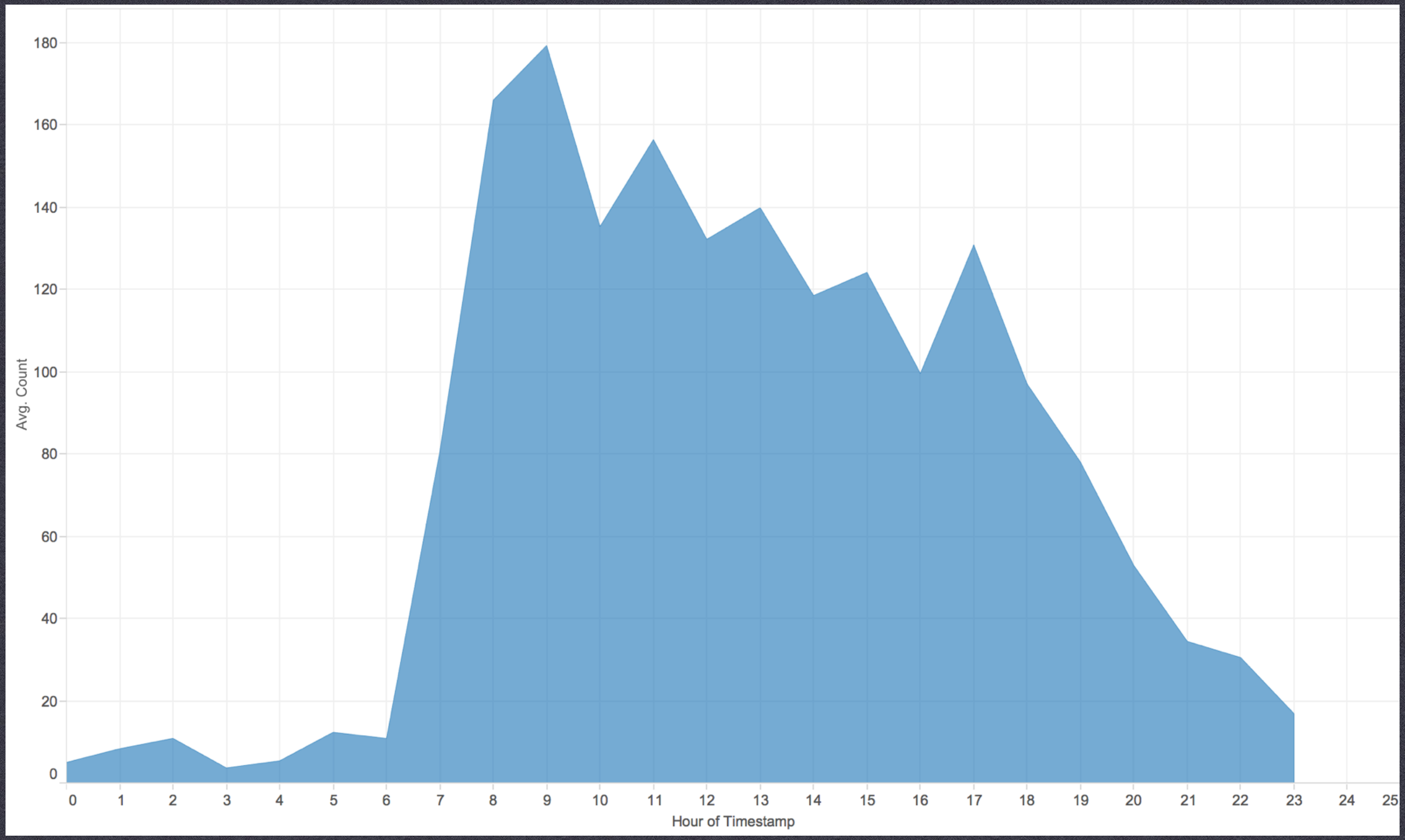


TOPIC

TRANSPORTATION - SENSORS - AND THE SMART CITY
GEOG 491/591 ADVANCED GIS

DATE **4-27-15**

LECTURE **#9 - PROJECT DESIGN**

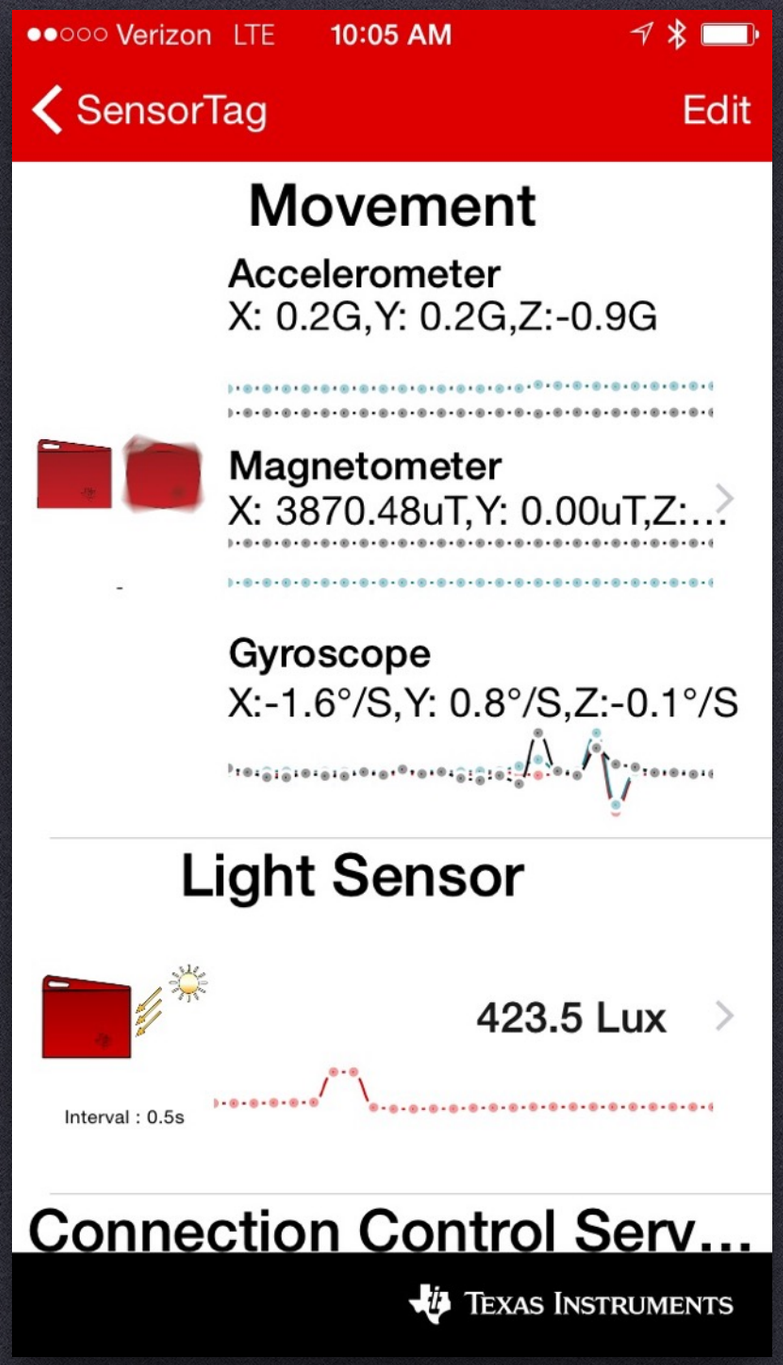
- **SENSOR TAG EXPERIMENTS**
  Hear student experiences
- **UO BIKE COUNTER**
  The State of the Sensor
- **PROJECT DESIGN**
  Smart or lucky?
- **ASSIGNMENTS 3 & 4**
  An overview of #4

