

# Web applications for clinical trial conduct and data visualization

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## Abstract

Clinical trial data visualization and conducting adaptive clinical trials demand extensive coding and time from data analysts and statisticians. To improve accuracy and efficiency of data analysis, we assembled a team to develop a collection of 14 R Shiny applications. These applications automate and simplify repetitive tasks while allowing investigators to visualize their data and improve data quality. Specifically, we developed three Clinical Trial Conduct Applications to streamline conducting Bayesian adaptive phase I clinical trials, and 11 Data Visualization Applications that provide a selection of commonly used clinical trial plots. These applications have been widely used by our team to communicate with investigators and prepare figures for publication. They have also been disseminated at two conferences and two workshops in 2023 and 2024, resulting in a 93% increase in users from 2023 to 2024 and >1,500 users across the US and internationally.

## Clinical Trial Conduct Applications

Clinical Trial Conduct Applications are used to obtain dose assignments for Bayesian dose finding designs. These applications were developed with the goal of making novel adaptive clinical trials more accessible while enhancing clinical trial innovation, quality, and efficiency by streamlining this recurring task. These applications implement the continual reassessment method (CRM), the time-to-event continual reassessment method (TITE-CRM), and the patient-reported-outcome continual reassessment method (PRO-CRM).



**CRM Conduct**  
Assign next dose and estimate MTD using CRM



**TITE-CRM Conduct**  
Assign next dose and estimate MTD using TITE-CRM



**PRO-CRM Conduct**  
Assign next dose and estimate MTD using PRO-CRM

## Data Visualization Applications

Data Visualization Applications are used to review data visually and to prepare publication-quality plots. These web applications were designed for use by both clinicians and data analysts offering intuitive and interactive customization to enhance clarity for dissemination of clinical insights. All applications feature four standardized tabs (Application Description, Data Description, Data Upload, and Visualization) and include drop-down boxes for variable selection as well as a sample data set.

## Data Visualization Applications

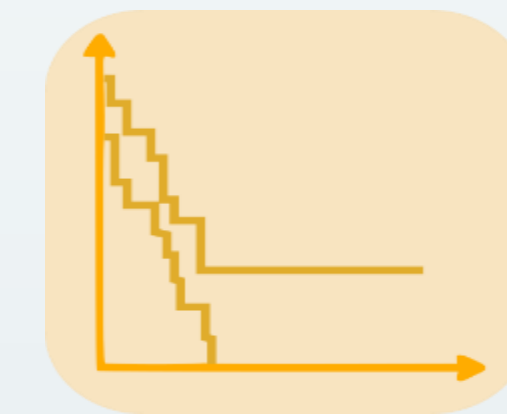
### Phase I Clinical Trials



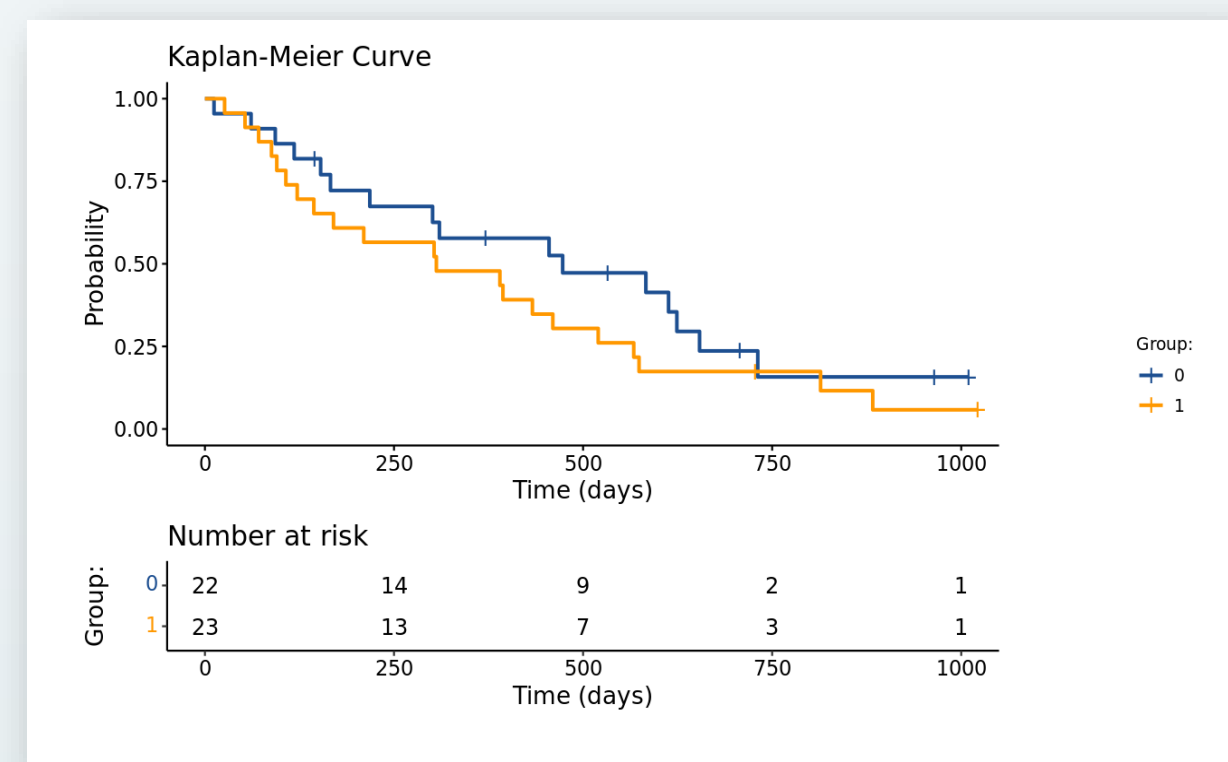
**Dose Finding**  
Visualize and report data from dose-finding trials



