Remark: We had 4 additional questions to answer, which are included at the end of this assignment (questions you wrote on our Assignment I.3).

K: Sampling Scheme 15/30
L: Questionnaire 50/50
M: Sample Size 15/20

80/100

Parking Meters at Carnegie Mellon University

Team F: Kaylee Makel, Nancy Geronian, Victor Wilczynski, Jeff Lee, Jungmoon Jang

A. Why is this topic interesting? Why does this survey need to be done now? Is there a client for whom you might do the survey?

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? In reality, Carnegie Mellon is in working stages of implementing technological improvements in terms of parking on its campus (i.e. Traffic21, ParkPGH). We want to survey on campus parking meters to determine if there is a high frequency in unpaid meters. To add, we would like to see if there are any correlations between other factors, such as owning an expensive car, time of day, etc. This project is very interesting for anyone who uses the parking meters on campus, especially those who have been ticketed for parking violations.

B. What question(s) do you propose to study? Give a brief answer that would have been understandable by a non-statistician.

We wish to look at different aspects of meter parking at Carnegie Mellon University:

a. How frequent do people not pay meters
b. Are certain days/times more likely to have unpaid meters
c. Are different types (color/brand/model) of cars more likely to be at an unpaid meter
d. Are cars registered as Pennsylvanian or outside states (by checking license plate) more likely to be at an unpaid meter

In our project we would like to survey the parking meters at different times and on different days and record how frequently they are unpaid and which types of cars are parked there. Depending on what we find out, we would like to see if there should be a push to seek alternative methods to coin operated parking meters.

C. What research has already been done on the topic or on the theoretical construct of central importance to your topic? What could be learned from survey results? Each group member should locate and review 1 relevant piece of research (e.g., article, report, book, etc)

1) Nancy Geronian: “Local, national companies contracted for parking meter efficiency: Revenue rises in Tampa with new meter technology” from Tampa Bay Business Journal by Mark Holan, Staff Writer on Friday December 31, 2011. Web. <http://www.bizjournals.com/tampabay/print-edition/2010/12/31/local-national-companies-contracted.html?page=all>.

Summary: The key point of this article states how advancing meter technology will reduce costs, increase revenue, and improve convenience, so in our project we can show how inefficient regular coin parking meters really are.

2) Kaylee Makel: Goals, IndustriesBy ApplicationsBy. "Integrated Parking Management." *Parking Solutions, Multi-Space Parking Meters | Digital Payment Technologies*. 2011. Web. 28 Jan. 2012. <http://www.digitalpaytech.com/parking-solutions/integrated-parking-management.aspx>.

Summary: As technology advances, consumers are now able to pay their parking meters via phone without bearing weather conditions or leaving an office meeting. Parking meters are now being monitored by space sensors using a Smartphone application which yields immediate payment without ever having to visit the pay station. This sort of technological advancement is beneficial for consumers, especially students and professors on a tight schedule.

3) Jeff Lee: “Environmental Indicators for Carnegie Mellon University: Baseline Assessment.” 2004. Web. <http://www.cmu.edu/greenpractices/campus-assessment/environmental-indicators/transportation.pdf> .

Summary: CMU wants to reduce the number of vehicles that travel to campus whereas more and more people find the convenience of driving to campus well worth the cost of permit/metered parking and/or the risk of being fined. There are multiple reasons as to why, including poor public transportation, unreliable shuttle service, and close proximity of metered parking.

4) Jung Moon Jang: M. Grynbaum, “The Last Days of the Old Parking Meter.” September 18, 2011. <http://www.nytimes.com/2011/09/19/nyregion/uprooting-the-old-familiar-parking-meter.html?pagewanted=all>.

Summary: New York City has replaced all of the parking meters to a solar-powered meter with Wi-Fi and ability to control eight parking spaces at once and to speak seven languages. The new meter system is very convenient because instead of carrying coins in pocket, people can pay with credit card. Also, because the parking meters no longer define each spot, it is expected that the city will have 10 to 15% more parking spaces.

5) Victor Wilczynski: “Advanced Parking Meters Help Increase Asbury Park's Parking Revenue by More Than 60 Percent.” November 1, 2011. <http://www.marketwatch.com/story/advanced-parking-meters-help-increase-asbury-parks-parking-revenue-by-more-than-60-percent-2011-11-01>.

Summary: The installment of 100 multi-space parking pay stations in New Jersey has increased parking revenue over 60 percent. The parking stations allow many different payment options including cash, coins, credit, and debit, so maybe Carnegie Mellon University should make a switch to more efficient methods.

