**Orko: Facilitating Multimodal Interaction for Visual Exploration and Analysis of Networks**

**Data visualization user interfaces**

- **WIMP-based direct manipulation interfaces**
- **Post-WIMP systems**
  1. Touch input
  2. Natural language interfaces (NLIs)
  3. Multimodal interaction

**Combinations of input modalities**

- **Individual**
- **Sequential**
- **Simultaneous**

**Challenges and complexities in interpreting NLIs**

- **Multiple interpretation**
- **Different ways to ask the same query**
- **Ambiguity**
  - Syntactic level
  - Semantic level

**Possible query types**

- **Explicit:** Operations and targets are specified (sufficient tasks and values information)
- **Follow-up and contextual:** Follow-up to the previous queries or actions (typically lack references to tasks or values associated with the task)
- **High-level:** Open-ended questions; multiple operations combined together

**System architecture**

- Two step approach parser:
  1. Grammar parser
  2. Lexicon parser

**Orko’s user interface**

A: Natural language input and action feedback
B: Action feedback
C: Network Canvas
D: Quick access icons
Orko’s user interface

Evaluation – user study

• Jeopardy-style evaluation approach
  – Facts: to modify the visualization and show each fact
  – Tasks: 10 tasks to explore the network and identify specific entities
  – Questions: to measure satisfaction and usability
  – Informal interview

Results and observations

• NLI and interpretation
  – Query interpretation: Issues with queries with multiple values and not separated by conjunctions
• Contextual and follow-up queries
  – Multitouch gestures: requested
  – Repeat preference: instead of follow-up utterances
• Proactive behavior

Critique

• Natural and fluid way to explore networks
• Features well integrated
• Clear breakdown and UI
• Immediate visual feedback and proactive behavior (help user think about other questions)
• Flexibility of choices: between audio and textual feedback
• Successful in explicit queries and most follow-up and contextual
• Evaluation – experienced participants and specific example (football)
• Only force-directed layout (Region-based identifications not useful = Scalability issues)
• Limited touch gestures
• Some features not used (ambiguity widget, follow-up gestures, task suggestions)
• Simultaneous interaction was not examined
• Ignored high-level questions
• Auto-complete function

Evaluation – user study

Summary of interactions per task for 6 participants

Results and observations

• Preferences of modalities:
  – Speech: typically for search, filtering, and topology-based tasks involving multiple nodes
  – Touch: typically for tasks like highlighting connections of individual nodes and changing values of existing graphical encodings

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