TOPIC

GOALS - OBJECTIVES - OUTCOMES

DATE 4-27-15

LECTURE #9 - PROJECT DESIGN



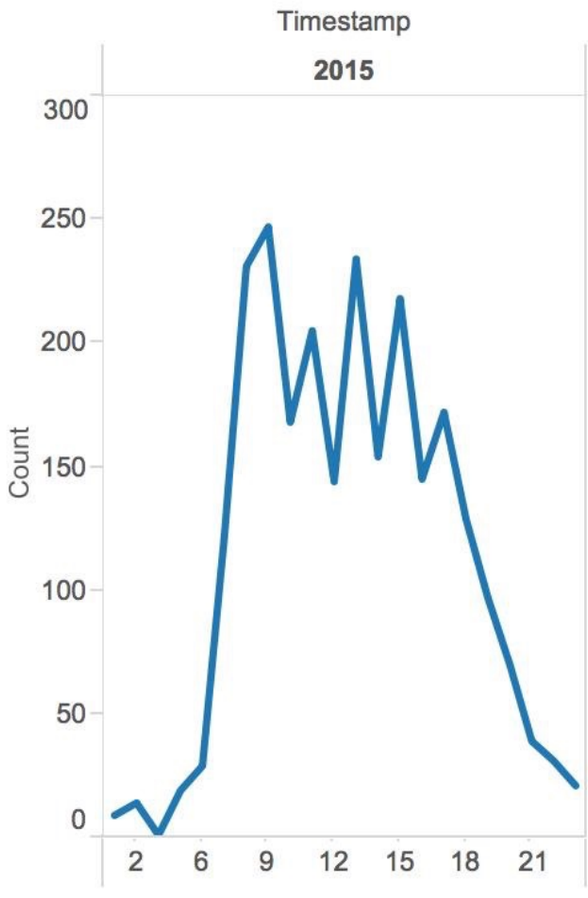
TOPIC

SENSOR TAG EXPERIMENTATION FOR CLASS

DATE **4-27-15**

LECTURE **#9 - PROJECT DESIGN**

Monday



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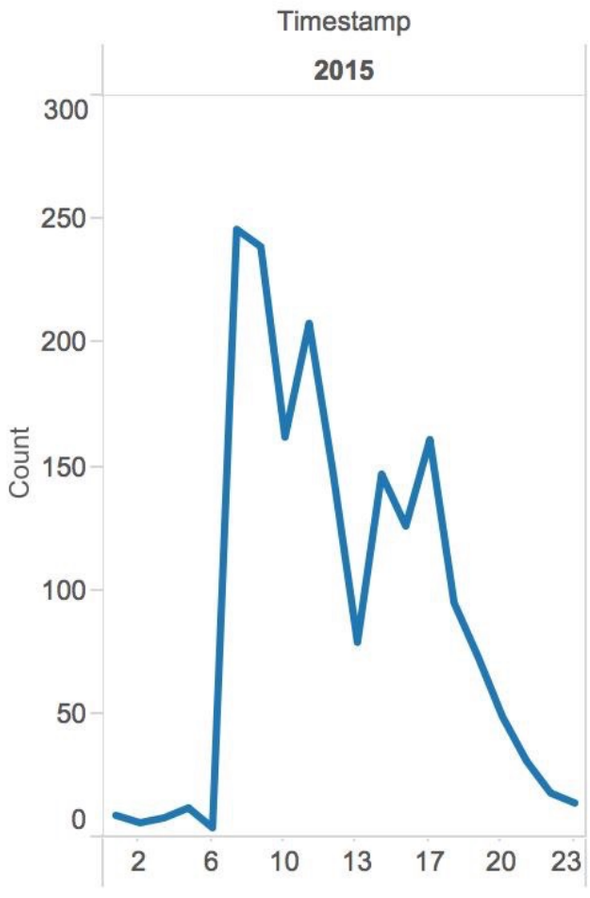

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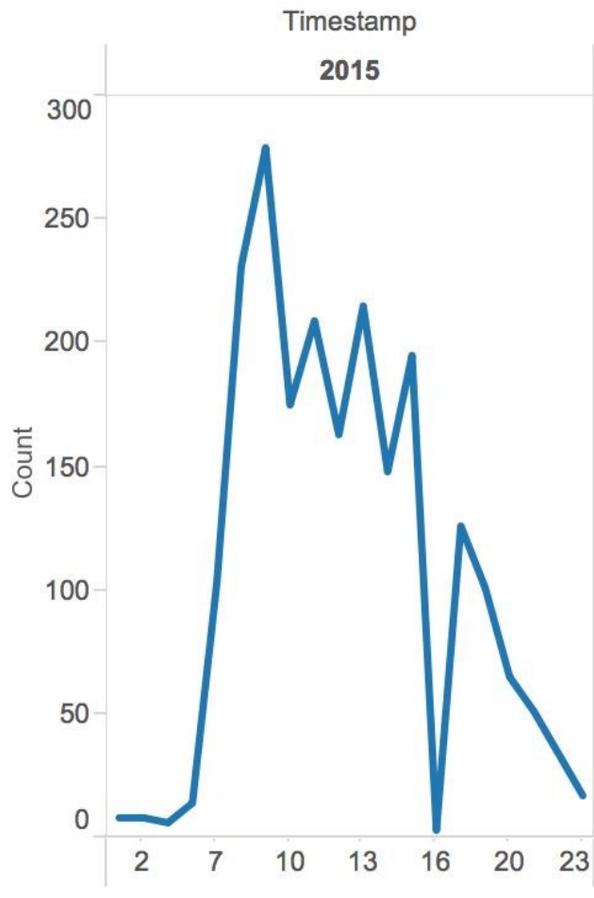

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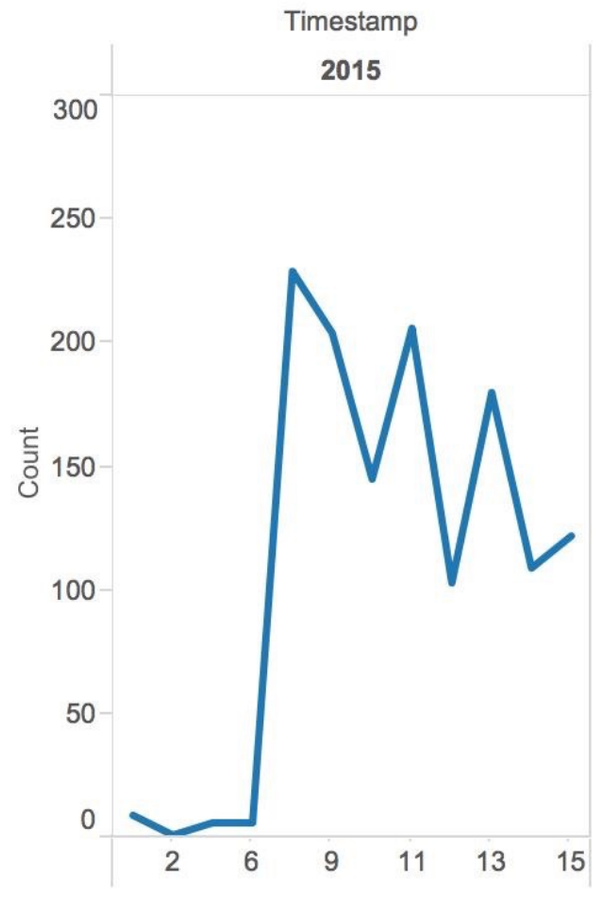

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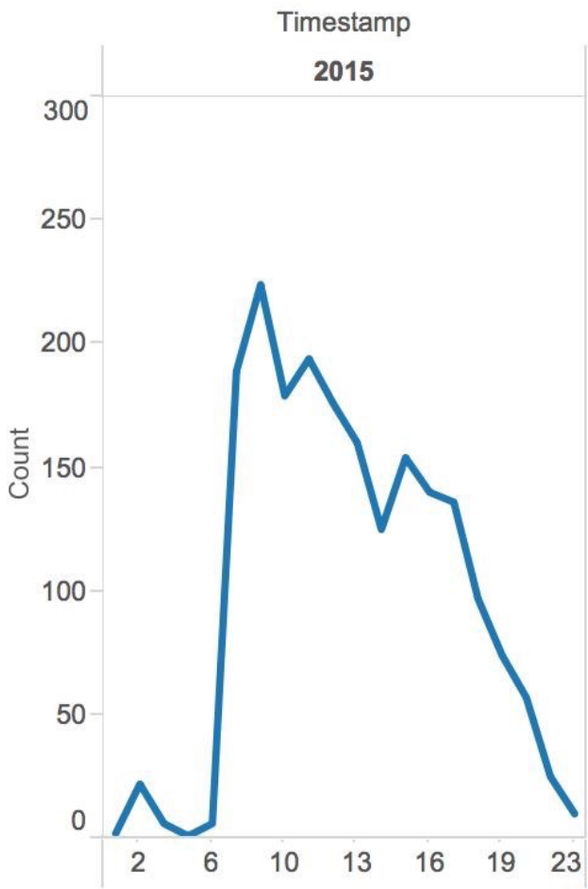

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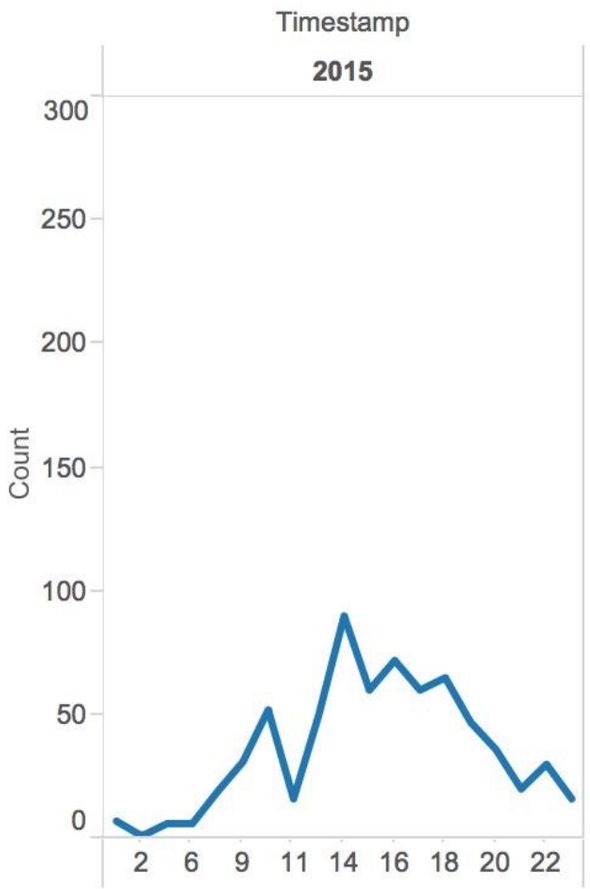

