Strategic Elements of Route Choice for Next Generation Digital Navigation Systems

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Context of Research:
Personal, Digital Navigation Systems

- Vehicle or PDA/Smartphone based
- Take into account
  - User’s position (GPS)
  - Construction, traffic, and other obstacles
- Automatic generation of routes that prioritize or consider:
  - Shortest distance
  - Least Time
  - Avoiding Freeways
  - Avoiding Tolls
  - Intermediate waypoints
- Generally offer a single best route
Overall Problem

• Current navigation systems oversimplify the criteria of route selection so that they can provide a single best route based on expressed user preferences.

• Better solution
  – Use stated and revealed preferences
  – Find nearly equivalent routes and present these to the user. Use responses to further calibrate user strategic travel profile
  – Need a way to intelligently classify users’ strategic interests.

• How do environmental spatial ability, attitudes toward risk, and strategic disposition affect the way that individuals choose to navigate?
Preferences and Heuristics as Strategies

• Preferences
  – Shortest distance
  – Least time
  – Fewest turns
  – Straightest path
  – Avoid freeways
  – Aesthetic appeal
  – Avoid left turns
  – Safety
  – Least complex

• Heuristics
  – Choose initially long straight segments (ISS) (Bailenson et al., 2000/2002)
  – Choose path with least angular deviation from target (Hochmair and Frank, 2000)
  – Move to regions containing target as soon as possible (Wiener and Mallot, 2003)
Other types of wayfinding strategies

- **Style**
  - Route (Landmark) vs. Orientation (Survey) (Lawton, 1994)

- **Explicit Techniques**
  - Look-back strategy, edge following (Cornell, Heth & Rowat, 1992)

- **Reliance on external aids**
  - Maps or knowledge (Hutchins, 1995; Ishikawa et al., 2008)
  - Digital vs. analog

- **Task-related**
  - Search vs. Access (Passini, 1992)
Questionnaire Development

- $n = 101$
- Environmental Spatial Ability (SBSOD)
  - 15-item (Hegarty et al., 2002)
- Strategists & Risk-takers indices
  - 40-item original questionnaire
  - Factor analysis for reduced set
    - 10 item strategic disposition
    - 5 item risk-taker
- Mode-specific attitudes about risk
- Mode-specific criteria ranking
  - walking
  - driving
Adapting Prospect Theory to Wayfinding

Choose between
- A sure $20
- A 50-50 chance at $40 or nothing

Choose between
- A sure million dollars
- A 50-50 chance at 2 million dollars or nothing

Choose between
- A sure route taking 15 minutes
- An alternative with 50-50 chance of taking 10 or 20 minutes

Variables
- Mode – Walking, Driving, Parking
- Mean – Low, High
- Variability – Probability, Payoff ratio
Means and Variances when Walking and Driving

• Modality matters
  – Mean important when walking
  – Scaled variance important when driving

• Similar outlook within individuals
  – $r(99) = .46$
Route Selection Criteria

- **Ranked Criteria**
  - Separate ranking by mode
  - Fast, safe, attractive, simple, easy
- **Mode Matters**
  - Simple (not complex) more important for driving routes.
  - Related to risk-taker, $r(99) = .34$
Route Asymmetry

Rationale
• People often take a different route from A to B than from B to A.
• Same criteria applied to the same environment
• Perception of the environment is key
  – These different routes appear “better” depending on one’s perspective.
• Golledge (1995) and Bailenson et al. (1998; 2000)

Questions
• What features in the environment tend to result in asymmetry?
• Are some individuals more prone to asymmetry than others? If so, why?
Route Asymmetry Study Design

- Seven legs between four waypoints
- Random order according to several criteria
  - Flagpole / Psychology excluded
  - Five unique connections (Routes)
- Position tracked with GPS
- Only immediate destination known
  - Subjects radioed for the next destination
- Each walk took about 25 minutes
- $n = 65$
Measuring Asymmetry

• Binary (Same / Different)
• Gate Coding
  – Major pathways & obstacles
  – Common sequence length
    • CHLQ, AFKP, etc.
• Some gates (and Routes) showed more asymmetry than others
  – “High-friction” areas
Obstacles and Asymmetry

- Risk-takers move through high-friction sites.
  - Fast potentially relevant
  - But not “simple”
- Symmetry connected to
  - SBSOD
  - Strategist
  - Lawton’s Orientation Strategy
- But not
  - Risk-taking
  - Fast / Simple preferences
Summary

• Mode matters, but
  – Similar criteria, weighted differently
  – Attitudes about risk transcend, but manifest differently

• Attitudes about risk-taking
  – Impact obstacle avoidance
  – Instrumental rationality & the cost of uncertainty

• Strategic thinking & environmental spatial ability
  – Symmetric travelers

• The inclusion of correct classification of individual strategies will lead to improved satisfaction with routes provided by navigation systems.

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