Engineering Tour Guide Scheduling

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Project Description

Goal:

Write an algorithm that schedules engineering tour guides for the Undergraduate Recruitment Committee.

How:

- Integer Programming in AMPL
- Objective: minimize variance in the number of tours a single guide must give i.e. we want all tour guides to give roughly the same number of tours

Current Method

1. Tour guides fill out doodle with their availability
2. Doodle is exported to Excel
3. URC board members create the schedule by hand
    a. Start with the date with the least available guides
    b. Schedule that day to capacity
    c. Move to the next available date
    d. Notes: selection of tour guides from the pool of available guides is done by inspection

Total time: 5-9 hours per semester

Sample Doodle Output

- Green - available
- Red- unavailable
- Yellow- available only if needed

	February 2016									March 2016					April 2016				
	Fri 5	Mon 8	Fri 12	Mon 15	Thu 18	Fri 19	Mon 22	Fri 26	Mon 29	Mon 7	Fri 11	Mon 21	Fri 25	Mon 28	Mon 4	Fri 8	Fri 22	Mon 25	Fri 29
	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM
Crystal Mejia	OK		OK			OK		OK			OK		OK			OK	OK		OK
Kylie Wu	OK		OK			OK		OK			(OK)		OK			OK	OK		OK
Chloe Blanchard				OK								OK	(OK)						
Alec Silverstein	OK	OK	OK	OK	OK			OK				OK	OK	OK		OK	OK	OK	
aroline Weinberg	OK	OK	OK	OK		OK	OK	OK	OK	OK	OK	OK	OK	OK	OK		OK	OK	OK
Bobbie Lock	OK				OK	OK		OK			OK		(OK)				OK		OK
Sona Roy	OK			OK	OK	OK			OK				OK		OK	OK	OK		
Priya Medberry			OK			OK		OK			OK					OK	OK		OK
Lilly	OK		OK		OK	OK		OK					OK			OK	OK		OK
Sammy Tbeile	(OK)					OK		OK			OK		OK			OK		OK	(OK)
Rhea						OK		OK					OK				OK		OK

Scheduling Details

- One tour per week
- Guides can answer yes, no, or maybe to the doodle
- “Maybe” tour guides are only used if there aren’t enough yes responses for that date
- Available data: four semesters worth of tour guide preferences and executed schedules
- Tour data is in a CSV file

Modified Doodle Output

- Input: CSV file
- Java program to modify the file to a format that AMPL can use
- Adds day/week labels and constraints
- Output: .dat file

	Fri 29	Mon 1	Fri 5	Mon 8	Fri 12	Mon 15	Thu 18	Fri 19	Mon 22
Week	1	2	2	3	3	4	4	4	5
Day	1	1	2	1	2	1	2	3	1
Capacity	2	1	2	2	2	3	3	3	1
Crystal Mejia	0	0	1	0	1	0	0	1	0
Kylie Wu	1	0	1	0	1	0	0	1	0
Chloe Blanchard	0	0	0	0	0	1	0	0	0
Alec Silverstein	1	1	1	1	1	1	1	0	0
Caroline Weinberg	1	1	1	1	1	1	0	1	1
Bobbie Lock	0	0	1	0	0	0	1	1	0
Sona Roy	0	1	1	0	0	1	1	1	0
Priya Medberry	0	0	0	0	1	0	0	1	0
Lilly	1	0	1	0	1	0	1	1	0
Sammy Tbeile	1	0	0	0	0	0	0	1	0
Rhea	0	0	0	0	0	0	0	1	0

