Putting Annotations To The Test

F. Becker[†1] T. Ertl[‡1]

[1]University of Stuttgart, Institute for Visualization and Interactive Systems (VIS), Germany

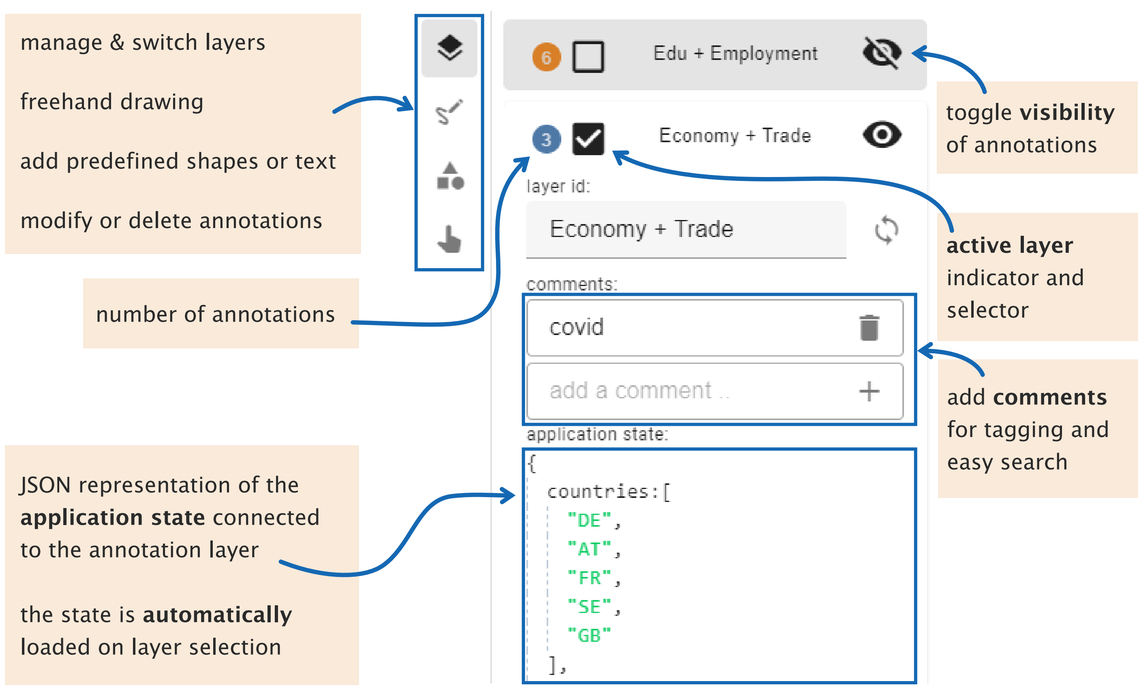
[†]franziska.becker@vis.uni-stuttgart.de [‡]thomas.ertl@vis.uni-stuttgart.de

Introduction

Externalization functionalities like annotations or direct manipulation of visual elements can support users by providing external memory capacity, giving them ways to think and interact with different representations and organize their thoughts [Kir17]. In the form of annotations or notes, these are not new to visualization [KHRL*19], but their effects on users' analysis workflow, results and recall thereof are not yet completetly understood. We present a visualization-agnostic externalization framework for use with digital pens which allows users to easily annotate web-based visualization systems. In a pilot study, we test its usability and investigate effects of annotations on analysis recall.

