Research in the wild

Reflection on research and data collection in theory and practice

Lecture

Linnéuniversitetet
Institutionen för medieteknik

4ME301-HT18
Scientific Theories and Methods

Nico’s research journey

- **Bachelor thesis**

  interaction with large multi-touch displays; digital storytelling

- **Master thesis**

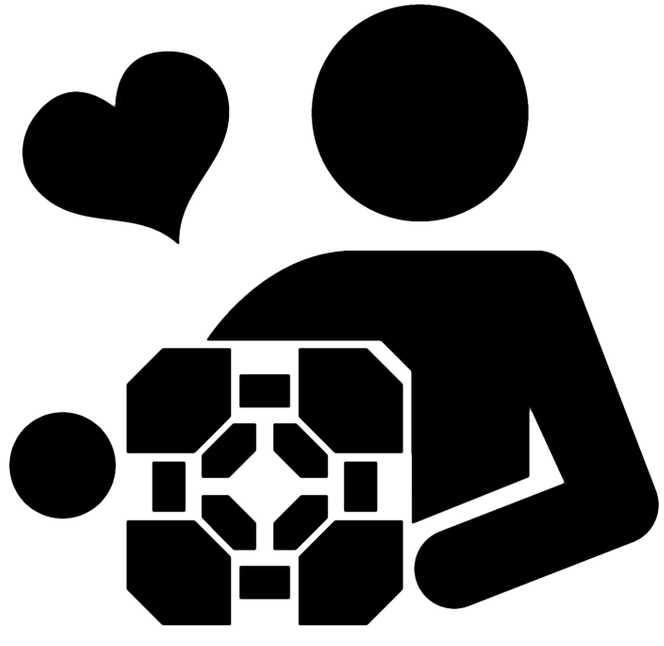
  open data exploration; virtual reality;
  vision-based motion controls

- **Doctoral studies**

  open data exploration; room-scale virtual reality;
  3D user interface; immersive analytics

Bachelor thesis

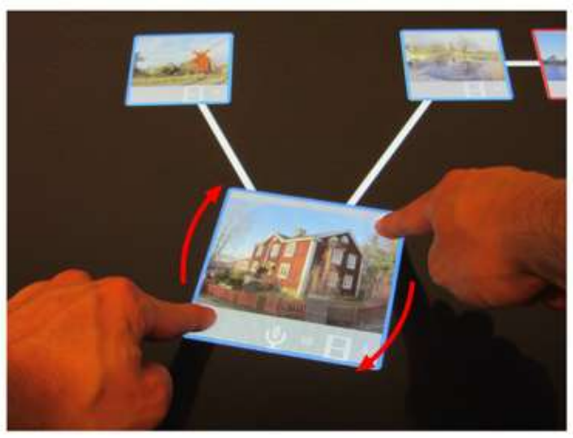
interaction with large multi-touch displays; digital storytelling

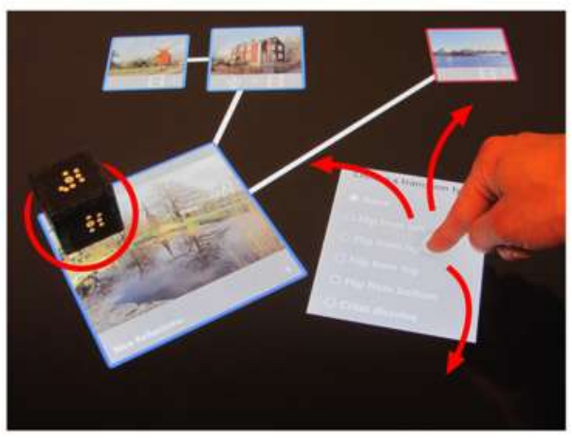


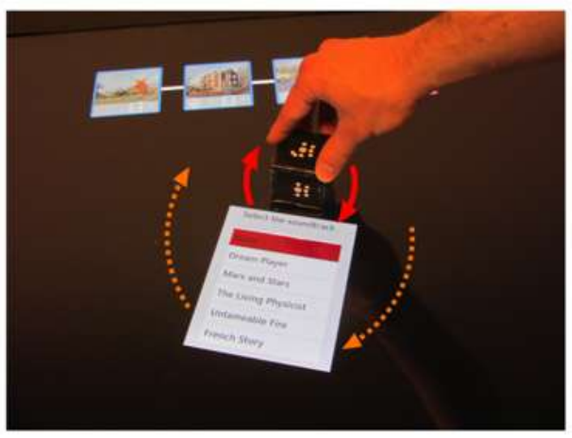
Scenario

- interaction with a large multi-touch display (SUR40)
  - natural user interface: touch
  - tangible user interface: tangible elements (cubes)
- digital storytelling
- support co-located, synchronous collaboration:
  two users inn the same space, at the same time
- information sharing

Developed prototype



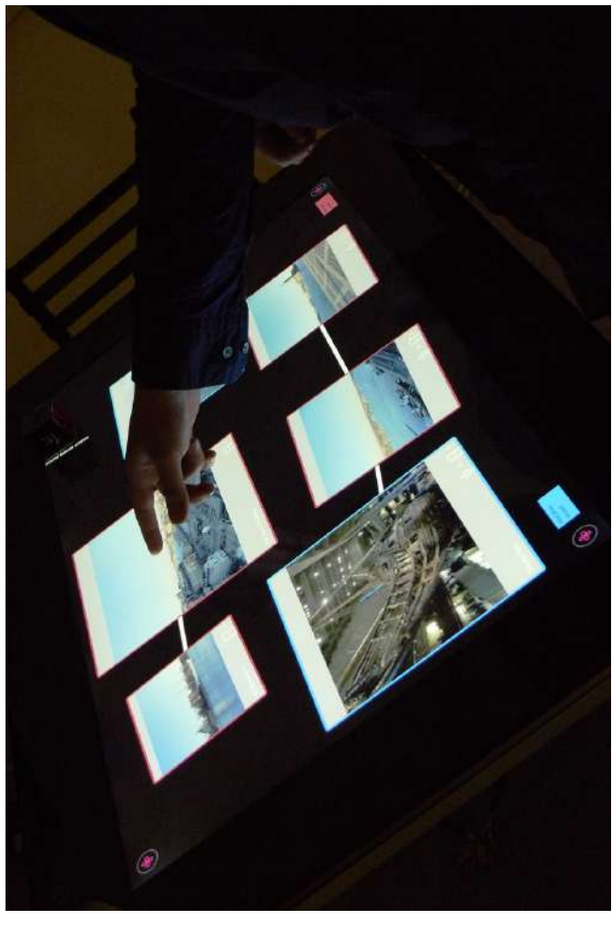




Study


BLUE / RED
16
"Storyboard Mode"
17
Choose Soundtrack
18
Edit META-Data
13
"Reconnection Mode"

Study



Study

- two-on-two session
    - 2 researchers: 1 leading the study, 1 observing/notes
    - 2 study participants: collaboration
- participants n = 10
- duration: ~1 hour
- 3 phases
    - pre-session
    - test (participants using the tabletop prototype)
        - set of pre-defined tasks
    - post-session

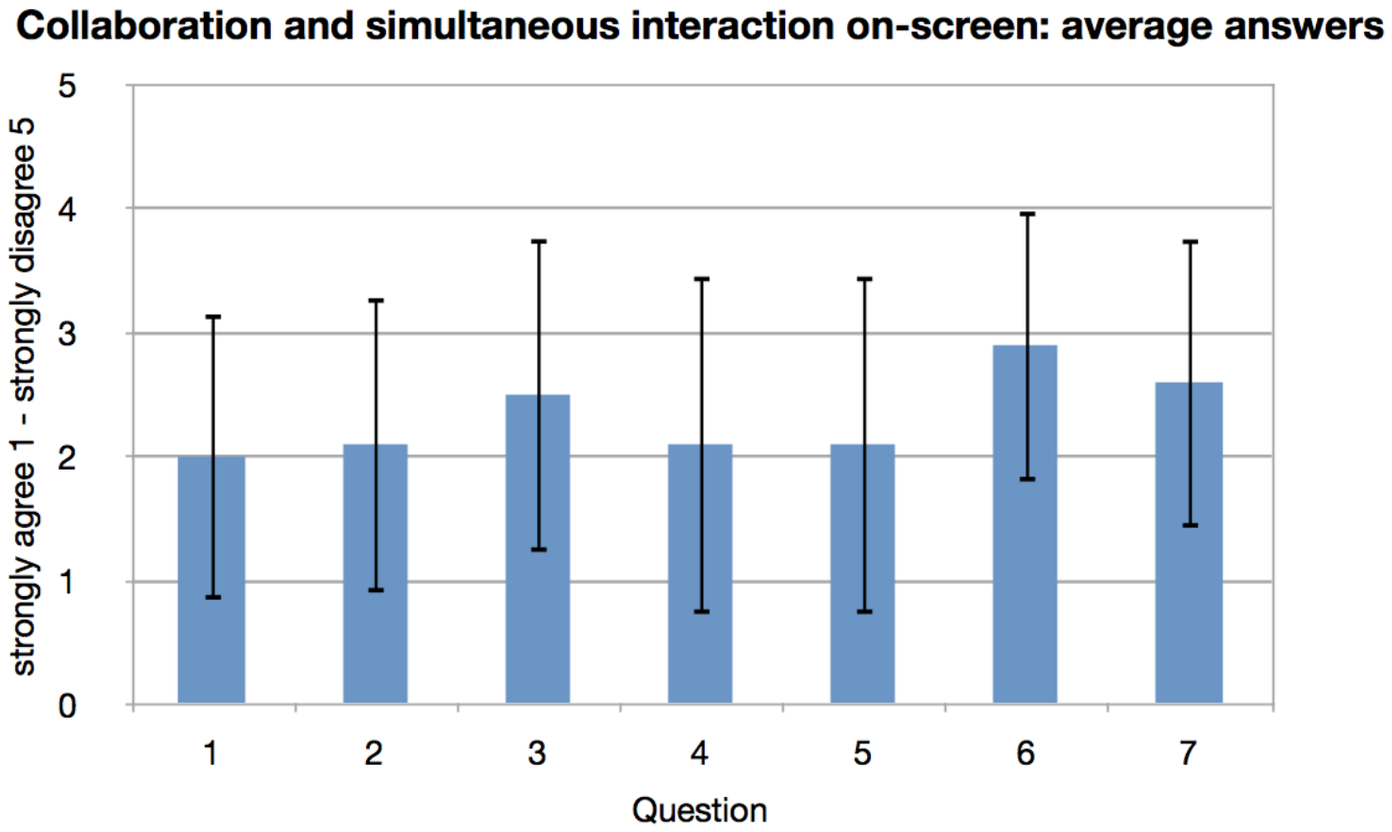
Data collection

- self-constructed questionnaire
  - different investigation “categories”

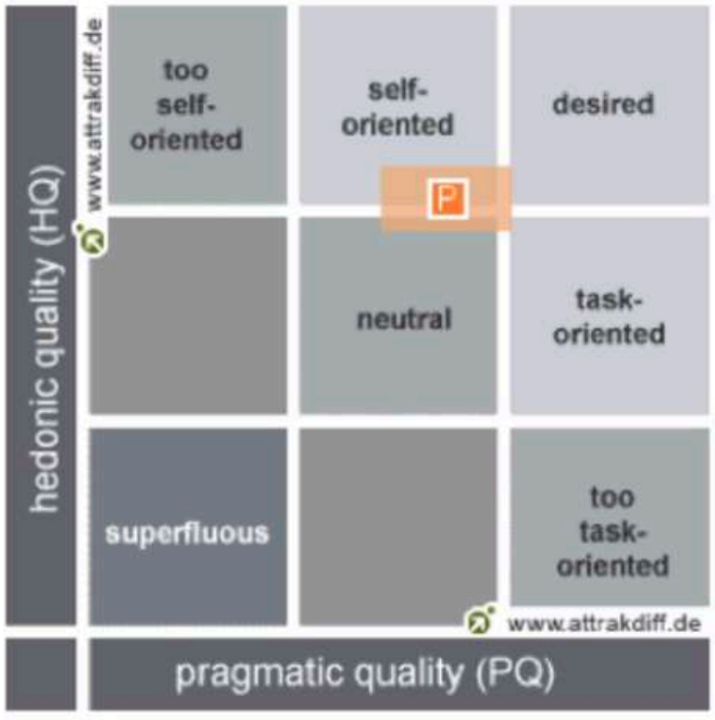
    multi-touch; tangible user interface; collaboration and simultaneous interaction on-screen; verbal collaboration during using the application; overall
    - 5 point Likert-scale (quantitative data)
    - open questions (qualitative data)
- [AttrakDiff] questionnaire
  - standardised approach to measure usability and design of a product
- video recording (as backup)
- think-aloud protocol

Results / Analysis

No.	Statement
1.	It was easy to interact with another person on-screen at the same time.
2.	Simultaneous multi-touch interactions from me and another person were always recognised correctly.
3.	It felt convenient to interact with another person on-screen at the same time.
4.	Sharing objects with another person helped me in my argumentation.
5.	I could always follow what was going on on-screen.
6.	Working on the same objects with another person enhanced my workflow.
7.	Working on the same objects with another person helped focusing on the current task.

