

Address, City, State, and/or Zip

3405 Michigan Union 530 S. State Street

Current City

-  Ann Arbor, Michigan
51,001 like this · 752,64...
-  Lake Ann, Michigan
785 like this · 8,350 wer...
-  Saint Ann'S Bay, Saint A...
742 like this · 3,583 wer...
-  Saint Ann, Missouri
533 like this · 3,920 wer...

Location
Where in the world are you?

家乡 :
安庆
安顺
安康

SKYHOOK
WIRELESS



YAHOO!
BOSS

Google
Developers

Positioning

Spatial Computing – University of Minnesota



Positioning

Spatial Computing – University of Minnesota

Learning Objectives

1. Know how your smartphone can figure out where you are (Hint: It's not just GPS!)
 - Never use the term “GPS” incorrectly ever again!
2. Be familiar with an important frontier in positioning: content-based positioning

Positioning is about a simple question:

“Where? ”



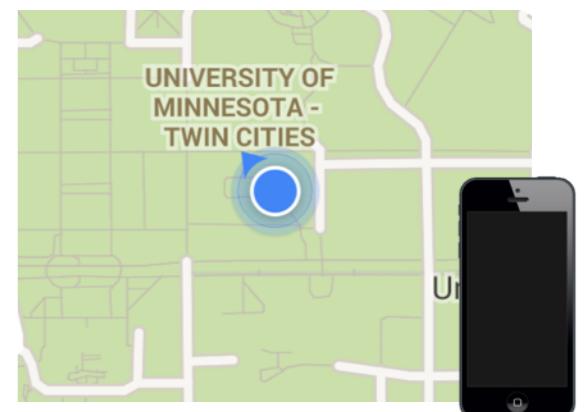
Where is this
property line?



Where should
this missile go?



Where is this
animal?



**Where is this
smartphone user?**

$\langle \mathbf{x}, z, z(\mathbf{x}) \rangle$

the “geo-atom”

(Goodchild et al. 2007)

Slides for Spatial Computing
by Brent Hecht
for the Spatial CCI Learning Mooc

$\langle \mathbf{x}, \mathbf{z}, z(\mathbf{x}) \rangle$

Main
subject of
this module!

Presence of cholera
Temperature
Population
Air Quality
Tweet content
Wikipedia article text

10°C
-10°C

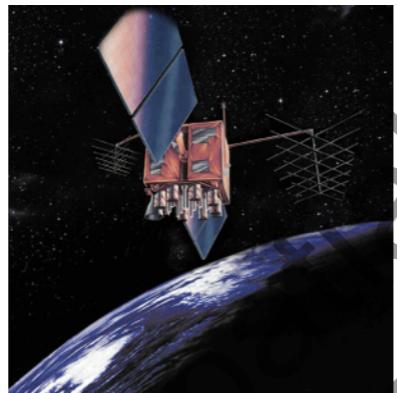




x is a vector, not a single value!

$$\langle \mathbf{x}, z, z(\mathbf{x}) \rangle$$

(44.97428, -93.232502, 264m, 10:33am)



Signal-based
Positioning

Content-based
Positioning

102.111.321.5

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Slides for Signal Processing by Brent Hecht
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Positioning

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Attributions

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[“Wifi”] By RRZEicons (Own work) [CC-BY-SA-3.0 (<http://creativecommons.org/licenses/by-sa/3.0>)], via Wikimedia Commons

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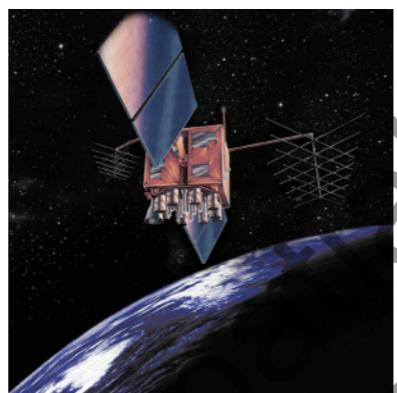
YAHOO!
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Positioning

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Signal-based
Positioning

Content-based
Positioning

Slides for Spatial Computing 101
BY Brent Hecht
1.321.5
flickr



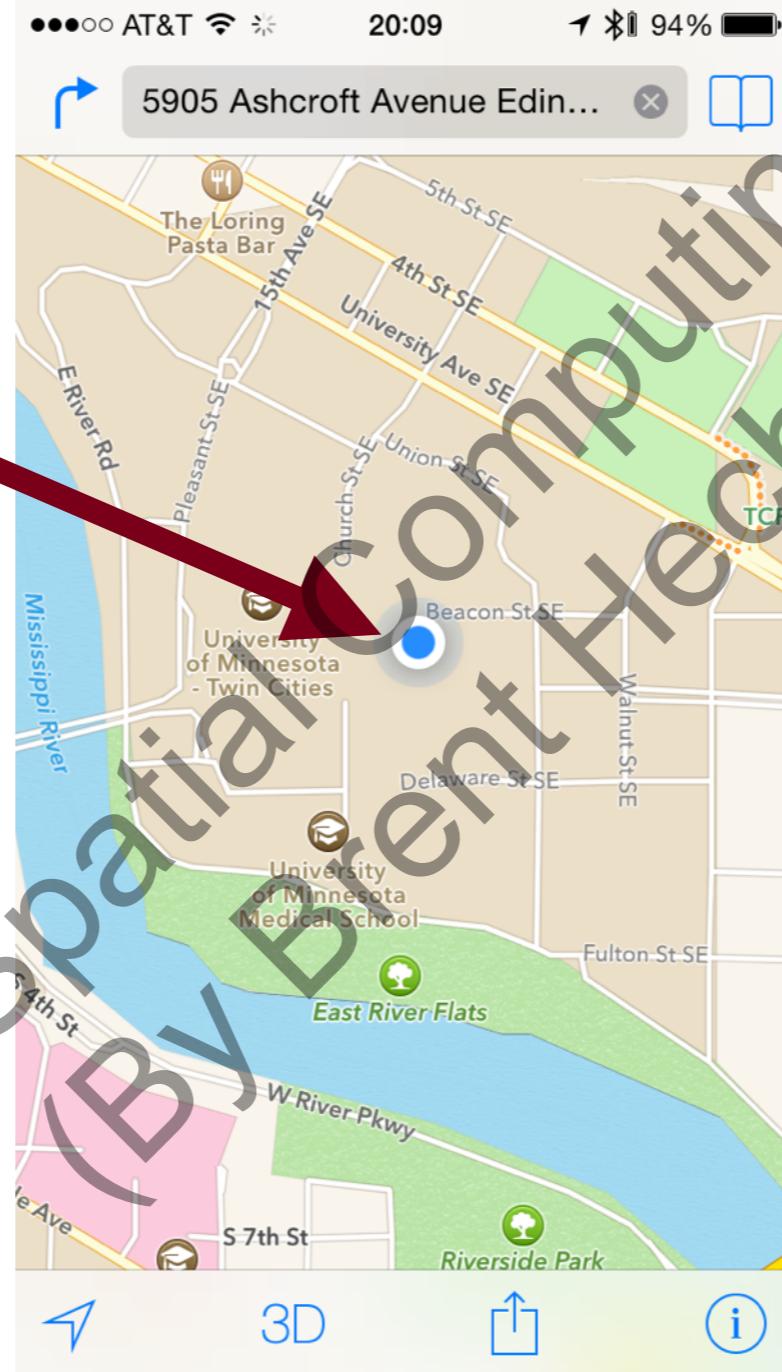
Slides for Spatial
(By Prof. Dr.-Ing. habil. Thomas H. Lutz)



Signal-based positioning is how your smartphone knows where you are!

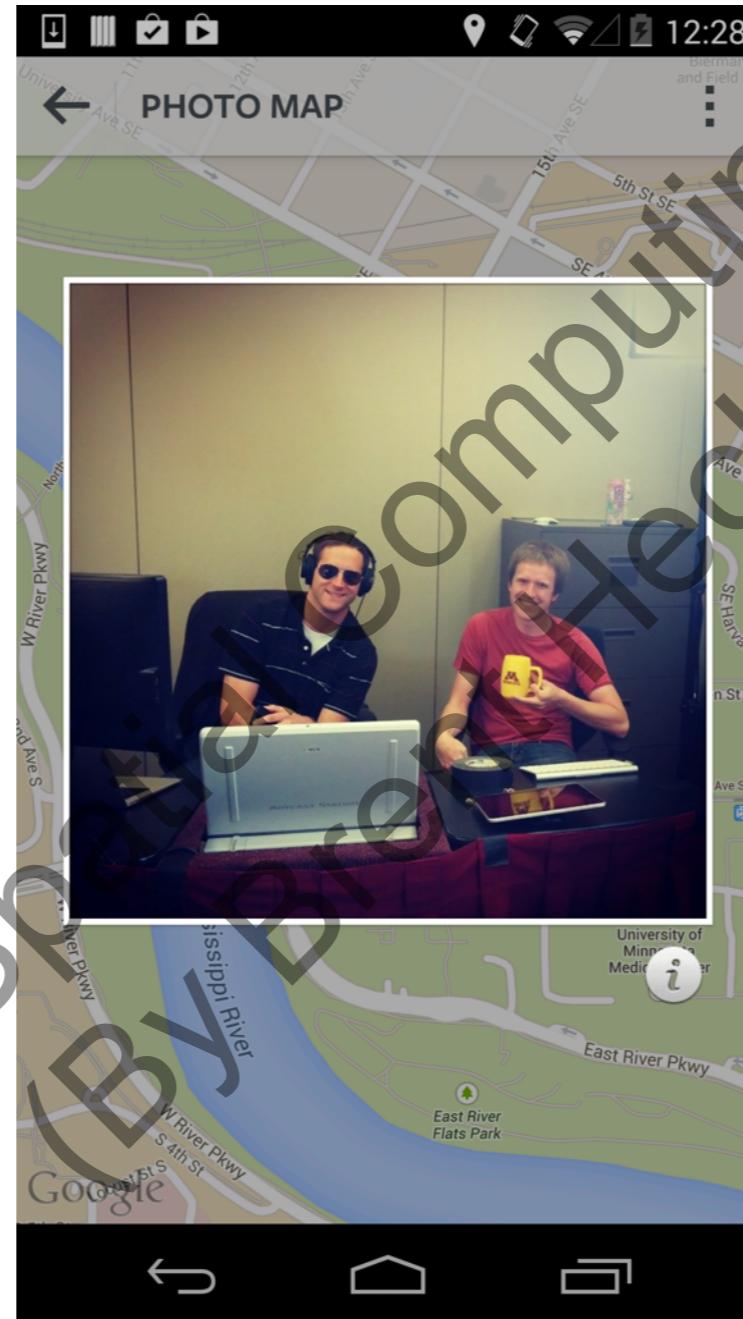
Computing MOOC

Signal-based positioning is responsible for....



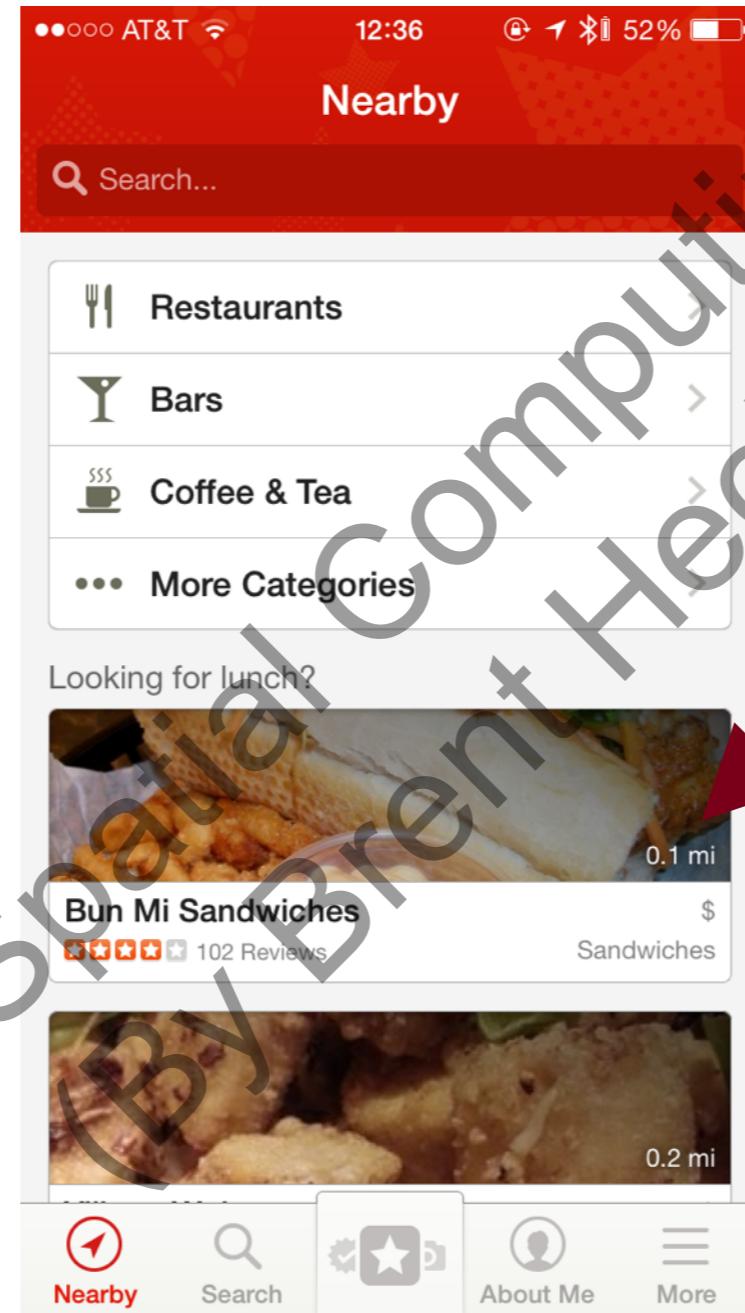
...the little blue dot in mobile map applications

Signal-based positioning is responsible for....



... correctly geotagging Instagram photos, tweets, and other social media VGI.

Signal-based positioning is responsible for....



... helping determine what's nearby in location-based services like Yelp, Foursquare, and so on.

Signal-based positioning is responsible for....



... helping scientists understand how species migrate.

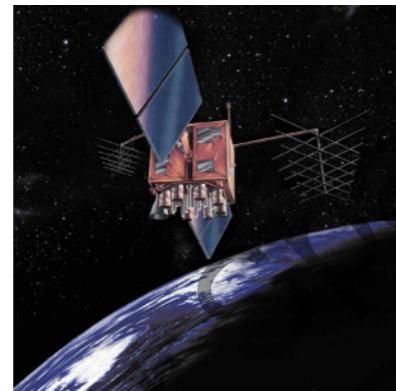
Signal-based positioning is responsible for....



...allowing farmers to implement optimal strategies for their crops.

Key Types of Signal-based Positioning

in your smartphone and in general



**Signal-based
Positioning**

- 1. Satellite-based
Positioning**
- 2. Wifi Positioning**
- 3. Cellular
Positioning**

Global Navigation Satellite System (GNSS)

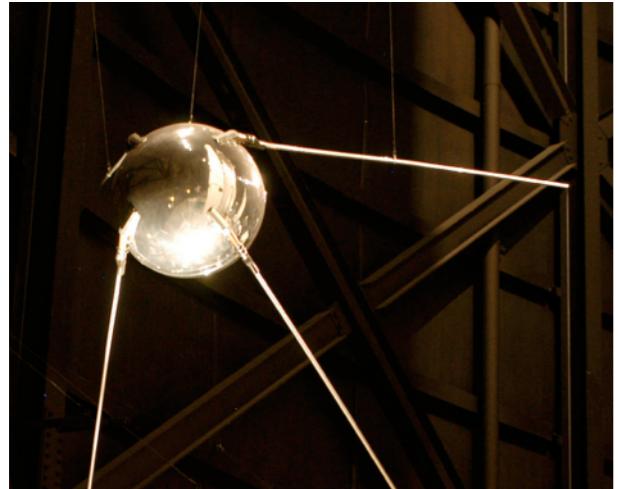
Slides for Spatial Computing Heidelberg
(BY)remixable

First GNSS

GPS

Global Positioning System

Slides for Spacecraft Imparting Mooc
(By Brent Shultz)



Scientists in America figure out how to track Sputnik using its radio transmissions



The U.S. wanted to be able to better target missiles (among other military applications)



KAL 007 shot down after drifting into Soviet space

GPS is a U.S. government technology born out of the Cold War

Slides for Spatial Computing Mooc
(By Berndt Recht)



Slices for National Computing
GPS BFFs

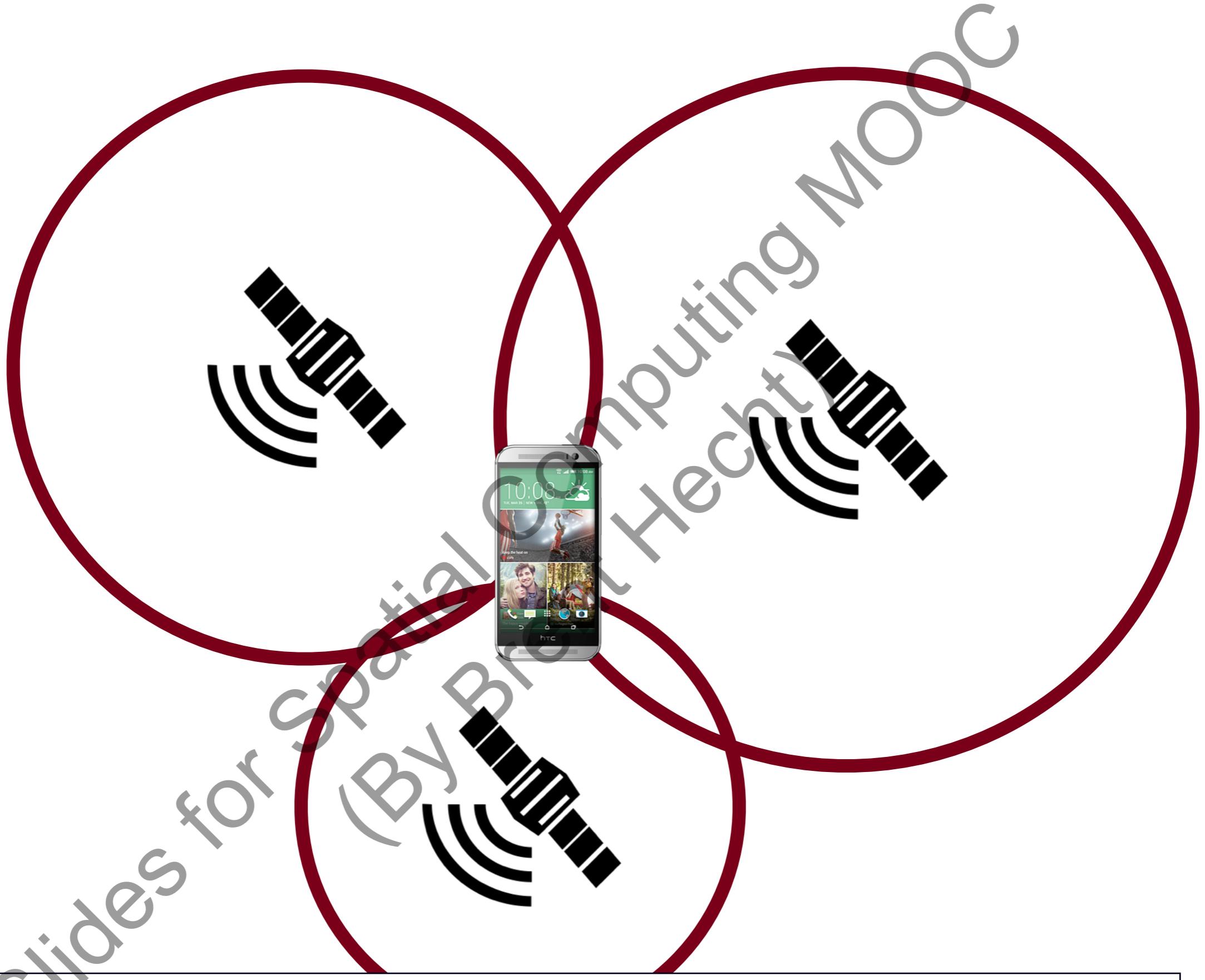
GPS is a U.S. government technology born out of the Cold War

How does GPS work?



- 24 satellite (+ some extras)
- each is on fixed, 12-hour orbit
- transmit radio signals at fixed intervals
- devices use trilateration

The more satellites, the better (3 = minimum)



**GPS is failing you
right now!**

Slides for Spatial Computing Mooc
(By Brent Yorgey)

GPS limitations

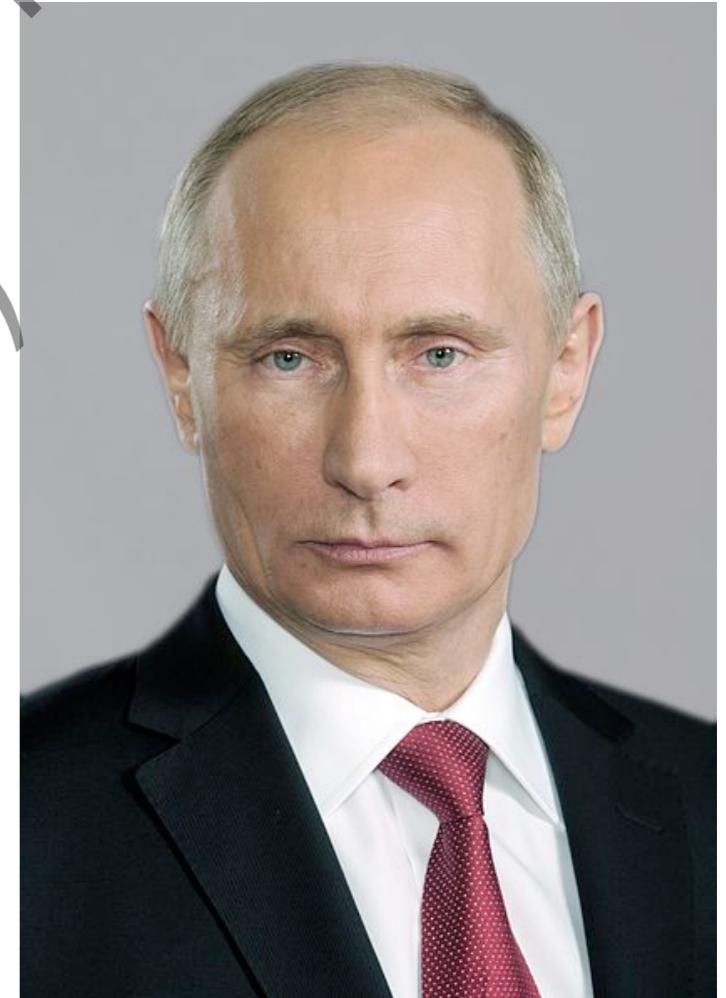
1. Does not work well indoors
(that's changing a bit)
2. Accuracy can be limited
3. Time-to-first-fix stinks
4. Multipath issues (urban canyon effect)

Hard for a smartphone to see satellites down there!



GPS limitations

1. Does not work well indoors
(that's changing a bit)
2. Accuracy can be limited
3. Time-to-first-fix stinks
4. Multipath issues (urban canyon effect)
5. Drain on power



Slides for Spring Computing
(B) GPS BFFs?



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The Free Encyclopedia

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List of smartphones using GLONASS Navigation

From Wikipedia, the free encyclopedia



This article includes a [list of references](#), but its sources remain unclear because it has insufficient [inline citations](#). Please help to [improve this article](#) by introducing more precise citations. (October 2012)

This is a list of smartphones that support GLONASS, the Russian GNSS.