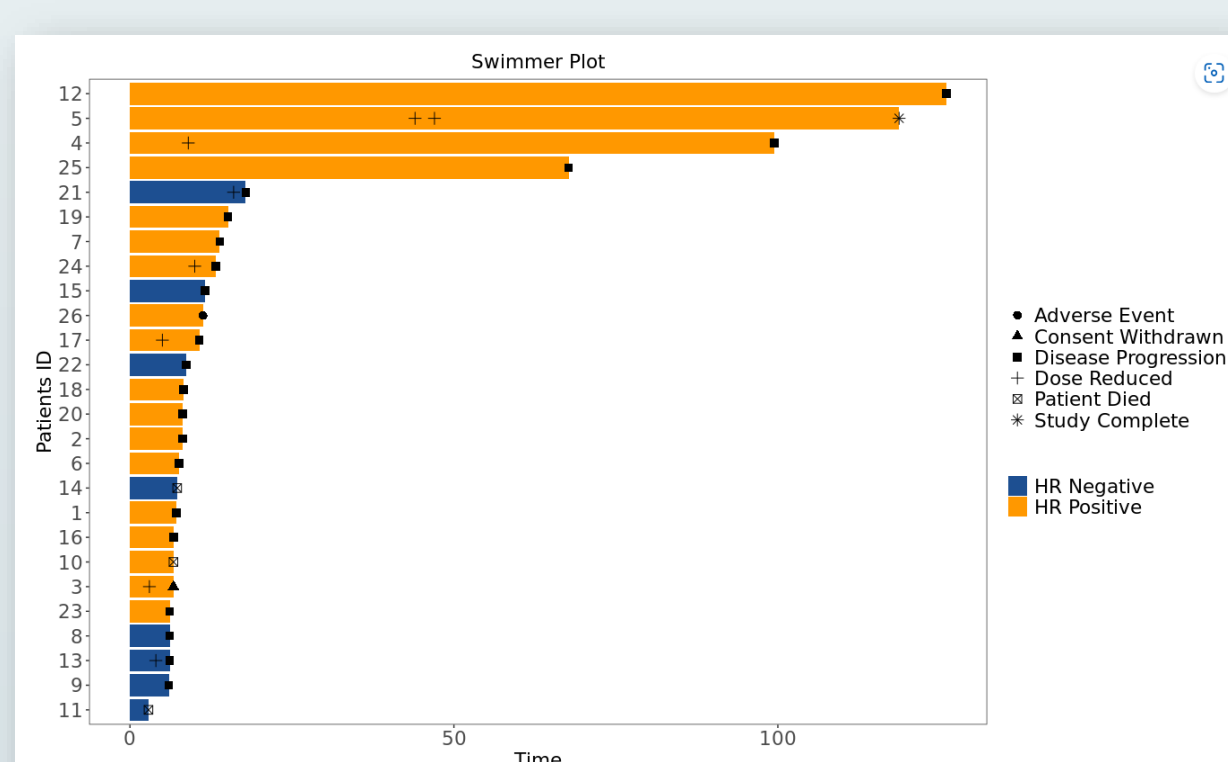
### Phase II and III Clinical Trials



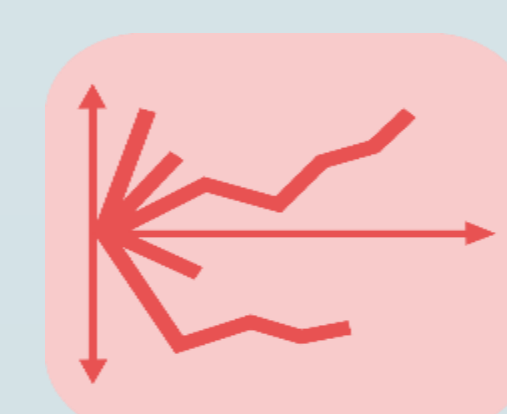
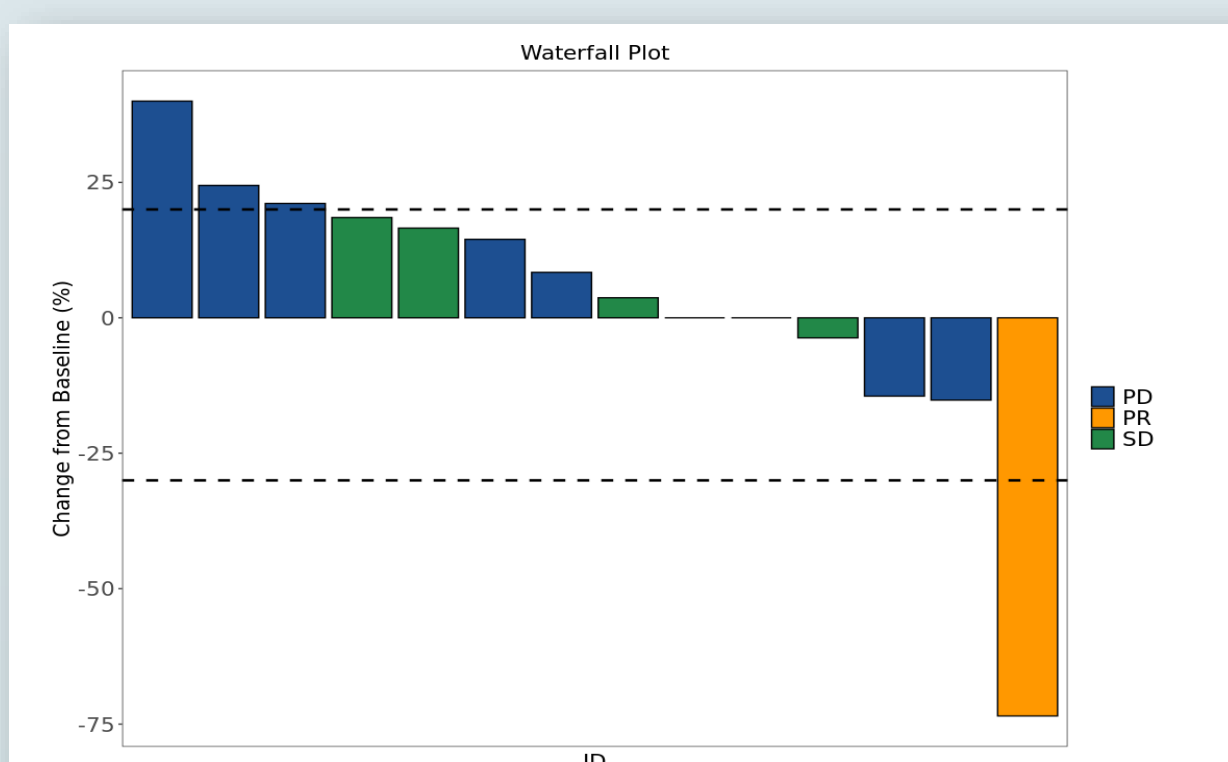
**Kaplan Meier**  
Visualize and summarize survival data



