Opportunity Knocks:
A Community Navigation Aid

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Outline

1. Need for navigation aids
2. Limitations of current devices
3. Advancing the State of the Art
4. Prototype: Opportunity Knocks
5. Future plans
The Need: Community Access for the Cognitively Disabled
Problems in Using Public Transportation

• Learning bus routes and numbers
Problems in Using Public Transportation

- Learning bus routes and numbers
- Transfers, complex plans
Problems in Using Public Transportation

• Learning bus routes and numbers
• Transfers, complex plans
• Recovering from mistakes
Result

- Need for extensive life-coaching
- Need for point-to-bus service
Result

- Need for extensive life-coaching
- Need point-to-bus service
- Isolation
Current GPS Navigation Devices

- Designed for drivers, not bus riders!
  - Should I get on this bus?
  - Is my stop next?
  - What do I do if I miss my stop?
- Requires extensive user input
  - Keying in street addresses no fun!
- Device decides which route is “best”
  - Familiar route better than shorter one
Vision

Can we build a system that...

- **Automatically learns** the daily pattern of the user’s transportation plans – no typing!
- **Provides proactive help** in carrying out the plans
- **Helps user recover** from mistakes
- **Is compatible** with today’s transportation infrastructure
Approach

- User carries **GPS cell phone**
- System **infers bus use** from
  - Position (near bus stop?)
  - Velocity (on foot? in a vehicle?)
  - Bus route information
- Over time system **learns about user**
  - Important places
  - Common transportation plans
- Mismatches = possible **mistakes**
Inferring Goals
Transportation Plans

Goals
- work, home, friends, restaurant, doctor’s, ...

Trip segments
- *Home* to *Bus stop A* on *Foot*
- *Bus stop A* to *Bus stop B* on *Bus*
- *Bus stop B* to *workplace* on *Foot*
User Model

- System learns a probabilistic model of the user’s pattern of transportation use
- Robust even if...
  - Data is missing
  - Behavior varies
- User is predictable, but not rigid!
Goal Prediction
Error Detection: Missed Bus Stop
Prototype: Opportunity Knocks

- GPS camera-phone
- “Knocks” when opportunity to help

- Can I guide you to a likely destination?
- I think you made a mistake!
- This place seems important – would you photograph it?
Example
Example
Example
Example (continued)
Example (continued)

This graph shows how the system reasons about abnormal conditions. When the dashed, abnormal line rises above 80% confidence, the system believes that the untrained model better matches the observed GPS signals than the trained model and therefore an abnormal condition exists. OK waits until the curve breaks 80% confidence before alerting.
Example (continued)
Status

- Proof of concept prototype
  - Can use machine learning to create a smarter, more useful personal navigation system for disabled persons

- Basic scientific contributions on predicting human behavior
  - Best paper award at national computer science conference, AAAI
Next Steps

- User interface design, testing
  - Audio
  - Graphical
  - Adaptive

- Develop & deploy
  - Have begun discussions with METRO
  - Seek commercial partnerships
Probabilistic Model: Dynamic Bayesian Network

\[ g_{k-1} \rightarrow t_{k-1} \rightarrow m_{k-1} \rightarrow x_{k-1} \rightarrow Z_{k-1} \]

\[ t_k \rightarrow m_k \rightarrow x_k \rightarrow Z_k \]

Goal

Trip segment

Transportation mode

\( x = \langle \text{Location, Velocity} \rangle \)

GPS reading
Error Detection

- Approach: model-selection
- Run two trackers in parallel
  - Tracker 1: learned hierarchical model
  - Tracker 2: untrained flat model
- Estimate the likelihood of each tracker given the observations
Novelty Detection

![Probability vs Time Graph](image)

- **Normal Activity**
- **Abnormal Activity**

Time [sec]: 0 - 600

Probability: 0 - 1

$\text{t1}$ and $\text{t2}$ indicate specific time intervals of interest.