

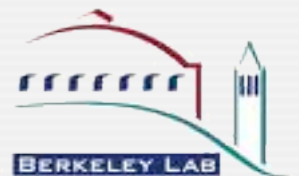
# *Cybercasing the Joint:* Privacy Implications Of Location Information

**Robin Sommer**

*International Computer Science Institute, &  
Lawrence Berkeley National Laboratory*

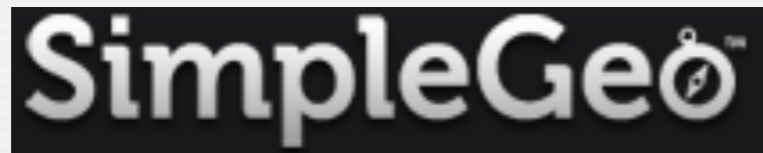
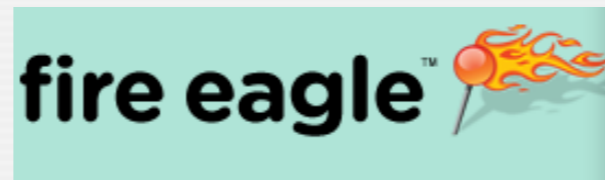
`robin@icsi.berkeley.edu`  
`http://www.icir.org`

*Network Monitoring, Advanced Attack Detection and Prevention*  
Guest Lecture, RWTH Aachen  
December 2010



# Location-Based Services

Everybody wants to know *where* you are!



# How Do *They* Know Where You Are?

GPS

# How Do *They* Know Where You Are?

GPS

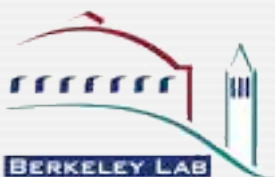


Extremely accurate! +/- 1m outdoors

# How Do *They* Know Where You Are?

## WIFI/Cell Towers

Source: Skyhook



# How Do *They* Know Where You Are?

## WIFI/Cell Towers

*"Skyhook ... [uses] over 250 million Wi-Fi access points and cellular towers. [...] Skyhook has deployed drivers to survey every single street, highway, and alley in tens of thousands of cities and towns worldwide*

*[...]*

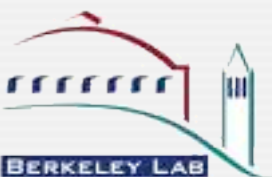
*As more users reference location for mobile devices, our database is automatically updated and refreshed. This is what we call our Automated Self Healing Network."*



Source: Skyhook

*"Accuracy 10 meters"*

# Example: Geolocation via the Browser



# Example: Geolocation via the Browser

<http://html5demos.com/geo>

## geolocation

Finding your location: checking...

[HTML5 demos](#) / [@rem built this](#) / [view source](#)

Safari 5 on a Mac  
No GPS involved ...

# Example: Geolocation via the Browser

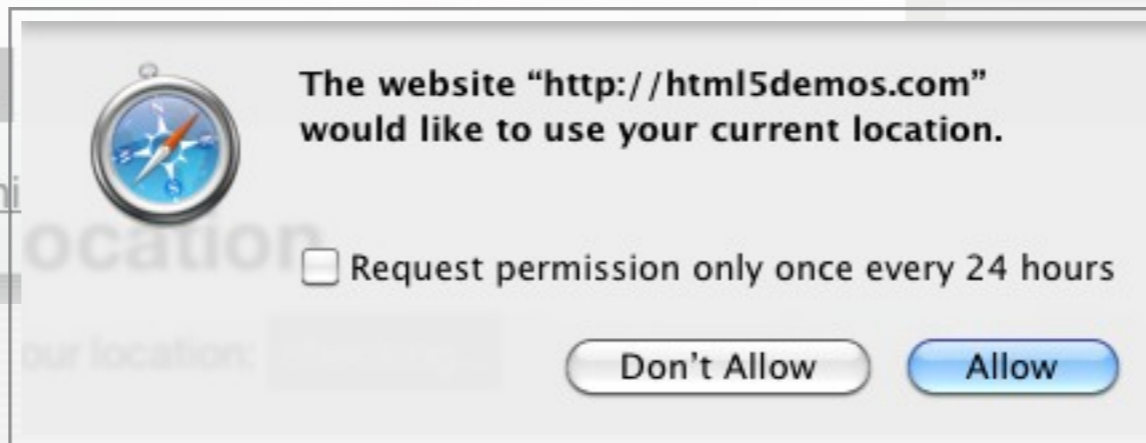
<http://html5demos.com/geo>

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No GPS involved ...

## geolocation

Finding your location: checking...

HTML5 demos / @rem built thi



# Example: Geolocation via the Browser

<http://html5demos.com/geo>

Safari 5 on a Mac  
No GPS involved ...

## geolocation

Finding your location: **found you!**



# How Do *They* Know Where You Are?

## IP Addresses

# How Do *They* Know Where You Are?

## IP Addresses

### GeoIP for your IP address

This is a comprehensive demo returning all of the data available from our various GeoIP databases. To obtain all the data returned below, you would need to purchase the [GeoIP City](#), [ISP](#), [Organization](#), [Domain Name](#), and [Netspeed](#) databases.

<b>Your IP Address</b>	24.7.112.75
<b>Countries</b>	United States
<b>Region</b>	CA (California)
<b>US Area Code</b>	510
<b>US Metro Code</b>	807
<b>Global Cities</b>	Berkeley
<b>US Zipcode*</b>	
<b>Latitude/Longitude</b>	37.8781/-122.2710
<b>ISP</b>	Comcast Cable
<b>Organization</b>	Comcast Cable
<b>Netspeed</b>	Cable/DSL
<b>Domain Name</b>	comcast.net

Source: MaxMind

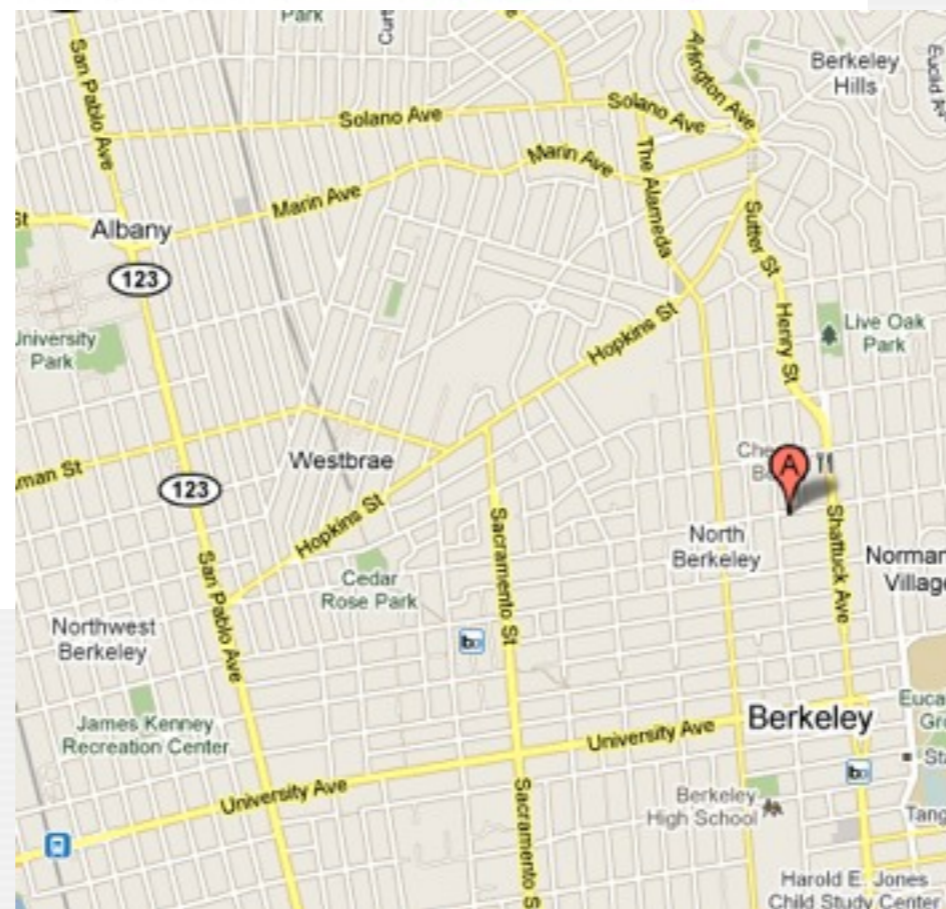
# How Do *They* Know Where You Are?

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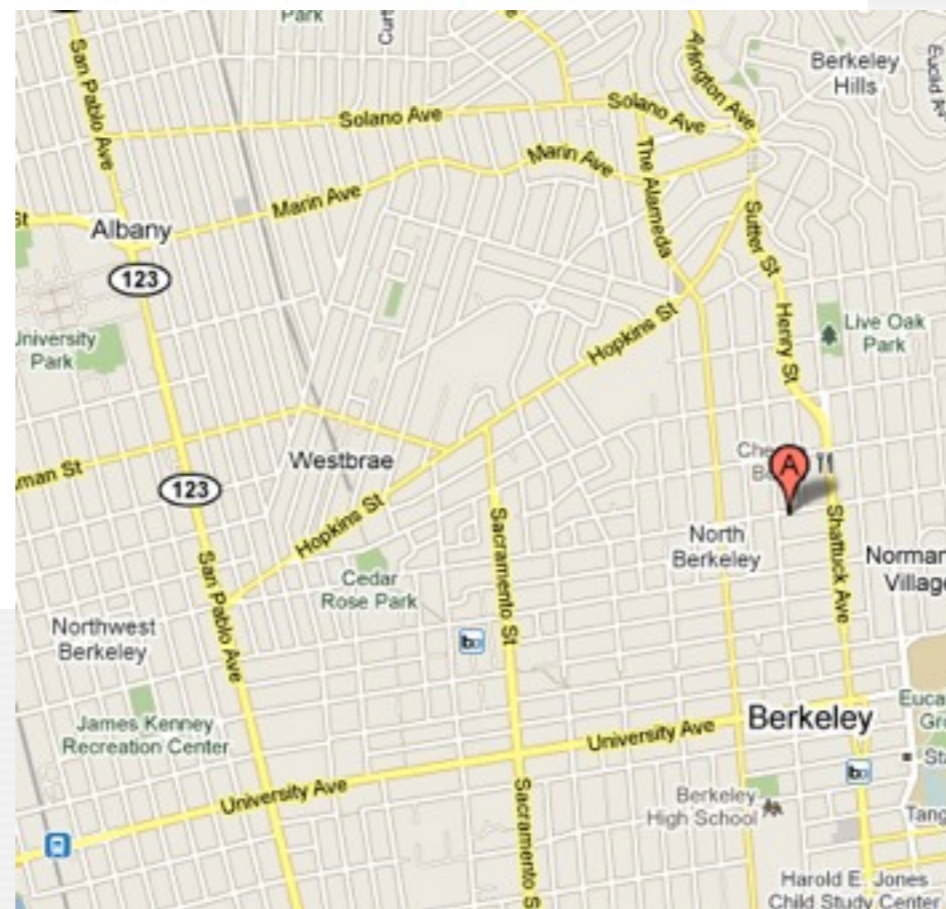
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<b>ISP</b>	Comcast Cable
<b>Organization</b>	Comcast Cable
<b>Netspeed</b>	Cable/DSL
<b>Domain Name</b>	comcast.net