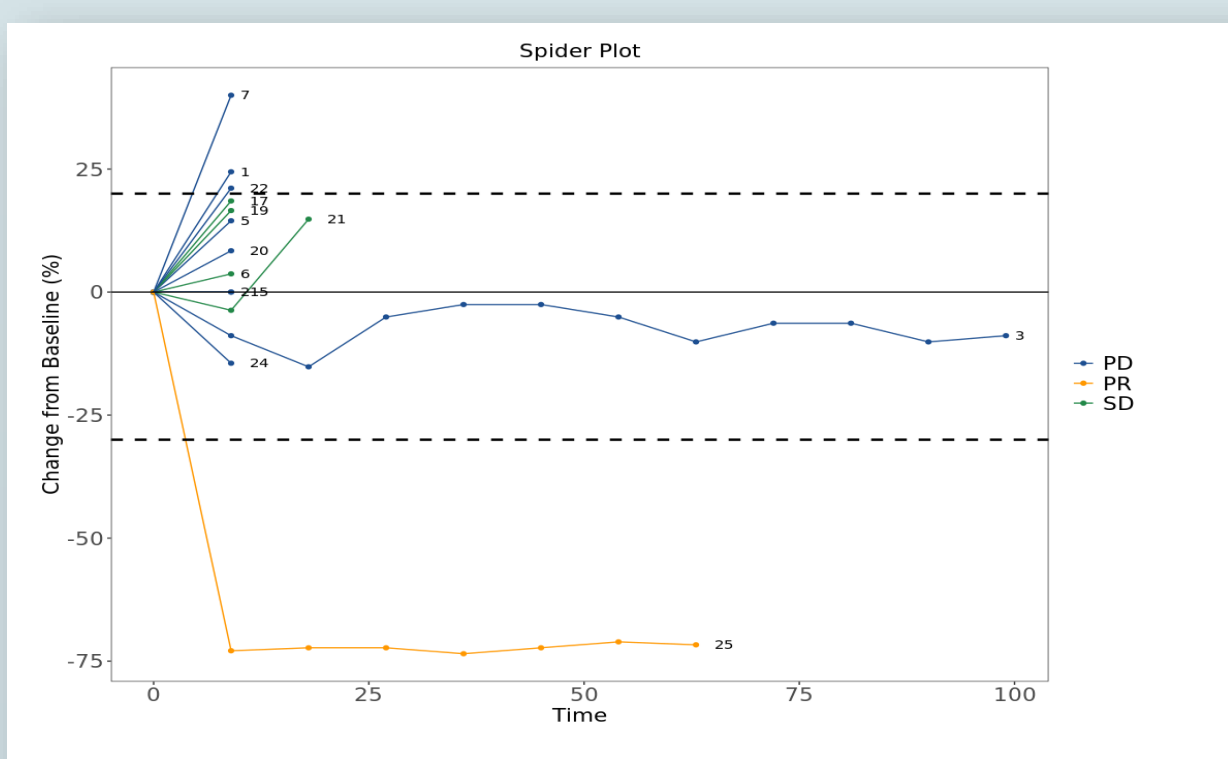
**Swimmer Plot**  
Visualize follow-up and events across individuals over time



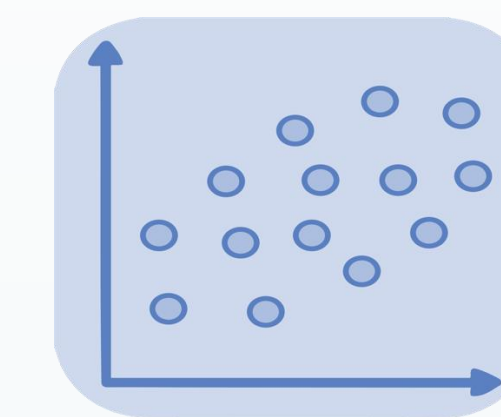
**Waterfall Plot**  
Visualize a change in one variable across individuals