D. What is the sampling frame? What population or populations do you plan to sample from?
The sampling frame: parking meters on Frew, Tech, and Margaret Morrison Street.

E. What is the target population? To what population(s) do you wish to make inferences?
How does the target population differ from the sampling frame, for your survey?
What possible sampling and non-sampling errors could arise in the survey that you plan to conduct?
Explain each possible error, how it could occur, and how you suggest tackling it.

The target population is all on campus parking meters, since our target population is not that large in size, we can observe all units in the target population. We are not sampling the drivers of these vehicles, since it is impracticable plan to wait around for the driver to hand them a survey or stick a survey into their windsheild. Reason being, people out of their consciousness will not want to admit that they blantantly did not pay their meter. The sampling frame are the meters on three streets on campus mentioned in part D.

We could see a sampling error in variance, although the three streets are located next to each other, they could be more attractive to different drivers considering the buildings they are closest to. We will handle this by analyzing the data for each street as well as combined to see if there is any significant difference. Although we will be able to survey every meter each time we survey, there may not always be a car parked at it. This could be considered a non-response error. I think that by analyzing data for number of cars parked versus illegally parked cars will still be sufficient to provide data. This information is still valuable because if we notice a certain time where there are very few cars then monitoring habits can be adjusted accordingly by the parking authority.

Another error could be a measurement error, since we do not know if a parking meter is broken or not. If it is broken, the driver is not able to pay and if we cannot identify that the driver has not paid because the meter is broken or for some other reasons, that would be a measurement error.

F. What is the mode of data collection? How do you plan to carry out the survey (e.g., by telephone, e-mail) and why?

We would carry out the survey by checking each parking meter at different times and on different days, and recording our observations.

G. What variables do you propose to measure?

Our main focus will be to see if there is an abundance of people parking illegally. However, we will also look at factors such as timing to see if there are certain times of day or certain days of the week that there is a higher frequency of illegal parking. We are going to record what state the car is registered (license plate) to see if there is a difference of out of state versus Pennsylvanian residents. We also are going to make note of variables such as make/model and color to see if there is any connection with these factors and illegal parking.

H. On the basis of feedback to your submission for Parts I and II, choose a final survey topic, and update or revise your answers to (A) through (G) above. Submit the revised proposal.

K. Decide on a sampling scheme (e.g., SRS, Stratified random sample, etc.) and explain why you chose it.

There are total of 206 parking meters on campus.

Margaret Morrison St	**5**
Tech St	29
Frew St	168
University Center	4

We have decided to not have a sampling scheme of a census of all 208 parking meters. Because observing, checking all 206 parking meters on campus is not very feasible because it would take a considerable amount of time, we are choosing to conduct random sampling by surveying every other parking meter until we survey 100 cars two times per day (explained later on in more detail), starting at a different location every time which will be decided upon before each group of two goes out and conducts the survey.

meters?

How long?
How long per meter?
How long to do all of them?

provide evidence that selecting every other meter is like random sampling (use what we have said in class about sample sizes for non-random samples!)

(a) sampling every other meter is not random sampling
(b) will this save you enough time? show me evidence that reducing to 100 is enough to make this a feasible project.

these questions seem like a good start. be sure to try them on a few meters, to see if there are any ambiguities or difficulties in recording answers to them.

How are you recording results? spreadsheet or word file on a laptop? clipboard? etc? Make sure everyone records exactly the same way so that the results are easy to mege into a single data set for analysis later.

L. Write a questionnaire with 20–30 questions. Up to approximately 1/3 of these can be background or demographic questions and the rest should be directly related to the research questions you will try to answer with your survey. NOTE: If your survey involves observations instead of asking people questions, then instead you should carefully describe your observation protocol. That is, list 20–30 things you will always look for when observing each unit in your survey.

Questions related to the parking meter

1. Is the vehicle parked at an expired meter?
2. Is the meter broken?

Ask first: is there a vehicle parked there at all? Just the fraction of meters in use is already interesting...