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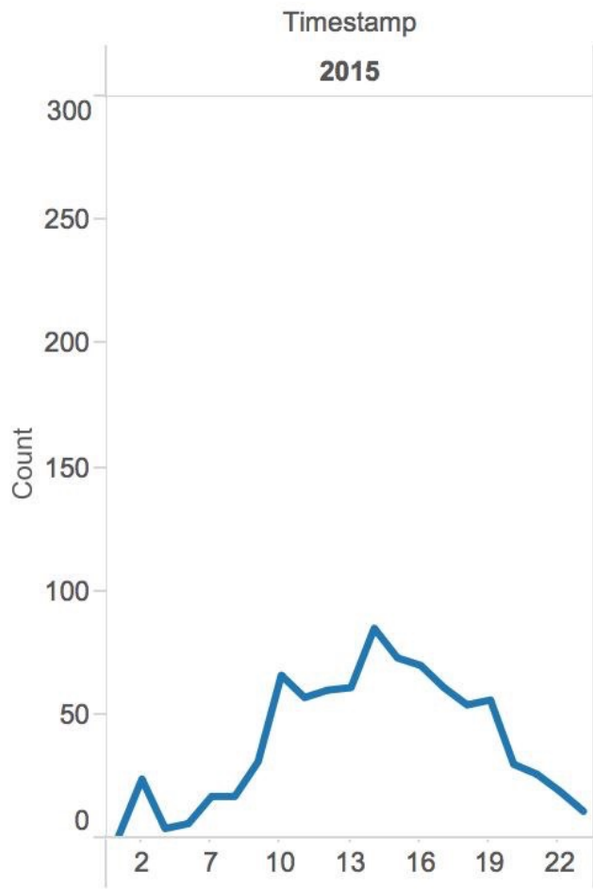


- **THE EFFECT OF WEATHER AND CLIMATE ON BICYCLE COMMUTING**
  Max Nankervis
- **ESTIMATING ANNUAL AVERAGE DAILY BICYCLIST AND ANALYZING CYCLIST SAFETY AT URBAN INTERSECTIONS**
  Krista Nordback

TOPIC

ASSIGNED READINGS FOR TODAY

DATE 4-27-15

LECTURE #9 - PROJECT DESIGN

- **UNIQUENESS OF STUDENT CYCLISTS?**
  Resiliency and Attrition

- **LONG-TERM CLIMATE VERSUS SHORT-TERM WEATHER**
  Rain's ranking versus Heat and Humidity in Data. Weather in morning is important. Hourly temperature as strongest predictor of hourly counts

- **CONTINUOUS COUNTERS**
  The value and the challenge of not having them

- **DATA VERACITY…**
  60% accuracy of counters? Under counting v over counting. Validation and calibration needs.

- **COMMUTER V NON-COMMUTER PATTERN**
  The commute variable

TOPIC

ASSIGNED READINGS FOR TODAY

DATE	LECTURE
4-27-15	#9 - PROJECT DESIGN

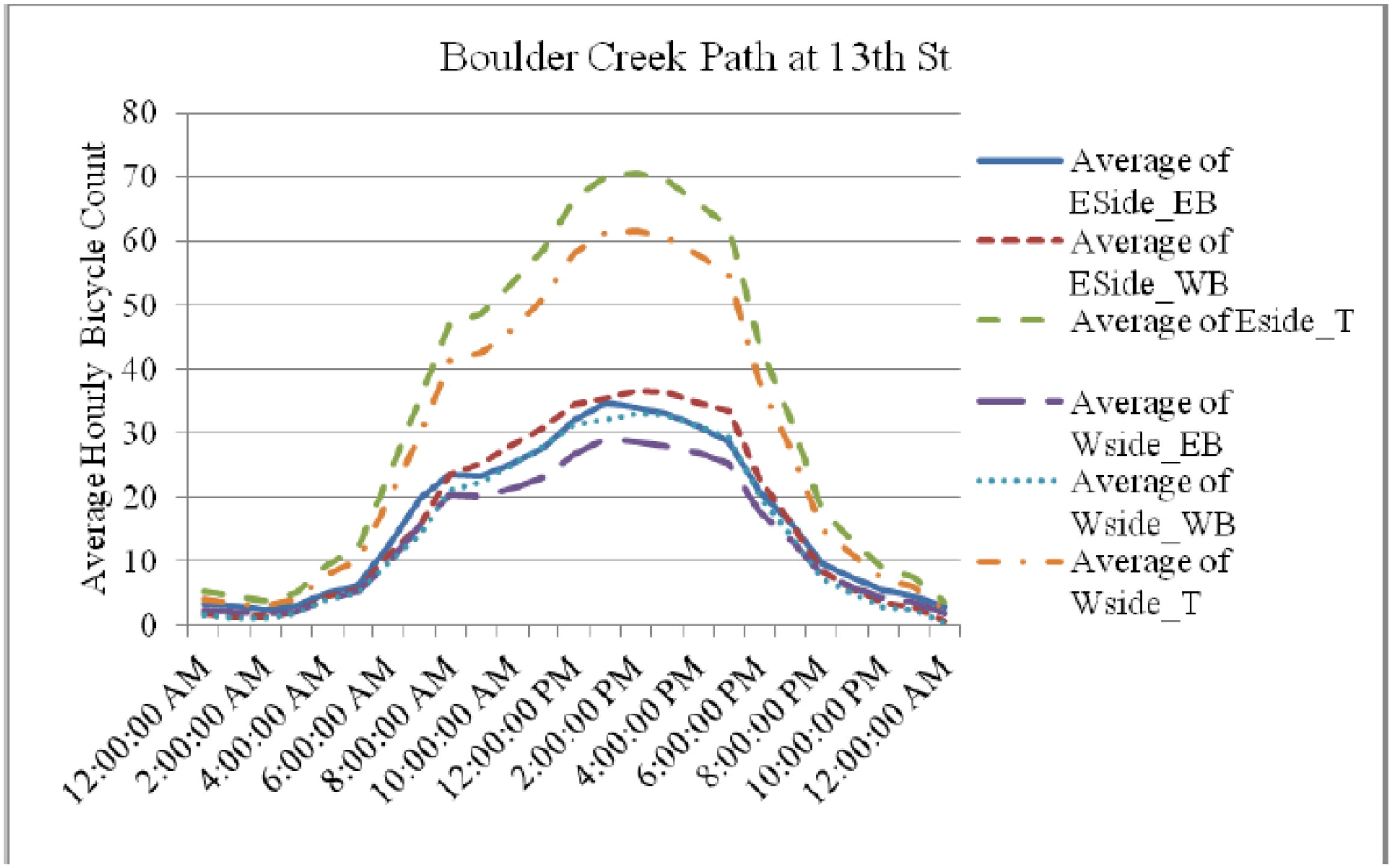


Figure 3-3: Example of a Non-Commute Pattern.

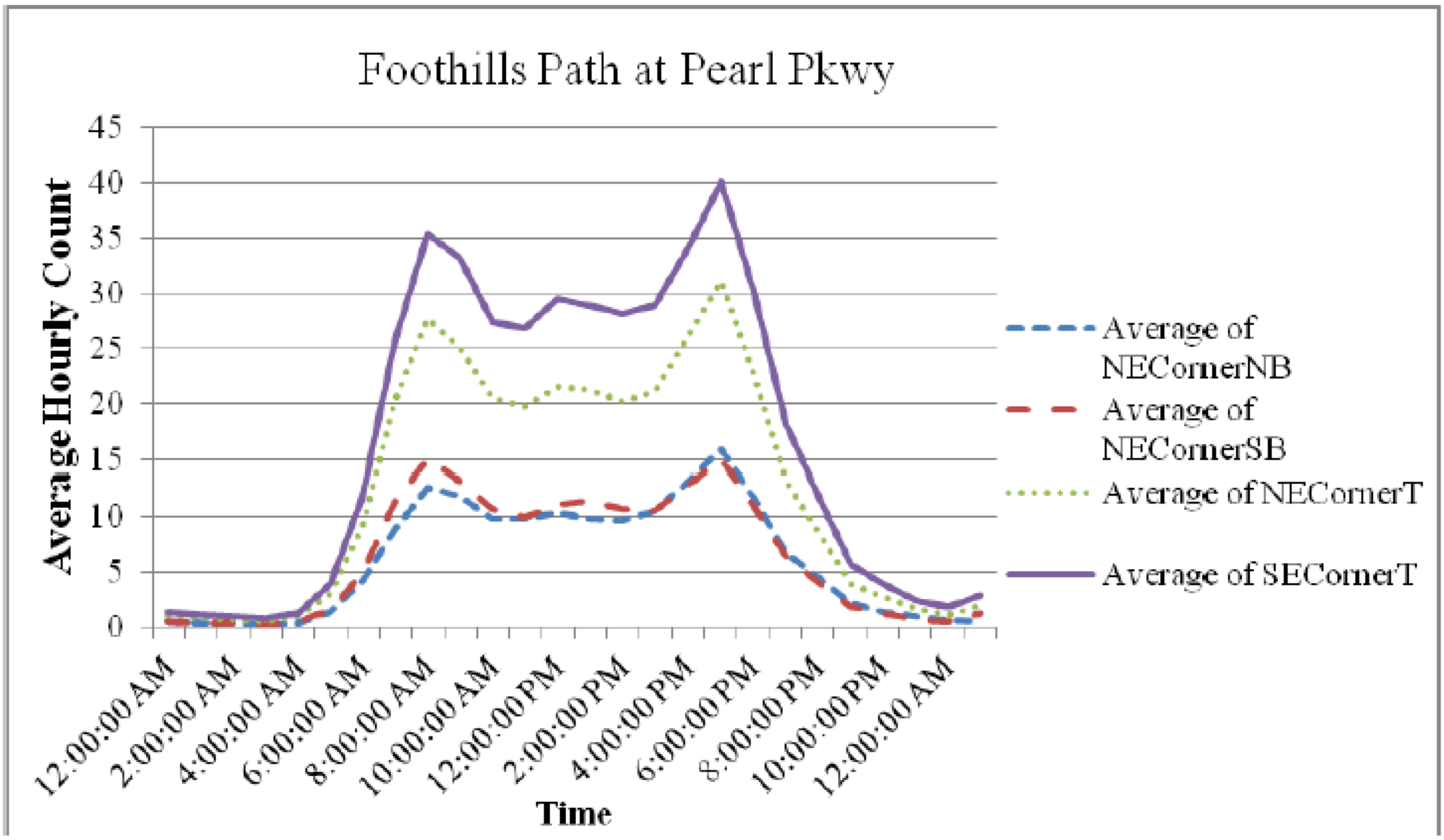


Figure 3-2: Example of a Location with a Commute Pattern.