Contents [hide]

- 1 Acer
- 2 Alcatel
- 3 Apple
- 4 Asus
- 5 BlackBerry
- 6 HTC
- 7 Huawei
- 8 LG
- 9 Meizu
- 10 Motorola
- 11 Nokia
- 12 OnePlus

https://en.wikipedia.org/wiki/List_of_smartphones_using_GLONASS_Navigation

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Galileo

Beidou-2 /
COMPASS

Positioning

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"new holland tractor" by Dan Davison / CC BY 2.0 (<https://flic.kr/p/8qXrXN>)

"Boeing 747-2B5B, Korean Air Lines AN0600191" by Michel Gilliland - Gallery page <http://www.airliners.net/photo/Korean-Air-Lines/Boeing-747-2B5B/0600191/LPhoto> <http://cdn-www.airliners.net/aviation-photos/photos/1/9/1/0600191.jpg>. Licensed under GNU Free Documentation License 1.2 via Wikimedia Commons - https://commons.wikimedia.org/wiki/File:Boeing_747-2B5B,_Korean_Air_Lines_AN0600191.jpg#mediaviewer/File:Boeing_747-2B5B,_Korean_Air_Lines_AN0600191.jpg

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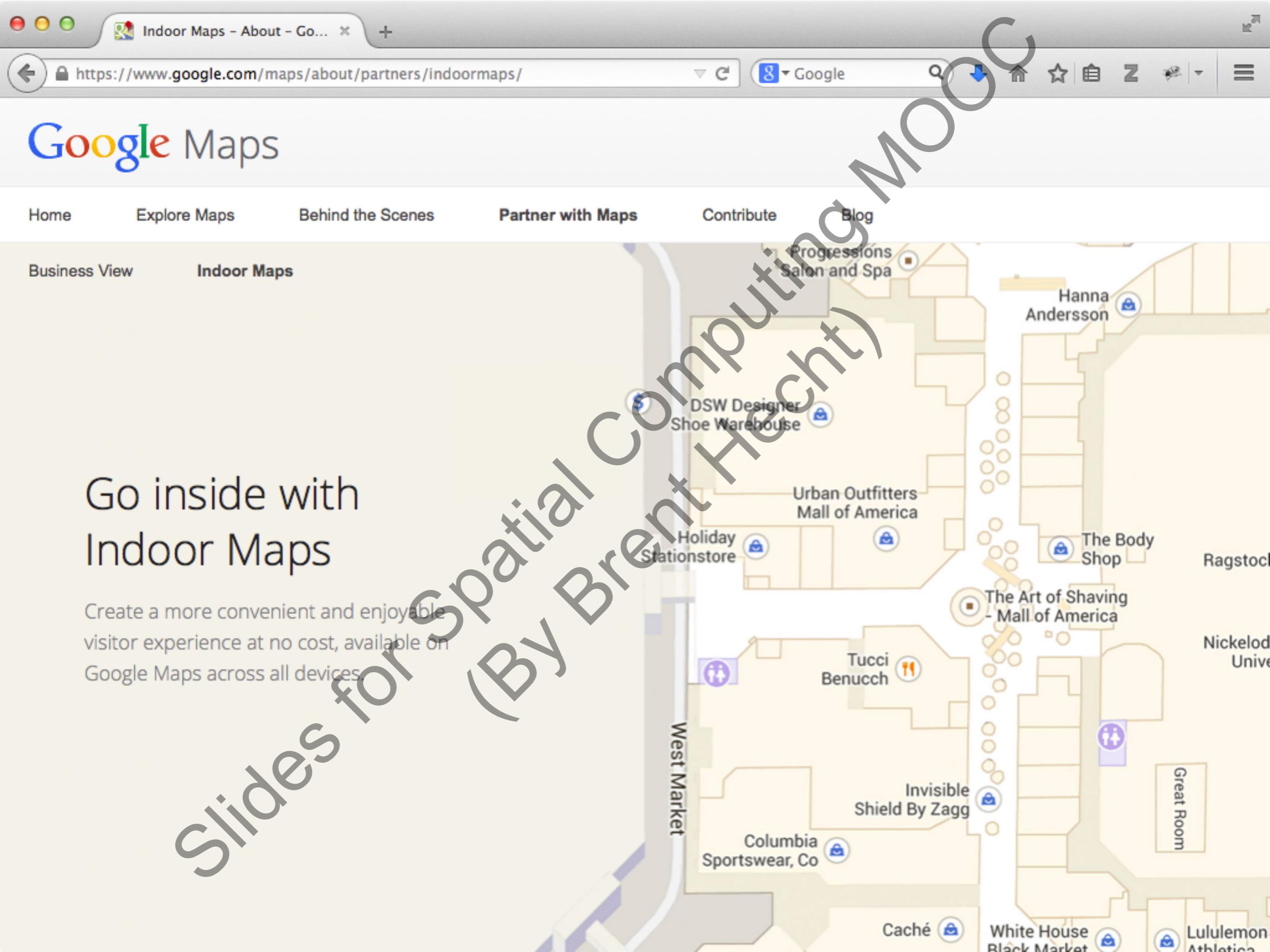
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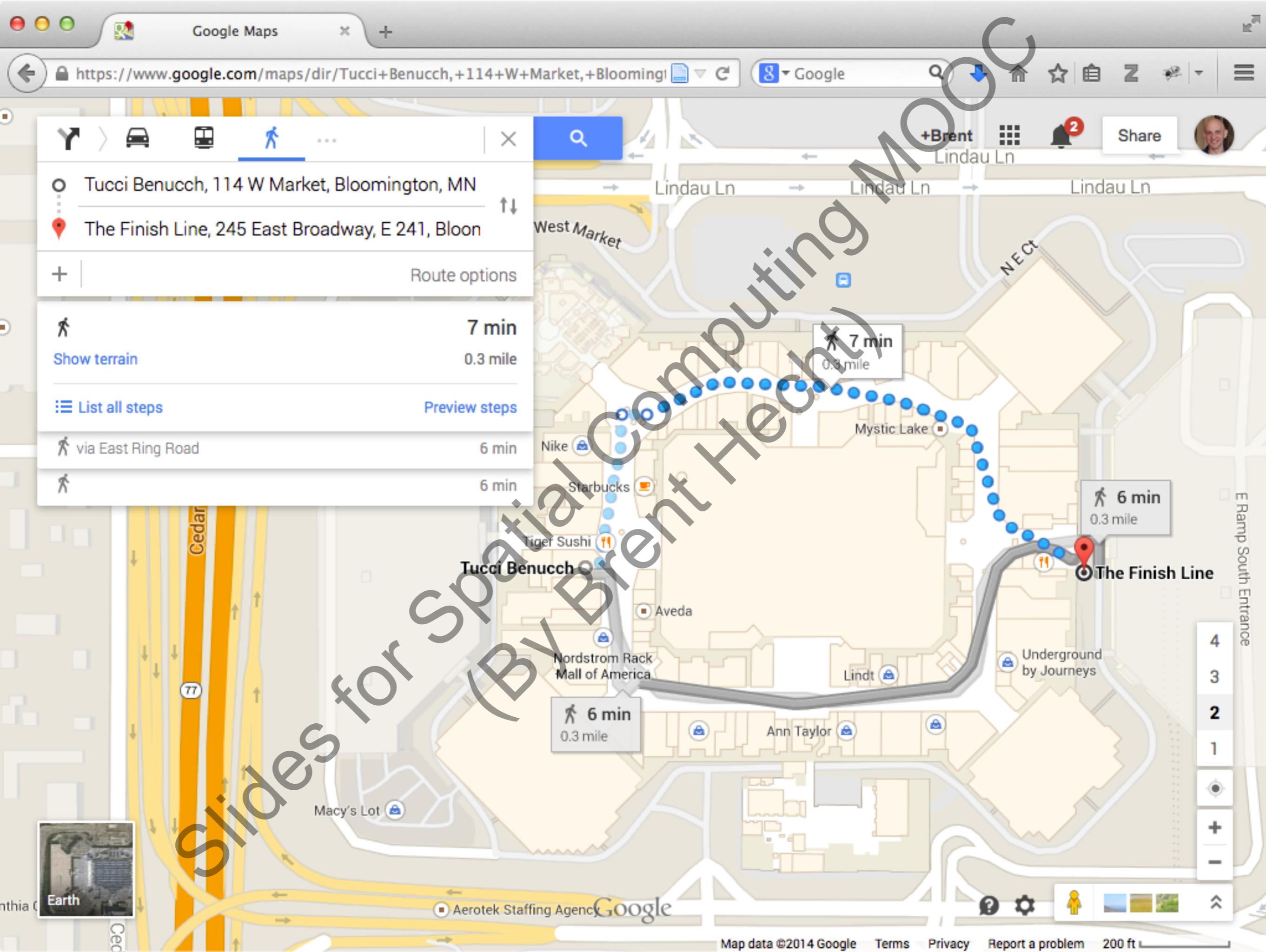
Google Maps

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Go inside with Indoor Maps

Create a more convenient and enjoyable visitor experience at no cost, available on Google Maps across all devices.





Slides for Spatial Computing Mooc
(By Bart Fidder)

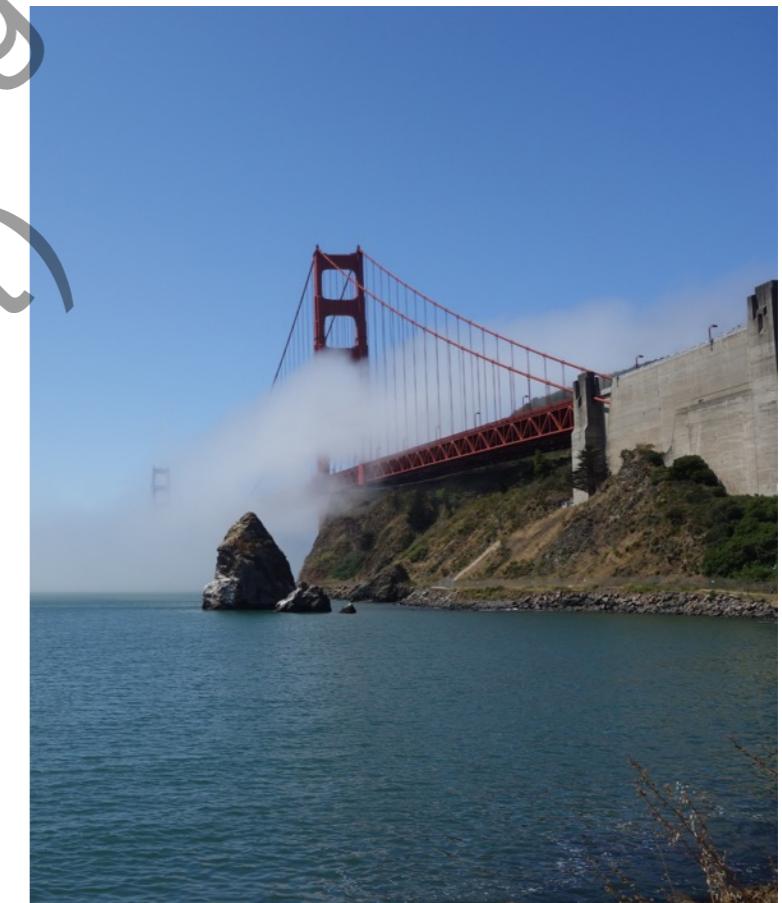
Wifi positioning to the rescue!



Coit Tower



Candlestick Park

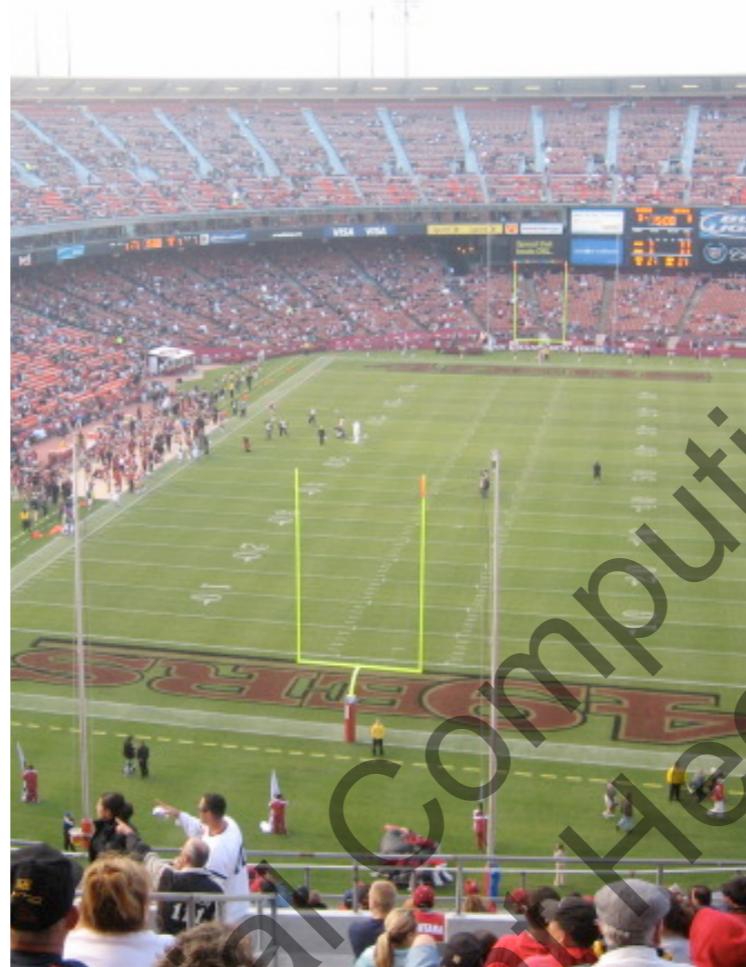


Golden Gate Bridge

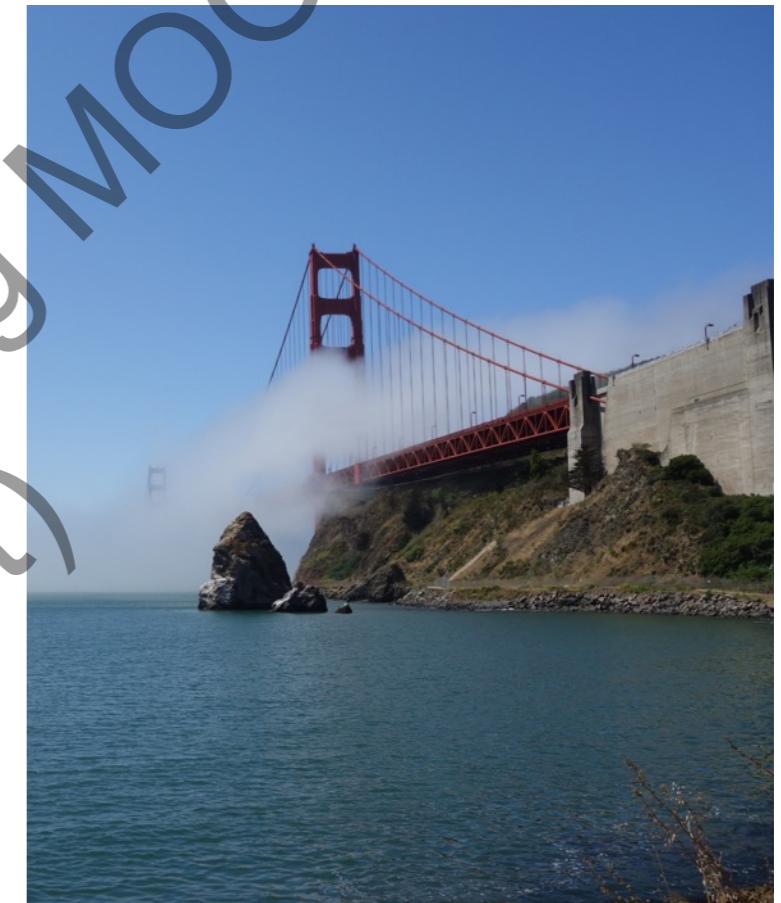
Slides for Spatial Computing
by Brent Hecht
BY
Slides for Spatial Computing
Hecht, Brent
San Francisco, CA
2014



Coit Tower

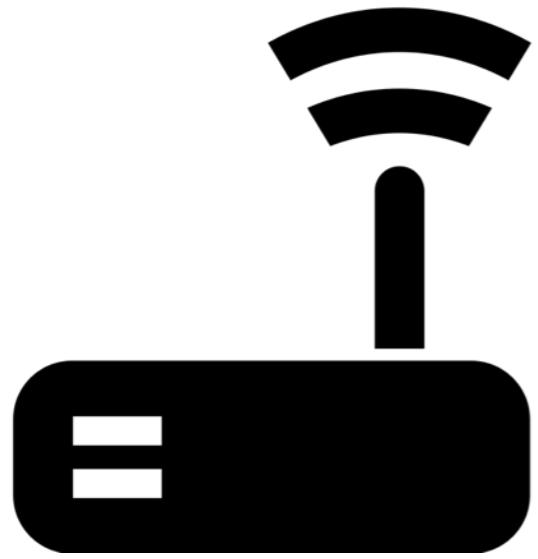


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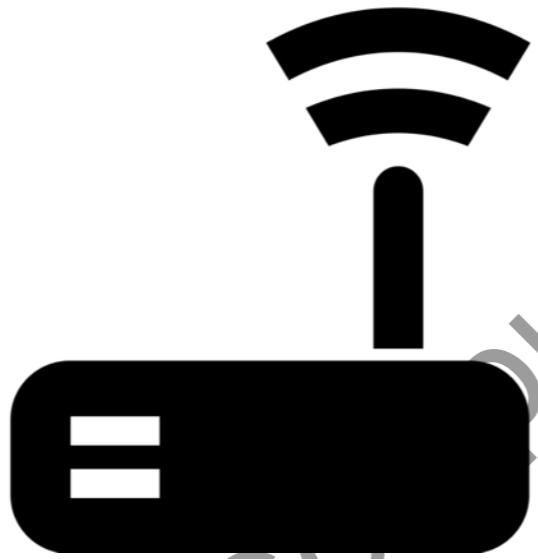


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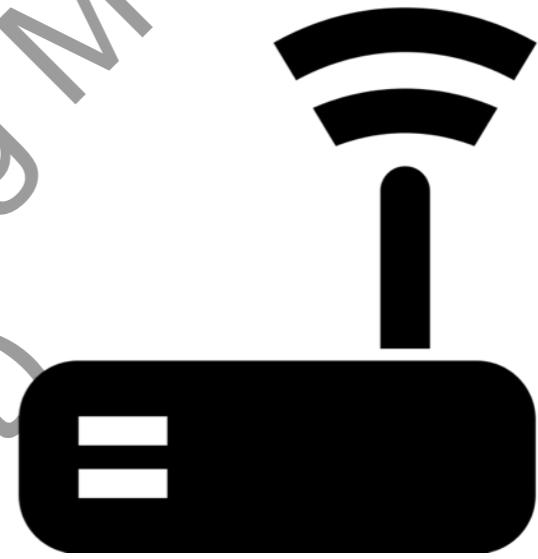
San Francisco, CA



Unique MAC
Address



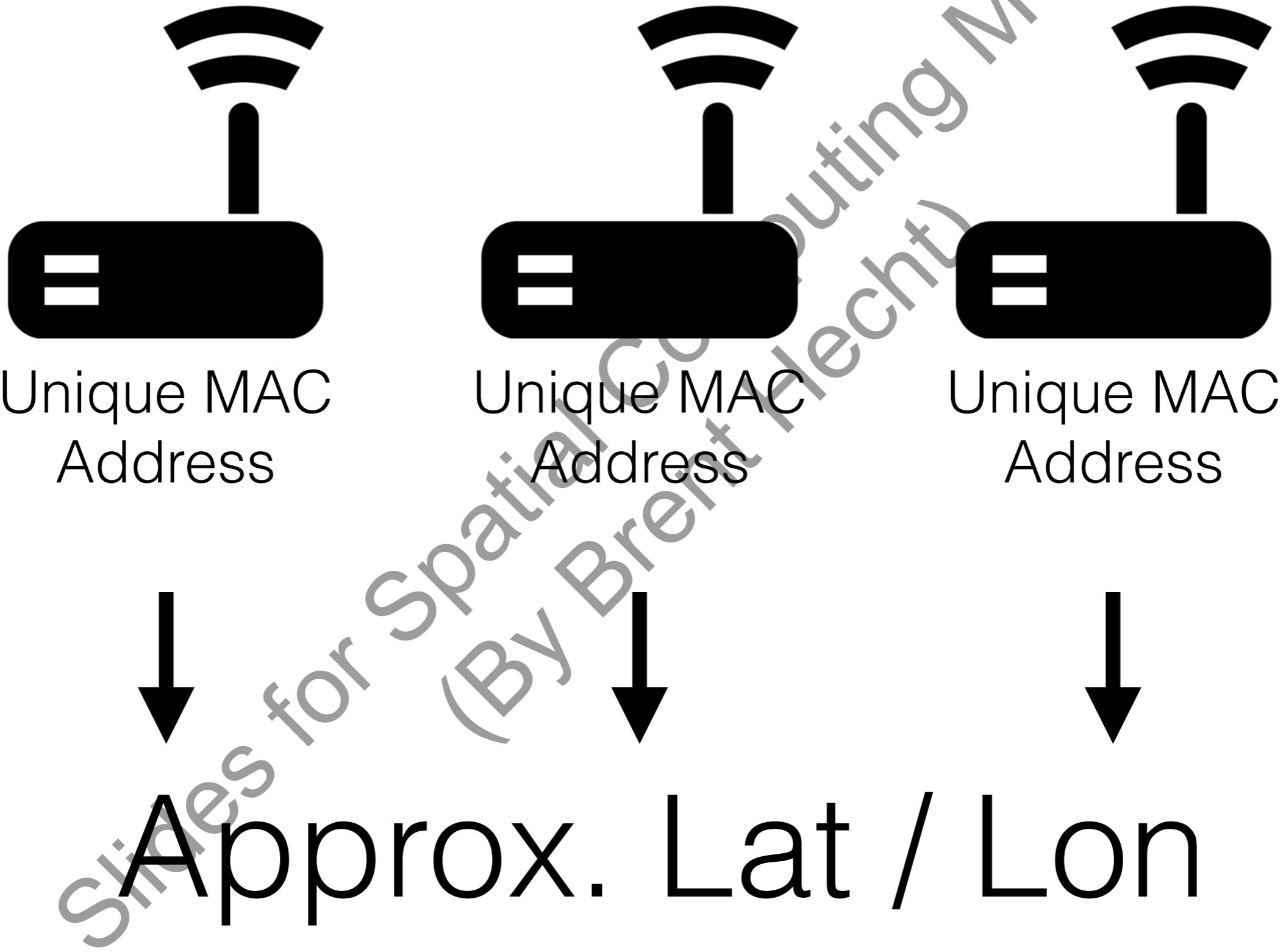
Unique MAC
Address



Unique MAC
Address

San Francisco, CA

*Spatial Computing
for Sensors
(By Brent Hecht)*



How does wifi positioning work?



