it's me"? – *Feeling Fickle, Champaign*

Dear Fickle, People's tastes do change, and graduate school has probably introduced you to new areas of math that you had never met before. Under those circumstances, it is quite likely that you will discover the math you came here loving is not actually the right area for you. qualifying exams can be stressful, but they also serve an important purpose: comps force you to "play the field", and may introduce you to the new love of your life. If you have no pressing reason to leave (a job offer, lack of funding, etc.), stay around until after comps and see where you stand once the dust settles! – *Ada*

• • •

Dear Ada, I am as in love with Graph Theory as I ever was, but lately it seems like we have no time for each other. I came to graduate school so that we could take our relationship to the next level (research), but instead I am required to satisfy my comp requirements by playing around with every kind of math except Graph Theory. How can I maintain my relationship with Graph Theory like this? Does it get better? – *Ready to commit, Champaign*

Dear Ready, if you knew before you came to grad school that you wanted to do research then it can be disheartening to discover you have to take classes for two years first! Comps are great for people who haven't yet found their area, but even people like you will find that in a couple of years you are using some things you learned from Algebra or Topology or even Real Analysis – I promise! In the meantime, keep your relationship with Graph Theory active by attending the weekly seminar, browsing interesting abstracts on the arXiv, and filling in your schedule with Combinatorics courses. – *Ada*

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Dear Ada, I have been in a committed relationship with Graph Theory since my senior year in college. I am now in my fourth year of graduate school. At a conference the other day I suddenly realized that everyone there was talking about completely unimportant things that don't matter to the real world. I am starting to question my whole relationship with Graph Theory and wonder if I can ever find meaning or fulfillment from it again. How can I tell if the passion is really gone? – *Cold feet, Urbana*

Dear Cold, This kind of epiphany can be very disconcerting, particularly if you are fairly far along in your graduate career. If it matters to you whether your research is ever likely to help someone in the real world, find out if it might! Your advisor should know of any applications (those sorts of things get mentioned in grant applications). Ask! You can then research those applications further to see if they seem important to you. You may also just need to see a really beautiful proof or result to restore your faith; try browsing the literature, or ask your friends and advisor what their current favourite proof is. – *Ada*

• • •

Dear Ada, I'm perfectly happy with my relationship with Math, and with my choice to commit to grad school. But it's hard work! The thing is, when I look around the department I see plenty of people whose relationships with Math look easy. Am I doing it wrong? Am I not smart enough for this? For me, this is hard and not always fun. Does that mean I shouldn't be doing it? – *Out of her Depth, Champaign*

Dear Depth, This is a very common feeling! It is so common that it has a name: "Impostor Syndrome". Women are particularly susceptible to this feeling that "I don't really belong here" and "it is so much easier for everyone else". With the possible exception of a few really remarkable mathematicians, however, everyone feels this way some of the time (or even most of the time). Most importantly, you don't have to like it. At least, you don't have to like it all the time. Some of the work you will do towards getting your degree really is just that — work. As long as the department and your advisor consider that you are making adequate progress toward your degree, you are doing just fine. Take their feedback seriously, and try not to think that you are just fooling them! – *Ada*

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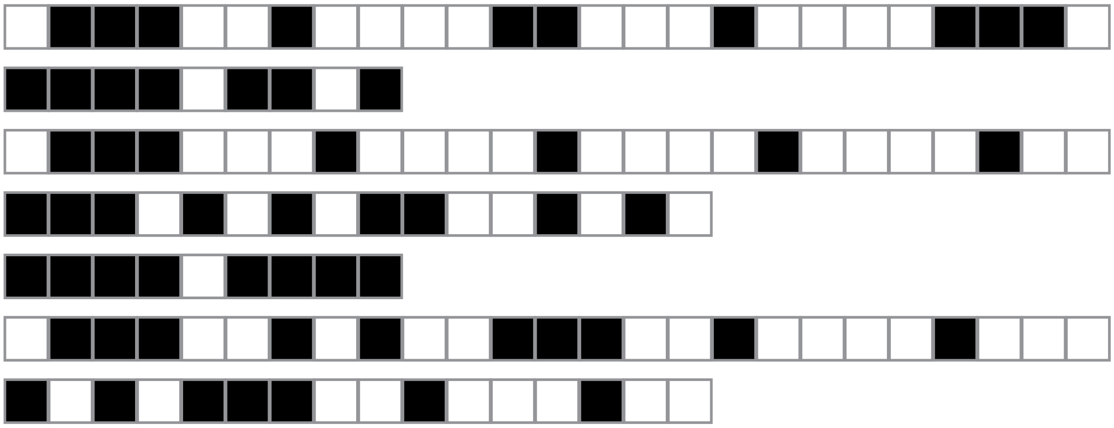
Do you have any questions about your relationship with Mathematics? Submit them to this column by emailing **student-editor@cms.math.ca** and see what Ada suggests!

The Distractions Page

Assemble

by Tyrone Ghaswala (University of Waterloo)



Tyrone Ghaswala

My favourite thing about the Fall term is finally having people around to talk math to again! That, and puzzle harvest season of course.

Ariadne's String

by Kseniya Garaschuk (University of British Columbia)

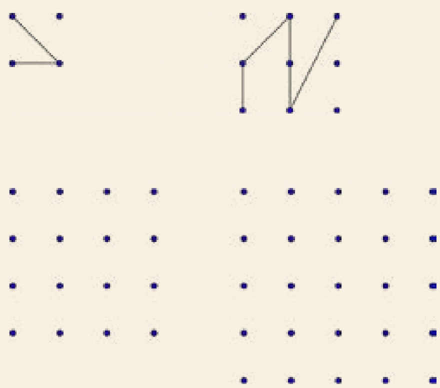
Suppose you have an $n \times n$ grid with vertices at lattice points. The rules of the game are as follows: draw a continuous zigzag line, where each line segment starts and ends at lattice points; line segments cannot touch (even at a vertex) and each subsequent line segment must be longer than the previous one. The goal: get as many line segments in as possible.

