



## Sharing Multimedia on the Internet and the Impact for Online Privacy



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1



## Question

On average, how often are you posting images and videos on the Internet (e.g. Facebook, Flickr, Craigslist) ?

- a) Never
- b) About once a month or less
- c) About once a week
- d) About once a day
- e) More than once a day

2



## A Popular Introduction to the Problem



3



## Question

How would you judge the issue raised by Colbert?

- a) It's a comedy. I don't worry about any of this.
- b) There is some truth to it but its mostly exaggerated.
- c) It's a comedy depiction of the reality but most of the stuff is becoming an issue.
- d) He only touched a small part of the problem. The actual issues are even more serious.

4



## Our Observations

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- Many Internet sites and mobile apps encourage sharing of data too easily and users follow.
- Users **and** engineers often unaware of (hidden) search and retrieval possibilities of shared data.
- Local privacy protection ineffective against inference across web-sites.

5



## Social Cause

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- People want to post on the Internet and like a highly-personalized web experience.
- Industry is improving search and retrieval techniques so that people can find the posts.
- Governments improve search and retrieval to do forensics and intelligence gathering

6



## Let's focus

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- The previous described issues are a problem with any type of public or semi-public posts and are not specific to a certain type of information, e.g. text, image, or video.
- However, let's focus on multimedia data: images, audio, video.

7



## Multimedia in the Internet is Growing

- YouTube claims 65k video uploads per day
- Flickr claims 1M images uploads per day
- Twitter: up to 120M messages per day  
=> Twitpic, yfrog, plixi & co: 1M

8



## Computer Science Problem

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- More multimedia data = Higher demand for retrieval and organization tools
- Image, video retrieval hard =>
- Solution: Workarounds...

9



## Workaround: Manual Tagging

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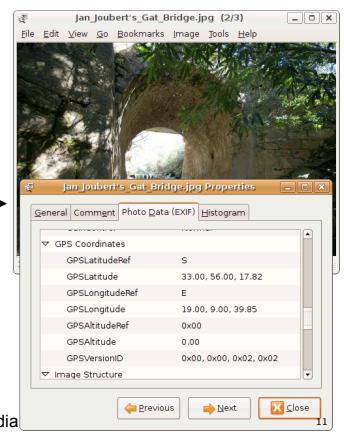


10



## Workaround: Geotagging

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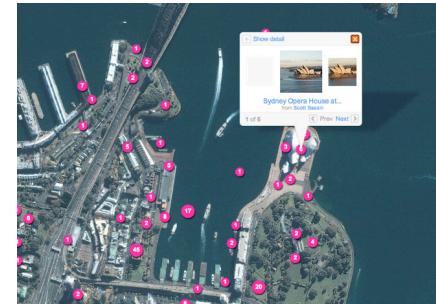
Source: Wikipedia

11



## Geo-Tagging

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Allows easier clustering of photo and video series as well as additional services.

12



## Support for Geo-Tags

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Social media portals provide programmatic interfaces to connect geo-tags with metadata, accounts, and web content.

Portal	%	Total
YouTube (estimate)	3.0	3M
Flickr	4.5	180M

Allows easy search, retrieval, and ad placement.

13



## Issues of Tracking using Geo-Tagging



“Be careful when using social location sharing services, such as FourSquare.”

14



## Question

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Did you know about geo-tagging and its potential?

- a) I had never heard about geo-tagging before.
- b) I knew about geo-tagging but never thought about what it could be used for.
- c) I knew about geo-tagging and knew the potential for photo organization and retrieval
- d) I know about geo-tagging, its use and the privacy risks.
- e) I only heard about privacy risks of geo-tagging but never really thought about what it is good for.

