Summer |2015

FACULTY newsletter

CPMS Physical and Mathematical Sciences

BYU Professor Uses Spatial Data to Help Prevent Illness

Above: Matthew Heaton shows his skills in solving statistical problems.

Summer temperatures can pose a serious threat to public health, but BYU professor Matthew Heaton is using statistics to help alleviate these problems.

With his education in spatial data analysis — the study of data collected over various locations — Heaton has spent the last few years analyzing heat-related 911 calls in Houston, Texas, providing valuable input that can help decrease heat-related health issues in the future.

"Houston issues a heat advisory when the heat index is above 106," Heaton said. "One of the interesting things we found is that 106 degrees is too high. Something like 103 would be more effective at decreasing the number of heat-related health incidences."

For this research, the Houston Fire Department gave Heaton access to the 911-call database so he could know when and where most heat-related injuries happened.

"If I know that they occur in the middle of the city at 3 o'clock in the afternoon . . . then I can tell [the city] to build more water fountains and where to build them," Heaton said.

His research and its application in Houston may help prevent heat-related injuries because the city will know better ways to keep its citizens hydrated. His research on heat-related 911 calls was published in *The Journal of the American Statistical Association*.

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Chefs Impressed by Computer-Generated Cookbook

By the mid-term exam, the students in Dan Ventura's class still couldn't stomach the cooking of an AI program they named PIERRE.

"It didn't kill anybody," said computer science professor Ventura. "Somebody said the soup tasted like grass."

By semester's end, they were taking PIERRE's creations to dinner parties and preparing a presentation for scientific meetings.

But the true test came in the culinary capital of the world: Paris.

That's where PIERRE met Sophie Grilliat, a French chef who owns her own catering business. Ventura and a colleague hired Grilliat to pick three of Pierre's soup recipes that she would pair with appetizers and desserts at a festival celebrating computational creativity.

"The French people take their food seriously, so this was potentially career suicide for her," said Ventura only half-jokingly.

In fact, at first glance, Grilliat was uncertain that the recipes would produce soup that was even edible.

PIERRE doesn't just exploit ingredient combinations that you'll find in traditional recipes that are highly rated. Instead, BYU computer scientists folded in an extra measure of creativity so that PIERRE predicts unusual combinations that taste surprisingly good together.

At the festival, the plan was to serve soups during breaks between poetry sessions. Grilliat ultimately settled on three recipes with the following computer-generated names: Broth of Pure Joy, Divine Steak over Water and Scrumptious Broth with Bean.

The soups proved so joyous, divine and scrumptious that they ran out of all three during the first break.

"My opinion about those recipes is mainly really good in terms of taste and on the principle," Grilliat wrote. "Actually those three recipes we decided to choose amongst a score the computer had generated were edible (which was not obvious at the beginning), and quite good!"

Above: Sophie Grilliat (left) and Dan Ventura (right) mix things up with the help of PIERRE.

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Announcements

- College Teaching Seminar
  Brown Bag Lunch
  September 17
  "What Your Science Librarian Can Do for You"
  Greg Nelson, HBLL
- Multi-College Women's Career Conversations Luncheon (WCC)
  (for all female STEM students)
  September 22, 12 p.m.
  HC 3rd floor assembly hall
- Corporate Recruiter's Open House
  September 23, 2 p.m. – 4 p.m.
  W170 BNSN
- STEM Fair
  September 24, 9 a.m. – 3 p.m.
  WSC Ballroom & Garden Court
- CHIRP proposals due in college
  September 30
- HITS proposals due in college
  September 30

Teaching Moment

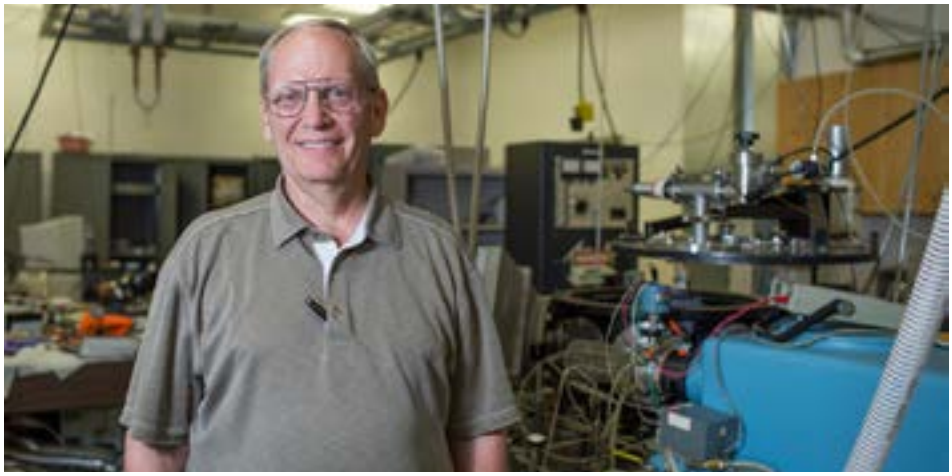
After participating in the 100th anniversary of the organization of the Alpine School District, Mark Clement found that the most important aspect of teaching is having a passion for it. The event discussed the various educational theories that have been used for improvement over the last 100 years. Out of all those, Clement felt the passion for teaching was the key element.

Clement quoted Lyon Phelps who said, "In my mind, teaching is not merely a life work . . . it is a passion.

Teaching is an art — an art so great and so difficult to master that a man or woman can spend a long life at it without realizing much more than his limitations and mistakes, and his distance from the idea. But the main aim of my happy days has been to become a good teacher, just as every architect wishes to be a good architect and every professional poet strives toward perfection."

Clement feels that after 20 years, he is beginning to realize how far he has to go, but he is excited to work towards perfection.

Professor's Curiosity Drives Research



Above: R. Steven Turley uses various tools to help manipulate the behavior of light

R. Steven Turley, professor in the BYU Department of Physics and Astronomy, has succeeded in turning his curiosity of the world into a career.

"I really like figuring out how to make things work," Turley said. "I've been intensely curious about how things work ever since I was quite young, and it never got beat out of me as I went through school."

His curiosity has driven him to not only discover how things work, but also to learn how to make them better. As Turley strives to understand the processes of the world around him, he has been able to combine his learning with his love for God.

"These things we're studying . . . these are things that God created," Turley said. "As a scientist, I love studying the works of His hands and how His universe works."

Turley is currently developing substances, called optical materials, that can manipulate the behavior of light,. One use for these materials is the process of photolithography, which can make the integrated circuits found in cell phones and computers.

"Right now the smallest circuits you can make using photolithography . . . [are] limited by the wavelength of light that you use," Turley said. "We are looking at wavelengths that are up to a hundred times smaller than the wavelengths that are being used in the current photolithography processes."

Turley hopes his research will assist in producing faster and more powerful integrated circuits.

Not only has Turley researched and accomplished many things on his own, he has also seen his students accomplish great things during their time at BYU.

"When our students finish [their research], they usually got a pretty rich experience in lots of different areas," Turley said. It may seem overwhelming at first, but Turley assures incoming freshmen that as they persevere and continue to work, they can "become the experts in that one little area. They can have something useful to contribute even as an undergraduate."

On one occasion, Turley accompanied an undergraduate sophomore who presented her work at a conference. At her booth was a long line of people, longer than at any other booth. Afterwards she told Turley that she had been offered a post doctorate by a university who assumed she was conducting doctoral studies.

"You really can do significant things as an undergraduate if you are persistent and you stick with it," Turley said.

Currently, several of Turley's students are working toward graduate degrees at prestigious schools, such as Berkeley and MIT. Many also have careers in their field of study.

By Camilla Stimpson

Faculty Funding & Publications Goals

Hit Refresh on Family Search

Above: Bill Barrett demonstrates the Virtual Pedigree and the Intelligent Pen.

We live in a technological, instant-access world. The Church of Jesus Christ of Latter-day Saints embraces the use of technology to fulfill its mission, and BYU is supporting the effort by developing revolutionary technologies for family history.

Computer science professor Bill Barrett and his students Kevin Bauer and Curtis Wigington are developing tools to help make FamilySearch.org easier to use. Their hope is that this will motivate more members to work on their family history.

"Now that everyone has Angry Birds on their smartphones, you've got to make family history as easy and as rewarding as flinging birds at some pigs," Bauer said.