Source: MaxMind

### City-level Accuracy

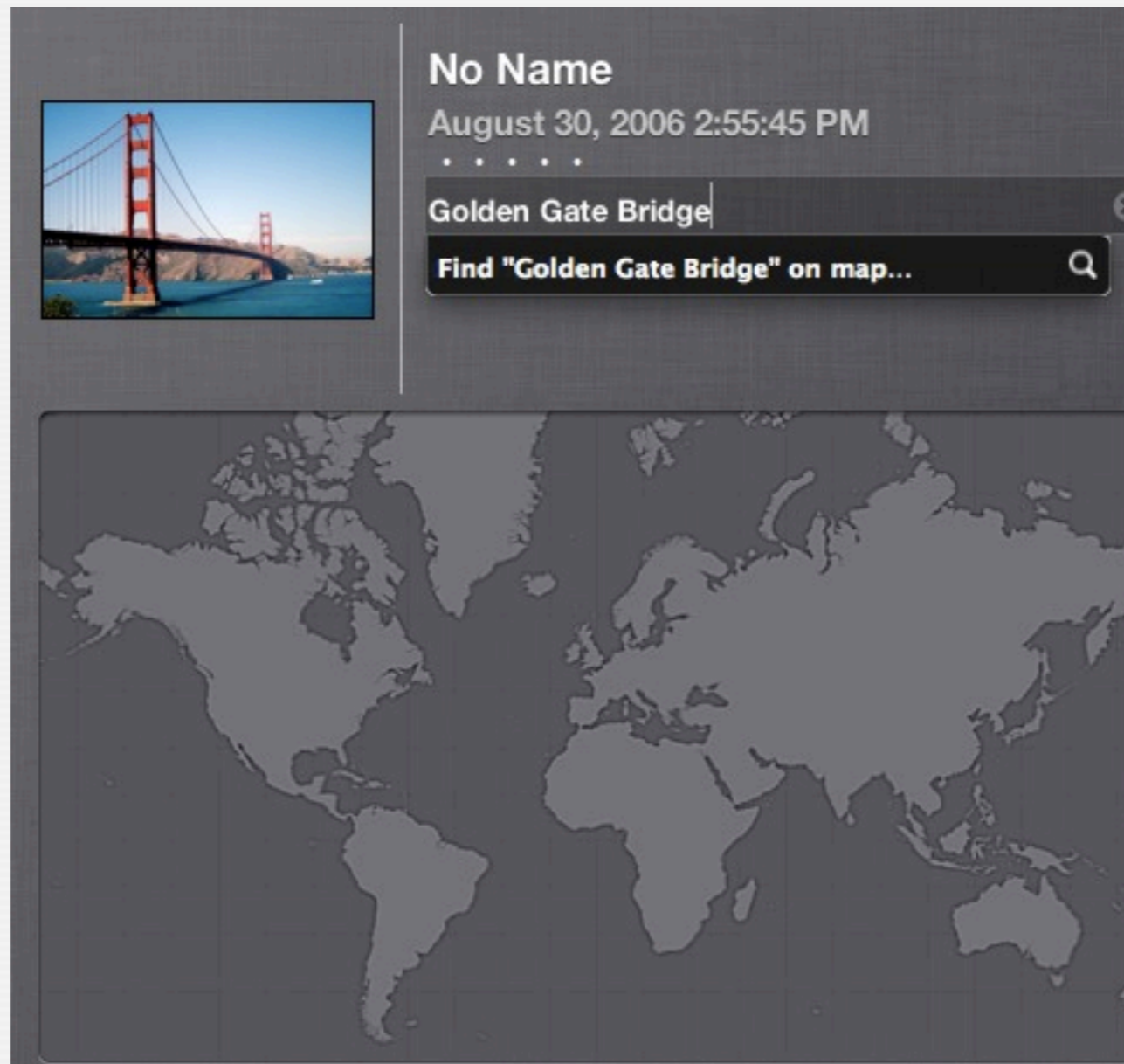


# How Do They Know Where You Are?

## The User

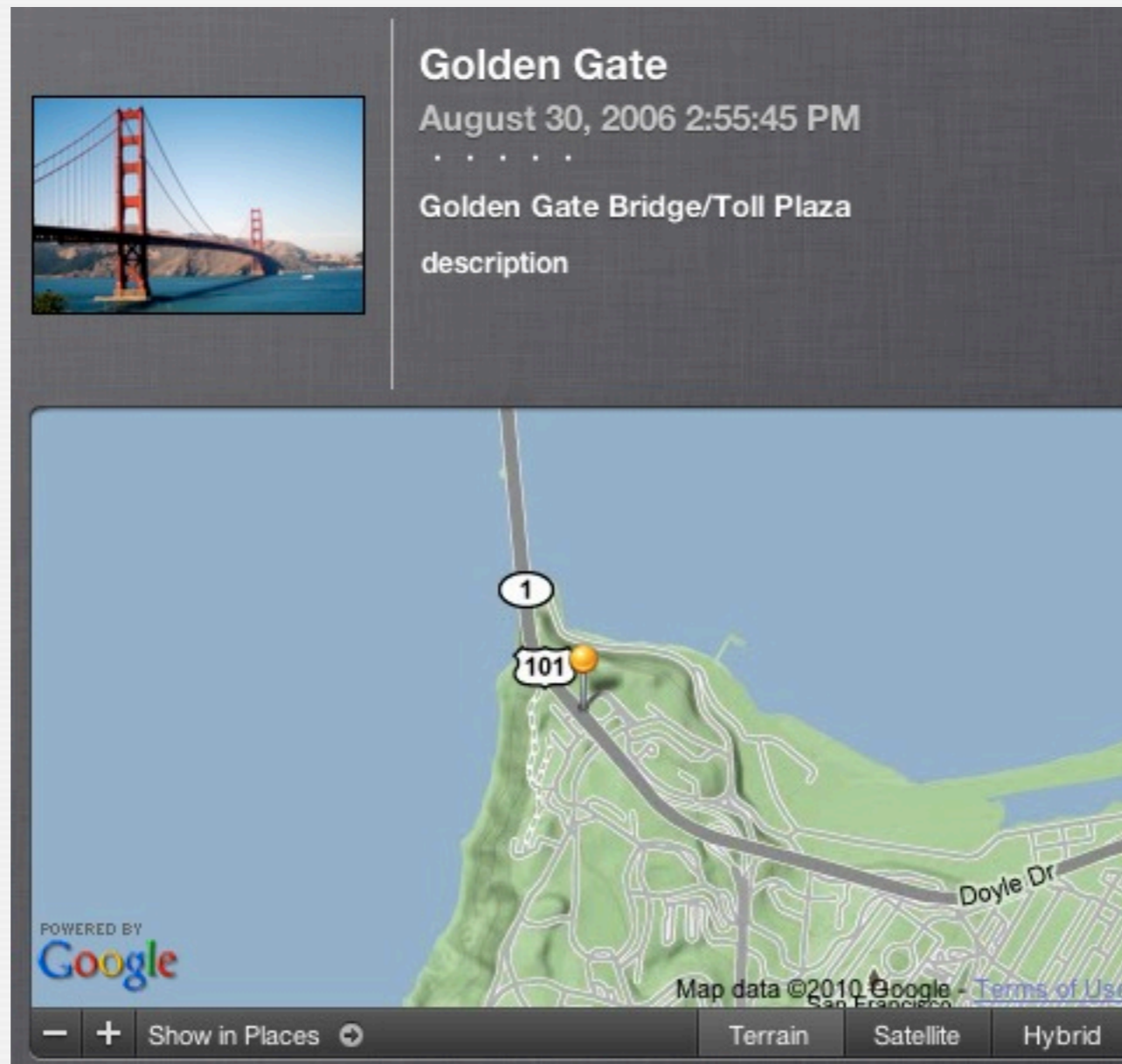
# How Do They Know Where You Are?

## The User



# How Do They Know Where You Are?

## The User

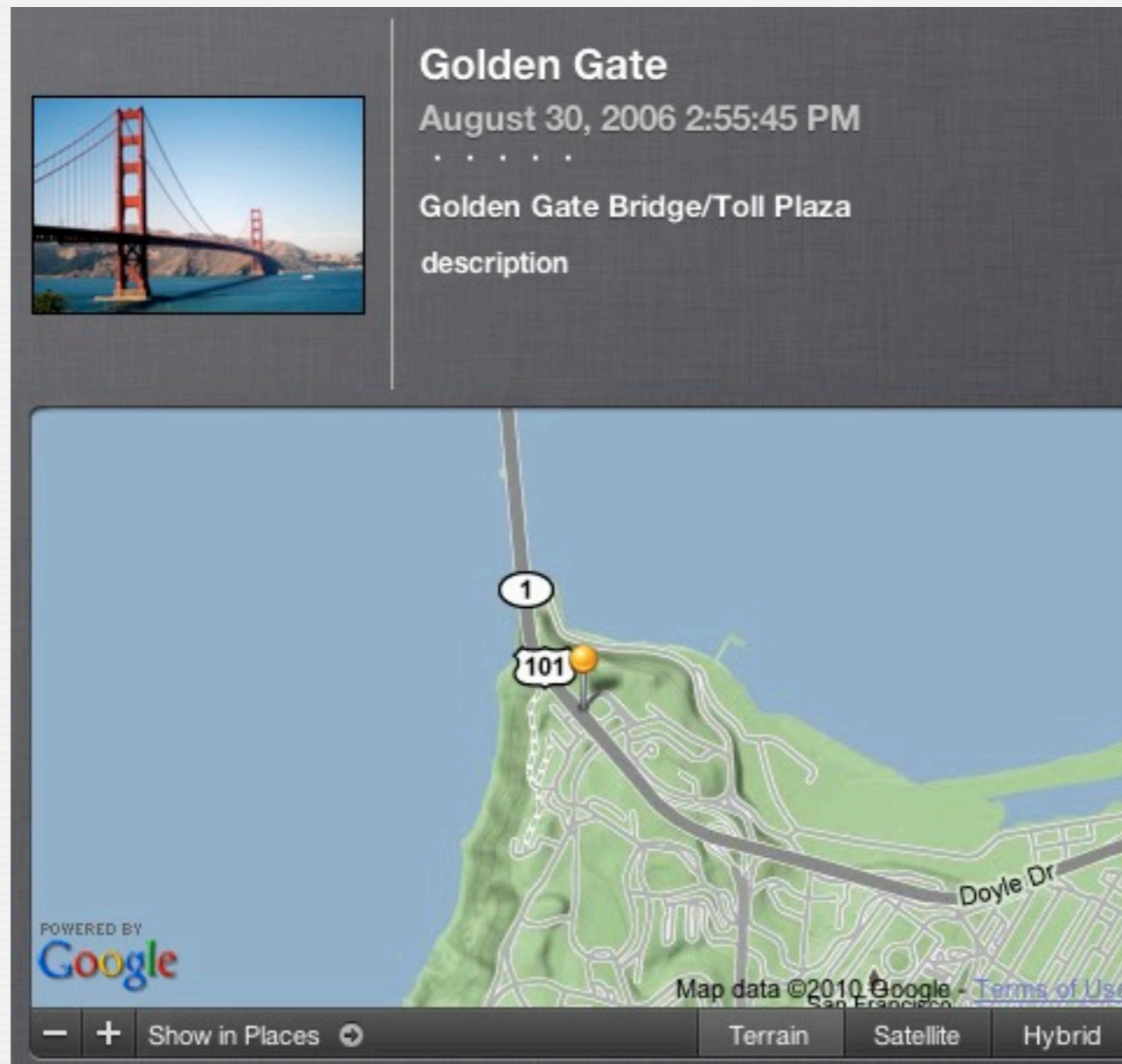


iPhoto

# How Do They Know Where You Are?

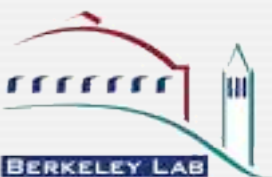
## The User

Typically city-level accuracy



iPhoto

# Why Is Your Location So Interesting?



# Why Is Your Location So Interesting?

- Well, it's cool.

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- Well, it's cool.
- New/improved services through personalization, e.g.,
  - Customized searches
  - Grouping/classification of information
  - “Hyper-local” news

# Why Is Your Location So Interesting?

- Well, it's cool.
- New/improved services through personalization, e.g.,
  - Customized searches
  - Grouping/classification of information
  - “Hyper-local” news
- Targeted Marketing
  - Target by current location
  - Target by tracked behavior
- Probably the single most important driver of location-based services.

# Example: foursquare



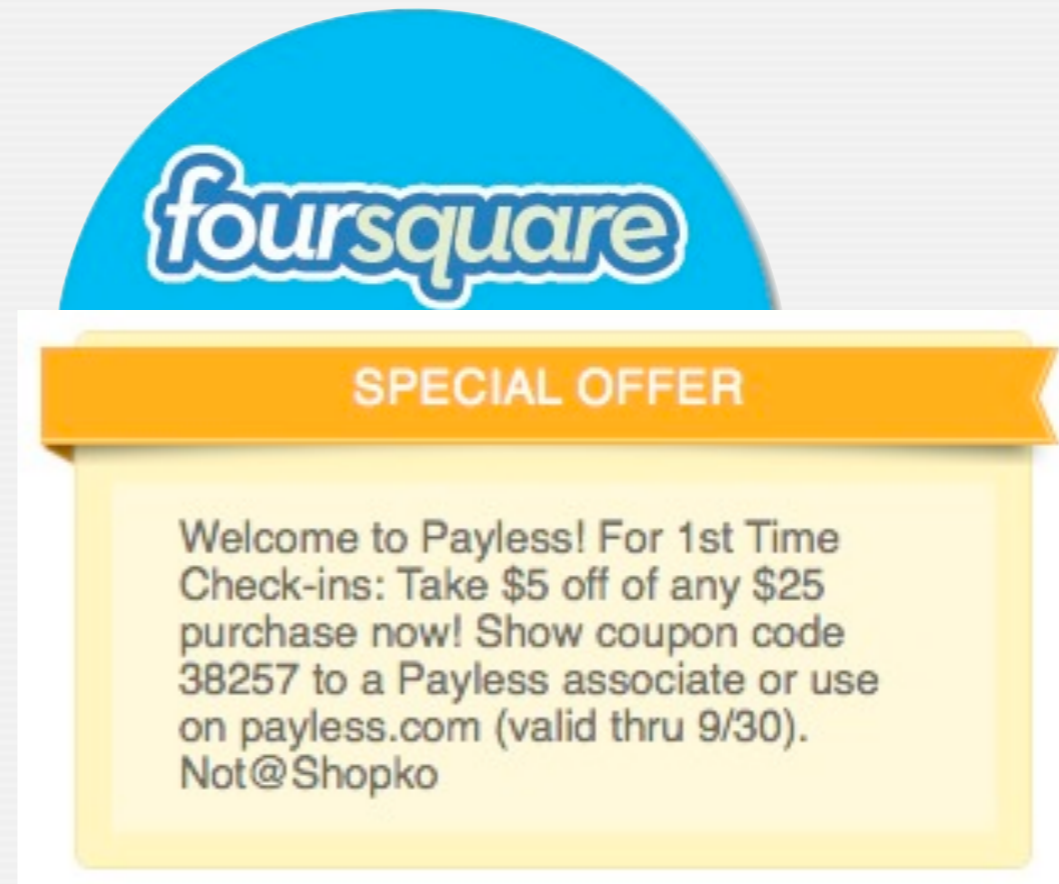
# Example: foursquare



# Example: foursquare



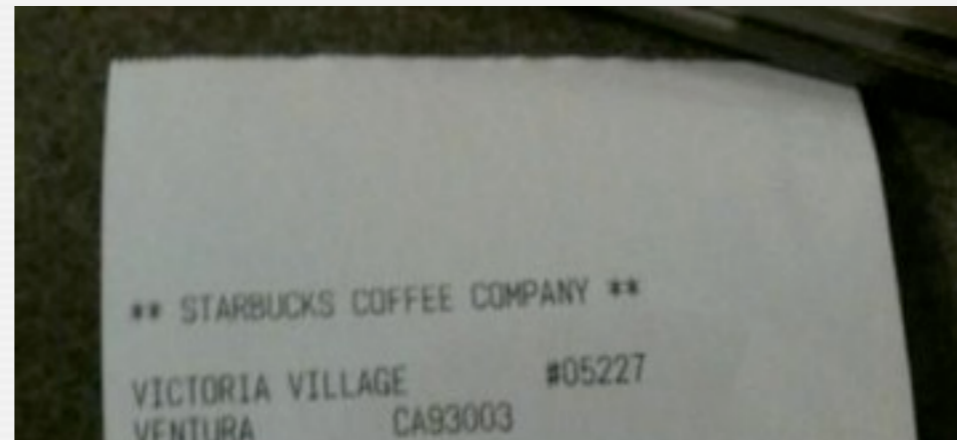
# Example: foursquare



# Example: foursquare



# Example: foursquare



## Real-time venue stats

Once you claim your venue on foursquare, you'll be able to check real time stats about your venue, including:

- most recent visitors
- most frequent visitors
- the time of day people check in
- total number of unique visitors
- histogram of check-ins per day
- gender breakdown of customers
- portion of foursquare check-ins broadcast to Twitter and Facebook
- ... and more coming soon!



