UbiComp is About Context
UbiComp is About Context

Who are you?
Where are you?
Where are you going?
What are you doing?
Who are you with?
Are you asleep?
Are you exercising?
What are you eating?
Where are your friends?
What do you want?
Location-Based Dating Apps

Grindr. It’s a guy thing.
Grindr is the largest all male location-based mobile network tool for Android, iPhone, iPod touch, iPad and BlackBerry.

Blendr is a social networking experience unlike any other. Using your mobile device’s location-based technology, you can connect with others nearby with similar interests, hobbies, profession and much more. Discover the world around you: make friends, and build connections and explore your surroundings. Blendr makes it easy to take that first step.

Who do you want?
Smart Phones are Great Sensors of Context
Sensing Context & Smartphones

Sensors:
- Accelerometer
- Camera
- Microphone
- GPS
- The Internet
- ...
Sensing Context

Sensor:
- Accelerometer (motion)

Inferred Context:
- Are you driving?
- How much did you exercise today?
- Did you get enough sleep last night?
- Is the phone in your pocket?
- ...

Sensors:
- Accelerometer
- Camera
- Microphone
- GPS
- The Internet
- The Internet
Sensing Context

Sensor:
› Camera

Inferred Context:
› Who are you with?
› Is it daytime?
› Are you on vacation?
› Are you out at a bar?
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

& Smartphones
Sensing Context

Sensor:
- Microphone

Inferred Context:
- What kind of place are you at?
- Is it crowded there?
- Are you at a movie theatre?
- Are you in an argument?
- Is the phone in your pocket?
- Who are you with?
- What are you saying?
- ...

Sensors:
- Accelerometer
- Camera
- Microphone
- GPS
- The Internet
- ...

& Smartphones
Sensing Context

Sensor:
› GPS (location sensing)

Inferred Context:
› Where are you?
› Who are you with?
› What are you doing?
› Where are you going?
› Are you stuck in traffic?
› Are you late for work?
› What is your routine?
› Where did you sleep last night?
› ...

& Smartphones

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerometer
› Camera
› Microphone
› GPS
› The Internet
› ...

Sensors:
› Accelerator
Sensing Context

Sensor:
- The Internet

Inferred Context:
- Who are you?
- Who are your friends?
- Who are your family?
- Who is your spouse?
- Where did you grow up?
- What places are near by?
- What is your schedule?
- ...

Sensors:
- Accelerometer
- Camera
- Microphone
- GPS
- The Internet
- ...

& Smartphones
Location
Why is location important?
Why is location important?

- A great deal of contextual information can be derived just by observing a user’s location.
- Entire industries are being built and reshaped around location
  - local deals (Groupon, living social), location sharing, local search, location-based ads, urban computing and “smart city” applications, ...
Who are your friends?

Bridging the Gap Between Physical Location and Online Social Networks

2010 Conference on Ubiquitous Computing

Justin Cranshaw
Norman Sadeh
Jason Hong
Niki Kittur
Eran Toch
Bridging the Gap Between Physical Location and Online Social Networks

The purpose of this work is to explore the relationships between online social networks, and the real world mobility patterns of their users.
We wanted to understand how the network of interactions on Facebook differs from the network of real world interactions.
We studied location data from over 200 Pittsburgh residents.

Some were continuously tracked via smart phones.

Others’ locations were approximated more discretely via their laptop usage.

We compared their collected location histories with data collected from their Facebook accounts.
Are Joe and Bob Facebook friends?

One of the questions we address in this work
We approach the problem in a very natural way. We look at the history of co-locations between Joe and Bob.
However, even with the history of co-locations between users, it’s still highly non-trivial to predict affinity.
One reason for the difficulty (there are many) is the large number of familiar strangers found in a dense urban environment.
One reason for the difficulty (there are many) is the large number of familiar strangers found in a dense urban environment.
Co-Locations

being in the same place at the same time

Context matters when looking at co-locations.
Co-Locations

being in the same place at the same time

Context matters when looking at co-locations.
Co-Locations

being in the same place
at the same time

Starbucks

We designed a set of contextual properties of co-locations that predict pretty well whether or not two people are friends.
What are the privacy implications here?
What are the privacy implications here?

[see above picture]
Location & Privacy
The (near) Future

Where are you?
But, what if you want some privacy?
Phones let you turn tracking off per app
But many applications use location in complex ways
Apps will need richer access control policies
Policy Configuration is Complex
Capturing Location-Privacy Preferences: Quantifying Accuracy and User-Burden Tradeoffs

*Personal Ubiquitous Computing, 2011*

Mike Benisch
Patrick Kelley
Norman Sadeh
Lorrie Cranor
we assume that the default behavior of a sharing service would be to deny access to your location in most cases. Between the hours of 9am and 5pm, on weekdays, and during the weekends, rules are simple and straightforward. However, at home, on the weekends, between the hours of 9am and 5pm, rules become more complex and may involve more interactions with friends and family.

In our analysis (Section 4.3), we focus on evaluating the accuracy of different privacy-setting types. For university community and Facebook friends, we find that Loc/Time+ is significantly more accurate than Loc settings. For these results, we hold constant the cost for inappropriately revealing a location at \( c = 20 \).

Figure 4: The average accuracy (bars indicate 95% confidence intervals) for each group, under each of the different privacy-setting types. For these results, we hold constant the cost for inappropriately revealing a location at \( c = 20 \).
- White-lists (on and off switches) do pretty well at capturing sharing preferences with close friends and family.
- For sharing with more diverse social groups, more expressive policies are required to capture user preferences.
- Even the most complex policies are only 60-70% efficient for social groups beyond Friends and Family.

