The BIG SIGMAA News

Volume 12, Issue 1 **Spring 2016**

Business, Industry, and Government Special Interest Group of the Mathematical Association of America

Acknowledgements:

- Thanks to Suzanne Weekes for her article about PICMath.
- Thanks as always to Collin Carano for the interesting and beautiful artwork.
- If you would like to contribute an article, a poem, a puzzle, or anything else to future issues of the BIG SIGMAA newsletter, please let me know.

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PICMath

Prof. Suzanne L. Weekes
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PIC Math (Preparation for Industrial Careers in Mathematical Sciences) is a program of the MAA and the Society for Industrial and Applied Mathematics (SIAM) which is funded by the National Science Foundation under grant DMS-1345499. Formally, the goals of PIC Math (*pronounced "**pick math**"*) are a) to help undergraduate mathematical sciences majors be aware of their choices for non-academic careers and opportunities for internships, b) to help mathematics faculty be more fully aware of non-academic career options for their students and help faculty develop connections with local industrial partners, c) to offer undergraduate students the opportunity to have a research experience related to problems from business, industry, and government (BIG), and 4) to provide training to undergraduate students and faculty in how to successfully work on problems from BIG. Visit the program website at http://www.maa.org/picmath. Ultimately, we believe that *this project will improve the knowledge, attitude, skills, and abilities of faculty and undergraduate students in the mathematical sciences toward STEM careers in business, industry, and government.* Prof. Michael Dorff of Brigham Young University (BYU) and Prof. Suzanne Weekes of Worcester Polytechnic Institute (WPI), two of the program's co-directors, work with faculty in the PIC Math program to achieve these goals.

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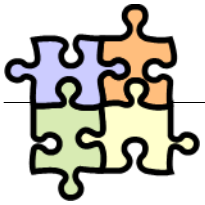
Inside this issue:



The Puzzle Corner

Here is a puzzle from the Internet:

William lives on a street whose house numbers range from 8 to 100. Lisa wants to know William's house number.

Lisa: Is your house number larger than 50?
William answers, but does not tell the truth.
Lisa: Is your house number a multiple of 4?
William answers, but again not truthfully.
Lisa: Is your house number a perfect square?
This time William answers truthfully.
Lisa: I will know your house number if you tell me whether or not the first digit is a 3.
Williams answers, but we don't know whether he answers truthfully or not.

At this point Lisa (who thinks William always tells the truth) guesses William's house number, but of course she is wrong.

What is William's house number? (*answer on page 6)*

2016 Joint Mathematics Meetings

The 2016 Joint Mathematics Meetings were held in January in Seattle, Washington. Almost 6,300 people attended the meetings. Highlights included the series of colloquium lectures by Timothy Gowers, the Gibbs lecture by Daniel Speilman (postponed from last year), and the Porter lecture by Jennifer Chayes. The BIG SIGMA contributed paper session was on Friday afternoon; an article about the presentations appeared in a recent issue of *FOCUS*. The BIG SIGMAA guest lecture was Friday evening. Dr. Genetha Gray from Intel Corporation talked about how, in her career, she has morphed from an applied mathematician to a data scientist; she also discussed some of the mathematical problems that data scientists are studying. A reception followed her talk.

The 2017 meetings will be held in Atlanta from January 4 to January 7. A preliminary list of invited speakers is available on the JMM website (accessible from both the AMS and the MAA websites). There will also be AMS Special Sessions and MAA Contributed Paper Sessions. The BIG SIGMAA session will be on Friday morning. If you would like to present a paper to the BIG SIGMAA session or any of the other sessions, you need to submit an abstract by September 20. Just go the JMM website, click on "Submit an abstract", and follow the instructions.

Mathematical Quotations from G. H. Hardy

I remember once going to see [Ramanujan] when he was lying ill at Putney. I had ridden in taxi cab number 1729 and remarked that the number seemed to me rather a dull one, and that I hoped it was not an unfavorable omen. "No," he replied, "it is a very interesting number; it is the smallest number expressible as the sum of two cubes in two different ways."

Reductio ad absurdum ... is one of a mathematician's finest weapons. It is a far finer gambit than any chess play: a chess player may offer the sacrifice of a pawn or even a piece, but a mathematician offers the game.

In great mathematics there is a very high degree of unexpectedness, combined with inevitability and economy.

The mathematician's patterns, like the painter's or the poet's must be beautiful; the ideas, like the colors or the words must fit together in a harmonious way. Beauty is the first test: there is no permanent place in this world for ugly mathematics.

I believe that mathematical reality lies outside us, that our function is to discover or observe it, and that the theorems which we prove, and which we describe grandiloquently as our "creations," are simply the notes of our observations.

Mathematical Poetry

There was a young fellow from Trinity
Who took the square root of infinity.
But the number of digits
Gave him the fidgets
He dropped math and took up divinity.

There was a young student from Rye
Who worked out the value of π.
"It happens," said he,
"That it's just over 3,
Though I'd rather you don't ask me why."

Sir Isaac Newton by Paul Ritger

While studying pressures and suctions,
Sir Isaac performed some deductions.
"Fill a mug to the brim, it
Will then reach a limit,
Quite easy, determined by fluxions."

A Mathematician's Clock

I have a really geeky clock;
It has a special chime:
At 2, 3, 5, 7, 11 o'clock,
It shouts out, "It's prime time!"

from *Six Significant Landscapes*
by Wallace Stevens

Rationalists, wearing square hats,
Think, in square rooms,
Looking at the floor,
Looking at the ceiling.
They confine themselves
To right-angled triangles.
If they tried rhomboids,
Cones, waving lines, ellipses—
As, for example, the ellipse of the half-moon—
Rationalists would wear sombreros.

PICMath (continued)

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This May, the third cohort of nearly 70 PIC Math faculty from universities all over the U. S. will meet their colleagues and the directors for the first time at the PIC Math **Summer Faculty Training Workshop** which is held at 4,500 feet above sea level on the campus of BYU in Provo, Utah. At these workshops, faculty participants hear from mathematicians working outside of academia about their individual career paths and experiences, and get insight about what can be done to prepare students well for non-academic careers. Industry speakers have included Jonathan Adler (Promontory Growth and Innovation), Shree Taylor (Delta Decisions of DC), Marylesa Howard (National Security Technologies, LLC), and Sumanth Swaminathan (W. L. Gore and Associates). PIC Math faculty must advise undergraduate students on research problems that come directly from industry so Profs. Dorff and Weekes engage with faculty on topics such as i) how to develop contacts with people in industry; ii) what are some sample undergraduate research problems from BIG; iii) how to successfully mentor undergraduates in research; iv) what are non-academic careers for mathematics students; and v) how to run their Spring Semester Research Course. The PIC Math faculty benefit from the experience of Prof. Dorff who has advised numerous undergraduate research projects and is the Director of the NSF-funded Center for Undergraduate Research in Mathematics (CURM) at BYU (http://curm.byu.edu/), and that of Prof. Weekes who has been the Director of the Center for Industrial Mathematics and Statistics (CIMS) at WPI and has run the NSF-funded WPI Research Experiences for Undergraduates Program in Industrial Mathematics and Statistics for many years (http://www.wpi.edu/+CIMS) .

PIC Math faculty are asked to *make an effort in the summer and fall to make their own BIG connections within the private or public sector with the aim of securing industrial projects* for student research teams in their spring semester research course. The program directors also obtain problems for the PIC Math faculty in case some are not successful themselves, or if they wish to have other problems available to their students. The **Spring Semester Research Course** that each faculty will run can have as few as 5 students, say, to however large, the faculty member can handle. The course will usually not be a lecture course but will be structured so as to facilitate students' progress on their industrial research problems. With the research problems we insist that the students need to see the context of the problem in its original, possibly very 'dirty' form and not in a sanitized version. *Students need to have the opportunity to develop for themselves the mathematical formulation of the problem.* They are used to solving problems from the back of a textbook chapter that have already been formulated in that they match up with the chapter but this sort of research asks more of them. They will need to bring and attain knowledge from different fields of math and statistics and from other disciplines, too. *The diversity and openness of these problems is appealing to many students and industrial problems are especially attractive to those who like seeing the real impact that their mathematics and statistics work can have.*

Determine optimal treatment site placement to mitigate the spread of Ebola in West Africa for different potential outcomes and explore different what-if scenarios. Problem from Dr. Sara Del Valle, Los Alamos National Laboratory.
Map taken from http://www.cdc.gov/vhf/ebola/images/west-africa-distribution-map.jpg

Each student team has an industrial liaison from the company that provided the research problem that they connect with on a regular basis. Usually the meetings are by phone or virtual. If geography allows, in-person meetings are even better. In particular, it is great if the students are able to go to the company site to present their research, findings, and recommendations. PIC Math faculty are given financial support from the program to develop and run the course, and material support is provided by the way of sample syllabi and regular check-ins with and feedback from the directors.