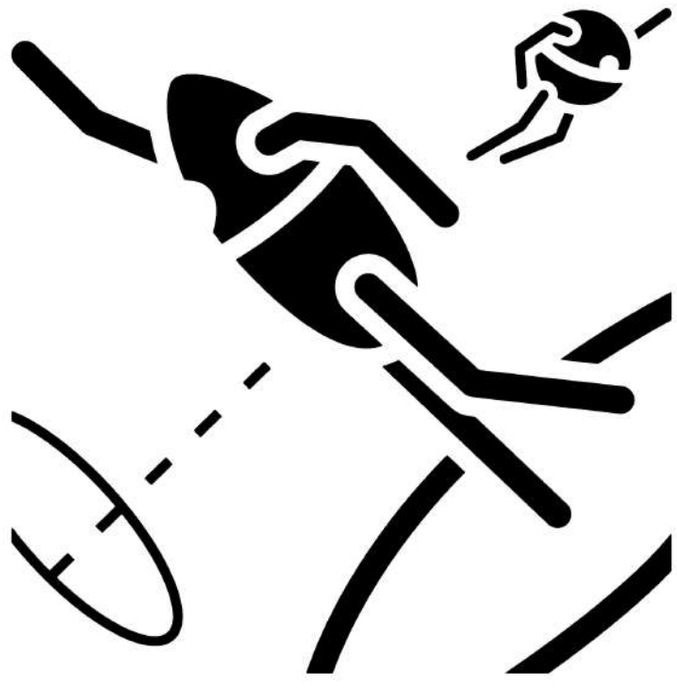


Results / Analysis



Master thesis

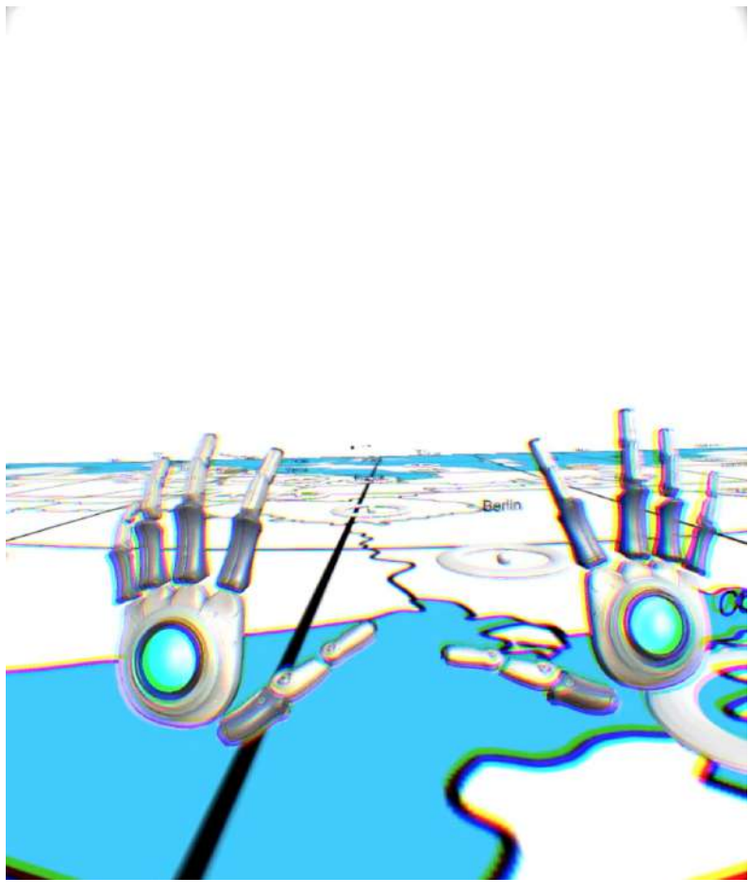
open data exploration; virtual reality; vision-based motion controls

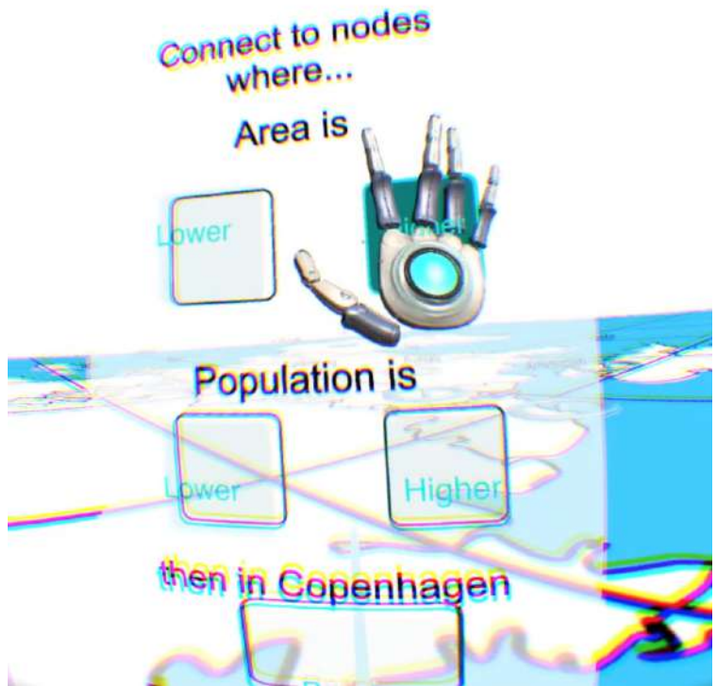


Scenario

- open data exploration (network-like)
  - data received from various open online sources
  - virtual reality using head-mounted display
  - vision-based motion controls for interaction
- explorative, non-time sensitive setting
- exploration of European capital cities

Developed prototype





Study

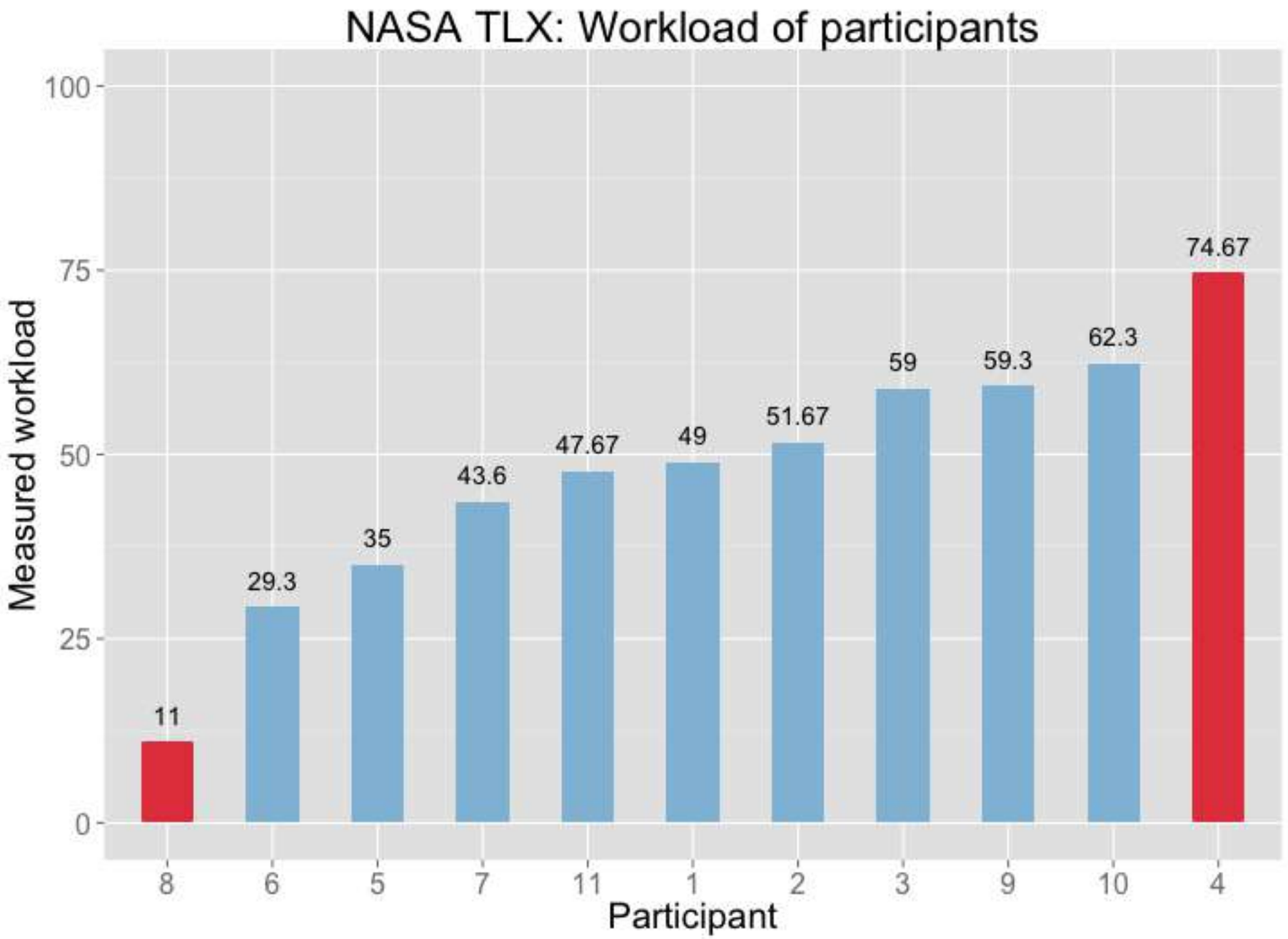
Study

- one-on-one session with 1 participant at a time
- participants n = 11
- duration: ~1 hour 15 minutes
- 3 phases
    - pre-session
    - test (participant using the VR prototype)
        - warm-up, task 1, task 2
    - post-session

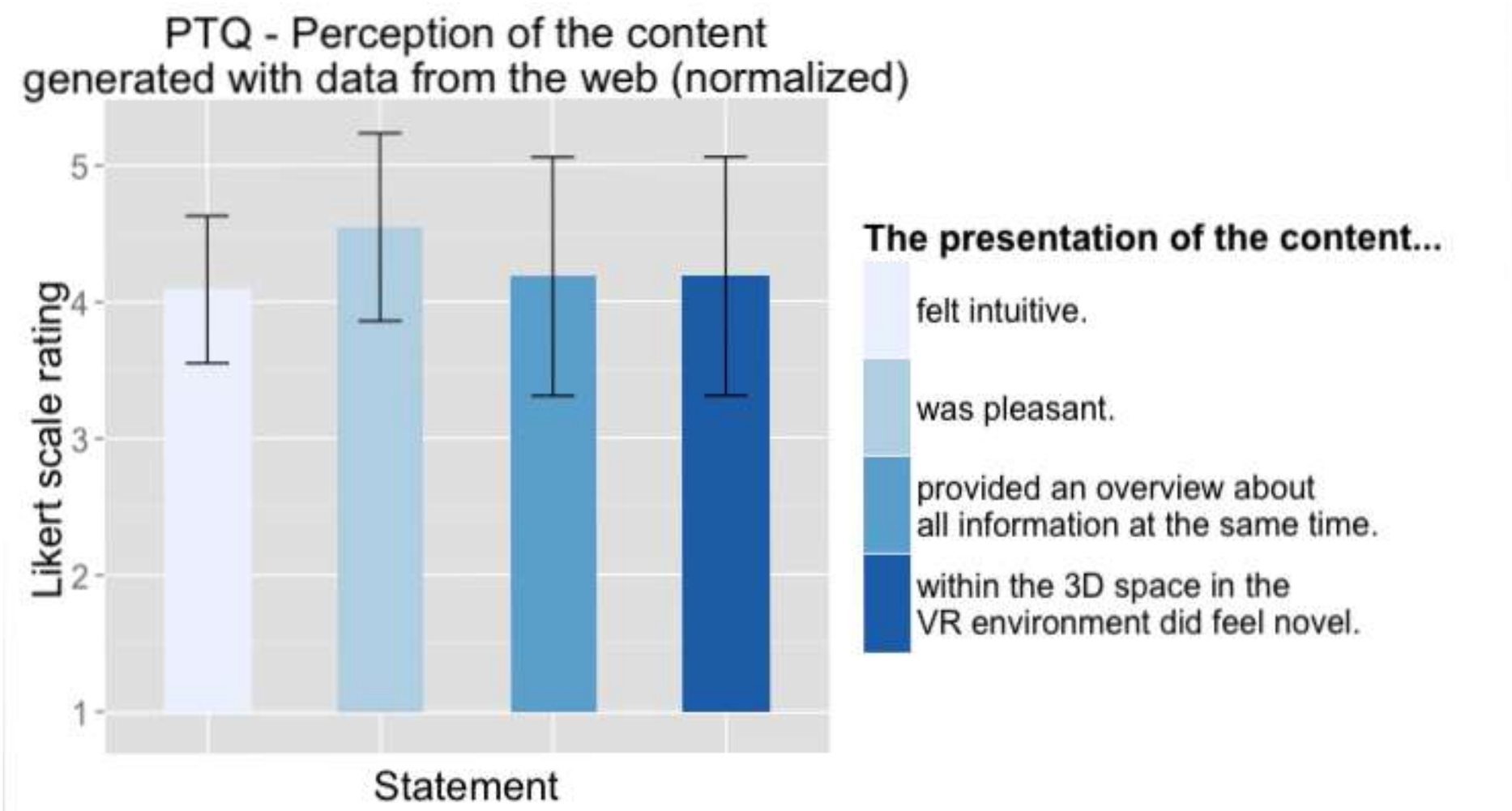
Data collection

- self-constructed questionnaires (pre- and post-session)
  - 5 point Likert-scale (quantitative data)
  - open questions (qualitative data)
- observations
- think-aloud protocol
- [NASA Task Load Index (TLX)] questionnaire
  - standardized method to report workload in self-assessment
- logging system
  - implemented in the VR application; keeping track of every user interaction

