Interactive Timeline-based Fan Charts

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Introduction

Static visualizations, such as pedigree charts and fan charts, are widely used in family history research due to their effectiveness in illustrating relationships. Among these, fan charts offer a space-efficient alternative to traditional tree structures, arranging ancestors in a radial format that is easily scalable for both digital and print mediums (e.g., [1] and [2]). Variants such as sunburst charts and semi-circular fan charts expand upon the radial layout of fan charts to maximize data density.

The use of color schemes in these visualizations varies significantly. In Figure 1, the colors represent generations relative to the focal individual, labeled as "1." Other color schemes are also common. For instance, colors can indicate an individual's sex, country of origin, century of birth, or other attributes.

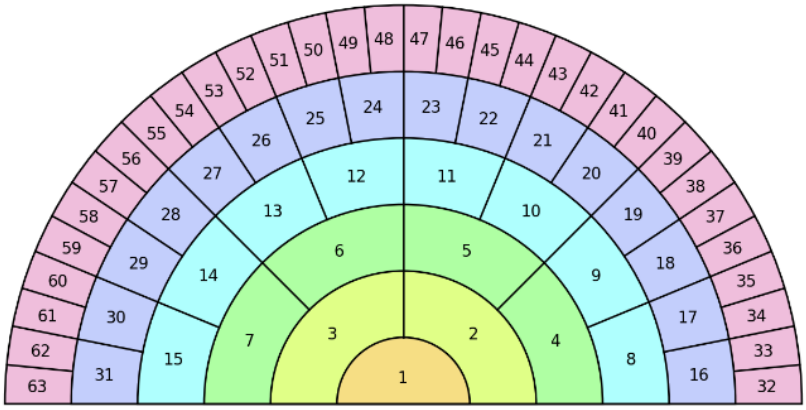

Figure 1 A generic fan chart displays the focus individual, labeled as "1," along with their ancestors. Lines divide sections to represent familial relationships, with colors differentiating generations.

Despite their usefulness, these static visualizations lack a temporal dimension. Genealogical research not only seeks to establish relationships but also to understand when and how individuals lived in relation to one another. Traditional fan charts fail to capture the chronological context of familial structures, leading to significant limitations in historical analysis. By visually highlighting temporal overlaps and gaps in ancestors' lifespans, interactive time-based charts reveal shared generational experiences, migrations, and cultural shifts. In doing so, these visual cues enhance genealogical analysis by making historical patterns more apparent and accessible.

Several existing visualizations attempt to incorporate time, such as the timeline fan charts discussed in [3][4]. These models align each individual's wedge with their birth year, allowing viewers to infer parental ages at the time of childbirth. However, these charts are still static, and their design introduces several key shortcomings. They provide limited insight into lifespans, as they only indicate birth years without showing how long individuals lived or whether their lifetimes overlapped with relatives. This omission obscures shared generational experiences and historical context. Additionally, they lack interactivity, preventing users from dynamically exploring historical connections or identifying trends such as patterns of early mortality or longevity across generations. Finally, they fail to represent uncertainty in genealogical data, assuming precise birth dates despite the fact that many historical records contain only estimates, which can misrepresent an individual's actual lifespan.

For example, in Figure 2, individuals labeled "47" and "46" had a child "23," born in the late 1800s. The chart reveals that parent "47" was significantly older than parent "46" but does not indicate their actual lifespans. