Interactive Visualization

End Report



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# Performance

No one wants to interact with slow or badly performing visualizations. In an era where data plays a vital role in decision-making processes, interactive visualizations have become invaluable tools for exploring and understanding complex information. However, the effectiveness of these visualizations heavily relies on their performance. Whether it's the loading speed, responsiveness, or smoothness of interactions, performance is a critical factor that significantly influences user experience and engagement.

## What makes visualizations slow?

There are many reasons as to why a visualization can perform badly, not all of them can be controlled and mitigated by the creators/designers as there are many that come from the client. Here are some of the most common reasons:

* Large data sets and lack of data optimizations:
  + Processing and rendering a substantial amount of data requires more computational resources, this is further exemplified when the data isn’t optimized either. Large or redundant datasets, unnecessary calculations or inefficient data structures can all slow down the processing and rendering of visualizations.
* Inefficient algorithms:
  + Poorly optimized code or inefficient algorithms used in the visualization can result in slow performance. Inadequate data processing techniques or rendering methods can put unnecessary strain on the system, leading to sluggishness.
* Complex rendering or interactivity:
  + Visualizations that involve complex rendering techniques or interactive elements can be more resource intensive. Advanced visual effects, real-time updates, or many interactions can increase the computational requirements.
* Network latency:
  + If the visualization relies on data fetched from a remote server or database, network latency can be a factor affecting performance. Slow internet connections or high latency can cause delays in fetching the necessary data.
* Insufficient hardware:
  + Although rare nowadays, with how much hardware has progressed, some users may still have underpowered hardware for very complex or large visualizations which leads to incompatibility or extremely bad performance.

## Methods to optimize visualizations

As with most things, technology and optimization techniques evolve and improve over time. And in the field of data visualization it is no different, many methods have been developed or improved to fix or mitigate the core problems that lead to slow performing visualizations. As not all issues can be resolved I’ll cover the ones that have straightforward solutions:

* Large data sets
  + Data filtering and aggregations: By applying filters and aggregations to divide the data into meaningful subsets, you can reduce the amount of data being rendered at once.
  + Data sampling: Instead of displaying the entire data set, you can sample a representative subset of the data. Techniques like random sampling or stratified sampling work great.
  + Progressive loading: Progressively loading data allows initial rendering to be faster while fetching additional data as needed. This is especially relevant to interactive visualizations.
* Lack of data optimization:
  + Data preprocessing: Optimizing data beforehand through cleaning, transforming, and aggregating it. Removing redundant/unnecessary data, applying data compression, and using appropriate data structures.
  + Data summarization: Summarizing data at different levels of detail to reduce complexity.
  + Data caching: Caching preprocessed or intermediate data can be used to avoid redundant computations. This again is relevant to interactive visualizations where users perform frequent similar operations.
* Network latency/speed, this cannot be fully resolved, but it can be mitigated through:
  + Data compression: Through compression, you reduce the amount data that needs to be sent over the network leading to smaller network payloads.
  + Data streaming: Instead of loading the entire data set at once, data streaming allows you to load and render smaller chunks of data. This can be combined with progressive loading to improve interactive performance.

## Why performance matters

Some of the most important aspects of the visualization experience are heavily affected by the performance of the underlying graphic, I’m going to cover what I find the most important and how they affect the experience of users.

* Interactivity:
  + Responsive and fast visualizations enhance the experience for users. When interactions like zooming, filtering, or panning are responsive, it creates a sense of fluidity and control. This promotes engagement and encourages the users to fully explore and understand the data presented to them. On the other hand, when those interactions are slow or laggy, it can frustrate the user, hamper their ability to interact with the data, and discourage continued use of the visualization.
* Cognitive load:
  + When a visualization loads and renders quickly and updates to it are seamless, it allows users to focus more on the data and insights they are trying to derive. While a slow or poorly performing visualization can introduce distractions and cognitive disruptions, which leads to an increased cognitive load. The reasons this happens is because users may have to wait a long time for data to render or rendering artifacts, leading to breaks in concentration and hindering the ability to process data effectively.
* Attention span:
  + Slow loading times, jaggy animations or low responsiveness can, like mentioned above, lead to frustration and impatience. Users may lose interest or become distracted, which causes them to drift away from the visualization leading to little or even no information being conveyed to the user.