Results / Analysis: Workload (NASA TLX)



Results / Analysis: Likert-scale



Results / Analysis: Logging

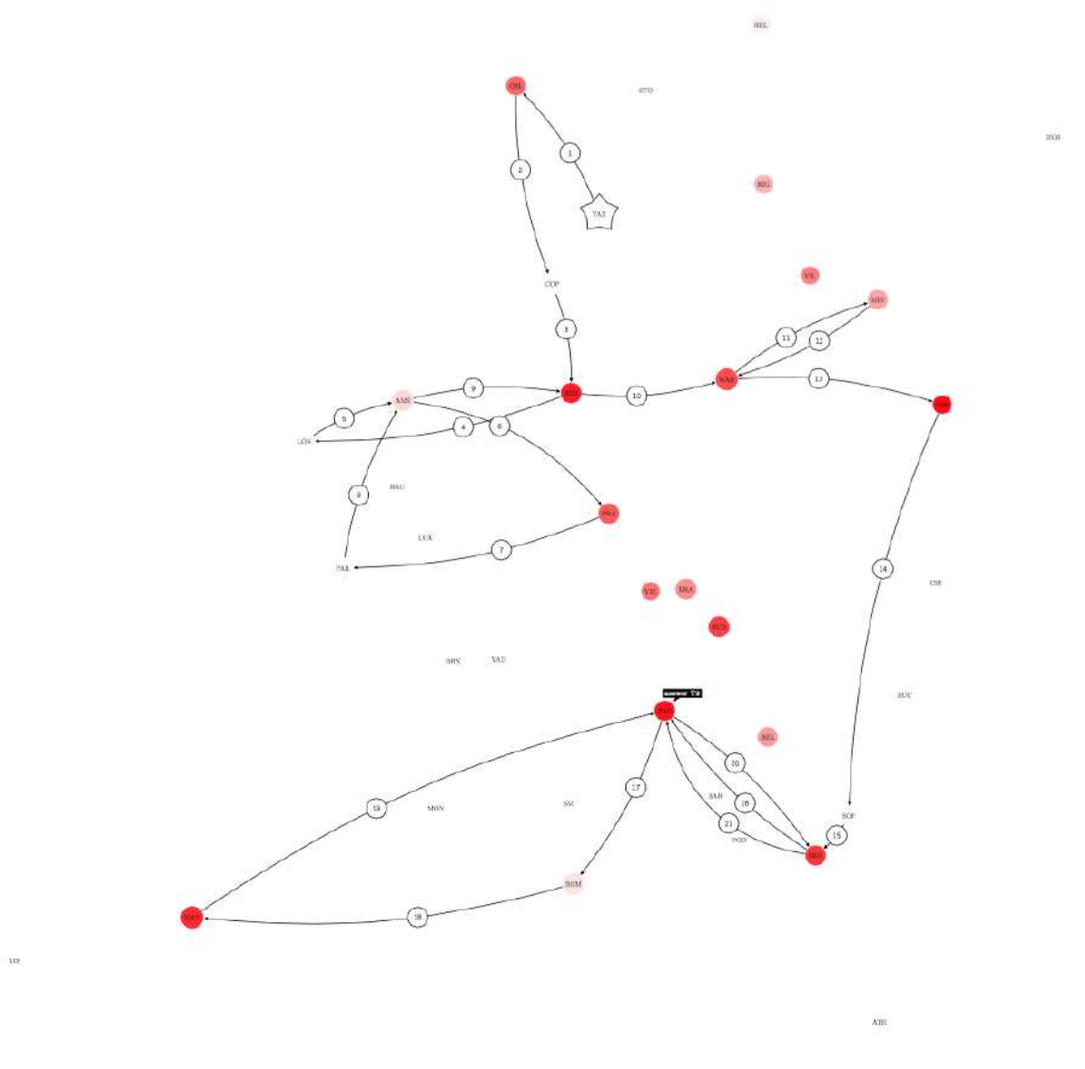
Analysis			Task 1		Task 2	
			AVERAGE	STDEVA	AVERAGE	STDEVA
Average time spent in traveled City (in sec)			32.94	12.94	31.82	10.93
Amount of unique visited cities (max. 45)			11	4	11	4
Amount of visited cities			14	5	13	5
Amount of interactions			42	15	48	19
	Movement/Travels	**SUM**	15	8	15	8
		Successful	13	5	12	5
		Unsuccessful	2	3	1	2
		Forbidden	1	3	2	2
	Content Exploration	**SUM**	14	5	13	5
		Trigger	12	4	12	5
		Dismiss	11	4	12	5
		Rotation	2	3	0	1
	Filter Menu	**SUM**	13	8	20	11
		Trigger	4	2	5	2
		Dismiss	4	2	5	2
		Connection	8	6	13	10
		Area	0	1	8	6
		Population	6	4	1	2
		Reset	2	2	4	3
		Size	1	0	2	1
		Area	0	0	1	1
		Population	1	0	0	0
		Normal	0	0	1	1
Amount of time for completion (in sec)			421.84	160.61	391.74	142.33
in minutes			7.03	2.68	6.53	2.37

Logging system

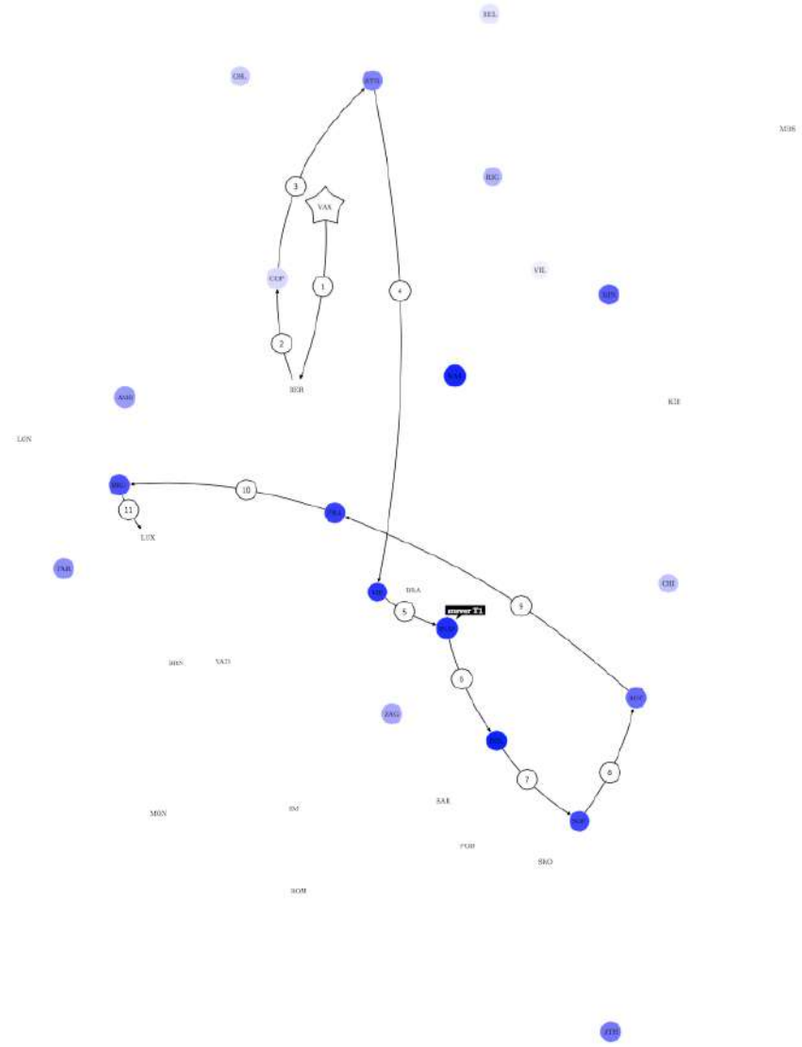
- “action-object-target” approach, [GitHub]
  - each entry within the log file represents an event within the operation of the VR prototype
  - timestamp when the event occurred
  - the “action”, the “object” performing the action and potentially the “target”, the performed action is applied on

Timestamp	Action	Object	Target
1.000000	MOVE	Player	Stockholm
3.000000	TRIGGER	Filter_Menu	
7.000000	FILTER_APPLY	Connection_Area _Higher	Stockholm
11.000000	DISMISS	Filter_Menu	

Results / Analysis: Pathway visualization (logging)



re-visiting



straight

Explorative Expert Discussion

- 2 explorative discussions with experts
  - human-computer interaction (3 experts)
  - information visualization (2 experts)
- presentation of the developed prototype
- semi-structured interview
- gain feedback on the developed VR application from the expert point of view

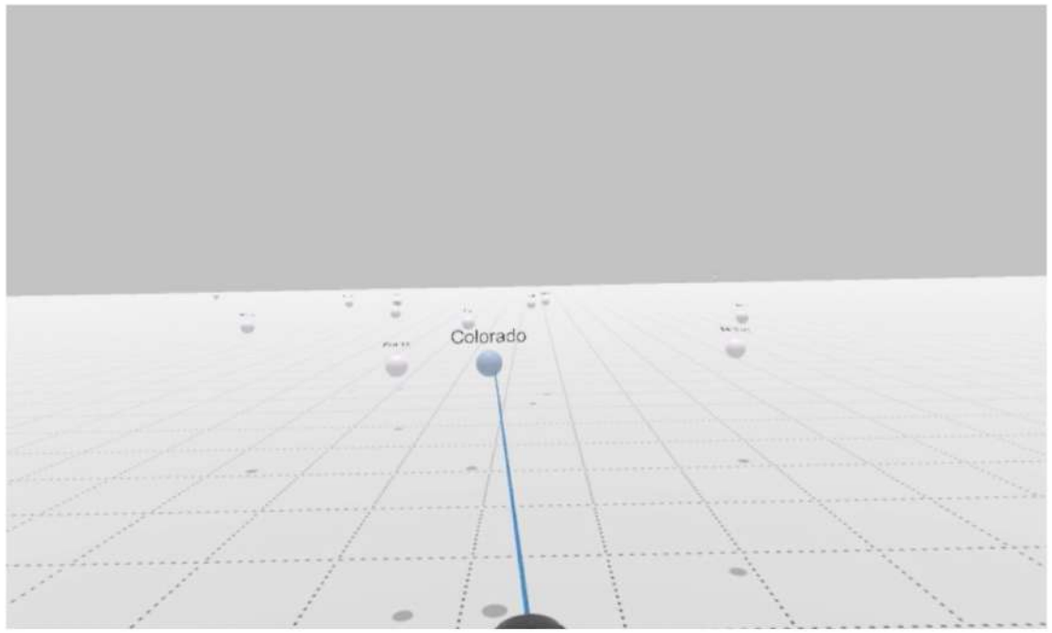
Doctoral studies

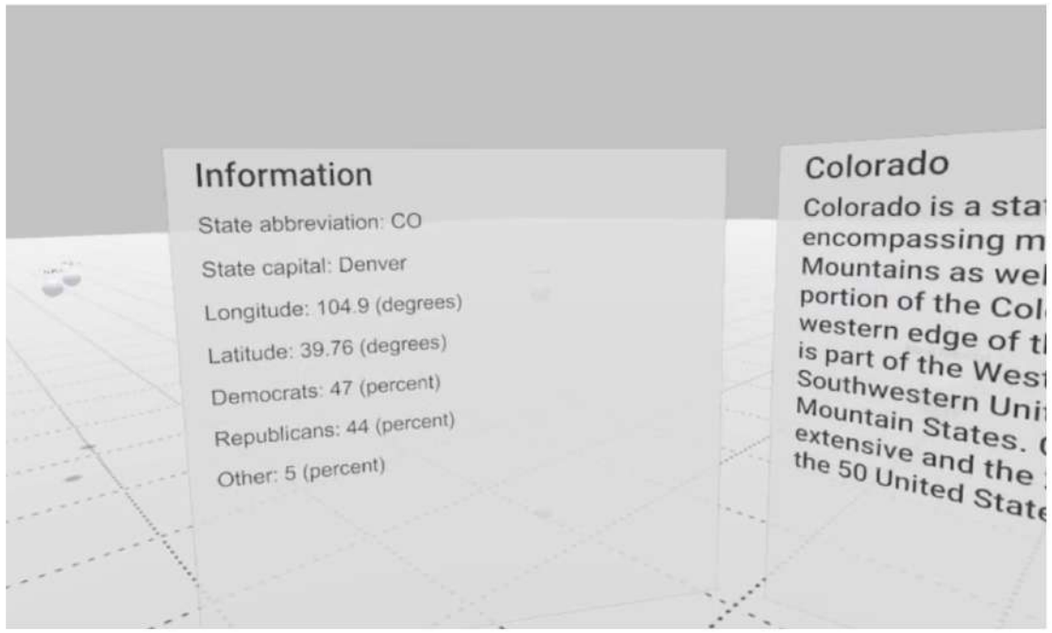
open data exploration; room-scale virtual reality; 3D user interface; immersive analytics

