

Math in the City

Introduction to a Hands-on Learning Experience

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What is Math in the City?

- innovative course in which students engage in a hands-on learning experience using mathematical modeling to understand current major societal issues of local and national interest
- run in collaboration with local businesses, research centers, and government organizations which provide data and act as consultants throughout the course
- engage students in a learning and discovery process
- the course provides a real world experience through a focus on modeling and applicability of concepts in the projects and course material

Course Description

- undergraduate interdisciplinary course (Math 435 in the future) offered to math and non-math majors
- teams of 3-5 students work on a semester long project meeting regularly with instructor(s)
- minimal required mathematical background (Differential Equations, Statistics, Matrix Theory)
- students learn in class the necessary background material
- using real data provided by the business collaborator, students construct a model; they analyze the model and draw conclusions
- at the end of the semester students write a report and give a presentation of their results for the business collaborators and the Mathematics Department (faculty and students)

Why do we need Math in the City?

I hear and I forget

I see and I remember

I do and I understand

– Chinese Proverb

Active Participation:

- students need more active participation in courses; they need to find places where they take decisions, analyze the results of their decisions, interact and communicate mathematical ideas with their peers
- the classroom standard lecturing provides little room for student participation; they know that usually their input (e.g. answers to our questions) makes little difference to the running of the course
- during an open ended process students don't feel threatened because they don't know the answer; the instructors don't know the answer, either!

Why do we need Math in the City? (contd.)

Real world experience:

- the projects are done in collaboration with **local** businesses, using **real** data
- find attractive projects for students: choose hot topics such as front page national issues to analyze
- the projects are not toy applications; they are semester long projects that involve mathematical difficulty
- students see how mathematics is used in non-academic environments; even our better students have difficulty solving “word problems”, creating mathematical models
- students visit the collaborators’ workplace

Why do we need Math in the City? (contd.)

Communication skills:

- students develop their oral and written communication skills through practice and feedback given throughout the course
- students work in groups; group meetings
- poster presentations and meetings with collaborators
- hour-long final presentation given by each group
- written homeworks and journals
- final report on work and results of the project

Why do we need Math in the City? (contd.)

- we expect MitC to be certified for the ACE 10 general education requirement:

ACE 10. *Generate a creative or scholarly product that requires broad knowledge, appropriate technical proficiency, information collection, synthesis, interpretation, presentation, and reflection.*

- provides more opportunities for a capstone course for our majors, as well as non-majors
- excellent experience for students who enter industry after graduation; also beneficial for students becoming teachers or entering graduate school

Other Math Modeling programs

- Education programs or courses that are based on a partnership with businesses or research centers have existed for a long time in business schools and engineering departments (e.g. Kellogg School of Management at Northwestern University, UNL Business School)
- Math modeling programs have also successfully started:
 - Harvey Mudd's Mathematics Clinics
 - the Mathematics Umbrella Group at the University of Florida
 - Math Clinics at the University of Colorado Denver,
- Unlike some of the above programs, Math in the City projects are geared towards the student, not towards the company; this is not a consultancy program
- Similar program, yet different: the research based experience at University of Alaska in the Astronomy Department initiated by Professor Travis Rector

How Math in the City is Done: The Projects

- semester-long project that is the largest component of the course
- student-focused chosen to deal with issues of current relevance and of large interest
- 2-3 projects offered each semester (3-5 students working on one project)
- group meetings during class time and outside; regular meetings with the instructor
- meetings with collaborators; visits of the workplace

Spring 2006

- Tell-tale of Heart Attacks
 - with Jane Meza from Univ of Nebraska Medical Center
 - statistical analysis found that men and women have different variables that predict their risk of future heart events
- Lake McConaughy, is your water gonna stay?
 - with Shuhai Zheng from Dept of Natural Resources
 - during the 7 year drought in Nebraska students set up a differential equations model to analyze and predict the water levels in the lake



The Tell-Tale Heart Attack: The Statistical Analysis of Predictors for Heart Events

University of
Nebraska
LINCOLN

Undergraduate Authors: Tigha Reichen, Arvin C. Gomez, Heidi Leung, Adeline Hwang
Research conducted for Math 299, Math in the City
Instructor: Dr. Peter Hsieh, CVP Department of Mathematics
In collaboration with Dr. Annalisa Iorio



Diagnosis

In previous study done at MIT, it was shown that the heart can be used to predict a patient's health. The researchers found that patients who had a heart rate of 100 or more per minute had a higher risk of heart disease. This study aims to investigate the relationship between heart rate and other factors, such as age, gender, and physical fitness, to better understand the predictors of heart events.

Statistical Methods

Our study begins with data collection from a large number of patients. We use statistical methods to analyze the data, including regression analysis and hypothesis testing. We also use simulation to model the data and test our hypotheses. The results of our study show that heart rate is a significant predictor of heart events, and that other factors, such as age and physical fitness, also play a role in determining the risk of heart events.

