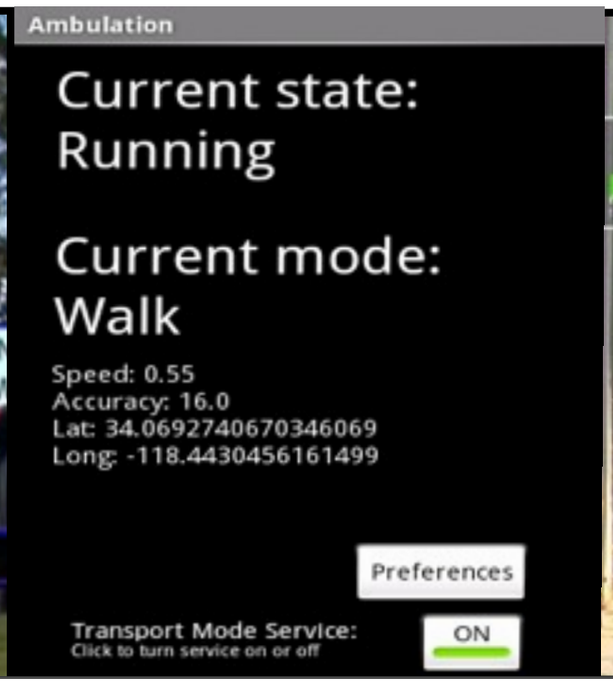
Participatory Sensing:
citizen science, scientific citizens, computational thinking

Deborah Estrin, UCLA CS and CENS, destrin@cs.ucla.edu
In collaboration with faculty, students, staff at CENS

Enabled by >3 x 10^9 mobile phone users, increasingly with gps, imagers, UI

Motivated by 6 x 10^9 people on planet earth and their concerns...



Acknowledgments: Collaborators and Sponsors

Collaborators

Technology Faculty/PIs:
Jeff Burke, Deborah Estrin, Mark Hansen, Ramesh Govindan, Martin Lukac, Nithya Ramanathan, Mani Srivastava

Application Faculty/PIs (Health science, Education, Ecology):
Jacqueline Casillas, Patricia Ganz, Jeff Goldman, Eric Graham, Jerry Kang, Jenny Kim, Jane Margolis, Maria Teresa Ochoa, Mary Jane Rotheram-Borus, Ida Sim (UCSF), , Dallas Swendeman, Michael Swiernik

Students/staff:
Staff: Betta Dawson, Mo Monibi, Joshua Selsky, Eric Yuen, Ruth West,
Graduate students: Amelia Acker, Peter Capone-Newton, Patrick Crutcher, Hossein Falaki, Brent Flagstaff, John Hicks, Donnie Kim, Keith Mayoral, Min Mun, Sasank Reddy, Jean Ryoo, Vids Samanta, Katie Shilton, Masanao Yajima, Nathan Yau,
Undergraduate students: Jameel Al-Azeez, Joey Degges, Gleb Denisov, Cameron Ketcham, Ashley Jin, Chenyang Xia

Sponsors and Partners/Collaborators

UCLA centers: CENS, REMAP, Global center for families and children, Health Sciences

Federal funding: NSF: NETS-FIND Program, OIA, Ethics, BPC; NIH, NOAA

Corporate funding: Google, Intel, MSR, Nokia, T-Mobile, Cisco, Sun (RIP)

CENS Center for Embedded Networked Sensing CENS Center for Embedded Networked Sensing CENS Center for Embedded Networked Sensing CENS Center for Embedded Networked Sensing CENS Center for Embedded Networked

Some definitions to start...

- **Participatory Sensing:** an approach to data collection and interpretation in which individuals, acting alone or in groups, use their personal mobile devices and web services to systematically explore interesting aspects of their worlds ranging from health to culture.

  continuum from automated sensing to participatory observation

- **Citizen Science:** scientific work in which individual volunteers or networks of volunteers, many of whom may have no specific scientific training, perform or manage research-related tasks such as observation, measurement or computation (Wikipedia).

  continuum from crowd sourcing (SETI at home,mechanical turk)...to engagement

- **Scientific Citizens:** systematic knowledge-base or prescriptive practice that is capable of resulting in a prediction or predictable type of outcome. (Wikipedia) as applied to our roles as citizens and community members

- **Computational Thinking:** a new way of solving problems ...uses many of the same techniques used by computer science...algorithmically solve complicated problems of scale....novel approaches to problem solving...conducting experiments that apply novel computing concepts to problems to show the value of computational thinking.(Wikipedia, CMU)

Participatory Sensing

enabled by mobile (smart)phones + web + social networking

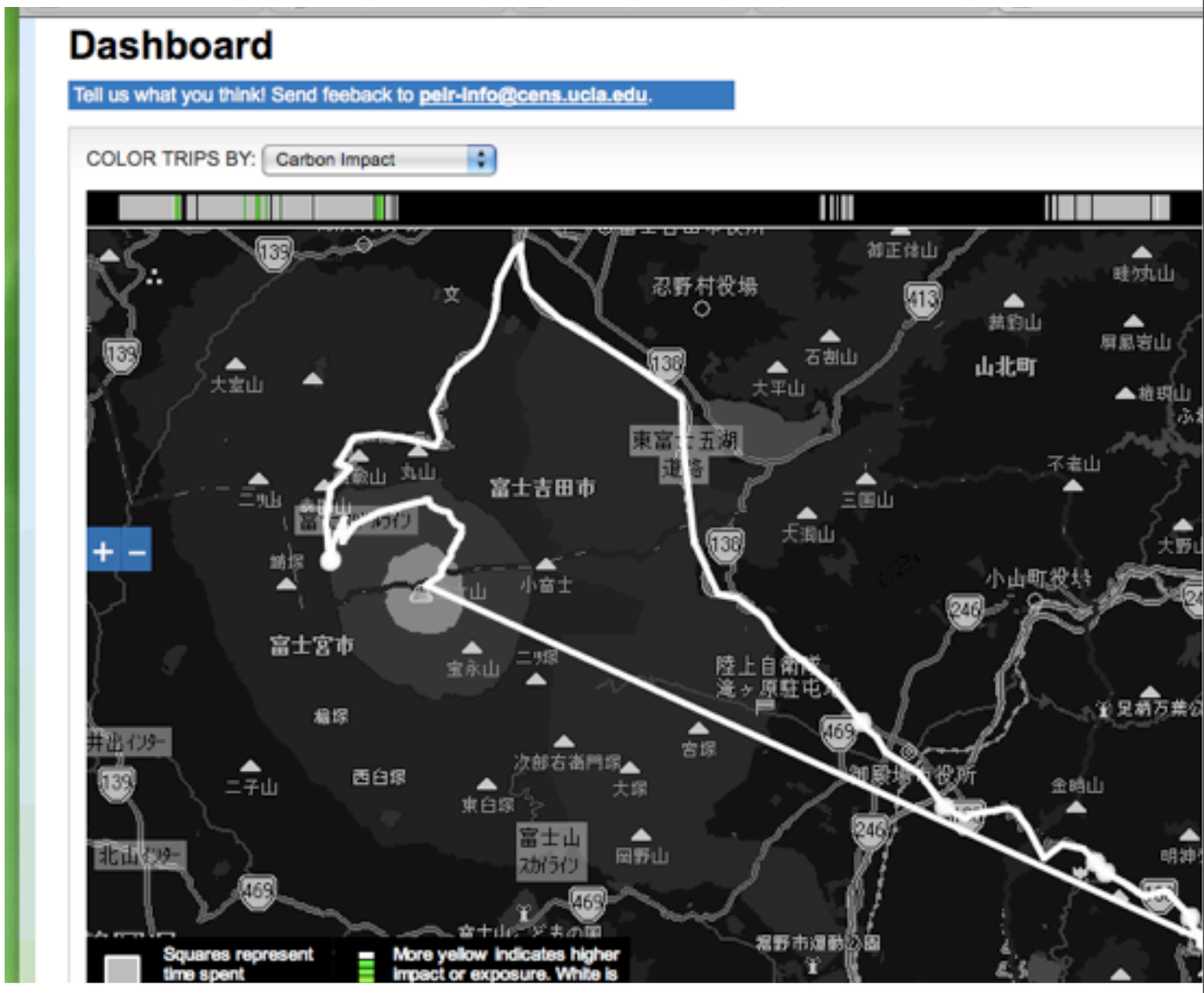
An approach to data collection and interpretation in which individuals, acting alone or in groups, use their personal mobile devices and web services to systematically explore interesting aspects of their worlds ranging from health to culture.