PHASE 1

calibration phase

PHASE 2:

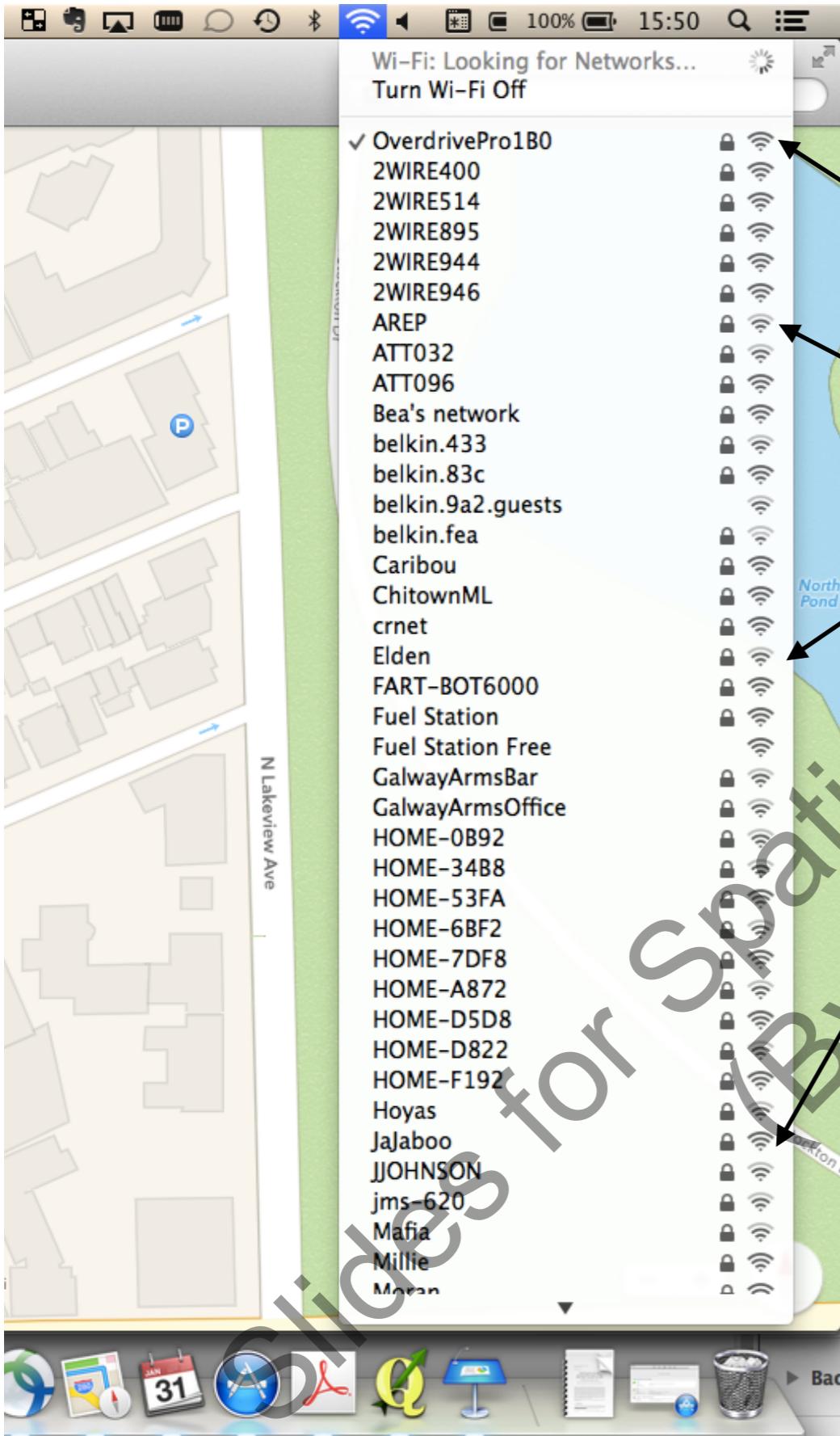
positioning phase
Fingerprinting!

Slides for Space Computing
(By) MG OOC

Wifi Fingerprint

Collecting these is goal of Calibration stage

(MAC addresses, signal
strengths, location of
fingerprint collector)



Two-Thirds of a Wifi Fingerprint

(missing the location at which this reading was taken)

Calibration Phase

aka collecting fingerprints



War Driving

Slides for 2D Real-Time Computing
OCW

Google Street
View cars: also
used to collect
Wi-Fi fingerprints



g Google told to delete Stre... +

www.theguardian.com/technology/2013/jun/21/google-street-view-payload Google

Edition: UK US AU Sign in Beta



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the guardian

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News > Technology > Google Street View

Google told to delete Street View payload data or face UK prosecution

Information commissioner's office says it will launch contempt of court proceedings if data is not deleted within 35 days

Josh Halliday

theguardian.com, Friday 21 June 2013 07.45 EDT

 Jump to comments (380)



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 +1 24

 Pin it

 Share 0

 Email

 Print

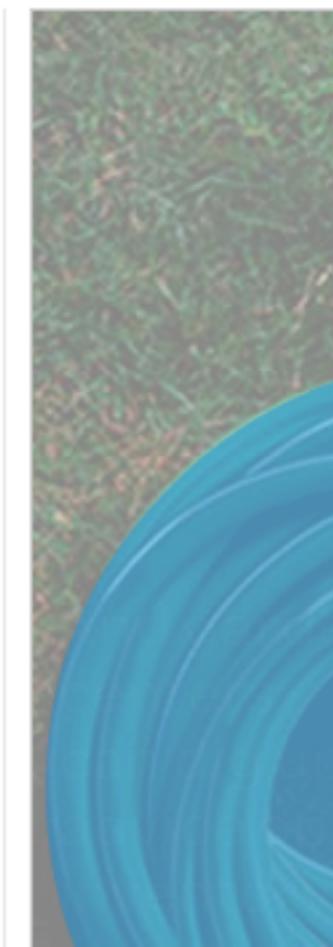
Article history

Technology

[Google Street View](#) · [Google](#)

UK news

[Information commissioner](#)





The New Street View
Car Driver

“[Positioning calculations] are performed live on the iPhone using a crowd-sourced database of Wi-Fi hotspot and cell tower data that is generated by tens of millions of iPhones sending the geo-tagged locations of nearby Wi-Fi hotspots and cell towers in an anonymous and encrypted form to Apple.”

(Apple, Inc. 2011)



3G Apple iOS Devices Secr... +

bits.blogs.nytimes.com/2011/04/20/3g-apple-ios-devices-secretly-storing Google

The New York Times

SECTIONS

Consolidated.db scandal

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SCUTTLEBOT News from the

In 2004, Loving Google but Not NYTIMES.COM | Before Google's I.P.C everyone in Silicon Valley was better. Ashwin Seshagiri

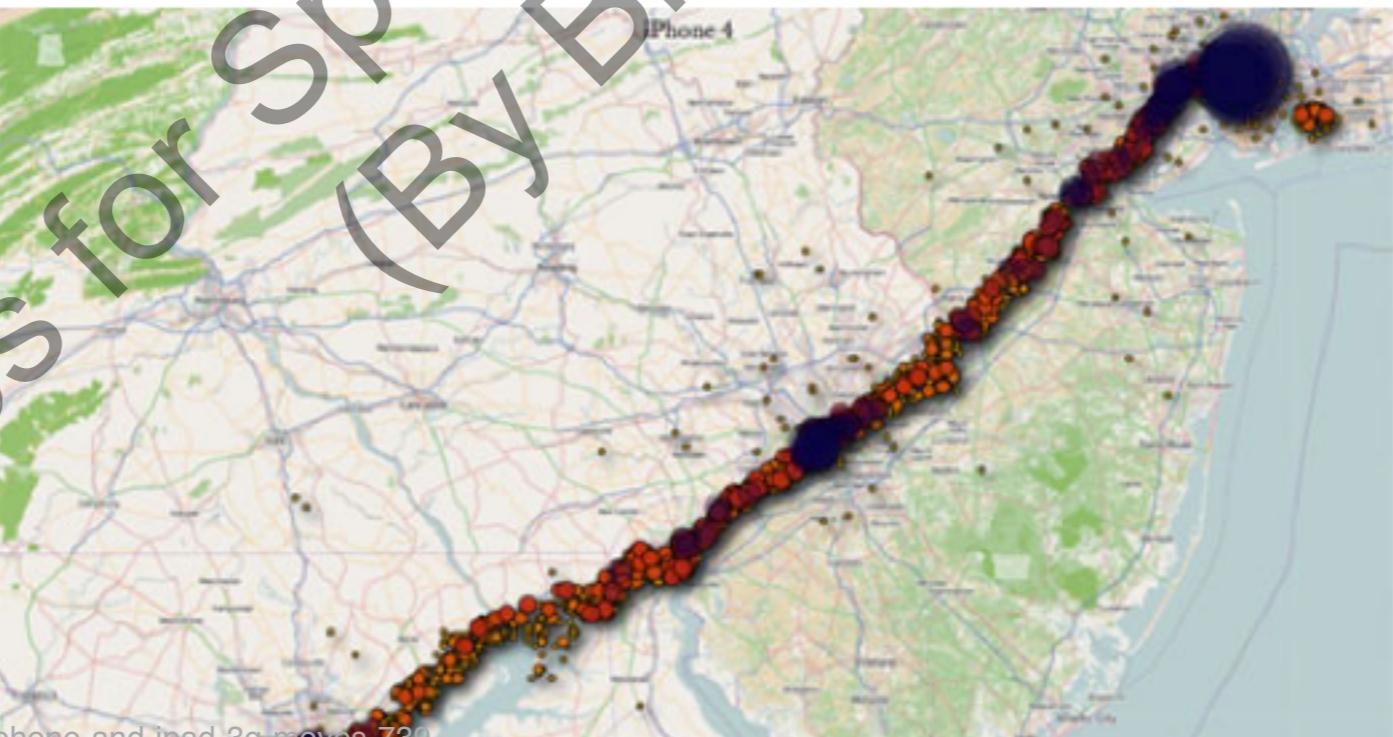
In the Sharing Economy, a Rift Classification BOSTON GLOBE | Are platforms like Up marketplaces for contractor services Natasha Singer

Slides for Spatial Computing (By Brent Hecht)

Bits

3G Apple iOS Devices Are Storing Users' Location Data

By NICK BILTON APRIL 20, 2011 3:04 PM ▾ 109 Comments



<http://www.vincentabry.com/en/apple-tracks-iphone-and-ipad-3g-moves-739>

adclick.g.doubleclick.net/aclk?sa=L&ai=BNTRIIImHzU6y6GoShpgOXg4HQCwAAAAAQASAAOA...CLVFn5QHAqtc96AFkmALD0QOoAgWoAgY; redirecturl2=https://www.tivo.com/roamiodvrs

How does wifi positioning work?



Fingerprinting!

PHASE 1

calibration phase

PHASE 2:

positioning phase

Spatial Computing
(By Brent Hecht)

MG OOC

Positioning Phase

aka using machine learning to determine position



These Wi-Fi networks are in range, so where am I?

Positioning Phase

aka using machine learning to determine position

✓ OverdrivePro1B0	WiFi icon
2WIRE400	WiFi icon
2WIRE514	WiFi icon
2WIRE895	WiFi icon
2WIRE944	WiFi icon
2WIRE946	WiFi icon
AREP	WiFi icon
ATT032	WiFi icon
ATT096	WiFi icon
Bea's network	WiFi icon
belkin.433	WiFi icon
belkin.83c	WiFi icon
belkin.9a2.guests	WiFi icon
belkinfea	WiFi icon
Caribou	WiFi icon
ChitownML	WiFi icon
crnet	WiFi icon
Elden	WiFi icon
FART-BOT6000	WiFi icon
Fuel Station	WiFi icon
Fuel Station Free	WiFi icon
GalwayArmsBar	WiFi icon
GalwayArmsOffice	WiFi icon
HOME-0B92	WiFi icon
HOME-34B8	WiFi icon
HOME-53FA	WiFi icon
HOME-6BF2	WiFi icon
HOME-7DF8	WiFi icon
HOME-A872	WiFi icon
HOME-D5D8	WiFi icon
HOME-D822	WiFi icon
HOME-F192	WiFi icon
Hoyas	WiFi icon
Jajaboo	WiFi icon
JJOHNSON	WiFi icon
jms-620	WiFi icon
Mafia	WiFi icon
Millie	WiFi icon
Moran	WiFi icon

fingerprint matching
algorithm (e.g. kNN,
neural networks)

✓ OverdrivePro1B0	WiFi icon
2WIRE400	WiFi icon
2WIRE514	WiFi icon
2WIRE895	WiFi icon
2WIRE944	WiFi icon
2WIRE946	WiFi icon
AREP	WiFi icon
ATT032	WiFi icon
ATT096	WiFi icon
Bea's network	WiFi icon
belkin.433	WiFi icon
belkin.83c	WiFi icon
belkin.9a2.guests	WiFi icon
belkinfea	WiFi icon
Caribou	WiFi icon
ChitownML	WiFi icon
crnet	WiFi icon
Elden	WiFi icon
FART-BOT6000	WiFi icon
Fuel Station	WiFi icon
Fuel Station Free	WiFi icon
GalwayArmsBar	WiFi icon
GalwayArmsOffice	WiFi icon
HOME-0B92	WiFi icon
HOME-34B8	WiFi icon
HOME-53FA	WiFi icon
HOME-6BF2	WiFi icon
HOME-7DF8	WiFi icon
HOME-A872	WiFi icon
HOME-D5D8	WiFi icon
HOME-D822	WiFi icon
HOME-F192	WiFi icon
Hoyas	WiFi icon
Jajaboo	WiFi icon
JJOHNSON	WiFi icon
jms-620	WiFi icon
Mafia	WiFi icon
Millie	WiFi icon
Moran	WiFi icon

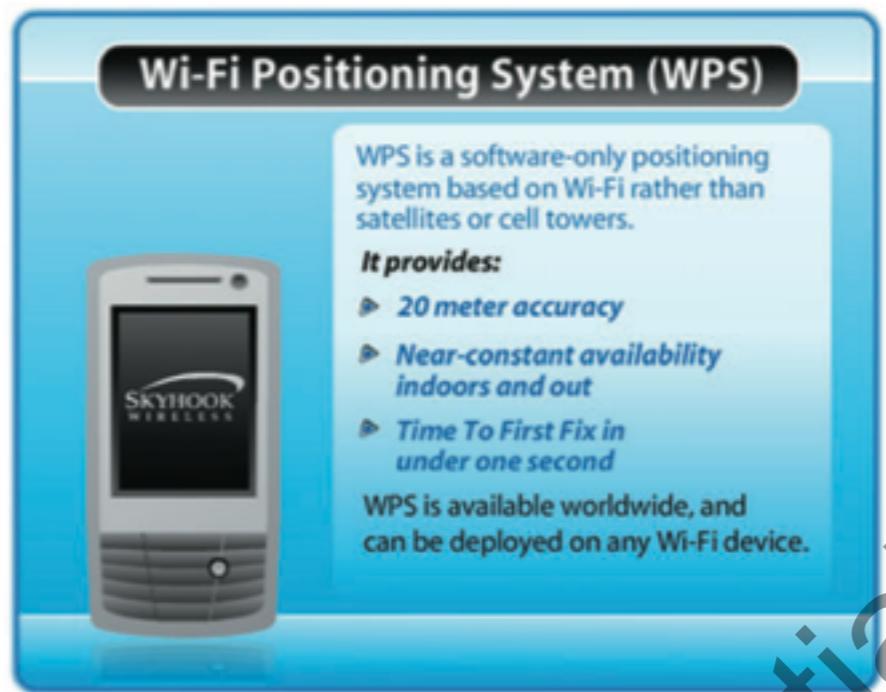
Available Wi-Fi
Networks and Signal
Strengths

Lat/Lon =
41.93635, -87.64332

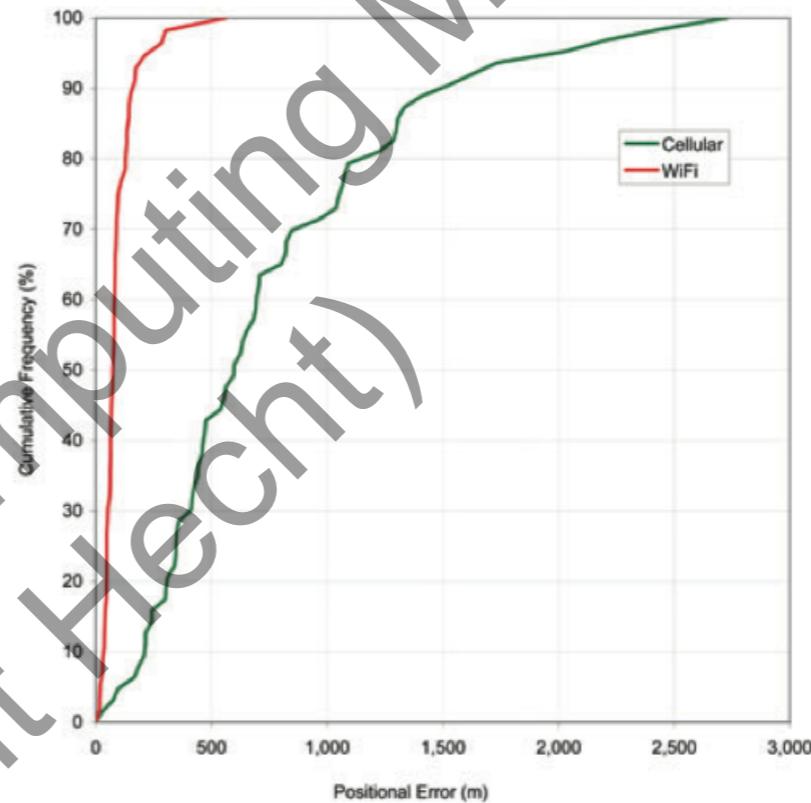
Wi-Fi Positioning Accuracy

Worse than GPS, better than cellular

Slides for Spatial Computing MOOC
(By Brent Hecht)



20m accuracy



74m accuracy
(median)

Images from “Accuracy of iPhone Locations: A Comparison of Assisted GPS, WiFi and Cellular Positioning” by Paul Zandbergen. *Transactions in GIS*, 2009, 13(s1): 5–26

Wi-Fi Positioning Accuracy

Worse than GPS, better than cellular

Can be used *in combination with*
GPS for improved accuracy

Slides for Spatial Computing MOOC
(By Brent Hecht)

“Skyhook Location’s hybrid positioning improves upon Wi-Fi positioning accuracy up to 35% in difficult environments by leveraging signals from as few as two GPS satellites. In deep urban settings Skyhook Location uses weak GPS signals and WiFi to acquire a location 100% of the time (A-GPS works only 70% of the time). From a complete cold start, Skyhook Location delivers a full hybrid location in 4 seconds (compared to 30-60 seconds for A-GPS).”

(Skyhook Wireless 2014)

Slides for  SKYHOOK°

Predictors of Performance

1. Number of access points
2. Quality of fingerprint database (degrades over time, conditions)
3. Quality of machine learning algorithm in positioning phase

No Wi-Fi hotspots in range out here...



Wi-Fi Positioning provides positioning for devices without GPS....

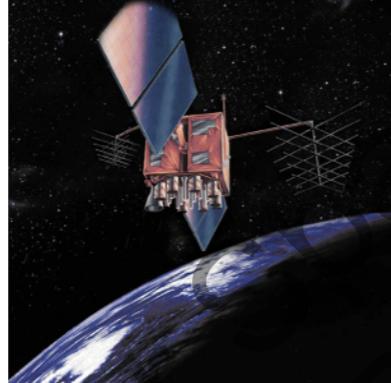


Slides
Tablets

Computers
(e.g. MacBooks)

Key Types of Signal-based Positioning

in your smartphone and in general



**Signal-based
Positioning**

**1. Satellite-based
Positioning**

2. Wifi Positioning

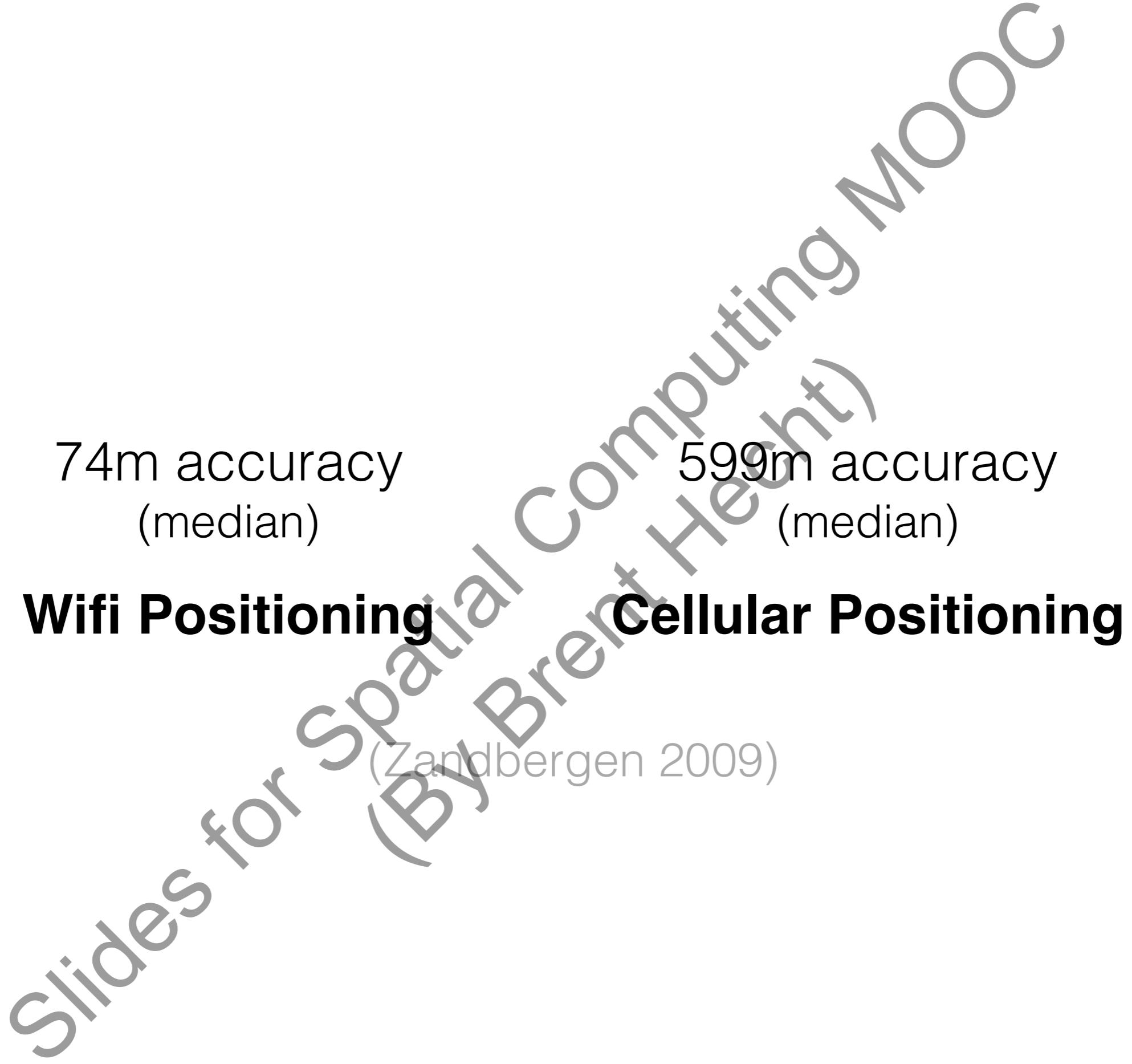
**3. Cellular
Positioning**

Cellular Positioning

1. Algorithms: Location of tower with strongest signal, Time Difference on Arrival, Angle of Arrival, Fingerprinting
2. Accuracy highly-dependent on number of towers
3. Least accurate of all three



Slides for Spatial Computing
(By Brent Wiens)



Positioning

Spatial Computing – University of Minnesota

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Fingerprint by Wilson Joseph from The Noun Project

"Blue iPod touch 5th Generation" by Guess Who - Created in Photoshop CS6.. Via Wikipedia - http://en.wikipedia.org/wiki/File:Blue_iPod_touch_5th_Generation.png#mediaviewer/File:Blue_iPod_touch_5th_Generation.png

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Router by Pedro Lalli from The Noun Project

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Google
Developers

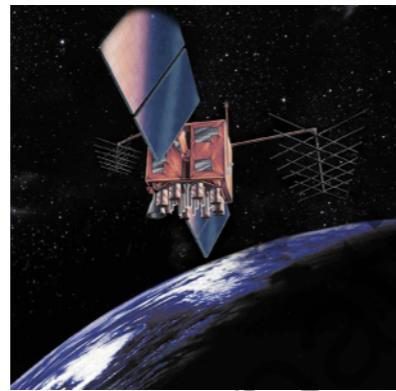
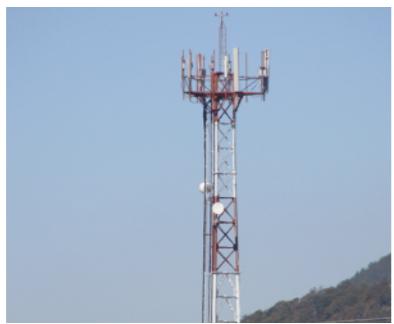
Positioning

Spatial Computing – University of Minnesota





Determining the location of a client's device
(e.g. for a mobile map, location-based service, scientific application)



Used when no signal-based position is available

(e.g. location inference in online communities)

Used when signal-based positioning is not useful for your needs
(e.g. need "home" not "current" location)

flickr



102.111.321.5

Slideset Spatial Computing MOOC
BY Brent Hecht

Geotags in tweets generally come from signal-based positioning in smartphones

A screenshot of the Echofon Twitter client interface. The timeline shows several tweets with geotags. One tweet from 'University of MN @UMNews' includes a map of Minneapolis with a red dot indicating the location. Another tweet from 'echofon @echofon' includes a map of the same area.