# Outline

## Privacy Implications

### *Case-study*

- Geotagging

### *Broadening the scope*

- Cybercasing without geotags
- Potential for global inference

# Privacy Implications of Geotagging



# Geo-Tagging



# Geo-Tagging



Property	Value
GPS LatitudeRef	S
GPS Latitude	33.00, 56.00, 17.82
GPS LongitudeRef	E
GPS Longitude	19.00, 9.00, 39.85
GPS AltitudeRef	0x00
GPS Altitude	0.00
GPS VersionID	0x00, 0x00, 0x02, 0x02

Source: Wikipedia

BERKELEY LAB

# Geo-Tagging



Defaults differ!

Jan\_Joubert's\_Gat\_Bridge.jpg (2/3)

File Edit View Go Bookmarks Image Tools Help

Jan\_Joubert's\_Gat\_Bridge.jpg Properties

General Comment Photo Data (EXIF) Histogram

GPS Coordinates

GPSLatitudeRef	S
GPSLatitude	33.00, 56.00, 17.82
GPSLongitudeRef	E
GPSLongitude	19.00, 9.00, 39.85
GPSAltitudeRef	0x00
GPSAltitude	0.00
GPSVersionID	0x00, 0x00, 0x02, 0x02

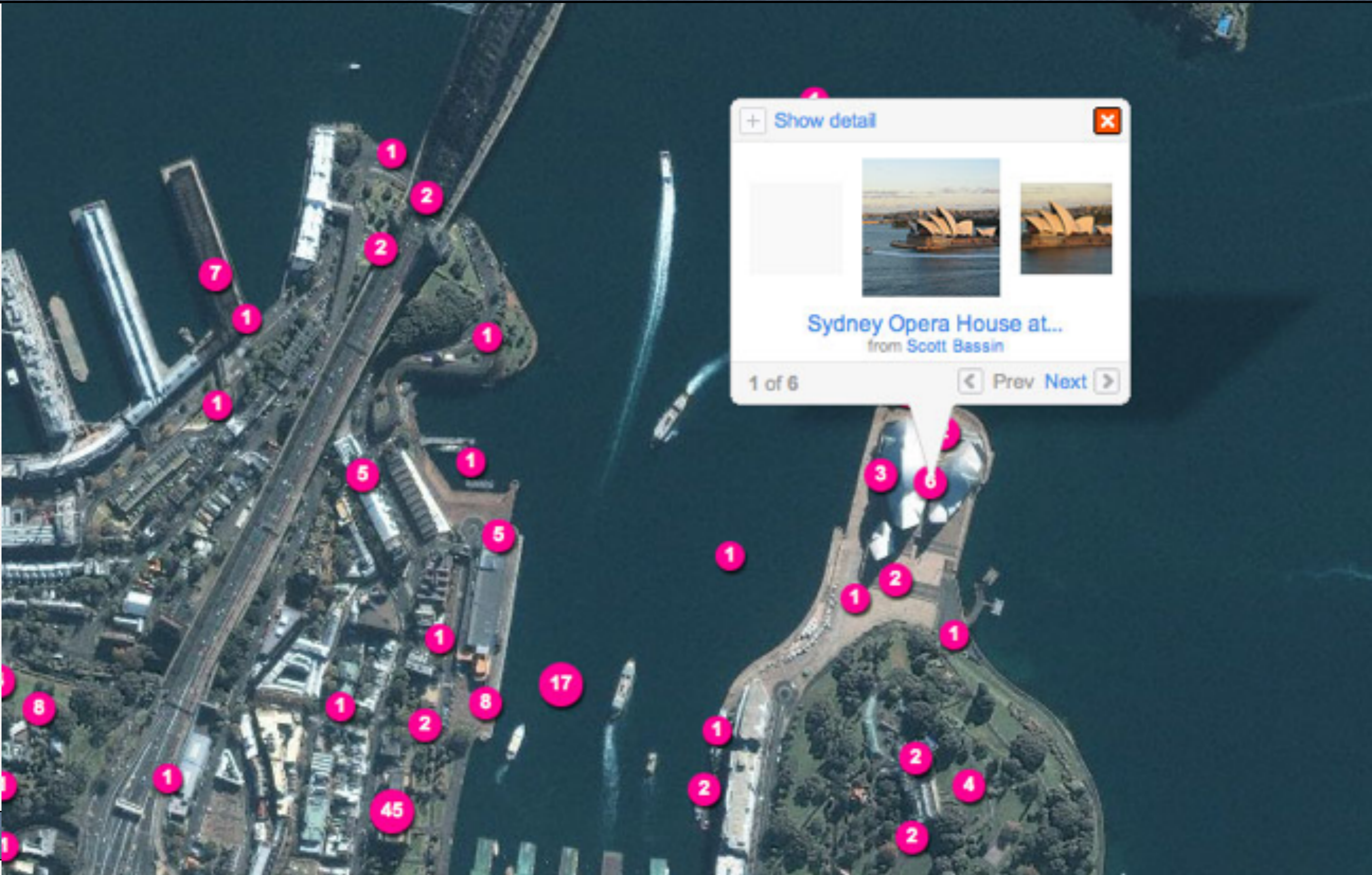
Image Structure

Previous Next Close

Source: Wikipedia

BERKELEY LAB

# Application: Location-based Searches



# Accessing Geotags

- EXIF Viewers allow direct inspection
  - Browser plugins
  - Command-line tools
- Webservice APIs allow programmatic/large-scale access
  - YouTube, Flickr, Facebook, ...
  - Easy to use script interfaces available (Python, Perl)

# YouTube



## Searching for videos

This section explains how to use the API to retrieve a list of videos matching a user-specified search term. To search for videos, submit an HTTP GET request to the following URL, appending the appropriate query parameters to your request:

```
http://gdata.youtube.com/feeds/api/videos
```

For example, a request to the following URL searches for the second set of 10 recently uploaded videos matching the query term "football" but not matching the query term "soccer":

```
http://gdata.youtube.com/feeds/api/videos?  
q=football+-soccer  
&orderby=published  
&start-index=11  
&max-results=10  
&v=2
```

# YouTube



## location

The `location` parameter restricts the search to videos that have a geographical location specified in their metadata. The parameter can be used in either of the following contexts:

- The parameter value can specify geographic coordinates (latitude,longitude) that identify a particular location. In this context, the `location` parameter operates in conjunction with the `location-radius` parameter to define a geographic area. The API response will then contain videos that are associated with a geographical location within that area.

Note that when a user uploads a video to YouTube, the user can associate a location with the video by either specifying geographic coordinates (-122.08427,37.42307) or by providing a descriptive address (Munich, Germany). As such, some videos may be associated with a location within the area specified in a search query even though those videos are not associated with specific coordinates that can be plotted on a map.

To exclude videos from the API response if those videos are associated with a descriptive address but not with specific geographic coordinates, append an exclamation point ("!") to the end of the parameter value. This practice effectively ensures that all videos in the API response can be plotted on a map.

The following examples show sample uses of this parameter:

```
location=37.42307,-122.08427&location-radius=100km  
location=37.42307,-122.08427!&location-radius=100km
```

# Flickr



## flickr.photos.search

Return a list of photos matching some criteria. Only photos visible to the calling user will be returned. To return private or semi-private photos, the caller must be authenticated with 'read' permissions, and have permission to view the photos. Unauthenticated calls will only return public photos.

### Authentication

This method does not require authentication.

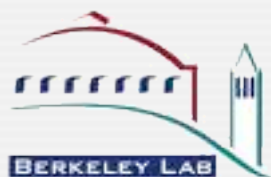
### Arguments

#### **api\_key** (Required)

Your API application key. [See here](#) for more details.

#### **user\_id** (Optional)

The NSID of the user who's photo to search. If this parameter isn't passed then everybody's public photos will be searched. A value of "me" will search against the calling user's photos for authenticated calls.



# Flickr



## flickr.photos.search

### **lat** (Optional)

A valid latitude, in decimal format, for doing radial geo queries.

Geo queries require some sort of limiting agent in order to prevent the database from crying. This is basically like the check against "parameterless searches" for queries without a geo component.

A tag, for instance, is considered a limiting agent as are user defined `min_date_taken` and `min_date_upload` parameters &mdash; If no limiting factor is passed we return only photos added in the last 12 hours (though we may extend the limit in the future).

### **lon** (Optional)

A valid longitude, in decimal format, for doing radial geo queries.

Geo queries require some sort of limiting agent in order to prevent the database from crying. This is basically like the check against "parameterless searches" for queries without a geo component.

A tag, for instance, is considered a limiting agent as are user defined `min_date_taken` and `min_date_upload` parameters &mdash; If no limiting factor is passed we return only photos added in the last 12 hours (though we may extend the limit in the future).

### **radius** (Optional)

A valid radius used for geo queries, greater than zero and less than 20 miles (or 32 kilometers), for use with point-based geo queries. The default value is 5 (km).

# Flickr



## flickr.photos.getExif

Retrieves a list of EXIF/TIFF/GPS tags for a given photo. The calling user must have permission to view the photo.

### Authentication

This method does not require authentication.

### Arguments

#### **api\_key** (Required)

Your API application key. [See here](#) for more details.

#### **photo\_id** (Required)

The id of the photo to fetch information for.

#### **secret** (Optional)

The secret for the photo. If the correct secret is passed then permissions checking is skipped. This enables the 'sharing' of individual photos by passing around the id and secret.

default value is 5 (km).

# Flickr



## flickr.photos.getExif

Retrieves a list of EXIF/TIFF/GPS tags for a given photo. The calling user must have permission to view the photo.

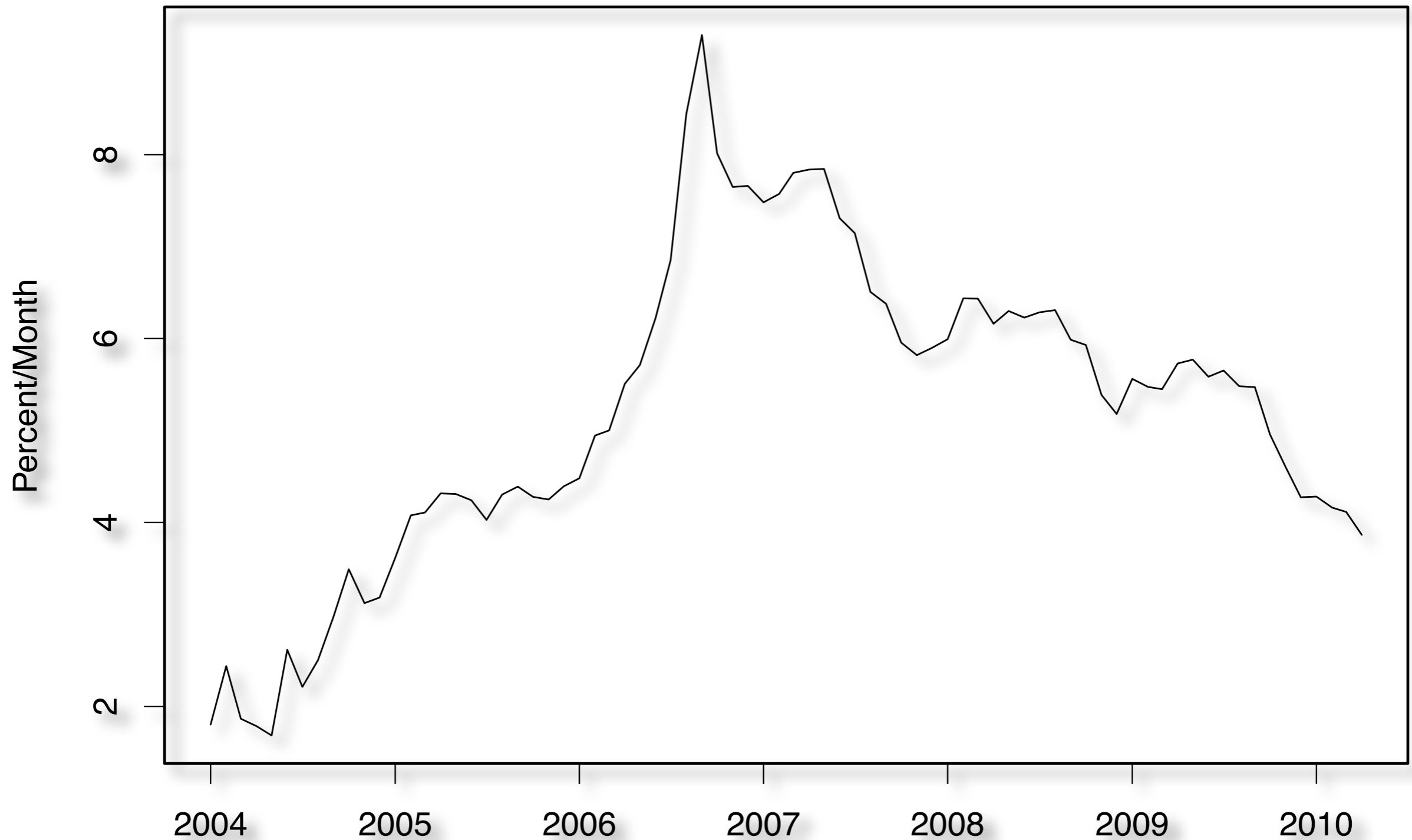
### Example Response

```
<photo id="4424" secret="06b8e43bc7" server="2">
  <exif tagSpace="TIFF" tagSpaceid="1" tag="271" label="Manufacturer">
    <raw>Canon</raw>
  </exif>
  <exif tagSpace="EXIF" tagSpaceid="0" tag="33437" label="Aperture">
    <raw>90/10</raw>
    <clean>f/9</clean>
  </exif>
  <exif tagSpace="GPS" tagSpaceid="3" tag="4" label="Longitude">
    <raw>64/1, 42/1, 4414/100</raw>
    <clean>64° 42' 44.14"</clean>
  </exif>
</photo>
```

