News from the Department of Mathematical Sciences
University of Massachusetts Lowell

Tangents

Spring 2013

Steve's Sector

From the Chair

Spring break has arrived, much to everyone's delight. The term spring break is a misnomer this year. It is snowing now, with more storms predicted to be on the way.

Steve Pennell

Congratulations to our fall graduates: Isaac Duodu, Adrian Kizito Kalyesubula, Tina Joy Kinch, Jeremy Ryan Lapointe, Martina K. Norska, Tyler Ouellet, Steven Michael Peters, and Nicolas Benjamin Spoors.

With the help of Deme Gys from the Office of University Advancement, our department is developing an external advisory board. We are fortunate that the following five people have agreed to serve on the board:

- Dr. John Burke, Senior Principal Scientist/Head of Systems Biology at Boehringer Ingelheim Pharmaceuticals and an alumnus
- Dr. Al Cuoco, Distinguished Scholar/Advisor at the Education Development Center, Inc. (EDC)
- Ms. Caroline Gagnon, Applications Specialist at MEDITECH and recent graduate
- Mr. Richard Jackson, Engagement Leader at Pegasystems Inc. and an alumnus
- Dr. Lucy Kimball, chair of the Department of Mathematical Sciences at Bentley University and an alumna

We plan to use their expertise to help us keep our curriculum relevant and up to date.

April is Math Awareness Month. This year's theme is the Mathematics of Sustainability. From http://www.mathaware.org: "Humanity continually faces the task of how to balance human needs against the world's resources while operating within the constraints imposed by the laws of nature. Mathematics helps us better understand these complex issues and is used by mathematicians and practitioners in a wide range of fields to seek creative solutions for a sustainable way of life. Society and individuals will need to make challenging choices; mathematics provides us with tools to make informed decisions."

The year 2013 has been dedicated to the Mathematics of Planet Earth. From http://mpe2013.org/: "Our planet is the setting for dynamic processes of all sorts, including the geophysical processes in the mantle, the continents, and the oceans, the atmospheric processes that determine our weather and climates, the biological processes involving living species and their interactions, and the human processes of finance, agriculture, water, transportation, and energy. The challenges facing our planet and our civilization are multidisciplinary and multifaceted, and the mathematical sciences play a central role in the scientific effort to understand and to deal with these challenges."

I hope everyone had a happy Pi Day on 3.14. Professor Ken Levasseur can't decide whether to celebrate 6.28 as Perfect Day (6 and 28 being the smallest two perfect numbers) or Tau Day (= 2π). What do you think?

This will be my last column as chair of the Department of Mathematical Sciences. My term as chair ends on June 30, and I am not running for re-election. I look forward to spending more time working with students and doing math.

Please keep in touch, and stop in to visit the next time you are in the area. Remember to check out our web site for items of interest. If you can, please join us for our annual Alumni Reception/Student Awards Ceremony on May 3 at UML's Inn and Conference Center.

Video Resources for Learning Mathematics

by Ken Levasseur

As you read this article, you can also view examples of videos that are discussed. Links to them are at http://faculty.uml.edu/klevasseur/videos/math_videos.html.

The Internet has spawned an important new source of learning materials in the form of videos. Inexpensive software is now available so that anyone can create them. Web sites such as Kahn Academy have become among the first places that students turn to learn basic. Many of us in the mathematics community have become amateur videographers, creating specialized videos for our own courses. There is a continuum that ranges from videos that address specific topics to off-the-cuff videos that are created to address a very specialized situation. While the former might have an indefinite shelf life, the latter videos may only be useful for the semester in which a course is running. In this article I'd like to highlight a few videos at different parts of the continuum.

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The *Tangents* Problem

The Spring 2012 Problems:

1. Suppose that every 12 hours you take a 200-milligram dose of antibiotic, which has a half-life of 24 hours. Find the amount of drug in your blood after the *n*th dose. Describe the steady state level of the drug immediately after doses.

2. Consider a rectangular array of integers with 10 rows and 5 columns, like the one below, in which the entries in the top row are distinct integers between 0 and 9 inclusive, and each entry below the top row is equal to 1 more than the entry immediately above it, modulo 10. For $1 \le i \le 10$, let m_i be the median of the numbers in the ith row. Show that the sum of the medians $m_1, \ldots, m_{10}$ is 45.

   Example:

i = 1	2 9 7 5 1	median is 5
i = 2	3 0 8 6 2	median is 3
i = 3	4 1 9 7 3	median is 4
i = 4	5 2 0 8 4	median is 4
i = 5	6 3 1 9 5	median is 5
i = 6	7 4 2 0 6	median is 4
i = 7	8 5 3 1 7	median is 5
i = 8	9 6 4 2 8	median is 6
i = 9	0 7 5 3 9	median is 5
i = 10	1 8 6 4 0	median is 4

Up to four correct solutions of either problem from among all that are submitted by September 1, 2013 will earn the solver a "UML Math" T-shirt. You may submit your solution to mathematics@uml.edu or mail it to Ken Levasseur, Department of Mathematical Sciences, North Campus/ Olney Hall, UMass Lowell, Lowell MA 01854.