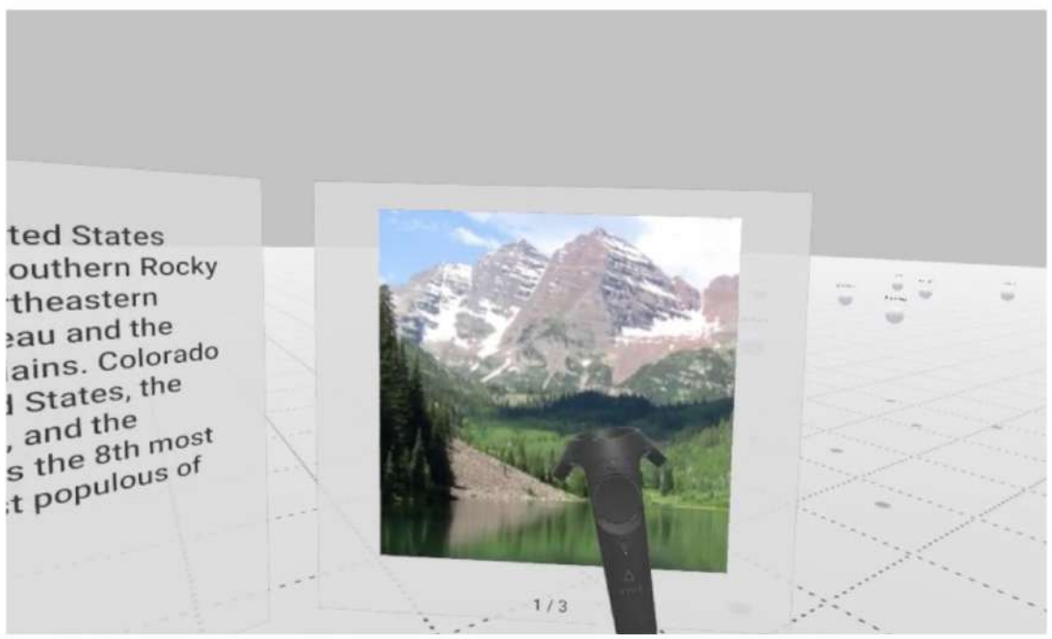
Input Tech Comparison — Scenario

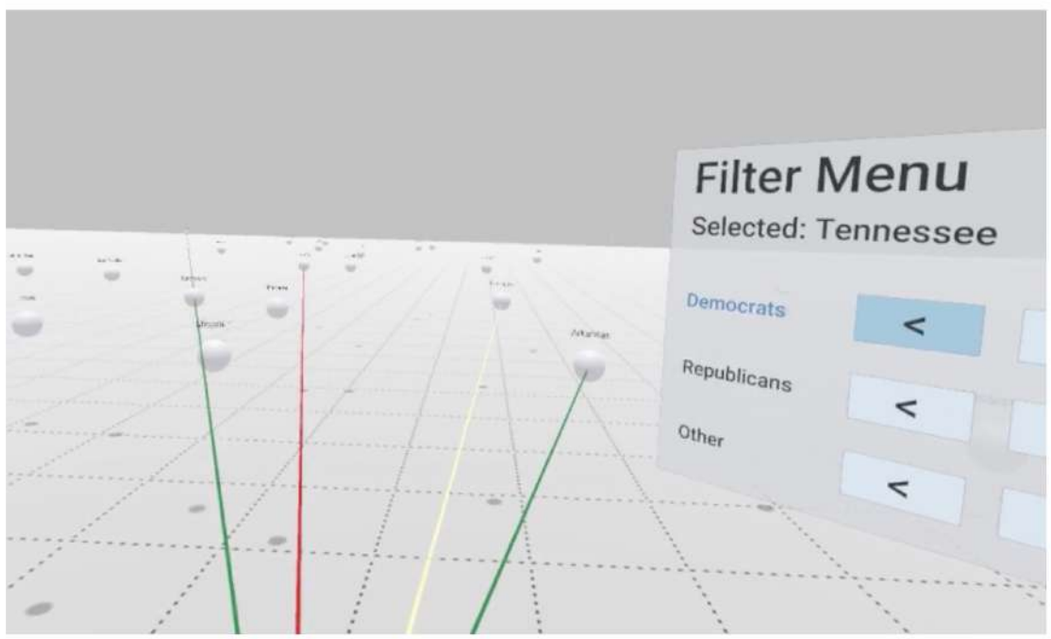
- open data exploration (network-like)
    - virtual reality using head-mounted display
- comparative interaction technology study
    - "traditional" gamepad (Xbox One)
    - vision-based motion controls (Leap Motion)
    - room-scale virtual reality (HTC Vive)
- explorative, non-time sensitive setting
- exploration of the results of the 2016 US presidential election

Developed prototype









[Video demo: Open Data Exploration in Virtual Reality (ODXVR)]

Study






Study

- one-on-one session with 1 participant at a time
- participants n = 24 (8 participants per interaction prototype)
- duration: ~45 min
- 3 phases
  - pre-session
  - test (participant using the VR prototype)
    - warm-up, task
  - post-session

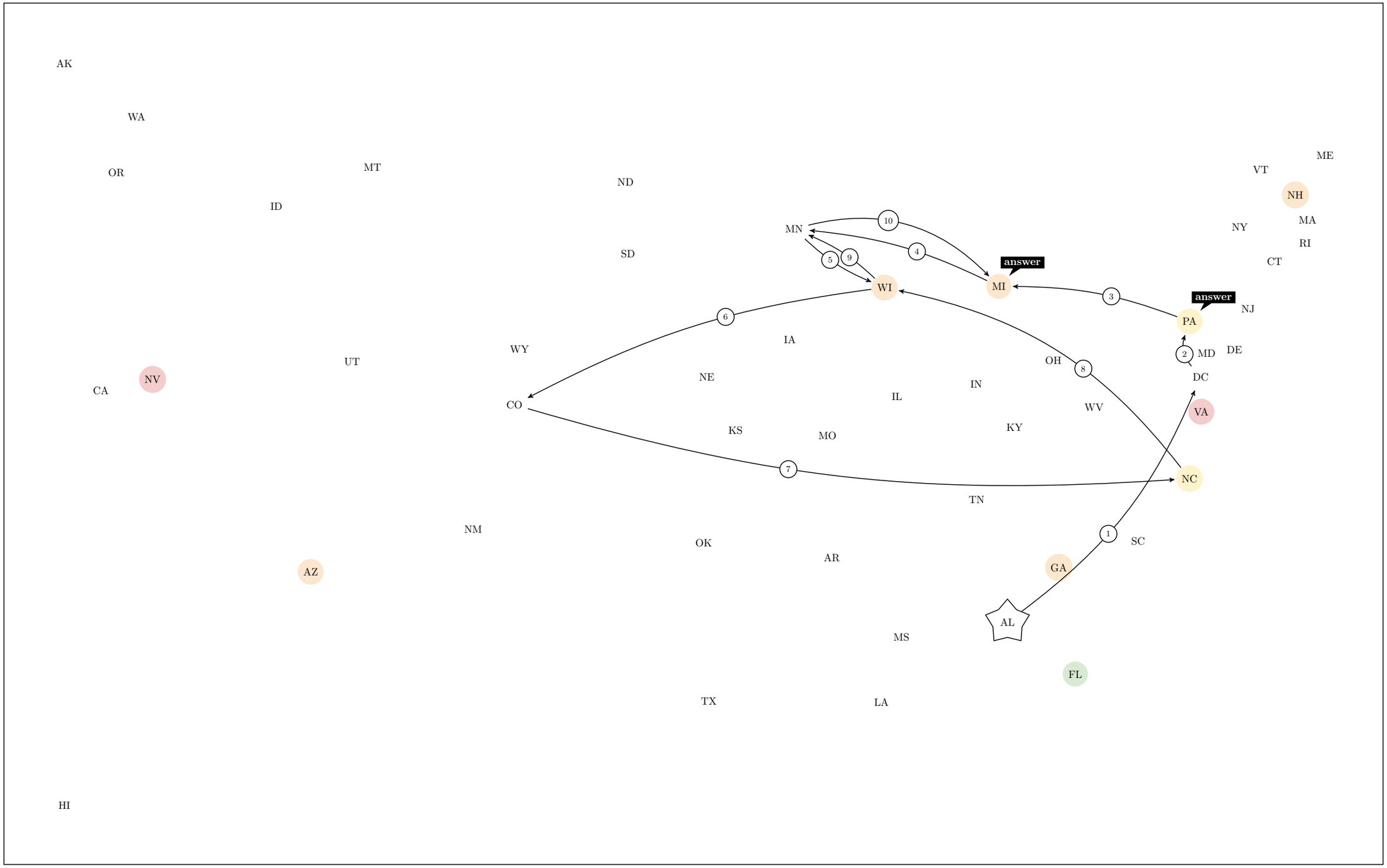
Data collection

- self-constructed questionnaires (pre- and post-session)
    - 5 point Likert-scale (quantitative data)
- observations
- think-aloud protocol
- logging system
    - implemented in the VR application; keeping track of every user interaction
    - “action-object-target-origin-state-mode”