To accomplish this, Bauer has worked alongside Barrett to develop the program Intelligent Pen, which allows a computer to trace over handwriting on documents to determine names and other information.

"With older documents, there's a lot of trouble that you run into because they're so degraded and worn out," Bauer said.

Intelligent Pen will help transform old, faded handwriting into script that is more clear and legible.

Wigington and Barrett developed another program called Virtual Pedigree, which makes it possible for users to navigate their family tree dynamically, with branches expanding and contracting as the data requires. Virtual Pedigree also allows users to view more than one branch of their family tree at once.

"People want things faster. They want it to do it for them. [Virtual Pedigree] helps enhance the experience," Wigington said.

This process did not come easy. Wigington, Bauer, and Barrett had to solve many puzzles along the way to figure out what would help Intelligent Pen and Virtual Pedigree work best.

Barrett described the process of developing these tools as an act of faith.

"You have no guarantee that this will work. You just believe in the idea. That belief alone will not do it. You've got to make it work," Barrett said. "It's this idea of taking a step into the darkness and waiting for the light to follow . . . with the idea that there is a solution and you have to go find it."

More information can be found at:

http://fhtl.byu.edu/projects/

http://virtual-pedigree.fhtl.byu.edu/

By Camilla Stimpson

Problem-Solving Starts with Math

Department of Mathematics Education professor Amy Tanner works to push her students out of their comfort zone to become independent problem-solvers.

"There are so many things that go into teaching," Tanner said. "The biggest thing I think about when I'm teaching is . . . how can I get [my students] to do most of the thinking and make most of the connections themselves?"

Tanner has been able to achieve this by involving her students in class. Tanner has worked at BYU for five years, and in that time she has learned much about how to make her classroom an effective environment for learning and growing.

One way Tanner stretches her students is by helping them think of new ways to solve mathematical problems.

"Something that every student has learned is how to cross multiply. . . . I give them proportion problems and then tell them they're not allowed to cross multiply," Tanner said. "It forces them to approach the problem in a way that's unfamiliar to them. . . . It forces them to really think about what's actually going on in the problem."

With Tanner's encouragement, students are able to come up with four or five different ways to solve the problem, as opposed to relying on the same method each time. They are able to dig deep into mathematical concepts and discover new ways to solve problems on their own.

"They see other people's ways of thinking about [the problem]," Tanner said, "and I have done nothing except say, 'don't use this particular method.'"

Doing work outside of the classroom is another method that has helped students grow in their studies.

"The advantage of being out of the classroom is that students are separated from their peers and from their teacher, so they can see what they actually do know on their own."

Tanner works toward her students solving methods and problems independently. She does not leave her students in the dark, but leads them to be able to problem-solve and understand how the concept works.

By Camilla Stimpson

Above: Amy Tanner teaches her students various math concepts.

BYU Professor Adds Research to Newton-Old Science Problem

Along with Isaac Newton and other famous scientists, BYU professor Lennard Bakker is adding his research to help explain a classic scientific problem—the n-body problem.

The n-body problem focuses on objects' motions as they interact with each other gravitationally. Bakker centered his research on the velocity an object would need in order to escape the gravitational pull of the masses around it.

Many researchers have studied this problem before, but with a limited number of bodies exerting gravitational forces. Bakker's research allows the n-body problem to be applied to any number of masses.

"The techniques we use to get that minimal velocity [required to escape gravitational pull] is very different from the way the previous results have been proven," Bakker said. "We can [input] 100 billion bodies moving in the plane and we can calculate that velocity of escape."

Bakker and his PhD student Skyler Simmons decided to conduct this research because of another issue they faced while studying the n-body problem.

"No one ever looked at possibilities of things colliding at the center of mass while trying to launch the particle vertically," Bakker said. "We allow collisions at the center of mass and we allow any number of bodies. . . . Most other research doesn't do that."

Bakker is excited about the benefits that his unique research approach can have in numerous different fields.

"Any new insight is big because the n-body problem is highly unsolvable in the classic techniques," Bakker said.

Bakker's research has practical application on both macro and micro levels. It can help determine the velocity an object needs to escape a galaxy or how fast a gas needs to be moving in order to escape the gravitational pull of the object ejecting it.