Thanks for the Contributions!

Our thanks to all who have contributed to the Department of Mathematical Sciences over the past few years. Your generosity has allowed us to make purchases, award scholarships, and engage in activities that would otherwise have been impossible.

Many of you have responded generously to fundraising contacts. These contributions can benefit the Department of Mathematical Sciences directly if you specify that you wish to have your gift directed to Mathematics. Otherwise it will provide valuable assistance to the University at the College level.

The Fall 2012 Problem:

Imagine a flat-bottomed pot with circular cross-section of radius 4 inches. What is the radius of the marble, with radius $0 < r \le 4$ inches which when placed in the bottom of the pot, requires the largest amount of water to be completely covered?

Correct solutions were submitted by Gerry Pellegrini, Thomas Lumenello (BS, 1964), Thomas Picanco (MS, 2011), Pete Pietrewicz (BS, 1969), Guy T. Moore Jr (BS, 1984 and MS, 2011), Issam Badr (MS, 2001), John Bast (MS, 1985), Mike Mumford (MS, 1994), and Peter MacPhee (MS, 1996).

Tom Lumenello prefaced his solutions with these comments:

> Your Fall 2012 Tangents arrived and reading the Alumni Update about Andy Miller took me down memory lane and my similar experiences with Professor Ouellette, Dr. Mingins and many other members of the Physics and Math departments and Administration during that time period. Great memories!
>
> Then when I looked at the Tangents problem I had to smile as it appeared to me as if the problem had come directly from one of Andy Ouellette's calculus exams.

Here is Tom's solution:

The sphere within the pot has a radius r. Therefore the sphere volume is $4/3\pi r^3$, and the depth of water within the pot to just cover the sphere is $2r$. As the bottom of the pot has a circular cross-section of radius 4 the volume of water, V, within the pot to just cover the sphere is:

$$V = 2\,r\,(\pi 4^2) - 4/3\pi r^3$$

The maximum volume is determined from the first derivative of the above with respect to r, the variable for pot depth, which is set to zero as follows.

$$dV/dr = 32\,\pi - 4\,\pi\,r^2 = 0$$

Cancelling π and dividing both sides by 4 this becomes $r^2 = 8$ or $r = 2\sqrt{2} \approx 2.8284$ inches

Steve Pennell, Chair

Writers: Ken Levasseur, Dan Klain, Ravi Montenegro, Guntram Mueller (emeritus), Raj Prasad, Jim Propp, Marvin Stick

Tangents is produced biannually by the Publications Office for the Department of Mathematical Sciences. Your comments are welcome.

Faculty Update

Jim Propp writes:

In spring 2013, the American Mathematical Monthly published a paper of mine called "Real Analysis in Reverse." It arose out of my interest in the pedagogy of calculus, and my continuing efforts to tinker with how I teach the subject in the Honors Calculus sequence.

Sooner or later, a rigorous approach to calculus runs into the need for a completeness axiom for the real numbers; without it, one can't prove the intermediate value theorem and other workhorse theorems of the calculus. A common choice of completeness axiom is the least upper bound property; another choice is the nested interval property, which has the virtue of relating more concretely to students' intuitions about decimal representations; and a more geometrical choice that I've flirted with is the cut property of Dedekind (not to be confused with his cut-construction of the real numbers from the rational numbers).

It's well known that many such axioms are equivalent to one another, but not quite as well known that many of the theorems of the calculus (such as the aforementioned intermediate value theorem) can also do double-duty as axioms! Putting it metaphorically: many of the "leaves" of the calculus tree actually contain the genetic code of the real numbers, so that if you plant them and nurture them appropriately, you can reconstruct the real number system from them.

See http://jamespropp.org/reverse.pdf for more details.

Applied Discrete Structures, by **Al Doerr** and **Ken Levasseur**, has been listed among the recommended open content texts by the American Institute of Mathematics (http://www.aimath.org) as part of their Open Textbook Initiative. In addition, it is listed on the University of Minnesota Open Textbook Catalog (https://open.umn.edu/opentextbooks/)

Some other recent faculty publications:

Kylafis, N. D., Contopoulos, I., Kazanas, D., & **Christodoulou, D. M.** (2012). Formation and destruction of jets in X-ray binaries. Astronomy & Astrophysics, 538, A5. doi: 10.1051/0004-6361/201117052.

Jones, L. K., Zou, F., **Kheifets, A.**, **Rybnikov, K.**, Berry, D., & Tan, A. C. (2011). Confident predictability: Identifying reliable gene expression patterns for individualized tumor classification using a local minimax kernel algorithm. Bmc Medical Genomics, 4, 10. doi: 10.1186/1755-8794-4-10.

Klain, D. A. (2011). If you can hide behind it, can you hide inside it? Transactions of the American Mathematical Society, 363(9).