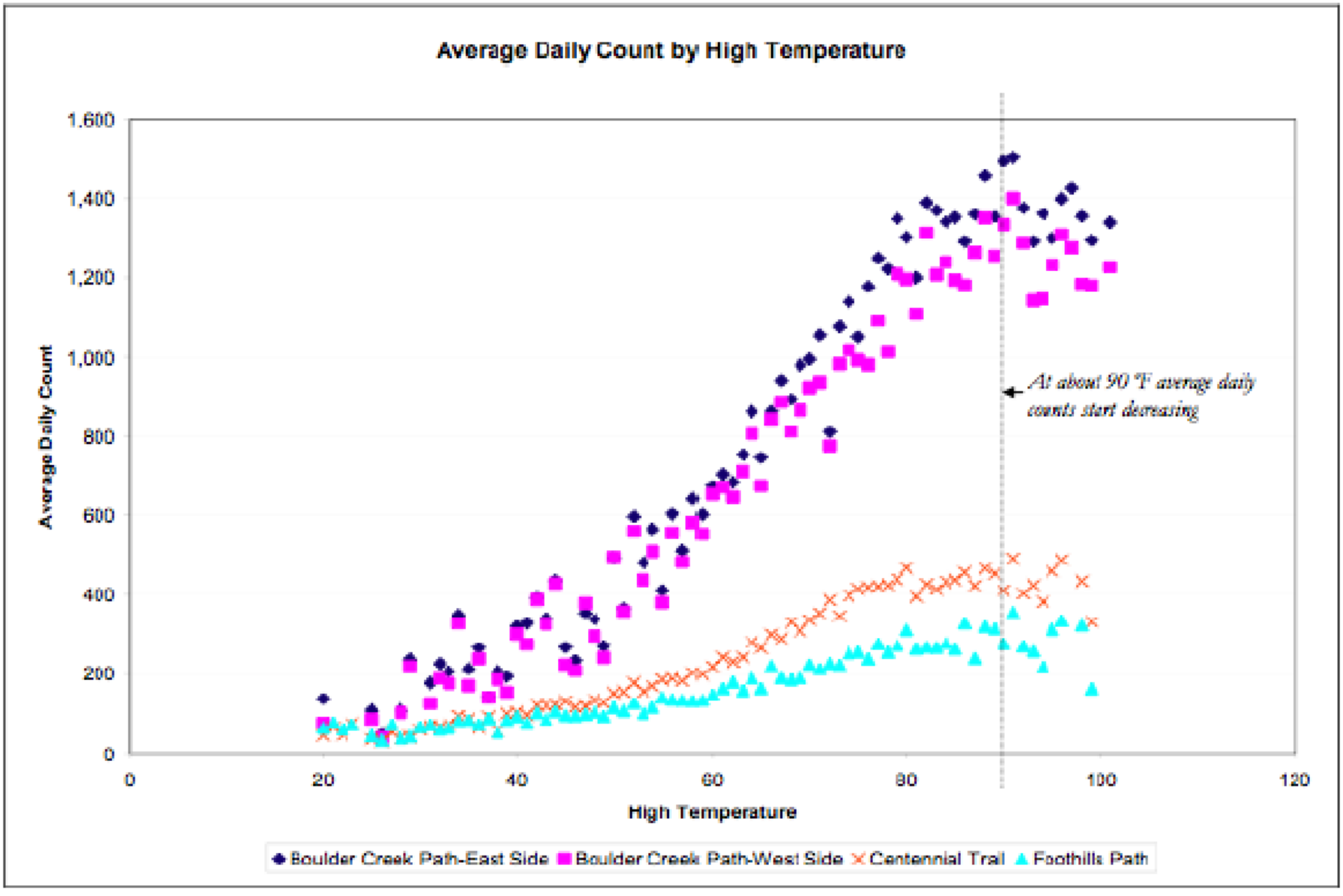


Figure 3-1: Average Daily Counts from Four Automated Boulder Count Stations (Lewin, 2005).

SOLUTIONS FOR STATE AND LOCAL GOVERNMENT
GOVERNMENT TECHNOLOGY

6 Principles in Planning City-Level Sensor Projects

In the fifth and final section of our Digital Communities quarterly report, we look at how cities can build the business case for sensor projects.

BY TOD NEWCOMBE / JUNE 6, 2014 1

23
5
8
0

1. **Start with your pain points.**

   Identify some of the major impediments to your city's growth and sustainability. The list could be broad, but usually includes: traffic congestion; lack of parking; aging water infrastructure and lost revenue from water leaks; transit ridership; and public safety.

2. **Build the business case.**

   Perhaps the hardest part, cities need to quantify the problem that needs fixing or quantify the value that the sensor project will bring. Don't be afraid to consider partnerships that could offer new sources of revenue.

3. **Do the boring stuff.**

   Update your governance models, set up shared services across departments, integrate data and redesign workflow. Like all technology projects, sensor-based solutions won't deliver their full value until the organizational issues are fixed first.

4. **Use leadership to get projects off the ground.**

   Sensor-based projects involve doing something new and often very different. That kind of change can be difficult to accept. Get leadership to push the project out the gate. Once the first sensor project is under way, the rest won't be so hard to launch.

5. **Look for less expensive options.**

   Can't afford to install a network of sensors? Consider putting sensors with GPS trackers on city-owned vehicles, turning them into mobile sensing devices for traffic and environmental monitoring, to name just a couple of possibilities. Scour through existing data to identify potential hot spots for where to selectively place sensors, reducing the number of devices needed to monitor traffic, transit or water lines, for example.

6. **Don't overlook privacy concerns.**

Smart City

Sensors

Budget

Visualization

Privacy & Security

Network

Sampling

Data

Part 1 - Proposal

Part 2 - Bicycle Transportation at UO

Real-time Data

Historic Data - Continuous

Historic Data - Sampled

Part 3 - Your Sensor Project

Transportation / Mobility

Individual or Team

Theoretical Hybrid Applied

Part 4 - Presentation

- **SMART CITY**
  How does your project fit into this context
- **SPECIFIC SECTOR**
  Sectors =
- **GOALS AND OBJECTIVES**
  What is your desired outcome?
- **WHY SENSORS?**
  What role with sensors play in your project

TOPIC

DEFINING/PROFILING YOUR PROJECT

DATE | LECTURE

- **BATTY**

  The convergence of information and communication technologies is producing urban environments that are quite different from anything we have experienced hitherto.
  … are intelligence functions that are able to integrate and synthesise this data to some purpose, ways of improving the efficiency, equity, sustainability and quality of life

- **GOVTECH**

  Some have called the smart city trend the most transformative thing to happen to cities since the urban renewal movement of the 1960s. It's happening in large part because of demographic, economic and fiscal changes affecting cities in America and around the globe. Since 2009, cities have cut more than a half million jobs from their payrolls. At the same time, however, the cost of doing government business keeps growing, putting pressure on budgets that have seen declines in revenue for every year between 2006 and 2012

TOPIC

ASSIGNED READINGS FOR TODAY - THE CALL TO ARMS!

DATE	LECTURE
4-1-15	#2 - THE SMART CITY

SMART ECONOMY (Competitiveness)	SMART PEOPLE (Social and Human Capital)	SMART GOVERNANCE (Participation)
▪ Innovative spirit ▪ Entrepreneurship ▪ Economic image & trademarks ▪ Productivity ▪ Flexibility of labour market ▪ International embeddedness ▪ *Ability to transform*	▪ Level of qualification ▪ Affinity to life long learning ▪ Social and ethnic plurality ▪ Flexibility ▪ Creativity ▪ Cosmopolitanism/Open-mindedness ▪ Participation in public life	▪ Participation in decision-making ▪ Public and social services ▪ Transparent governance ▪ *Political strategies & perspectives*
SMART MOBILITY (Transport and ICT)	**SMART ENVIRONMENT (Natural resources)**	**SMART LIVING (Quality of life)**
▪ Local accessibility ▪ (Inter-)national accessibility ▪ Availability of ICT-infrastructure ▪ Sustainable, innovative and safe transport systems	▪ Attractivity of natural conditions ▪ Pollution ▪ Environmental protection ▪ Sustainable resource management	▪ Cultural facilities ▪ Health conditions ▪ Individual safety ▪ Housing quality ▪ Education facilities ▪ Touristic attractivity ▪ Social cohesion

Fig. 2. A typology of smart city functions.

