Team F

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Parking Meters at Carnegie Mellon University

Question & Motivation

Coin parking meters are becoming a rarity in today's technologically advanced era,

so why at Carnegie Mellon has there not been a technological improvement in terms of parking on its campus since CMU is known for being such a big tech hub?

Research Question

We want to survey on campus parking meters to determine if they are being efficient in their purpose of generating revenue.

- To add, we would like to see if there are any correlations between other factors, such as the estimated value of the car, time of day, day of week, color of car, location of car, etc.
- We would like to find any interesting facts about cars parked at Carnegie Mellon Univeristy parking meters.

Questionnaire

We used coding for some our survey questions in order to make data analysis a bit easier

1:Yes 0:No

1:Car 2:Truck 3:SUV 4:Van 5:Motorcycle/scooter 6: Other

Date	Location	Parking Meter	Vehicle Present?	Color?	Type?	Make?	Model?	State of license plate?	Expired meter?	Broken meter?	Ticket?	What for?	How much?	Clean (1) or Dirty (0)?	Registrat (license
Temperature	Tech St	1	1	blue	4	dodge	caravan	pa	0	0	0	0	0	0	
65		2	1	green	1	acura	3.2tl	pa	0	0	0	0	0	0	
Start time		3	1	black	3	toyota	4runner	pa	0	1	0	0	0	1	
12:10pm		4	1	silver	4	mazda	mazda5	pa	0	0	0	0	0	0	
End time		5	0												
2:10pm		6	1	gray	1	audi	a4	pa	0	1	0	0	0	1	
3/27/12		7	0												
		8	0												
		9	0												
		10	1	red	3	subaru	forester	il	0	0	0	0	0	1	
		11	1	blue	1	honda	civic	pa	0	0	0	0	0	1	
		12	1	white	4	mercedes	r350	pa	0	0	0	0	0	1	
		13	0												
		14	1	silver	4	honda	odyssey	pa	0	0	0	0	0	0	
		15	1	red	3	kia	sorento	pa	1	0	0	0	0	1	
		16	0												
		17	0												
		18	1	black	1	bmw	z4	pa	0	0	0	0	0	1	
		19	1	brown	1	mini	cooper	pa	1	0	0	0	0	1	

Additional information we recorded when completing the census

-Date
-Day of week
-Temperature
-Start time
-End time
-Total percentages of parked cars
-Surveyors

Reference Sheet

- Acura

- Audi

- ~~Beetle~~

- BMW

- Buick

- Cadillac

- Chevy

- Chrysler

- Dodge

- Ferrari

- Fiat

- Ford

- GMC

- Honda

- Hummer

- Hyundai

- Infiniti

- Isuzu

- Jaguar

- Jeep

- KIA

- Lamborghini

- Land Rover/Range Rover

- Lexus

- Lincoln

- Lotus

- Maserati

- Mazda

- Mercedes

- Mercury

- Mini

- Mitsubishi

- Nissan

- Oldsmobile

- Plymouth

- Pontiac

- Porsche

- Rolls-Royce

- Saab

- Saturn

- Scion

- Shelby

- Subaru

- Suzuki

- Toyota

- Volkswagen

- Volvo

Color: try to fit color of vehicle to one of the following color schemes:

Red, black, blue, white silver/gray, gold/beige, purple, green, yellow

Type of vehicle: code the following:

1. Car/sedan
2. Truck
3. SUV
4. Van
5. Motorcycle/scooter
6. Other??

Make: Acura, Audi, etc. (use this sheet for answering the question)

Model: examples...

Focus, Accord, F150, Explorer, Trailblazer

Survey methodology

Date Started: 3/19/2012

Target Population: Meter Parking available to on campus for commuters to Carnegie Mellon Pittsburgh Campus

Sampling Frame: Campus Map of Parking Meters (Frew St, Tech St, Margaret Morrison St, Frew St, Morewood Parking Lot)

Sample Design: Census

Sample Size: 224 meters

Use of Interviewer: Data Collection by Observation

Mode of Administration: Netbook or Paper and Pencil

Computer Assistance: None

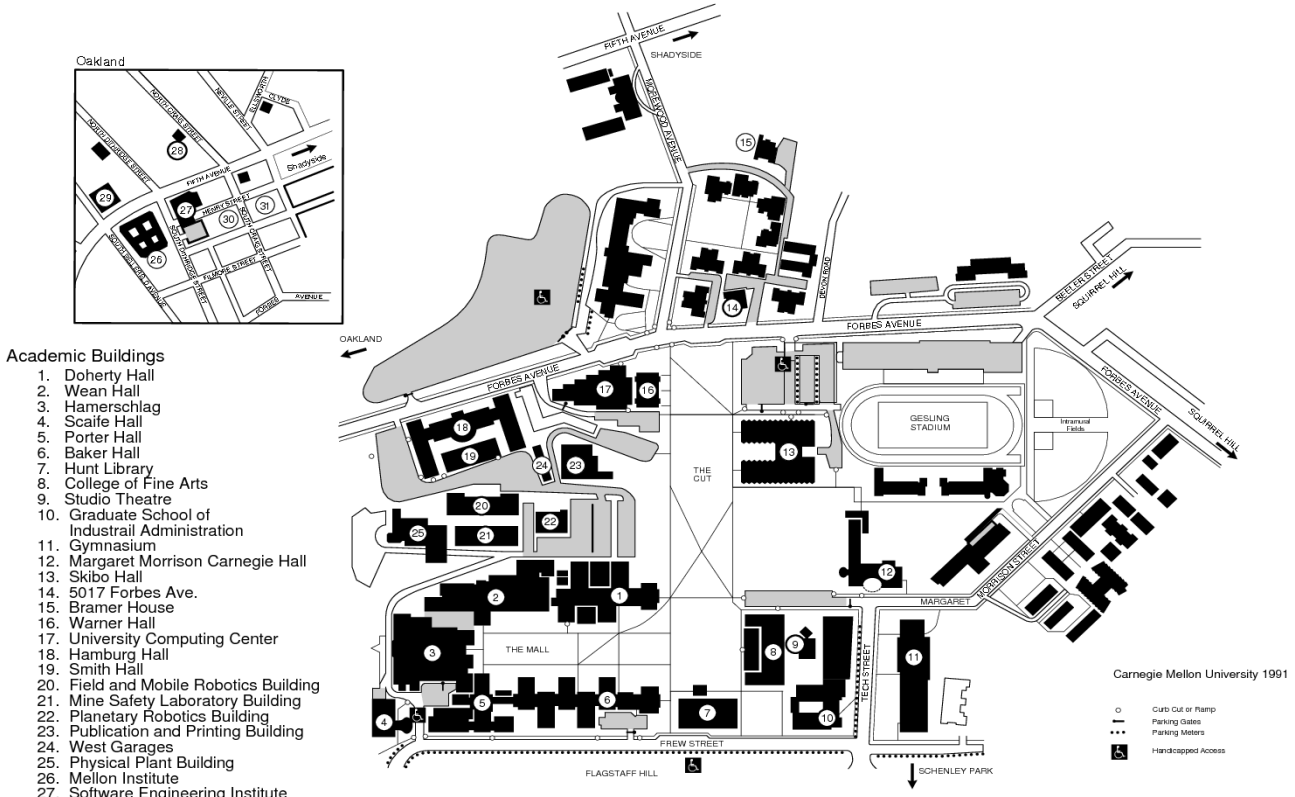
Reporting Unit: Parking meters

Time Dimension: One survey census

Frequency: Twice a day, Monday to Friday

Map of Parking Meters

Carnegie Mellon University Campus Map



224 Meters

Margaret Morrison: 5

Tech: 29

Frew:168

University Center: 6

Morewood Parking: 16

Data Collection Schedule

Initially we made two time variables to further study morning commuters, from 8 am to 12:30 pm, and afternoon commuters, from 12:30 pm to 5 pm. Our data collection for our survey and break up of surveyors went like this:

Monday, Wednesday, Friday Data Collection		
Jung Moon/(Nancy and Victor help)	Morning	9:00-12:00 PM
Victor/Nancy	Afternoon	3:30-6:30 PM
Tuesday and Thursday Data Collection		
Jeff	Morning	9:00-12:00 PM
Kaylee/Nancy	Afternoon	12:00-3:00 PM

Census

Difficulty in collecting data:
During Rush Hour
Student Class times

Glitches/how we fix 'em?

