News from the Department of Mathematical Sciences
University of Massachusetts Lowell

Tangents

Spring 2010

New Master's Option: PSM in Industrial Mathematics

In 1997, the Sloan Foundation began funding an initiative to develop a new Master's degree in science called the Professional Science Master's (PSM) degree. The objective was to train students in the sciences to seamlessly step into positions in business, industry and government. The PSM degree is normally a mix of traditional math and science courses together with "Plus courses" in the areas of communications and management. Another key component of the degree is a significant internship experience, normally 2-3 months of paid employment in industry. Nationwide, the number of PSM programs has grown steadily, with 151 degree programs by the end of 2009. More important than the growth is the evidence that students who complete the program really do have a significant advantage when they enter the workforce.

In 2009, UMass Lowell launched an initiative to start PSM programs in all of the sciences, and Mathematical Sciences has been among the first to get a PSM program approved. We are now accepting applications for our PSM program in Industrial Mathematics. Requirement of the program are

PSM™
PROFESSIONAL
SCIENCE MASTER'S

- Nine courses in mathematics and science, including a four course science cluster
- Three Plus Courses, with Professional Communications and two electives
- An internship that will provide the student with 340 hours of work experience.

The program has been developed to support the state's growing technology-dependent industries and will contribute to the economic development of the state and, in particular, the high-technology corridor near Boston and Lowell. We look forward to working with the local industrial community, particularly because many of them have already hired UML Math graduates. We've been in contact with several of them and have initiated a seminar series

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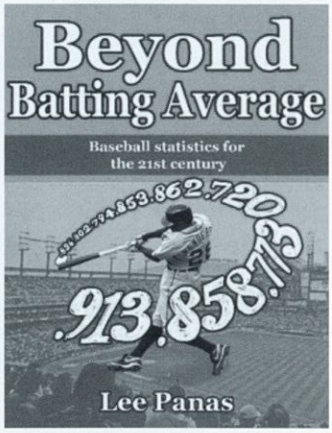
Beyond Batting Average

UMass Lowell Mathematics Department alumnus **Lee Panas** recently published a book entitled *Beyond Batting Average*. In this book, he introduces fans to sabermetrics or the study of baseball statistics. No longer is the discussion of baseball statistics limited to simple measures such as batting average, runs batted in and earned run average. Over the past few decades, a multitude of more advanced measures have been brought into the game. In fact, there are so many new statistics that it has been difficult for many fans to keep up.

This book introduces these measures to fans with easy to understand explanations and examples. It also illustrates the evolution of baseball statistics from simple traditional measures to the more complex metrics of today. Readers will learn how baseball statistics are connected to winning and losing games, how to interpret them, and how to apply them to performance on the field.



Mr. Panas works as a research analyst at Brandeis University. He also writes about baseball at his blog DetroitTigerTales.com, *Heater Magazine* and *Baseball Prospectus* and has contributed to books such as *Tigers Corner, Graphical Player* and *How Bill James Changed Our View of Baseball.*

Save a Tree! — Opt for electronic delivery of *Tangents*!

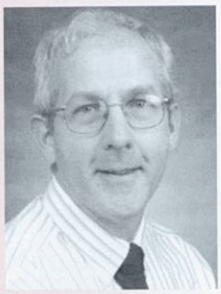
In an effort to save some trees, and save the department some money, we are hoping to distribute more copies of *Tangents* electronically in the form of pdf documents. If you don't opt for electronic delivery, we will continue mailing you *Tangents*. Instructions for opting out of the paper version are on the math department web page, http://faculty.uml.edu/math/. You will also find a link to pdf copies of all previous issues at the same location.

Steve's Sector

Spring 2010—From the Chair

Even though it feels like 2010 just started, it is already the beginning of March as I write this column. As usual, it has been an active time in the math department, and there are many people to congratulate:

- Junior math major Eva Moscat has been awarded a Technical Training Foundation Endowed Scholarship. Congratulations, Eva.



Steve Pennell

- Jennifer A. Armstrong, Stephen J. Bilozur, Phillip C. Carignan, and Erin R. Morrissey completed their BS degrees in December. Best wishes to all of them for continued success. Erin is working on her M.Ed. degree at Boston University, and Phil has been accepted into the UML MS program in Mathematics.
- Junior math major Angus MacDonald was recently named to the 2009 Northeast-10 Conference Fall All-Academic teams. He ran as a member of UMass Lowell's distance medley relay team the Boston University St. Valentine's Day Invitational. The team took third place and provisionally qualified for the NCAA Championship. Congratulations, Angus.
- Teaching Assistant/Graduate student and former undergrad math major Keith McElroy will complete his MS degree this semester and will then start work on his Ph.D. He has not yet decided which school he will attend. Congratulations and good luck, Keith. We will miss you.