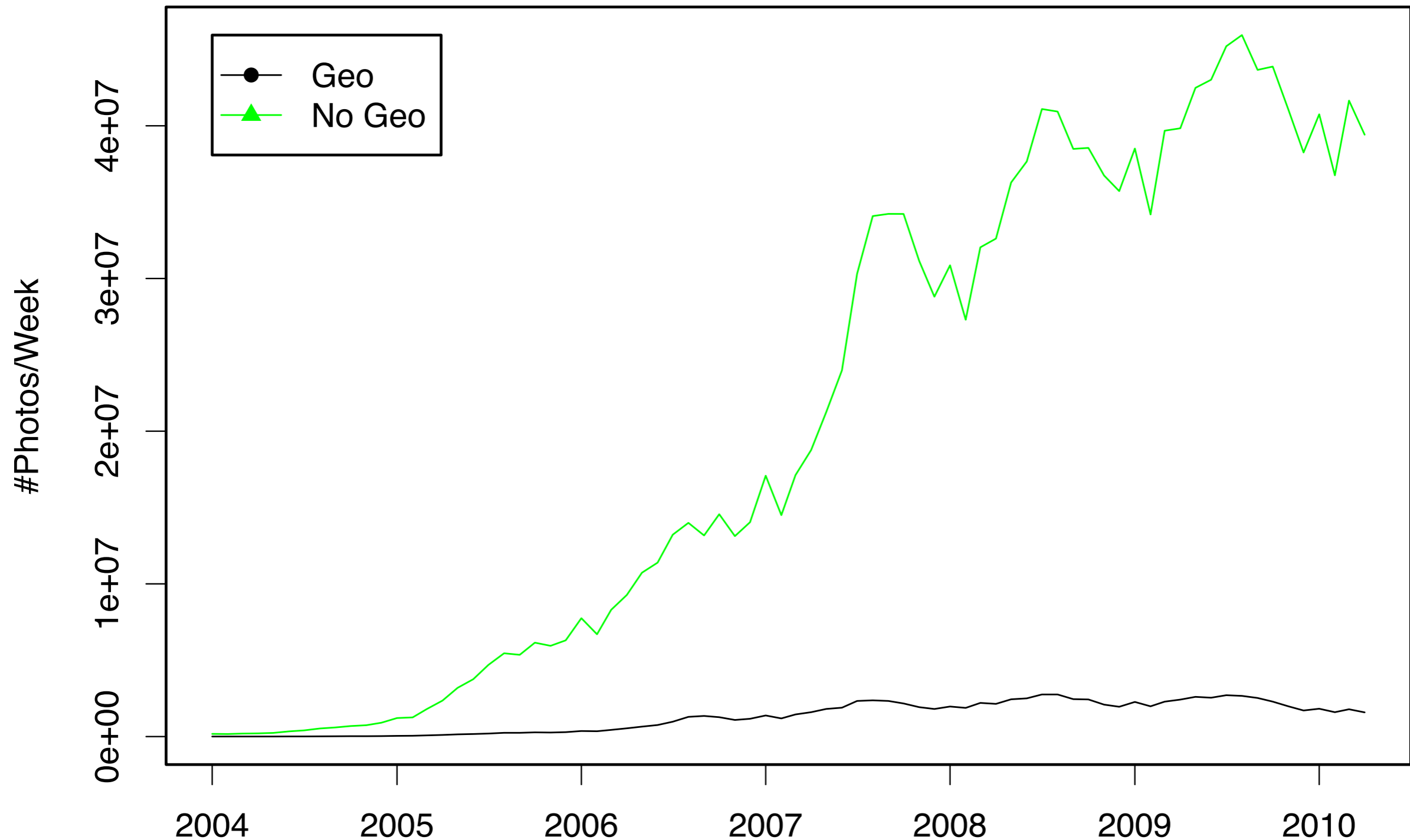
# How Much is Geotagged?

- Many repositories for images/videos use geotags
  - How much of their content is already geotagged?
- YouTube
  - Opt-out policy
  - Estimate that about 3% of all videos are geotagged
- Flickr
  - Opt-in policy
  - Website states that 124M images come with geo-location
  - Examined first four months of 2010:
    - 158M images uploaded
    - 4.3% come with precise geotags (that's ~8M total)
- Small percentage, but poised to raise.

# Detour: Geotagged Uploads on Flickr



# Detour: Uploads per Week on Flickr



# Where's the Problem with Geotagging?

*Many people seem to be **unaware** of*

- Geotagging
- High precision
- Easy-to-use APIs

*Leads to underestimation of impact on privacy*

# Could You Do Real Harm?



# Could You Do Real Harm?

## **Cybercasing**

Using online information and services to mount real-world attacks.



Source: Mitch Blunt / Wired

# Could You Do Real Harm?

## **Cybercasing**

Using online information and services to mount real-world attacks.

### *Case Studies*

1. Twitter
2. Craigslist
3. YouTube

*Goal: Demonstrate potential  
& raise awareness*

Source: Mitch Blunt / Wired

Guest Lecture, RWTH Aachen

# Case Study: Stalking on Twitter

- Photos posted to Twitter feeds may have geotags
  - Searched for tweets from celebrities for demonstration
- *Picfog* allows to find tweets from a certain location
  - Searched for feeds with photos originating in Beverly Hills, CA
  - Found a private feed of a model, who used it to communicate with friends.
- Examined the feed of a host of a US reality-TV show
  - Located his home; his kid's school; where he walks his dog; his "secret" office
  - Found photos with location showing him on travel, meeting "celebrities"
  - All photos taken with an iPhone 3GS and hosted on *twitpic.com*

# Stalking Celebrities

twitpic

[Click here to login or](#)



Working with the very talented Adam Hamilton on creating a new album. My best Bill.

Source: ABC News

# Stalking Celebrities

## EXIF IFD1

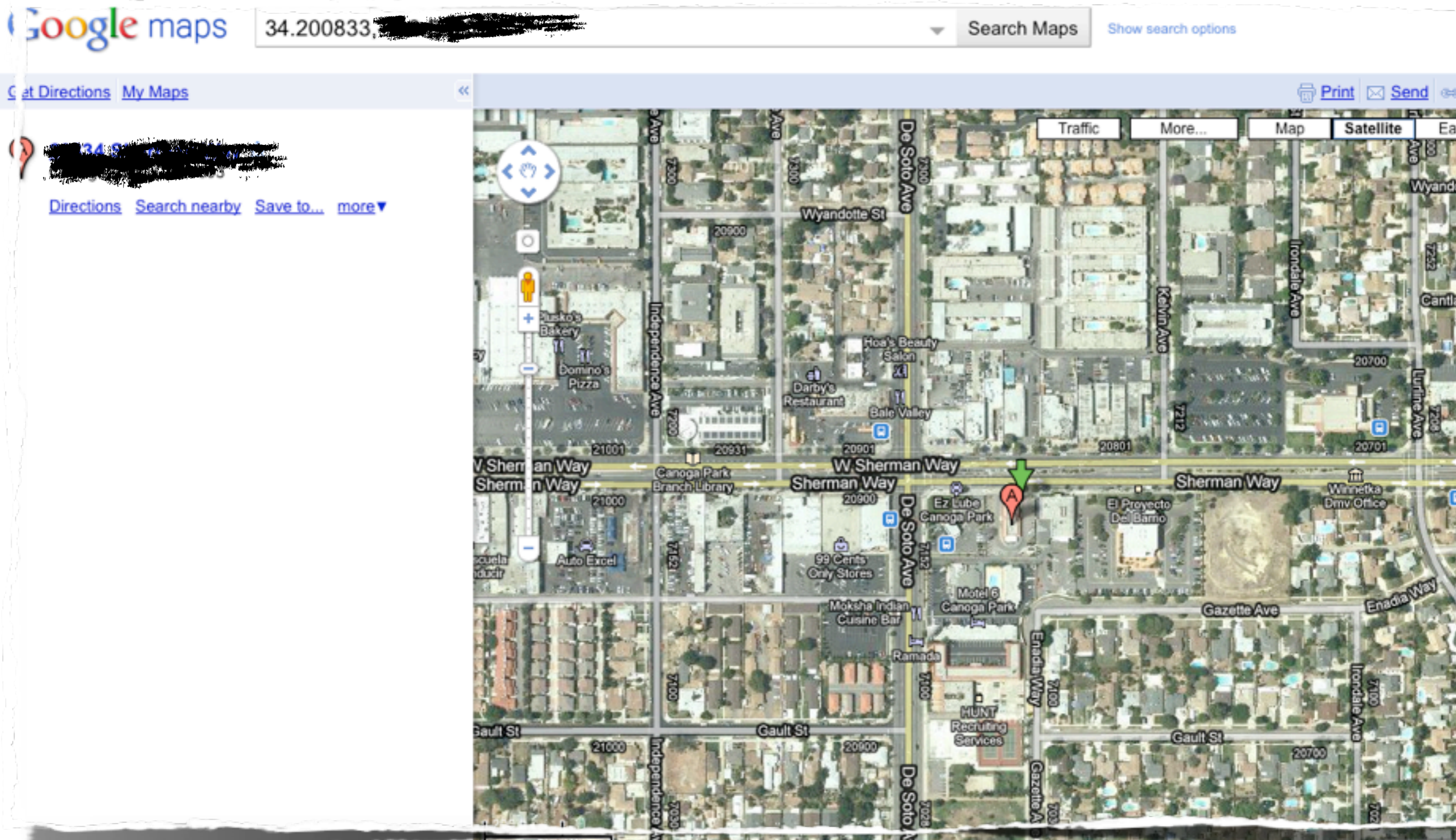
- Compression {0x0103} = JPEG compression (6)
- X-Resolution {0x011A} = 4718592/65536 ==> 72
- Y-Resolution {0x011B} = 4718592/65536 ==> 72
- X/Y-Resolution Unit {0x0128} = inch (2)
- Y/Cb/Cr Positioning (Subsampling) {0x0213} = centered / center of pixel array (1)
- Embedded thumbnail image:



## EXIF GPS IFD

- GPS Version ID {0x00} = 0x02,0x02,0x00,0x00
- GPS Latitude Reference {0x01} = N
- GPS Latitude {0x02} = 34/1,12/1,3/1 [degrees, minutes, seconds] ==> 34° 12' 3" == 34.200833°
- GPS Longitude Reference {0x03} = W
- GPS Longitude {0x04} = [REDACTED] [degrees, minutes, seconds] ==> [REDACTED]

# Stalking Celebrities



# I Can Stalk U

## I Can Stalk U

Raising awareness about inadvertent information sharing

Home

How

Why

About Us

Contact Us

If you came from the Social Media White Noise Podcast, see [our response](#)

### What are people *really* saying in their tweets?



[albeeta](#) I am currently nearby 10456 Riverside Dr Los Angeles CA

less then a minute ago · [Map Location](#) · [View Tweet](#) · [View Picture](#) · [Reply to albeeta](#)



[chrisbeanland](#) I am currently nearby <http://maps.google.com/?q=51.5385,-0.133>

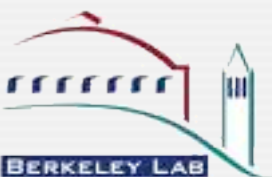
less then a minute ago · [Map Location](#) · [View Tweet](#) · [View Picture](#) · [Reply to chrisbeanland](#)

### Links

- Mayhemic Labs
- PaulDotCom
- SANS ISC
- Electronic Frontier Foundation
- Center for Democracy & Technology

How did you find me?

# Case-Study: Craigslist



post to classifieds

my account

help, faq, abuse, legal

search craigslist

for sale ▼ >

## event calendar

S	M	T	W	T	F	S
28	29	30	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25

haiti earthquake relief

avoid scams & fraud

personal safety tips

craigslist blog

progressive directory

craigslist factsheet

best-of-craigslist

CL<sup>TV</sup> season 2

craigslist movie & dvd

craigslist foundation

sfc

sby

eby

pen

nby

scz

## community

activities lost+found  
 artists musicians  
 childcare local news  
 general politics  
 groups rideshare  
 pets volunteers  
 events classes

## personals

strictly platonic  
 women seek women  
 women seeking men  
 men seeking women  
 men seeking men  
 misc romance  
 casual encounters  
 missed connections  
 rants and raves

## discussion forums

1099 gifts pets  
 apple haiku philos  
 arts health politic  
 atheist help psych  
 autos history queer  
 beauty housing recover  
 bikes jobs religion  
 celebs jokes rofo  
 comp kink science  
 crafts ltr shon

## housing

apts / housing  
 rooms / shared  
 sublets / temporary  
 housing wanted  
 housing swap  
 vacation rentals  
 parking / storage  
 office / commercial  
 real estate for sale

## for sale

appliances arts+crafts  
 antiques auto parts  
 barter baby+kids  
 bikes beauty+hlt  
 boats cars+trucks  
 books cds/dvd/vhs  
 business cell phones  
 computer clothes+acc  
 free collectibles  
 furniture electronics  
 general farm+garden  
 jewelry garage sale  
 materials household  
 rvs motorcycles  
 sporting music instr  
 tickets photo+video  
 tools toys+games  
 wanted video gaming

## jobs

accounting+finance  
 admin / office  
 arch / engineering  
 art / media / design  
 biotech / science  
 business / mgmt  
 customer service  
 education  
 food / bev / hosp  
 general labor  
 government  
 human resources  
 internet engineers  
 legal / paralegal  
 manufacturing  
 marketing / pr / ad  
 medical / health  
 nonprofit sector  
 real estate  
 retail / wholesale  
 sales / biz dev  
 salon / spa / fitness  
 security  
 skilled trade / craft  
 software / qa / dba  
 systems / network  
 technical support  
 transport  
 tv / film / video  
 web / info design



post to classifieds

my account

help, faq, abuse, legal

search craigslist

for sale

### event calendar

S	M	T	W	T	F	S
28	29	30	1	2	3	4
5	6	7	8	9	10	11
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19	20	21	22	23	24	25

haiti earthquake relief

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personal safety tips

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best-of-craigslist

CL<sup>TV</sup> season 2

craigslist movie & dvd

craigslist foundation

sfc

sby

eby

pen

nby

scz

### community

- activities
- artists
- childcare
- general
- groups
- pets
- events
- lost+found
- musicians
- local news
- politics
- rideshare
- volunteers
- classes

### personals

- strictly platonic
- women seek women
- women seeking men
- men seeking women
- men seeking men
- misc romance
- casual encounters
- missed connections
- rants and raves

### discussion forums

- 1099
- apple
- arts
- atheist
- autos
- beauty
- bikes
- celebs
- comp
- crafts
- gifts
- haiku
- health
- help
- history
- housing
- jobs
- jokes
- kink
- litr
- pets
- philos
- politic
- psych
- queer
- recover
- religion
- rofo
- science
- shon

### housing

- apts / housing
- rooms / shared
- sublets / temporary
- housing wanted
- housing swap
- vacation rentals
- parking / storage
- office / commercial
- real estate for sale

### for sale

- appliances
- antiques
- barter
- bikes
- boats
- books
- business
- computer
- free
- furniture
- general
- jewelry
- materials
- rvs
- sporting
- tickets
- tools
- wanted
- arts+crafts
- auto parts
- baby+kids
- beauty+hlth
- cars+trucks
- cds/dvd/vhs
- cell phones
- clothes+acc
- collectibles
- electronics
- farm+garden
- garage sale
- household
- motorcycles
- music instr
- photo+video
- toys+games
- video gaming

### jobs

- accounting+finance
- admin / office
- arch / engineering
- art / media / design
- biotech / science
- business / mgmt
- customer service
- education
- food / bev / hosp
- general labor
- government
- human resources
- internet engineers
- legal / paralegal
- manufacturing
- marketing / pr / ad
- medical / health
- nonprofit sector
- real estate
- retail / wholesale
- sales / biz dev
- salon / spa / fitness
- security
- skilled trade / craft
- software / qa / dba
- systems / network
- technical support
- transport
- tv / film / video
- web / info design



post to classifieds

my account

help, faq, abuse, legal

search craigslist

for sale

event calendar

S	M	T	W	T	F	S
28	29	30	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25

haiti earthquake relief

avoid scams & fraud

personal safety tips

craigslist blog

progressive directory

craigslist factsheet

best-of-craigslist

CL<sup>TV</sup> season 2

craigslist movie & dvd

craigslist foundation

## Vintage Womens Beach Cruiser (san jose south)

Date: 2010-11-29, 3:10PM PST

Reply to: [sale-83ymb-2086140069@craigslist.org](mailto:sale-83ymb-2086140069@craigslist.org) [\[Errors when replying to ads?\]](#)

Here is a 1950's - 60's something vintage women's / Ladys / Girls Cruiser.