Statistical Analysis

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Female

Female patients in our study showed a higher risk of heart events compared to male patients. This is likely due to the fact that women have a higher heart rate and are more likely to have other risk factors, such as high blood pressure and diabetes. Our study shows that heart rate is a significant predictor of heart events for both men and women, but that other factors, such as age and physical fitness, also play a role in determining the risk of heart events.

Regression Model

We used a regression model to analyze the data and determine the relationship between heart rate and other factors. The results of our study show that heart rate is a significant predictor of heart events, and that other factors, such as age and physical fitness, also play a role in determining the risk of heart events. Our study shows that heart rate is a significant predictor of heart events, and that other factors, such as age and physical fitness, also play a role in determining the risk of heart events.



Urban and Arctic in North America

A Scientific Study
The study focuses on the relationship between urban and arctic environments in North America. It examines the impact of climate change and human activity on these environments. The results of the study show that urban environments are warmer and have higher levels of pollution, while arctic environments are colder and have lower levels of pollution. The study also shows that human activity is a significant factor in determining the temperature and pollution levels of these environments.



Fall 2006:

- Traffic in Lincoln
 - with Mark Lutjeharms from Schemmer Associates
 - students performed an analysis of traffic in downtown (discrete model) and on a street (continuous model)
- Was there a bubble in the Lincoln real estate market?
 - with Michelle Slack from Lincoln County Assessor
 - students used multilinear regression models to analyze how the price of a house is computed and also at the price increase over the decade 1995–2005 (the nationwide real-estate bubble)

Fall 2008

- **Benefits and costs of sustainable design**
 - with Jim Dyck from The Architectural Partnership
 - students worked on 3 projects at two LEED certified buildings: The Earth House at the Prairie Hill Learning Center and the Nature Center at Pioneers Park
 - students used linear programming to analyze savings vs. costs for green features: fluorescent lighting, strawbale walls, sink aerators, low flow toilets, etc. They also analyzed the green benefits of sustainable design: quantifiable and unquantifiable.



NATURE CENTER ADDITION
PIONEERS PARK





PRAIRIE HILL
Learning Center

'Earth House'



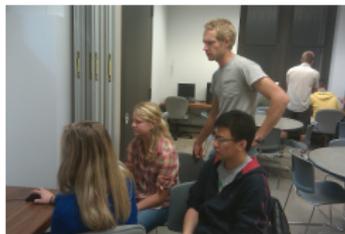
PRAIRIE HILL
Learning Center
Roca, Nebraska

Fall 2010

- Recycling in Lincoln
 - with Gene Hanlon, recycling coordinator for City of Lincoln
 - three groups of students working to analyze recycling:
 - working to minimize cost and maximize green benefit
 - using linear/integer programming and routing methods
 - math models become difficult with realistic assumptions:
differing frequency of pickup, quantity and type of materials;
scheduling constraints; capacities

Groups this Semester

- group 1 is minimizing costs associated with collection of residential materials from drop-off recycling sites with data from Bruce Von Busch from Von Busch and Sons Refuse
- group 2 is minimizing costs associated with collection of recycled materials from city and county buildings with data from Chris Zegar of Recycling Enterprises
- group 3 is optimizing green benefits for the drop-off sites



Development of Math in the City

Development has been supported by

- University ITLE grant (2006-2007, PI Radu)
- NSF – CCLI award (2010–2013, PI Radu, Co-PI Hartke) to ensure sustainability and dissemination of the course to other institutions

Sustainability

- provide course structure and documentation: instructor handbook, student handbook
- create a portfolio of 4-6 projects and provide ideas for possible collaborators
- develop a network of businesses that provide projects on a continuous basis
- modules for mathematical content
- involve other instructors in the course

Development of Math in the City

Dissemination

– occurring through the workshop and presentations at conferences and other institutions

Workshop

- 2-day “initiation” workshops
- 8–10 nonlocal instructors who have an interest in starting a Math in the City course at their institution
- includes the students’ final presentations
- discussion of structure of course, how to find projects, course management, etc.
- website and mailing list for future discussion; develop a network for Math in the City instructors

Benefits to the Students

Educational:

- students understand how to translate a complex real-life situation into a mathematical model
- develop better communication skills in writing and for oral presentations
 - slide presentation in front of undergraduate, graduate students and faculty during the last week of classes
 - poster presentations at the Nebraska Research Expo (organized in collaboration with UNL Epscor)
 - poster presentations at the UNL Undergraduate Research Fair
- learn mathematical software: SPSS, Maple, Sage
- exposure to workplaces outside academia (they can show off and improve their “employable skills”)

Benefits to the Students

Personal:

- learn how to deal with setbacks, meeting deadlines for their project, how to work in groups, learn to take initiative
- increased self confidence and sense of achievement
- connect with possible employers in the city; find job or internship opportunities
- the course provides a non-standard experience that students will remember and tell to others