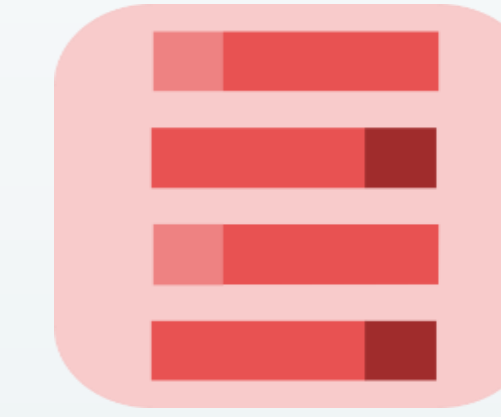
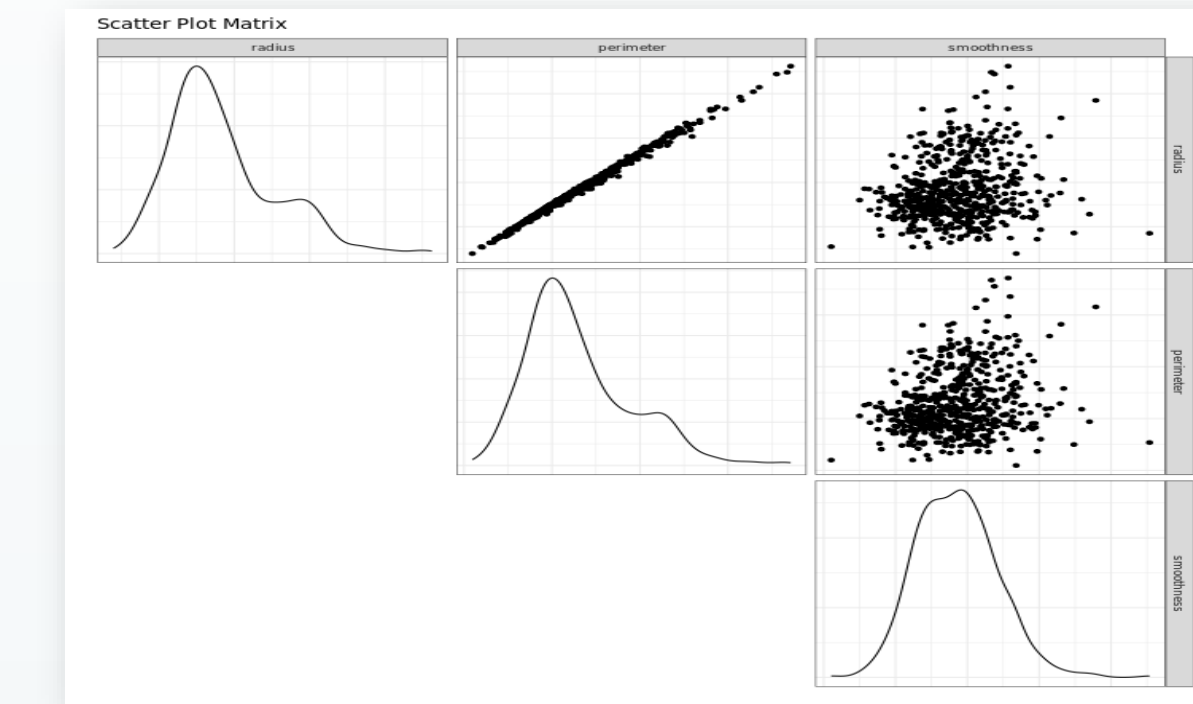
**Spider Plot**  
Visualize change from baseline across individuals



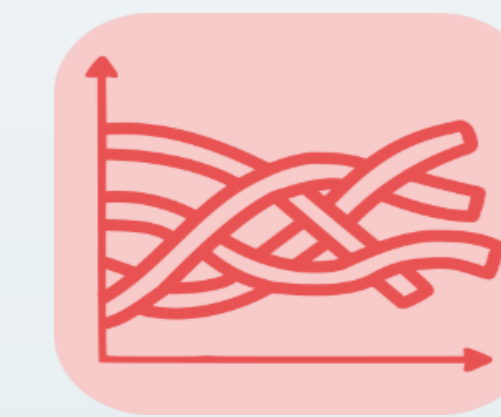
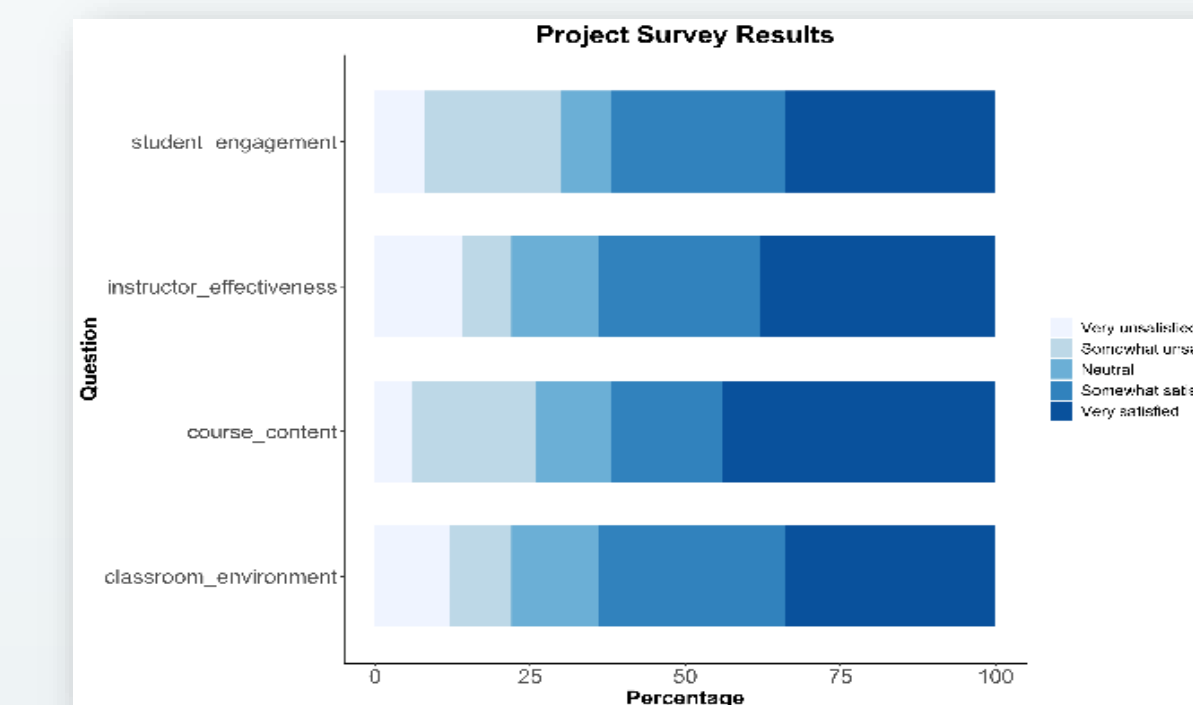
## Data Visualization Applications