15



## Scientific Approach: Can you do real harm?

- Cybercasing: Using online (location-based) data and services to mount real-world attacks.
- Three Case Studies:



Broadcast Yourself

16



## Case Study 1: Twitter

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- Pictures
- From an -located
- From an -located
- Home location
- Where they live
- The place where they work
- The place where they play
- “Secret” office



17



## Celebs unaware of Geo-Tagging

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Click here to login or

Working with the very talented Adam Hamilton on creating a new album. My best, Bill  
Source: ABC News <sup>18</sup>

18

## 10100101 101CS101 10100101 Celebs unaware of Geotagging

### 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} = [degrees, minutes, seconds] ==> [ ] == [ ]

19

## 10100101 101CS101 10100101 Google Maps shows Address...

Google maps 34.200833, -118.2437

Get Directions My Maps  
Directions Search nearby Save to... more▼



20

## 10100101 101CS101 10100101 Case Study 2: Craigslist

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"For Sale" section of Bay Area [Craigslist.com](#):  
4 days: 68729 pictures total, 1.3% geo-tagged

- Many ads with geo-location otherwise anonymized
- Sometimes selling high-valued goods, e.g. cars, diamonds
- Sometimes "call Sunday after 6pm"
- Multiple photos allow interpolation of coordinates for higher accuracy

21

## 10100101 101CS101 10100101 Craigslist: Real Example

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22

## 10100101 101CS101 10100101 Case Study 3: YouTube

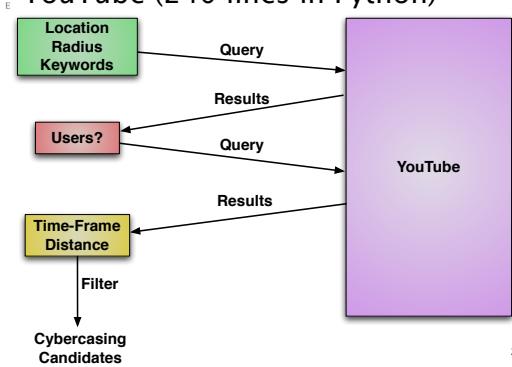
- INTERNATIONAL COMPUTER SCIENCE INSTITUTE
- Once data is published, the Internet keeps it (in potentially many copies).
  - Programmatic YouTube interface is easy to use and allow quick retrieval of large amounts of data

Can we find people on vacation in YouTube?

23

## 10100101 101CS101 10100101 Cybercasing on YouTube

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Experiment: Cybercasing using YouTube (240 lines in Python)



24



## Cybercasing on YouTube

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### Input parameters

**Location:** 37.869885, -122.270539

**Radius:** 100km

**Keywords:** kids

**Distance:** 1000km

**Time-frame:** this\_week

25

25



## Cybercasing on YouTube

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### Output

**Initial videos:** 1000 (max\_res)

► **User hull:** ~50k videos

► **Potential hits:** 106

► **Cybercasing targets:** >12

26

26



## Cybercasing on YouTube

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First Day of [REDACTED] Vacation

[REDACTED] videos | Subscribe



27



## Corollary

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People are unaware of

1. geo-tagging
2. high resolution of sensors
3. large amount of geo-tagged data
4. easy-to-use APIs allow fast retrieval
5. resulting inference possibilities

G. Friedland and R. Sommer: "Cybercasing the Joint: On the Privacy Implications of Geotagging", Proceedings of the Fifth USENIX Workshop on Hot Topics in Security (HotSec 10), Washington, D.C., August 2010. <sup>28</sup>

28



## The Threat is Real!

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### Bits

Business • Innovation • Technology • Society

September 12, 2010, 10:24 AM

Burglars Picked Houses Based on Facebook Updates

By NICK BILTON

### News Feed

Top News • Most Recent 63

Share: Status Question Photo Link Video

Going to the beach for the weekend! (Someone else will be home though so think again Facebook Bandits!)

Share

Illustration by Nick Bilton/The New York Times

29



## Question

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Do you think geo-tagging should be illegal?

- No, people just have to be more careful. The possibilities still outweigh the risks.
- Maybe it should be regulated somehow to make sure no harm can be done.
- Yes, absolutely this information is too dangerous.

30

30

But...

Technical Question: Is this really about geo-tags?