real time
(*always on*)

real place
(*always carried*)

real context
(*historical*, *environmental*, *spatial*, *social*)

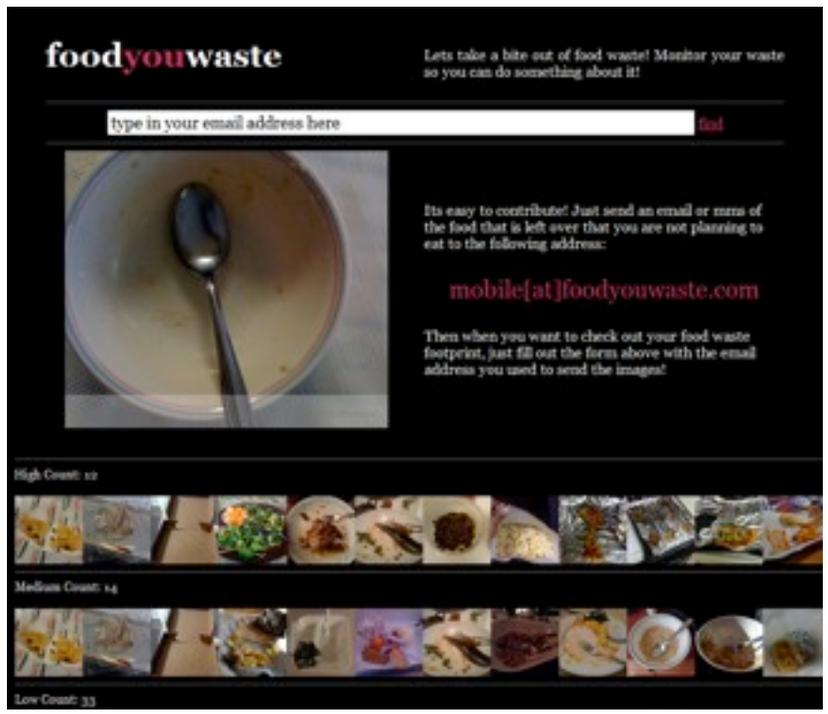
real applications
(civic and environmental data, transportation, health, education)



Center for Embedded Networked Sensing

Campaigns – focused, lightweight, easy to create/join/analyze

http://garbagewatch.com/



http://foodyouwaste.com/

Distributed data gathering challenges

- Spatially and temporally constrained, systematic data collection operations.
- Exploring a single hypothesis/phenomena/ theme.
- Using human-in-the loop sensing to gather data.
- With automatic and manual tagging (classification), auditing, and analysis.
- Precedent : Community-Based Participatory Research, Photo Voice

Approach scales *down* as well as *up*

- Even useful at small *n*
- Real use can drive and guide innovation

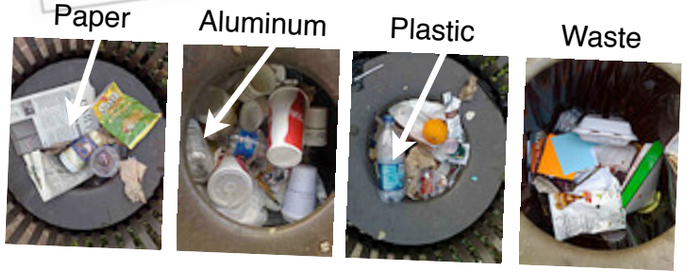
Nature article: “Phoning in Data”

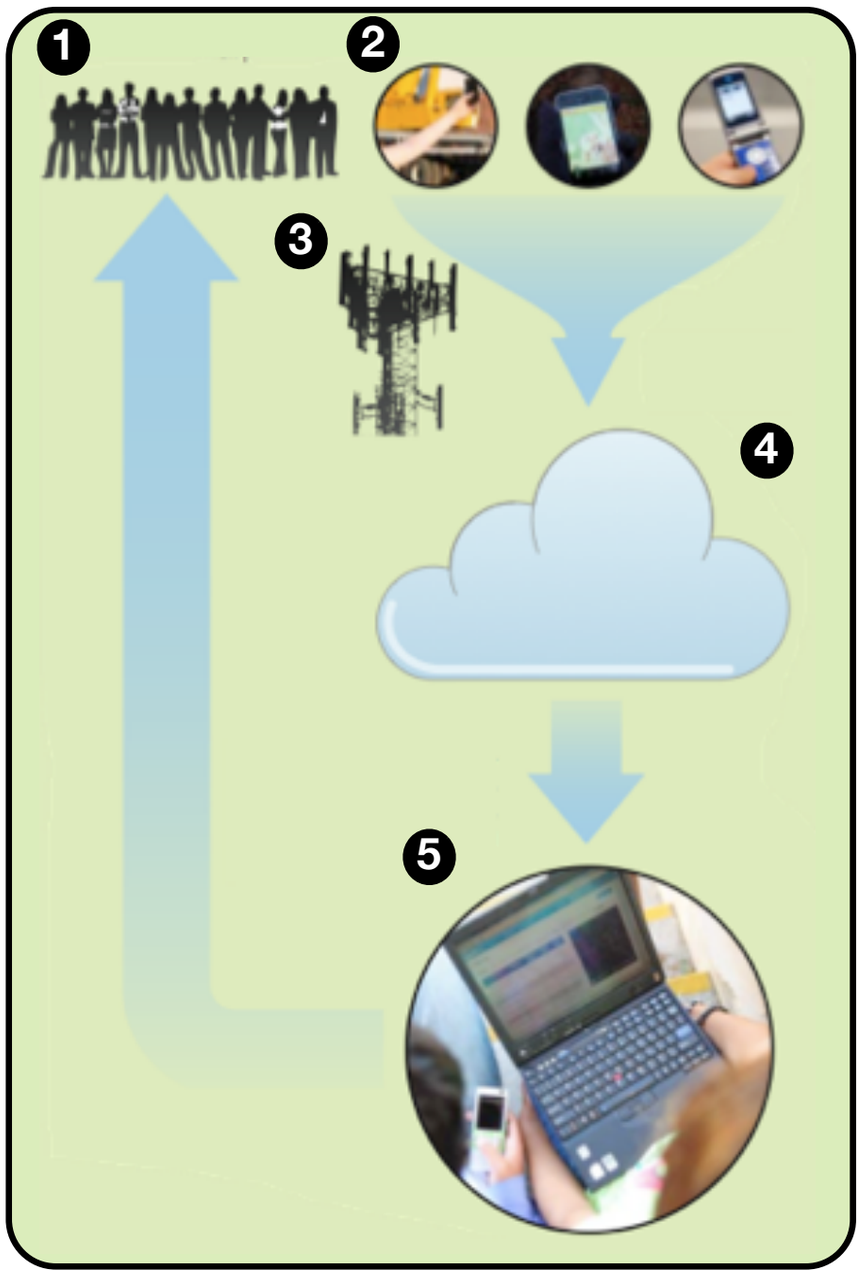
Civic and environmental data campaigns

leveraging coordinated, real-time, geo-coded, tagged, images and prompted entries