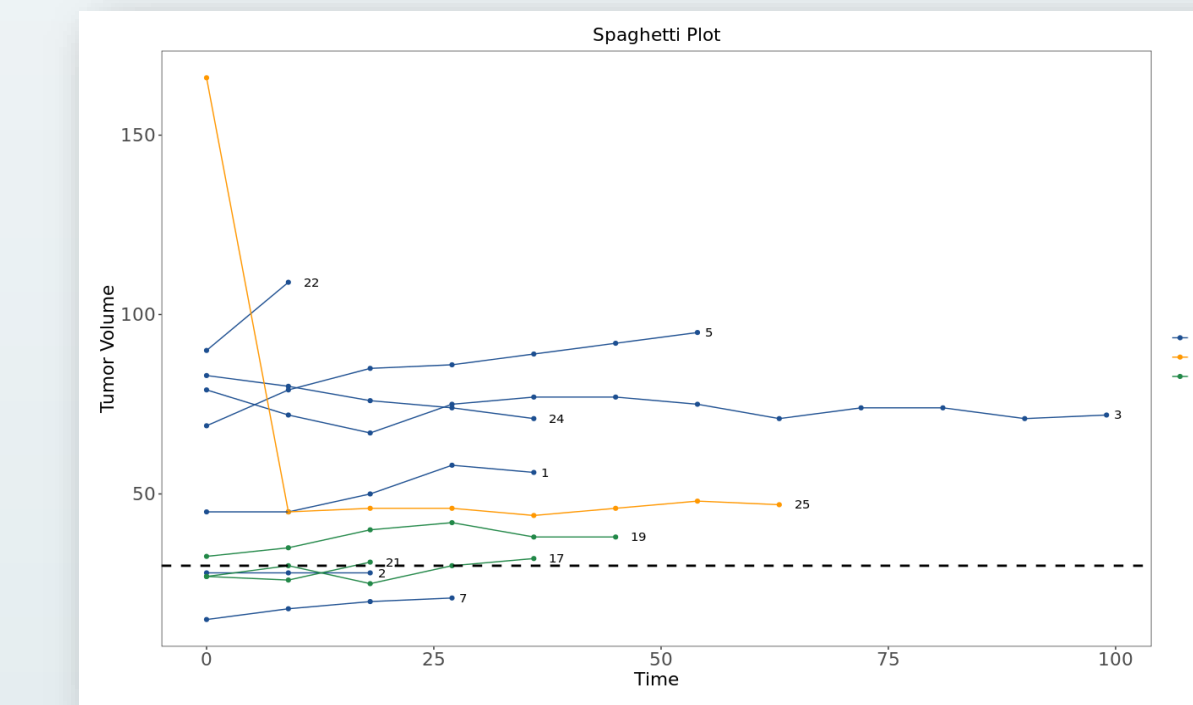
**Correlation Plot**  
Visualize correlation among continuous variables



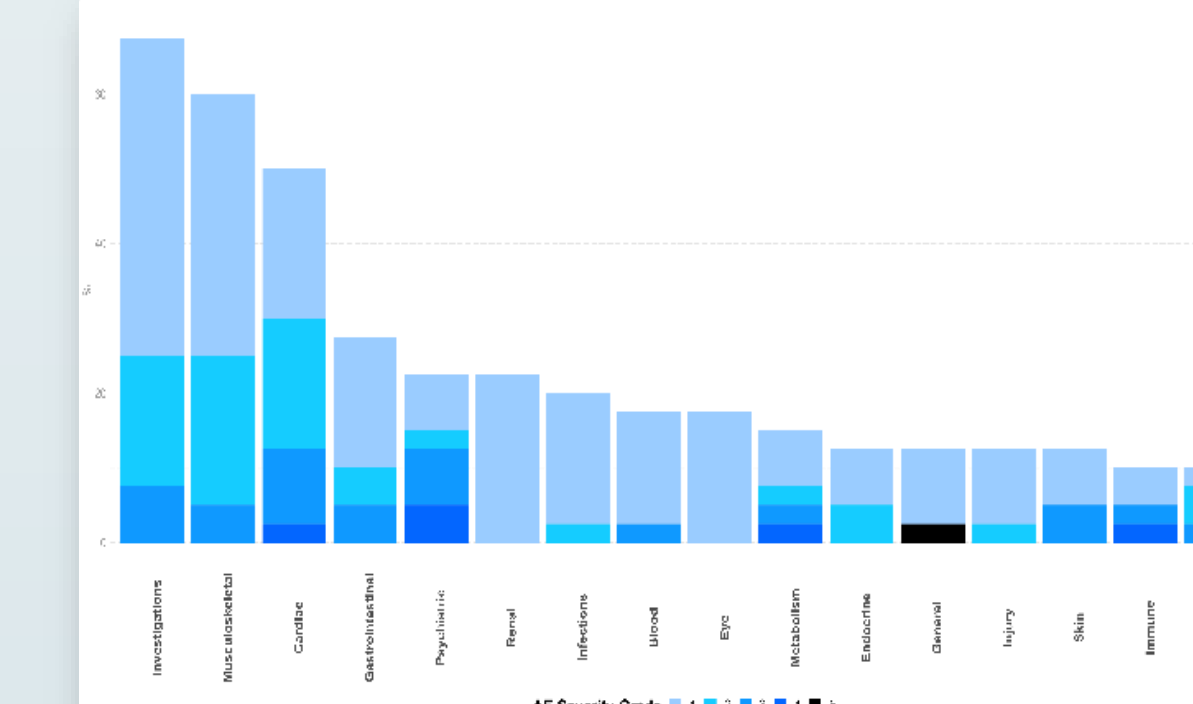
**Likert Plot**  
Visualize Likert scale data



