A case study on implementing screen reader accessibility in dynamic visualizations

Millions of people worldwide work in jobs where assessing dynamic data presented visually to them is a key part of their tasks. Since the data is only represented in a visual format, these occupations are out of reach for visually impaired people, making them unable to review hundreds of information-heavy cases per day and determine outcomes for each one in just a couple of minutes. In this work, we aim to shrink that gap by detailing the implementation of screen reader accessibility features to real-world visualizations used by fraud detection analysts. We propose a set of features that should be validated with users and, if proved to be useful, transformed into guidelines for creating these types of accessible charts.

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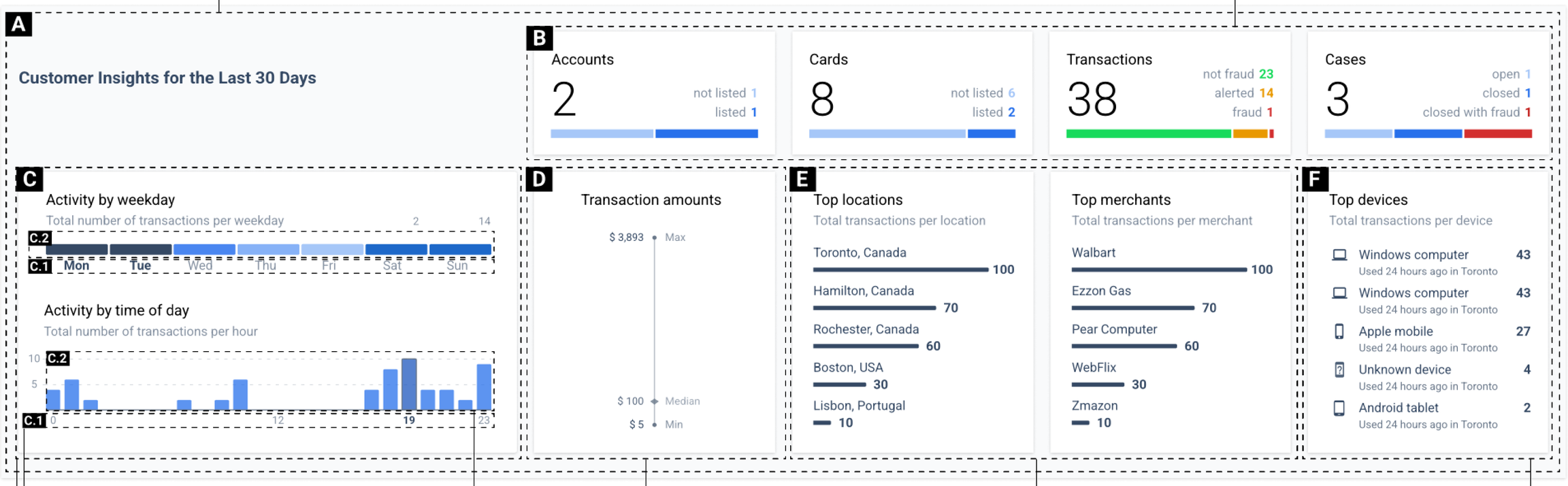
A Overall organization of the visualizations: "***Customer insights for the last 30 days***" is the first information that the screen reader announces. It clearly states what the analyst is about to encounter, giving them room to explore it further or move on. Additionally, a hidden paragraph that is only available to the screen reader software is included describing the main trends in the data. The description is dynamic and adapts to the customer data. In the example, the screen reader would read: "***Customer with two accounts, eight cards, 38 transactions, and three cases. More active on Monday and Tuesday and at 7 pm. Median amount per transaction is 100 dollars. Top location is Toronto, Canada; top merchant is Walbart; top device is a Windows computer.***"

B Since these cards have a title visible to the screen reader that announces the element that is being counted, for example, "Transaction statistics", we swap the visible "transactions" for "total". This way, the screen reader will announce the following: "***Transactions statistics; total: 38; alerted: 14; fraud: one***". The same applies to the other similar cards.



C.2 Chart elements: The details regarding the value of each bar are available after the axes are announced and the user can skip them and go to other chart elements as they wish. In the example of the second plot, the aria-label will read the hour in the day and the count for that particular time. With the aria-roledescription, we describe the shapes as chart elements.

C.1 Axes: In the axes, we hide labels and ticks from the screen reader using the aria-hidden attribute and describe the axis range. In the second plot, the x-axis aria-label is: "***Axis ranging from 12 am to 11 pm***"; in the y-axis is: "***Axis ranging from zero to ten transactions***".

E Top merchants and locations: In this case, the approach is similar to the customer behavior charts [**C**]. We also generate an invisible paragraph stating which is the most common location or merchant and their count. The user can explore it further to know the type of chart, the range of the x-axis, and the count for each particular element.

D Transaction amounts: There is no visible gain in forcing the user to go through each element of this minimalist boxplot. Therefore, we completely hide it from the screen reader with an aria-hidden attribute and use text to describe what is shown visually. It works because it is a small amount of data. The screen reader reads the following: "***The middle value in the dataset. Half the transactions made by this customer were below $100 and the other half was above***."

F Devices: In this segment, data on each device is turned into full sentences, so the information is more naturally read by the screen reader. In the first device, it will read: "***A Windows computer was used 43 times. Last seen 2 hours ago in Toronto***."

C Customer behavior: These two charts have hidden paragraphs only visible to the screen reader that describe the main trends in the data. For example, for the second plot in [**C**] this description will read: "***The days with most activity are Monday and Tuesday with 14 transactions. Minimum was two, on Friday***." When the screen reader finds the chart itself, it will de- scribe the type of visualization the user is interacting with. For example, "***an heatmap showing the distribution of transactions over the days of the week***". During this interaction, the user can navigate to another plot or skip a certain description via the keyboard shortcuts.

CONCLUSIONS AND FUTURE WORK

The implementation that is described above was designed taking into consideration general web accessibility recommendations and the limited literature on the topic. From those references and from our knowledge of these types of tasks, we compiled a group of features that should be part of these systems: 1) hierarchized; 2) skippable; 3) navigable; 4) natural; and 5) detailed on request. We did not have the opportunity to test our work with visually impaired users because, in the field of fraud detection, we were unable to find any such users. This is precisely the problem we aim to address by enabling people to perform complex tasks and have access to these jobs.

In the future, we aim to test these charts with actual screen reader users and be able to validate if the features we identified in this implementation can be transformed into actual guidelines.

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