Questions related to the vehicle (if there is a vehicle at this meter)

1. What color is the vehicle?
2. Type of vehicle (compact, minivan, truck, etc.)
3. Make of vehicle (Chevy, Ford, BMW, Mazda, Honda, Pontiac, etc.)
4. Model of vehicle (Accord, Focus, Protégé, Sunfire)
5. What state is their license plate from?
6. Does the vehicle have a ticket?
    a. How much is the ticket?
    b. What were they ticketed for?
7. Is the car clean or dirty?
8. Do they have registration? (tag located on license place)
    a. Is the registration expired?
9. Do they have their vehicle inspected? (tag located on windshield)
    a. Is their inspection expired?
10. Does the vehicle have any after market additions? (fancy exhaust system, suspension lift, spoiler, fancy rims)
11. Is the vehicle parked at a handicapped parking spot?
    a. Do they have a handicapped tag/license plate
12. Does the vehicle have any major dents, scrapes, or shattered windows?
13. Is the vehicle driving on a spare tire?
14. Is the vehicle parked in a legal parking spot or did they make their own spot?
15. Does the vehicle have a parking pass to park on another on-campus location?

year of car?

some sense of how expensive the car is (current new price, current market price, or something)?

if the units are parking meters, you will never see this will you? or do you mean something else?

Questions not related to either the meter or the vehicle

1. What day of the week is it?
2. What is the time?
3. What street is the vehicle parked on?
4. What is the weather like? (sunny, rainy, cold, hot, etc.)
5. Total percentage of cars parked on each street out of the 100 unit sample
6. What was the starting location of the survey ?

M. Give some idea of the sample size you will require and how you arrived at this number (talk about the margin of error for inferences you want to make).

(a) show calculation, don't just talk about it

(b) the p in this calculation is not response rate, it is the probability of some outcome in your survey (e.g., probability that the meter is expired, or probability that the meter is in use, etc.)

If we were doing a census, our sample size was going to be 206 and the margin of error would be zero. However, since we are taking a 100 unit random sample of the parking meters on campus, the margin of error is calculated understanding that this is sampling without replacement. We hope to have a margin of error less than 0.05, since that is a common goal held by many surveys. Our p here will be about .9 because we will believe we will receive a "response" for high percentage of parking meters. We want to use the 95% confidence interval, since again this is commonly used. As a result, if we were to take 100 random sample of the parking meters on campus, the margin of error is about 4.189% at standard 95% confidence interval which is reasonable compared to 7.231% if we were to sample 50 parking meters. To note, since we are unsure about p which we need to calculate margin of error, we have used p=0.9. Nevertheless, the value of p in our survey is 1 since we are observing the parking meters; there is no way the meters going to "not respond" to our survey.

In addition to the questions for II.4:

1) *How many parking meters are there in your target population?*

There are total of 206 parking meters on campus.

Margaret Morrison St	**5**
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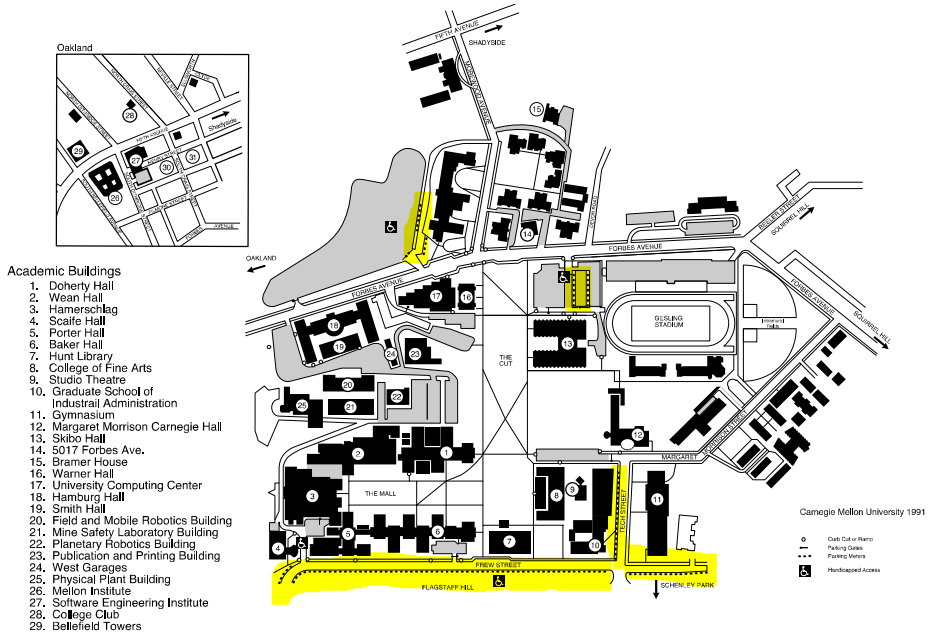
2) *Provide a map (preferable official) of the locations of all of the meters in your target population:* Map is on the next page and they are on the streets listed above.

