

# Math in the City

## Fall 2010: Recycling in Lincoln

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# A Fine Grained Look at Math in the City Fall 2010

## Spring 2010

- Math in the City will be offered Fall 2010
- discussions about mathematical topic — routing
- What mathematical background?
- Started calling potential collaborators in April 2010
  - Post Office, grocery stores
  - recycling companies, city of Lincoln
  - Union Pacific railroad
- late announcement of course
- started recruiting students: posters, email, advisors

# Establishing the Collaboration

August 2010

- Meetings with Gene Hanlon from City of Lincoln
- Gene arranged meetings with Bruce Von Busch from Von Busch and Sons and Chris Zegar from Recycling Enterprises
  - What data can they provide?
  - What are questions they would like answered?
  - What are reasonable things that can be done during the semester?

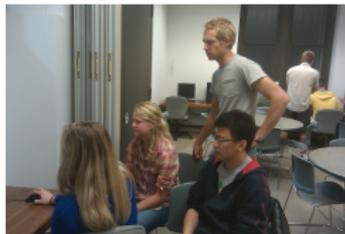
# Classes Begin

August 2010

- Petronela and I introduce the course and discuss the project
- students split into groups
  - projects have different data, but similar questions
- Gene Hanlon gives a presentation on recycling
- We spend time looking at the data that we have
  - data is given lots of formats and measurements
  - data overload
- Have the students start working with the data, calculating basic quantities and formulating their own questions
- some students used Google Docs to make it easy to share work

## 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



# Beginning of Semester

## September 2010

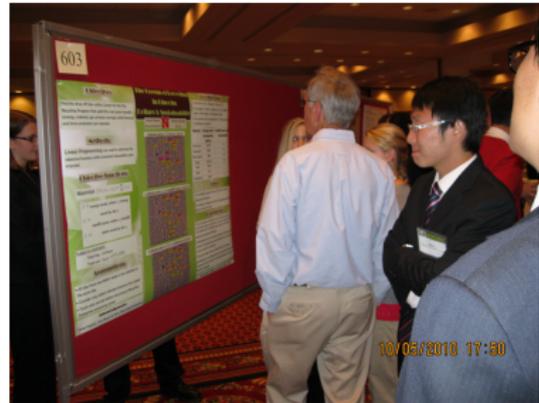
- Present mathematical background
  - mathematical modeling, estimation
  - linear programming
- Discuss concepts, but do not spend much time on proofs
  - emphasis is on relating quantities and using tools
- 3 homeworks that reinforce the mathematics
  - short, basic methods, applications
- Interdisciplinary background
  - first homework is for each student to research a commodity or issue in recycling and write an essay on it
  - the essays and students are then the expert on that topic for later in the semester
- meet for lectures on Mon and Wed, groups on Fri

## Mid-Semester Goal

October 5, 2010

- Nebraska Research and Innovation Conference
  - sponsored by Nebraska EPSCoR
  - to foster industry, govt, and academia connections
- students presented at the poster session
- tight timeline
  - simplified model of the “ideal day”
- wrote a report of these results, including introduction and motivation
- benefits of presenting posters; student reaction; DD

# Posters at Nebraska Research and Innovation Conf. on Oct 5, 2010



## Second Part of Project

October, 2010

- mathematical background on integer programming and the traveling salesman problem
- add routing to make the models more realistic
- need to do more programming
- transition to less lecture and more group meetings

# Computer Software

October, 2010

- We showed the students both Sage and Maple, but the students chose to work with Sage
- Sage is a free open-source mathematical environment similar to Maple, Matlab, etc.
- Advantages of Sage:
  - free and open-source; capable
  - can be run through a web browser—increases accessibility to students
  - easy to share Sage worksheets on the server
  - Python is a real programming language; easy to learn, can easily manipulate data
- Disadvantages:
  - not as polished as Maple
  - documentation has some gaps
  - frustrations of students with programming

# Visit to Landfill and Recycling Enterprises

October 22, 2010

- We visited the Lincoln landfill, tour by Gene Hanlon
- Visited Recycling Enterprises, tour by Chris Zegar
- student reaction

# Things Come Together

November, 2010

- Limits of computational approach reached when incorporating multiple visits to a site and multiple subtours
- Focus on approximate optimal answers, and quantifying how good they are
- Students brainstormed about different approaches and came up with different ideas
  - discussion with the instructors helped to channel the ideas
- wrote the final report with **many** iterations
- final hour-long presentations
  - prepared slides, gave practice talks

# Managing Groups

- Having student buy-in for everyone is key
- Expectations need to be clearly set, and instructor needs to step in when necessary
- discussions with each group during each class meeting time
- as the end of the project got closer, students needed to meet more outside of class as a group
- Had students keep journals where they recorded their work, plus what they were confused about or future directions
  - I learned that ...
  - I had difficulties with ...
  - I need to do ...
- We had mainly seniors, so were more experienced with group work
- Possibility of having group leaders?

# Assessment

- 20% Homeworks
- 30% Project participation (documented through student journals, communication with team and instructors, participation in the poster session)
- 35% Project (memos, intermediate drafts, final report)
- 15% Performance during oral presentation (understanding of the work, communication skills, quality of the slides)

# Reflections

- Teaching MitC is personally very rewarding
- Set high (but realistic) expectations and students will meet them
- Allow the possibility of failure (student-focused)
- Keep everything focused on the project (no busywork)

## Role of a GTA

This is not a typical assignment for a TA, some qualities to look for in order to enhance the experience for students and teacher alike:

- Learn a variety of new material quickly
- Comfort with open ended questions
- Creativity
- Adaptability
  - The GTA will deal with students in different venues (in class, office hours, individual meetings) and often is learning the material at the same time as the students.

# Role of a GTA

- Communication
  - With students
  - With the professor(s). In this course, the GTA can serve as a collaborator, and an open line of communication between the GTA and professor is very important to stay on the same page.
- Preparation of materials for future courses.
  - In Fall 2010, for dissemination.
  - In other institutions, for sustainability (there is no textbook).
- Grading (Homework mostly)