Twitter API

A screenshot of an IDE (IntelliJ IDEA) showing Java code for interacting with the Twitter API. The code is part of a class named 'InstagramCollector.java' and includes methods for searching images and saving them. The code uses the Twitter4j library.

```
private static final String CONSUMER_KEY = "CONSUMER_KEY";
private static final String CONSUMER_SECRET = "CONSUMER_SECRET";
private static final String OAUTH_TOKEN = "OAUTH_TOKEN";
private static final String OAUTH_TOKEN_SECRET = "OAUTH_TOKEN_SECRET";

Date begin = new SimpleDateFormat("yyyy-MM-dd");
Date lastDate = new Date();

int maxPages = 100;
int curPage = 0;

while (curPage < maxPages) {
    System.out.println("Getting images from " + begin);
    MediaFeed resultFeed = instagram.search(
        begin, lastDate, maxPages);
    List<MediaFeedData> results = resultFeed.getMedia();
    int i = 0;
    for (MediaFeedData result : results) {
        ImageData imgData = result.getImage();
        System.out.println("Saving: " + imgData.getUrl());
        ...
    }
}
```



Figure 2. Mapping “Gross Community Happiness” in Greater London (best seen in color).

(Quercia et al. 2012)

Spatial Computing
by Brent Hecht
Sentiment Analysis
Algorithms

Only 1-3% of tweets are geotagged!

Slides for Spatial Computing MOOC BY Brent Hecht

Echofon | 48 | 115

Check out our new release on our blog: buff.ly/1nULI7j
via Buffer

University of MN @UMNews Jul 31, 2014
#UMN prof explains why Millennials are waiting longer to get married, have kids and buy homes. z.umn.edu/no8
via TweetDeck

echofon @echofon Jul 31, 2014
Check out our new conversation feature on our blog! Click here: buff.ly/1qLQUXV
via Buffer

Spatial Computing @SpatialCompMOOC Jul 31, 2014
Is this the first live tweet from a MOOC video? It's like Ellen at the Oscars!
#vgirocks
via Twitter for Android from Minneapolis

University of MN @UMNews Jul 31, 2014
So #UMNproud: #UMN topped @Forbes' list of most improved schools since '09 in its America's Best Colleges rankings. z.umn.edu/no2
via Twitter Web Client

University of MN @UMNews Jul 31, 2014
As a #UMN McNair Scholar, Amber Jones has discovered a love for researching female activists. z.umn.edu/nny pic.twitter.com/0BGor1UucJ
via Twitter Web Client

echofon @echofon Jul 30, 2014
We've released a new update! Check out the new features on our blog: buff.ly/1o5w81W
via Buffer

Vernon Davis @VernonDavis85 Jul 30, 2014
Leaked scene from my upcoming super hero movie #CaptainTorpedo youtu.be/1c0iLVgvbMI pic.twitter.com/FL17TQ2fD5



edchi edchi

wonderful afternoon at the 20th anni. of HCI at StanfordU. Terry Winograd toasted by many, inc. my ex and current boss: S.Card and L.Page.

21 Feb



Slides for Spatial Computing
(by Brent Hecht)



Only 1-3% of tweets are geotagged!

Slides for Spatial Computing MOOC BY Brent Hecht

The image shows a Twitter timeline from the Echofon application. There are 115 tweets listed, all from July 31, 2014. Each tweet is accompanied by a small map of the Minneapolis-St. Paul area with a red location pin and a question mark, indicating that the tweet has no geolocation information. The tweets include posts from the University of MN (@UMNews), Echofon (@echofon), and Vernon Davis (@VernonDavis85). The tweets are as follows:

- Check out our new release on our blog: buff.ly/1nULI7j via Buffer
- University of MN** @UMNews #UMN prof explains why Millennials are waiting longer to get married, have kids and buy homes. z.umn.edu/no8 via TweetDeck
- echofon** @echofon Check out our new conversation feature on our blog! Click here: buff.ly/1qLQUXV via Buffer
- Spatial Computing** @SpatialCompMOOC Is this the first live tweet from a MOOC video? It's like Ellen at the Oscars! #vgirocks via Twitter for Android from Minneapolis
- University of MN** @UMNews So #UMNproud: #UMN topped @Forbes' list of most improved schools since '09 in its America's Best Colleges rankings. z.umn.edu/no2 via Twitter Web Client
- University of MN** @UMNews As a #UMN McNair Scholar, Amber Jones has discovered a love for researching female activists. z.umn.edu/nny pic.twitter.com/0BGor1UucJ via Twitter Web Client
- echofon** @echofon We've released a new update! Check out the new features on our blog: buff.ly/1o5w81W via Buffer
- Vernon Davis** @VernonDavis85 Leaked scene from my upcoming super hero movie #CaptainTorpedo youtu.be/1c0iLVgvbMI pic.twitter.com/FL17TQ2fDF



The use of implicit and explicit geographic information contributed or consumed by Internet users to generate a position for these users (with or without their knowledge or consent).

We'll cover the following content-based positioning-related topics:

- 1 **Geoparsing**: Extracting place names from natural language text
- 2 “**Home Locations**”: The dynamics of location fields in user profiles (and more)

Positioning

Spatial Computing – University of Minnesota

Attributions

Twitter location maps © OpenStreetMap contributors (www.openstreetmap.org/copyright)

"Cell tower in jovel chiapas" by Leogeograph - Own work. Licensed under Creative Commons Attribution-Share Alike 3.0 via Wikimedia Commons - https://commons.wikimedia.org/wiki/File:Cell_tower_in_jovel_chiapas.JPG#mediaviewer/File:Cell_tower_in_jovel_chiapas.JPG

[“Wifi”] By RRZEicons (Own work) [CC-BY-SA-3.0 (<http://creativecommons.org/licenses/by-sa/3.0>)], via Wikimedia Commons

Address, City, State, and/or Zip

3405 Michigan Union 530 S. State Street

Current City

-  Ann Arbor, Michigan
51,001 like this · 752,64...
-  Lake Ann, Michigan
785 like this · 8,350 wer...
-  Saint Ann'S Bay, Saint A...
742 like this · 3,583 wer...
-  Saint Ann, Missouri
533 like this · 3,920 wer...

Location
Where in the world are you?

家乡 :
安庆
安顺
安康

SKYHOOK
WIRELESS



YAHOO!
BOSS

Google
Developers

Positioning

Spatial Computing – University of Minnesota



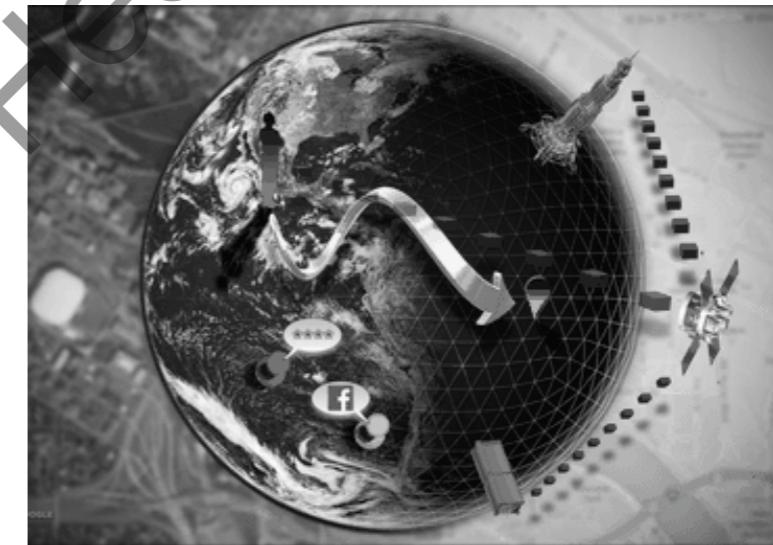
We'll cover the following content-based positioning-related topics:

- 1 **Geoparsing:** Extracting place names from natural language text
- 2 “Home Locations”: The dynamics of location fields in user profiles (and more)

Geographic Information Retrieval (GIR)



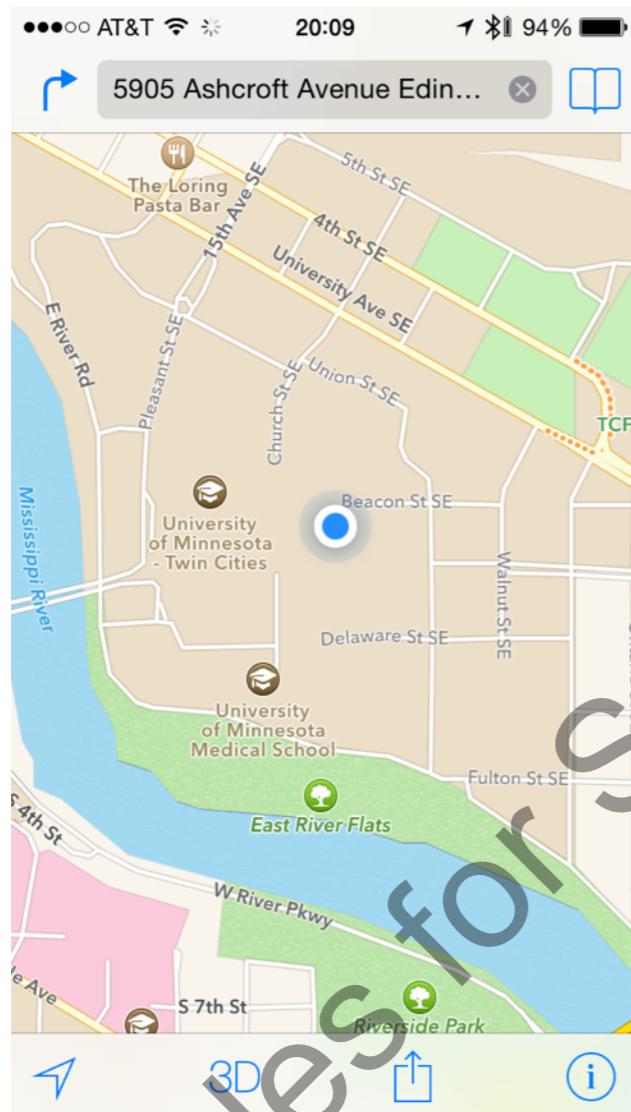
Search



Spatial
Computing

(By +
Brent Hecht)
Spatial Computing MOOC

Geoparsing and geocoding are useful for both...



...positioning for **users**

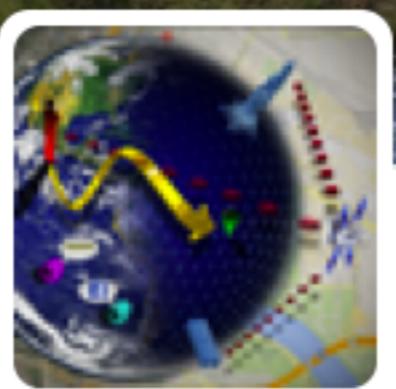
The news article discusses the proposal for Minneapolis to become a sister city to Bosaso, Somalia. It quotes Council Member Abdi Warsame, who said a sister-city arrangement would formalize informal relationships between the two communities. The article notes that Minneapolis has a diverse port city on the northern end of the country, home to people who have fled other areas during Somalia's civil war, and a large number of residents with connections to Minnesota.

Perhaps even more importantly, Warsame said, a sister-city agreement would help raise Somalia's status in the United States and the rest of the world.

"I think it will galvanize the Somali community in the United States as a whole," he said.

Bosaso would be Minneapolis' 10th sister city.

...positioning for **documents**



Spatial Computing

@SpatialCompMOOC

TWEETS

6

FOLLOWING

8

FOLLOWERS

133

Headed to Washington to do some
apple picking, jamming out to Chicago!
#seventiesmusic #itsraining



42

Tweet

Gazetteers

The screenshot shows the homepage of the GeoNames website. At the top, there is a search bar with a dropdown menu set to "all countries". Below the search bar is a text input field with placeholder text: "enter a location name, ex: \"Paris\", \"Mount Everest\", \"New York\"". To the right of the search area, there are three main sections: "Browse the names", "Information", and "Download". The "Browse the names" section contains links to "Countries", "Largest cities", "Highest mountains", "Capitals", "Postal codes", "Wikipedia", "Country statistics", and "Recent modifications". The "Information" section contains links to "About GeoNames", "Data Sources", "User manual", "Ambassadors and Team", "Forum", "Blog", "Mailing list", "Donations and Sponsoring", and "Commercial Support and Consulting". The "Download" section contains links to "Info", "Free Gazetteer Data", "Free Postal Code Data", and "Premium Data". At the bottom left, there is a Creative Commons Attribution 3.0 license logo, and at the bottom center, a note stating: "This work is licensed under a Creative Commons Attribution 3.0 License".

geonames.org

Gazetteers

<place name,
spatial footprint (**x**)>

<place name,
spatial footprint (**x**)>

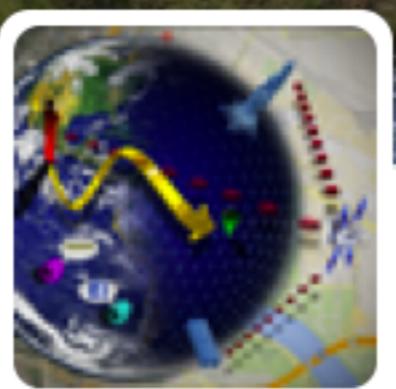
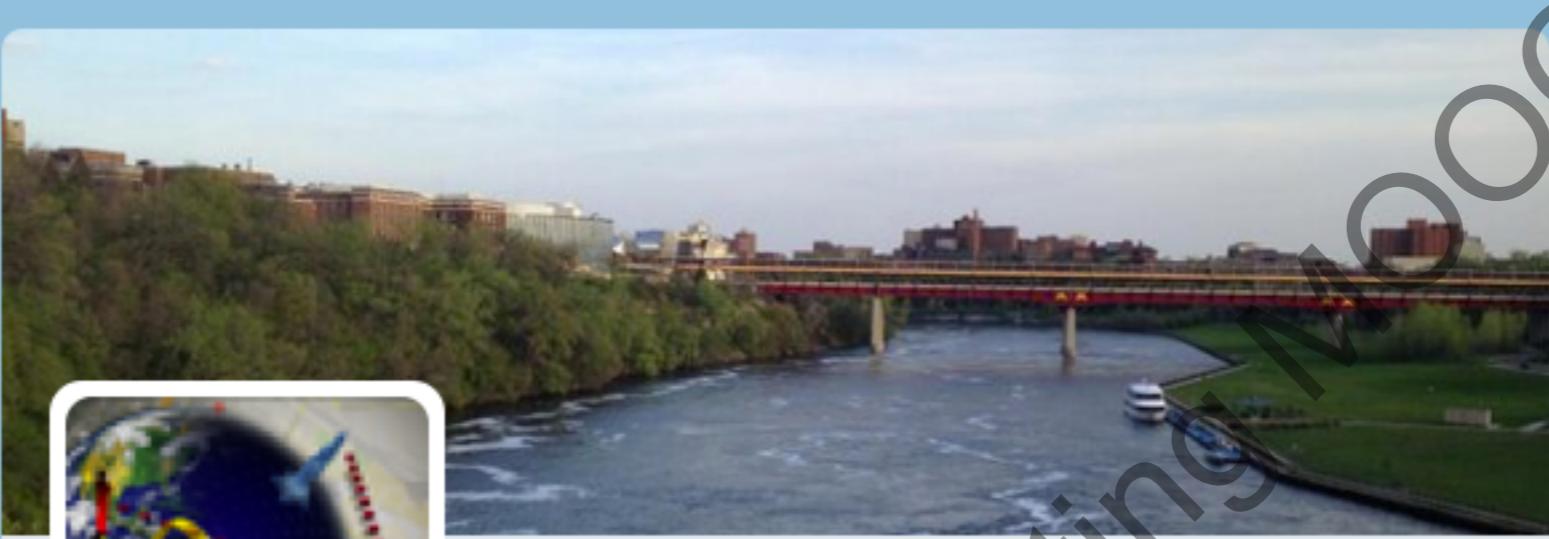
<place name,
spatial footprint (**x**)>

<“Minneapolis, MN”
(44.9833, -93.2667)>

<“McCarthy, AK”,
(61.4328° N, -142.9108)>

<“Riga, Latvia”,
(56.9489, -24.1064)>

Slides for Spatial Computing MOOC
(BY Brent Hecht)



Spatial Computing

@SpatialCompMOOC

TWEETS

6

FOLLOWING

8

FOLLOWERS

133

Headed to Washington to do some
apple picking, jamming out to Chicago!
#seventiesmusic #itsrainin



42

Tweet

Ambiguity

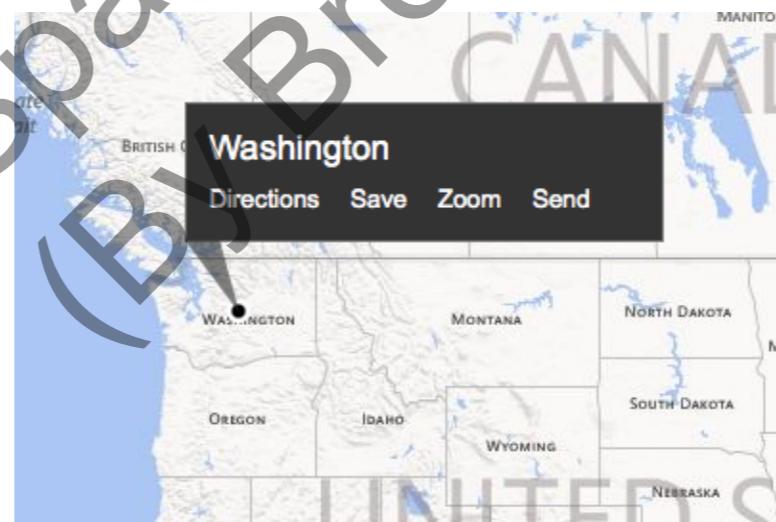
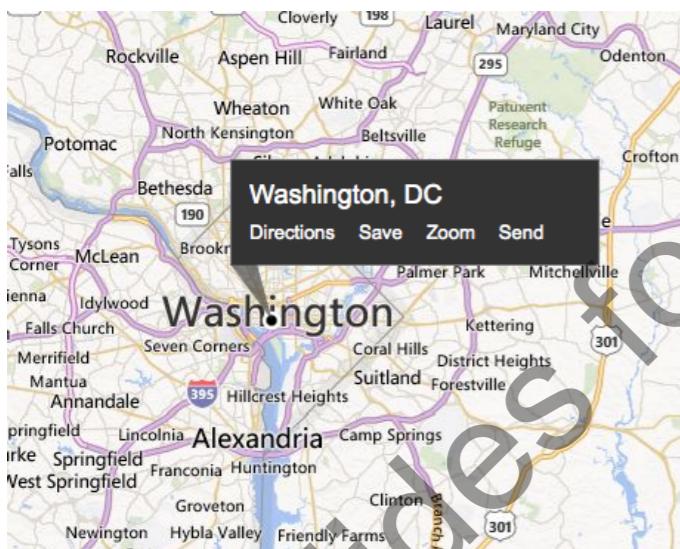
Ambiguity is a fundamental problem in
geographic information retrieval
(and information retrieval and natural language
processing more generally)

Slides for Spatial Computing (Hecht)
BY-BE
Computing MOOC

Geo/Geo Ambiguity

one place name (*toponym*) → more than one place

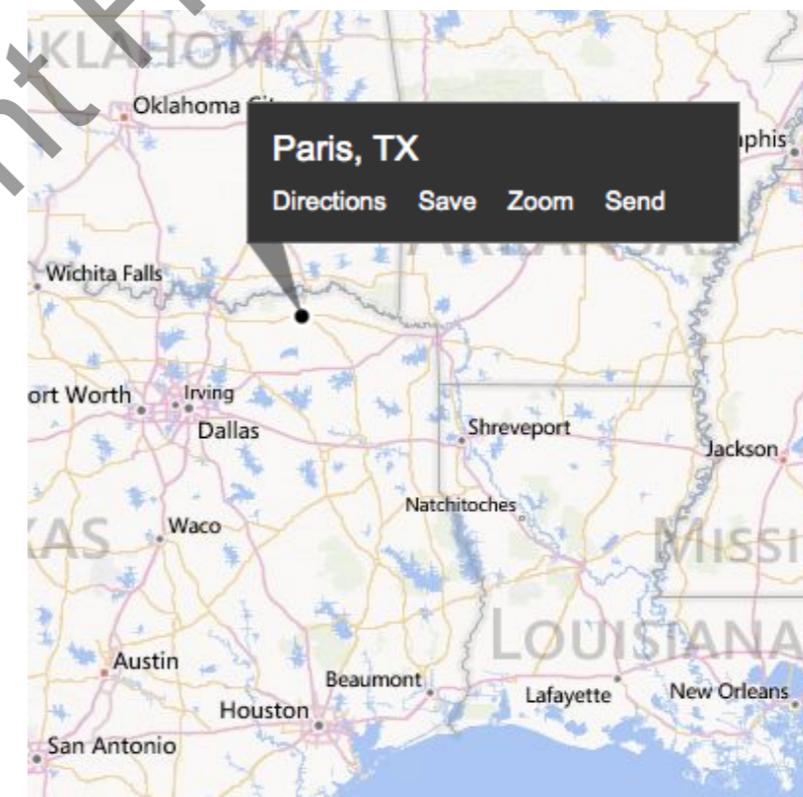
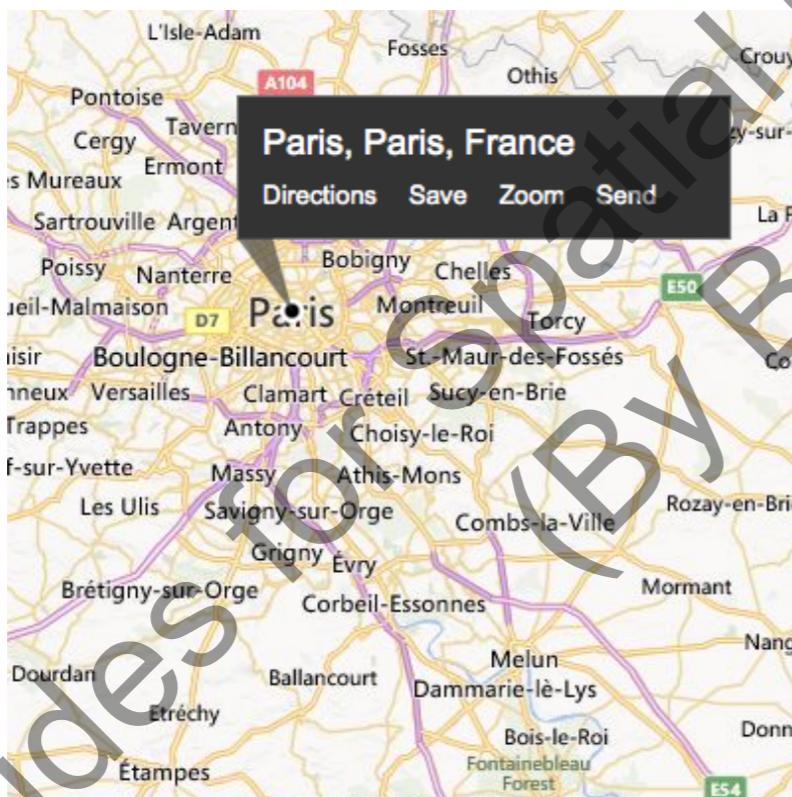
“Washington”