Here are some small maximal cases and some bigger ones for you to try!

Let me give you a little hint to make sure you're on the right track: you should be able to fit 9 line segments in the last grid. Have fun.

This puzzle originally comes from Dr. Gordon Hamilton and his website **http://mathpickle.com**.

He uses it for his students to practice applying Pythagorean theorem. But an algorithm for finding the largest number of segments or a formula for how many there are in an $n \times n$ grid is still unknown (as far as I am aware), so it's an open problem you can tackle.



Kseniya Garaschuk

Best thing about fall? The leaves, the smell, the colours and, of course, Halloween.

The CMS Student Committee is looking for proactive mathematics students interested in joining the Committee in the roles of **chair, regional representatives for Quebec and Ontario, and English-to-French translator**. Francophone applicants are preferred for the positions of translator and regional representative for Quebec. If you are interested, or know someone who may be, please visit our website **http://studc.math.ca** for more information and an application form. If you have any questions, please contact us at **chair-studc@cms.math.ca**.

Le comité étudiant de la SMC est à la recherche d'étudiants en mathématiques dynamiques qui seraient intéressés à joindre le comité étudiant pour combler les postes du **président, représentants régionaux pour le Québec et pour l'Ontario, et du traducteur anglais-francais**. Les applicants francophones seront préférés pour les postes du traducteur et du représentatif regional pour le Quebec. Si vous êtes intéressé ou connaissez quelqu'un qui pourrait l'être, veuillez consulter notre site web **http://studc.math.ca** pour plus d'informations et pour télécharger le formulaire d'application. Pour toute question, veuillez nous écrire à **chair-studc@cms.math.ca**.

The eighth Ottawa Mathematics Conference was held on June 19-20. Once again, this conference organized by and for graduate students was a success. This year, there were over 40 participants from 10 different universities, to listen to 17 student speakers and 2 keynote speakers. Even though each talk was in a different field, the audience was focused and asked stimulating questions. Right from the start, the participants got along well. It made for an enjoyable atmosphere during both the conference and the social events. We hope to see you next year!

We invite you to participate in the next poster session that will be held at the **2015 CMS Winter Meeting in Montreal, December 4th-7th**. CMS now offers a lower registration fee for poster session participants. More information about participating will be posted on our website (studc.math.ca) and our Facebook page (CMS Studc) in the coming months. Studc is planning a number of other exciting student events to be held during the meeting, including a student workshop and a social. Check the meeting website http://cms.math.ca/Events/winter15/.e for the most up-to-date information.

Nous vous invitons à participer à la prochaine compétition qui aura lieu lors de la **Réunion d'hiver SMC 2015 à Montreal, du 4 au 7 decembre**. La SMC offre maintenant une réduction sur les frais d'inscription pour les participants de la session de présentation par affiches. D'autres informations sur l'événement seront mises en ligne sur notre site web (studc.math.ca) et sur notre page Facebook (CMS Studc) dans les mois à venir. Studc prépare actuellement d'autres activités excitantes destinées aux étudiants qui prendront part à la réunion, y compris des ateliers ainsi qu'une activité sociale. Consultez le site web de la réunion, http://cms.math.ca/Reunions/hiver15/.f, pour obtenir les informations les plus récentes.

The 2015 Canadian Undergraduate Mathematics Conference took place at the University of Alberta from June 17-21. With attendees representing universities from coast to coast, the conference truly captured the spirit of the Canadian undergraduate mathematics community. The 2015 CUMC featured 71 student talks and six keynotes, with topics ranging from the mathematics behind string theory and wolf packs to graph-theory games and statistics. Attendees also took part in a Gender Diversity in Mathematics evening, roundtable discussions, and a closing banquet at the historic Fort Edmonton Park to close the conference.

L'édition 2015 du Congrès Canadien des Étudiants en Mathématiques a eu lieu à l'Université de l'Alberta du 17 au 21 juin. Avec des participants venus d'un bout à l'autre du pays, le congrès a bien su capturer l'esprit de la communauté d'étudiants sous-gradués canadiens. Le CCÉM 2015 a donné l'occasion à soixante-et-onze étudiants de donner des exposés auxquels se sont ajoutés six conférenciers pléniers. Les sujets, très diversifiés, sont allés des mathématiques de la théorie des cordes ou des meutes de loups jusqu'aux jeux en théorie des graphes, en passant par la statistique. Les participants ont aussi pris part à une soirée de la diversité des genres en mathématiques, à des discussions en tables rondes et à un banquet de clôture au lieu historique de Fort Edmonton Park.

Notes from the Margin is a semi-annual publication produced by the Canadian Mathematical Society Student Committee (Studc). The Margin strives to publish mathematical content of interest to students, including research articles, profiles, opinions, editorials, letters, announcements, etc. We invite submissions in both English and French. For further information, please visit studc.math.ca; otherwise, you can contact the Editor at student-editor@cms.math.ca.

Notes from the Margin est une publication semi-annuelle produite par le comité étudiant de la Société mathématique du Canada (Studc). La revue tend à publier un contenu mathématique intéressant pour les étudiants tels que des articles de recherche, des profiles, des opinions, des éditoriaux, des lettres, des annonces, etc. Nous vous invitons à faire vos soumissions en anglais et en français. Pour de plus amples informations, veuillez visiter studc.math.ca; ou encore, vous pouvez contacter le rédacteur en chef à student-editor@cms.math.ca.

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