Hans Schaffers, Nicos Komninos, Marc Pallot, Brigitte Trousse, Michael Nilsson, Alvaro Oliveira

TOPIC

THE SMART CITY - FRAMEWORKS

DATE 4-1-15

LECTURE #2 - THE SMART CITY

Innovation Economy

- 1- Intelligent city clusters: manufacturing, business services, health, tourism
- 2- Intelligent city districts: CBD, techno park, mall, university campus, port area, airport city
- 3- New companies creation / intelligent incubators

City Infrastructure and Utilities

- 4- Smart transport, mobility and parking
- 5- Broadband, DSL, FTTH, wi-fi, embedded systems
- 6- Energy saving / smart grid
- 7- Environment monitoring, real time alert, safety

Governance

- 8- Government services to citizens
- 9- Decision making / participation / direct democracy
- 10- Monitoring & measurement: The city as database

Fig. 1. Smart city key application areas

Smart Cities and the Future Internet: Towards Cooperation Frameworks for Open Innovation
Hans Schaffers, Nicos Komninos, Marc Pallot, Brigitte Trousse, Michael Nilsson, Alvaro Oliveira

TOPIC

THE SMART CITY - FRAMEWORKS

DATE 4-1-15

LECTURE #2 - THE SMART CITY

- **TIMELINE**
  How long do you think it will take?

- **SCALE**
  Big/small - also geographic scale

- **AUDIENCE / PARTNERS**
  Who are you doing this for? Who with?

- **WHY SENSORS?**
  What role with sensors play in your project

TOPIC

DEFINING/PROFILING YOUR PROJECT

DATE | LECTURE

- **WHAT SENSOR(S)?**
  Who will access your data? How?
- **WHAT CATEGORY**
  Who will access your data? How?

TOPIC

ONTOLOGY - SENSOR SPECIFICS

DATE

LECTURE

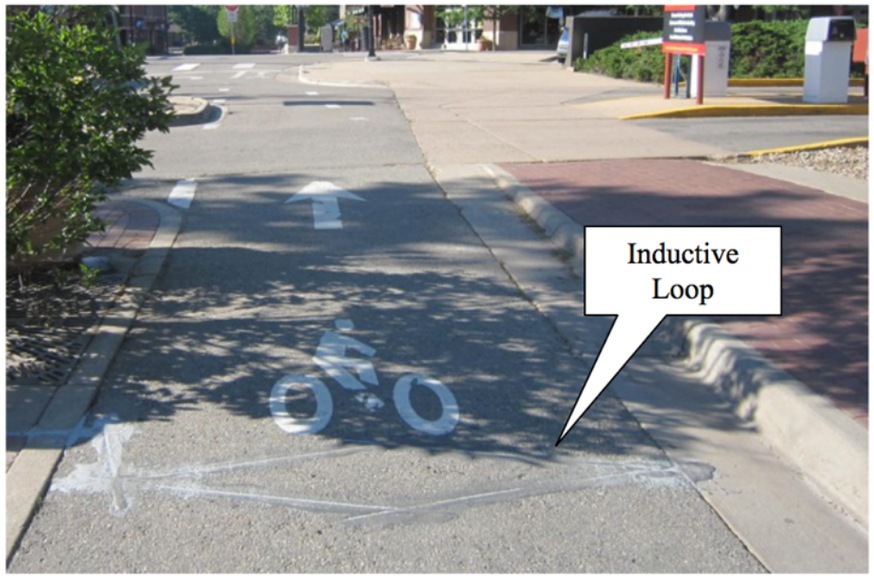


Figure 2-6: Eco Counter Inductive Loop on a Separated Bicycle Facility.

Figure 2-7: Eco Counter Inductive Loops in Roadway Shared with Motorists.

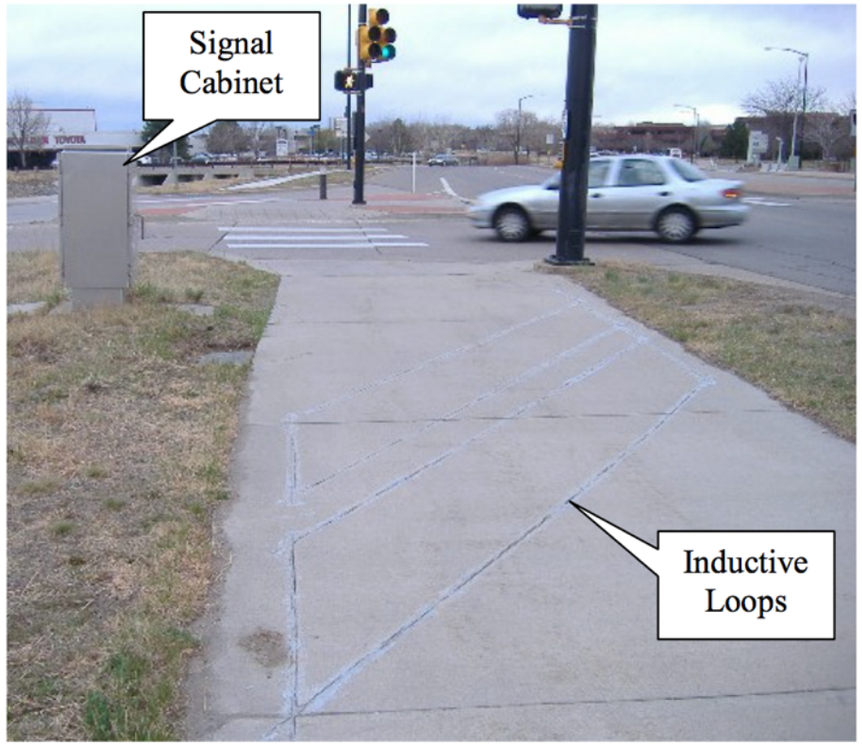
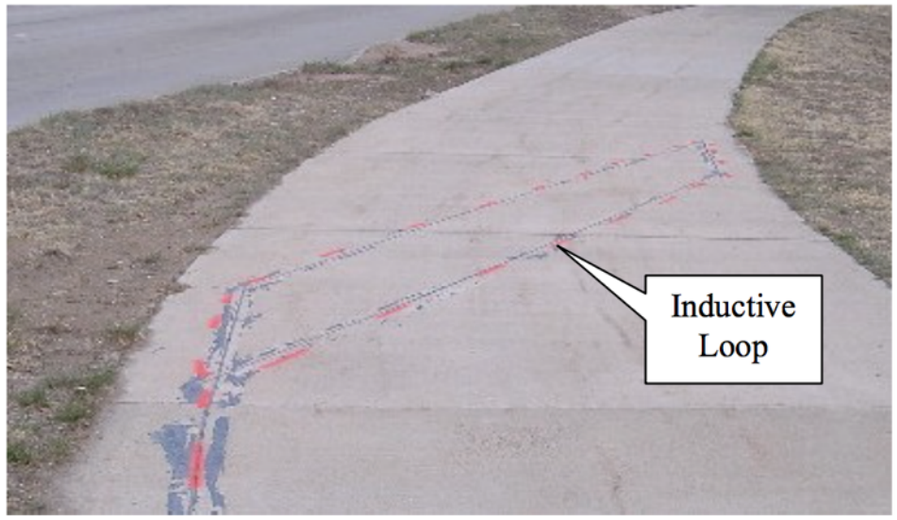


Figure 2-4: Directional Inductive Loops at Foothills and Pearl Parkway.

