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A Framework for Data Quality and Feedback In Participatory Sensing

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Introduction: Use mobile devices to form interactive participatory networks where individual and institutional users gather, analyze, and share local data.

Large Installed Base of Mobile Phones

- Media capture and signal processing
- Wireless interfaces to external sensor
- Localization support.
- Always on and network-connected

Data collection and documentation play a vital role in civic participation and community life.

Enable distributed human-in-the-loop sensor systems at personal, social and urban scale.

- Task human-carried mobile devices as sensor nodes
- Leverage imagers and microphones, local processing and network connectivity for easy, high quality data collection.
- Leverage USB and Bluetooth to peer with external sensors
- Support both bottom-up and top-down experimental design of distributed data gathering, classification and analysis.

Problem Description: Modeling “human factors” important for efficient, informative, and interactive data gathering.

Reputation and incentive mechanisms for data quality and increased participation.

- Can we optimize participant data gathering times by choosing the best users for a certain campaign?
- Can incentives be used to increase quality of sampling of individuals and increase overall participation?

Context awareness and mobility profiles to provide efficient feedback.

- Is mobility data effective to learn significant locations and routes of users? Can non-location sensors be used to gather additional context?
- What feedback mechanisms are most effective for both informative and incentive purposes?

Proposed Solution: Quality of Sampling, Context Awareness, and Feedback Mechanisms

Model data gathered by users into quality of sampling (QOS) metrics.

- **Timeliness**
Sampling, communication, audit latency.
- **Capture**
Noise based on sampling behavior.
- **Relevancy**
Does data represent sampling objective.
- **Coverage**
Spatial/temporal coverage.
- **Responsiveness**
Directed request probability.

Monitor QOS to determine macro-level trends and short term changes.

Online Summation and Management

Compare different aggregation techniques for quality metrics to decide which is appropriate for finding long-term trends and abrupt changes with minimum memory/computation footprint.

Compare average/variance, bayesian, and estimated moving average models.

Incentives to encourage high quality participation.

Economic vs Game Based Incentive System

Compare credit based system to providing a game type structure.

System Architecture Overview

Deliver feedback that matches the context.

Just-In-Time and Context Aware Feedback

Determine user's current and future context (location, route, social setting) to figure out the appropriate feedback to provide.

Create mobility profiles of users to determine their likely travel patterns and use non-location sensors (accelerometers, audio, light) to gain additional context regarding the environment.

Use various modalities for feedback (visual, auditory, or haptic).

Campaign Examples

Public Health:
Noise

Urban Planning:
Clean Neighborhood

Cultural:
Community Mapping