Ineligible unit:

1) cars parked in between spaces

2) double parking

3) vehicles that were parked, but being attended

4) CMU Transportation cars parked in parking spaces behind Morewood

5) cars parking at meters that we passed already and marked as not present

Police car double parked

Possible errors

Possible errors from:

1) making best judgement on colors (basic colors used)

2) missing values

3) higher nonresponse rate from drivers driving away because they noticed we were taking notes on their cars and whether they paid the parking meters or not

4) can't tell if the meter is broken or not

5) Mon/Wed afternoon: meters behind Porter were unpaid

Interesting features from collecting data

Improvements

- Changed variables
- Find better relating variables (times left on the meters)
- Better coding for entering data
- Add Saturday
- Data recording technique

Successes

- Getting census done in about 2 hours instead of 3
- Finished collecting without complications
- Weather was not a variable
- Getting harassed by undercover state police officer
- Learned where the broken meters are so we can park for free

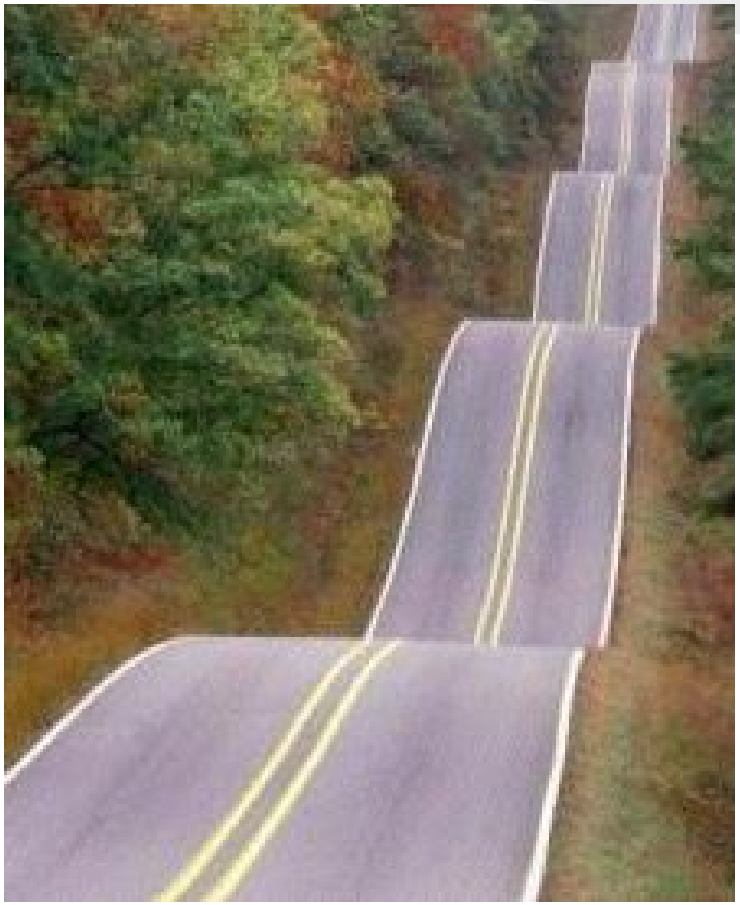
Data Analysis

- After data collection concluded (50 man hours of data collection)
- Ran our data in R
- Regression of Variables

