Lab 1: Measuring the Real World
Math/CS-484: F/K - Visualizing Scientific Data
Leif DeJong

Model: The model to be built is measuring a 2D enclosed space in order to calculate its area. Several measuring tools will be used in order to demonstrate the variety of results from this methodology.

Process: The process is broken up into stages.The first stage involves <u>collecting data</u> of the enclosed area. The second stage involves <u>post processing the raw data</u>, and the third stage involves <u>visualizing the data</u>.

Assumptions: The enclosed area is a **rectangle,** the enclosed area is **flat,** the sidewalks are **straight,** and the corners of the sides are a 90° angle

Collecting Data:

Method 1 - "The Shoe": This method involves walking around the parameter of the enclosed area heel to toe keeping count of every side. This is repeated three times whereafter the shoe will be measured and the total steps multiplied to the length of the shoe.

Method 2 - "Large Wheel": Using the large measuring wheel, walk around the parameter of the enclosed area taking note of the length of each side. This is to be repeated three times.

Method 3 - "Small Wheel": Using the small measuring wheel, walk around the parameter of the enclosed area taking note of the length of each side. This is to be repeated three times.

Method 4 - "Tape Measure": Using the tape measure, have a partner on one end of the four sides and walk along a side until you reach the end whereafter you take the reading, roll up the tape, and then start over except with another side of the enclosed area. This is to be repeated three times.

Method 5 - "Google Planimeter": Using Google's planimeter software based on Google's Maps, take three readings to the enclosed space's area.[1]

Method 6 - 'Planimeter": Using Charlie Peck's Planimeter, take a map of campus, set the scale to the planimeter, take the measurement, do the correct math, and record your results three times. Convert the units from ft^2 to m^2.

Post Processing the Raw Data:

Step 1: Convert from feet to meters using Google's Unit Converter keeping precision to a max.

Step 2: <u>Average the "Short Sides"</u>: Take the average values of the Bundy Side and Heart Side to acquire a measurement for the short side of the rectangle.

Step 3: <u>Average the "Long Sides"</u>: Take the average values of the Barrette Side and Tyler Hall Side to acquire a measurement for the long side of the rectangle.

Step 4: <u>Find the Area</u>: Multiply the values for the short and long side together to get the area of the rectangle. Make sure that the units are meters squared and the precision is two.

Visualizing the Data:

For the scope of this project, I found it appropriate to use a bar graph to visualize the data. It allows me to have a flat view of all the data and the arithmetic mean.

What makes good visualizations is being able to present the scope of your data and having it be analyzed without biasing it.
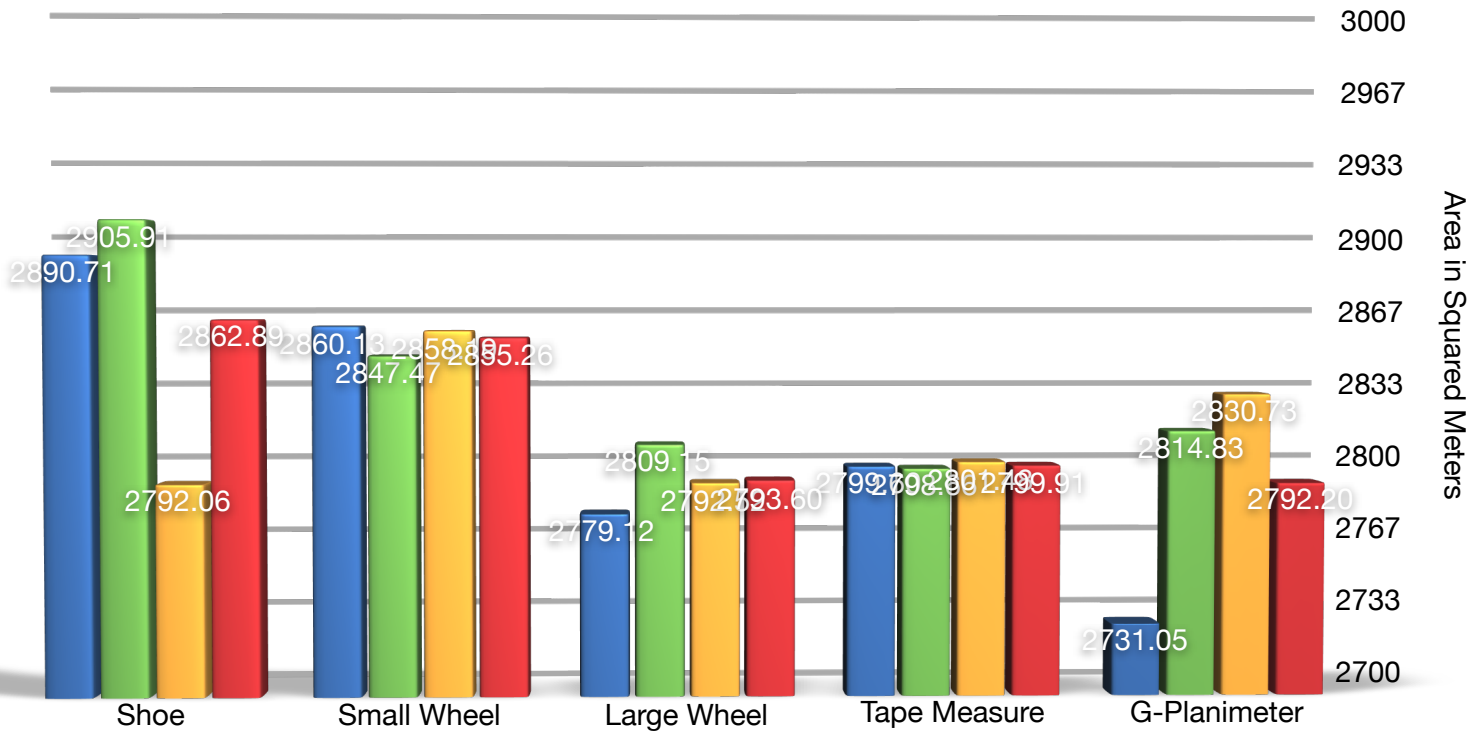
There are two Visualizations:

1) Has the 5 first measurement methods
2) Has **all** 6 measurement methods

Visualizing the Data Continued...

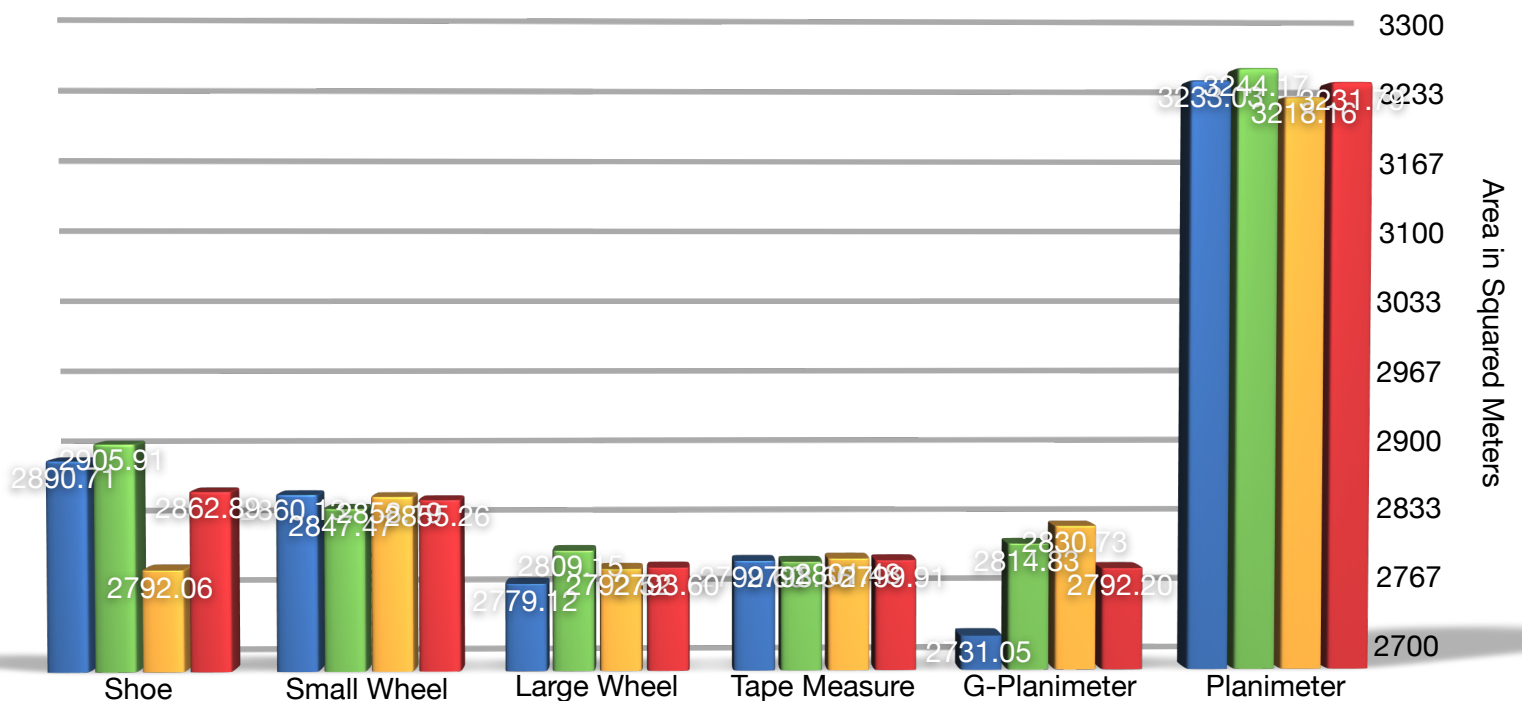**Visualization 1**: First 5 Methods

Visualization 2: All Methods

General: The irregularity of the sidewalks along with objects protruding or intruding may have caused some error with some of the measurement devices. Our assumptions about the experiment also lead to a conceivable amount of error along with improper use of some of the tools when trying to make accurate measurements. Like any experiment, it is subject to a certain amount of human error.