GarbageWatch

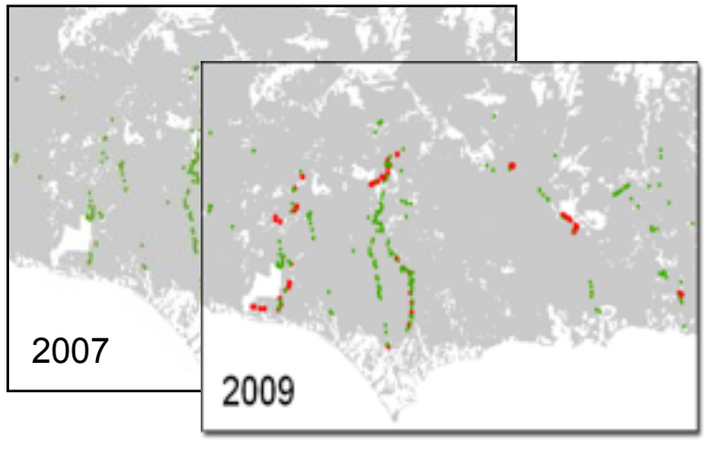
Recycling Practices on Campus





What's Invasive

Invasive plant and pest monitoring



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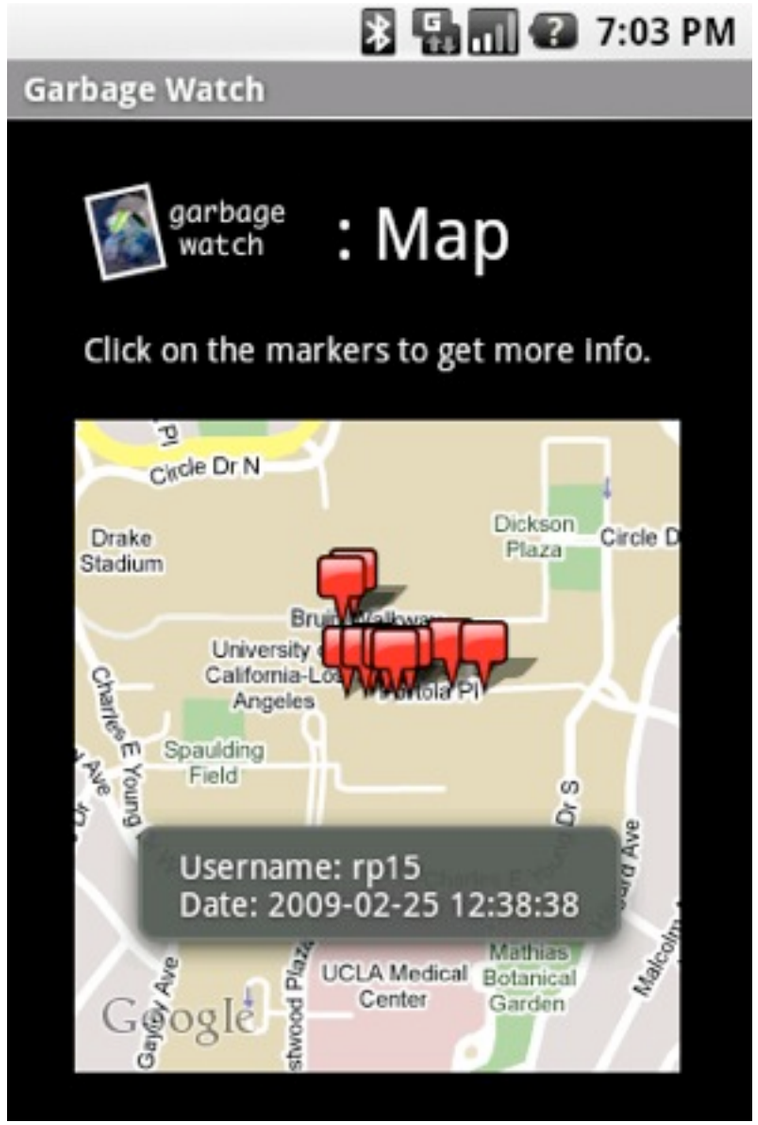
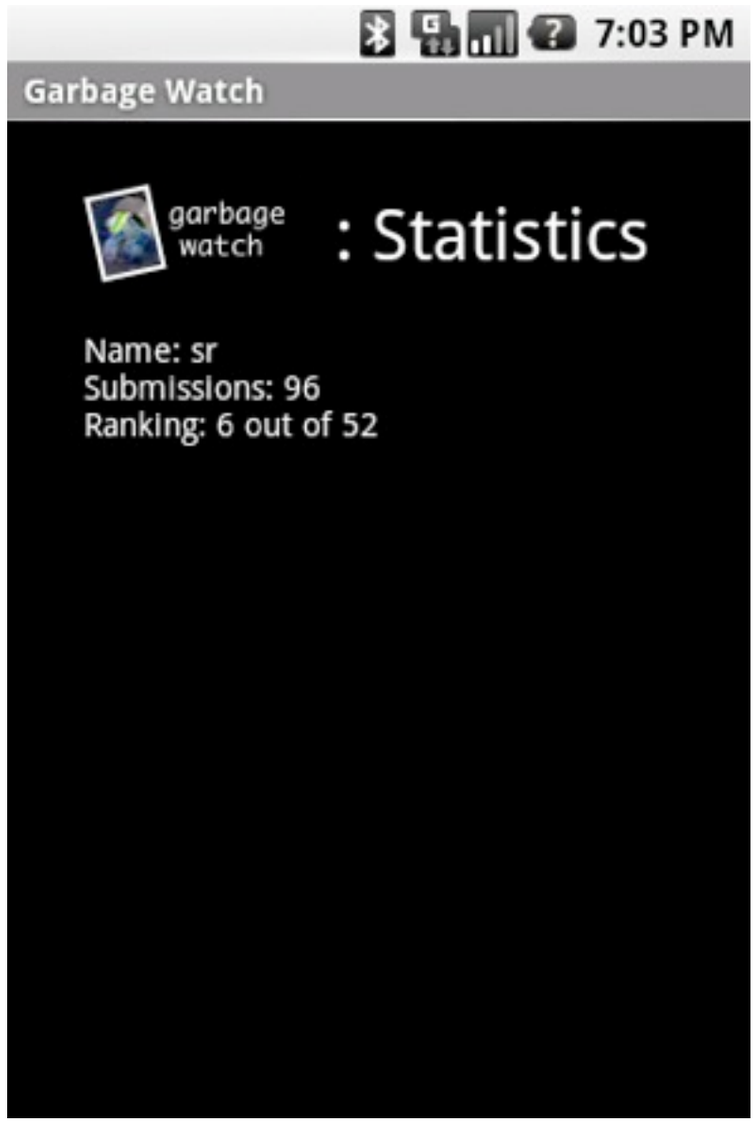
Scientific citizens:
PS application developed by/for undergraduate sustainability class at UCLA

Screen shots taken from the application running on a SmartPhone (Android)





Citizen science data campaigns: *What's Invasive!*

w/National Park Service, Santa Monica Mountains

http://whatsinvasive.com

Mobile app available on Android Market and iPhone App store

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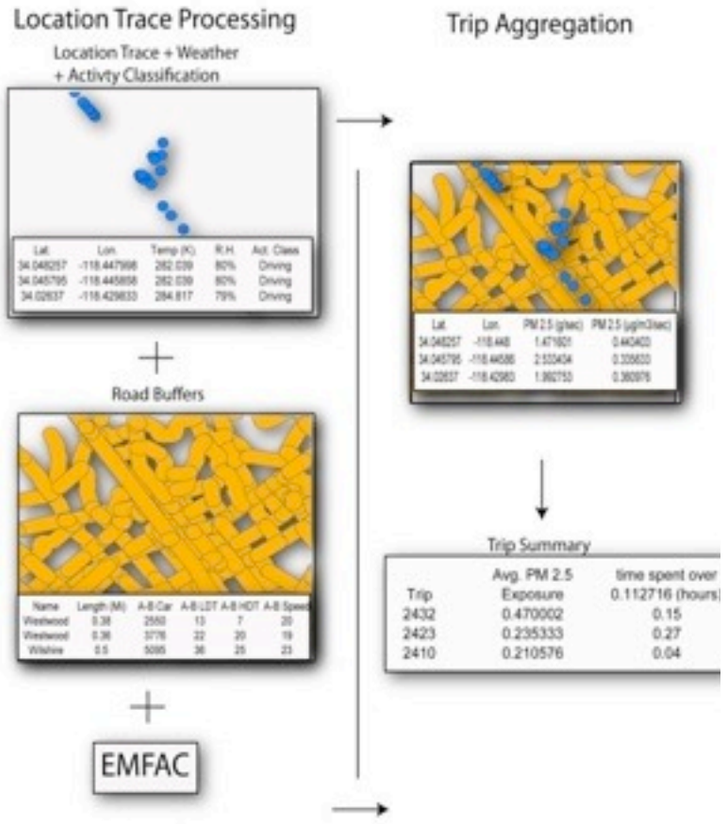
Scientific Citizens:
personal and community sustainability tools