Geo/Geo Ambiguity

one place name (*toponym*) → more than one place

“Paris”

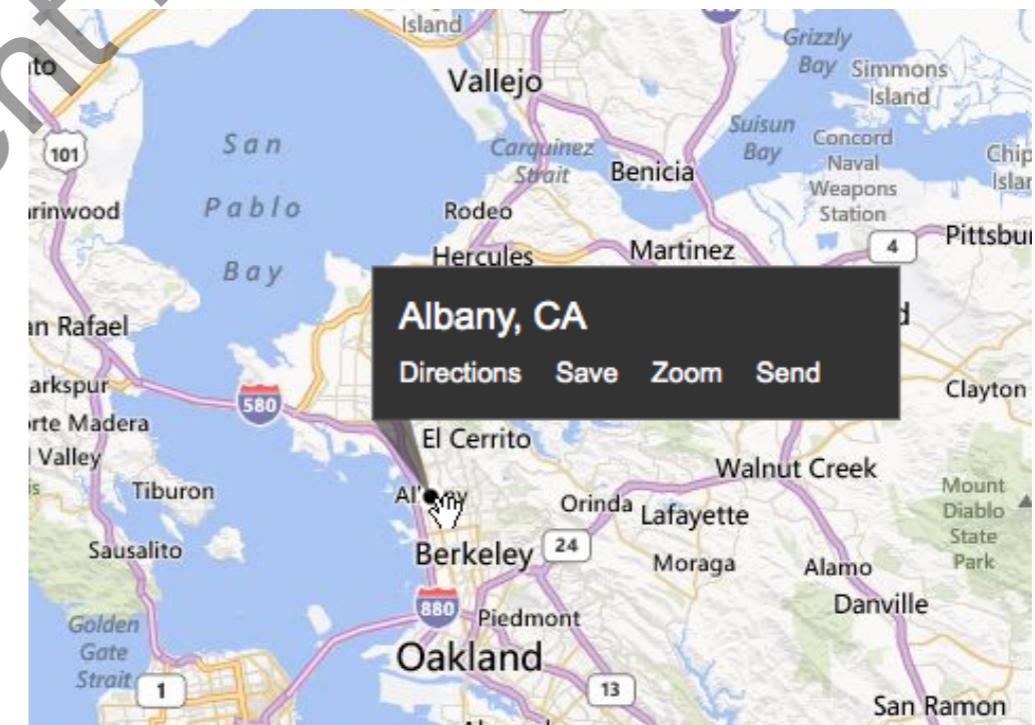
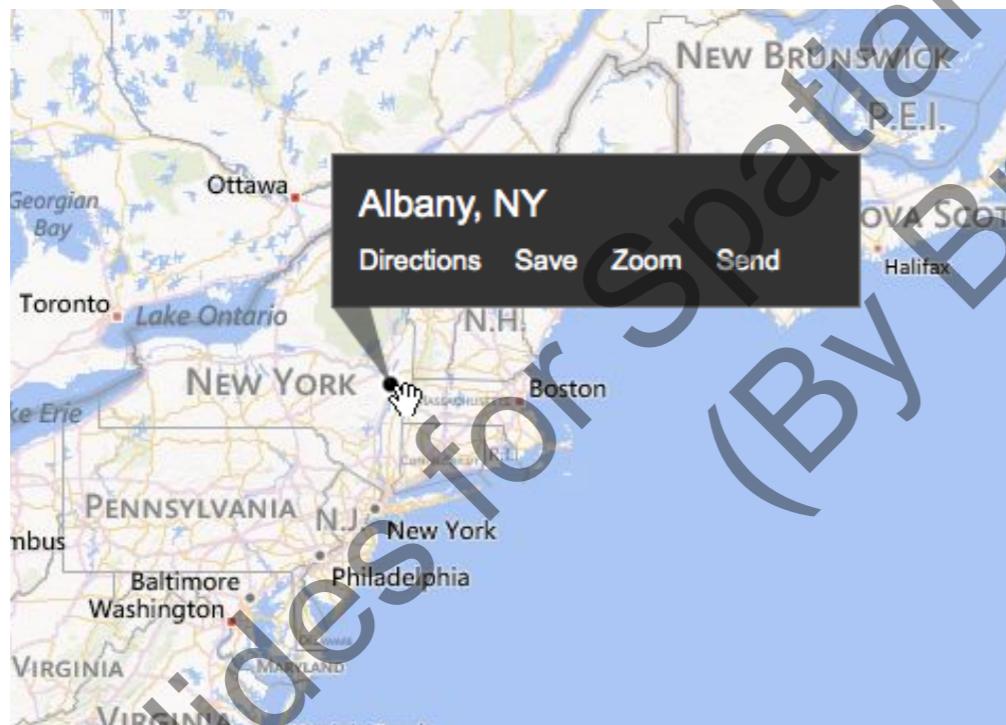


Slides for Spatial Computing
BY Brent Hecht

Geo/Geo Ambiguity

one place name (*toponym*) → more than one place

“Albany”

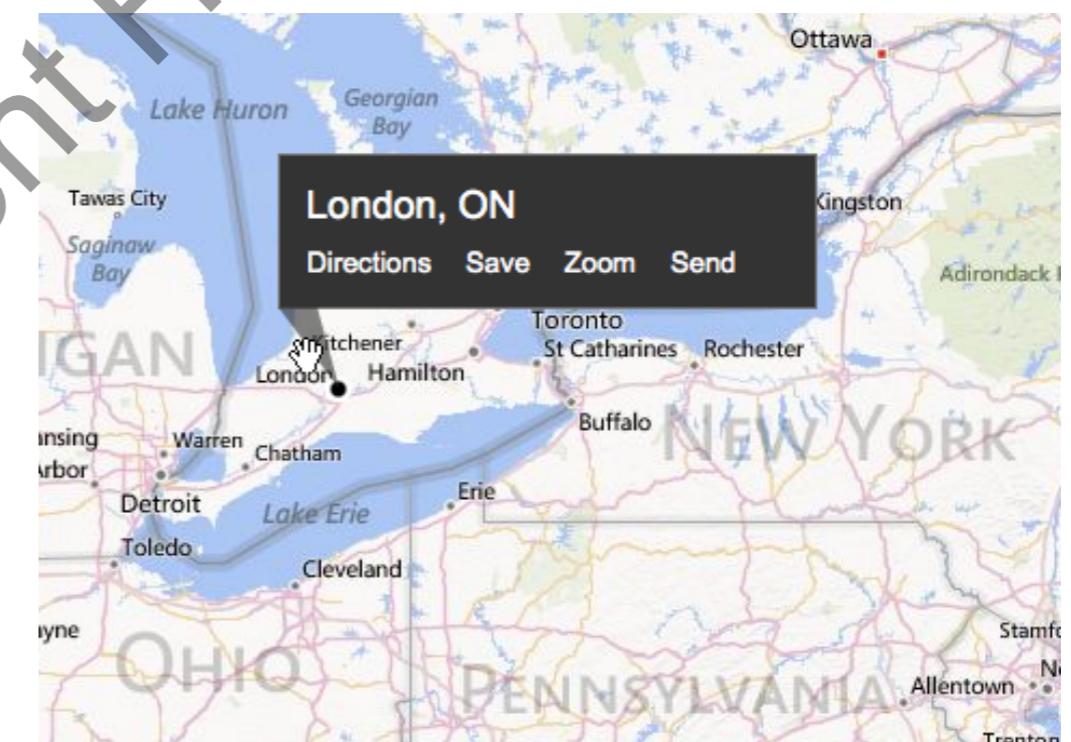


Slices for Spatial Computing
(BY Brent Hecht)

Geo/Geo Ambiguity

one place name (*toponym*) → more than one place

“London”



Slides for
Spatial Computing
BY Brent Hecht

Geo/Non-Geo Ambiguity

one term → a place name and ≥ 1 other meaning

Slides for Spatial Computing
(By Brent Hecht)



TWEETS

6

Spatial Computing

@SpatialCompMOOC

FOLLOWING

8

FOLLOWERS

133

Headed to Washington to do some
apple picking, jamming out to **Chicago!**
#seventiesmusic #itsrainin



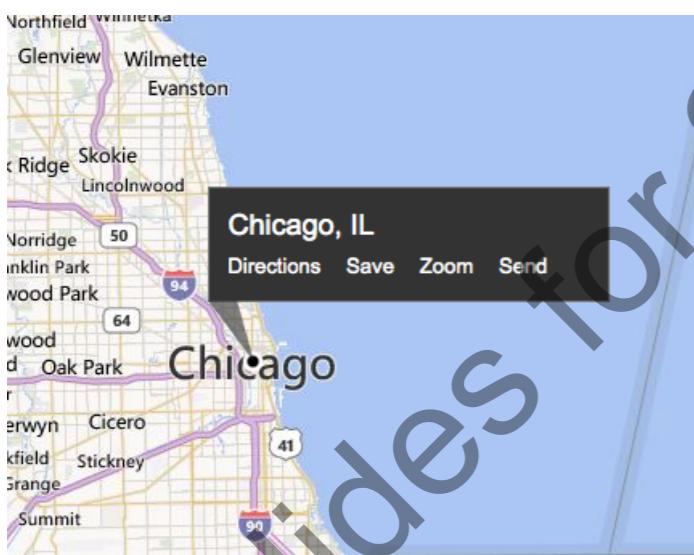
42

Tweet

Geo/Non-Geo Ambiguity

one term → a place name and ≥ 1 other meaning

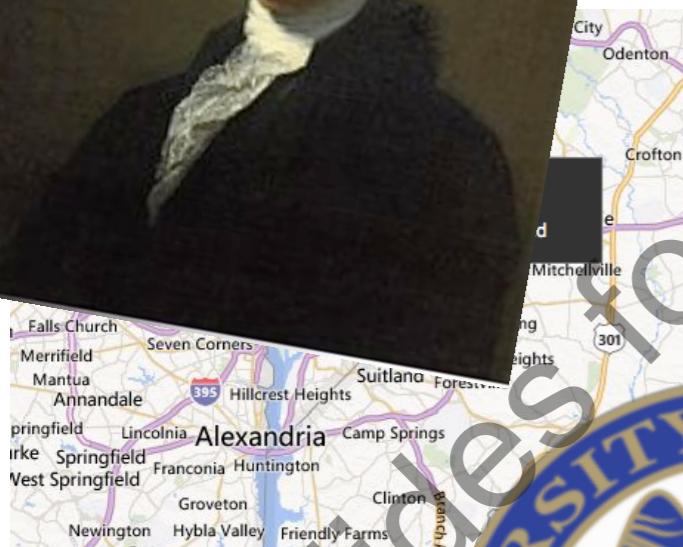
“Chicago”



Geo/Non-Geo Ambiguity

one place name (*toponym*) → more than one place

“Washington”

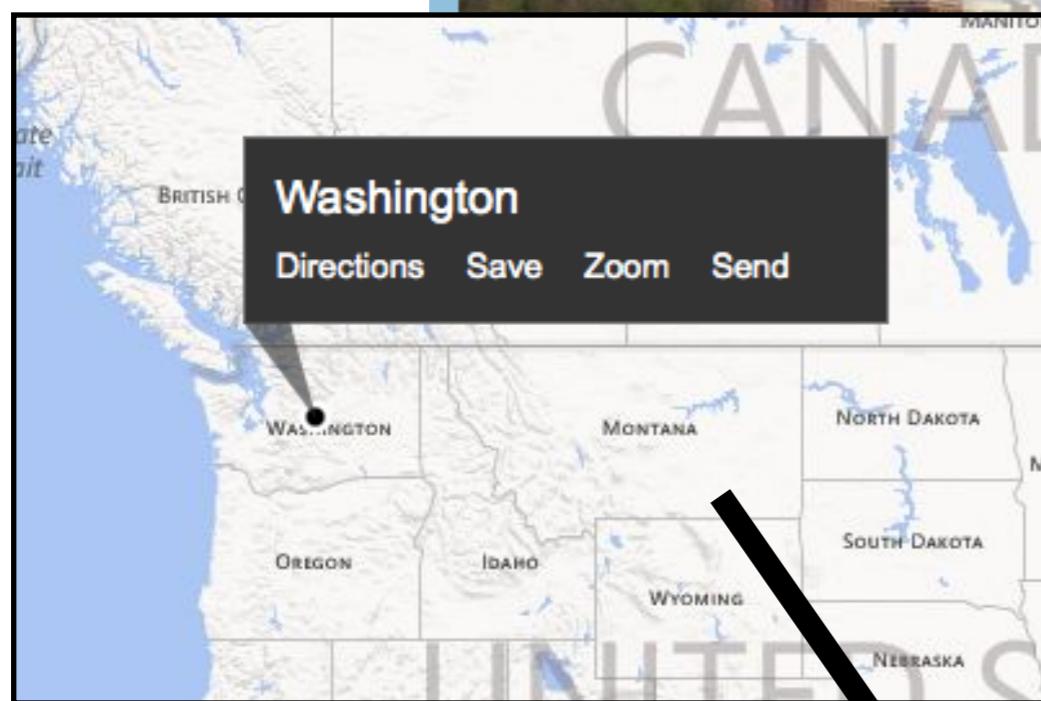


Slices for Spatial Computing
(By Laurent Hécht)



Geo/Non-Geo
Ambiguity

Geo/Geo Ambiguity



Spatial Computing

SpatialCompMOOC

LOWING

FOLLOWERS

133

6

8

Headed to Washington to do some
apple picking, jamming out to Chicago!
#seventiesmusic #itsraining



42

Tweet

SemanticRelatedness(A,B) =

A single numeric estimate of the number
and strength of relationships between
concepts A and B.

CONCEPT A



CONCEPT B



$SR(A,B)$
= High

SemanticRelatedness(A,B) =

A single numeric estimate of the number
and strength of relationships between
concepts A and B.

CONCEPT A



CONCEPT B

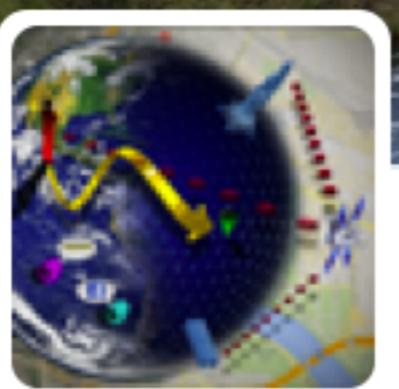
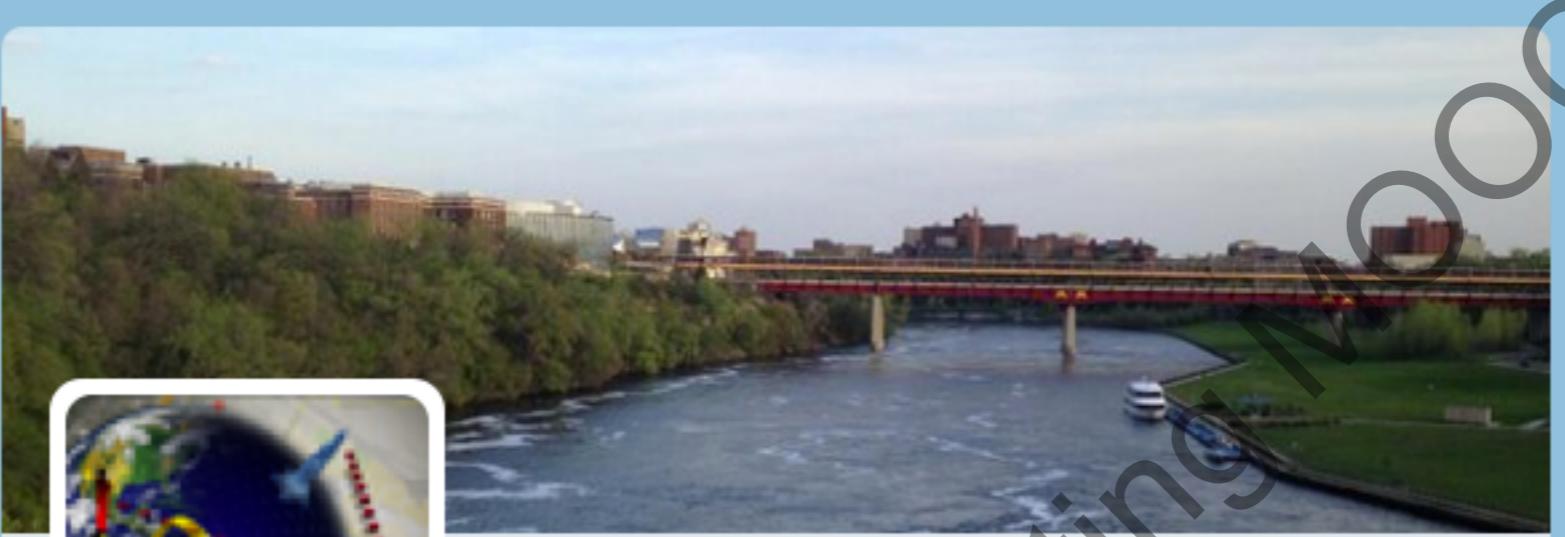


Dr. Shashi Shekhar

Garth Brooks

$SR(A,B)$

= **High**
Low



Spatial Computing

@SpatialCompMOOC

TWEETS

6

FOLLOWING

8

FOLLOWERS

133

Headed to Washington to do some
apple picking, jamming out to Chicago!
[#seventiesmusic](#) [#itsrainin](#)



42

Tweet



Washington state is
well-known for...



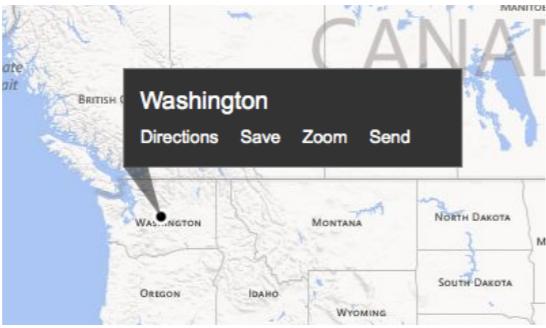
...Apples



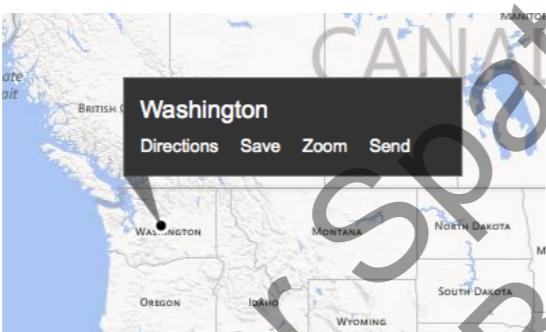
...Rain

Slides for Spatial Computing MOOC
(By Brent Hecht)

$SR("apple picking") = \text{High}$

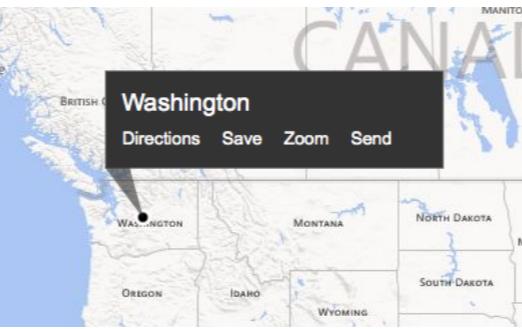


$SR("its raining") = \text{High}$

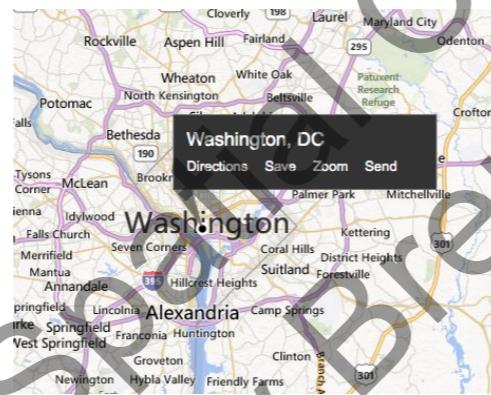


Slides for Spatial Computing
(By Brent Hecht)

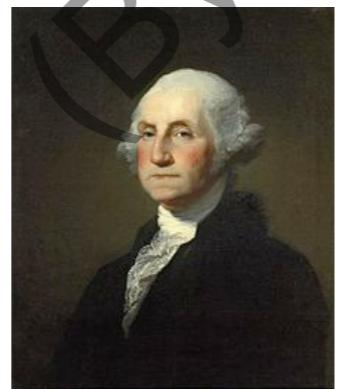
SR(
Sliders for Survey Computing Hecht)