A relatively new department initiative is a series of "boot camps" for students who perform poorly in various introductory courses. Chuck Ormsby ran the first boot camp in January 2009 for students who passed Calculus I in the fall 2008 semester but did not earn the grade of C required to continue to Calculus II. Since then we have run 4 other boot camps:

- Summer 2009, for incoming first-year students who wanted to boost their score on the Calculus Readiness Test to place into Calculus I, run by Chuck Ormsby.
- Winter Intersession 2010, for fall 2009 Management Precalculus students, run by Zahra Fardmanesh-Karimy. Successful participants raised their grade (to a maximum of C). Students who failed Management Precalculus but who had a "high F" were allowed to participate.
- Winter Intersession 2010, for fall 2009 Calculus IA, run by Chuck Ormsby. Successful participants raised their grade (to a maximum of C). Students who failed Calculus IA but who had a "high F" were allowed to participate.
- Winter Intersession 2010, for fall 2009 Calculus I students who did not earn the grade of C required to continue to Calculus II, run by Ron Brent.

These boot camps have been very successful, with approximately 90% of participants improving their course grades. We plan to continue offering the boot camps if the provost continues to fund them.

April is Math Awareness Month. This year's theme is Mathematics and Sports, a timely topic with the Winter Olympics taking place this year. For more information, go to http://www.mathaware.org or Google Math Awareness Month.

I hope everyone had a happy Pi Day on 3.14.

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 7 at UML's Inn and Conference Center.

The *Tangents* Problem

This problem was suggested by Emeritus Professor Shim Berkovits.

Given a chess board with 1 in. sided squares, what is the radius of the largest circle that crosses only black squares?

Up to four correct solutions from among all that are submitted by September 1, 2010 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.

The Fall 2009 problem

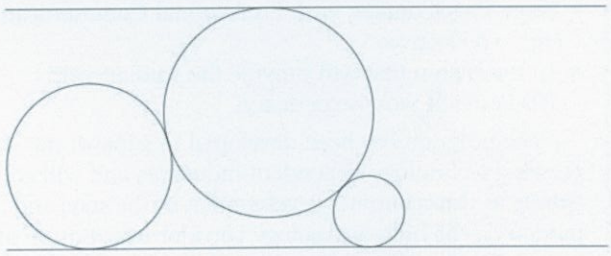
Consider the integer 1,052. It comes close to having an interesting property. If you take its units digit and move it to the leftmost position, you get 2,105, which is very nearly double 1,052. Find the smallest positive integer with the property that if you move the units digit to the front position you exactly double the original integer.

The smallest integer that satisfies the stated conditions is 105263157894736842. This problem was solved by Bryan Crompton (Class of 2010). In his own words, here is how he found this number:

The method of figuring it out is to realize that the units digit determines what the other digits should be. The next digit should be the remainder mod 10 of the previous digit multiplied by two plus any carry over from two digits before. The process can be stopped when a digit that is half of the units digit (rounded down for odd numbers) is found and the digit before this is less than five (if the units digit is even) or greater than or equal to five (if the units digit is odd). Starting from all possible unit digits, we find that starting with two produces the smallest number.

The Spring 2009 problem

There was a flaw in this problem that made the solution overly complicated. Had balls been larger, or the pipe smaller the balls could have been packed as in the following figure. As Guy Moore (B. S., 1984) pointed out the lateral distance between two circles whose radii add up to S in a pipe of radius R would be $2(R(S\text{-}R))^{1/2}$. With the given radii, the packing is much more complicated.



Probability in unexpected places: a card trick, code breaking, and catching kangaroos

BY RAVI MONTENEGRO

Sometimes probabilistic "paradoxes" have surprising applications. However, mathematical tools often do not exist to prove the reliability of the resulting computations, so instead practitioners have to rely on heuristics, intuition and experience. In recent work several co-authors and I have given the first proofs of the efficacy of two such applications to code-breaking, one involving the well-known Birthday Paradox and one the lesser-known Kruskal Count.