Figure 4: The average accuracy (bars indicate 95% confidence intervals) for each group, under each of the different privacy-setting types. For these results, we hold constant the cost for inappropriately revealing a location at $c = 20$. 

Figure 4: The average accuracy (bars indicate 95% confidence intervals) for each group, under each of the different privacy-setting types. For these results, we hold constant the cost for inappropriately revealing a location at $c = 20$. 

For this we used a one-sample t-test.
- White-lists (on and off switches) do pretty well at capturing sharing preferences with close friends and family.

- For sharing with more diverse social groups, more expressive policies are required to capture user preferences.

- Even the most complex policies are only 60-70% efficient for social groups beyond Friends and Family.

People have complex preferences

Figure 4: The average accuracy (bars indicate 95% confidence intervals) for each group, under each of the different privacy-setting types. For these results, we hold constant the cost for inappropriately revealing a location at $c = 20$. 

For this we used a one-sample t-test.

White-lists (on and off switches) do pretty well at capturing sharing preferences with close friends and family.

For sharing with more diverse social groups, more expressive policies are required to capture user preferences.

Even the most complex policies are only 60-70% efficient for social groups beyond Friends and Family.

People have complex preferences

Figure 4: The average accuracy (bars indicate 95% confidence intervals) for each group, under each of the different privacy-setting types. For these results, we hold constant the cost for inappropriately revealing a location at $c = 20$. 

For this we used a one-sample t-test.
Continuous Friend-To-Friend Location Sharing With Rich Privacy Settings
Who?  
Where?  
When?

Rule is a conjunction of Who, Where and When clauses.

Policy is a disjunction of Rules.

Location Sharing Policies
Location Sharing Policies

Example Rules

CMU Rule
Your friends in the Carnegie Mellon network can see your location when you are at CMU, on weekdays between 8:00 am and 6:00 pm

Family Rule
Family (John, Catrina and 2 others) can see your location wherever you are, at all times

Friends Rule
Friends (Henriette, Jason and 6 others) can see your location wherever you are, on weekends between 8:00 am and 6:00 pm

Location Sharing Policies
Comments, Limitations, Criticisms???
Comments, Limitations, Criticisms???

[raise hands now]
Efficiency is a **best case** analysis. It assumes the user is actually capable of knowing (and specifying in advance) the optimum policy. Real world policies will be less accurate.
• Efficiency is a **best case** analysis. It assumes the user is actually capable of knowing (and specifying in advance) the optimum policy. Real world policies will be less accurate.

**Comments, Limitations, Criticisms???

• The analysis (for the most part) ignores **user motivations** and **utilities** of sharing. There are many complex reasons why people would want to share their location. It’s difficult for the participant to anticipate in advance what these reasons might be.
Why do people share their location?
Why do people share their location?

[sorry, raise hands again]
Location Sharing is more than checking up on friends.
Foursquare
It's more fun with friends!

Hi Justin Cranshaw
Pittsburgh, PA
Last seen 1 week ago at: Legume

Friends' Recent Check-ins

Jorge Ortiz @ Giaimo & Giaimo
"Re-signing my East Village apartment lease for another year."
New York - 45 minutes ago

Yanneh @ WINLAB
North Brunswick, NJ - 1 hour ago

Eran T @ קריית בוסון
20 hours ago

Katie Klancheski @ Manhattan Inn
Brooklyn, NY - 1 day ago

Newly Crowned Mayors
Near Pittsburgh, PA
Checkins

- When users are at a place they want to share with their friends, they “check-in.”
- Check-ins are viewable only by your social connections, and other people who are checked-in to the same place as you.
- If people are checked in near by to you, you’ll receive a push notification on your phone.
- Users get points and rewards for checkins.
Your friends’ check-ins provide ambient cues into what they’re up to.
Your friends’ check-ins provide ambient cues into what they’re up to.
Your friends’ check-ins provide ambient cues into what they’re up to.

By seeing where your friends go, you can discover new places to visit.
Your friends’ check-ins provide ambient cues into what they’re up to.

By seeing where your friends go, you can discover new places to visit.
Foursquare Apps: An Ecosystem of Location Sharing
4SQ App Gallery

Featured Apps

- SoundTracking

Get foursquare on your mobile

- iPhone
- Android
- BlackBerry
- OVI
- palm
- Windows Phone

Interested in building something?
The foursquare API enables developers to build applications that interact with the foursquare platform.

You can use the API to create new ways to check-in to foursquare or visualize the data generated by the foursquare community.

foursquare Developer Site

Submit your foursquare App

Recently Added Apps

1. GoodHop

Take a look at what others have already built using our API.

https://foursquare.com/app/goodhop#
Oust.me

Description

Oust.me is a strategic geo location game, which uses geo locations as the main game feature to build territories, influencers and top spots. Oust.me collects all your recent history of check-ins from before mentioned services and let you play a strategic interactive game at one spot.

Screenshots

![Oust.me](https://foursquare.com/app/oustme)

Oust.me

- **Category:** Games
- **Created by:** Oust
- **Date added:** April 14, 2011
- **More info:** Learn more

Like it: 1 Like
DON'T EAT AT

Get a text message when you check into a NYC restaurant that is at risk of being closed for health code violations.
Takeaway:

‣ People share their locations for lots of different reasons.

‣ Understanding user motivations is important to understanding how to design privacy mechanisms for location sharing.
UbiComp envisions a world with thousands of invisible computing devices embedded wherever we go.

This suggests we can expect lots of third party devices tracking our location (not just cell phones).

This may mean even **less** control over our location data (at least the smart phone is **ours**).
Questions?

Justin Cranshaw
jcransh@cs.cmu.edu
@jcransh (twitter)