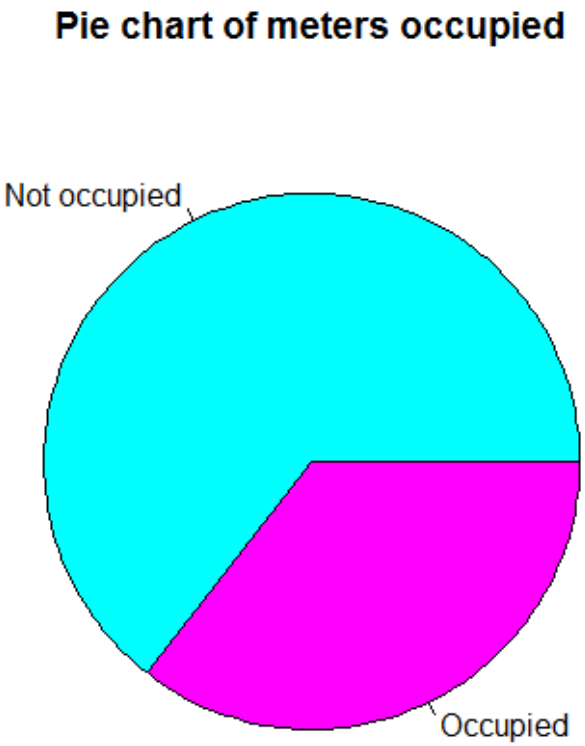
- Basic confidence intervals to provide insight and answers to our questions

Some bumps in the "R" road...

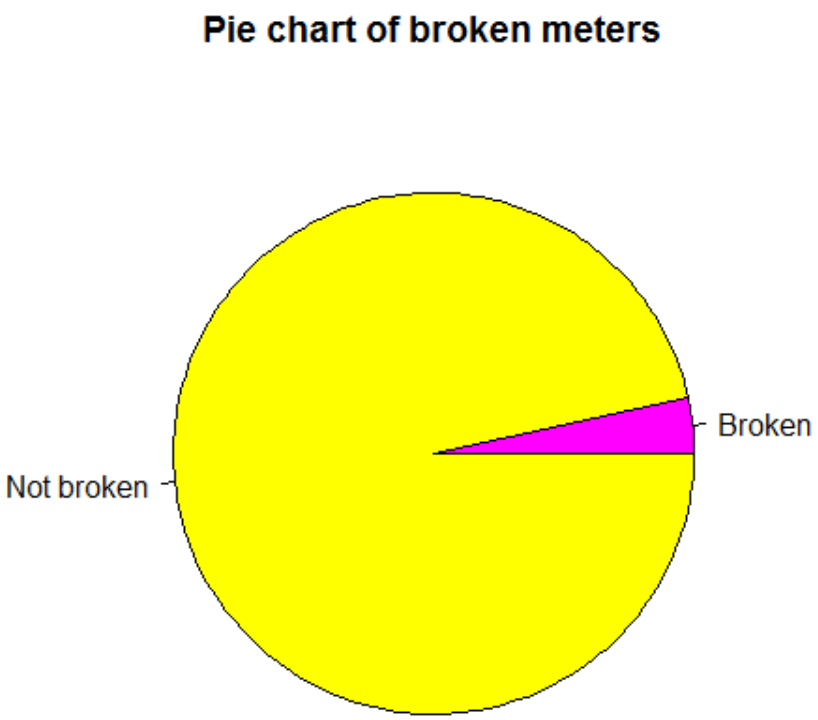
- Excessive cleaning and organizing the data
  - Ex) Capital letters vs. Lowercase letters
  - State abreviation
  - Colors: generic
  - Coding some variables that weren't
  - Any blanks needed to imputated
    - Making the data uniform