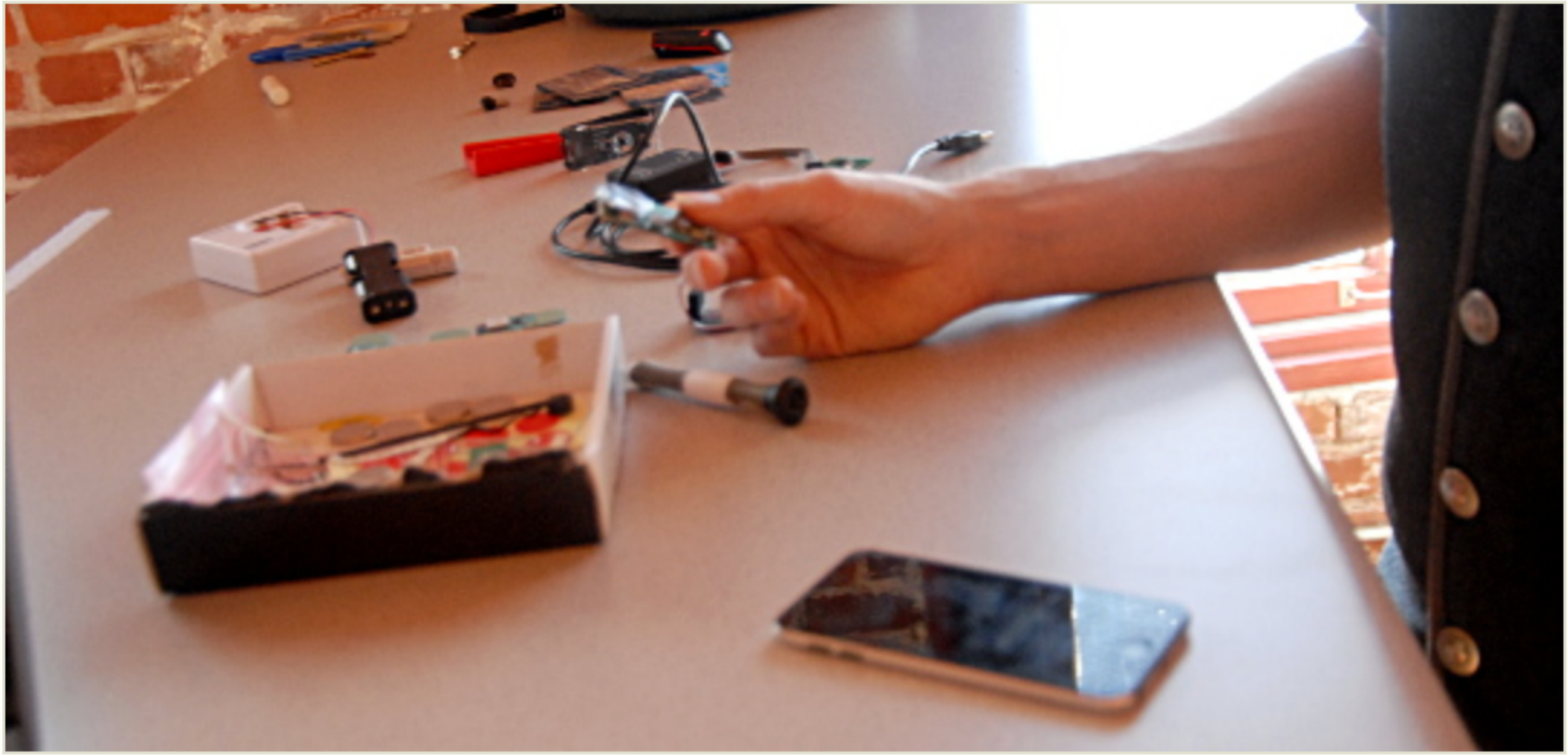


TOPIC

ONTOLOGY - SENSOR SPECIFICS

DATE	LECTURE

How Knock's bike counter works



TOPIC

ONTOLOGY - SENSOR SPECIFICS

DATE	LECTURE

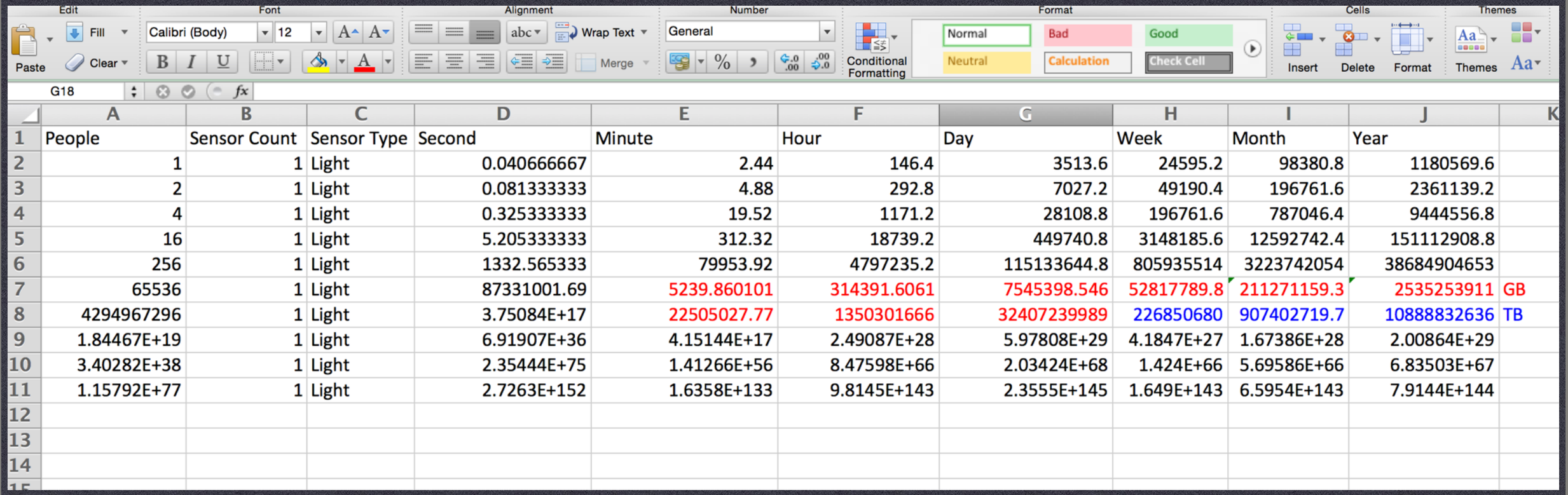
- **WHAT KIND?**
  Quantitative/qualitative - sentiment?
- **MEASURAND?**
  What is actually being measured? How will it be transformed?
- **VOLUME**
  How much?
- **OPEN/CLOSED**
  Who will access your data? How?
- **STORAGE**
  How will you store it? Where will you store it?
- **CONCERNS / RISKS**
  Risks for data loss?

TOPIC

DATA

DATE

LECTURE



	A	B	C	D	E	F	G	H	I	J	K
1	People	Sensor Count	Sensor Type	Second	Minute	Hour	Day	Week	Month	Year	
2	1	1	Light	0.040666667	2.44	146.4	3513.6	24595.2	98380.8	1180569.6	
3	2	1	Light	0.081333333	4.88	292.8	7027.2	49190.4	196761.6	2361139.2	
4	4	1	Light	0.325333333	19.52	1171.2	28108.8	196761.6	787046.4	9444556.8	
5	16	1	Light	5.205333333	312.32	18739.2	449740.8	3148185.6	12592742.4	151112908.8	
6	256	1	Light	1332.565333	79953.92	4797235.2	115133644.8	805935514	3223742054	38684904653	
7	65536	1	Light	87331001.69	5239.860101	314391.6061	7545398.546	52817789.8	211271159.3	2535253911	GB
8	4294967296	1	Light	3.75084E+17	22505027.77	1350301666	32407239989	226850680	907402719.7	10888832636	TB
9	1.84467E+19	1	Light	6.91907E+36	4.15144E+17	2.49087E+28	5.97808E+29	4.1847E+27	1.67386E+28	2.00864E+29	
10	3.40282E+38	1	Light	2.35444E+75	1.41266E+56	8.47598E+66	2.03424E+68	1.424E+66	5.69586E+66	6.83503E+67	
11	1.15792E+77	1	Light	2.7263E+152	1.6358E+133	9.8145E+143	2.3555E+145	1.649E+143	6.5954E+143	7.9144E+144	
12											
13											
14											

TOPIC

BIG DATA - VOLUME

DATE 4-6-15

LECTURE #3 - DATA FOR THE SMART CITY

- # LUX

  The primary sensor data type for ambient light sensors is illuminance in lux (lumens per square meter). The principles outlined in this topic are based on taking lux values as input and reacting to that data in a program.
  Lux readings are directly proportional to the energy per square meter that is absorbed per second. Human perception of light levels is not so straightforward. Human perception of light is complicated because our eyes are constantly adjusting and other biological processes are affecting our perception. However, we can think of this perception from a simplified perspective by creating several ranges of interest with known upper and lower thresholds.

  The following example data set represents rough thresholds for common lighting conditions, and the corresponding lighting step. Here, each lighting step represents a change in lighting environment.

TOPIC

SENSOR DATA - LIGHT

https://msdn.microsoft.com/en-us/library/windows/desktop/dd319008%28v=vs.85%29.aspx

DATE 4-6-15

LECTURE #3 - DATA FOR THE SMART CITY

Lighting condition	From (lux)	To (lux)	Mean value (lux)	Lighting step
Pitch Black	0	10	5	1
Very Dark	11	50	30	2
Dark Indoors	51	200	125	3
Dim Indoors	201	400	300	4
Normal Indoors	401	1000	700	5
Bright Indoors	1001	5000	3000	6
Dim Outdoors	5001	10,000	7500	7
Cloudy Outdoors	10,001	30,000	20,000	8
Direct Sunlight	30,001	100,000	65,000	9

TOPIC

SENSOR DATA - LIGHT

https://msdn.microsoft.com/en-us/library/windows/desktop/dd319008%28v=vs.85%29.aspx

DATE 4-6-15

LECTURE #3 - DATA FOR THE SMART CITY

- # HOW WILL YOUR SENSOR(S) COMMUNICATE?

  ## How does the sensor and it's data inform a system - a smart city?

TOPIC

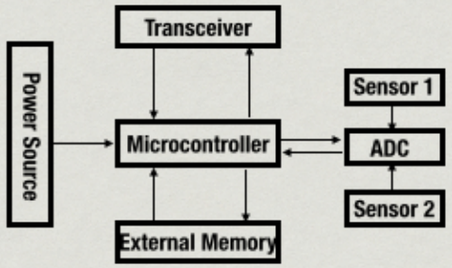
NETWORK

DATE

LECTURE

Sensor system / sensor node

- Microcontroller
- Power
- Memory
- Transceiver
- Sensor(s)
- ADC



Open vs Closed

- Closed Hardware examples:
  - Traditional smoke detecter
  - Oven
- Manually open
  - Sensors that store data locally but allow physical download
  - Traditional GPS
  - Traffic Counter
- Open Hardware examples:
  - Basically any sensor system that sends its data out over a communication type.
  - Sensor Tag
  - Smartphone

Networking Terms

- Ad Hoc Network:
  - An ad hoc network typically refers to any set of networks where all devices have equal status on a network and are free to associate with any other ad hoc network device in link range
- Infrastructure mode Network:
  - A network where all devices communicate through a single access point, which is generally the wireless router. An infrastructure mode network requires a central access point that all devices connect to.
- Local Area Network (LAN)
  - A local area network (LAN) is a computer network that interconnects computers within a limited area such as a home, school, computer laboratory, or office building, using network media.
- Wide Area Network (WAN)
  - A wide area network (WAN) is a network that covers a broad area (i.e., any telecommunications network that links across metropolitan, regional, national or international boundaries) using leased telecommunication lines.
- Personal Area Network (PAN)
  - A personal area network (PAN) is a computer network used for data transmission among devices such as computers, telephones and personal digital assistants.