"We've opened a door to much larger numbers of bodies in terms of these types of investigations," Bakker said. "There are lots of things now to explore with more than four bodies moving on the plane. . . . This can be done now."

By Tanner Call

Above: Lennard Bakker, BYU professor in the math department

Spatial Data

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Heaton chose to specialize in spatial data analysis because of the various types of work he gets to do. Although it is a field that not many specialize in, there are many practical applications for spatial data analysis, which include tracking the spread of diseases, climate change, and even brain injuries.

"I love being able to play in everyone's backyard," he said. "I get to learn about different research fields without ever leaving mine."

Not only does Heaton get to use his knowledge of statistics, but his contributions also make positive, practical changes wherever he works.

"I get excited about seeing results and drawing maps of data collection over space," Heaton said. "Finding the temperature related to heat advisory is significant because we can have a direct impact on the ground."

By Tanner Call

Chefs Impressed

Continued from page 1

While PIERRE is strong in creativity, he's weak in culinary technique. Another AI chef from IBM has the same problem. But Grilliat loves the combination of using artificial intelligence to get inspiration and human chefs to make it a reality.

"It remains very stimulating to offer a new mix of ingredients we would never expect to suit with each other, which is one of the essences of cooking as one of the most interesting human experiences!" Grilliat wrote.

So geek out and cook one of these computer-generated recipes in your crock pot at home.

By BYU News

College Publications

Chemistry & Biochemistry

J. Jiang, S. Luo, & S.L. Castle, "Solid-phase synthesis of peptides containing bulky dehydroamino acids", *Tetrahedron Letters* (2015), Volume 56, Issue 23, pp. 3311-3313.

M. Kaja, W. Silvestre-Alcantara, S. Lamperski, D. Henderson, & L. B. Bhuiyan, "Monte Carlo investigation of structure of an electric double layer formed by a valency asymmetric mixture of charged dimers and charged hard spheres", *Molecular Physics* (2015), Volume 113, Issue 9-10, pp. 1043-1052.

S. Anand, T.M.B. Alvarez, W.E. Johnson, M.S. Esplin, K. Merrell, T. F. Porter, & S.W. Graves, "Serum biomarkers predictive of pre-eclampsia", *Biomarkers in Medicine* (2015), Volume 9, Issue 6, pp. 563-575.

S. Lamperski, M. Kaja, & D. Henderson, "Interfacial properties of linear molecules modeled by dimer near a hard wall. A Monte Carlo and density functional theory investigation", *Molecular Physics* (2015), Volume 113, Issue 9-10, pp. 997-1002.

W.K. Walker, B.M. Kay, S.A. Michaelis, D.L. Anderson, S.J. Smith, D.H. Ess, & D.J. Michaelis, "Origin of Fast Catalysis in Allylic Amination Reactions Catalyzed by Pd–Ti Heterobimetallic Complexes", *Journal of the American Chemical Society* (2015), Volume 137, pp. 7371-7378.

Computer Science

R.M. Farrell, I. Rojas, R.A. Martin, C. Lund, B. Reimschiissel, K.W. Franke, & J.D. Hedengren, "Optimized Terrain Surveillance with UAV Flight Path Planning", *Journal of Computing in Civil Engineering* (2015).

D. Yi, M.A. Goodrich, & K.D. Seppi,. "MORRF: Sampling-Based Multi-Objective Motion Planning", *Proceedings of the Twenty-Fourth International Joint Conference on Artificial Intelligence* (2015), pp. 1733-1739.

R. Smith, J.T. Prince, & D.A. Ventura, "A coherent mathematical characterization of isotope trace extraction, isotopic envelope extraction, and LC-MS correspondence", *BMC Bioinformatics Academic Journal* (2015), Volume 16, Issue 7.

Geology

J.H. McBride, S.T. Nelson, B.D. Heiner, D.G. Tingey, T.H. Morris, & K.A. Rey, "Neotectonics of the Seveier Desert basin, Utah as seen through the lense of multi-scale geophysical investigations", *Elsevier* (2015), Volume 654, pp. 131-155.