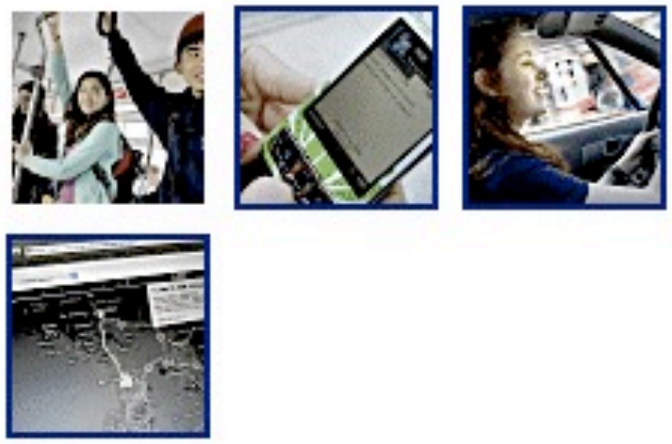
leveraging gps/accelerometer/wifi-based location-activity-time series

PEIR: Personal Environmental Impact Report



Center for Embedded Networked Sensing

http://peir.cens.ucla.edu

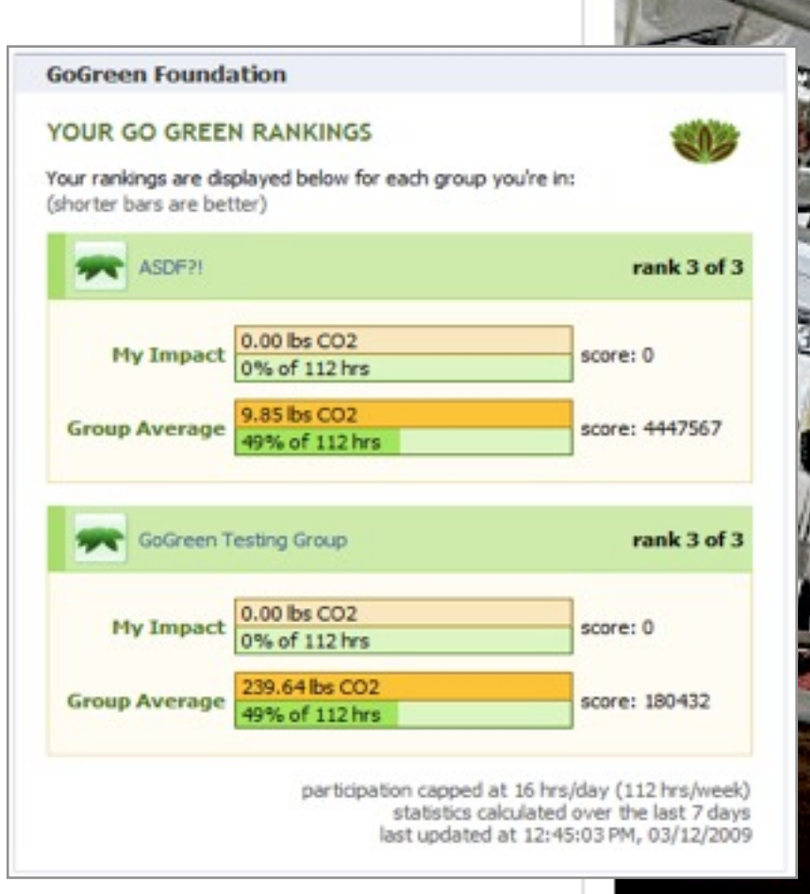


« PREVIOUS NEXT »

Program helps kids find their carbon impact

Catalina Gutierrez (center) and twin brother Trevor are learning to make better carbon-based transit decisions. (Brant Ward / The Chronicle)

Brant Ward / The Chronicle



GoGreen Foundation

YOUR GO GREEN RANKINGS

Your rankings are displayed below for each group you're in:
(shorter bars are better)

ASDF?! rank 3 of 3

My Impact	0.00 lbs CO2 0% of 112 hrs	score: 0
Group Average	9.85 lbs CO2 49% of 112 hrs	score: 4447567

GoGreen Testing Group rank 3 of 3

My Impact	0.00 lbs CO2 0% of 112 hrs	score: 0
Group Average	239.64 lbs CO2 49% of 112 hrs	score: 180432

participation capped at 16 hrs/day (112 hrs/week)
statistics calculated over the last 7 days
last updated at 12:45:03 PM, 03/12/2009

Biketastic:

bicycle commuters document, plan, share route data
...to promote safe cycle commuting

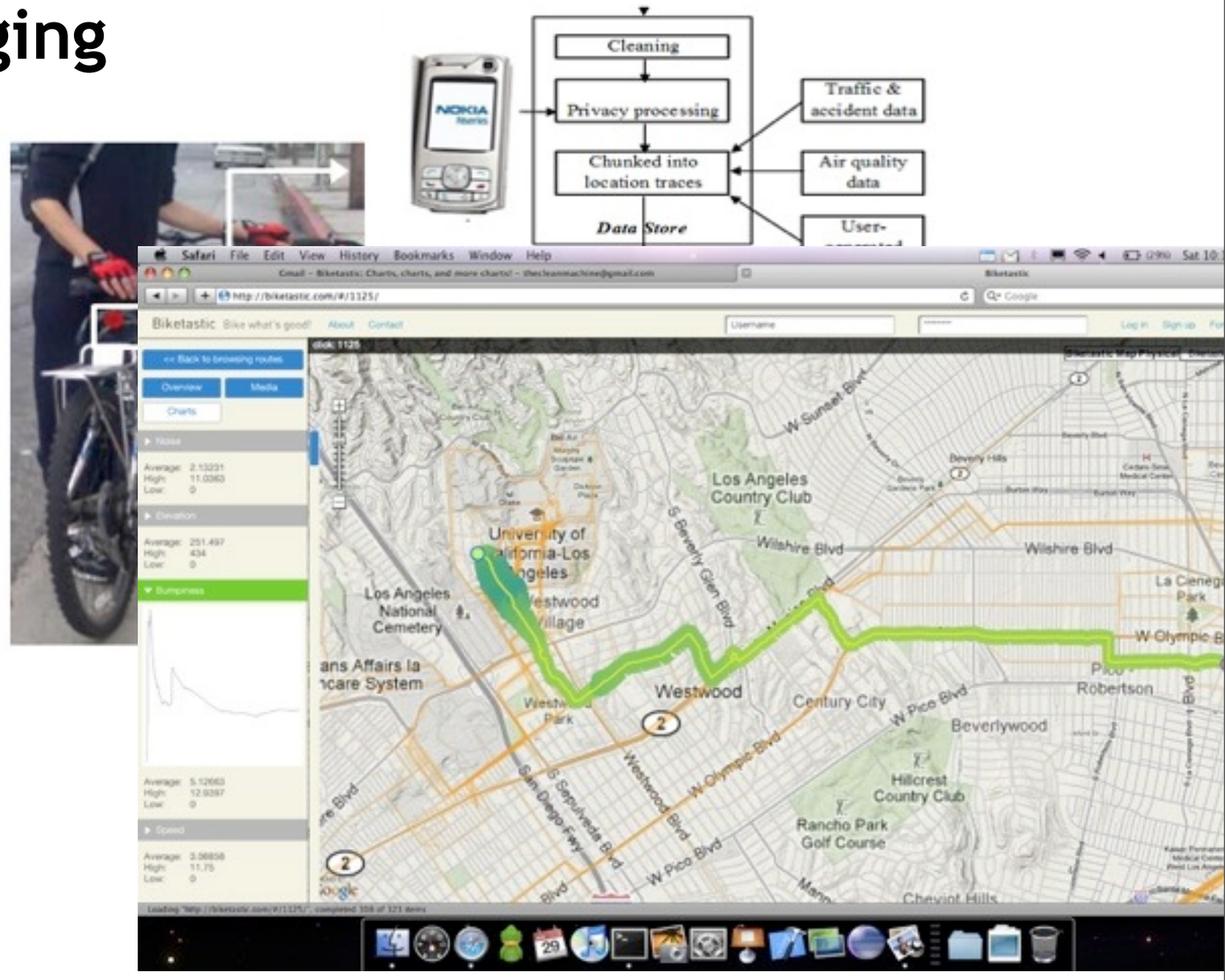
location+motion trace augmented with images and tagging

