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

Arjun Srinivasan
John Stasko
What is multimodal interaction?

How can we support multimodal interaction for visual data exploration and analysis?

Why support multimodal interaction?
What is multimodal interaction?
Two or more modes of input/output
Two or more modes of input/output
Two or more modes of input/output
Two or more modes of input/output
Two or more modes of input/output
Two or more modes of input/output
Touch & Speech
How can we support multimodal interaction for visual data exploration and analysis?
Orko

An accomplished Troll wizard from "He-Man and the Masters of the Universe"
Operations

Find Nodes
Find Connections
Find Path
Filter Nodes
Color Nodes
Size Nodes
Interface Actions
Operations

Find Nodes
Find Connections
Find Path
Filter Nodes
Color Nodes
Size Nodes
Interface Actions
Operation: Find Connections

Target

“Show Ronaldo’s connections”

Target
Find Ronaldo’s connections.
Show connections between Pogba and Bale.
Highlight the shortest path from Evra to Kroos.
Color by position.
Size nodes by betweenness centrality.
Only show German forwards.
...

Are any of these players right footed?
Filter by this player’s club.
Show connections of these players.
Color nodes by country > Now club > How about position?
Show German strikers with more than 30 goals > How about French strikers?
...

How are France and Italy connected?
Players from which countries tend to play more with clubs in the same country?
Find interesting clusters of players.
Modify the network to focus on English players.
...
Explicit

Find Ronaldo’s connections.
Show connections between Pogba and Bale.
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Contextual & Follow-up

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High-level

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Players from which countries tend to play more with clubs in the same country?
Find interesting clusters of players.
Modify the network to focus on English players.
...
Show nodes connected to Ronaldo.

Show Ronaldo's connections.
Find players linked to Ronaldo.
Highlight players who play with Ronaldo.
Which players play in the same team as Ronaldo?
Show nodes directly connected to Ronaldo.
Find nodes adjacent to Ronaldo.
Show Ronaldo's teammates.
Who all is Ronaldo directly connected to?
Find players with a direct link to Ronaldo.
Find direct connections of Ronaldo.

...
Interface Manager

Response Processor

NL Query Processor

Response Generator

Database
Interface Manager

Response Processor

NL Query Processor

Response Generator

Client

Server

Database
Goal: To find connections of high goal scoring players for England

“Show connections of English players with more than 20 goals”
> “Show England players”
> “Show players with more than 20 goals”
> “Show connections”

“Show connections of these players”

“Show English players with more than 20 goals”

“Show connections”
Goal: To find connections of high goal scoring players for England

“Show connections of English players with more than 20 goals”

> "Show English players"
> "Show players with more than 20 goals"
> "Show connections"

“Show connections of these players”

“Show English players with more than 20 goals”

“Show connections”
- Active/highlighted nodes
- Active filters
- Active visual encodings
- Operations & targets from previous query
Context

- Active/highlighted nodes
- Active filters
- Active visual encodings
- Operations & targets from previous query

(new/current query)

Individual
Sequential
Simultaneous
Ambiguity Widgets

Gao et al., UIST '15
Operation Suggestion

Find connections of wayne
Highlighted nodes directly connected to Wayne Rooney
- wayne rooney
- Wayne Hennessey

Goals: 45 - 67

Ronaldo and Rooney
Highlighted Cristiano Ronaldo

Find node(s)
Find connections
Find path

Find Ronaldo’s connections
Highlighted nodes directly connected to Cristiano Ronaldo
- Cristiano Ronaldo
- João Moutinho
- Stephen Ward
- Zoltán Gera
- Robbie Brady
- David Meyler
- Daryl Murphy
- Wes Hoolahan
- Darren Randolph

Goals
- Cristiano Ronaldo: 56
- Gareth Bale: 19
- Toni Kroos: 11
- Luka Modrić: 10
- Sergio Ramos: 10
- Pepe: 3
- Mateo Kovačić: 1
- Lucas Vázquez: 0

Position
- Striker: 3
- Midfielder: 3
- Defender: 2
Proactive Summary

Chart Reordering
Why support multimodal interaction?
User Study

Goals:

● Collect observational data on how people interact with network visualizations when they have the option of using multimodal input.

● Assess basic usability of the system

● Collect qualitative feedback on Orko’s design and multimodal interaction
User Study

6 participants

Network of European soccer players

10 tasks (no training)

~30 min sessions
Sample tasks

- Show that Wayne Rooney and Pedro play for different teams (both club and national) but share a spot on a team with Gary Cahill.
  
  [fact]

- Name a FC Barcelona midfielder. Identify at least two non-Barcelona midfielders the player plays with.
  
  [indirect question]

Sample task

- Show that Wayne Rooney and Pedro play for different teams (both club and national) but share a spot on a team with Gary Cahill.
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**Input style**

- **S**: Speech
- **T**: Touch
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1 sequential speech+touch

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No simultaneous use of modalities

- S: Speech
- T: Touch
- ST: Speech+Touch
- TS: Touch+Speech
Only three instances of sequential input where touch preceded speech
### Participants

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<tr>
<th>Tasks</th>
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<th>P4</th>
<th>P5</th>
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30 instances of sequential input where speech preceded touch
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Speech (individually) was the dominant input modality (~50%)
<table>
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<tr>
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<th>P1</th>
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<th>P5</th>
<th>P6</th>
<th>Avg.</th>
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<tr>
<td><strong>Overall SUS scores</strong> (out of 100)</td>
<td>80</td>
<td>70</td>
<td>82.5</td>
<td>80</td>
<td>52.5</td>
<td>87.5</td>
<td><strong>75.42</strong></td>
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<td><strong>Would want to use the system frequently</strong> (out of 5)</td>
<td>4</td>
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<tr>
<td><strong>Found various functions well integrated</strong> (out of 5)</td>
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<td><strong>4.33</strong></td>
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<tr>
<td><strong>Natural language query interpretation</strong> (out of 5)</td>
<td>4</td>
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</table>
“It [multimodal interaction] was fun to use and a very intuitive way to explore a network”

“I was surprised by the speech feature. I did not expect it to work as well as it did”

“...having worked with many visualization programs before, having to go through and manually clicking is really annoying especially when you have a ton of dropdowns. So I really like the speech feature, I know it’s still in a rudimentary stage but it does a really good job”
● “It was a little frustrating when the system did not understand my voice or did not react at all to voice”

● “If the system used the keyboard, an auto-complete function would be very helpful”
What’s next?

- Exploring layout modification, alternative representations, and network metrics
What’s next?

● Exploring layout modification, alternative representations, and network metrics

● Exploring other visualizations and data domains
What’s next?

- Exploring layout modification, alternative representations, and network metrics
- Exploring other visualizations and data domains
- Toolkits to incorporate multimodal interaction
Listening…
Thank you

Arjun Srinivasan

John Stasko

Creating Natural Data Visualization and Analysis Environments

Team Members: Arjun Srinivasan, John Stasko

We live in a data-rich era. Data visualization and exploration capabilities are becoming more widely used in a variety of disciplines including business, health, education, and public policy, to name just a few. Currently, people use visualization systems on desktop and laptop computers and typically interact via keyboard and mouse. Such interactions, while useful, pale in comparison to the natural, fluid interactions presented in futuristic feature films such as "Minority Report" and "Iron Man" where characters interact with large, projected wall displays through speech, gaze, and gesture. To move towards such futuristic interfaces, we must develop new forms of Natural User Interfaces (NUIs) employing multimodal interactions.

https://www.cc.gatech.edu/gvu/ii/naturalvis/