Data Visualization Show & Tell

B2 (~~English level~~)

Bridging Code and Interactive Visualization in Computational Notebooks

Yifan Wu, Joseph M. Hellerstein, Arvind Satyanarayan (UIST 2020)

What is this paper about? 🤔

TL;DR

B2 is a set of ideas and an extension for Jupyter Notebook to improve the data analysis workflow considering interactive charts and their reproducibility/display.

In other words, how can interactive charts be leveraged on notebooks?

Keywords

(Exploratory) Data Analysis

- Data Visualization
- Vega-Lite
- Literate programming
- Jupyter Notebook

How is it structured? 🗃️

1. Introduction

2. B2 demo (case study style)

3. Related work

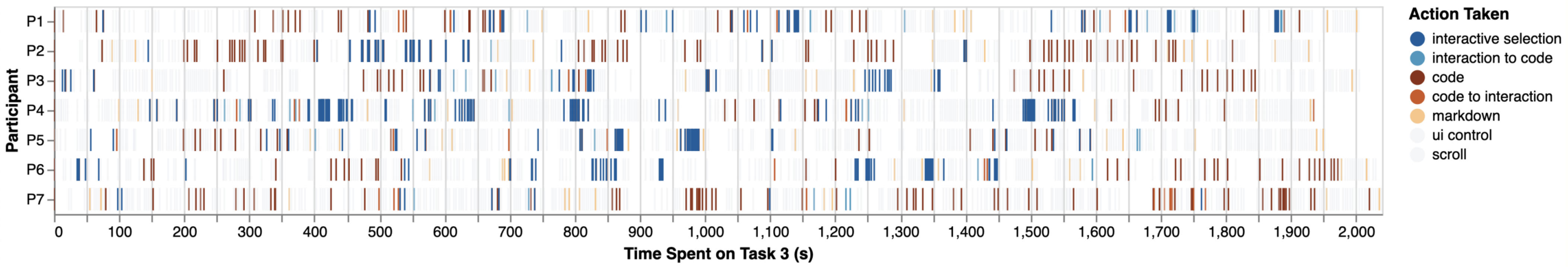
4. *Theoretical* considerations

5. System design and implementation

6. Evaluation

    - First-use study w/ 7 participants (low number due to COVID-19)
    - *Metrified* notebook and qualitative feedback

7. Conclusion



Participants' interaction traces while working on one of the tasks.

Entry point ⛩️

Isolation

"Currently, although (...) [code cells and visualizations] may be interleaved, they remain siloed:

interactive visualizations must be manually specified as they are divorced from the analysis provenance expressed via data frames, while code cells have no access to users' interactions with visualizations (...)."

Shared representation

"The fundamental task of data analysis involves iterative data transformation, and both code [via data frame manipulations] and interactive visualizations [via interactive selections] can capture this task as a data query."

In this paper, "interactive selections" are based on Vega-Lite's *selections*. They map user input (like a mouse click) into data queries, which can subsequently be used to filter data points, for example.

The three gaps 🚧

Semantic gap

This gap "(...) prevents each side [code cells and visualizations] from understanding the work that is happening in the other;"

"(...) an analyst must manually construct appropriate interactive visualizations from scratch even if the code that specifies the data frame captures semantics that can automate visualization design."

The three gaps 🚧

Semantic gap

This gap "(...) prevents each side [code cells and visualizations] from understanding the work that is happening in the other;"

Temporal gap

This gap "(...) allows only code to persist, and only interactions on visualizations to be transient;"

Layout gap

This gap occurs "(...) between the notebook's linear structure and rich coordinated multi-view visualizations."

Key features 🚑

- Dashboard panel
  - The charts are displayed on a dashboard located to the right of the notebook in order to facilitate (interactive) multi-view displays (regardless of the source cell).
- Interaction log
  - Interactive selections are represented by their underlying predicate definitions in code cells.
- Reactive cells
  - Cells marked as *reactive* (via the `%%reactive` IPython magic command) are automatically recomputed when new interactions occur.
- *Auto plotting*
  - Charts can be *inferred* from a data frame or from the list of columns available on the dashboard (heuristic-based).
  - If two data frames derive from the same data frame, the generated charts will be linked.

Intermediate remarks 🚀

Placing Data Visualization in the workflow

"(...) we should work on standardized data interfaces for visualization for both input and output data. Input data is defined as the data used for the visualization. Output data is defined as data created by interacting with the visualization (e.g., selections, filtering)." (Schmidt & Ortner, 2020)

Leveraging Data Visualization *in practice*

In practice, it is sometimes easier and faster to manipulate a data frame, draw some conclusions, and proceed with the analysis — instead of creating and using a chart. This approximation of charts to data manipulation seems, at least at first glance, to invite the user to plot data.

Demo!

😈 📓 📊