Shoe: After spending 45 minutes walking around the enclosed area, sources of error include potentially losing count especially on "Trial 3" and not having the exact step every iteration of the process.

Small and Large Wheel: This measurement tool often oscillated horizontally which could lead to a source of error. The wheels were subject to slipping or being interrupted by the condition of the sidewalk.

Tape Measure: When I did the measurement, I moved the tape, rippled it, tugged it, and remeasured. This may be the explanation why the measurements are very close and create this misguided assumption of the actual area.

G-Planimeter: I do not know exactly how the software was engineered and therefore have to assume that there is a certain amount of error involved with the methodology.

Planimeter: I have a feeling by looking at the results that there was a lot of error with the operation of this device. This could also be error in the actual map or the precision at which it was measured.

Absolute and Relative Error: Included in the "Totals and Error" table below.

Resources:

1) Daft Logic - Google Maps Area Calculator Tool
http://www.daftlogic.com/projects-google-maps-area-calculator-tool.htm

Shoe Data

	Bundy Side	Barrett Side	Heart Side	Tyler Side	Short Side Avg (m)	Long Side Avg (m)	Area (m²)
Trial 1 (ft)	158	216	161	215			
Trial 2 (ft)	157	224	160	212			
Trial 3 (ft)	154	217	157	210			
Trial 1 (m)	45.82	62.64	46.69	62.35	46.255	62.495	2890.71
Trial 2 (m)	45.53	64.96	46.4	61.48	45.965	63.22	2905.91
Trial 3 (m)	44.66	62.93	45.53	60.9	45.095	61.915	2792.06

Small Wheel Data

	Bundy Side	Barrett Side	Heart Side	Tyler Side	Short Side Avg (m)	Long Side Avg (m)	Area (m²)
Trial 1 (ft)	148.4	204.5	152.1	205.3			
Trial 2 (ft)	148.6	204.6	152.11	203.1			
Trial 3 (ft)	148.11	204.5	152.7	204.6			
Trial 1 (m)	45.23232	62.3316	46.36008	62.57544	45.7962	62.45352	2860.13
Trial 2 (m)	45.29328	62.36208	46.363128	61.90488	45.828204	62.13348	2847.47
Trial 3 (m)	45.143928	62.3316	46.54296	62.36208	45.843444	62.34684	2858.19

Large Wheel Data

	Bundy Side	Barrett Side	Heart Side	Tyler Side	Short Side Avg (m)	Long Side Avg (m)	Area (m²)
Trial 1 (ft)	146	202.1	150.4	201.6			
Trial 2 (ft)	146.3	202.7	151.9	202.9			
Trial 3 (ft)	146.2	202.3	150.6	202.8			
Trial 1 (m)	44.5008	61.60008	45.84192	61.44768	45.17136	61.52388	2779.12
Trial 2 (m)	44.59224	61.78296	46.29912	61.84392	45.44568	61.81344	2809.15
Trial 3 (m)	44.56176	61.66104	45.90288	61.81344	45.23232	61.73724	2792.52

Tape Measure Data

	Bundy Side	Barrett Side	Heart Side	Tyler Side	Short Side Avg (m)	Long Side Avg (m)	Area (m²)
Trial 1 (ft)	147.5	202.5	150.2	202.4			
Trial 2 (ft)	147.6	202.6	150	202.3			
Trial 3 (ft)	147.8	202.3	150.1	202.6			
Trial 1 (m)	44.958	61.722	45.78096	61.69152	45.36948	61.70676	2799.60
Trial 2 (m)	44.98848	61.75248	45.72	61.66104	45.35424	61.70676	2798.66
Trial 3 (m)	45.04944	61.66104	45.75048	61.75248	45.39996	61.70676	2801.48

Google Planimeter Data

	Area (m²)					
Trial 1	2731.05					
Trial 2	2814.83					
Trial 3	2830.73					

Planimeter Data

	Area (m²)					
Trial 1	3233.03					
Trial 2	3244.17					
Trial 3	3218.16					

Totals and Error

	Shoe	Small Wheel	Large Wheel	Tape Measure	G-Planimeter	Planimeter
Trial 1 (m²)	2890.71	2860.13	2779.12	2799.60	2731.05	3233.03
Trial 2 (m²)	2905.91	2847.47	2809.15	2798.66	2814.83	3244.17
Trial 3 (m²)	2792.06	2858.19	2792.52	2801.48	2830.73	3218.16
Mean (m²)	2862.89	2855.26	2793.60	2799.91	2792.20	3231.79
Absolute Error	27.82	4.87	-14.48	-0.31	-61.15	1.24
Relative Error	0.0097163	0.0017045	-0.0051821	-0.0001119	-0.0219015	0.0003847