The Kruskal Count is a probabilistic concept discovered by Martin Kruskal, which Martin Gardner popularized with the following card trick. Shuffle a 52 card deck and deal the cards out, 9 per row for 5 rows and 7 in the last row. Now look at the first card. Whatever number is on it jump this many cards to the right, with Ace = 1 and J/Q/K = 5, wrapping around to the left side of the next row. Repeat from the new card, continuing until the next jump would step you past the end of the deck. Mark this last card as a "trap."

Now explain the rules for jumps to a friend. Then predict that if they pick a card from the first row they will end in your trap. If you didn't give away how you picked the trap then 5/6 of the time your magical powers will awe as you did when starting at the first card. Try to figure why this works and how probability enters into it. An explanation can be found at the URL given at the end of this column. You can also try this trick online at a site created with Alexander Frieden, a recent UML math undergraduate: http://faculty.uml.edu/ rmontenegro/ kruskal.html

In a 1978 paper John Pollard applied the same trick to a mathematical problem related to code breaking, the Discrete Logarithm Problem. This is a modular arithmetic version of logarithms, so that for instance modulo 11 we say $\log_7 2 = 3$ because $7^3 = 343 = 2 \bmod 11$. This is related to codes because methods of "Public Key Encryption" can be broken if certain "hard" math problems can be solved. In fact, the security of transactions on the web depends on the difficulty of factoring very large numbers. Encryption methods related to discrete logarithms may be preferable as it is (provably) harder than factoring. Pollard's Kangaroo method for Discrete Logarithm is easier to understand with large figures. As such, rather than explaining it here, a more detailed write-up is available at http://tinyurl.com/y97x27h

It has been shown that in a more general setting than integers modulo N, namely when the representation of a cyclic group of order N provides no information about its structure beyond that given by group multiplication (whereas integers modulo N have both multiplication and addition), then at least order Sqrt(N) group operations must be performed to find Discrete Logarithm. With Prasad Tetali of Georgia Tech we proved that the random walks given by Pollard's Kangaroo method require an average of (3/2)Sqrt(N) steps in total, for large N. This leads to a surprising conclusion, that a probabilistic approach based on a card trick is provably nearly the fastest possible method for solving the mathematical problem of finding a Discrete Logarithm.

References

- R. Montenegro and P. Tetali. "How long does it take to catch a wild kangaroo?" In Proc. of 41st ACM Symposium on Theory of Computing (STOC 2009), pp. 553-559 (2009).
- Jeong Han Kim, Ravi Montenegro, Yuval Peres and Prasad Tetali. "A Birthday Paradox for Markov chains with an optimal bound for collision in the Pollard Rho algorithm for discrete logarithm." The Annals of Applied Probability vol. 20(2), pp. 495-521 (2010).

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New Master's Option: PSM in Industrial Mathematics

to help increase awareness of the program on campus. As students begin to pass through he program, the seminars will also be a vehicle for them to report on their work in their internships.

For more information on our Industrial Mathematics program, go to http://faculty.uml.edu/math/ index_psm.html. The program is an affiliate of the National Professional Science Master's Association (http://npsma.org/).

Steve Pennell, Chair

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

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

Dedekind's Forgotten Axiom

Jim Propp gave a talk in March 2010 in Washington D.C. at a national meeting on the History and Pedagogy of Mathematics. His talk, entitled "Dedekind's Forgotten Axiom and Why We Should Teach It", grew out of his teaching of honors calculus and real analysis over the past few years. Rigorous expositions of calculus and real analysis require the use of a completeness axiom for the real numbers. The one that's most commonly used is the Least Upper Bound property, usually attributed to Richard Dedekind. However, the completeness property of the reals that Dedekind actually proposed is much simpler—so much simpler that it can be taught at the freshman level. Dedekind's axiom says that if one divides the real numbers into two sets A and B so that every element of A is less than every element of B, then there exists a real number c such that every number less than c is in A and every number greater than c is in B. It's very similar in spirit to Dedekind cuts, but it's an axiom rather than a construction. For more information, see http://jamespropp.org/hpm10-slides.pdf.

UML Mathematical Sciences Online

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

Have you lost your past issues of *Tangents*? Go to the alumni section of the UML Math web page for links to back issues.

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

Alumni Update

Ron Buttigliereri (B. S., 1985) is working at the Apple Store at the Pheasant Lane Mall in Nashua and is "enjoying life being called a Genius."

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

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 UML phonathon and other fundraising contacts. These requests 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.

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Department of Mathematical Sciences
University of Massachusetts Lowell
Olney Hall
UML North
Lowell, MA 01854