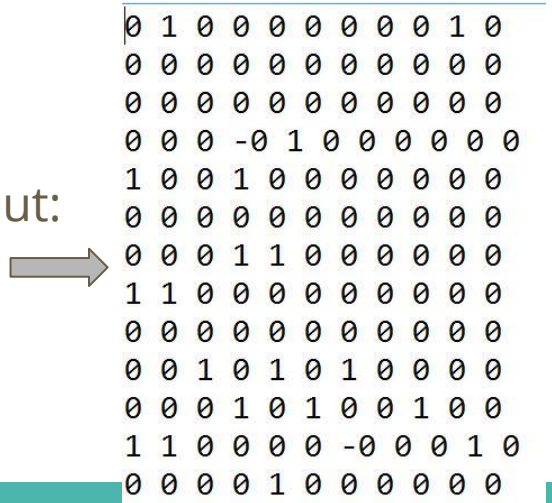
Integer Programming

- Input: .dat file of modified doodle
- Parameters: capacities and tour guide availability for each day
- Decision Variable: 1 if a tour guide is assigned to that day; 0 otherwise
- Objective: minimize variance in the number of tours each guide must give, as well as minimize the number of only if necessary guides
- Constraints:
  - A tour guide is assigned to a time if and only if they are available at that time
  - A tour guide is assigned to no more than one tour a week (as per admissions office regulations)
  - Number of scheduled tour guides must meet the forecasted capacity (no penalty for scheduling more guides than necessary)
- Output: .txt file of binary values of decision variables

Creation of Final Schedule

- Input: .txt file of binary values of decision variables
- Java program that matches the binary values with tour guides and dates
- Output: .csv file with the final schedule that lists day of the week, date, and tour guide

Input:



Spring 2016 Schedule

- The average number of tours given is 5 per guide, and the variance we found for the optimal schedule below is 2.3636.

Row Labels	Count of Date
Alec Silverstein	5
Bobbie Lock	5
Caroline Weinberg	9
Chloe Blanchard	2
Crystal Mejia	5
Kylie Wu	5
Lilly	4
Priya Medberry	5
Rhea	5
Sammy Tbeile	5
Sona Roy	5
Grand Total	**55**

Date	Guide
Fri 29	Lilly
Fri 29	Sammy Tbeile
Mon 1	Sona Roy
Fri 5	Crystal Mejia
Fri 5	Bobbie Lock
Mon 8	Alec Silverstein
Mon 8	Caroline Weinberg
Fri 12	Crystal Mejia
Fri 12	Priya Medberry
Mon 15	Chloe Blanchard
Mon 15	Alec Silverstein
Mon 15	Caroline Weinberg
Thu 18	Bobbie Lock
Thu 18	Sona Roy
Thu 18	Lilly
Fri 19	Crystal Mejia
Fri 19	Kylie Wu
Fri 19	Priya Medberry
Fri 19	Sammy Tbeile
Fri 19	Rhea
Mon 22	Caroline Weinberg
Fri 26	Lilly
Fri 26	Rhea
Mon 29	Caroline Weinberg
Mon 29	Sona Roy
Mon 7	Caroline Weinberg
Fri 11	Bobbie Lock
Fri 11	Priya Medberry
Fri 11	Sammy Tbeile
Mon 21	Chloe Blanchard
Mon 21	Alec Silverstein
Mon 21	Caroline Weinberg
Fri 25	Kylie Wu
Fri 25	Sona Roy
Fri 25	Lilly
Fri 25	Sammy Tbeile
Fri 25	Rhea
Mon 28	Alec Silverstein
Mon 28	Caroline Weinberg
Mon 4	Caroline Weinberg
Mon 4	Sona Roy
Fri 8	Crystal Mejia
Fri 8	Kylie Wu
Fri 8	Priya Medberry
Fri 22	Kylie Wu
Fri 22	Bobbie Lock
Fri 22	Priya Medberry
Fri 22	Rhea
Mon 25	Alec Silverstein
Mon 25	Caroline Weinberg
Mon 25	Sammy Tbeile
Mon 25	Rhea
Fri 29	Crystal Mejia
Fri 29	Kylie Wu
Fri 29	Bobbie Lock

Comparison to Previous Schedules

Using this algorithm, we returned to the schedule created by URC tour captains for Spring 2015, using guide availability from that semester and actual schedule for that time.

Schedule outputted by our algorithm →

Row Labels	Count of Date
chloe	2
Leon An	2
Lilly Wang	2
Robert Adelson	2
Robert Viramontes	2
Sarah Gouveia	1
Sona Roy	2
Srishti Goel	2
Kaitlin	0
Sidney Perkins	0
Grand Total	**15**
Average	**1.5**
Variance	**0.444444444**

Schedule determined by heuristic →

Row Labels	Count of Date
Sona	2
Robert	1
Sarah	2
Chloe	1
Shristi	2
Leon	2
Sigal	3
Lily	1
Sid	0
Robert A	1
Kaitlin	1
Grand Total	**16**
Average	1.454545455
Variance	0.611570248

Demonstration

https://youtu.be/l1P8BmjkOsc