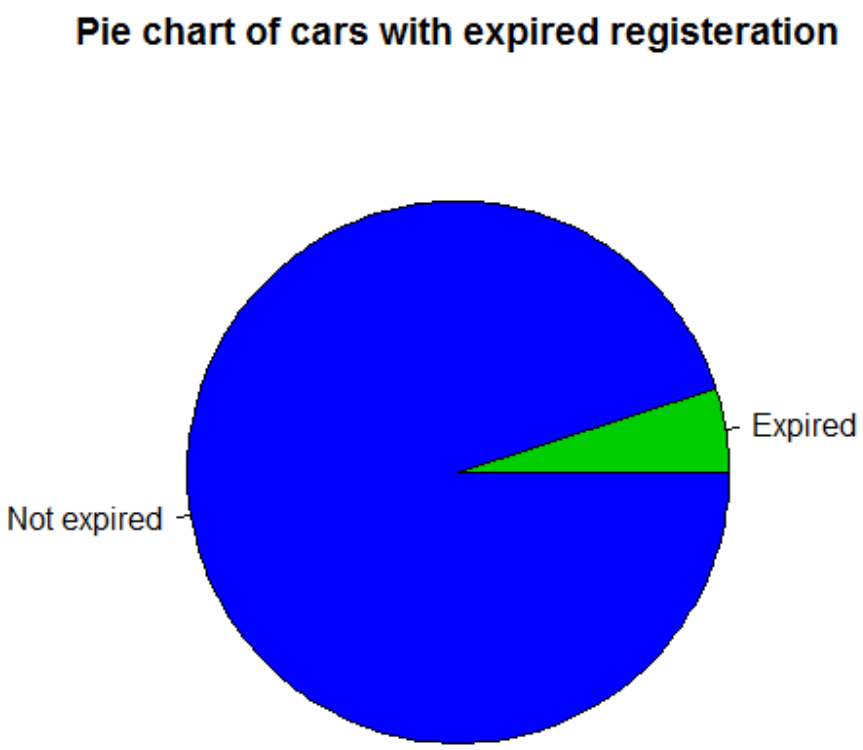
Cars Parked



Broken Parking Meters



Expired Registration Plates



Data Analysis

Number of Meters: 2240

Number of Commuters Using Meters: 794 (35.4464%)

Number of Commuters who failed to pay for meters: 213 (9.5089%)

Number of Commuters who parked at broken meters: 74 (3.3036%)

Number of Commuters who received a ticket: 30 (1.3392%)

Data Analysis

In our regression model, the value of 0 is a paid meter:

By Street: Rsq=0.4224 P-value=0.1065

meter=0.25512-0.04083MM-0.11786MWD-0.03561TECH-0.0733UC

By Day: Rsq= 0.4055 P-value=2.2e-16

meter= 0.27273+0.05630M-0.18619T+0.1549W-0.06096TH

By Time Rsq= 0.4072 P-value=2.2e-16

meter: 0.12051 +0.23217PM

By Time and Street: Rsq=0.4047 P-value=2.2e-16

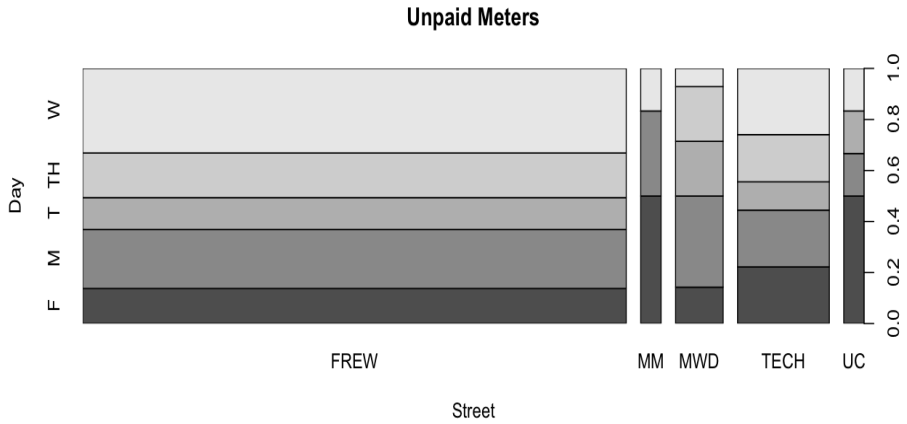
By Time and Day: Rsq= 0.3968 P-value= 2.2e-16