Has a Sears Headbadge but I believe it was made by Roadmaster.

The Blue Paint with White Pinstripes is in very nice condition.

Tires are 26 x 1.75

Newer Comfy Seat

Front tire is Original.

Handlebar mirror shown in pics is not included.

149.00 Sold as is. Any and all questions welcome.

regards

James

408 5[REDACTED]

ps If you are looking for a newer Cruiser check out my ad for a Pink and White Ladys Balloon Tire Cruiser.

- it's NOT ok to contact this poster with services or other commercial interests



celebs

jokes

rofo

tools

toys+games

transport

comp

kink

science

wanted

video gaming

tv / film / video

crafts

l tr

shop

web / info design



# craigslist

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Tires are 26 x 1.75

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Front tire is Original.

Four days of the Bay Area's *For Sale* section:  
1.3% of ~69K photos geotagged

ps If you are looking for a newer Cruiser check out my ad for a Pink and White Ladys Balloon Tire Cruiser.

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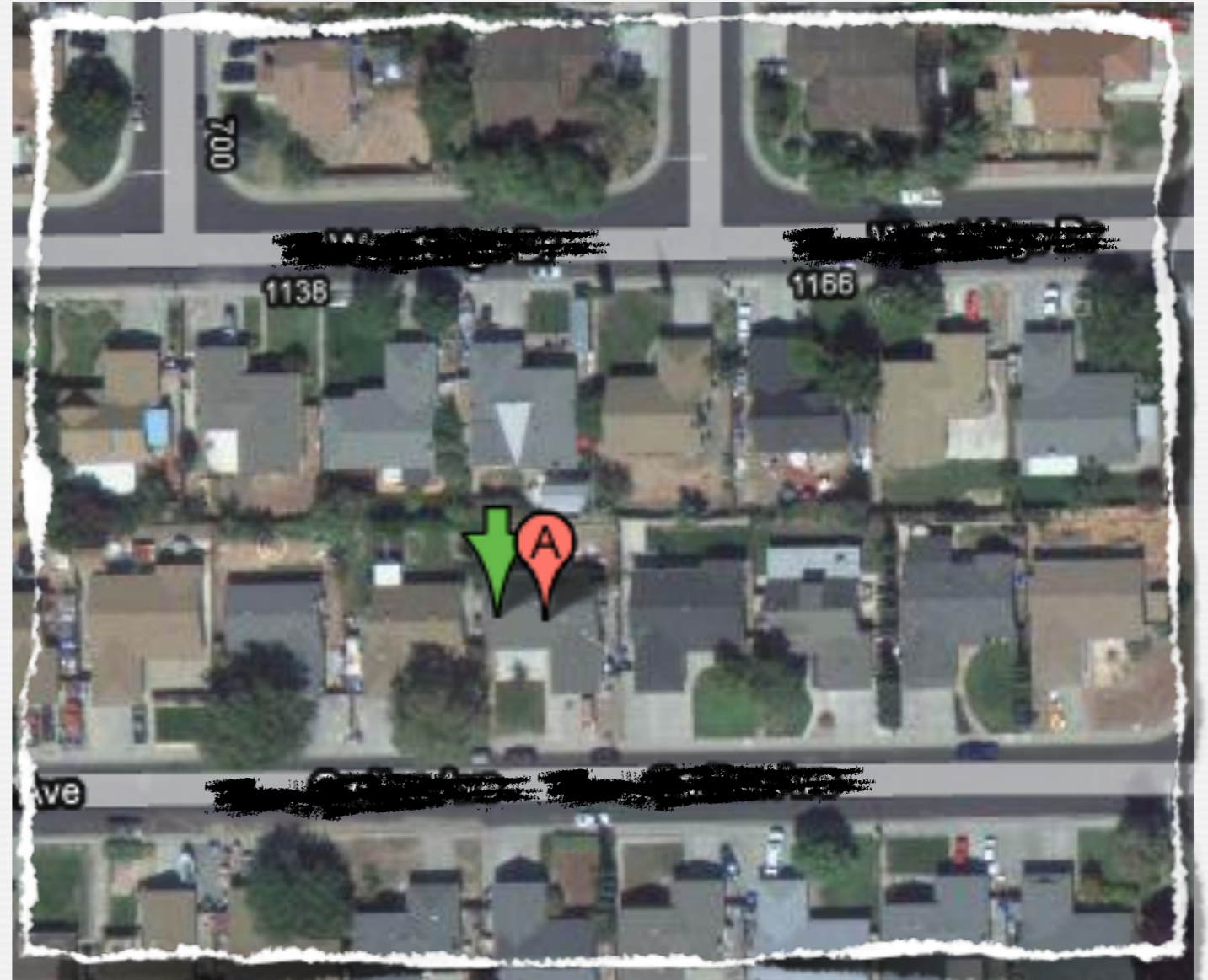
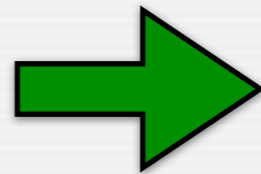
web / info design



# Craig's List: A Real Example



# Craig's List: A Real Example



# Our Own Posting on Craigslist

## Photo in Posting

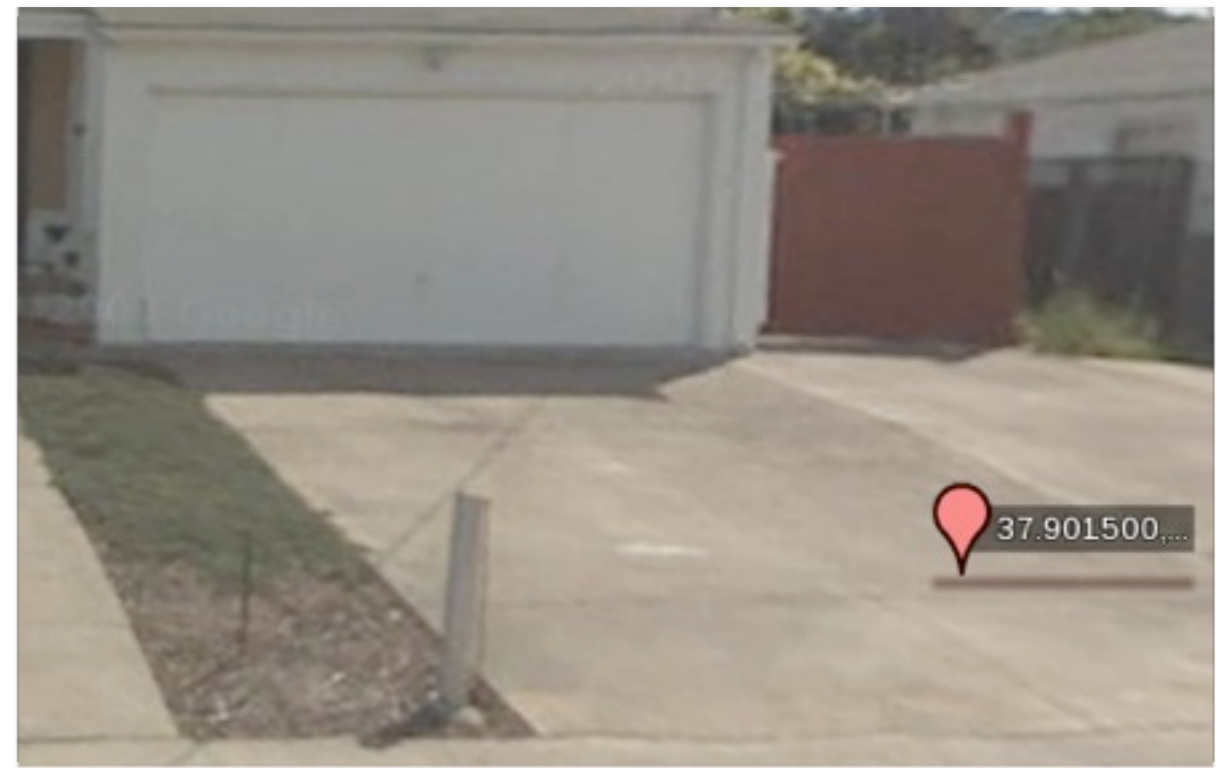


# Our Own Posting on Craigslist

Photo in Posting



Google's StreetView



# Cameras on Craigslist

#	Model	#	Model
414	iPhone 3G	6	Canon PowerShot SD780
287	iPhone 3GS	3	MB200
98	iPhone	2	LG LOTUS
32	Droid	2	HERO200
26	SGH-T929	2	BlackBerry 9530
20	Nexus One	1	RAPH800
9	SPH-M900	1	N96
9	RDC-i700	1	DMC-ZS7
6	T-Mobile G1	1	BlackBerry 9630

# Case Study: Cybercasing YouTube

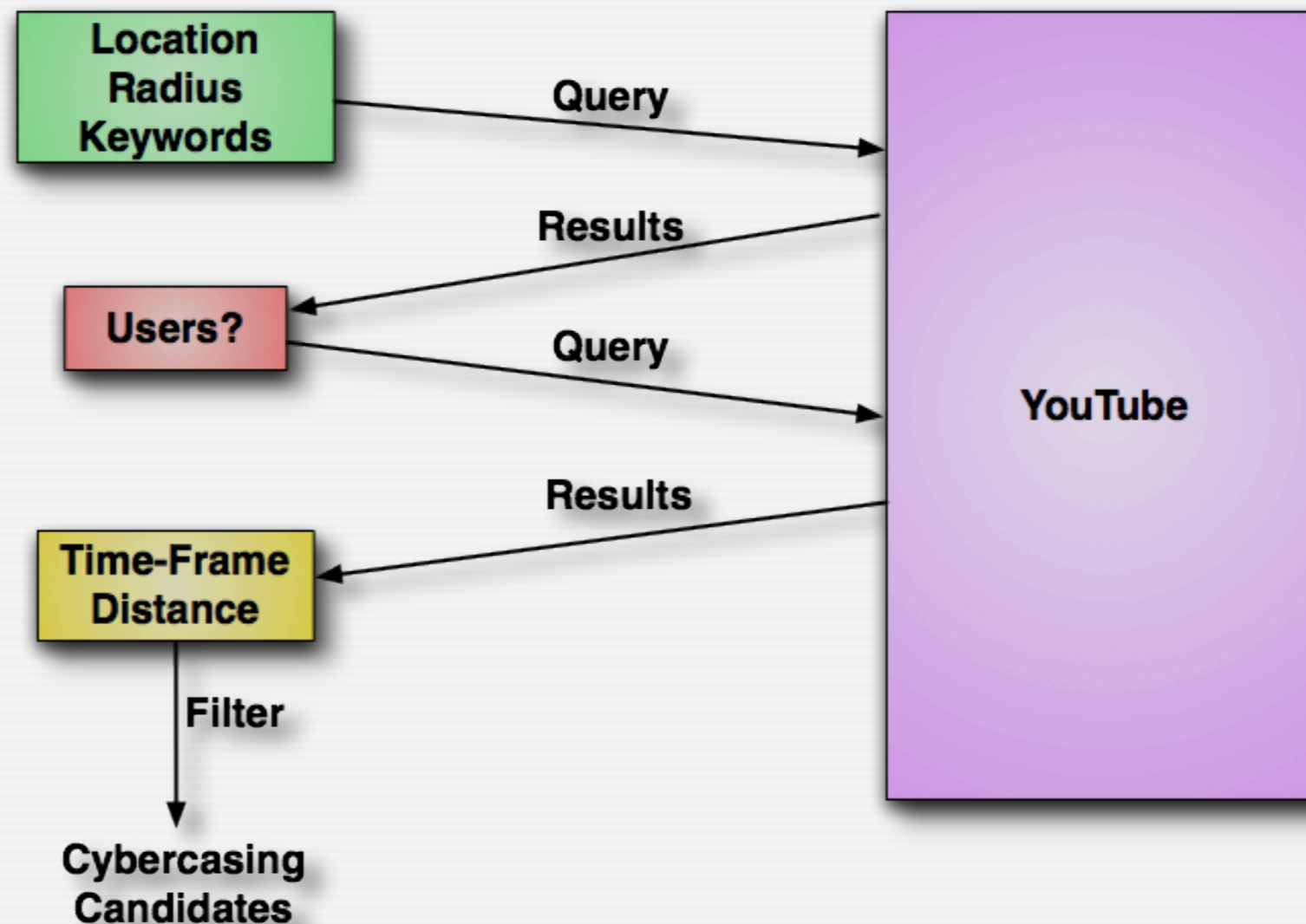
## Can we find people currently on vacation?