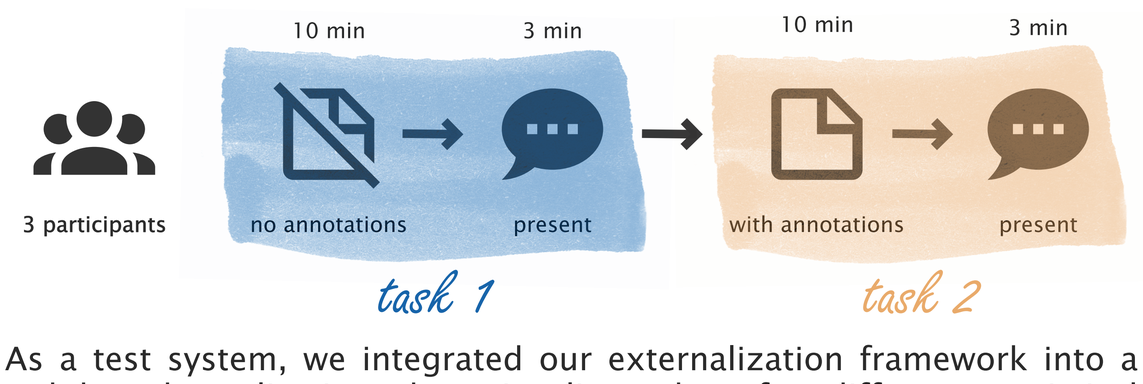
Externalization Framework

web-based **library** **automated** state-tracking

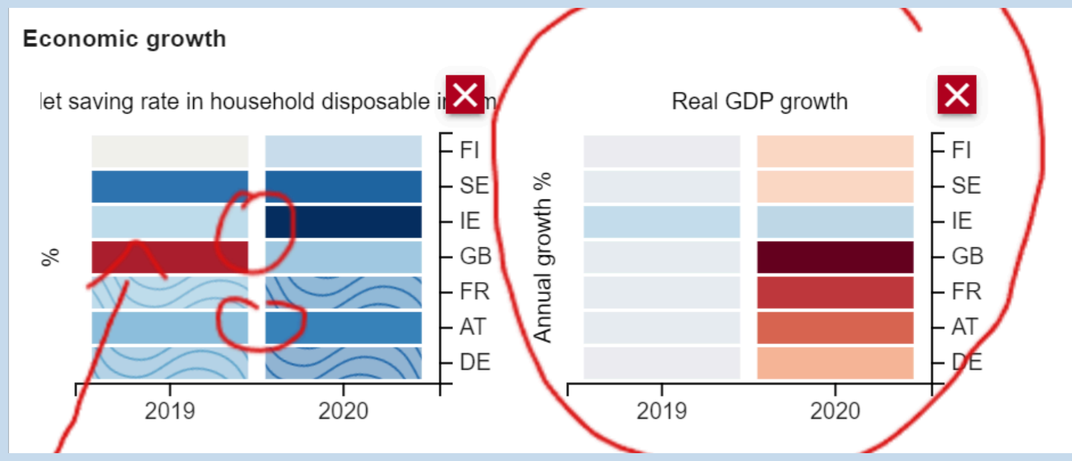


Study Design

We ran a small pilot study to evaluate the usability of our externalization framework and try out our study design which investigates participants' recall of analysis findings. The study employed a within-subject design; each participant completed two tasks – one with and one without annotation features. In each task, participants were asked to explore the same dataset in order to answer an open-ended question and present their findings with examples afterwards.



As a test system, we integrated our externalization framework into a web-based application that visualizes data for different statistical indicators, e.g. GDP, for a subset of countries around the world in the years 2014 to 2021. It employs both simple visualizations like bar charts and more complex visualizations like parallel coordinates. During the study, participants used a Microsoft Surface Pro 4 with a digital pen.



Partial screenshots from different annotations created by participants during the pilot study where circles, lines and arrows indicate data points of interest, trends or comments.

Results

To evaluate the usability of our framework, we looked at the recorded interactions and feedback from participants during the pilot study. In order to compare the verbal finding summaries, we analyzed them in terms of detail and content, comparing the tasks for each participant.

Usability

- easy to use with little training
- **mode-switching** leads to errors & interrupts analysis process
- freehand **drawing** preferred to predefined shapes or digital text

Recall

- only minor differences between summary findings
- **reduced recall** for one participant after losing annotations
- think-aloud may decrease motivation for verbal summary

Discussion & Future Work

Overall, our prototype and study design seem promising, but failed to show much difference for the two conditions. This may be due to the short task times, which do not easily allow for more in-depth analysis. Consequently, the time span between making a finding and reporting it is quite small, which may allow for easy recall in any condition. For future research, we plan to either give participants more time to gather insights or to use interference tasks to make recall of their findings more challenging – providing more opportunity to measure differences. It would also be interesting to investigate how the expectation to have annotations available during reporting affects the report. Additionally, we plan to improve our framework in terms of usability to make sure users can easily utilize all of its features during analysis.

References

[Kir17] KIRSH D.: Thinking with external representations. In *Cognition Beyond the Brain: Computation, Interactivity and Human Artifice*, Cowley S. J., Vallée-Tourangeau F., (Eds.). Springer, Cham, 2017, pp. 61–84. doi: 10.1007/978-3-319-49115-8_4.

[KHRL*19] KIM Y.-S., HENRY RICHE N., LEE B., BREHMER M., PAHUD M., HINCKLEY K., HULLMAN J.: Inking your insights: Investigating digital externalization behaviors during data analysis. In *Pro. of the 2019 ACM Int. Conf. on Interactive Surfaces and Spaces* (New York, NY, USA, 2019), ISS '19, Association for Computing Machinery, p. 255–267. doi: 10.1145/3343055.3359714.

University of Stuttgart
Germany

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Institute for Visualization and Interactive Systems