Carnegie Mellon University Campus Map



3) *Provide a careful description of all the times of day and week you will look at meters, and why these represent all of the variation in usage, not paying for parking, etc., that you hope to see:*

how long would a census take?

We found that conducting a census of parking meters on campus is not very well feasible therefore our problems dealt with how to get a randomized sample and dividing up the variable time when conducting our study.

Since parking meter fees apply between 8 am and 5pm, we will create two groups to administer our census. We will conduct a study of morning commuters, from 8am to 12:30pm, and afternoon commuters, from 12:30pm to 5pm. Specific times will not be of interest to us as long as the study is done in the 4.5 hour time slot (However we will best try to conduct the study near the middle of our bin width, approximately 10:15am and 2:45pm).

good

After creating two time groups, we then found that parking meter fees also only apply on weekdays. We then made a Hypothesis that Mondays, Wednesday, and Fridays compared to Tuesdays and Thursday are quite similar in school days (Most classes are scheduled in either of the two grouped weekdays), we will create two groups in examining school days. We now have 4 different subgroups of times we will examine parking meters on campus in conducting our census. For example, if we are collecting data for group (Monday Wednesday Friday, afternoon), my survey on Wednesday 3:00pm would be just as valid as a survey conducted on Friday 1:00pm for studying commuter's behavior towards parking meters.

good

agree with this general idea, but am worried that there may be day differences in the two groups. especially fri afternoons for example. it would be good if in pretesting you could collect evidence about how similar MW and F are (and T Th in their group). If they are similar, great. If not, it suggests breaking down your data by day for some/all questions.

We feel that our 4 subgroups cover some key demographics of student, faculty, and visitors for presence on campus. We may be able to find some interesting differences between morning commuters versus afternoon commuters' behavior towards parking meters on campus. In each of the 4 subgroups, we will conduct a full sample of all parking meters on campus (Frew Street, Tech Street, Margaret Morrison Street, University Center).

ok

which study? are you talking about pretest? if so, good

After this initial study, we may or may not need to revise some questions or variables of interest to better assess our study on parking meters. We may find that the bin widths on specific times or specific days are not representative of our sample and need to make more subgroups if need be.

4) *It may be the case that doing a census at all of the times you provide in (3) is too much work. Provide a plan for how to sample locations to read the meters, if you can only afford to sample 1/3 of the meters at each day and time, and explain why this produces a repsentative sample of the target population.*

Since we understand sampling the entire target population of 206 at a time is very unreasonable, we are choosing to conduct random sampling by surveying every other parking meter until we survey 100 cars two times per day (explained earlier on in detail), starting at a different location every time which will be decided upon before each group of two goes out and conducts the survey. As noticed previously, sampling 100 out of 208 would yield a small enough margin of error, so we would choose this amount.

You are on the right track in terms of splittign the week up into MWF and TH parts, and looking at morning and evening use separately. Using a fixed sample of meters at all days and times seems fine to me too (rather than re-sampling meters each time you go out, for example).

I'm not sure I understand your findings regarding doing a census rather than a sample; it seems like you have gathered some evidence about this but you have not provided the evidence, only your conclusions. Hard to evaluate your conclusions or make suggestions without the evidence!

Regarding sampling plan and sample size there are a couple of things to think about

1. A non-random sample or a less-random sample need not be hopeless but you really have to argue that what you are doing covers the population well and doesn't introduce unintended biases. For example,
   * do cars tend to park every other meter when the meters are no very full? If so, then a samping plan that involves every other meter could have an unintended bias. What about other possible biases?

   * instead of a strict "every other meter" rule, you might try think about a "random start / random skip" method (there will be a handout on tues that discusses this in one part)

   * We talked in class about sample sizes for non-random samples that are large enough to be "representative". Is your proposed sample size appropriate from this pov?

2. Your sample size discussion under M above seems to be on track but it's hard to tell without your calculations. I think you are using the wrong p -- see my comments above about that. If you use the "generic" value of 1/2 for p, it doesn't increase your sample size very much above 100. Do the calculation, tell me what you think.

3. what is the evidence for and against doing a full census here [relative to a sample of whatever size you settle on after doing the calculation)? I don't want to force you into a sample and I don't want to force you into a census. I want you to make the best intellectual decision, trading off your effort vs reliability/validity of your survey (or census).