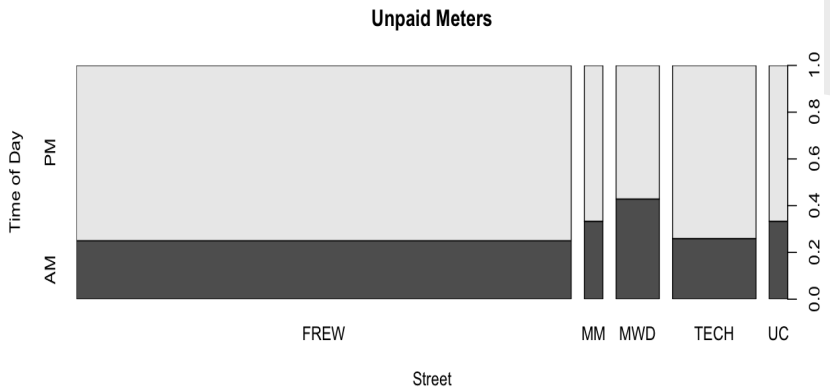
By Street and Day: Rsq=0.4041 P-value= 2.2e-16

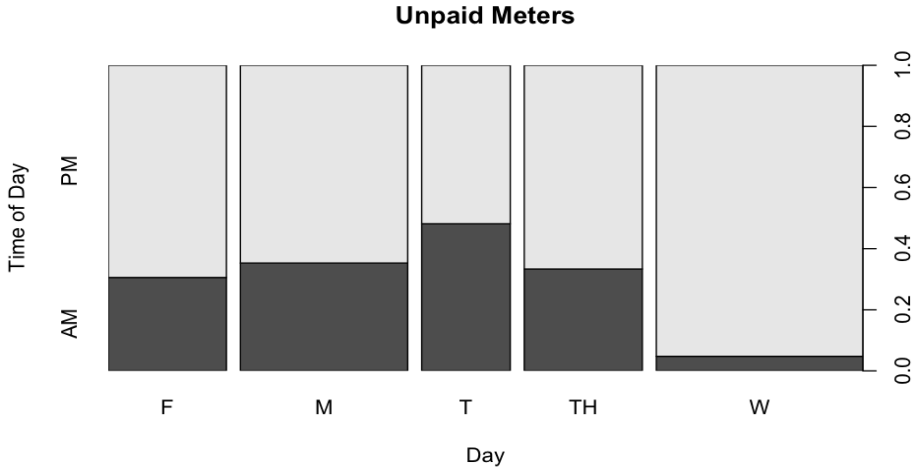
By Street, Day, and Time: Rsq=0.394 P-value= 2.2e-16

Additional Regression (see Appendix)