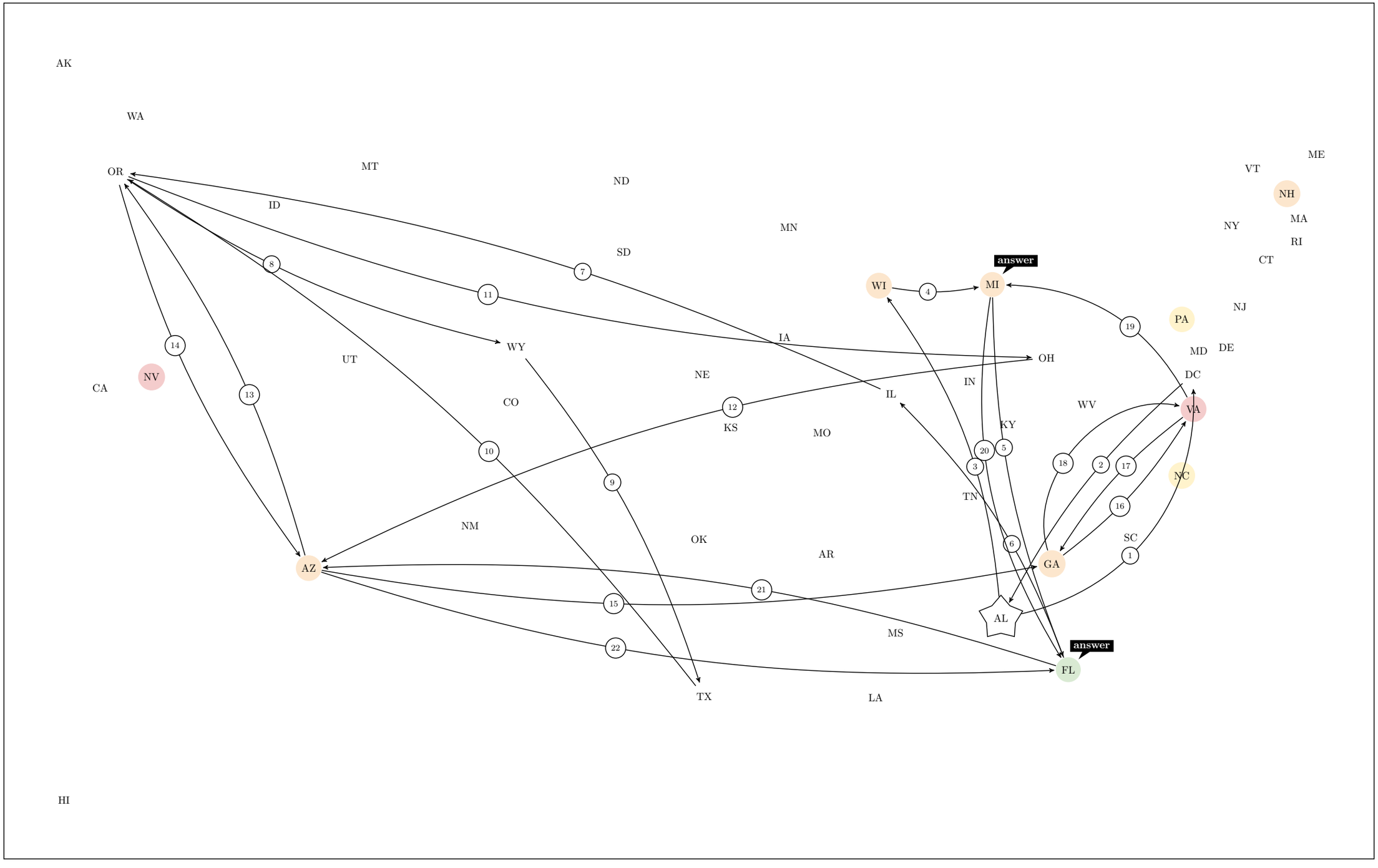
Data collection

- [Simulator Sickness Questionnaire (SSQ)]
    - standardized method for quantifying simulator sickness
- [NASA Task Load Index (TLX)] questionnaire
    - standardized method to report workload in self-assessment
- [Flow Short Scale (FKS)]
    - standardized method to evaluation the interaction “flow” when operating a system or completing a task

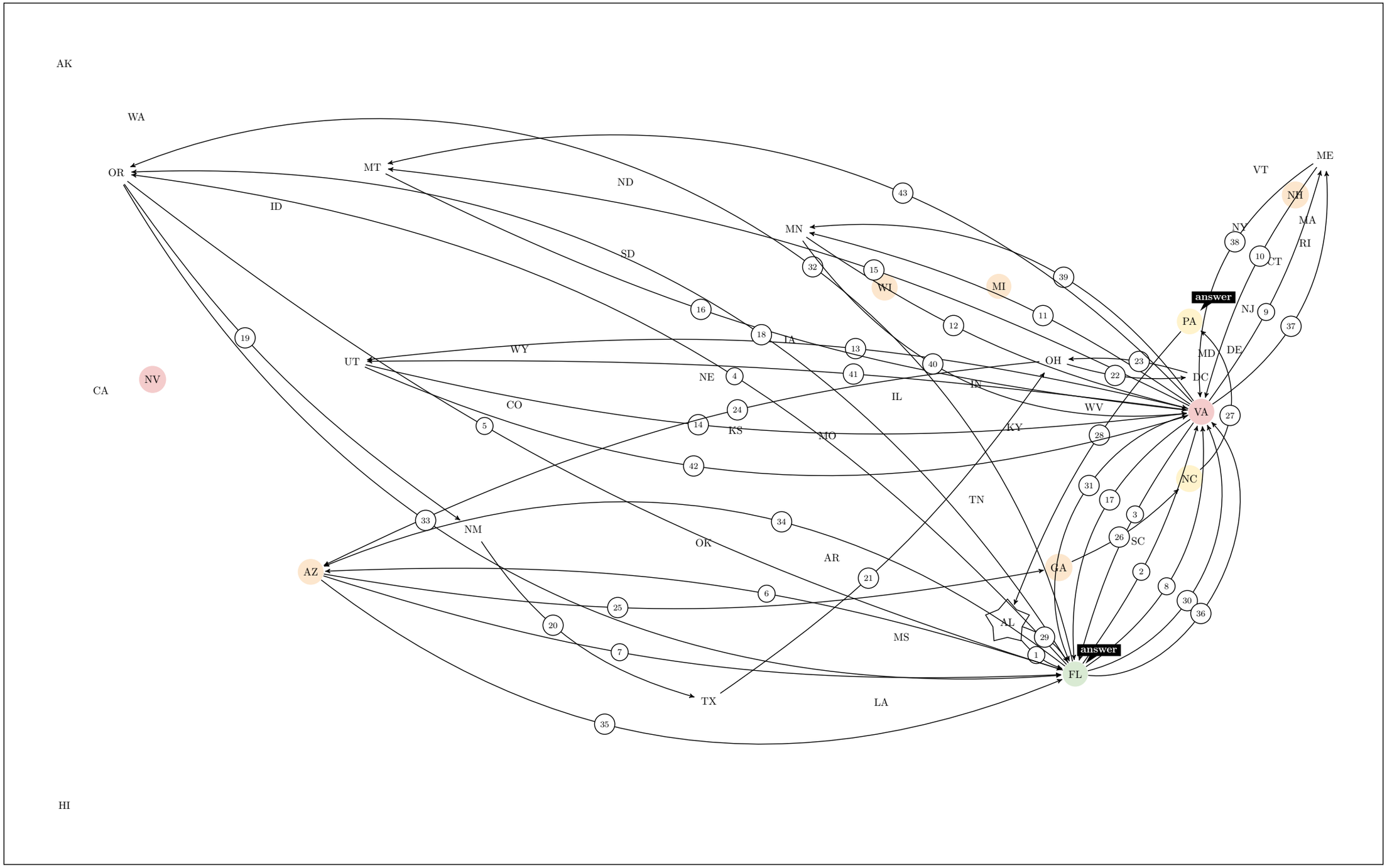
Results / Analysis: Pathway visualization (logging)



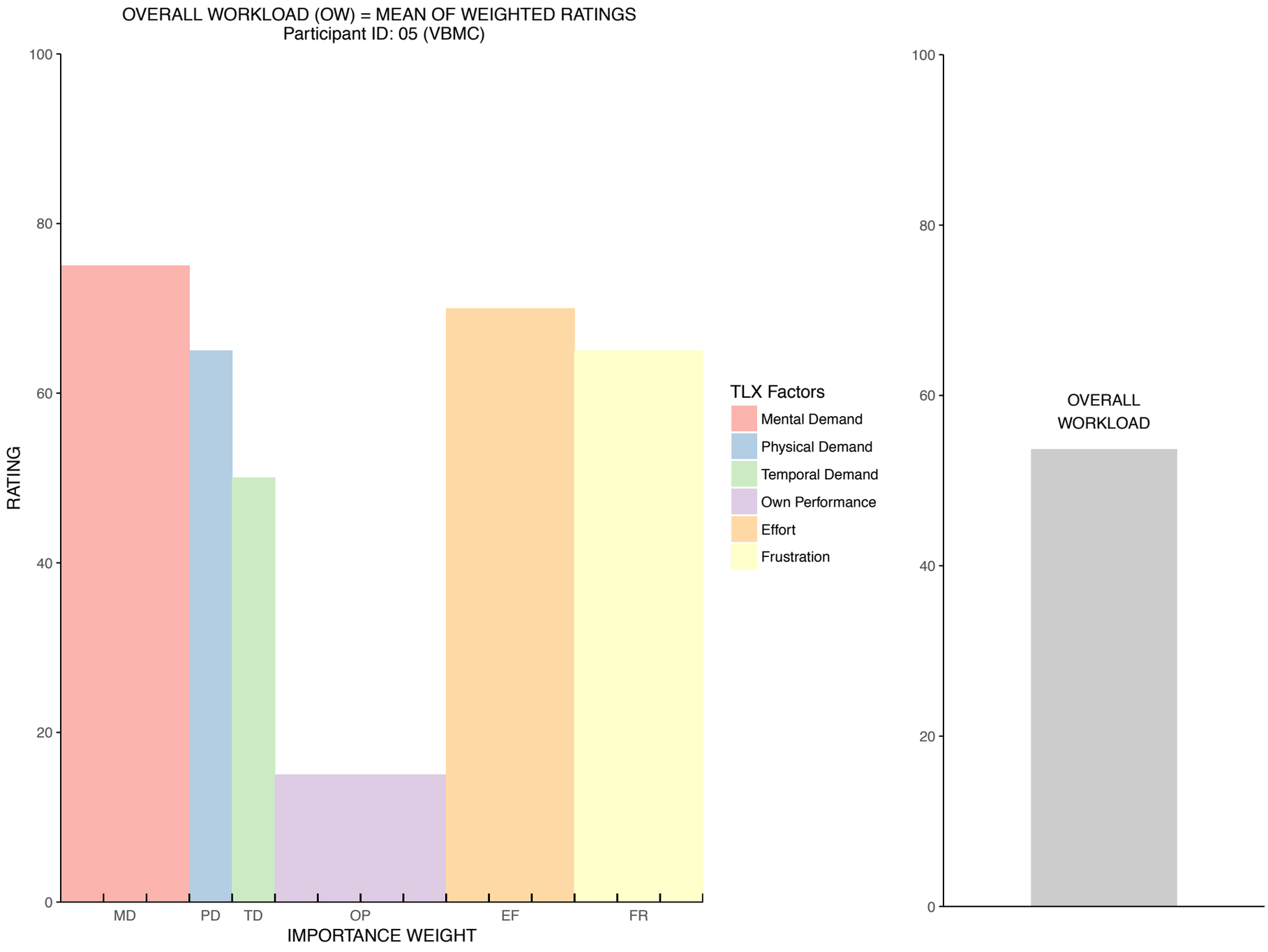
Results / Analysis: Pathway visualization (logging)



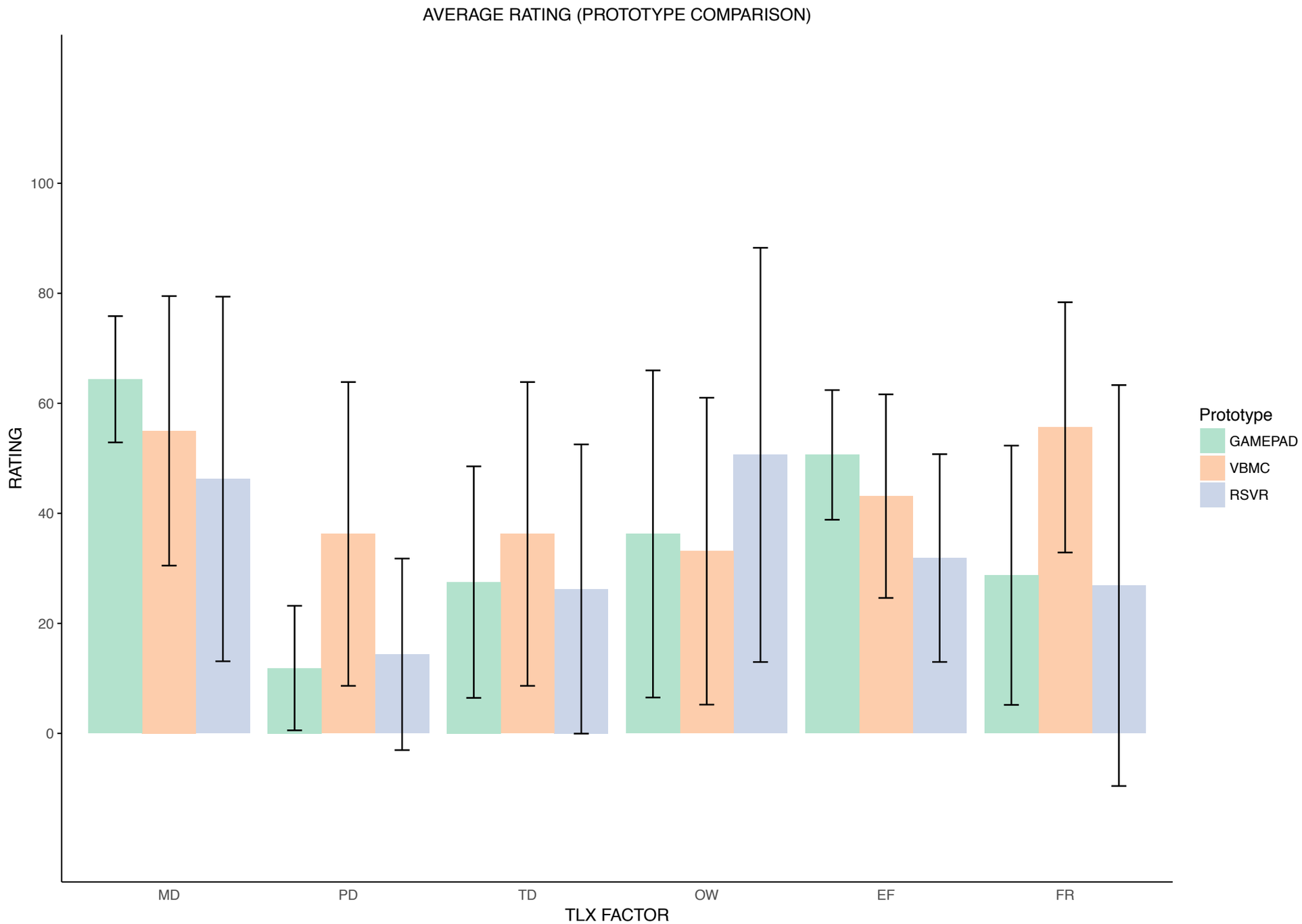
Results / Analysis: Pathway visualization (logging)