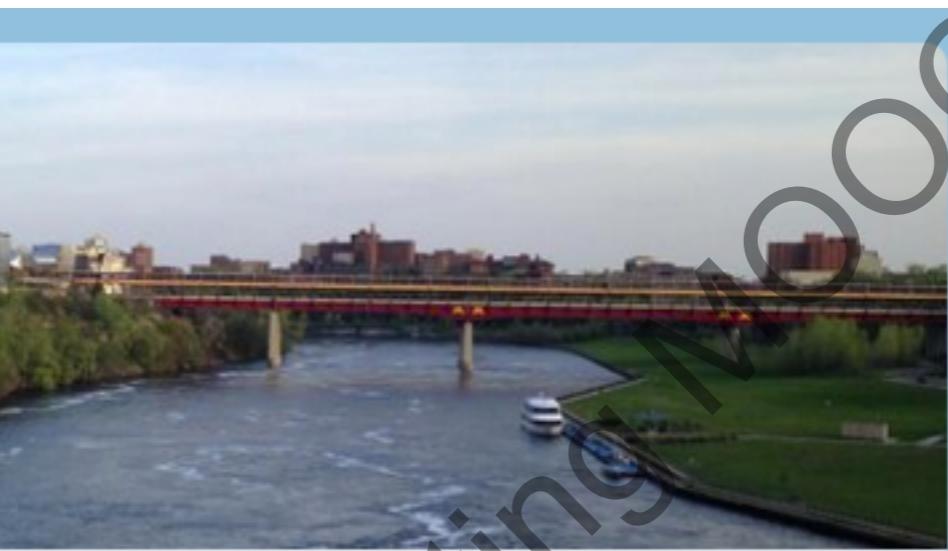
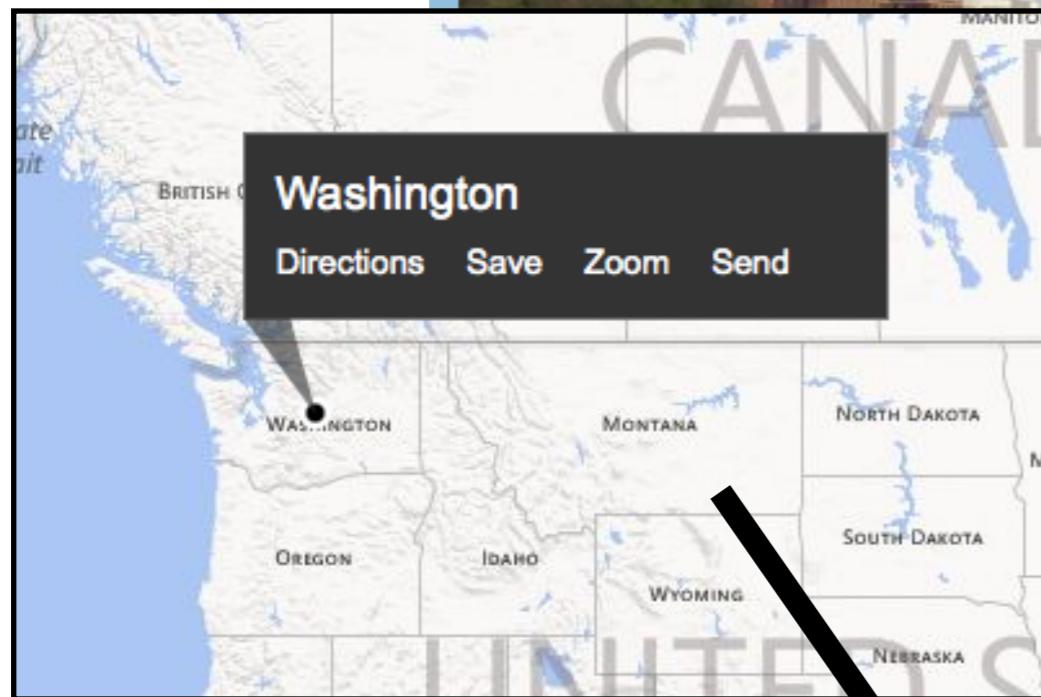
, “apple
picking”)



, “apple
picking”)



, “apple
picking”)



Spatial Computing

@SpatialCompMOOC

LOWING

FOLLOWERS

133

6

8

Headed to **Washington** to do some
apple picking, jamming out to Chicago!
#seventiesmusic #itsraining



42



Slides for Spatial Computing MOOC

Slides for BYSPrentHochng MOOC

Spatial Computing
@SpatialCompMOOC

TWEETS 6 FOLLOWING 8 FOLLOWERS 133

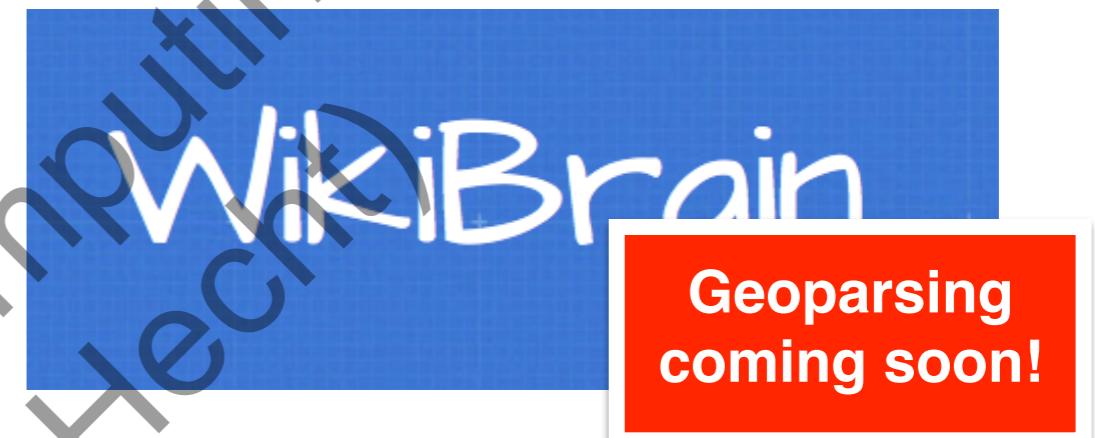
Headed to Washington to do some apple picking, jamming out to **Chicago!**
#seventiesmusic #itsrainin...

42 Tweet

Tools



DBpedia Spotlight



WikiBrain



Yahoo! BOSS
PlaceSpotter API



Berico Technologies'
CLAVIN

Positioning

Spatial Computing – University of Minnesota

Attributions

Search by Marcos Folio from The Noun Project

"Redskins uniforms12" by Washington Redskins (logos and uniforms)Fma12 (vector graphics image) - Own work.
Licensed under Creative Commons Attribution-Share Alike 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Redskins_uniforms12.png#mediaviewer/File:Redskins_uniforms12.png

"Red Apple" by Abhijit Tembhekar from Mumbai, India - Nikon D80 Apple. Licensed under Creative Commons Attribution 2.0 via Wikimedia Commons - https://commons.wikimedia.org/wiki/File:Red_Apple.jpg#mediaviewer/File:Red_Apple.jpg

"22 Regen ubt" by Tomasz Sienicki [user: tsca, mail: tomasz.sienicki at gmail.com] - Own work. Licensed under Creative Commons Attribution 3.0 via Wikimedia Commons - https://commons.wikimedia.org/wiki/File:22_Regen_ubt.jpeg#mediaviewer/File:22_Regen_ubt.jpeg

Address, City, State, and/or Zip

3405 Michigan Union 530 S. State Street

Current City

-  Ann Arbor, Michigan
51,001 like this · 752,64...
-  Lake Ann, Michigan
785 like this · 8,350 wer...
-  Saint Ann'S Bay, Saint A...
742 like this · 3,583 wer...
-  Saint Ann, Missouri
533 like this · 3,920 wer...

Location
Where in the world are you?

家乡 :

-  安庆
-  安顺
-  安康

SKYHOOK
WIRELESS



YAHOO!
BOSS

Google
Developers

Positioning

Spatial Computing – University of Minnesota



We'll cover the following content-based positioning-related topics:

- 1 **Geoparsing**: Extracting place names from natural language text
- 2 “**Home Locations**”: The dynamics of location fields in user profiles (and more)

Spatial Computing (@Spati...)

Twitter, Inc. (US) https://twitter.com/spatialcompmooc/

Google

Search Twitter

6 8 134 1

Tweets Tweets & replies Photos & videos

Spatial Computing @SpatialCompMOOC · Sep 29
Module 2 opens in < 1 hour! This week, we'll cover the crit
spatial query languages (think SQL, but optimized for spati

Spatial Computing @SpatialCompMOOC · Sep 25
Learn more about your instructors at their websites: @bhecht
/1t0OUpV and Dr. Shekhar: bit.ly/1t0OUpU

Spatial Computing @SpatialCompMOOC · Sep 22
Welcome to Module 1 of the University of Minnesota's Spa
MOOC!

Who to follow · Refresh · View all

reed.co.uk @reedcouk

A screenshot of a Twitter profile page for "Spatial Computing (@SpatialCompMOOC)". The profile picture shows a globe with various locations marked. The bio reads: "The Twitter account for the University of Minnesota's Spatial Computing MOOC taught by Dr. @bhecht and Dr. Shashi Shekhar". Below the bio, there are links to "Minneapolis, MN" (with a red arrow pointing to it), "coursera.org/course/spatial...", and "1 Photo or video". A thumbnail image shows a classroom setting with students and a projector screen. The top navigation bar includes icons for home, search, messages, and a pen. The header also features a magnifying glass icon and the word "Search Twitter". The main timeline shows three tweets from the account, each with engagement metrics (likes, retweets, replies). A large watermark reading "(BY BRIENTHEDGEE)" is diagonally across the page.

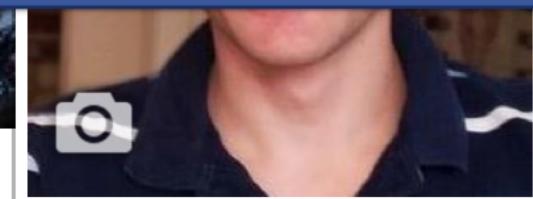


Brent Hecht



Brent

Home



Brent Hecht

[Update Info](#)[View Activity Log](#)

10+

...

[Timeline](#)[About](#)[Photos](#)[Friends 460](#)[More ▾](#)

About

[Overview](#)[Work and Education](#)

Places You've Lived

[Contact and Basic Info](#)[Family and Relationships](#)[Details About You](#)[Life Events](#)

CURRENT CITY AND HOMETOWN

Current City



Minneapolis, Minnesota

Friends ▾

[Save Changes](#)[Cancel](#)

Add your hometown

OTHER PLACES LIVED

Add a place

Slides for Spatial Computing (BY Brent Hecht)



[Timeline](#)[About](#)[Photos](#)[Friends 29 Mutual](#)[More ▾](#)

ABOUT

Assistant Professor at University of Minnesota - Twin Cities

Past: Northwestern University and Microsoft Research

Studied Computer Science at Northwestern University

Past: University of California, Santa Barbara and Macalester College

Lives in Minneapolis, Minnesota

PHOTOS · 100



Brent Hecht shared a link.

March 10

A Crash Course in Modern Geography for Researchers and Practitioners

Thanks to the rise of ubiquitous computing, location-based ser content, and related phenomena, geography plays an increase the work of HCI researchers and practitioners. Through recent integrate the geography and HCI communities like last year'...

SITES.GOOGLE.COM

[Unlike](#) · [Share](#)

You and 6 others like this.



Brent Hecht

March 3

Happy to announce that Steph and I are engaged! — w





Edit Profile

Name

Brent

H

Picture



Change Picture

Username

www.pinterest.com/

bjhecht

About You

Location

Website

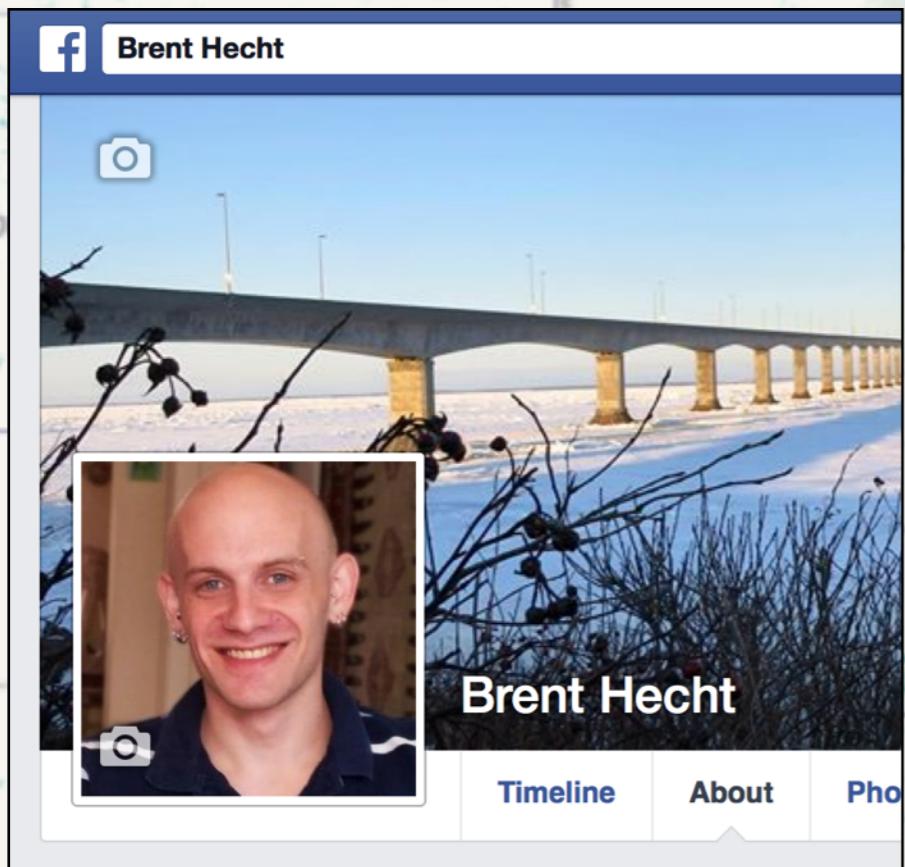
Verify Website

Visit [Account Settings](#) to change your password, email address, and Facebook and Twitter settings.

Cancel

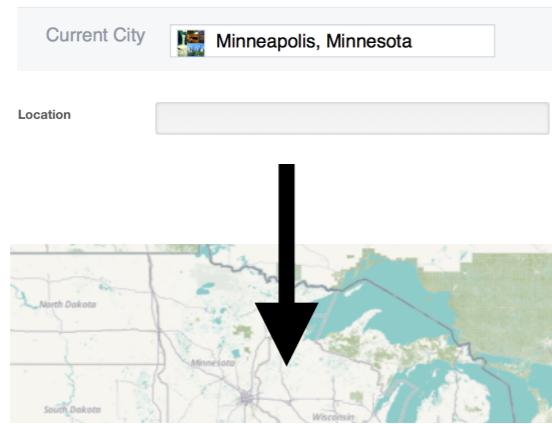
Save Profile

Slides for Spatial Computing
(By Brent Hecht)



Slides for Spatial/Computing MOOC
(By Brent Hecht)

Structure of the rest of this video:



Go over **how** to use location fields to position users.

Understand the advantages and disadvantages of location field positioning.

Wrap-up positioning with discussion of **location-inference attacks**.

Brent Hecht

Update Info View Activity Log 10+ ...

Timeline About Photos Friends 460 More

CURRENT CITY AND HOMETOWN

Current City



Minneapolis, Minnesota

Save Changes

Cancel

Toponym
(a.k.a. place name)



Add your hometown

OTHER PLACES LIVED



Add a place



(44.98, -93.27)

Machine-readable Representation
(e.g. lat/lon coordinate)

Slides for Spatial Computing
(By Brent Hecht)



Google Maps API Web Services

g+1 174

▼ Google Maps Web Services

Overview

Directions API

Distance Matrix API

Elevation API

Geocoding API

Time Zone API

Client Library

► Support

► Related APIs

The Google Geocoding API

This document discusses the Geocoding API v3. Note that the Geocoding API v2 has been turned down and is no longer available. Users of the Geocoding API v2 service should [upgrade](#) to v3.

This service is also available as part of the [Google Maps JavaScript API](#), or with a [Java client library](#).

[What is Geocoding?](#)

[Before You Begin](#)

[API Key](#)

[Usage Limits](#)

[Geocoding API Request Format](#)

[Geocoding \(Latitude/Longitude Lookup\)](#)

[Geocoding Responses](#)

[JSON Output Formats](#)

[XML Output Formats](#)

[Status Codes](#)

[Error Messages](#)

[Results](#)



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Locations API

Bing | 11 out of 22 rated this helpful – [Rate this topic](#)

Use the Locations API to get location information.

For an example of how to use the Locations API with Bing Maps AJAX Control 7.0, see [Displaying Location Search Results Using the REST Services](#).

In this section

Find a Location by Address	Use these URL templates to get latitude and longitude coordinates for a location by specifying values such as a locality, postal code, and street address.
Find a Location by Point	Use this URL template to get the location information associated with latitude and longitude coordinates.
Find a Location by Query	Use these URL templates to get latitude and longitude coordinates that correspond to location information provided as a query string.
Location Data	Use this description to understand the results returned in the response to a Locations API request.

MapQuest Geocoding API

LICENSED DATA APIs

» GEOCODING API WEB SERVICE

Geocoding is the process of matching addresses with geographic coordinates. easily access the MapQuest geocoder through a simple HTTP request. The Ge functions: address, reverse, and batch.

Geocoding API Resources

[Documentation](#)

Instructions, code samples, and demos all combined in easy-to-follow, easy

[Forums](#)

Discuss and collaborate with developers who are using the Geocoding API.

[Features](#)

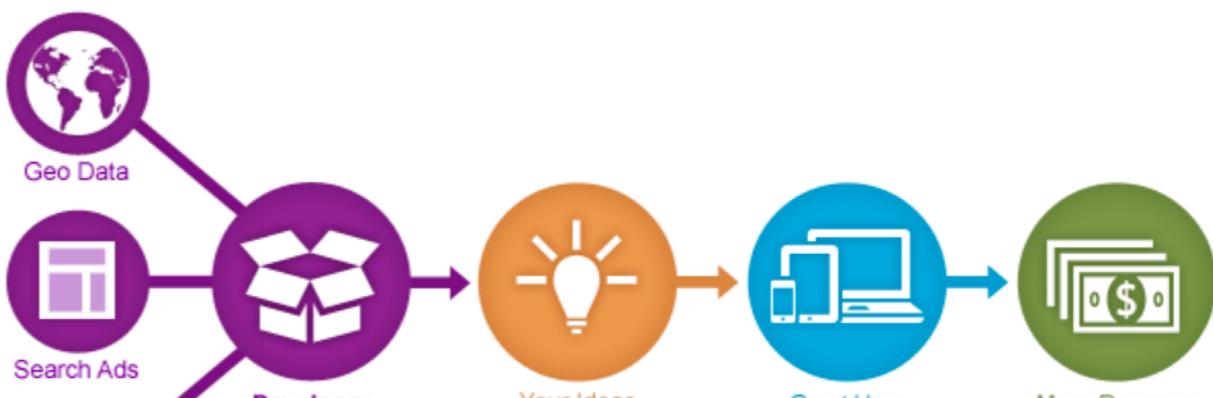
[Address geocoding](#)

Provide either a single-line address or an address broken down into its components. geocodes in order of confidence.



Yahoo BOSS Geo Services

Yahoo BOSS is a suite of services that provides Developers premium API's that can support Search and Content applications. BOSS Geo services include two primary offerings today, Placefinder and PlaceSpotter, which allows developers to geo-enrich their applications and make them more location aware. Learn more about our offerings below.



“200 Union St. SE,
Minneapolis, MN”

“United States”

“Minnesota”

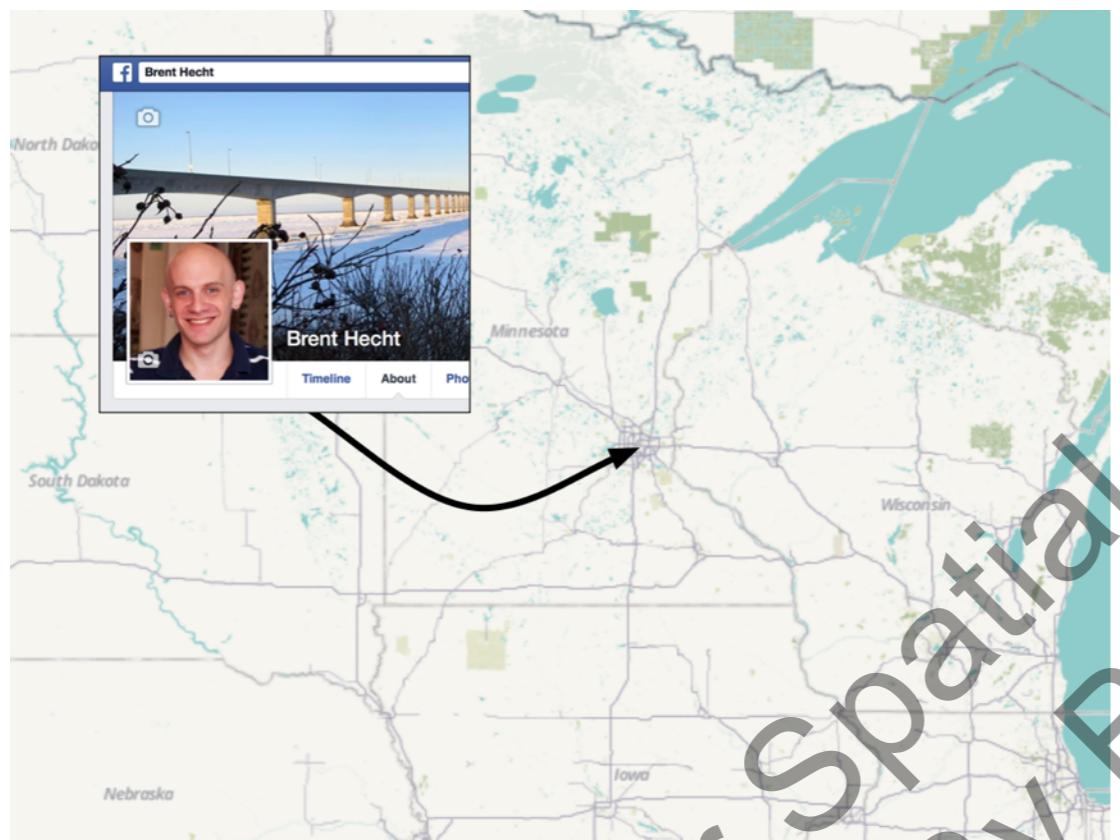
“Minneapolis, MN”



Google
Developers

The Google Geocoding API

```
"address_components" : [
  {
    "long_name" : "Minneapolis",
    "short_name" : "Minneapolis",
    "types" : [ "locality", "political" ]
  },
  {
    "long_name" : "Hennepin County",
    "short_name" : "Hennepin County",
    "types" : [ "administrative_area_level_2", "political" ]
  },
  {
    "long_name" : "Minnesota",
    "short_name" : "MN",
    "types" : [ "administrative_area_level_1", "political" ]
  },
  {
    "long_name" : "United States",
    "short_name" : "US",
    "types" : [ "country", "political" ]
  }
],
"formatted_address" : "Minneapolis, MN, USA",
"geometry" : {
  "bounds" : {
    "northeast" : {
      "lat" : 45.05125,
      "lng" : -93.1945439
    },
    "southwest" : {
      "lat" : 44.890144,
      "lng" : -93.32916299999999
    }
  },
  "location" : {
    "lat" : 44.983334,
    "lng" : -93.26666999999999
  },
  "location_type" : "APPROXIMATE",
  "viewport" : {
    "northeast" : {
      "lat" : 45.05125,
      "lng" : -93.1945439
    },
    "southwest" : {
      "lat" : 44.890144,
      "lng" : -93.32916299999999
    }
  }
}
```



Map users
Slides for Spatial Computing
(By Brent Hecht)

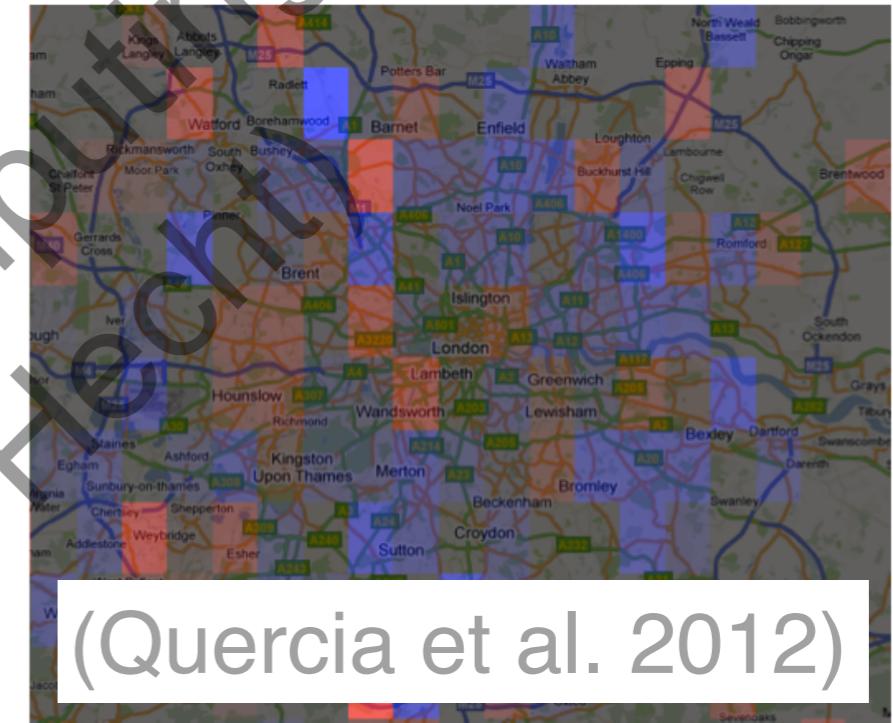


Figure 2. Mapping “Gross Community Happiness” in Greater London (best seen in color).