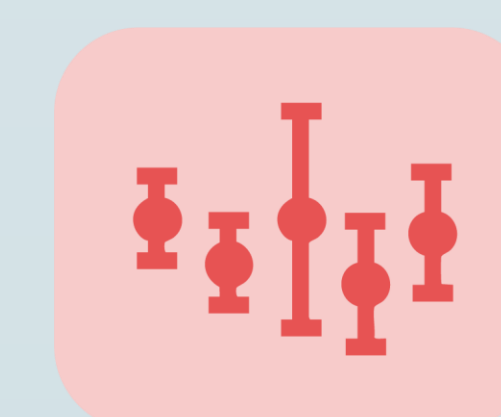
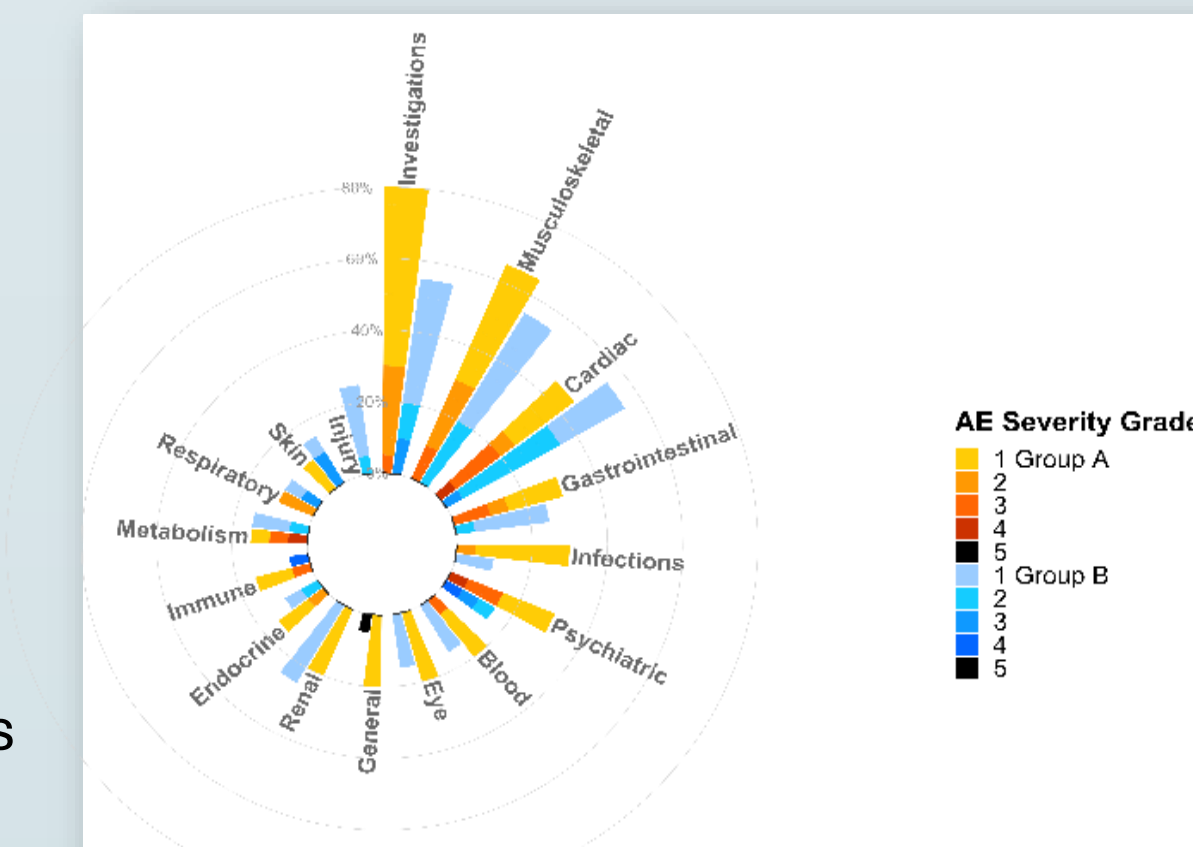
**Spaghetti Plot**  
Visualize the change of a variable across time for individuals