31

## Ongoing Work: The Berkeley Multimodal Location Estimation Project



<http://mmle.icsi.berkeley.edu>

32

## Multimodal Location Estimation

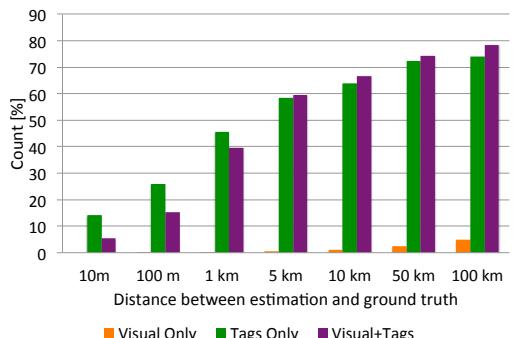
We infer location of a Video based on content and context:

- Allows faster search, inference, and intelligence gathering even without GPS.
- Use geo-tagged data as training data

G. Friedland, O. Vinyals, and T. Darrell: "Multimodal Location Estimation," pp. 1245-1251, ACM Multimedia, Florence, Italy, October 2010.

33

## ICSI's Evaluation Results



G. Friedland, J. Choi, A. Janin: "Multimodal Location Estimation on Flickr Videos", ACM Multimedia 2011

34

## YouTube Cybercasing Revisited

	Old Experiment	No Geotags
Initial Videos	1000 (max)	107
User Hull	~50k	~2000
Potential Hits	106	112
Actual Targets	>12	>12

YouTube Cybercasing with Multimodal Location Estimation vs using Geotags

G. Friedland, J. Choi: Semantic Computing and Privacy: A Case Study Using Inferred Geo-Location, International Journal of Semantic Computing, Vol 5, No 1, pp. 79–93, World Scientific, USA, 2011.

35

## Question

Do you think research about geo-location should be abandoned?

- No, of course not.
- No, but regulated.
- Yes, absolutely.

36

But...

Is this really only about geo-location?

No, it's about the privacy implications of Internet search and (multimedia) retrieval in general.

37

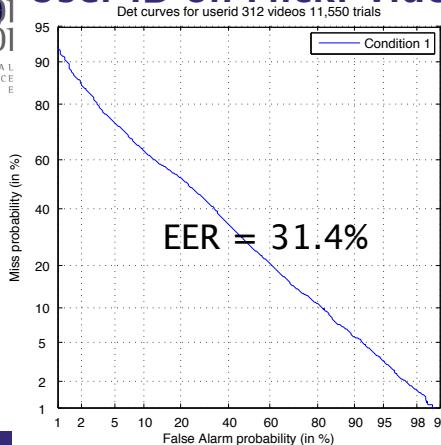
## Another Multimedia Example

Idea: Can one link videos across accounts? (e.g. YouTube linked to Facebook vs anonymized dating site)

Let's try an off-the-shelf speaker verification system: ALIZE (GNU GPL)

38

## User ID on Flickr videos



39

## Persona Linking using Internet Videos

### Result:

On average having 20 videos in the test set leads to a 99.2% chance for a true positive match!

H. Lei, J. Choi, A. Janin, and G. Friedland: "Persona Linking: Matching Uploaders of Videos Across Accounts", at IEEE International Conference on Acoustic, Speech, and Signal Processing (ICASSP), Prague, May 2011

40

## Solutions that don't work

- I blur my faces (audio and image artifacts can still find you)
- I only share with my friends (but who and with what app do they share with?)
- I don't do social networking (others may do it for you)

41

## Question

And now? What do you think has to be done?

- Nothing can be done. Privacy is dead.
- We need to educate people about this and try to save privacy. (fight)
- I will really think before I post, and I agree with b).
- I will really think before I post, and I agree with a).
- I won't post anything anymore! (flee)

42



## My Personal Advice

### **Think before you post:**

- Make sure you know who can read your post and you choose material appropriate for the audience.
- Make sure you know what you are posting: Is there hidden data included in your post? Are you allowed to reveal the information? Are you offending anybody?
- The Internet keeps data forever and in potentially many copies. Your need for privacy will change, however.
- Perform regular searches to find out what was posted about you by others.

43



## More examples and more discussion

<http://cybercasing.blogspot.com>

44



## Thank You! Questions?

Work together with:

Robin Sommer, Jaeyoung Choi, Luke Gottlieb, Howard Lei, Adam Janin, Oriol Vinyals, Trevor Darrel, and others.

45