- That means their house is likely empty right now ...
- Uploading photos normally from home, but now from Far Far Away.

# Case Study: Cybercasing YouTube

Can we find people currently on vacation?

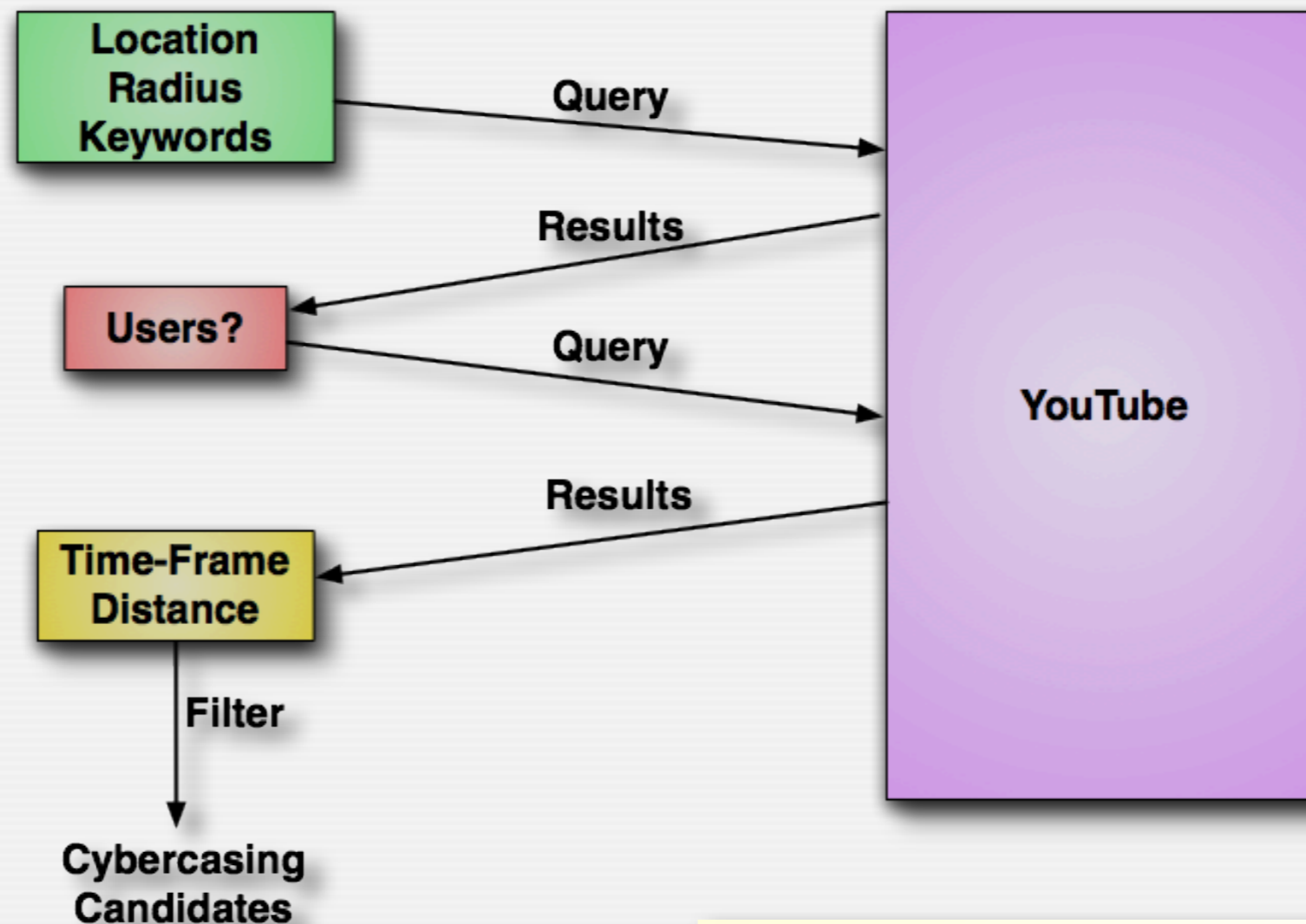
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# Case Study: Cybercasing YouTube

Can we find people currently on vacation?

- That means their house is likely empty right now ...
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204 lines of Python

# Example Run



## Input:

- *Location* 37.869885, -122.270539
- *Radius* 100km
- *Keywords* kids
- *Distance* 1000km
- *Time frame* this\_week

# Example Run



## Input:

- *Location* 37.869885, -122.270539
- *Radius* 100km
- *Keywords* kids
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## Output:

- *Initial videos* 1000 (max)
- *User hull* ~50k videos
- *Potential hits* 106
- *Targets:* >12

# Example Run



## Input:

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## Output:

- *Initial videos* 1000 (max)
- *User hull* ~50k videos
- *Potential hits* 106
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Took about ~15 min.

# Potential Targets

## First Day of Beach Vacation



1 videos

Subscribe



# Potential Targets

## First Day of Beach Vacation

1 videos

Subscribe

We learn that

- he is traveling in the Caribbean
- yesterday was 1st day of vacation
- he lives with his kids in Albany, CA
- his real name is on YouTube
- he is always timely in posting videos

0:02 / 0:24

# Potential Targets

## First Day of Beach Vacation

1 videos

Subscribe

About somebody else we learn

- he has moved out of San Francisco recently
- he bought a new place in New Jersey
- at a likely price of about \$400K
- his name and age



# Cybercasing for Real ...

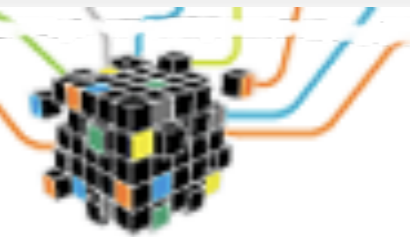
## Bits

**Business ■ Innovation ■ Technology ■ Society**

September 12, 2010, 10:24 AM

### Burglars Picked Houses Based on Facebook Updates

By **NICK BILTON**



# Cybercasing for Real ...

## Bits

**Business ■ Innovation ■ Technology ■ Society**

September 12, 2010, 10:24 AM

### Burglars Picked Houses Based on Facebook Updates

By **NICK BILTON**

Well, not really ...

# Related: Cybercasing foursquare



**PLEASE ROB ME**

**Raising awareness about over-sharing**

Check out our [guest blog post](#) on the CDT website.

# Related: Cybercasing foursquare



At least folks provided locations explicitly here.

# Preventing Misuse Of Geolocation

- **Key to risk mitigation: educating users**
  - The problem cannot be solved by purely technological means
- **Still, technology can help:**
  - Enable users to make educated choices
  - Protect by design: opt-in, rather than opt-out

# Preventing Misuse Of Geolocation

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  - Enable users to make educated choices
  - Protect by design: opt-in, rather than opt-opt

## Example: iPhone user interface



3G



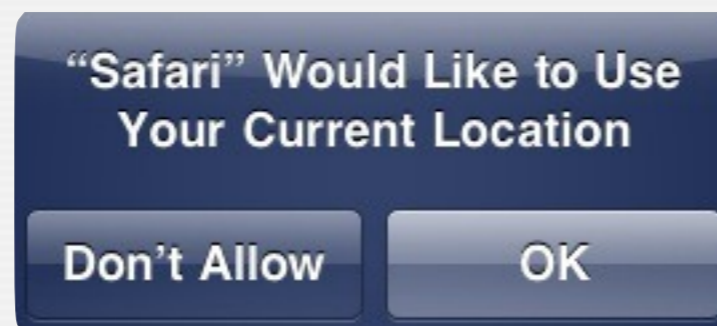
# Preventing Misuse Of Geolocation

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3G

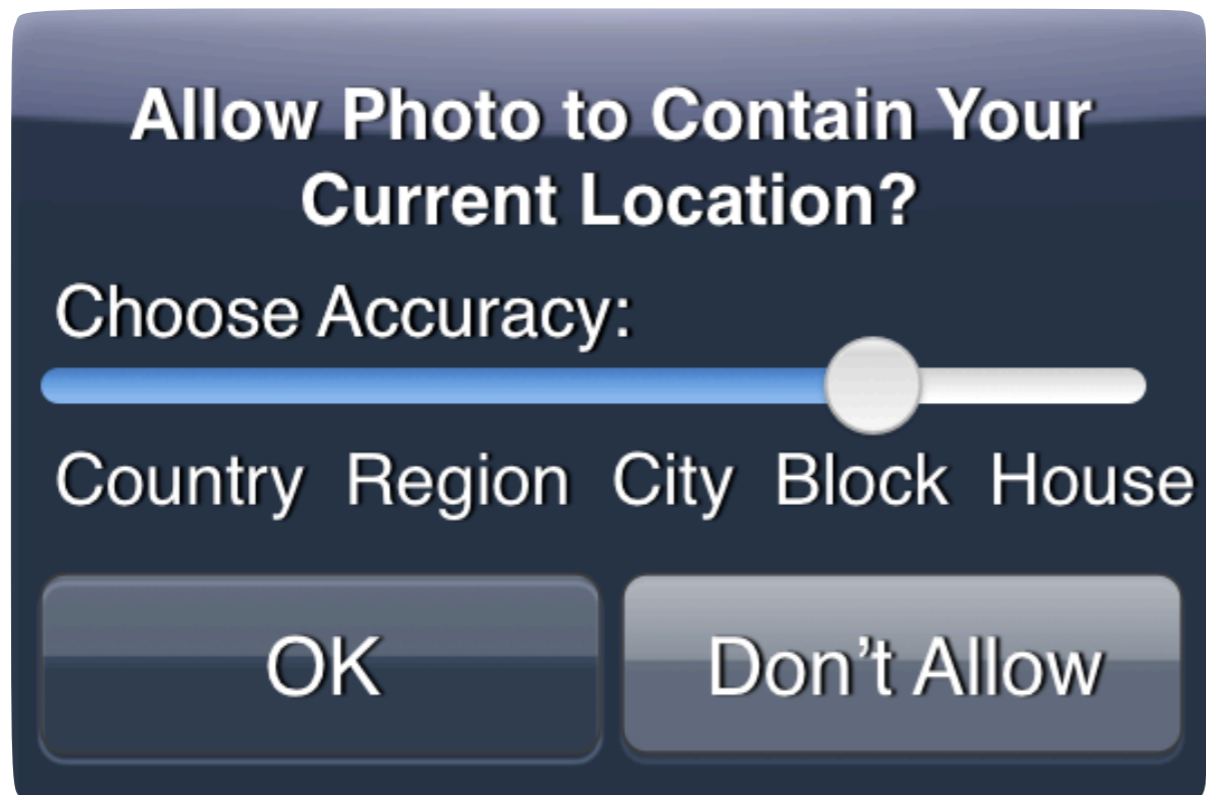


4G

# Preventing Misuse Of Geolocation

- Key to risk mitigation: educating users
  - The problem cannot be solved by purely technological means
- Still, technology can help:

## Suggestion



4G

# Preventing Misuse (2)

- Research on privacy-preserving location sharing
  - Learning location of friends if and only if they are actually close [Zhong et al.]
  - Retrieve POI information without revealing your location [Olumofin et al.]
  - Location-based service that enforces privacy preferences [Poolsappasit et al.]
- No real-world server/API uses such approaches yet
- Interesting research questions:
  - How would such a service need to be structured?
  - What would be the incentives for the service provider?

# What Does That All Mean?

- **Primarily, this work wants to raise awareness**
  - No reason to overreact
  - There's clearly a trade-off between benefits and risks of geolocation
  - Different people have different perspectives; we have heard the full spectrum
- **Resonated strongly with the non-tech community**
  - Covered extensively by mainstream media
  - Some good reports, some not so good ...

# Coverage Themes



# Coverage Themes

the *Atlantic* THURSDAY, JULY 22, 2010  
POLITICS | BUSINESS | CULTURE

**TOP SCIENCE AND TECH STORIES**

**How Tech-Savvy Thieves Can 'Cybercase' A House**  
Researchers say digital photos and videos reveal a trove of information on users' whereabouts  
NIRAJ CHOKSHI

**Would Users Pay for Premium Privacy?**  
A prominent venture capitalist has made a fortune from "premium privacy" services, but a business model already exists.  
NIRAJ CHOKSHI

# Coverage Themes

The screenshot shows a web browser displaying the ParentCentral.ca website. The page features a navigation menu with categories like 'Home', 'Babies & Pregnancy', 'Education', 'Family Health', 'Activities', and 'News & Features'. Below the menu, there are utility links for 'Text Size', 'Email this Article', 'Print this Page', 'Report Typo or Correction', and 'BOOKMARK'. The main article is titled 'Posting pictures online reveals more than you know' and is dated August 2, 2010. The author is RANCINE KOPUN, a FEATURE WRITER. The article text includes: 'Big Brother has arrived, in case you missed it. In fact, you probably did miss it.' and 'Those images you've been uploading to the web — your amusing YouTube video, the car-for-sale pictures on Craigslist, the TwitPic updates — may be embedded with coding that can reveal where the picture was taken, according to a report from the International Computer Science Institute, an independent, non-profit research institute in the United States.' A large photograph of a baby sitting on grass is shown, with a caption below it: 'LARRY PESCE PHOTO' and 'The picture Larry Pesce uploaded to Flickr of his daughter Corinn that had geographic information embedded in it that allowed computer users to figure out where it was taken.'

# Coverage Themes

## Celebrities' Photos, Videos May Reveal Location

Geo-Tags Embedded in Photos, Videos Could Give Away Private Locations, Personal Information

By KIMAE HEUSSNER

July 16, 2010



23 comments

Print RSS | FONT SIZE: A A A | SHARE: Email Twitter Facebook [+]

Keeping tabs on your favorite celebrities might be easier than you think -- and much easier than they want. But they likely have no one to blame but themselves.



William Shatner, M.C. Hammer, and Arnold Schwarzenegger are among a number of celebs that are... (Getty Images)

According to two teams of computer scientists, Hollywood stars could be unintentionally giving up the exact locations of their homes and private whereabouts through pictures uploaded to the Internet, leaving them wide open to attacks by tech-savvy thieves (not to mention unwanted visits by starstruck fans).

Most cameras and video recorders don't instantly attach location data (or geographic coordinates) to photos and videos. But some smartphones, such as the iPhone, automatically embed the user's latitude and longitude in each photo's

metadata. It's possible to disable the function, but the researchers said many people don't even realize that they might need to.