Capture & share route features

Collects: **location, duration, stops/ starts, roughness,** prompted images/tags

Web interface compares route qualities

Future: mash up routes with air quality, traffic conditions, accidents



CENS Center for Embedded Networked Sensing

http://biketastic.com, mobile app available on Android Market

Participatory Sensing for health and wellness: another opportunity for engaging with data in everyday life

leveraging geo/time-coded user input as well as activity traces

what can we learn,
what impact can we have,
with access to

...all 168 hours of the week...
...all 1440 minutes of the day...

Health & Wellness: Experience Sampling

Hybrid of time-location trace with media capture and self-report.

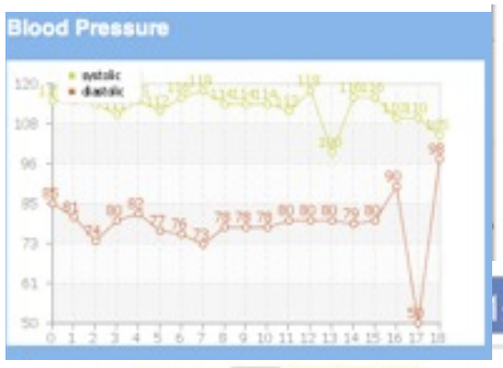
Our Actions

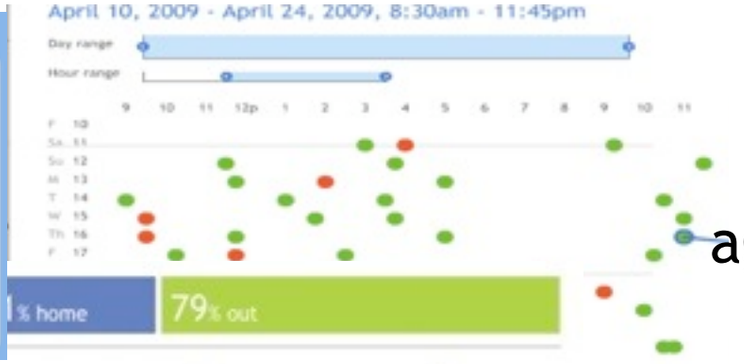
Our Self Report

Geocoded and time-stamped EMAs

Mobility traces

Private Data Storage





Visualization

aggregate measures, trends, patterns

event detection

Processing

Photo – Marshall Astor

Capture your life in **data**. One **tweet** at a time.

Get Started Now »

Step 1. Follow @yfd on Twitter

Step 2. Sign in to *your*.flowingdata with Twitter

Step 3. Start recording data (via direct messages) following a few simple guidelines

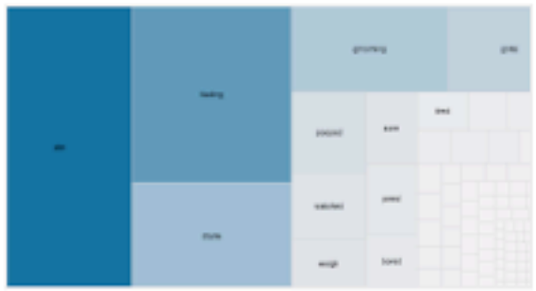
Making Choices

We make tiny choices every day. Those choices become habits, and those habits develop into behaviors. *your*.flowingdata helps you record these choices.

READ MORE

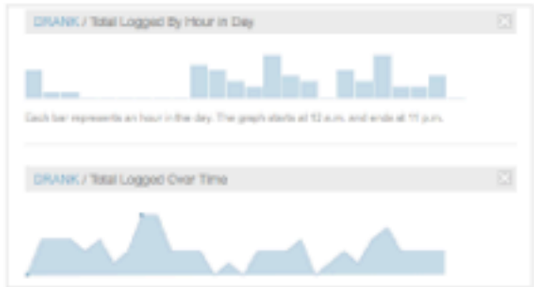
Collect data anywhere.

The ubiquity of Twitter allows you to record data from just about anywhere. If you can tweet, you can record data.



Interact with your data.

Data is meant to be played with. Use interactive data visualization and explore your data.

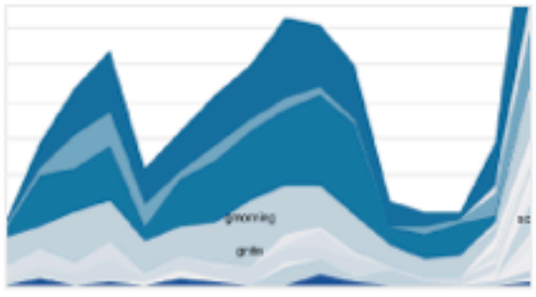


Customize views to your data.

All data is not created equally. Create custom visualization pages for what you're most interested in.

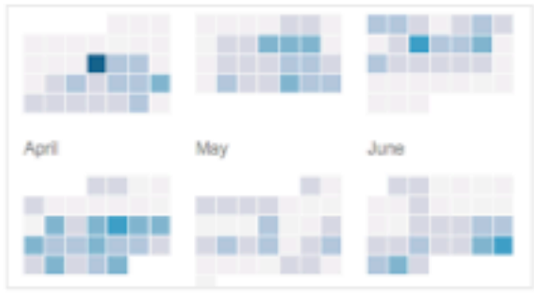
Share your findings.

Some data is meant to be private, but some is worth sharing. You decide what others can and can't see.



Understand yourself.

In the same way you can see growth from reading old entries in a diary, monitor your growth and progress through data.



Explore your data easily.

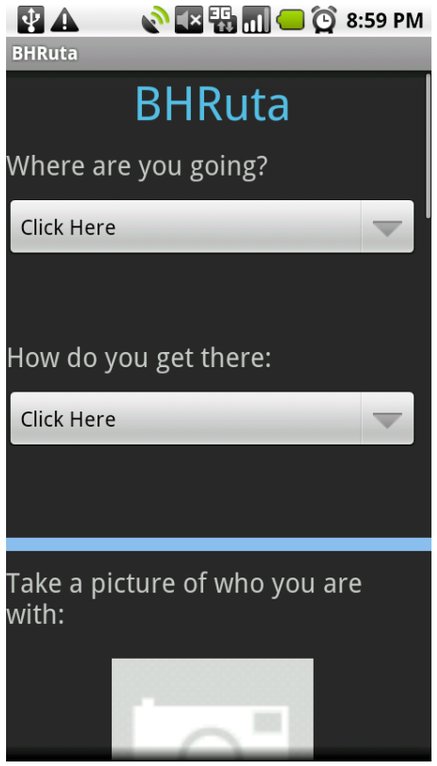
your.flowingdata was designed by a statistician, but you don't have to be one to play with your data.