J.W. Barnes, R.D. Lorenz, J. Radebaugh, A.G. Hayes, K. Arnold, & C. Chandler, "Production and global transport of Titan's sand particles", *Planetary Science* (2015), pp. 1-19.

Mathematics

S. Humphries & D.C. Skabelund, "Character Tables of Metacyclic Groups", *Glasgow Mathematical Journal* (2015), Volume 57, Issue 2, pp. 387-400.

S. Humphries & E.L. Rode, "A Class of Groups Determined by Their 3-S Rings", *Rocky Mountain Journal of Mathematics* (2015), Volume 45, Issue 2, pp. 565-581.

S. Humphries & A. Manning, "Curves of period two points for trace maps", *Transactions of the American Mathematical Society* (2015), Volume 367, pp. 5721-5751.

P. Jenkins & K. Pratt, "Coefficiant Bounds for Level 2 Cusp Forms and Modular Functions", *Acta Arithmetic* (2015), Volume 168, pp. 341-367.

X. Li, "On Weil's explicit formula", *Science in China Mathematics* (2015), Volume 58, Issue 5, pp. 915-982.

Physics & Astronomy

M.J. Mehl, D. Finkerstadt, C. Dane, G.L.W. Hart, & S. Curtarolo, "Finding the stable structures of N1-xWx with an *ab initio* high-throughput approach", *Physical Review B* (2015), Volume 91, pp. 1-19.

D.C. Thomas, B.Y. Christensen, & K.L. Gee, "Phase and amplitude gradient method for the estimation of acoustic vector quantities", *Journal of The Acoustical Society of America* (2015), Volume 137, Issue 6, pp. 3366-3376.

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Physics & Astronomy (cont.)

E.J. Hunter, T.W. Leishman, "Talking, Teaching and Listening: Gender differences in teachers' responses to acoustic environments", *Conference Proceedings* (2015), pp. 721-726.

A.T. Wall, K.L. Gee, T.B. Neilsen, B.M. Harker, S.A. McInerny, R.L.McKinley, & M.M. James, "Investigation of multi-lobed fighter jet noise sources using acoustical holography and partial field decomposition methods", *AIAA Meeting Proceedings* (2015), pp. 1-15.

M.M. James, A.R. Salton, J.M. Downing, K.L. Gee, T.B.Neilsen, B.O. Reichman R.L. McKinley, A.T. Wall, & H.L. Gallagher, "Acoustic Emission from F-35 Aircraft during Ground Run-Up", *AIAA Meeting Proceeding* (2015), pp. 1-25.

B. Reichman, J.M. Downing, A. Aubert, R.L. McKinley, K.L. Gee, T.B. Neilsen, A.T. Wall, & M.M. James, "Acoustical Environment of an F-35B Aircraft During Vertical Landings", *AIAA Meeting Proceedings* (2015), pp. 1-15.

B.M. Harker, T.B. Neilsen, K.L. Gee, A.T. Wall, & M.M. James. "Spatiotemporal Correlation Analysis of Jet Noise from a High-Performance Military Aircraft", *AIAA Meeting Proceedings* (2015), pp. 1-27.

J. Aleksić, S. Ansoldi, L.A. Antonelli, . . . J.W. Moody, . . .A.E. Whehrle, & B. Jordan, "Unprecedented Study of the Broadband Emission of Mrk 421 during flaring activity in March 2010", *Astronomy & Astrophysics* (2015), Volume 578, Issue A22, pp. 344-350.

J. Aleksić, S. Ansoldi, L.A. Antonelli, . . . J.W. Moody, . . . Y. Yatsu, & A. Zook, "The 2009 multiwavelength campaign on Mrk 421:Variability and correlation studies", *Astronomy & Astrophysics* (2015), Volume 576, Volume A126, pp. 344-350.

S.D. Bergeson, M. Lyon, J. B. Peatross, N. Harrison, D. Crunkleton, J. Wilson, S. Rupper, A. Diaw, & M.S. Murillo, "A neutral strongly coupled laser-produced plasma by strong-field ionization in a gas jet", *AIP Conference Proceedings* (2015), Volume 1668, pp. 1-12.

J. Peatross, M. Ware, "Research Communication 101: Six tips for communicating your research project outside of the lab", *SPS Observer* (2015), Volume 576, Issue 1, p. 22.

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