

# Visualizing Time-Variant Sets on a Handheld Device

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## ABSTRACT

We propose a radial method for visualizing time-series data on mobile devices. We display a single “snapshot” of the data at a given moment in time, and allow the user to easily navigate forwards and backwards in time to view other snapshots. Transitions from one snapshot to another are smoothly animated to preserve context. As a proof of concept of this idea, we have implemented *U.S. Supreme Court*, a mobile app that lets users visualize the membership of the United States Supreme Court at any date in history.

## CCS Concepts

•Human-centered computing → Information visualization; Mobile devices; Touch screens;

## Keywords

Time-Series Data, Mobile Application Development

## 1. INTRODUCTION

We designed and implemented a mobile app called *U. S. Supreme Court*<sup>1</sup> that lets users explore a data set of all United States Supreme Court justices since 1789, the year the court was established. Mathematically, the Supreme Court is an example of a *well-ordered set* [4]. That is, the court has a “first” member and a “last” member, with all other members uniquely ranked somewhere in between. Other organizations that follow the well-ordered set model include the U. S. Joint Chiefs of Staff, the senior leadership of some religious organizations [2], and corporate boards of directors.

## 2. VISUAL LAYOUT

<sup>1</sup>Our prototype app is available as a free download from both Google Play and Amazon Appstore under the title “US Supreme Court.”

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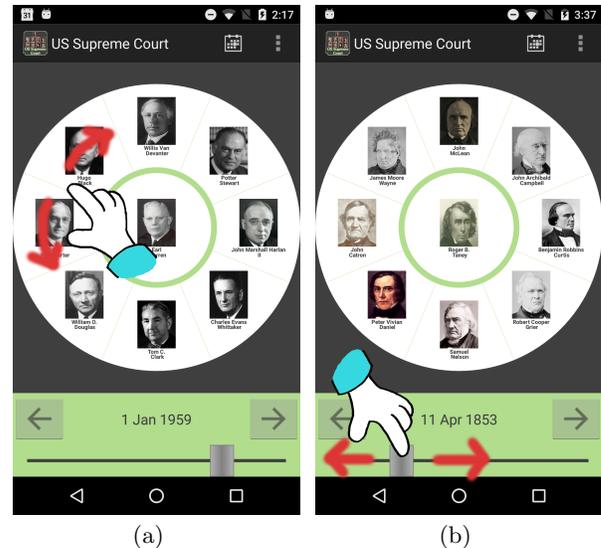


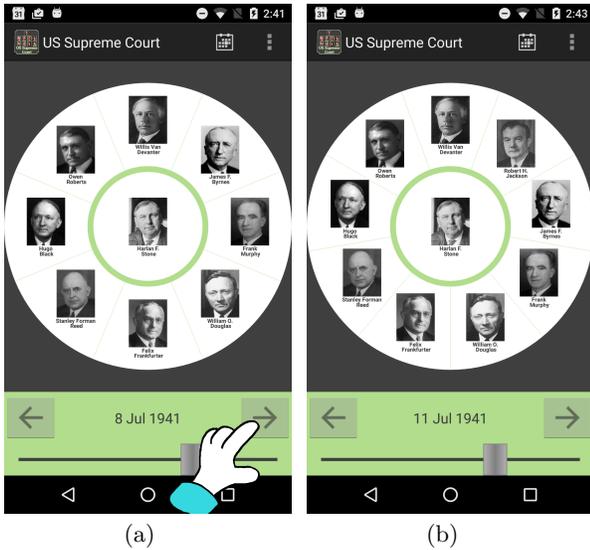
Figure 1: (a) If the user swipes his/her finger clockwise, the chart updates to a future date. Swiping the user’s finger counterclockwise moves the chart to a date in the past. (b) Moving the slider to the left moves the chart to an earlier date; sliding to the right moves it to a later date. The slider’s precision allows the selection of years but not days or months, so by default it jumps to 1 January of the selected year.