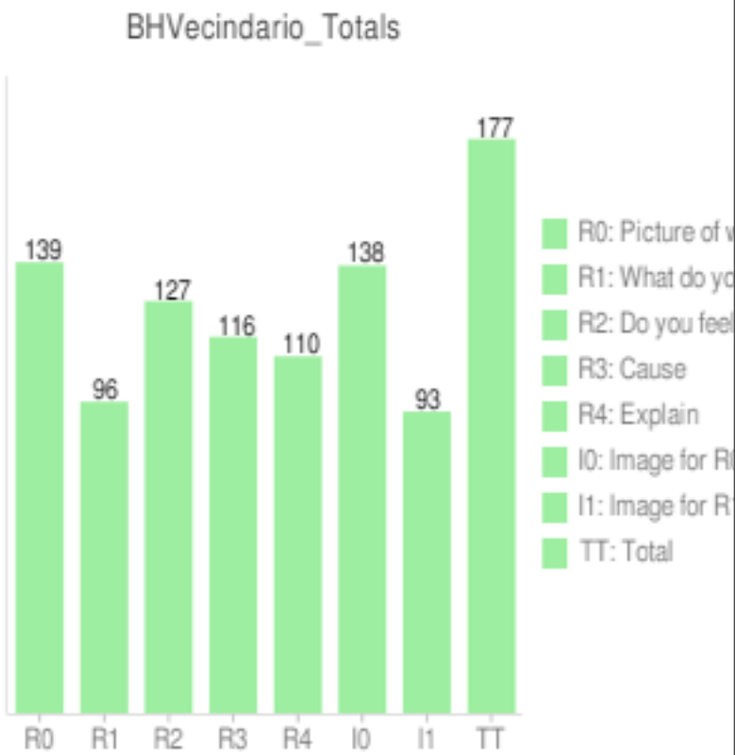
Follow @yfd on Twitter and Get Started Now

Yau, Hansen

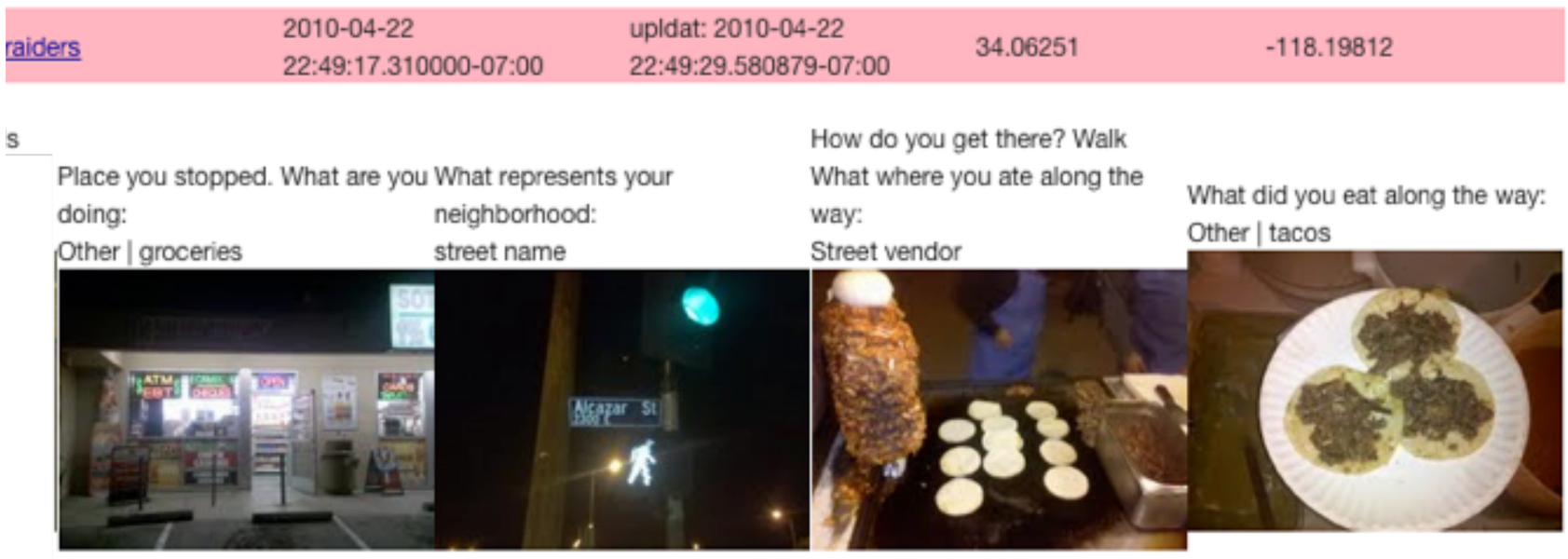
Healthier communities: Building a Healthy Boyle Heights

“ … Typically planning processes and planners come in and plan with an outside perspective instead of looking at existing patterns of resident flow.”





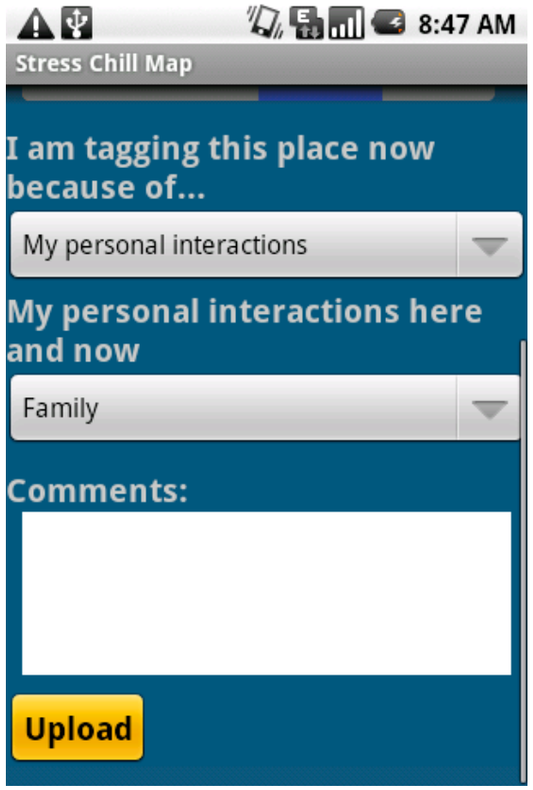
- ~100 residents/6 weeks documenting conditions in and between work, school, home.
- Where they go and gather, the conditions surrounding them.