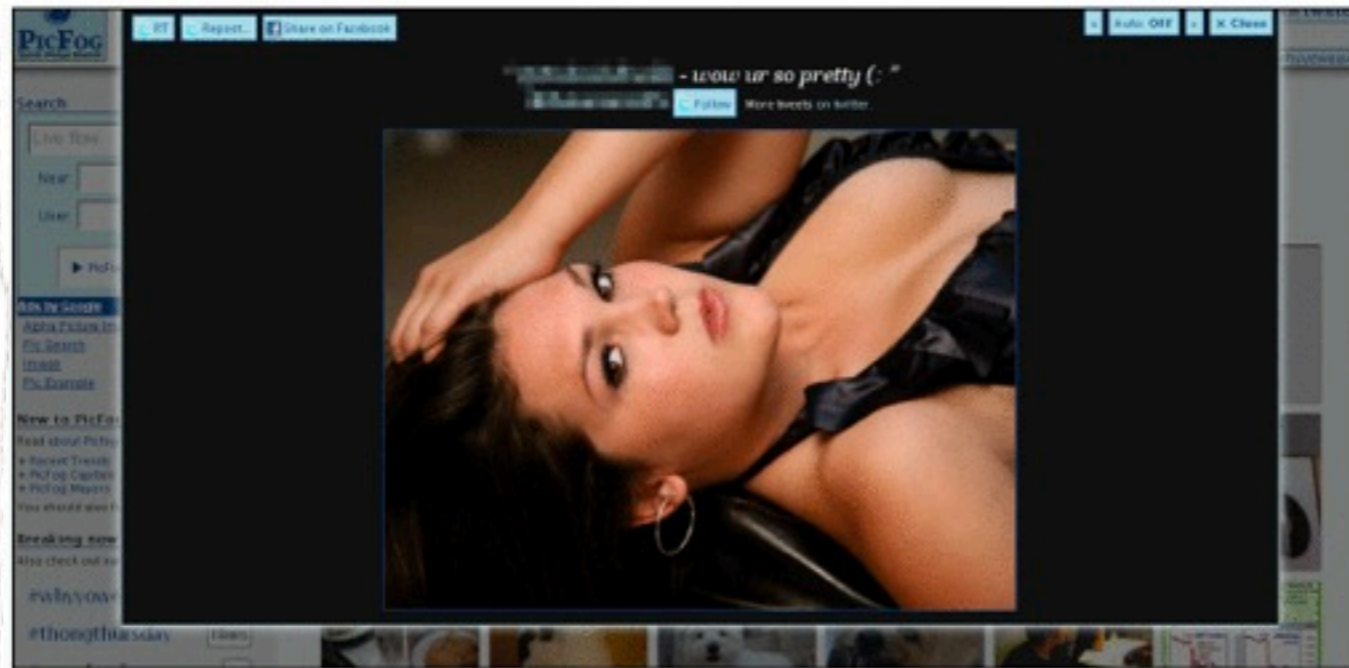
- The scientists say geotag data embedded in photos and videos that are uploaded to Twitter and other online sites often reveals location information that stars -- as well as the rest of us -- probably don't want to share.

# Wo wohnt diese unbekannte Schönheit?



von Henning Steier - Nicht nur Paparazziträume werden wahr: Zwei Forscher zeigen, wie sich mit einfachen Mitteln Nutzer von Twitter, YouTube, Flickr und Craigslist ausspionieren lassen.

16 Kommentare



PicFog.com ist eine ergiebige Quelle für Stalker.

«Wir wollen zeigen, wie von Ihnen online veröffentlichte Geoinformationen genutzt werden können, um Leute offline zu attackieren», schreiben Gerald Friedland und Robin Sommer in einem Aufsatz, den sie Mitte August auf einer Sicherheitskonferenz in Washington D.C. präsentieren werden. Die beiden Informatiker vom International Computer Science Institute (ICSI) im kalifornischen Berkeley haben sich für ihre Studie auf Craigslist, YouTube, Flickr und Twitter umgeschaut.

Cele

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By KI MA  
July 16, 2

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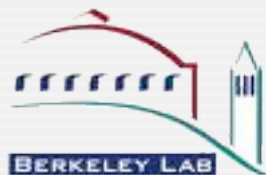


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# Web Photos That Reveal Secrets, Like Where You Live

By KATE MURPHY  
Published: August 11, 2010

When Adam Savage, host of the popular science program "MythBusters," posted a picture on [Twitter](#) of his automobile parked in front of his house, he let his fans know much more than that he drove a Toyota Land Cruiser.



Adam Savage, host of the popular science program "Mythbusters," posted a picture on Twitter of his automobile parked in front of his house that was geotagged.

## Multimedia



Institute (ICSI) im kalifornischen Berkeley haben sich für ihre Studie auf Craigslist, YouTube, Flickr und Twitter umgeschaut.

Embedded in the image was a geotag, a bit of data providing the longitude and latitude of where the photo was taken. Hence, he revealed exactly where he lived. And since the accompanying text was "Now it's off to work," potential thieves knew he would not be at home.

Security experts and privacy advocates have recently begun warning about the potential dangers of geotags, which are embedded in photos and videos taken with GPS-equipped smartphones and [digital cameras](#). Because the location data is not visible to the casual viewer, the concern is that many people may not realize it is there; and they could be compromising their privacy, if not their safety, when they post geotagged media online.

Mr. Savage said he knew about geotags. (He should, as host of a [show popular with technology followers](#).) But he



- SEND TO PHONE
- PRINT
- REPRINTS
- SHARE



Cele

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By KI MA  
July 16, 2

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# Web Geotagging avslører deg

By KATE M  
Published: /

When A  
"MythB  
in front  
drove a



twitpic



## Ny teknologi i smarttelefoner forenkler jobben for plageånder og tyver.

ERLEND LÂNKE SOLBU  
erlend.lanke.solbu@nrk.no

Publisert 13.07.2010 13:09.

Adam Sav  
science pr  
posted a p  
automobile  
that was g

**Smarttelefonene har inntatt norske lommer for fullt det siste året. Men vær oppmerksom - det er ikke nødvendigvis bare deg den gjør hverdagen enklere for.**

### Automatisk geotagging

**Geotagging** er et konsept som merker forskjellige mediefiler med **metadata** som inneholder geografisk informasjon som lengde- og breddegrad. På mange nye telefoner blir disse metadataene automatisk lagt til mediefilene du lager. Dette betyr at bildene du laster opp på nettet ofte inneholder nøyaktig informasjon om hvor du befinner deg.

### Multime



Skriv ut Del/tips

### Les

iPhone - den nye splintelefonen?

### Lenker

- Geotagging
- metadata
- New Scientist
- I can stalk U

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# Beyond Geotags



# Multimodal Location Estimation

- Photos and videos tend to come with context
- Content hints
  - Visible objects (persons, landmarks)
  - Audio track (speakers, unique background noise)
- Meta information
  - Title (“Jim’s house in San Francisco”)
  - Tags (“kids”, “Golden Gate Bridge”)
  - User names (let’s see what else the user has uploaded; let’s check Facebook)
- Combining these may allow to estimate a location much better than one would assume.

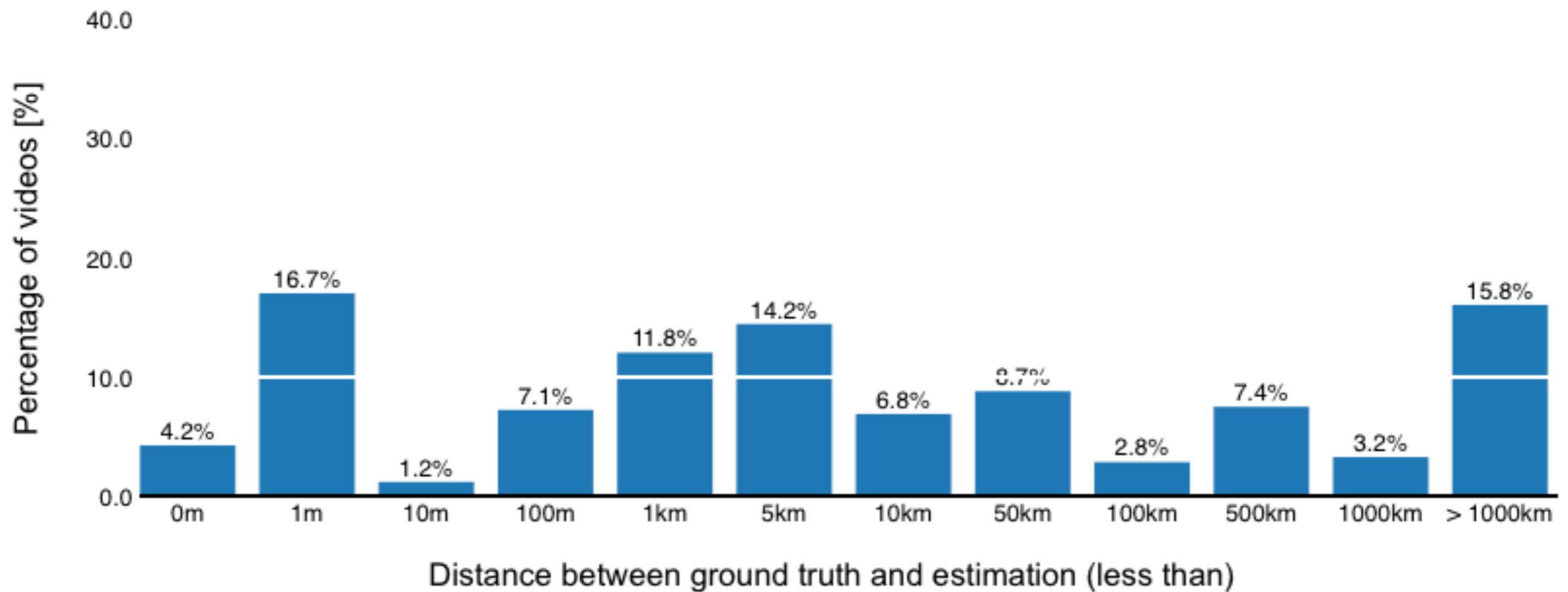
# MediaEval



## MediaEval

- Challenge for research teams:
  - Given: 5000 random videos from Flickr (no geotags)
  - Task: Determine location where they have been recorded
  - Independent evaluation using geotags as ground truth.
- Participants can use all kinds of resources:
  - Visual and audio content
  - Meta-data (title, tags, user names)
  - Content from external sites (social networks, Wikipedia, geotags)

# ICSI's Results



# YouTube Cybercasing Revisited



## **Input:**

- *Location* 37.869885, -122.270539
- *Radius* 100km
- *Keywords* kids
- *Distance* 1000km
- *Time frame* this\_week

# YouTube Cybercasing Revisited



## Input:

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- *Radius* 100km
- *Keywords* kids
- *Distance* 1000km
- *Time frame* this\_week

## Output:

- *Potential hits:* 112
- *Targets:* >12

# Global Inference Potential

Inference is not limited to location information.

- Correlation of different sources can reveal a lot about you.
- The Web's tendency to “never forget” poses a significant privacy risk.



Geotagged, and  
on Twitter

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Public property  
records

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Public records  
of convicts



Geotagged, and  
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Public records  
of convicts



Geotagged, and  
on Twitter



Public property  
records



Well, would I really want to hire you?

# Ingredient: Property Records

New York City Department of Finance  
**Office of the City Register**

# Ingredient: Property Records

New York City Department of Finance  
Office of the City Register

## Property Address:

If you know the property address, complete the fields below and press "Find BBL" to find the Borough/Block/Lot of the property. Address fields indicated by an asterisk (\*) are required. If an address is found, the fields in the Property Borough/Block/Lot section will be populated.

Borough/County:

Street Number:

Street Name:

Unit:

# Ingredient: Property Records

## New York City Department of Finance Office of the City Register

### Property Address:

If you know the property address, complete the fields below and press "Find BBL" to find the Borough/Block/Lot of the property. Address fields indicated by an asterisk (\*) are required. If an address is found, the fields in the Property Borough/Block/Lot section will be populated.

Borough/County:

Street Number:

Street Name:

## Search Results By Parcel Identifier

### Current Search Criteria:

Borough: MANHATTAN / NEW YORK  
Block: 01264  
Lot: 0005  
Date Range: To Current Date  
Document Class: All Document Classes

Records 1 - 10 << previous next >> Max Rows 10 [Search Options] [New BBL Search] [Edit Current Search] [View Tax Map] [Print Index]

View	Reel/Pg/File	CRFN	Lot	Partial	Recorded / Filed	Document Type	Pages	Party1	Party2	Party 3/ Other	More Party 1/2 Names	Corrected/ Remarks	Doc Amount
DET IMG		2009000329043	5	ENTIRE LOT	10/8/2009 4:17:09 PM	AGREEMENT	18	NYCDOT DIV. OF FRANCHISES, CONCESSIONS, & CONSENTS	RCPI LANDMARK PROPERTIES, LLC				0
DET IMG		2009000028656	5	PARTIAL LOT	1/30/2009 4:53:12 PM	NYC REAL PROPERTY TRANSFER TAX	3	MERRILL LYNCH & CO., INC	BANK OF AMERICA CORPORATION				48,016,000
DET IMG		2007000463339	5	ENTIRE LOT	9/10/2007 11:02:40 AM	AGREEMENT	22	RCPI LANDMARK PROPERTIES, L.L.C	RCPI 30 ROCK 22234849, L.L.C.		✓		0
DET IMG		2007000463338	5	ENTIRE LOT	9/10/2007 11:02:39 AM	AGREEMENT	24	RCPI LANDMARK PROPERTIES LLC	RCPI 30 ROCK 22234849, L.L.C		✓		0
DET IMG		2007000234699	5	ENTIRE LOT	5/4/2007 4:48:02 PM	BOTH RPTT AND RETT	1	QUANTA U.S. HOLDINGS, INC.	ROCKEFELLER & CO., INC.				0
DET IMG		2006000279948	5	ENTIRE LOT	5/19/2006 12:39:17 PM	AGREEMENT	11	M. ARTHUR GENSLER JR. & ASSOCIATES, INC.	WACHOVIA BANK, NATIONAL ASSOCIATION				0
DET IMG		2006000103743	5	PARTIAL LOT	2/22/2006 5:21:29 PM	UCC3 TERMINATION	3	PONTIUS REALTY, INC	U.S. BANK NATIONAL ASSOCIATION, AS TRUSTEE				0
DET IMG		2005000445247	5	ENTIRE LOT	8/9/2005 11:49:30 AM	ASGN OF ASGN OF L&R	20	GREENWICH CAPITAL FINANCIAL PRODUCTS, INC.	LASALLE BANK NATIONAL ASSOCIATION, AS TRUSTEE		✓		0
DET IMG		2005000445246	5	ENTIRE LOT	8/9/2005 11:49:29 AM	ASSIGNMENT, MORTGAGE	23	GREENWICH CAPITAL FINANCIAL PRODUCTS, INC.	LASALLE BANK NATIONAL ASSOCIATION, AS TRUSTEE		✓		0
DET IMG		2005000326692	5	ENTIRE LOT	6/3/2005 5:10:02 PM	TERMINATION OF ASSIGN OF L&R	17	RCPI LANDMARK PROPERTIES, L.L.C.	LASALLE BANK NATIONAL ASSOCIATION, AS TRUSTEE				0

Search Options

New Parcel Identifier Search

Edit Current Search

View Tax Map

# Ingredient: Property Records

New York City Department of Finance  
Office of the City Register

Property Address:

## Detailed Document Information

[Click help for additional instructions]  
Selecting a help option will open new window

### Current Search Criteria:

Borough: MANHATTAN / NEW YORK  
Block: 01264  
Lot: 0005  
Date Range: To Current Date  
Document Class:

DOCUMENT ID:	2009012901179002	CRFN:	2009000028656	COLLATERAL:	N/A
# of PAGES:	3	REEL-PAGE:	N/A-N/A	EXPIRATION DATE:	N/A
DOC. TYPE:	NYC REAL PROPERTY TRANSFER TAX	FILE NUMBER:	N/A	ASSESSMENT DATE:	N/A
DOC. DATE:	1/1/2009	RECORDED / FILED:	1/30/2009 4:53:12 PM	SLID #:	N/A
DOC. AMOUNT:	\$48,016,000.00	BOROUGH:	MANHATTAN	MAP SEQUENCE #:	N/A
% TRANSFERRED:	77.4%	RPT #:	N/A		
MESSAGE:	N/A				

PARTY 1						
NAME	ADDRESS 1	ADDRESS 2	CITY	STATE	ZIP	COUNTRY
MERRILL LYNCH & CO., INC	4 WORLD FINANCIAL CENTER		NEW YORK	NY	10080	US

PARTY 2						
NAME	ADDRESS 1	ADDRESS 2	CITY	STATE	ZIP	COUNTRY
BANK OF AMERICA CORPORATION	C/O JOHN GUBA	BANK OF AMERICA CORPORATE CENTER, 100 TYRON STREET	CHARLOTTE	NC	28255	US

# Ingredient: Convict Records



# Ingredient: Convict Records



**Evesham Township Police (NJ)** On October 30, 2010 at approximately 1:40 AM, the Evesham Police Department attempted to conduct a motor vehicle stop on a vehicle on W. Route 70 at the intersection with Route 73, Marlton, NJ.

The vehicle that the officer attempted to stop refused to submit to the motor vehicle stop. The vehicle continued on Route 73 north into Mt Laurel and then into Maple Shade Township. The vehicle pursuit ended on Route 38 and Ruddrow Avenue, Maple Shade, NJ. This is the location where the driver of the suspect vehicle pulled to the side of the roadway and finally submitted to the traffic stop.

The incident led to the arrest of:

[REDACTED], black, female, 42 years of age, [REDACTED] Road, Elkins Park, PA

Daniels was charged with Eluding Police, a crime of the third degree, Driving While Intoxicated and other related motor vehicle violations.

Daniels was released pending a Municipal Court Hearing.

Nobody was injured during this vehicle pursuit.



November 5 at 10:19am · Like · Comment

Jeremy Merck likes this.

# Ingredient: Face Recognition



Google Goggles

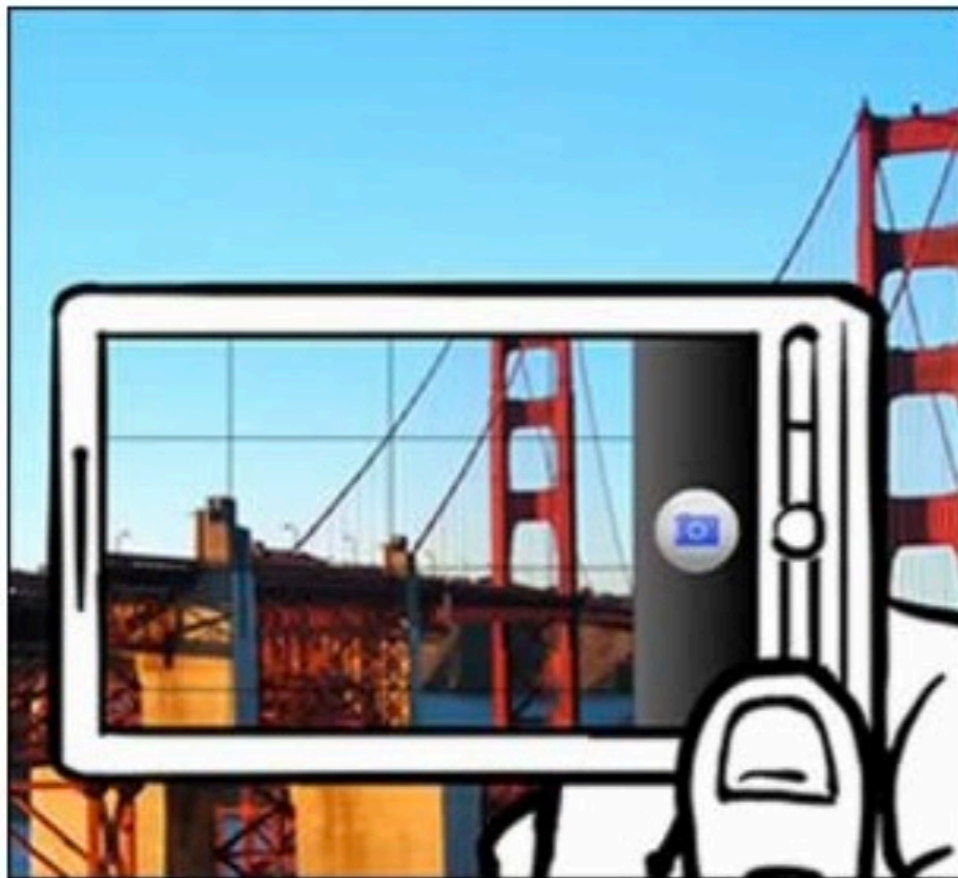
Use pictures to search the web.

# Ingredient: Face Recognition



Google Goggles

Use pictures to search the web.

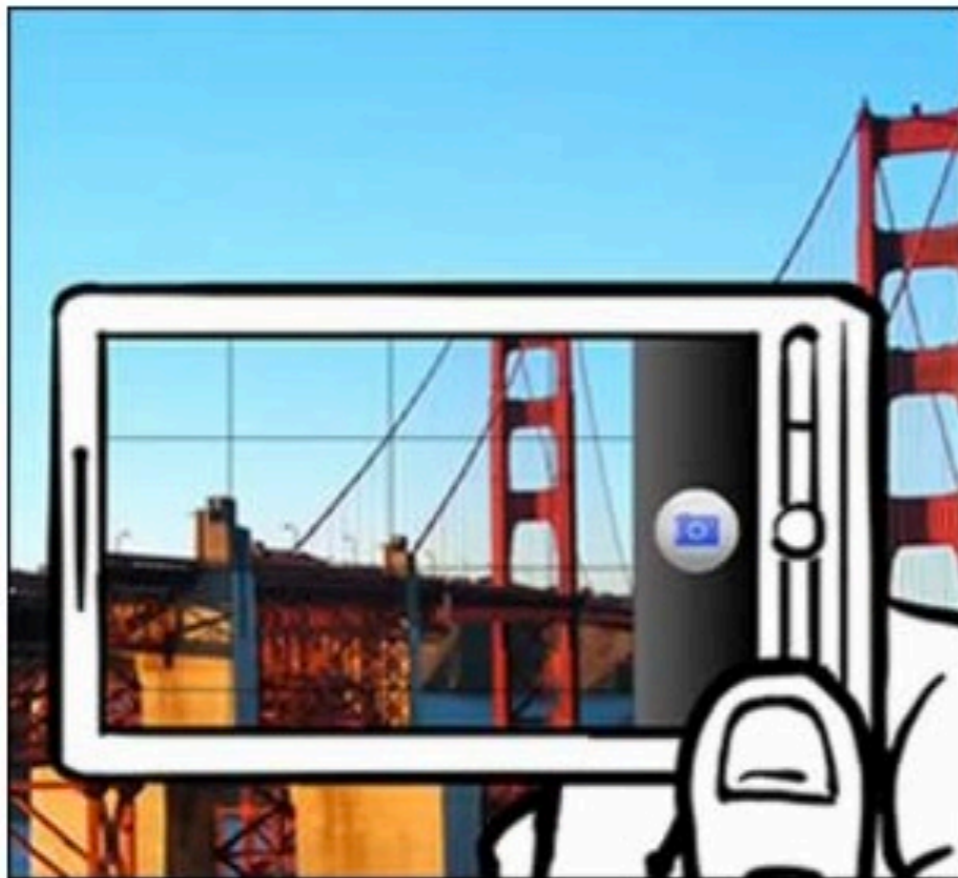


# Ingredient: Face Recognition



Google Goggles

Use pictures to search the web.



## Google debates face recognition technology

By Maija Palmer in London

Published: May 19 2010 22:42 | Last updated: May 20 2010 01:02

**Google** executives are wrestling over whether to launch controversial facial recognition technology after a barrage of criticism over its privacy policies.

Eric Schmidt, chief executive, said a series of public disputes over privacy issues had caused the management team to review its procedures and the launch of new technologies. According to Google executives, facial recognition is one of the key topics of internal debate.

Mr Schmidt said: "Facial recognition is a good example . . . anything we did in that area would be highly, highly planned, discussed and reviewed. When you go through these things, you review your management procedures."

However, he would not rule out any eventual roll-out, saying: "It is important that we continue to innovate."

Facial recognition has the potential to be the next privacy flashpoint. Google already uses the technology in its Picasa photo sharing service. This lets users tag some of the people in their photos and then searches through other albums to suggest other pictures in which the same faces appear.

However, Google has held back on launching the technology more broadly. It was not included, for example, in the **Google Goggles** product, launched last year. This allows people to search for something on the internet by taking a picture of it on a mobile phone.

### ▼ EDITOR'S CHOICE

[Google I/O Conference 2010](#) - May-19

[Google web expansion set to rile rivals](#) - May-20

[Tech blog: Google's apps ambitions](#) - May-19

[Android overtakes Windows in smartphones](#) - May-19

[Google looks to make peace with Murdoch](#) - May-18

[In depth: Google](#) - Dec-21

# Ingredient: Correlation

The Spokeo logo features the word "spokeo" in a bold, lowercase, sans-serif font. The letter "o" is replaced by a blue circular icon containing a white globe with latitude and longitude lines. A small "TM" trademark symbol is positioned to the upper right of the "o".

Spokeo aggregates data from hundreds of online and offline sources, including but not limited to: phone directories, social networks, marketing surveys, mailing lists, government censuses, real estate listings, and business websites. All of the data aggregated is publicly available, and accessible by anyone from those respective sources. Finding, consolidating, and organizing all of the data meaningfully, however, could take an individual weeks, whereas Spokeo automates the data aggregation process and offers it at lightning speed.

Spokeo's unique and powerful algorithms can swiftly navigate, sift through, and collect multitudes of scattered data that are spread across hundreds of locations, and synthesize that information in one convenient summary, delivering the most comprehensive snapshot of people-related, public data offered online to date. The search results represent an unparalleled mosaic of the vast stockpiles of public information accessible, and can offer invaluable insight into both the individual being searched, as well as the different types of information published.

# Correlation: Business Version

## Social Network Analysis

Booz | Allen | Hamilton

Booz Allen Hamilton uses Social Network Analysis to analyze the structure of connections across diverse types of entities—people, places, organizations, locations, goods, resources, and events. The outcome is a product that allows our analysts to understand how the structure of nonphysical networks affects the behavior of its members at multiple levels—individuals, groups, and organizations.

Booz Allen can apply Social Network Analysis techniques, such as link analysis, clustering, and block modeling, against financial and transactional data sets to help financial institutions protect themselves against illicit or fraudulent activities. Using Social Network Analysis, Booz Allen can:

- Reveal the hidden relationships between people, banks, and organizations
- Identify previously unknown key individuals within a financial network
- Uncover transactions conducted by a set of entities over time inconsistent with normal business and individual check cashing activities
- Uncover entities having unusual numbers of financial transactions over time not typical of the business or occupation of the entities
- Detect locations to effectively monitor for suspicious financial transactions
- Determine individuals to target to effectively disable illegal networks
- Reveal organizations that enable the illegal transfer of funds
- Help stop unintentional prohibited transfers to/from account transactions with a bank's non-customers
- Trace the relationships between a country's leaders and its financial infrastructure



# Risk Factors

- More information is online and publicly accessible
  - Individual provide much personal information without much concern
  - Public databases provide access to information previously inaccessible.
- Technically, it is really easy to get this information
  - Public APIs
  - Data collectors and aggregators
  - Vast resources available at little expense (Amazon, 80legs)
- Technology is ready to do all pieces of the puzzle
  - Location estimation, face recognition, speaker identification, text analysis

# Stephen Colbert



# Stephen Colbert



... an American satirical late night television program ... The show focuses on a fictional anchorman character [...]described [as] a "well-intentioned, poorly informed, high-status idiot",

*Wikipedia*

# Conclusion

- **Location-based services are rapidly emerging**
  - Significant commercial push for personalized services and marketing
- **Privacy implications often not well understood**
  - Example: “Cybercasing” by leveraging geotags
- **New technical capabilities will only increase the risk**
  - We have the main ingredients already ...
- **Important to raise awareness**
  - No need to overreact, there’s always a trade-off between risk and benefit
  - However, users need to be able to make educated decisions

# Thanks for your attention.

**Robin Sommer**

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Lawrence Berkeley National Laboratory*

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`http://www.icir.org`

Much of the presented material is joint work  
with Gerald Friedland, likewise at ICSI.