TOPIC

NETWORK

DATE

LECTURE

BikePortland.org
To inform and inspire

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« County more 'vigilant' on Hawthorne Bridge inspections as tacks claim more victims
Parking and planning: Lessons from a map of Portland land value »

This $50 device could change bike planning forever

Posted by Michael Andersen (News Editor) on January 13th, 2015 at 3:56 pm

Knock Software founder William Henderson with a matchbox-sized device similar to the one he's developed that could sell for $50, last for two years and count every bike that passes by.
(Photos: M.Andersen and J.Maus/BikePortland)

Representing Oregon's Injured Cyclists Since 1982
SWANSON, THOMAS, COON & NEWTON

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Passing on the right from a rider's perspective

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Weekend Bike Camp
July 10-12, 2015

TOPIC

NETWORK

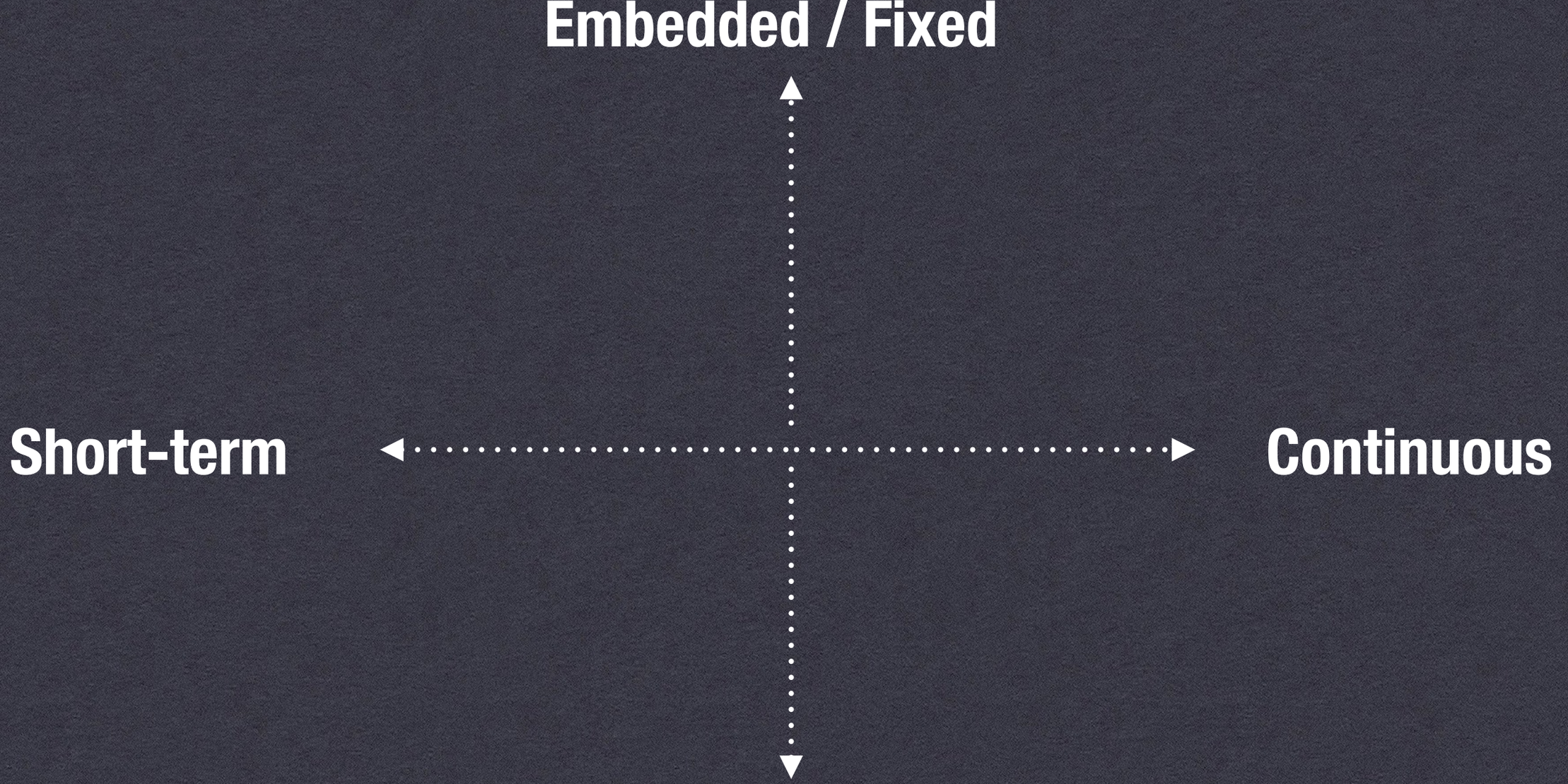
DATE	LECTURE

- **LOCATION**
  Where?
- **NUMBER**
  How Many?
- **SPATIAL DISTRIBUTION**
  What will it tell you?
- **RATE**
  What is the frequency of observation?