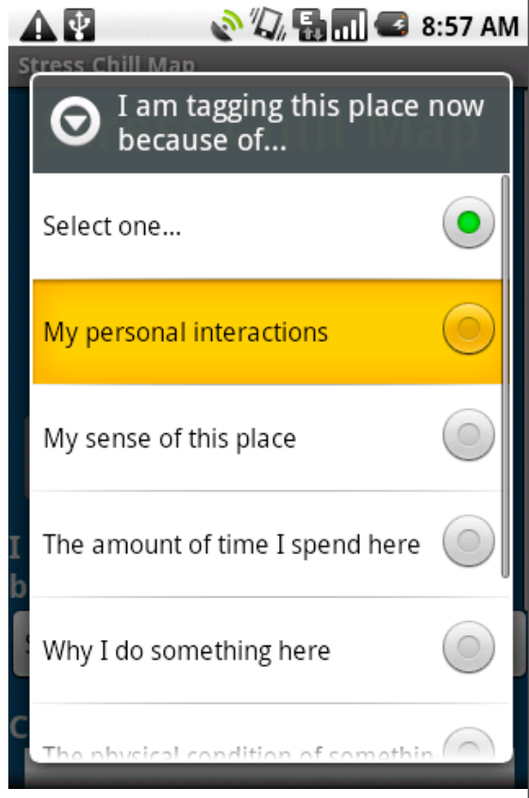


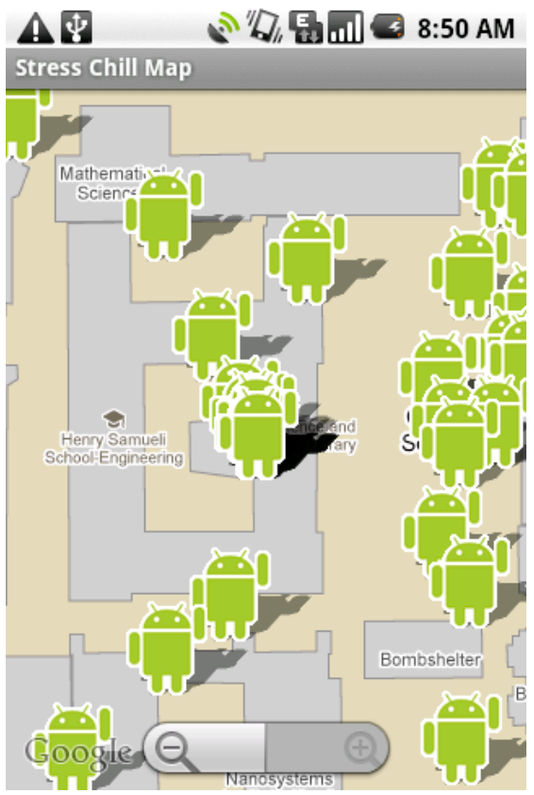
Lukac et al

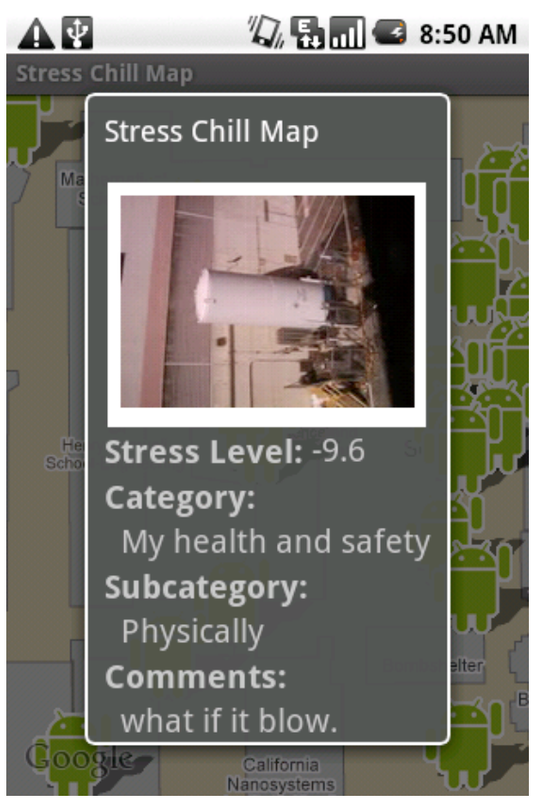
Participatory sensing as a a tool for (teaching) Computational Thinking

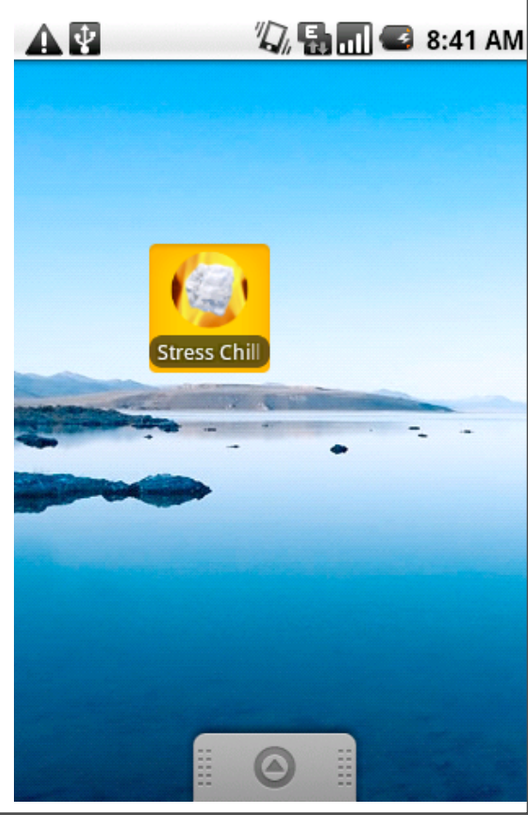
- Computational thinking and data in everyday life
- **Stresschill mapping** pilot w/~300 high school students in LA
- Inquiry-based observation, analysis: **biological, physical, environmental, social sciences, arts/culture**
- critical thinking teaching opportunity: personal privacy, how **computational thinking can lead to alternative realities**











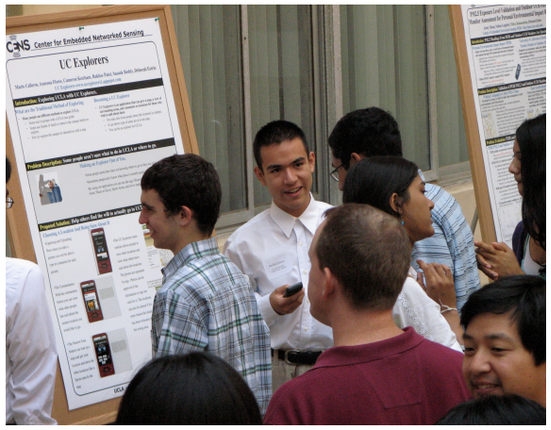
2010 UCLA CENS High School Scholars Summer Program

Education Director: Karen Kim, Ph.D.

Contact Info: Office 310-206-3026

Fax: 310-206-3053

email: karenkim@cens.ucla.edu



Engaging high school students in authentic research experiences

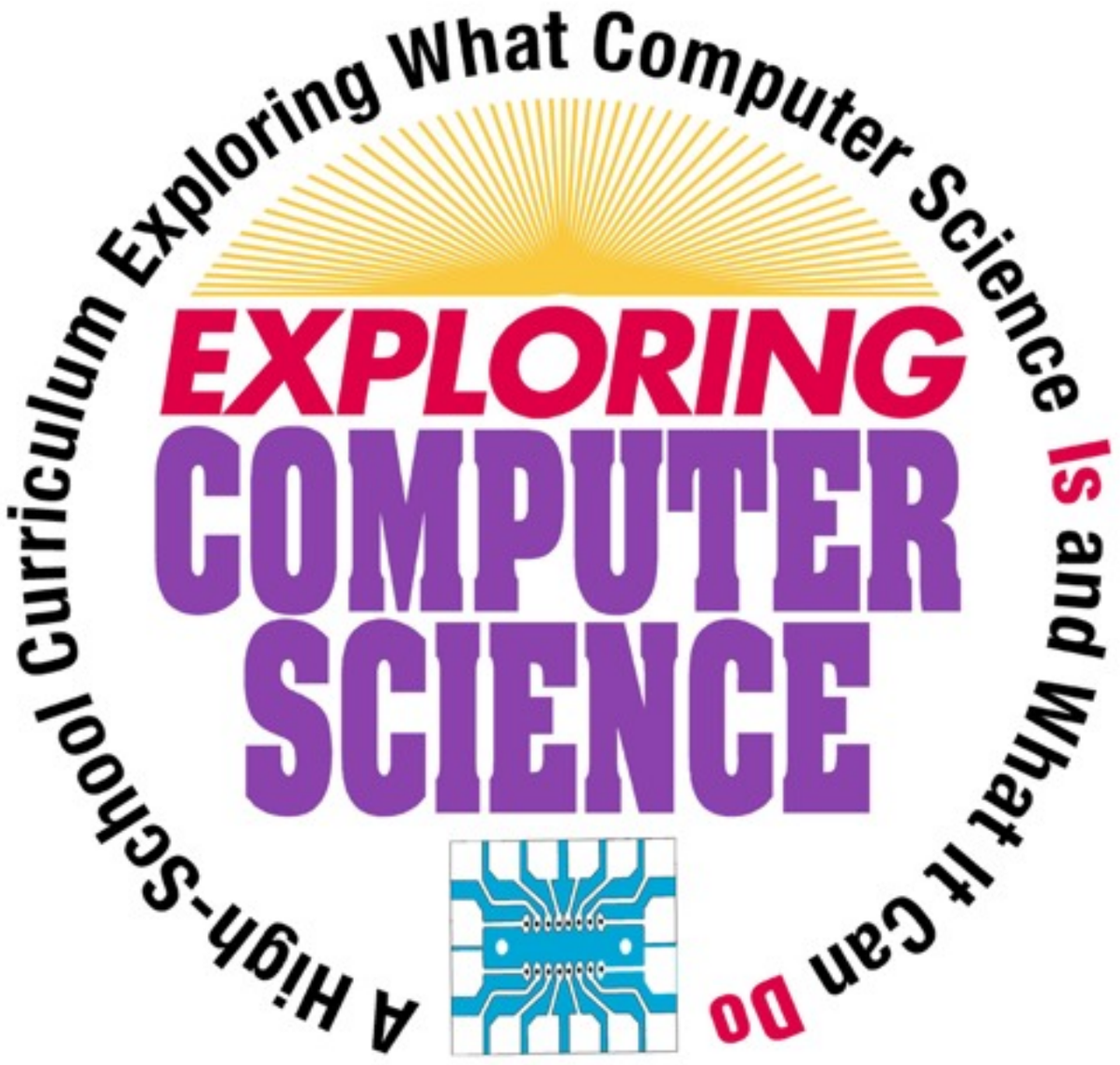
The Center for Embedded Networked Sensing (CENS) at UCLA is offering a unique opportunity for LAUSD high school students to gain first-hand experience in cutting-edge research that has direct impacts on scientific and social communities. Selected CENS High School Scholars will be a part of an 8 week summer research program in which students will participate in hands-on computer science research, learn more about life as a college student, and prepare for college and future careers. Women and underrepresented students are encouraged to apply.