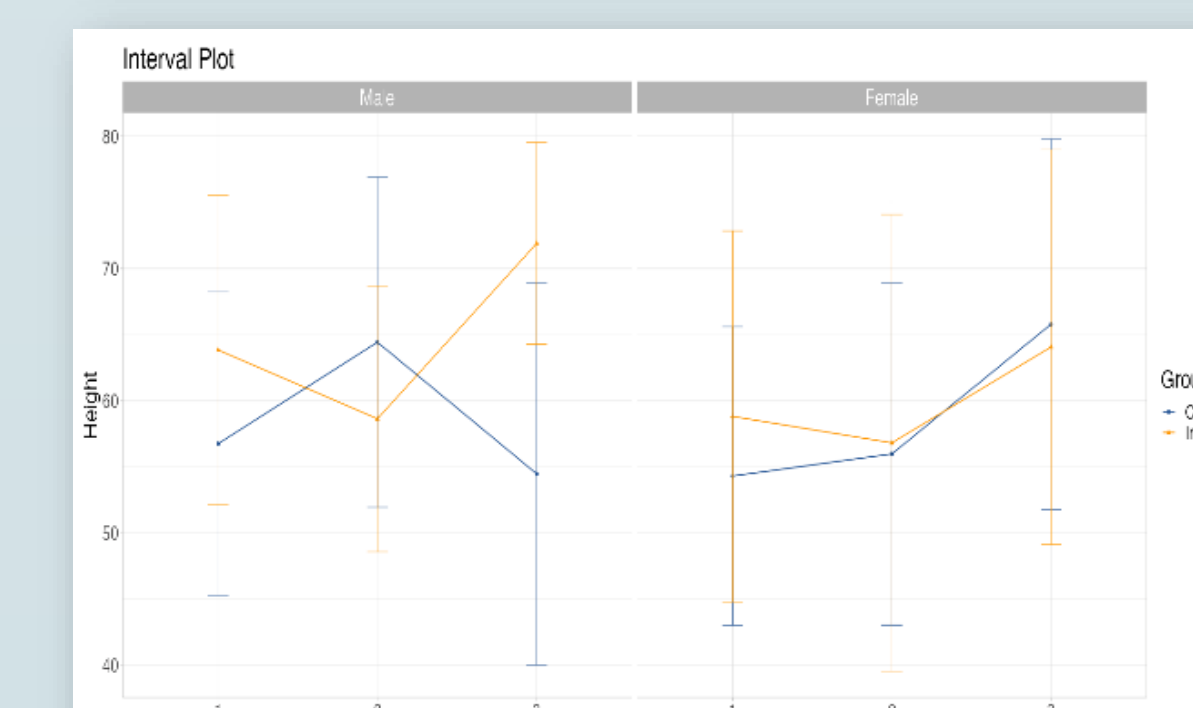
**One Group AE Visualization**  
Visualize adverse event data for one arm studies