Do a geographic sentiment analysis

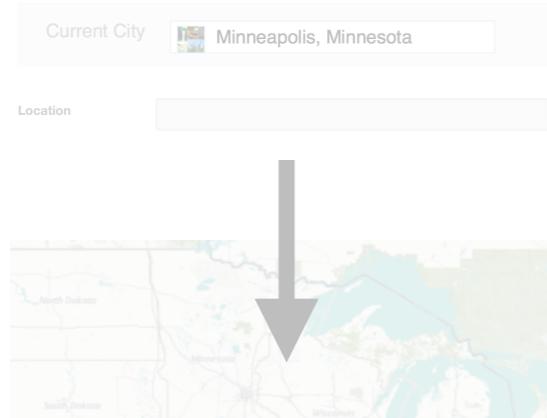
Questions you may be asking yourself
at this point:

What do you mean by **some** applications?

How is **geo/geo ambiguity** dealt with?

Slides for Spatial Computing MOOC
(By Brent Hecht)

Structure of the rest of this video:



Go over **how** to use location fields to position users.

Understand the **advantages** and **disadvantages** of location field positioning.

Wrap-up positioning with discussion of **location-inference attacks**.

Location Field Positioning



PROS

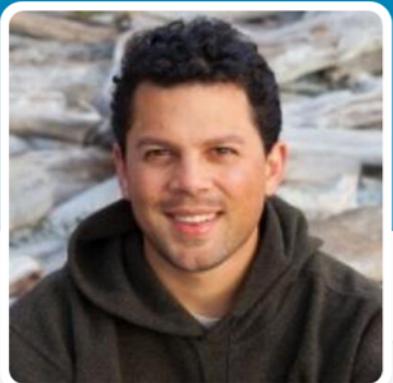


CONS



Many location fields
are blank

Slides for Spatial
(By Brent Hecht)



Shilad Sen
@shiladsen FOLLOW YOU
Joined September 2010

 Tweet to  Message

No Location



Pedro Pereda Mellado
@PeredaFP FOLLOW YOU
Joined October 2007

 Tweet to  Message

No Location



Colin Kaepernick 
@Kaepernick7
Do not underestimate the determination
of a quiet man - Iain Smith
Joined June 2009

 Tweet to Colin Kaepernick  Message

No Location



jonathan andrade
@golyandrade
Amanecer de la comida, panzon y feliz.
Joined September 2012

 Tweet to jonathan andrade

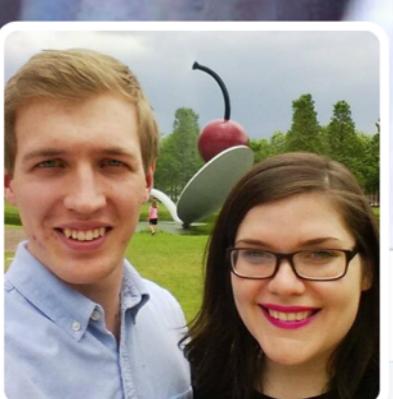
No Location



Stephanie H
@hashtaghille FOLLOW YOU
Joined March 2011

 Tweet to  Message

No Location



Alyson Glass 
@glassak
I went to Juniata College and now I
don't.
Joined January 2010

 Tweet to Alyson Glass

No Location

18% of Twitter user profiles have
nothing in their location field

(Hecht et al. 2011)

Slides for Spatial Computing Mooc
(By Brent Hecht)

Location Field Positioning



PROS



CONS



Many location fields
are blank

Scale is sometimes
insufficient

Slides for Spatial Computing MOOC
(By Brent Hecht)

Slides for Spatial Computing MOOC

Jessica Vita
@jvitak FOLLOW YOU
Asst Prof at Maryland (@I_UMD). Research HCI/CMC/CSCW, c privacy & identity. s O's/Ravens! PhD fr

Kiri Carini
@tomatopurl FOLLOW YOU
Just an Oregon tree-hugger trying to survive on the flat land of Maryland's Eastern Shore. Employed @ Dorchester County Tourism & UMCES.| #GISTribe

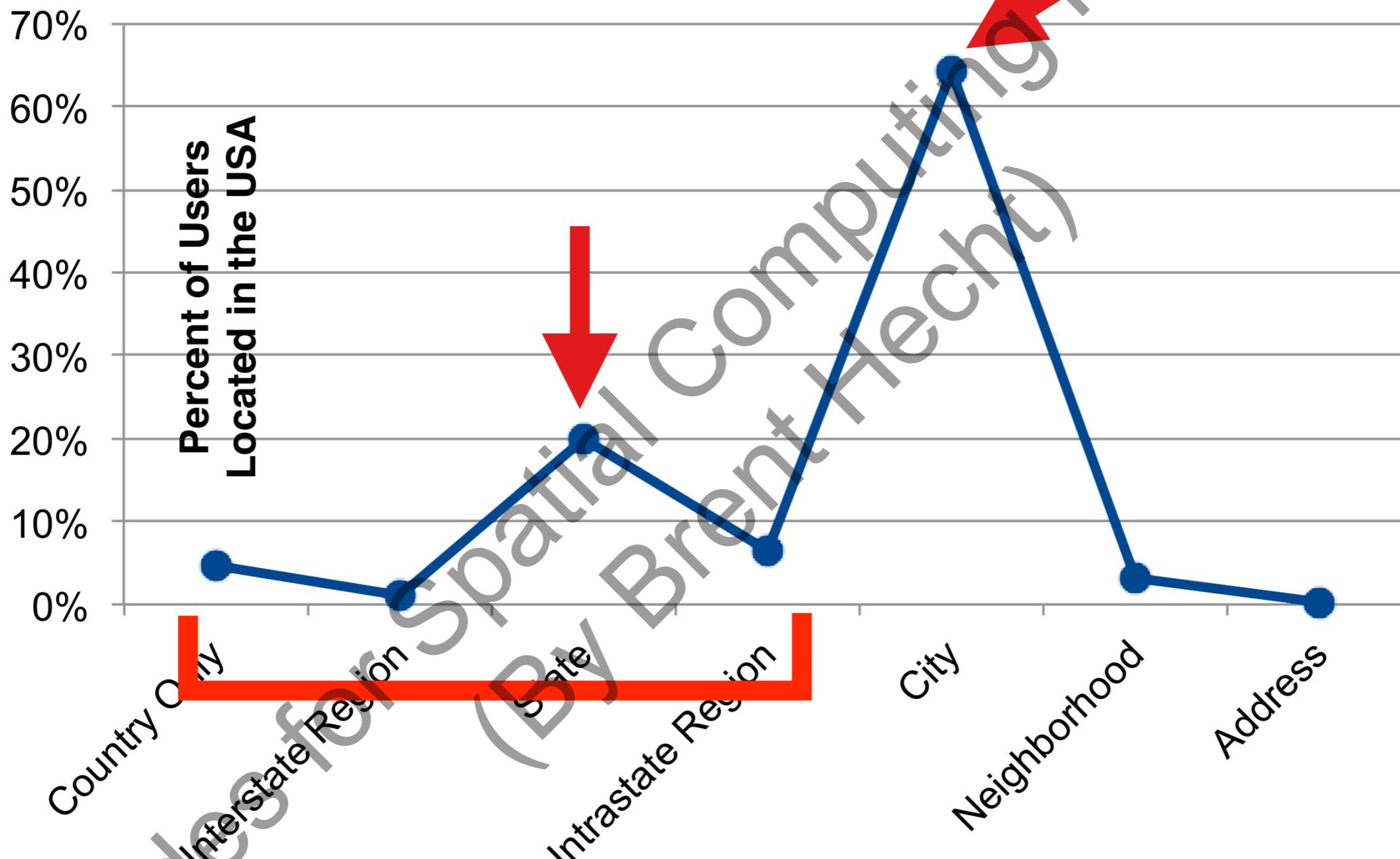
Maryland jessicavitak.com

Maryland goo.gl/qiLtVV

Joined December 2012 Joined March 2008

[Tweet to](#) [Tweet to](#) [Message](#)

Geographic Scale (In Order of Increasing Localness from Left to Right)



(Hecht et al. 2011)

Geoweb Scale Problem

“Alaska”

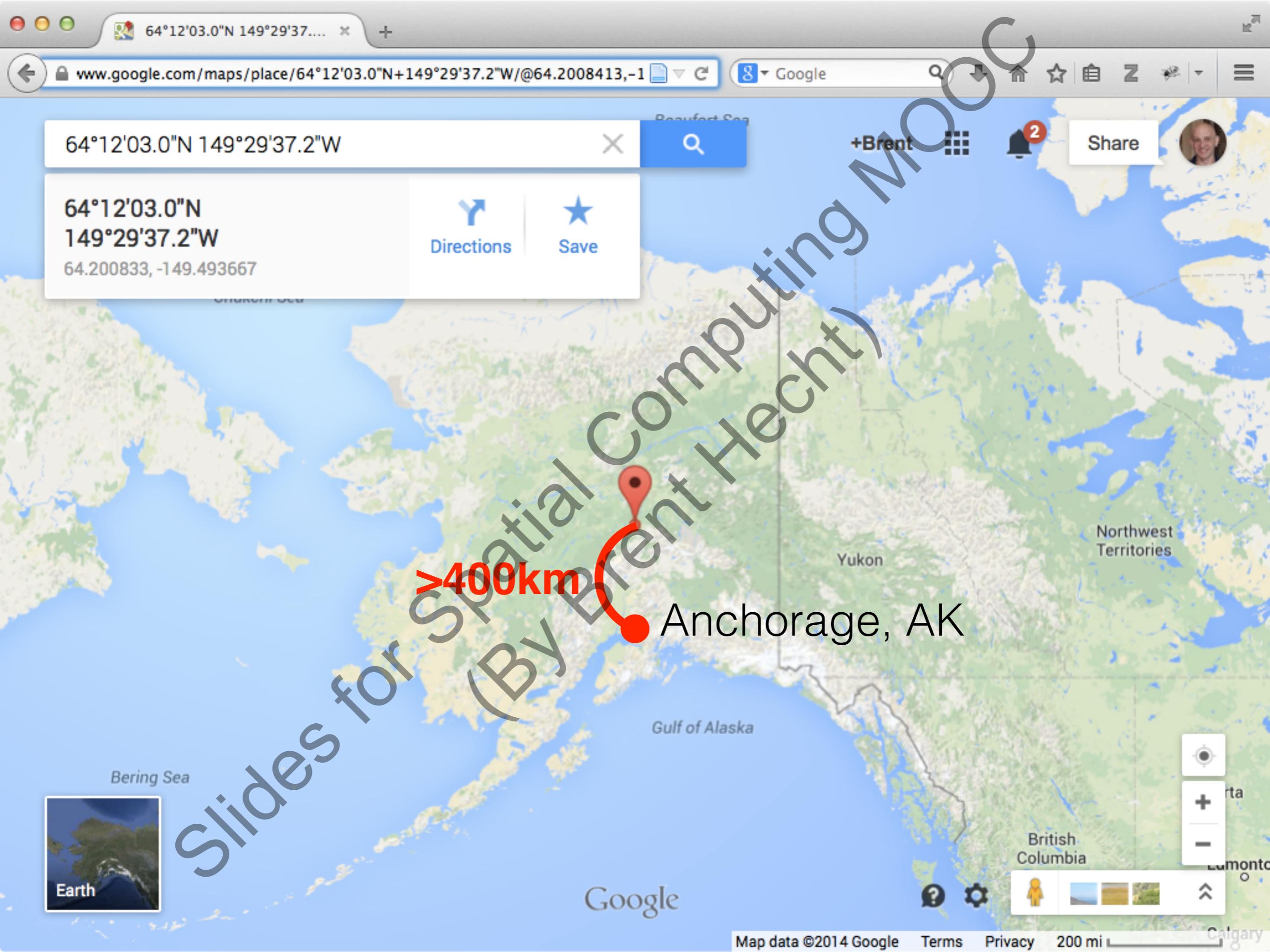
“Minneapolis, MN”

“200 Union St. SE,
Minneapolis, MN”



The Google Geocoding API

```
  "address_components" : [
    {
      "long_name" : "Alaska",
      "short_name" : "AK",
      "types" : [ "administrative_area_level_1", "political" ]
    },
    {
      "long_name" : "United States",
      "short_name" : "US",
      "types" : [ "country", "political" ]
    }
  ],
  "formatted_address" : "Alaska, USA",
  "geometry" : {
    "bounds" : {
      "northeast" : {
        "lat" : 71.3902351,
        "lng" : -129.9945562
      },
      "southwest" : {
        "lat" : 51.214766,
        "lng" : 172.4445167
      }
    },
    "location" : {
      "lat" : 64.20084129999999,
      "lng" : -149.4936733
    },
    "location_type" : "APPROXIMATE",
    "viewport" : {
      "northeast" : {
        "lat" : 71.3902351,
        "lng" : -129.9945562
      },
      "southwest" : {
        "lat" : 51.214766,
        "lng" : 172.4445167
      }
    }
  },
  "types" : [ "administrative_area_level_1", "political" ]
```



Google

Geoweb Scale Problem

The GSP occurs when latitude and longitude coordinates – the foundation of spatial representations on the geoweb – are not appropriate for the desired scale of a given spatial computing research project or application.

(Hecht and Gergle 2011)

Slides for Spatial Computing MOOC

```
        "types" : [ "administrative_area_level_1", "political" ]  
    },  
    {  
        "long_name" : "United States",  
        "short_name" : "US",  
        "types" : [ "country", "political" ]  
    }  
,  
    "formatted_address" : "Alaska, USA",  
    "geometry" : {  
        "bounds" : {  
            "northeast" : {  
                "lat" : 71.3902351,  
                "lng" : -129.9945562  
            },  
            "southwest" : {  
                "lat" : 51.214766,  
                "lng" : 172.4445167  
            }  
        },  
        "location" : {  
            "lat" : 64.20084129999999,  
            "lng" : -149.4936733  
        },  
        "location_type" : "APPROXIMATE",  
        "viewport" : {  
            "northeast" : {  
                "lat" : 71.3902351,  
                "lng" : -129.9945562  
            },  
            "southwest" : {  
                "lat" : 51.214766,  
                "lng" : 172.4445167  
            }  
        },  
        "types" : [ "administrative_area_level_1", "political" ]  
    }  
}
```

Location Field Positioning



PROS



CONS



Many location fields
are blank

Scale is sometimes
insufficient

Lots of non-geographic
information

Slides for Spatial Computing MOOC
(By Brent Hecht)

16% of Twitter location fields contain
non-geographic information

(Hecht et al. 2011)

Slides for Spatial Computing Mooc
(By Brent Hecht)

Location: “Loserville :)”

Location: “With God”

Location: “Middle Earth”

Location: “justin biebers heart”

Slides for Spatial Computing Height
(By Brent Hecht)

Popular Culture References

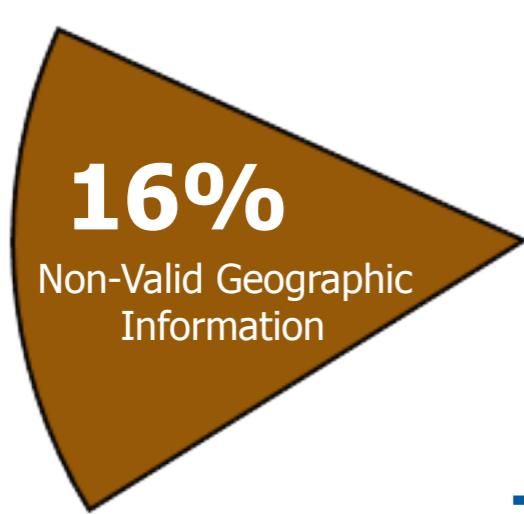
“BieberTown”
“PLZ Justin follow me”
“Bieberland...love!”
“JaeJoongs heart”
“Next to Waldo :D”
“Schrute Farms”

Privacy References

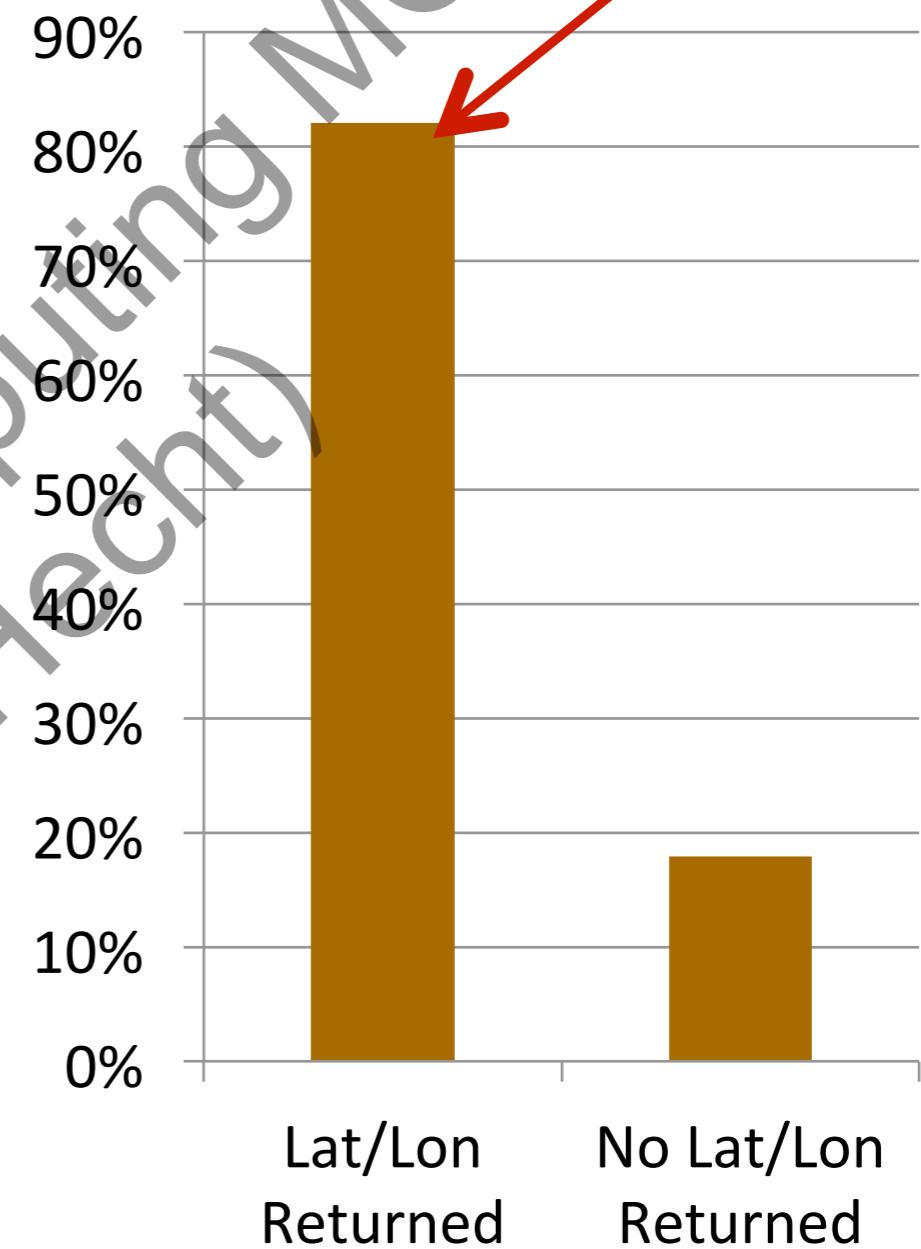
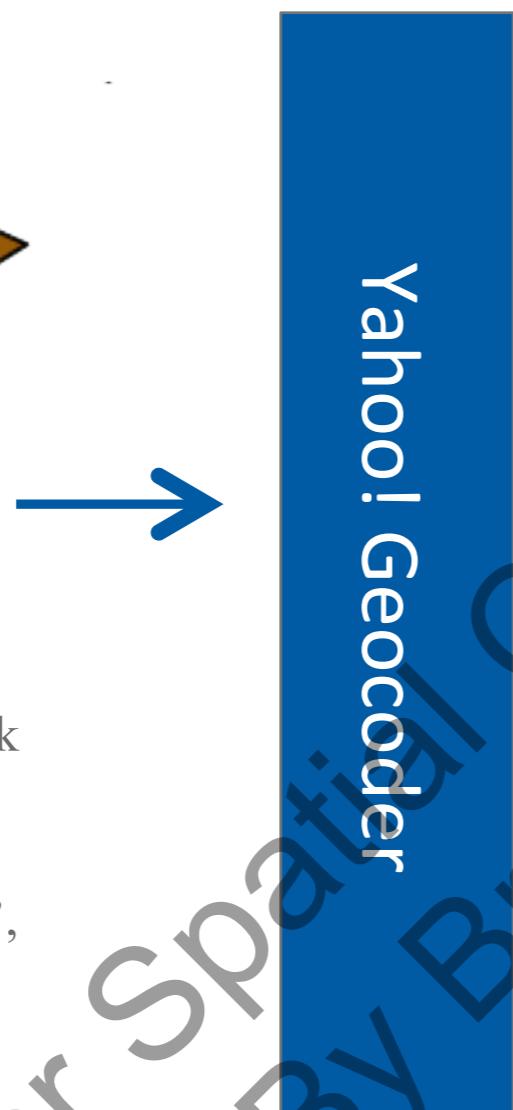
“Stalker City”
“MindingMyOwn”
“UM...STALKER!”
“kgb answers”
“stalker much?”
“for me to know n u to find
out”

Negative Emotions Towards Current Location

“preferably anywhere but here”
“a hole in the ground”
“swirling in the abyss”
“Loserville :)”



“Stalker City”, “NONE YA BISNESS”, “Justin Biebers Heart”, “The Void”, “Redneck Hell”, “In the Middle of Nowhere”, “yer mum”, “BSNBC”, “in God’s Graces”, etc...