PIC Math research projects have come from a variety of companies that include DEKA Research and Development, Los Alamos National Laboratory, Neptune and Company, Youngstown Police Department, Bell Labs, Field Museum of Chicago, Avista Utilities, AstraZeneca, Sproxil Inc., Rand Corporation, and The Coca-Cola Company. Special thanks to Dr. Derek Kane, Dr. Stephanie Fitchett, Dr. Marylesa Howard, Dr. Aaron Luttman, Dr. Sara Del Valle, Dr. Genetha Gray, Dr. Jeffrey Saltzman, and Dr. Greg Coxson for providing the program with director-sourced industrial research problems. Directors and faculty are always looking for new agencies and companies to work with *so please contact us if you are interested in giving us an industrial problem!*

The PIC Math program has also produced the **PIC Math Industrial Case Study Videos**. These are four 2-video sequences highlighting some research problems that mathematicians and statisticians encounter outside of academia. Visit http://

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PICMath (continued)

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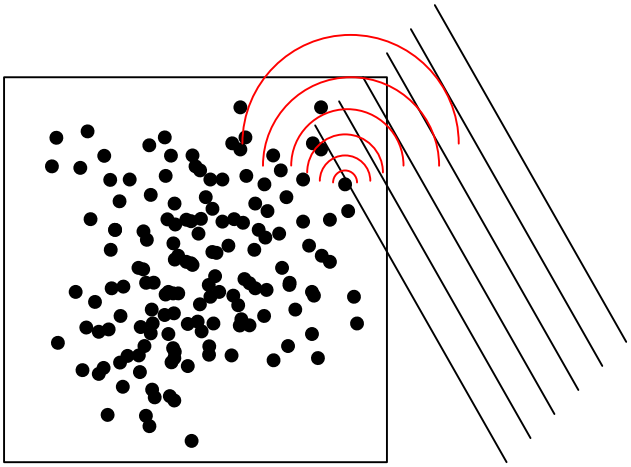
www.maa.org/programs/faculty-and-departments/pic-math/solving-real-world-problems. The first video in each sequence features a professional mathematical scientist in industry talking about his/her career and they talk about the sort of problems that they work on. The second video in the sequence features a mathematics or statistics faculty presenting some technical background and an approach that one may use to make progress on the industrial research problem. These are a good place to point people when they ask "*what can you do with a math degree?*" The four video sequences are the following:

***Improving Marketing Strategies*:** Use text analytics to help an online company distinguish between its business customers and its private consumers from messages on gift cards. Featuring Dr. Jonathan Adler & Prof. Talithia Williams;

Creating More Realistic Animation for Movies: Use mathematics to make realistic, art-directable animations to simulate phenomena such as water, fire, smoke, wind in the movie and gaming industries. Featuring Dr. Alex McAdams & Prof. Joseph Teran;

***Building a Better Filter*:** Use mathematics and statistics to help understand waste capture mechanisms and to optimize microstructures to create better filtration devices. Featuring Dr. Sumanth Swaminathan & Prof. Louis Rossi;

Finding the Safest Place to Store Nuclear Waste: Use mathematics and statistics to study the feasibility and safety of prospective subsurface nuclear waste storage sites. Featuring Dr. Genetha Gray & Prof. Gwen Spencer.



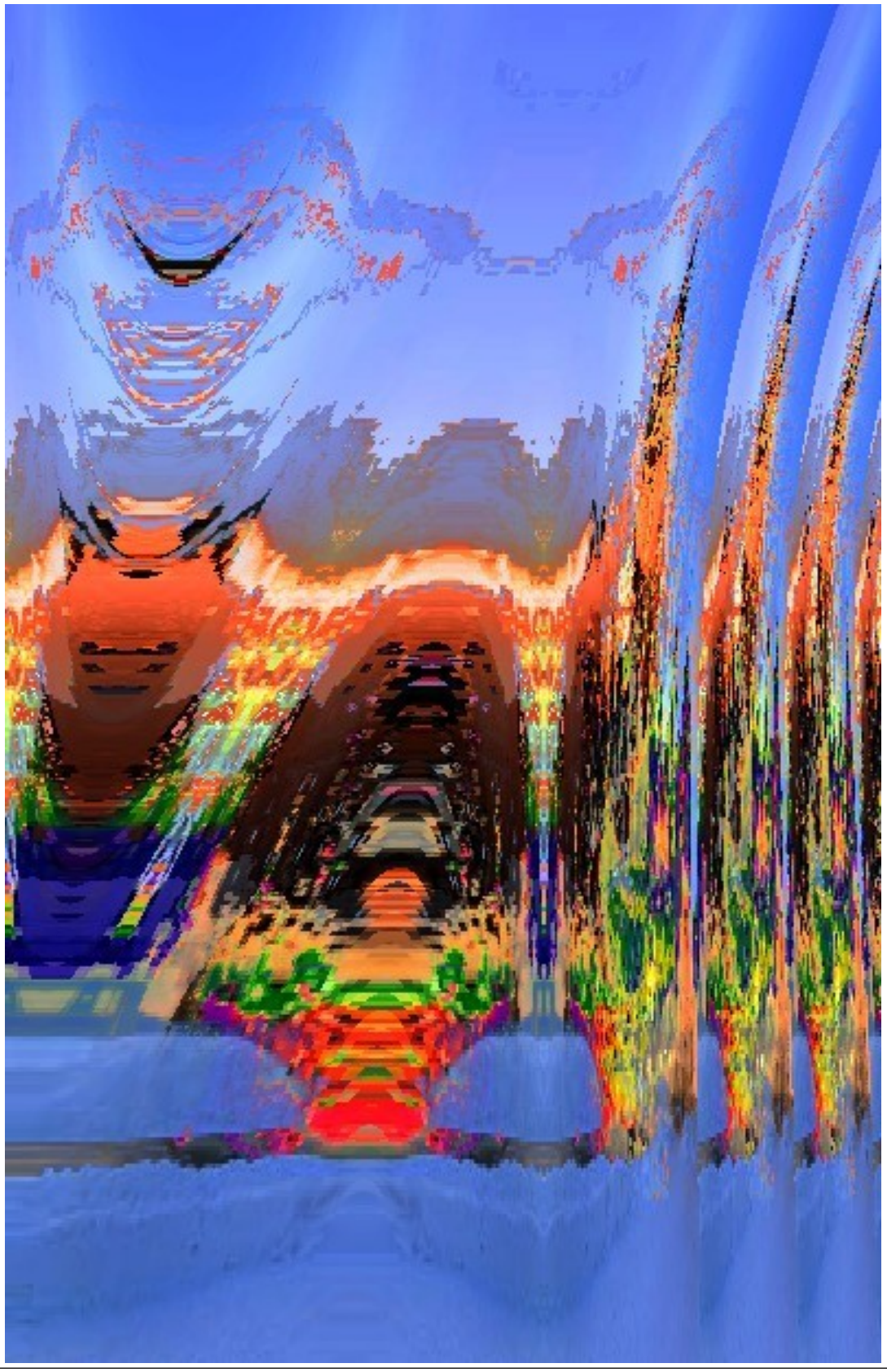
Given tomographic data in the region surrounding a tumor, can you extract the volume occupied by the tumor? Problem from Dr. Derek Kane, DEKA Research and Development