Klain, D. A. (2011). On the equality conditions of the Brunn-Minkowski Theorem. Proceedings of the American Mathematical Society, 139(10) doi: 10.1090/S0002-9939-2011-10822-0.

Klain, D. A. (2012). Steiner symmetrization using a finite set of directions. Advances in Applied Mathematics, 48(2) doi: 10.1016/j.aam.2011.09.004.

Giacaglia, G. P., Levine, L., **Propp, J.**, & Zayas-Palmer, L. (2012). Local-to-global principles for the hitting sequence of a rotor walk. Electronic Journal of Combinatorics, 19(1), P5.

Propp, J. (2012). A Galois Connection in the Social network. Mathematics Magazine, 85(1), 34-36. doi: 10.4169/math.mag.85.1.34.

Alumni Update

Jane Tang Grossman (BS, 1971). Jane's YouTube channel, bbdhrggl, containing piano and math tutorials averages over a million views per month. Students, young and old, write her from all over the world. She is enjoying her retirement project. Website: https://sites.google.com/site/pianoandmathtutorials/

Susan Gail Koumpouras (BS. 1989), is now a Technical Business Analyst at EBSCO Publishing.

UML Mathematical Sciences Online

Have you visited Mathematical Sciences web page lately? Our address is http://faculty.uml.edu/math

You can follow us on Twitter: http://twitter.com/UMassLowellMath.

Video Resources for Learning Mathematics *Continued from page 1*

Tutorials

In updating Applied Discrete Structures, the book Al Doerr and I wrote in the 1980's, we've added multimedia resources that include videos on specific topics. For example, one is on how to multiply permutations that are in cycle form. Anyone who has taken abstract algebra may vaguely recall how this is done. It's not terribly difficult—you just have to learn the rules. This can be taught in class, but it's just as easy to refer students to this video, freeing up time to discuss the more abstract theory associated with permutations.

Weekly Introductions in a Course

I usually teach an online course each semester. I've been doing it since 1996, when most of the courses on UMass Online were purely text-based. Adding a video introduction to each week's worth of material has had several benefits. Online courses tend to be created before the semester even starts. By the time you reach a specific week, what's gone on in the course so far through discussions and chats might necessitate slight adjustments in the course. Although it's possible to make some adjustments to the written materials, I find that it's more efficient to summarize them in a quick 10-20 minute video that students are asked to watch before starting that week's work. Student who are more accustomed to learning in face-to-face course are likely to find this "jump start" into the week beneficial even if the video exactly matches what's going on in the notes. The example provided in this category is a lead-in to cosets, direct products and isomorphisms.

Chat Transcripts

Chats play different roles in different online systems. UMass Online has been marketed to students with the promise that they can do work on their own time. This allows students with work or family commitments during normal class times to still take classes. For this reason, attendance in chat sessions is not normally required. They take the form of "online office hours Some instructors now can use a tablet computer to write mathematical notation, as they would have on a blackboard. Personally, I find that I can quickly type virtually any mathematical notation using *Mathematica* and/or LaTeX. Students can read it much more easily than my handwriting! Attendance in chats tends to be in the 10-50% range, but the video chat systems allow for archiving of sessions so that students who can't attend can still watch at a later time.

Quick Clarifications

Anyone who has taught at all knows the feeling of realizing there was some way that you could have made your exposition of class material so much better by doing something different from what you just did. Or maybe you just made a mistake, and students have been dispersed until your next class meeting. This might not happen frequently, but when it does there is something you can do about it. Creating a quick video to clarify what just went on in the class gives students an extra chance to think about the course and clear up possible misunderstandings that might otherwise hinder learning for up to a week.

Another use of quick clarifications is to explain grading and to clarify common misconceptions that appear in student work. Instead of writing the same comments on every homework paper, you need only write "see the" where the comment would go.

Final Remarks

The degree of access to videos varies according to their function. I tend to keep chat transcripts and quick clarifications inside a closed system available to students only. For chat transcripts, the reason is for privacy since I don't think students expect our conversations to be open to the general public. For quick clarifications, they tend to be too specialized to be of much interest outside my courses. For more polished presentations, I frequently export to YouTube or at least make the link public.

In order to engage students in learning, many educators have turned to a strategy of "flipping" their courses. The idea is to require students to prepare for a class by reading, watching or listening to background material. Then when the class meets, the students are engaged in activities such as problem sessions that have traditionally been assigned as homework. The reasoning behind this approach is that class time is precious and lecturing to passive students is not the best use of that time. I think that videos among the most effective ways to deliver the information in mathematics.

What Are You Up To?

Want to keep your classmates up to date on what you're doing and where you are? Take a few moments to tell us where you are, and whatever else you might like to share.

We can be contacted by mail at Department of Mathematical Sciences, North Campus, UMass Lowell, Lowell MA 01854. Telephone: (978) 934-2410. Email: mathematics@uml.edu

You might also wish to contact our Office of Alumni Relations, Southwick Hall 250, UML North, Lowell MA 01854-3629. Toll free telephone: (877) UML-ALUM. Email: Alumni_Office@uml.edu

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