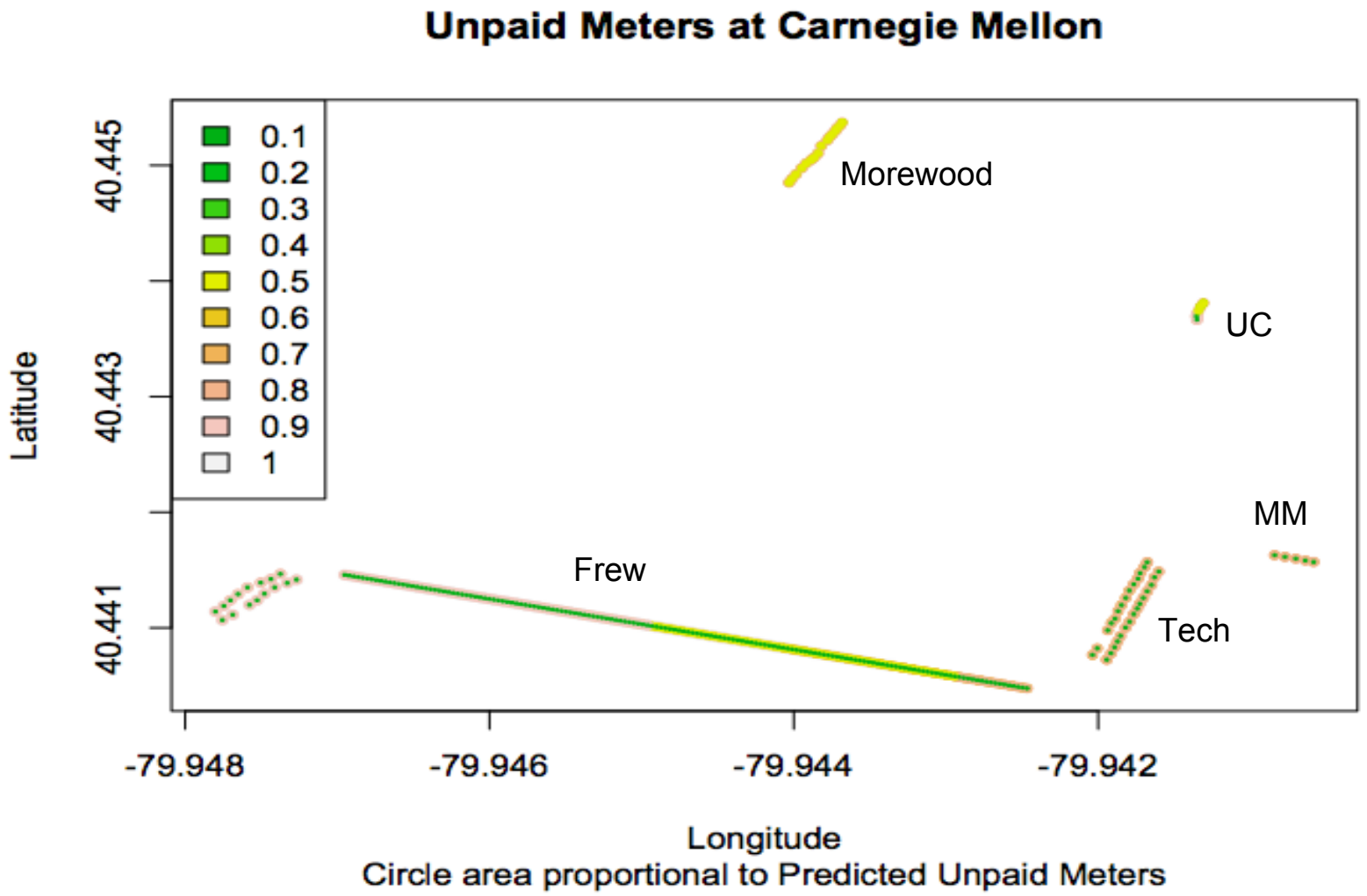
Graphs


Unpaid Meters
Day
W
TH
T
M
F
0.0
0.2
0.4
0.6
0.8
1.0
FREW
MM
MWD
TECH
UC
Street


Unpaid Meters
Time of Day
PM
AM
0.0
0.2
0.4
0.6
0.8
1.0
FREW
MM
MWD
TECH
UC
Street


Unpaid Meters
Time of Day
PM
AM
0.0
0.2
0.4
0.6
0.8
1.0
F
M
T
TH
W
Day

Graph


Unpaid Meters at Carnegie Mellon
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Morewood
UC
MM
Frew
Tech
Latitude
40.445
40.443
40.441
-79.948
-79.946
-79.944
-79.942
Longitude
Circle area proportional to Predicted Unpaid Meters

Further Analysis

Assuming our variables are all independent variables:
Parking Tickets cost $30.
Parking Meters cost 8 minutes for $0.25
If we say the average commuter parks for about 2.5 hours it costs about $4.69.
On a given on length of weekdays at Carnegie Mellon (Monday- Friday)
Predicted Meter Revenue: $3723.86
Predicted Lost Meter Revenue: **$6781.74**
Predicted Lost Meter Revenue on Broken Meters: **$347.06**
Predicted Ticket Revenue : $900.

Chances of Commuters receiving a ticket: **14.08%**
Expected cost of risk : $4.23
Some commuters find that it is worth it to run the risk of not paying for meter.