At the end of the project course, one student team from each school, designated as the official PIC Math team, submits its research project solution to the **PIC Math Student Research Competition**. Learning to be *effective communicators* is very important so students' entries consist of not just of a *written report* but also a *video recording of an oral presentation* of their work. The video takes the place of an in-person presentation to their judges. The submissions are adjudicated by mathematicians working in industry and math faculty with industrial math experience and they give written feedback to the directors and faculty about each school's submission. Each judge assesses about 10 teams' work and receives a stipend from the program. In our first competition last May, our judges were faculty with a lot of experience working on industrial problems and also industry professionals: Prof. Marcel Blais (WPI), Dr. Aaron Luttman (National Security Technologies), Prof. Kara Maki (Rochester Institute of Technology), Joseph Simonis (Edward Jones), Dr. Lawrence Stone (Metron), and Dr. Rebecca Wasyk (Federal Reserve Board). *Do let us know if you would be willing to be a judge!*

The program funds a student from each team to present either orally or a poster at the P**IC Math Summer Student Recognition Conference** that is held at a session either at the MAA MathFest or the SIAM Annual Meeting. *The 2015/16 research teams will present in Boston at the SIAM Annual Meeting on Monday July 11, 2016*. The first (2014/15) cohort presented at the 2015 MAA MathFest in Washington, DC.

Thus far, during the first two years of the PIC Math program we have worked with over 65 faculty members from 60 different universities and colleges located in 30 states. Over 750 undergraduates have worked on industrial research projects through the program! We look forward to continuing this work and we hope that with continued support from universities and partnerships with business, industry, and government that this effort continues and grows as we prepare our young mathematicians and statisticians for the workforce.

Ripples in Space and Time by Collin Carbano



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Business • Industry • Government
Special Interest Group of the MAA

from the MAA Website:

BIG SIGMAA serves as a unifying link between business, industry, and government mathematicians, academic mathematicians, and mathematics students. The SIGMAA provides resources and a forum for MAA members who share an interest in mathematics used in business, industry, and government, aids in professional development, helps build partnerships between industry and academics, and increases awareness of opportunities for mathematicians in business, industry, and government.

Puzzle Corner Solution

Lisa guesses William's house number under the (false) assumption that he is always telling the truth. Based on that assumption, after three questions she has narrowed the options to a choice between two numbers, one of which has an initial digit of 3. This means that Williams's (false) answer to the first question must have been "No".

We don't know how William answered the second and third questions, but there are four possible combinations of Yes and No answers. Based on the (false) assumption that the house number is less than 50, the only combination that results in exactly two solutions is "Yes - Yes", with solutions 16 and 36.

Since William answered the second question untruthfully and the third question truthfully, this means that William's house number is a perfect square between 50 and 100 that is not a multiple of 4. The only such number is 81.

Thus William's house number is 81.