TOPIC

SAMPLING

DATE	LECTURE

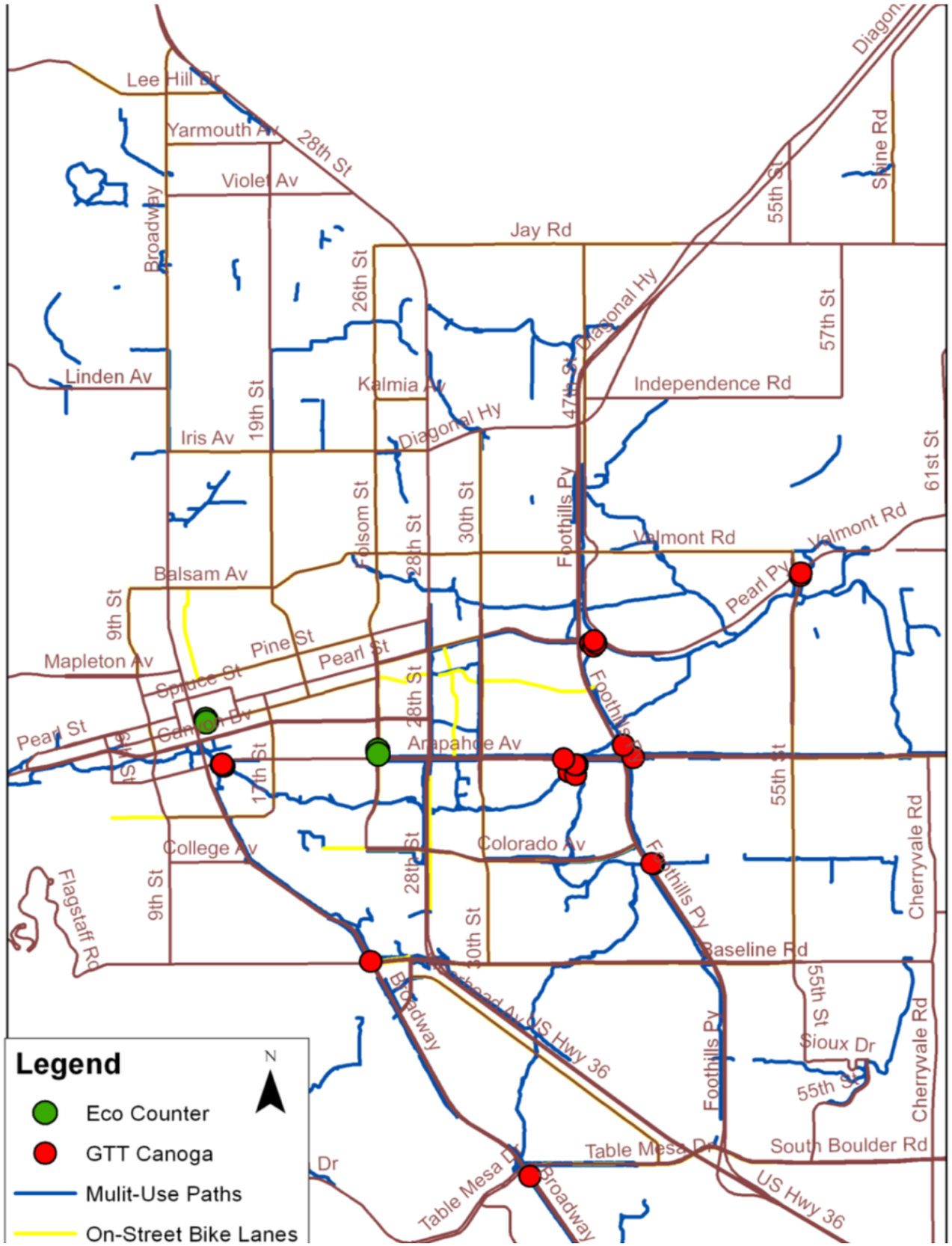


TOPIC

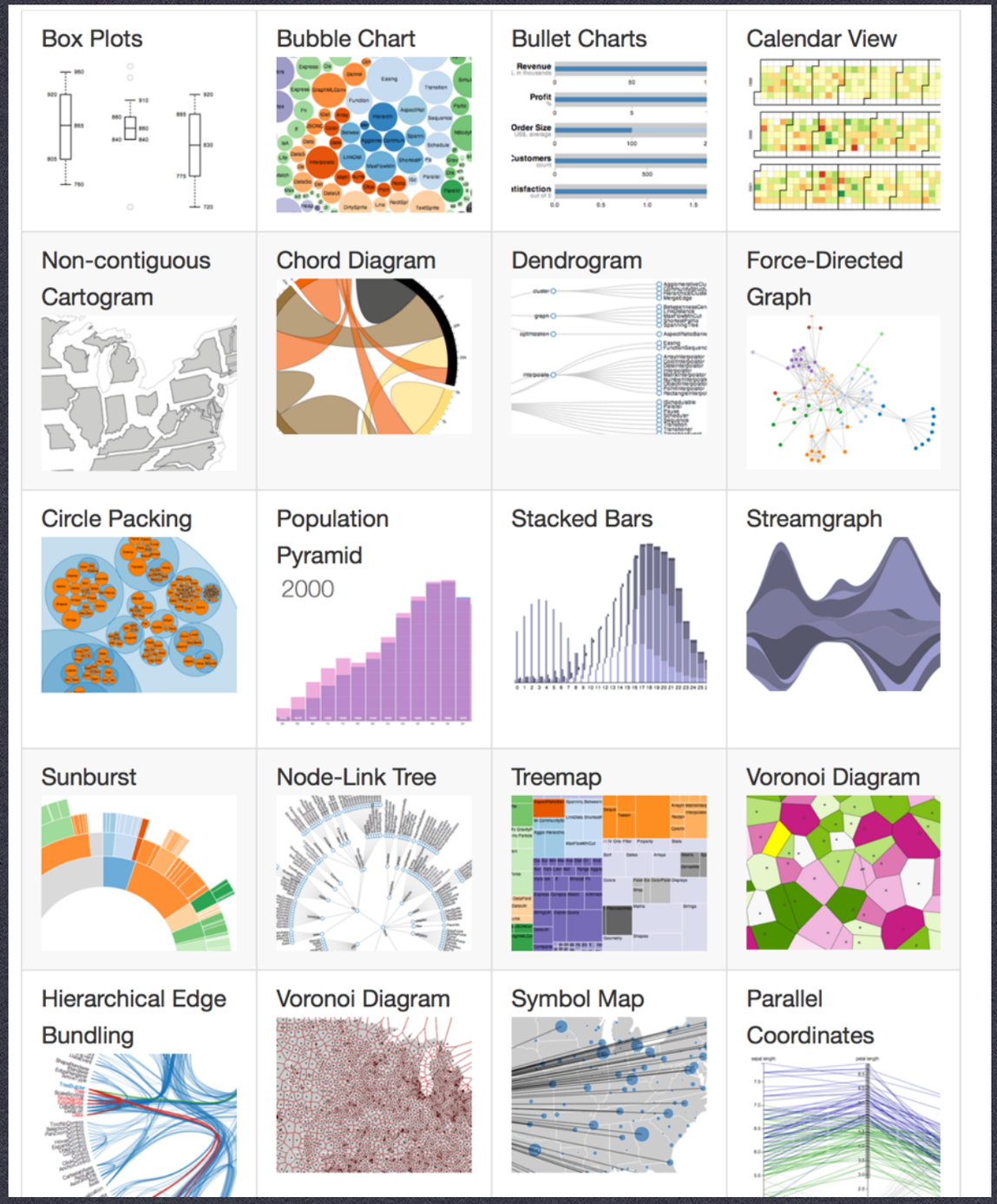
SAMPLING

DATE

LECTURE


Lee Hill Dr
Yarmouth Av
28th St
Violet Av
Broadway
Jay Rd
26th St
55th St
Spine Rd
Diagonal Hy
57th St
Linden Av
19th St
Kalmia Av
Independence Rd
Iris Av
Diagonal Hy
47th St
Foothills Py
61st St
Folsom St
28th St
30th St
Valmont Rd
Valmont Rd
Balsam Av
Pearl Py
9th St
Pine St
Mapleton Av
Spruce St
Pearl St
Pearl St
28th St
Arapahoe Av
17th St
55th St
College Av
Colorado Av
Cherryvale Rd
9th St
28th St
Flagstaff Rd
30th St
Foothills Py
Baseline Rd
Broadway
US Hwy 36
55th St
Sioux Dr
Foothills Py
Cherryvale Rd
55th St
Table Mesa Dr
South Boulder Rd
Table Mesa Dr
Broadway
US Hwy 36
Legend
N
Eco Counter
GTT Canoga
Mulit-Use Paths
On-Street Bike Lanes

- HOW WILL YOU COMMUNICATE YOUR SENSOR PROJECT DATA?
- WHAT TECHNIQUES MIGHT YOU USE?
- WHAT TECHNOLOGIES/PLATFORMS WOULD YOU USE?



TOPIC

VISUALIZATION

DATE	LECTURE

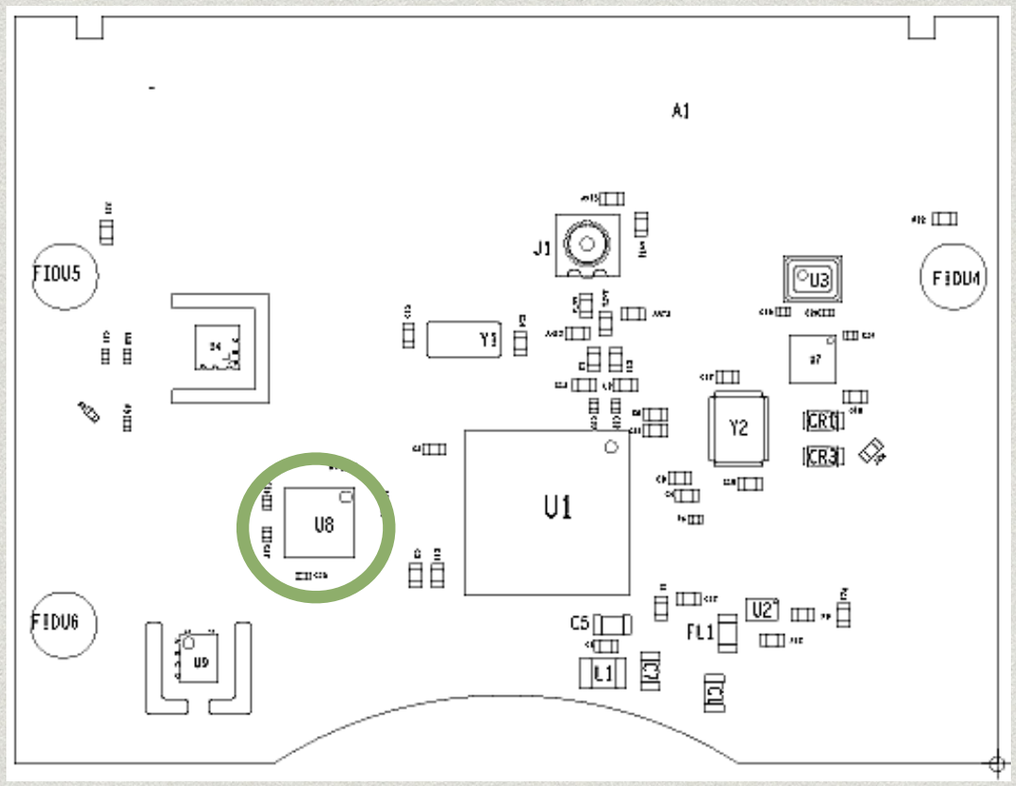
- WHAT WILL YOUR PROJECT COST?
- HOW MUCH DO THE SENSORS COST?
- WHAT WILL DATA AND DATA STORAGE COST?
- WILL YOUR PROJECT SAVE MONEY?
- BACK OF THE ENVELOPE…

TOPIC

COST PROJECTION AND ANALYSIS

DATE

LECTURE



SENSOR:
HUMIDITY AND TEMPERATURE
TEXAS INSTRUMENTS HDC1000YPAR
1: $5.25
100: $3.85
1000: $2.48

- WHAT DO YOU SEE AS THE KEY CONCERNS OR CHALLENGES FOR YOUR PROJECT? RISKS?
- CONSIDER PRIVACY ISSUES
- CONSIDER SECURITY ISSUES

TOPIC

CONCERNS - CHALLENGES

DATE | LECTURE

- HOW TO DEVELOP A SENSOR PROJECT PROPOSAL
- TEAMWORK

TOPIC

THIS WEEK'S LAB

DATE 4-27-15

LECTURE #9 - PROJECT DESIGN

URL's to extract data from the bike counter

Bike Counter

The default is json format

http://ig-coho.uoregon.edu/sensors/bikecounter?scale=hourly

Adding &format=csv to the url

http://ig-coho.uoregon.edu/sensors/bikecounter?scale=hourly&format=csv

Change the scale variable to request: monthly, weekly, daily, or hourly