Project ACCESS: Wayfinding for Persons with Cognitive Disabilities

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The Need: Community Access for the Cognitively Disabled
The Problem

- **Using public transit is cognitively challenging**
  - Learning bus routes and numbers
  - Transfers
  - Recovering from mistakes
  - Point to point shuttle service slow, expensive

- **Current GPS units hard to use**
  - Require extensive user input
  - Loss of signal near buildings, inside vehicles
  - Little support for complex transit plans
A personal guidance system that
- Requires no explicit programming by user or caregiver
  - Learns the user’s routine
- Robust in the face of signal loss / noise
  - Leverage real-world constraints & user model
- Proactively assists user in completing transportation plans
  - Helps with changing mode of transportation
  - Recognizes user errors
  - Helps user recover
Idea

- User carries GPS cell phone
- System infers user’s state
  - Walking? Getting on a bus?
- System learns about user
  - Important places, routes
- Breaks from routine = user may be confused or lost
  - Offer help
  - Call caregiver
Approach: Learn Hierarchical DBN from Unlabeled Data

Cognitive mode
{ routine, novel, error }

Goal

Trip segment

Transportation mode

Edge, velocity, position

Data (edge) association

GPS reading
High Probability Trip Segments
Conditioned on Goal

Goal = Workplace

Goal = Home

: bus  : car  : foot
Error Detection: Missed Bus Stop

blue = foot  green = bus
ACCESS Prototype

- Cell phone with GPS, camera, high-speed internet access
- Prompts when it infers that user is...
ACCESS Prototype

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About to begin a transportation plan

- Confirm destination?
- Here is your route!
ACCESS Prototype

- Cell phone with GPS, camera, high-speed internet access
- Prompts when it infers that user is…

About to change mode

• This is your bus!
• Your stop is next!
ACCESS Prototype

- Cell phone with GPS, camera, high-speed internet access
- Prompts when it infers that user is…

Making an error

- You missed your stop!
- Here is how to get back on track …
ACCESS Prototype

- Cell phone with GPS, camera, high-speed internet access
- Prompts when it infers that user is…

Visiting a new destination

- Please take a picture!
Status

- Medical partnerships
  - Funding by National Institute of Disability & Rehabilitation Research (NIDRR)
- Extension to indoor navigation
  - Hospitals, nursing homes, assisted care communities
  - Wi-Fi localization
- Multi-modal interface
  - Speech, graphics, text
  - Guidance strategies
  - WOZ study with users with cognitive disabilities
Observations

- By and large, people lead regular lives – can learn useful movement patterns with surprisingly little data (2 weeks)
  - Many patterns hold across individuals
- Modeling abstract behaviors (goals, trips) increases robustness & predictive power
  - 5 blocks into the future → 50 blocks
- People with cognitive disabilities and their caregivers are eager for technological assistance
  - Safety & independence trump privacy
  - Comfortable with technology – but may be too trusting
  - No one size fits all solution – seamless automatic customization necessary
Papers

D. Patterson et al., Opportunity Knocks: a System to Provide Cognitive Assistance with Transportation Services, *UBICOMP-2004*.

L. Liao, D. Fox, & H. Kautz, Learning and Inferring Transportation Routines, *AAAI 2004*.