We use a *disconnected ring* layout [1] for our visualization of the Supreme Court. Ring-based layouts seem to work well for well-ordered sets, as they visually communicate the ranking within the set while making efficient use of screen real estate. In our visualization, we place the Chief Justice in the center of the ring, with the Associate Justices around the circumference.<sup>2</sup>

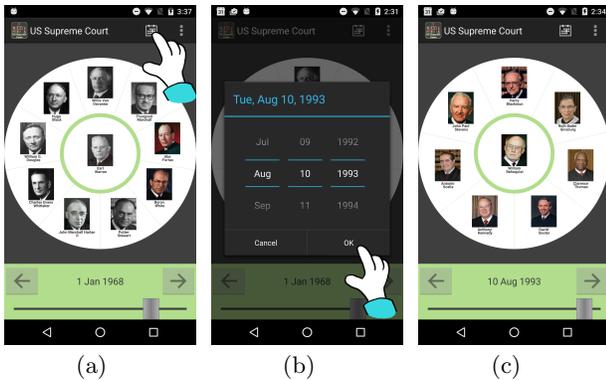
## 3. USER INTERACTION

Our method currently supports four ways of “moving through” the data. We rank them from least precise to most precise. Users may employ all four methods during the course of a single session using the app.

<sup>2</sup>Justices’ portraits reproduced in this paper are taken from [supremecourt.gov](http://supremecourt.gov), and are in the public domain.



**Figure 2:** The screenshot on the left shows the court on 8 July 1941, when James F. Byrnes was installed as a new Associate Justice. Tapping the “forward” button advances the chart three days to 11 July, when Robert H. Jackson was also added to the court. This change is reflected by a small picture of Robert H. Jackson appearing near the 1-o’clock position on the outer ring.



**Figure 3:** Tapping the calendar icon in the app’s toolbar opens up a date-selector widget, which allows the user to jump to any date since 1789. In this example, the user has chosen 10 August 1993, the date Ruth Bader Ginsburg was added to the Court.

- *Low precision:* The user can rotate the outer circle with his/her finger, counter-clockwise to go back in time, clockwise to go forward in time (see Figure 1(a)). While this gesture allows the user to specify the direction of navigation, it is not well suited for selecting an exact date.
- *Medium precision:* To select a specific year, the user can adjust a slider bar located underneath the graphic; left to go back in time, right to go forward (see Figure 1(b)). When the user moves the slider, the chart updates to show how the court looked on January 1 of the selected year. This is acceptable to get a broad overview of the court’s progression over time, but insufficient when multiple changes occur in the court within a single calendar year. For these years, more precise controls are needed.
- *Medium-High Precision:* Directly above the slider are two buttons. These buttons navigate the user to dates in which changes took place in the court. Tapping the “back” button takes the user to the date of the previous change in the court; tapping the “forward” button jumps to the date of the next change (see Figure 2).
- *High precision:* To see what the court looked like on a specific date, the user can select the calendar option from the app’s toolbar. After the user selects an exact date on the calendar, the chart updates immediately to show the court’s membership on that date (see Figure 3).

Consistent with the Visual Information Seeking Mantra [3], the app also supports the notion of “details on demand.” If the user taps any justice’s portrait, the app opens a pop-up window with a higher-resolution portrait of that justice, accompanied by brief biographical information.

#### 4. DISCUSSION AND FUTURE WORK

We propose a method for visualizing time-variant data sets on small-screen devices such as smartphones and tablets, and introduce a software prototype, *U.S. Supreme Court*, as a proof of concept. Rather than rendering a global overview of the data set, we instead display individual snapshots of the data at given moments in time, and provide tools of varying granularity to navigate forwards and backwards in time. While the initial public feedback from users has been promising, we would like to conduct a formal user study to evaluate the effectiveness of this approach against more conventional timeline-based visualizations.

#### 5. REFERENCES

- [1] G. M. Draper, Y. Livnat, and R. F. Riesenfeld. A Survey of Radial Methods for Information Visualization. *IEEE TVCG*, 15(5):759–776, 2009.
- [2] M. Jin, I. S. K. Delai, and G. M. Draper. Visualizing apostolic succession. *BYU Studies Quarterly*, 55(2):115–126, May 2016.
- [3] B. Shneiderman. The eyes have it: a task by data type taxonomy for information visualizations. In *IEEE Symposium on Visual Languages*, pages 336–343, 1996.
- [4] Wolfram Mathworld. Well-ordered set. <http://mathworld.wolfram.com/WellOrderedSet.html>. Accessed 22 April 2016.