# Dashboard design principals

Dashboards play a crucial role in visually representing complex data in a concise and intuitive manner. A well designed dashboard can provide valuable insights, facilitate effective decision-making, and enhance the overall experience of a user.

## Free Creative Chart Dashboards Templates The concept of a dashboard

What is a dashboard? Dashboards serve as a control panel or summary of information that provide quick and easy ways to access and understand important data. Just like a cars dashboard, which shows you only the most vital information at a glance, a digital dashboard collects and presents key data and metrics in a concise visual format. They’re designed to give a clear and understandable overview of what’s happening.

## The design principles of dashboards

When it comes to designing effective dashboards, there are several key principles to keep in mind. These design principles can help create intuitive, visually appealing, and actionable dashboards. Here are some of the essential design principles for dashboards:

* Simplicity
  + Keeping dashboards clean and uncluttered is one of the most important principles. It helps not only to decrease the cognitive load of a dense data visualization such as a dashboard, but also increases the accessibility and usability of it.
* Information Hierarchy
  + Arranging data in a logical and hierarchical structure and prioritizing the most important information allows the dashboard to facilitate the smooth mental assimilation of data. This can be done using visual cues like size, shape, opacity, color and positioning of the data or visualizations.
* Consistency
  + Maintaining a consistent layout, typography, color scheme and visual style throughout the dashboard promotes familiarity and reduces cognitive load, easing navigation and leads to more effective decision making and a better user experience.
* Effective and contextual
  + By ensuring that the data displayed is relevant to the users goals and needs, and choosing appropriate charts types you can very effectively tailor the experience to match the context and true purpose of the dashboard.
* Interactivity (The drill down concept)
  + Interactivity empowers users to engage with data dynamically, transforming static information into a dynamic tool for exploration and analysis. “Drill-down” functionality is an additional layer of interactivity, letting users delve deeper into specific data points or dimensions to uncover even more detailed insights when needed. In essence, interactivity, including drill-down capabilities, elevates dashboards from passive displays to active decision support systems.
* Accessibility
  + Complying with modern accessibility guidelines does not just help ensure usability for the visually impaired, but can also lead to a more pleasant experience to all users through convenience. The process of ensuring accessibility also comes with user testing and feedback, that needs to be collected and reflected upon throughout development.

## The importance of dashboards with interactive visualizations

Dashboards in the context of interactive visualizations are invaluable tools for extracting meaningful insights from complex data. They bridge the gap between raw data and actionable knowledge, making information accessible and understandable. Interactive visualizations within dashboards empower users to interact with data in a dynamic, user-friendly manner, transforming passive data consumption into an active exploration.

One key advantage is the ability to provide real-time monitoring and feedback. Dashboards with interactive visualizations allow users to track data as it evolves, enabling them to respond promptly to changing conditions or emerging trends. This real-time awareness is crucial in today's fast-paced business environment, where timely decisions are often the key to success.

Ultimately, the synergy of dashboards and interactive visualizations unlocks the transformative potential of data. It empowers organizations to make informed decisions, identify opportunities, and address challenges with agility. In an era where data is a strategic asset, dashboards with interactive visualizations are essential tools for driving innovation, efficiency, and competitive advantage.

# Human Computer Interaction Basics

Human-Computer Interaction stands at the forefront of our digital age, shaping the way we interact with technology. At its core, HCI is the interdisciplinary field that explores the synergy between humans and computers, seeking to make this interaction more intuitive, efficient, and user-friendly. In an era where technology permeates every facet of our lives, from our phones to our homes, HCI plays a pivotal role in designing interfaces and systems that bridge the gap between human cognitive abilities and the capabilities of machines. The field encompasses a wide range of disciplines, from psychology and design to computer science and engineering, all working together to create interfaces and experiences.

## What are the main/popular interaction techniques

## Optimizing interfaces for human usability (Human/e design?)

# Evaluation

## Example Chart

## Usability study

## Improvements and conclusions