Program Overview

- Eight week summer internship experience on the UCLA campus
- Direct involvement in hands-on computer science research in a nationally recognized lab
- Introduction to CENS technology and programming cell phones
- Participation in a community of faculty,

Building an Engaging Curriculum—Focused on Computational Thinking

Jane Margolis, et al



College-Preparatory Math Elective Credit

http://www.csta.acm.org/Curriculum/sub/ExploringCS.html

Instructional Units

1. Human Computer Interaction
2. Problem Solving with Computer Science
3. Web Design
4. Introduction to Programming (Scratch)
5. Robotics
6. Data Analysis (Python or R/ Participatory Urban Sensing)

contact: margolis@ucla.edu

Exploring Computer Science in LAUSD

20 High schools

Over 900 Students

Almost All Students of Color--
(Latino/a,
African American,
Asian)

LAUSD Breakdown by gender and race of students who

LAUSD	Female	Males	TOTAL
Latino	246	398	507
African American	46	48	94
Asian	28	54	82
Unknown			45
White	18	25	43
Filipino	4	7	11
Pacific Islander	0	2	2
TOTAL	**342**	**534**	**921**

OAKLAND, SAN JOSE WILL BEGIN THIS YEAR

PLANS UNDERWAY IN CHICAGO, SAN DIEGO, OREGON

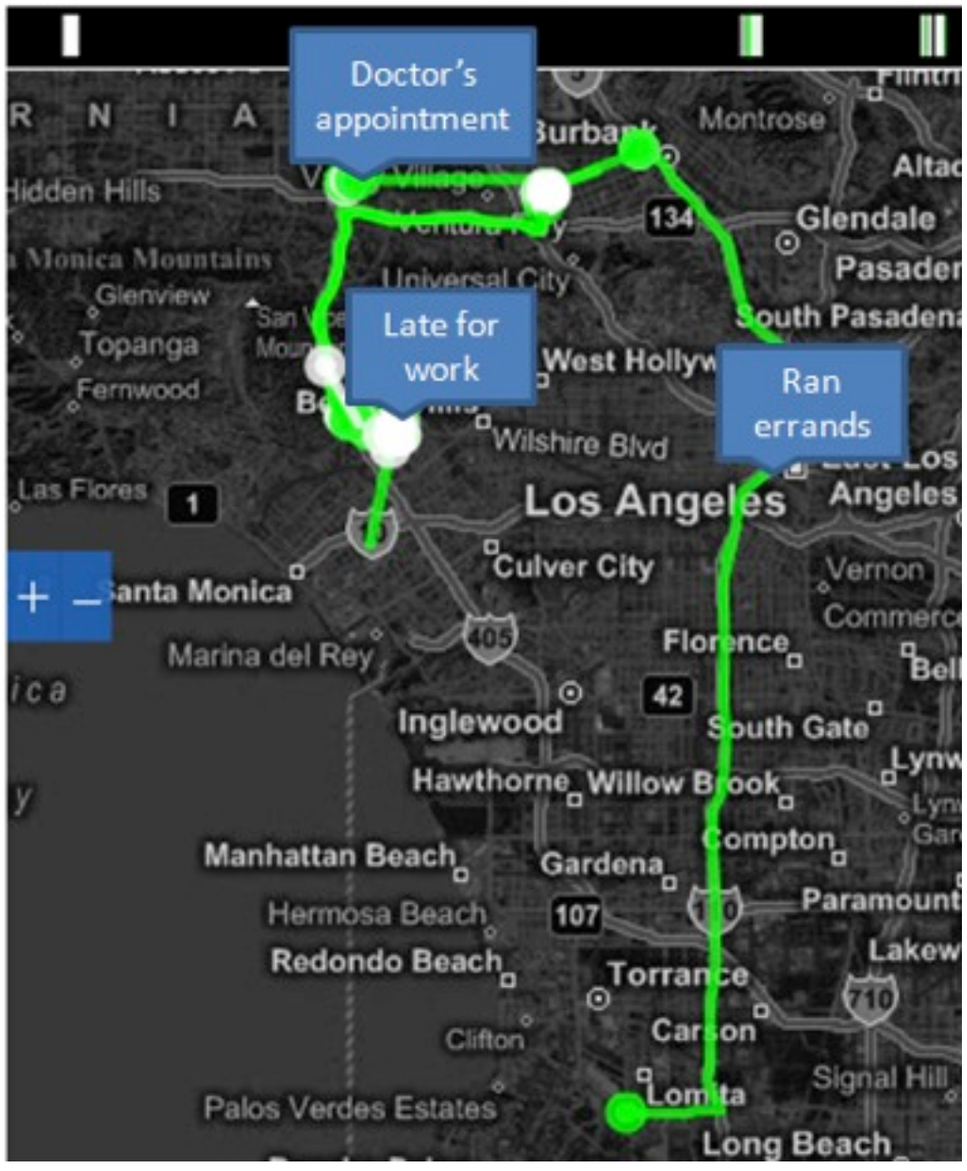
Personal privacy presents a teaching opportunity for critical thinking and Computational Thinking

Sensitive data

- Quantify habits, routines, associations
- Increasingly easy to share, mine
- Anonymizing location traces/geocoded time series is often infeasible
- Available to government, insurance, employers, creditors, ...

Diverse usage

- Collected by individuals
- Using apps authored by ... anyone?
- Shared with nobody, everybody, or some set in between



Personal Data Vault (PDV):
allow participants to retain control over their raw data

Mobile App

- Data Capture / Upload (Prompted, Automated)

- Reminders

- Feedback, Incentives

Well defined interfaces allow mobile functions to be mixed, matched, and shared

Personal Data Vault

- User Identity and Authentication

- Long-term Data Management

Patient defined selective sharing with Open mHealth Server function

Third Party Services

- Analytics for Personal Data Streams

- Interface to Clinical Care Plan, Personnel

- Integration with EHR/PHRs

- Cross Patient Aggregation

Well defined interfaces allow analytics functions to be mixed, matched, shared, compared

vault + filters = granular, assisted control over what you send to who, what that data says about you, whether you reveal who you are or share anonymously, ...

Conclusion

If you can’t go to the field with the sensor you want...go with the sensor you have!

Participatory Sensing can bring computational thinking to the classroom and the livingroom.

It takes a healthy research ecosystem to bring information technology innovations to meaningful societal use

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Corporate funding: Google, Intel, MSR, Nokia, T-Mobile, Cisco, Sun (RIP)