Results / Analysis: NASA TLX



Results / Analysis: NASA TLX



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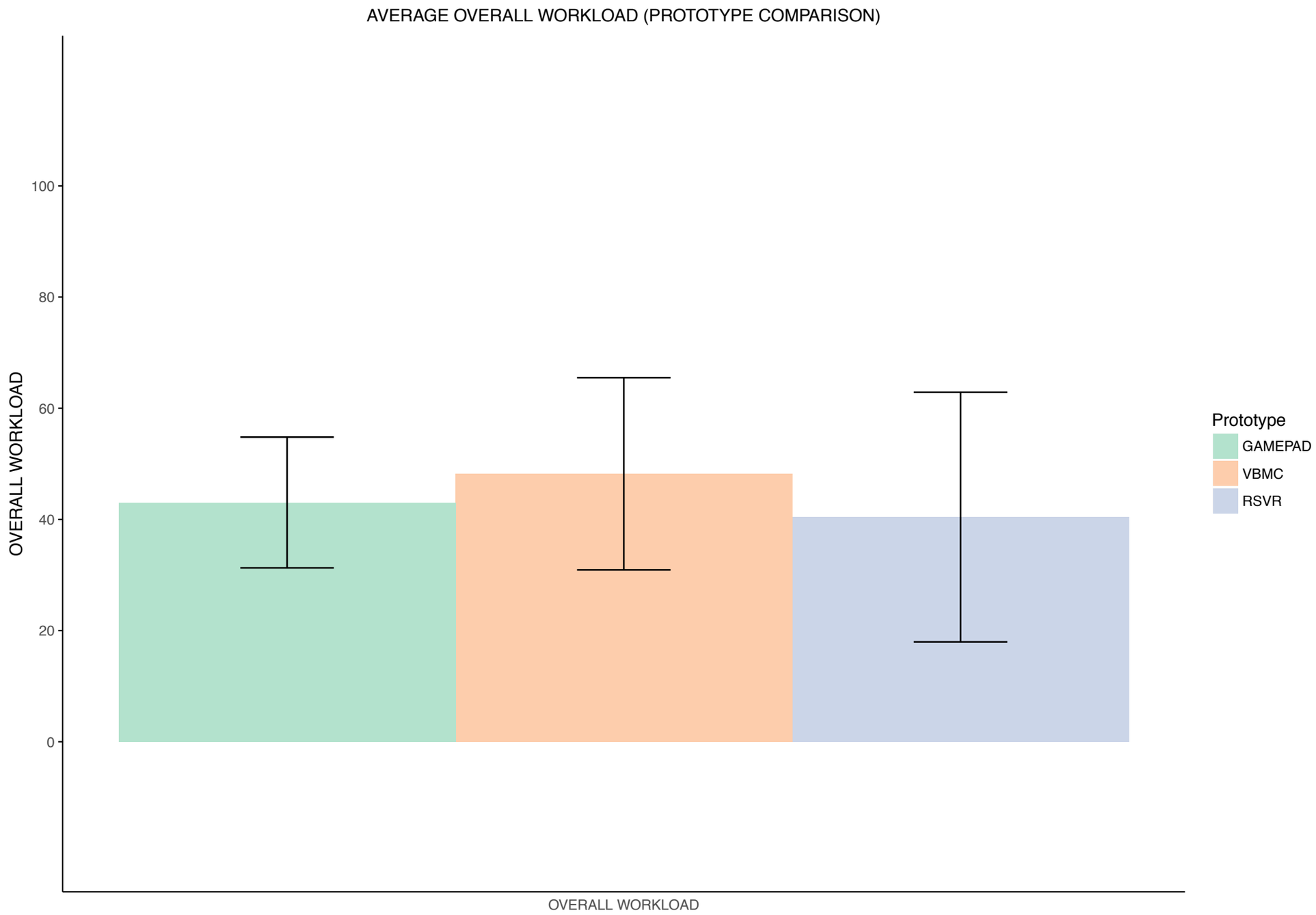
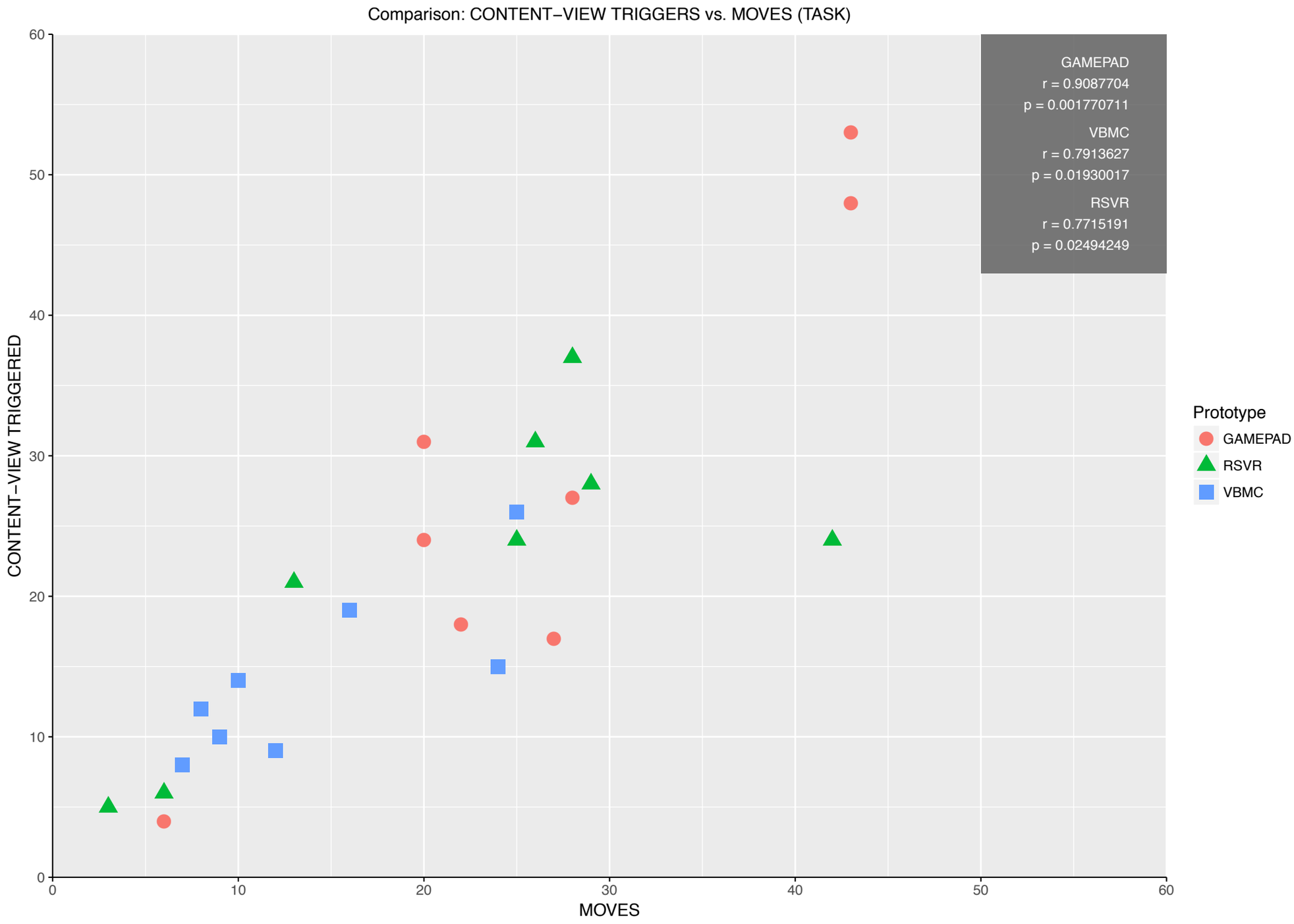
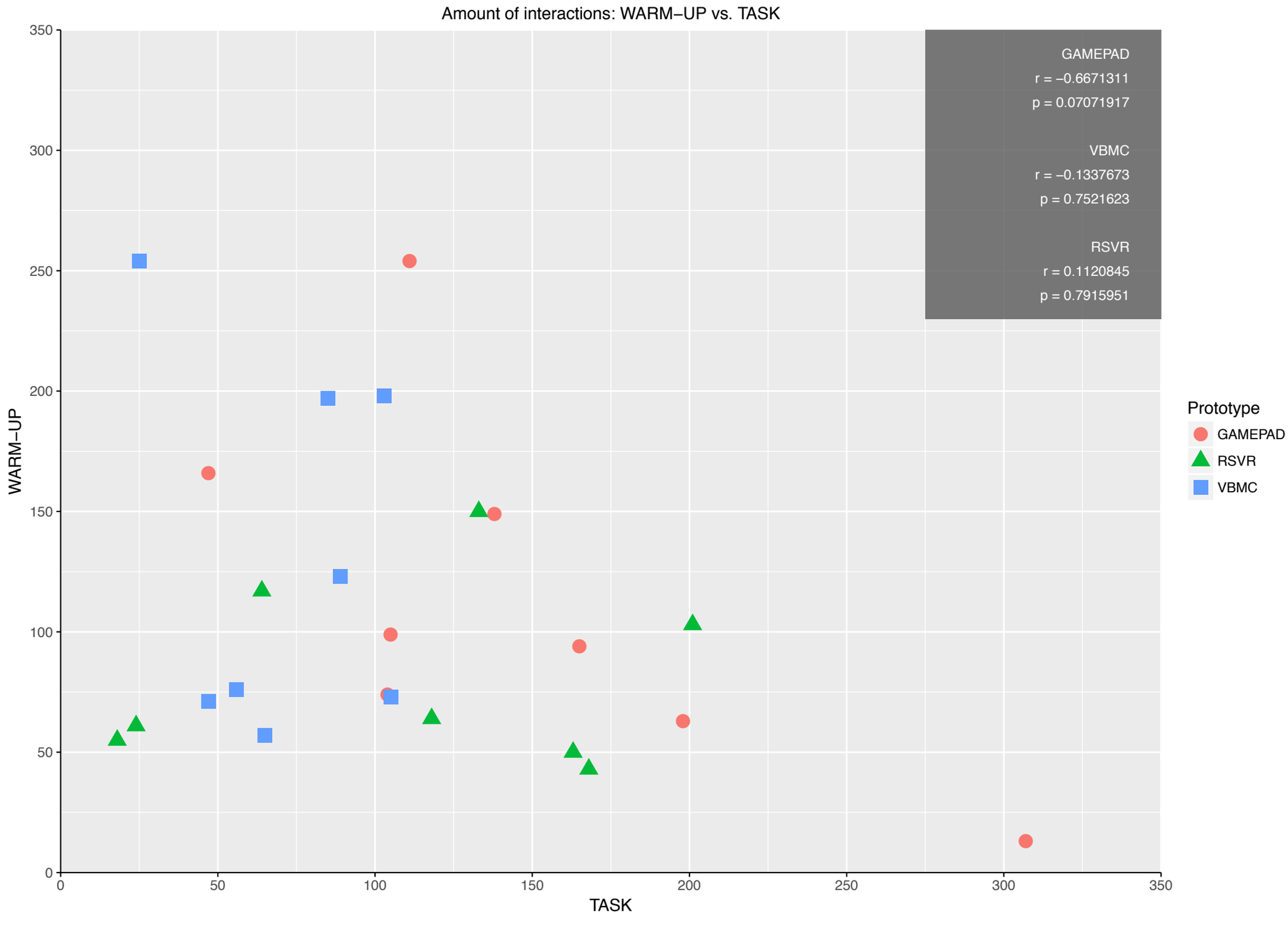


Results / Analysis: Logging



Results / Analysis: Logging



Results / Analysis:

Logging

Analysis			GAMEPAD		VBMC		RSVR	
TASK			AVERAGE	STDEV	AVERAGE	STDEV	AVERAGE	STDEV
Average time spent in traveled node (in sec)			25.35	26.024	24.09	8.882	26.91	8.690
Amount of unique visited nodes (max. 45)			14.00	5.632	9.25	3.059	11.50	5.477
Amount of visited nodes			25.50	10.928	12.88	4.190	20.38	11.759
Amount of interactions			146.88	78.844	71.88	28.402	111.13	68.674
Average amount of interactions per minute			19.57	5.480	14.02	2.421	11.98	4.715
	Movement/Travels	**SUM**	26.13	12.369	13.88	7.120	21.50	13.126
		Successful	24.50	10.928	11.88	4.190	17.75	10.886
		Forbidden	1.63	1.685	2.00	4.036	2.13	2.800
		(RSVR) No transition	-	-	-	-	1.63	1.061
	Content Exploration	**SUM**	55.75	32.710	28.38	11.624	43.75	22.537
		Trigger	27.75	16.246	14.13	5.987	22.00	11.314
		Dismiss	28.00	16.466	14.25	5.651	21.38	11.135
		Image interaction	0.00	0.000	0.00	0.000	0.38	1.061
		(GAMEPAD) Button A	0.00	0.000	-	-	-	-
		(GAMEPAD) D-pad next	0.00	0.000	-	-	-	-
		(GAMEPAD) D-pad prev	0.00	0.000	-	-	-	-
		(VMBC) next	-	-	0.00	0.000	-	-
		(VMBC) prev	-	-	0.00	0.000	-	-
		(RSVR) touch	-	-	-	-	0.38	1.061
		(RSVR) point	-	-	-	-	0.00	0.000
	Filter Menu	**SUM**	36.13	25.295	20.38	22.640	29.63	26.137
		Trigger	12.13	7.680	5.13	4.190	10.13	9.731
		Dismiss	12.00	7.746	4.75	3.615	10.13	9.731
		Democrats	5.25	5.203	4.88	7.019	5.13	5.055
		less than	1.88	1.642	2.25	3.284	0.25	0.463
		greater than	2.25	1.982	1.38	2.774	3.88	4.643
		off	1.13	2.031	1.25	1.581	1.00	1.069
		Republicans	5.38	5.012	4.50	7.801	4.13	3.758
		less than	2.63	2.264	1.75	3.770	1.25	1.753
		greater than	1.38	1.685	1.50	3.117	2.13	2.475
		off	1.38	1.598	1.25	1.488	0.75	1.165
		Other	1.38	1.923	1.13	2.100	0.13	0.354
		less than	0.50	1.069	0.75	1.753	0.00	0.000
		greater than	0.25	0.707	0.00	0.000	0.00	0.000
		off	0.63	1.408	0.38	0.518	0.13	0.354
	Bookmark	**SUM**	9.25	4.400	1.63	3.159	3.00	2.828
		(RSVR) Set	-	-	-	-	1.88	1.885
		(RSVR) Unset	-	-	-	-	0.75	1.035
		(GAMEPAD, VBMC) Set / Unset	7.50	2.928	1.00	1.927	-	-
		Forbidden	1.75	2.712	0.63	1.408	0.38	0.518
		Amount of unique bookmarked nodes	3.38	1.408	0.50	0.926	1.50	1.773
	Wrong context	**SUM**	19.63	17.435	7.63	5.423	13.25	11.511
		Exploration	1.63	1.923	6.25	5.036	8.25	8.615
		Content	11.63	14.412	1.00	2.138	0.75	1.035
		Filter	6.38	5.263	0.38	0.518	4.25	4.528
		GAMEPAD	22.63	19.331	-	-	-	-
		Button A	8.75	5.600	-	-	-	-
		Button B	8.88	13.527	-	-	-	-
		Button X	3.00	4.106	-	-	-	-
		Button Y	2.00	1.512	-	-	-	-
		VBMC	-	-	7.63	5.423	-	-
		finger spread	-	-	0.88	0.991	-	-
		thumb up right	-	-	1.00	2.138	-	-
		thumb up left	-	-	0.38	0.518	-	-
		index point forward	-	-	3.38	3.114	-	-
		index point right	-	-	0.63	0.916	-	-
		index point left	-	-	1.38	1.598	-	-
		RSVR	-	-	-	-	18.25	15.229
		App Menu	-	-	-	-	1.25	1.753
		Trigger	-	-	-	-	13.25	11.511
		Grip	-	-	-	-	3.75	4.621
Amount of time for completion (in sec)			459.96	267.405	302.05	97.199	531.41	306.190
	in minutes		7.67	4.457	5.03	1.620	8.86	5.103

Results / Analysis: Observations and think-aloud protocol

Collection of qualitative feedback and observations

#	Point of interest	Categorization
16	Application of filter options systematically for guided exploration in order to identify suitable nodes as task solution.	Interaction
12	Overall pleasant experience, incl. movement transitions	Experience
10	Occlusion noted (e.g. due to nodes in more dense areas, or bookmarked ndoe, will occlude content-view)	User Interface
6	Concept of filter (partially) unclear from instruction video	Application Concept
5	Minimal (to none) filter options applied during task, following a "trial and error" strategy	Interaction
5	Request for other view on the nodes (map view, birds-eye view, etc)	User Interface
5	Button layout on physical controller was not intuitive from the start and needed to be learned (troubles remembering which button does what)	User Interface
4	Suggestion to attach more/additional information directly to the nodes (preventing to open the content-view e.g. to check on values after specific filter was applied, or e.g. when pointing and highlighting a node)	User Interface
4	Challenges selecting far away nodes and then triggering movement; Selection through gaze input was physically noticable	Interaction
4	Participant did not remember at first that the content-view displays information required to solving the task.	Experience
3	Selected filter option is not visible in menu after closing and opening filter menu; Applied filter is not displayed when filter menu is closed	User Interface
2	Overall selection (highlight) + trigger interaction was perceived too much; would have prefered selection + immediate execution	User Interface
2	Filter menu placement would have been prefered infront instead of slightly to the right	User Interface
2	Filter concept, incl. colors, were clear for meaning making.	Application Concept

Results / Analysis: Flow Short Scale (FKS)

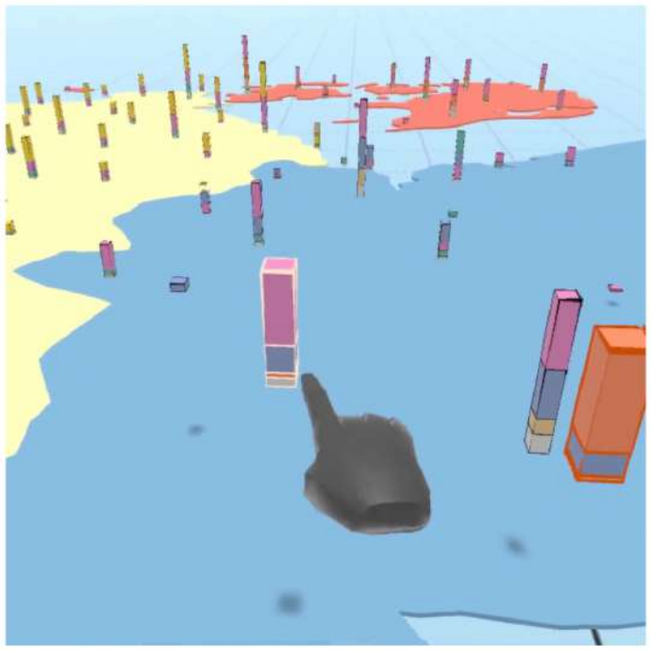
Flow Short Scale	GAMEPAD		VBMC		RSVR	
	AVERAGE	SD	AVERAGE	SD	AVERAGE	SD
F I - Smooth automatized process						
8) I knew what I had to do for each step of the way.	4.625	1.767766953	4.875	1.642080562	5.375	1.922609833
7) The right thoughts/movements occur of their own accord.	4.75	1.488047618	4.375	1.922609833	4.375	1.505940617
9) I felt that I had everything under control.	4.875	1.552647509	4.875	0.991031209	5.5	1.927248223
4) I had no difficulty concentrating.	5	1.927248223	4.25	2.49284691	5.875	1.457737974
5) My mind is completely clear.	5.5	1.195228609	4.125	1.726888201	5.625	0.7440238091
2) My thoughts/actions ran fluidly and smoothly.	5.25	1.669045921	4.75	1.488047618	5.5	1.690308509
F II - Ability to absorb						
6) I was totally absorbed in what I was doing.	6.25	0.7071067812	6.125	1.125991626	6.25	1.035098339
1) I felt the right amount of challenge.	4.5	1.195228609	4.75	1.38873015	4.625	1.685018016
10) I was completely lost in thought.	2.5	1.195228609	4	1.603567451	2.75	1.488047618
3) I did not notice time passing.	4.625	1.846811925	4.875	1.125991626	6	1.309307341
F III - Concern						
11) Something important to me was at stake here.	2.375	1.407885953	2.625	2.263846285	2.875	1.807721534
12) I did not make any mistake here.	3.375	1.685018016	2.75	1.982062418	4.25	1.832250763
13) I was worried about failing.	1.875	1.642080562	3.375	2.386719207	2.375	1.922609833
Addtion - Fit of Skill and Requirements						
14) Compared to all other activities which I partake in, this one is ...						
15) I think that my competence in this area is...	5.125	1.726888201	5	2.927700219	6.25	3.875
16) For me personally, the demands were	4.375	0.9161253813	4.75	1.164964745	1.58113883	1.457737974

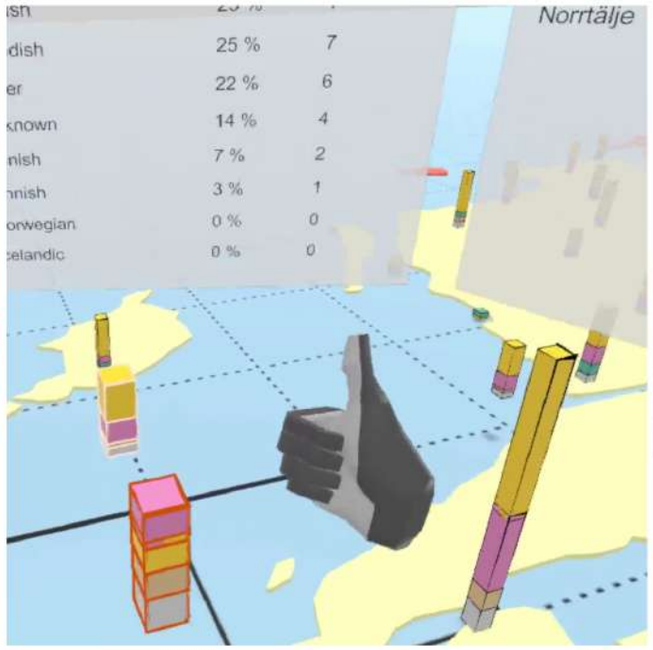
Prototype		Flow (1-10)	Smooth process (F I)	Absorb (F II)	Concern (F III)
GAMEPAD (N=8)	AVERAGE	4.79	5.00	4.47	2.54
	SD	0.96	0.33	1.54	0.76
VBMC (N=8)	AVERAGE	4.70	4.54	4.94	2.92
	SD	0.60	0.33	0.88	0.40
RSVR (N=8)	AVERAGE	5.19	5.38	4.91	3.17
	SD	1.03	0.52	1.61	0.97

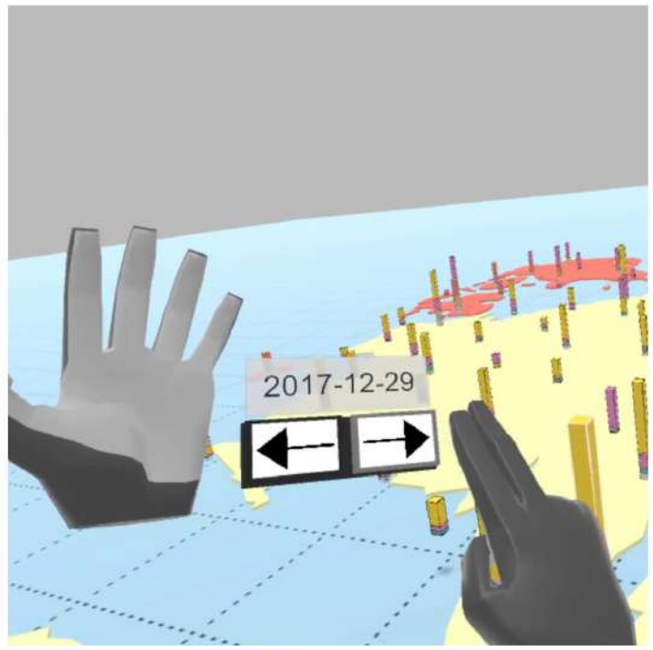
Collaborative Immersive Analytics – Scenario