Interesting Analysis

Holding for Frew Street: Rsq= 0.3402 P-value: 0.07927

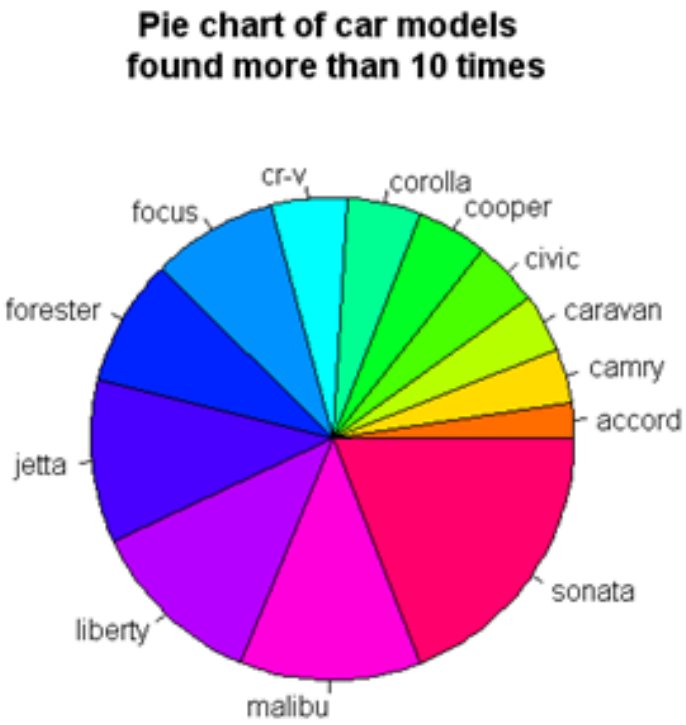
Ticket= 0.10625-0.10625

Margaret Morrison+0.17946

Morewood+0.15301

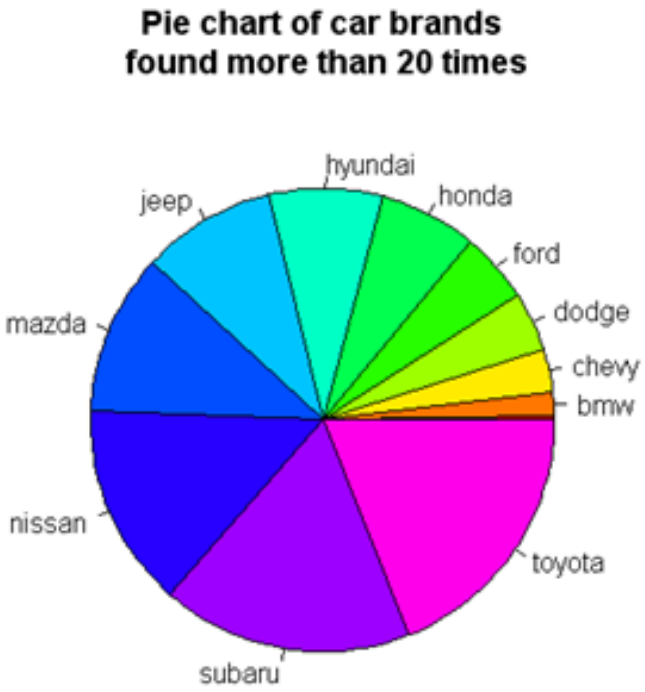
Tech+0.06042UC

Fun Facts:Car Models



Fun Facts: Colors

Fun Facts: Car Brands



Surprising Results

- Large majority of parking spaces are not used compared to how many spots are taken during the weekend when they do not have to pay for parking meters
- Large percentage of expired registration plates
- Broken meters do not get fixed
- Small percentage of unpaid meters are ticketeted
- Large percentage of unpaid meters

Good News

- We learned about a lot of necessary improvements for the parking meter system at Carnegie Mellon University, which is backed up by factual census analysis
- We were able to answer our main research question with statistically significant results

Conclusion

The use of parking meters is less effective than we initially anticipated.

Pumped for Meeting of the Minds!

Any questions, comments, or suggestions?

PUMP! PUMP! PUMP IT UP!