**Two Group AE Visualization**  
Visualize adverse event data for two arm studies

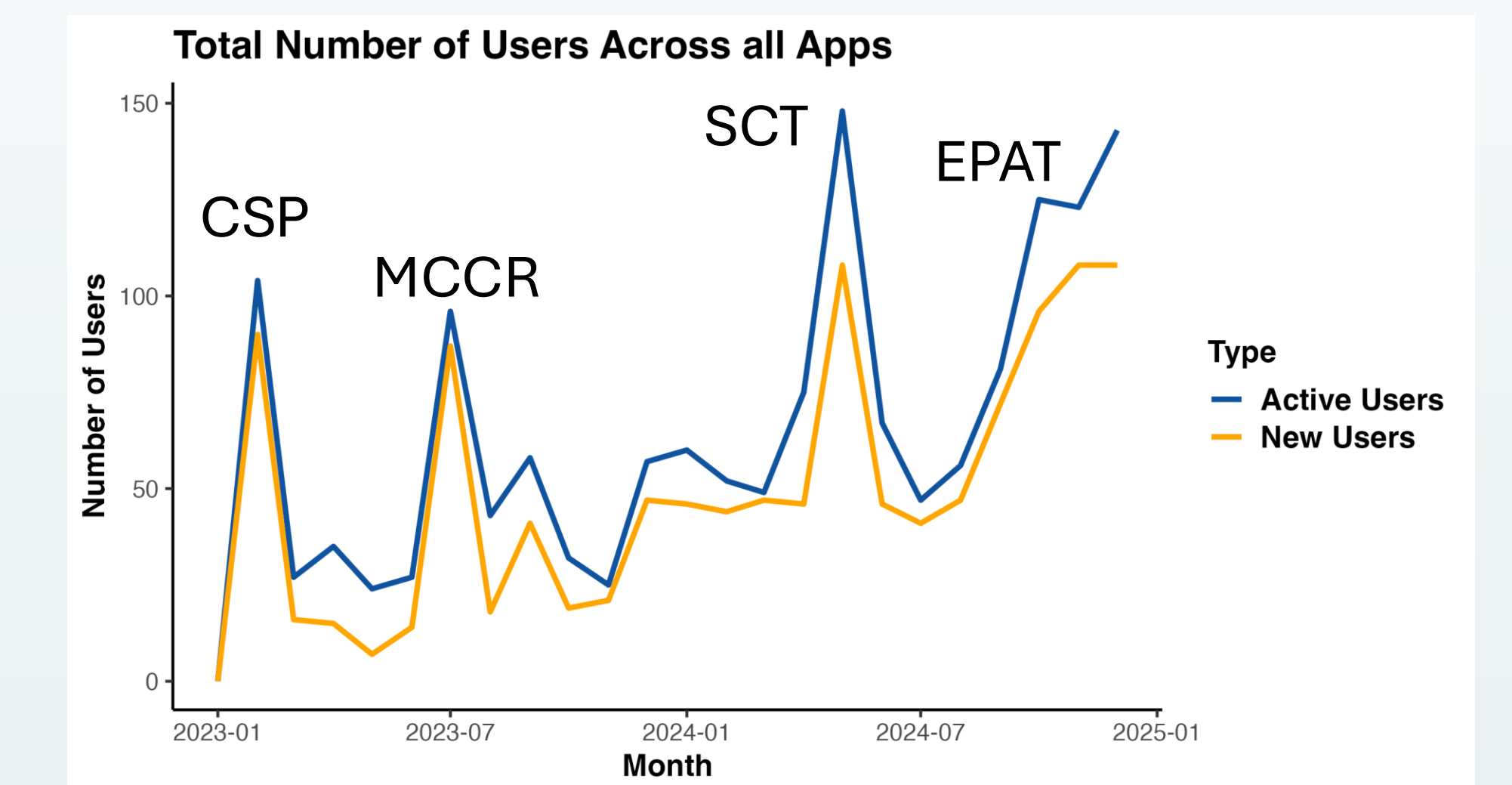


**Interval Plot**  
Visualize mean and variability of a continuous variable by groups or over time

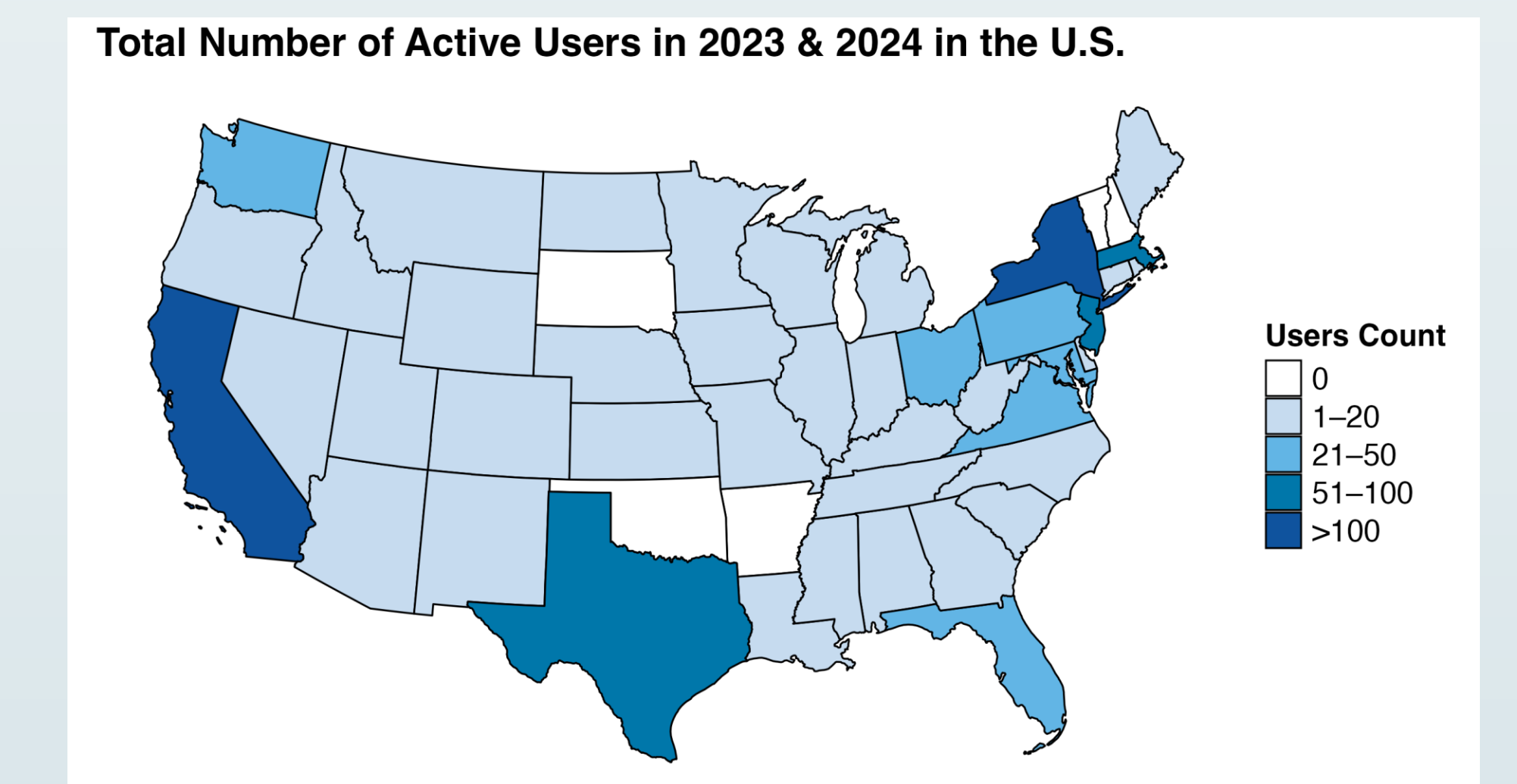


## Dissemination and Impact

In 2023, the first 5 data visualization web applications were disseminated at the Conference on Statistical Practice (CSP) and the Methods in Clinical Cancer Research Workshop (MCCR), while developing the remaining applications. In 2024, all the applications were presented at the Society for Clinical Trials (SCT) conference and the Early Phase Adaptive Trials Workshop (EPAT) leading to increased number of users. The number of active users increased by 93% from 2023 to 2024.



The web applications had >1500 active users across 47 countries in 2023 and 2024, of those 920 were in the US across 43 states, DC, and US territories.



## Acknowledgements

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