(Hecht et al. 2011)

Location Field Positioning



PROS



CONS



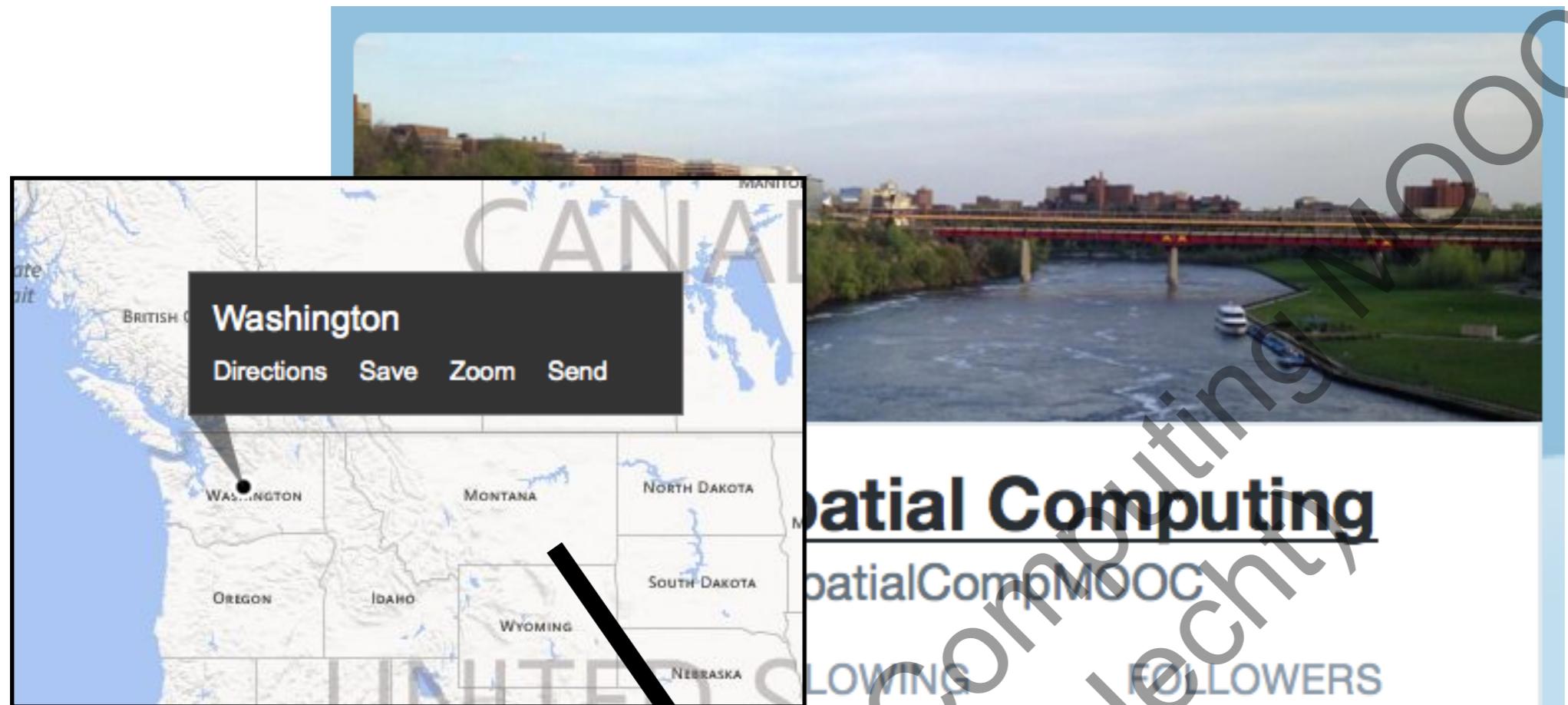
Many location fields
are blank

Scale is sometimes
insufficient

Lots of non-geographic
information

Disambiguation is hard

Slides for Spatial Computing MOOC
(By Brent Hecht)



6

8

133

Has made it to Washington to do some
apple picking, jamming out to Chicago!
[#seattle](#) [#tacoma](#) [#music](#) [#itsaliving](#)



42

Tweet

A blue button with a white feather icon and the word "Tweet".

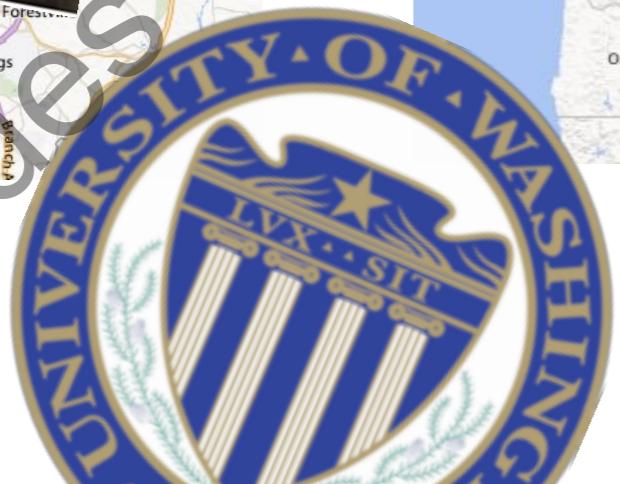
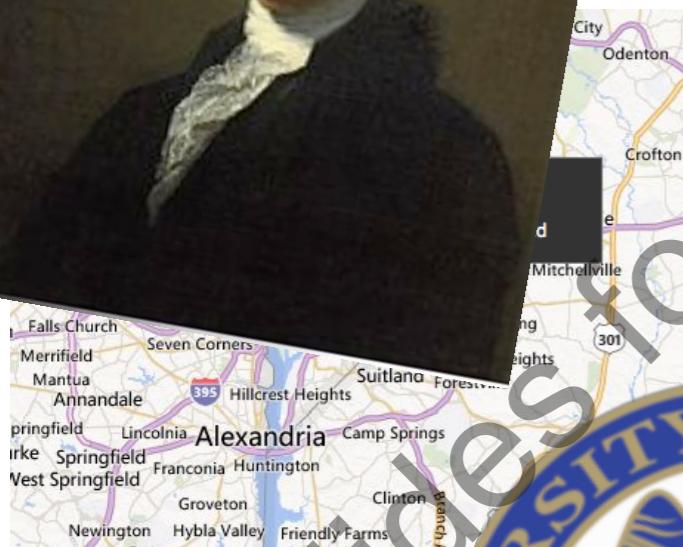
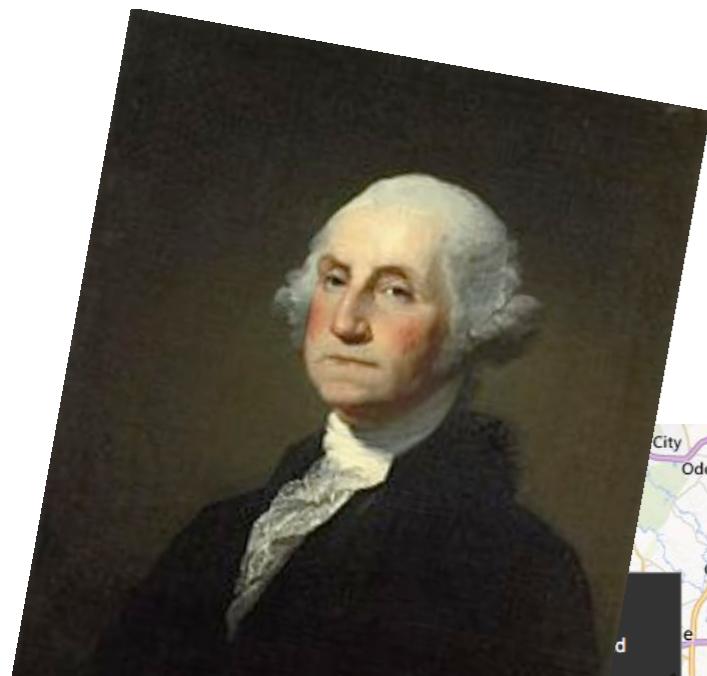
Slides for
BYU Prent Hechner

MOOC

Toponym Ambiguity

one place name (*toponym*) → more than one place

“Washington”



Slices for Spatial Computing
(By Laurent Hécht)

Location Field Positioning



PROS



Sometimes is only way
to position users

CONS



Many location fields
are blank

Scale is sometimes
insufficient

Lots of non-geographic
information

Disambiguation is hard

Slides for Spatial
(By Brent Hecht)

Location Field Positioning

PROS

Sometimes is
only way to
position users

CONS

- Many location fields
are blank
- Scale is sometimes
insufficient
- Lots of non-geographic
information
- Disambiguation is hard

Slides for Spatial Computing MOOC
(BY Brent Hecht)

Only easily
accessible
geographic
information

No geotags!

••••• T-Mobile LTE 11:14 92%

Brad Paisley AVAILABLE NOW

MOONSHINE In The Trunk

Following

Brad Paisley @BradPaisley

In 1972, a crack commando unit was sent to prison by a military court for a crime they didn't commit. I was also born.

Nashville, TN bradpaisley.com

87 FOLLOWING 2.9M FOLLOWERS

Tweets Photos Favorites

Brad Paisley @BradPaisley 14h

I see you're shocked I used an emoji. I'm sorry. It's just..so convenient on the new IOS. I regret any pain or confusion it may have caused.

112 713

Brad Paisley @BradPaisley 15h

Got to ride on a real fire truck and everything! Take that @carrieunderwood

#cmaawards youtube.com/watch?

Timelines Notifications Messages Me

Location Field Positioning

PROS

Sometimes is
only way to
position users

Unique
spatiotemporal scale

CONS

Many location fields
are blank

Scale is sometimes
insufficient

Lots of non-geographic
information

Disambiguation is hard

Go Gophers! Beat
the Badgers!

Doing some
recording for
@SpatialComp
MOOC

At dentist appt.
#toothfail

OMG! Just
drove on a lake!
#itscold



Brent Hecht

@bhecht

Assistant Professor of Computer
Science at the University of
Minnesota

Slices for Spatial Computing Mooc
(BY Brent Koech)



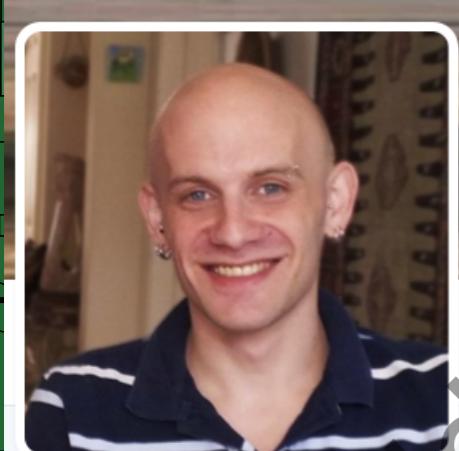
Go Gophers! Beat
the Badgers!

Doing some
recording for
@SpatialComp
MOOC

At dentist appt.
#toothfail

OMG! Just
drove on a lake!
#itscold

Headed to
#Amsterdam!

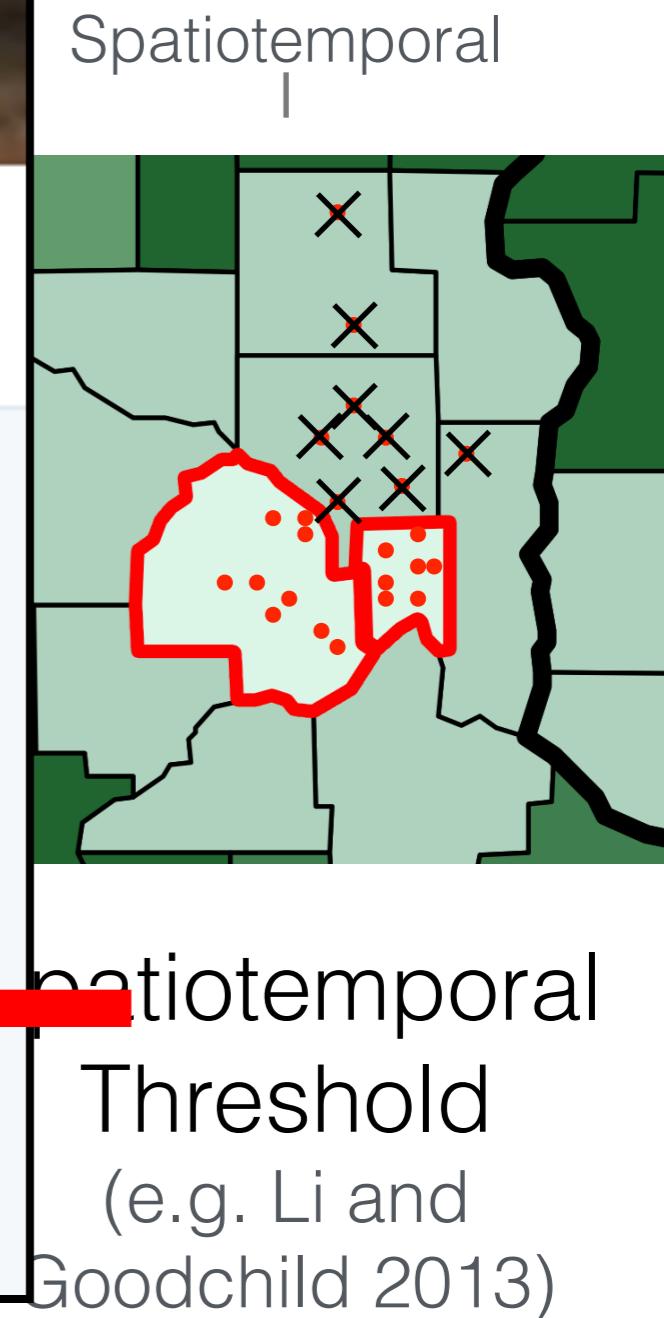
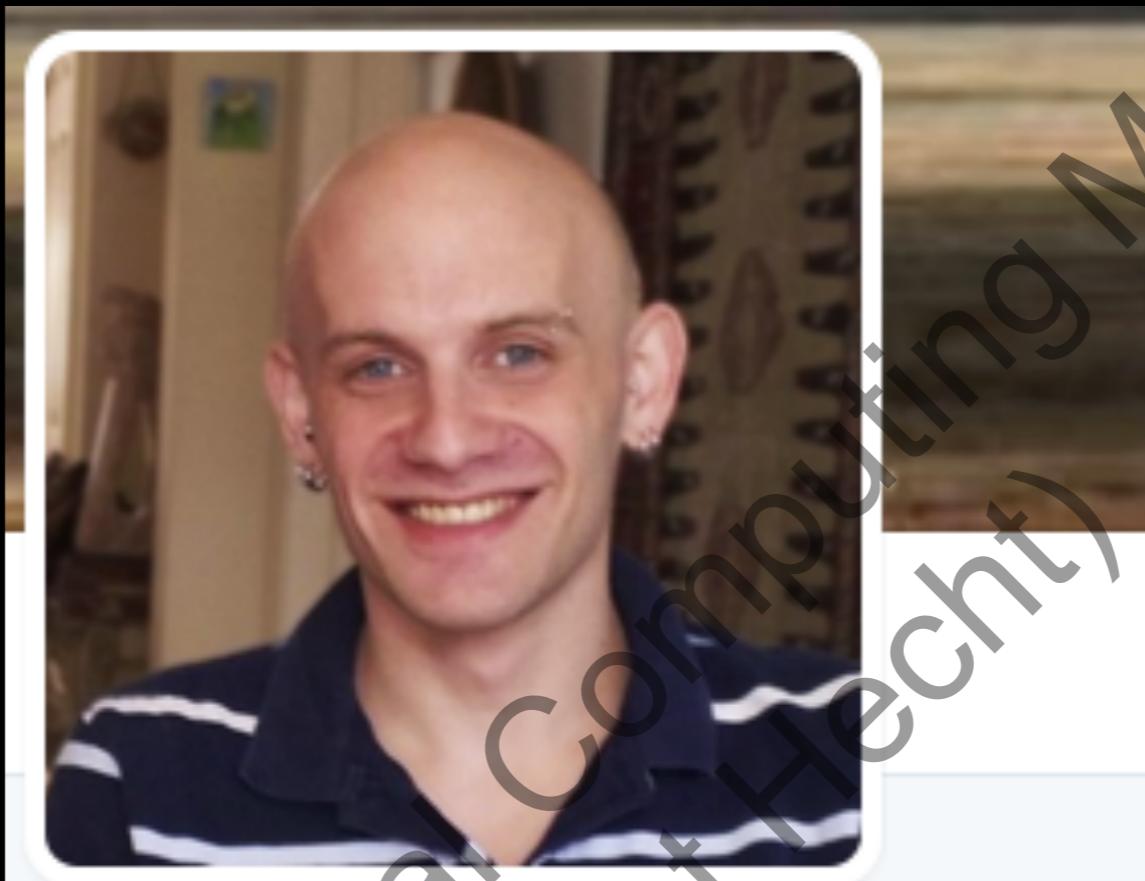
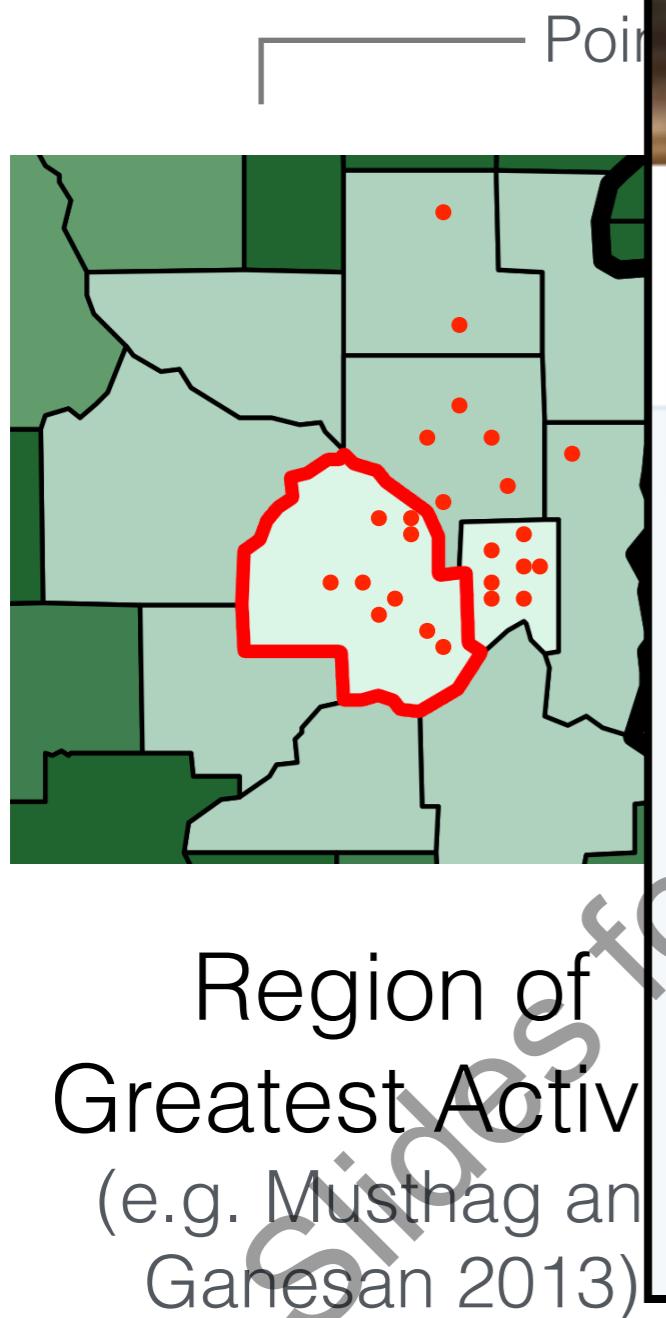


Brent Hecht

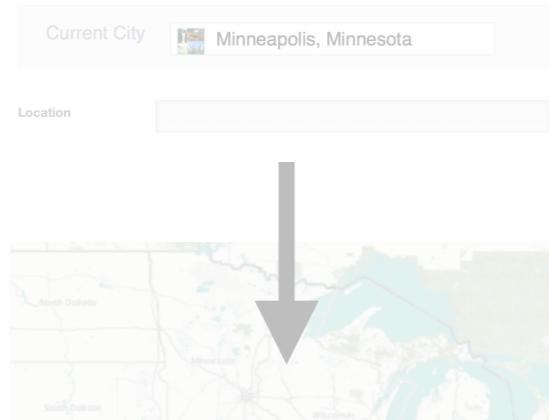
@bhecht

Assistant Professor of Computer
Science at the University of
Minnesota

Data-driven ways to determine home regions



Structure of the rest of this video:



Go over **how** to use location fields to position users.

Understand the **advantages** and **disadvantages** of location field positioning.

Wrap-up positioning with discussion of **location-inference attacks**.



Ayim Notellingü

@geoprivacy

I never reveal my location

TWEETS

5

FOLLOWING

39

FOLLOWERS

1

Tweets

Tweets & replies

6 Ayim Notellingü @geoprivacy · 35s

Just picked up some local wild boar from Lunds!

6 Ayim Notellingü @geoprivacy · 52s

Just had Snickers-on-a-stick at the fair, youbetcha!

6 Ayim Notellingü @geoprivacy · 1m

Still happy the Gophers won last night!

6 Ayim Notellingü @geoprivacy · 2m

Sure am loving these cheese curds!

Slides for Spatial Computing MOOC
(By Brent Hecht)



Ayim Notellingü

@geoprivacy

📍 I never reveal my location

TWEETS

5

FOLLOWING

39

FOLLOWERS

1

Tweets

Tweets & replies

6

Ayim Notellingü @geoprivacy · 35s

Just picked up some local wild rice from
Lunds!

6

Ayim Notellingü @geoprivacy · 52s

Just had Snickers-on-a-stick at the fair,
youbetcha!

6

Ayim Notellingü @geoprivacy · 1m

Still happy the Gophers won last night!

6

Ayim Notellingü @geoprivacy · 2m

Sure am loving these cheese curds!

Slides for Spatial Computing MOOC
(By Brent Hecht)

Sampling Strategy	Model Selection	Accuracy	Baseline Accuracy	% of Baseline Accuracy
Country-Uniform-2500	Calgari	72.71%	25.00%	291%
Country-Uniform-2500	Count	68.44%	25.00%	274%
Country-Random-20K	Calgari	88.86%	82.08%	108%
Country-Random-20K	Count	72.78%	82.08%	89%
State-Uniform-500	Calgari	30.28%	5.56%	545%
State-Uniform-500	Count	20.15%	5.56%	363%
State-Random-20K	Calgari	24.83%	15.06%	165%
State-Random-20K	Count	27.31%	15.06%	181%

Table 2: A summary of results from the country-scale and state-scale experiments. The better performing model selection algorithm is bolded for each experiment. The CALGARI result reported is the best generated by $\text{Min}U = 2$ or $\text{Min}U = 5$.

Slides for Spatial Computing
 (By Brent Hecht et al. 2011)

People followed by Ayim ... x g wild rice region - Google ... x +

https://twitter.com/following

g Google Search Twitter Search Lock More

Home 1 Direct Message # Twitter



Ayim Notellingü

@geoprivacy

I never reveal my location

Who to follow · Refresh · View all



MOCA Follow @MOCALosangeles



Art in America Follow @AiANews



TWEETS 5 FOLLOWING 36 FOLLOWERS 3

Edit

The profile card for The Current features a background image of a concert crowd with the text "MORE THAN MUSIC". It includes the station's logo and a "Following" button.

TheCurrent verified

@TheCurrent

The Current, a non-commercial radio station in Minnesota, plays the best new music next to the music you already love, from local to legendary. 89.3...

The profile card for the Minnesota State Fair features a background image of a horse and a ferris wheel. It includes the fair's logo and a "Following" button.

Minnesota State Fair

@mnstatefair

The official Twitter of the Great Minnesota Get-Together. Visit us A 27-Labor Day, Sept. 7, 2015! #mnstatefair

Upload

Sign in



Chairman Franken's Opening Statement on Mobile Privacy

 Sen. Al Franken Subscribe 1,488

2,084

 Add to  Share  More 8  1

<http://www.franken.senate.gov/?p=video&id=1497>



Chairman Franken questioning Apple, Google, and Experts on mobile privacy
by Sen. Al Franken
3,241 views



Sen. Franken Stands Up for Biodiesel and Renewable Fuels
by Sen. Al Franken
167 views



Sen. Franken Disappointed Student Debt Bill Blocked
by Sen. Al Franken
250 views



Sen. Franken Questioning the CEOs of AT&T, T-Mobile USA, and Sprint
by Sen. Al Franken
1,692 views



Franken-McFadden Debate With Complete Audio
by UpTakeVideo
1,066 views



"SHUT UP!" Bill O'Reilly's Heated Feud with Al Franken featuring Al Franken
by The Book Archive
23,850 views



Franken McFadden Debate- Oct 1, 2014 - full video
by UpTakeVideo
9:13

d Stern - Al Franken vs Scott DePace

Positioning

Spatial Computing – University of Minnesota

Attributions

Some maps © OpenStreetMap contributors (www.openstreetmap.org/copyright)

Slides for Spatial Computing MOOC
(By Brent Hecht)