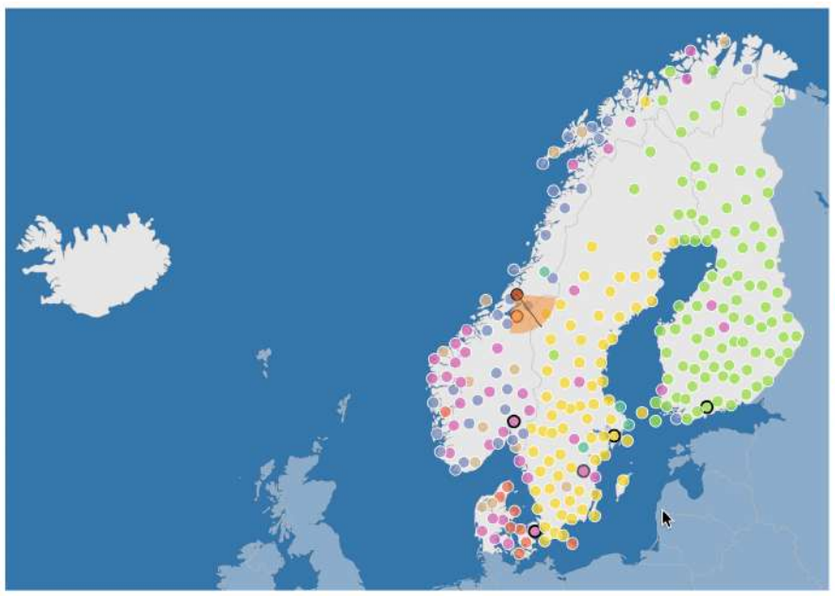
- hybrid collaborative immersive analytics study
    - immersive data exploration (VR, 3D gestural input)
    - non-immersive data exploration (monitor, pointer)
    - co-located, synchronous collaboration (two users)
- explorative, non-time sensitive setting
- exploration of language variability within tweets
  in the Nordic region (linguistic perspective)
- proof-of-concept study to investigate user engagement in
  the scenario of collaborative data exploration / sense making

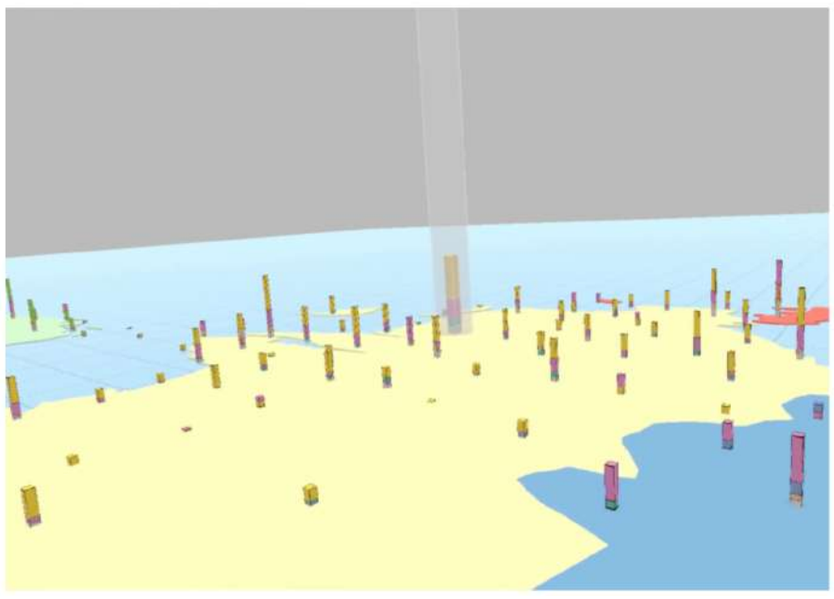
Developed prototype

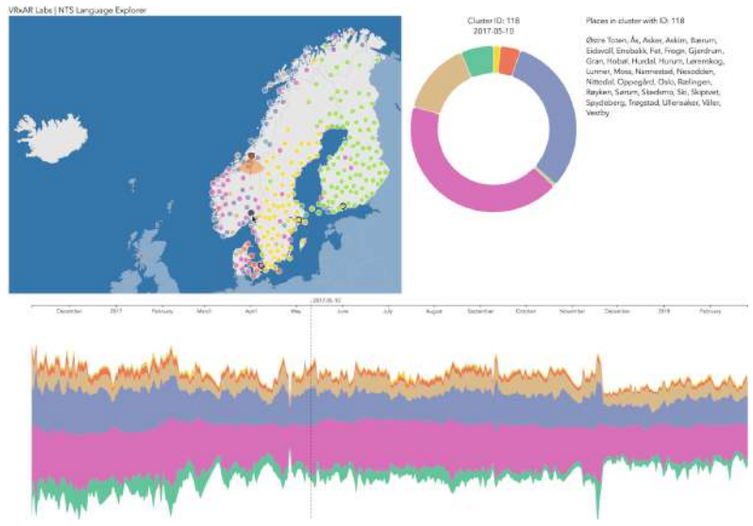






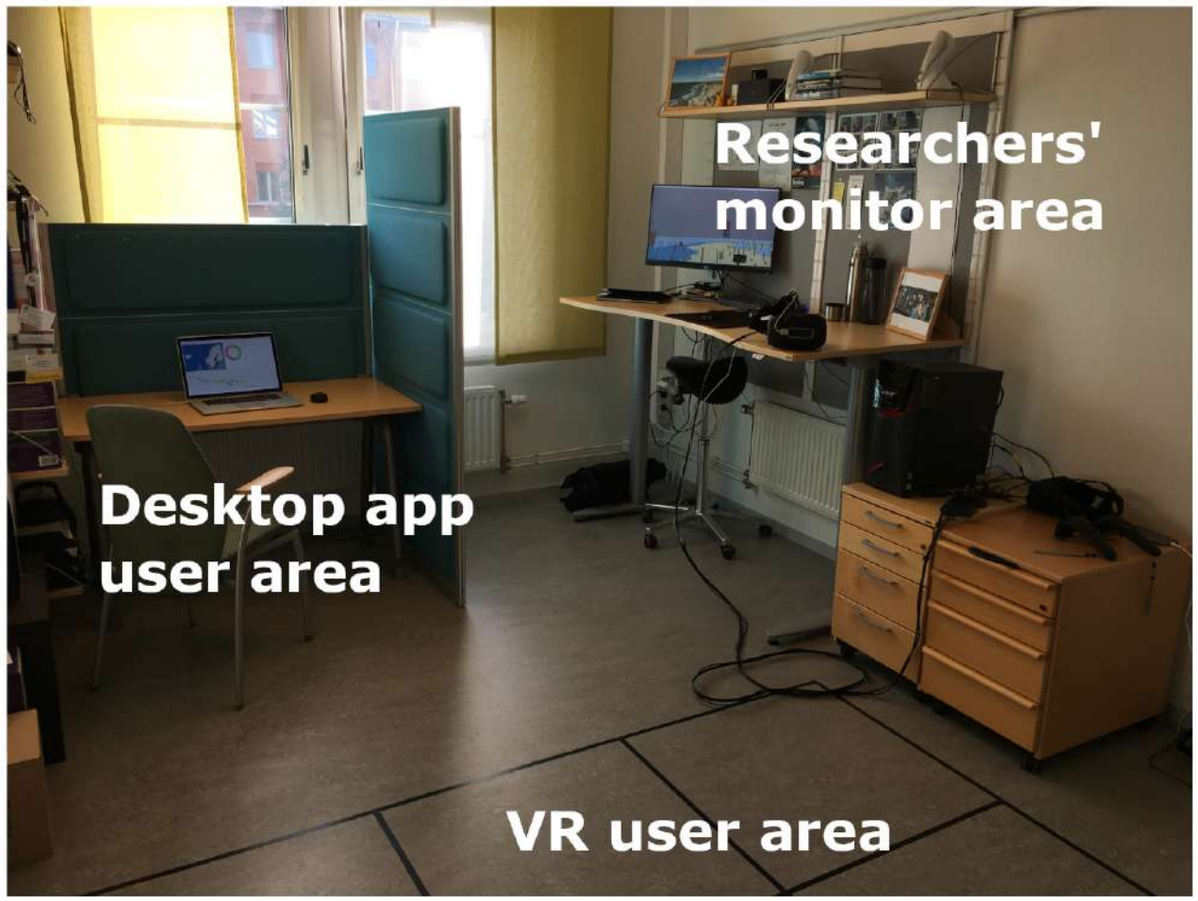


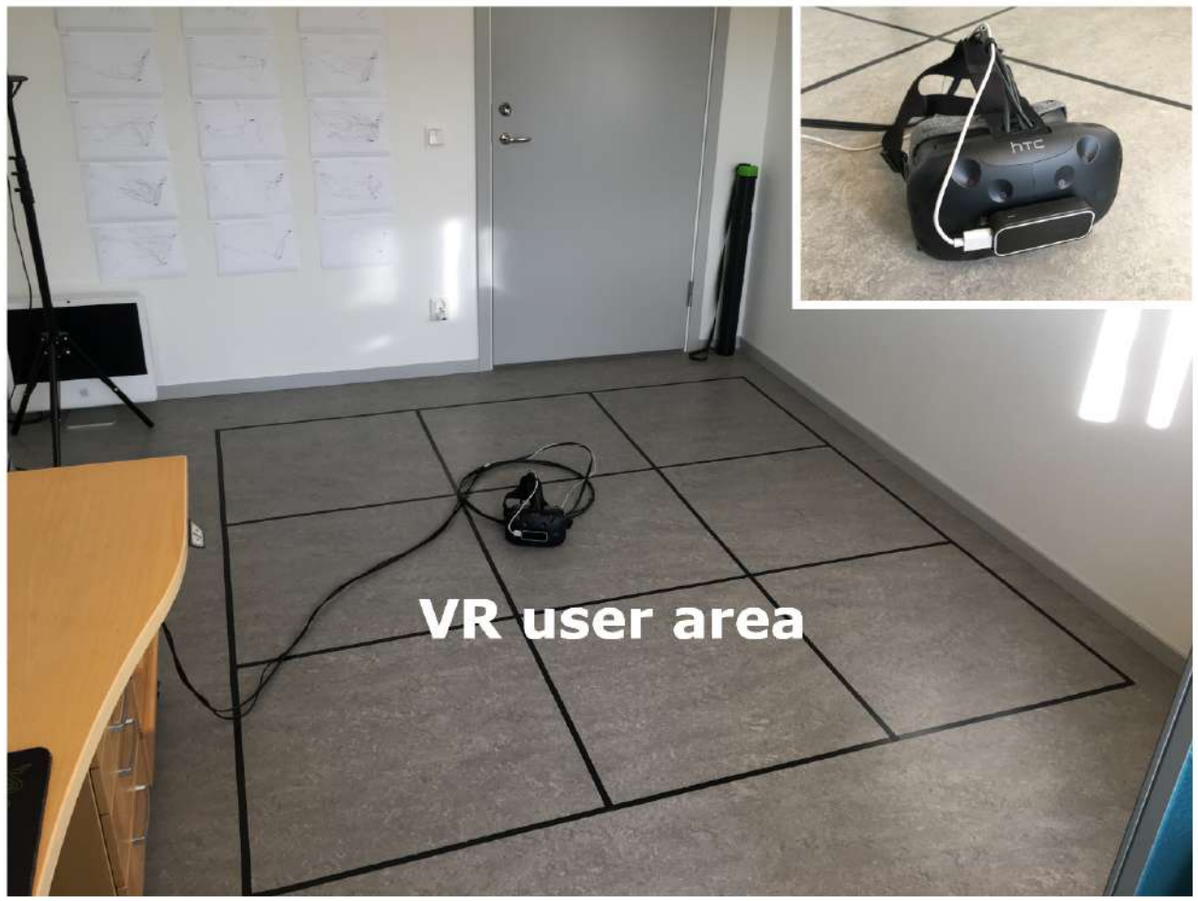




[Video demo: Hybrid Collaborative Immersive Analytics]

Study


Researchers'
monitor area
Desktop app
user area
VR user area


htc
VR user area

Study

- two-on-two session (2 participants, 2 researchers)
- participants n = 6 (2 participants at the same time)
- duration: ~30 min
- 3 phases
  - (introduction)
  - task 1 (user 1 = VR, user 2 = desktop)
  - task 2 (user 1 = desktop, user 2 = VR)
  - post-study interview

Data collection

- observations
- think-aloud protocol
- logging system
    - count “move” and “time” interactions in both applications (VR, desktop)
- semi-structured interview (post-study)

Results

- based on initial feedback, further studies are likely
- highly multi-disciplinary topic, which opens up research possibilities in many different directions
- to be continued…

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Additional references

Portal icons in the presentation available via

bit.ly/portaliconpack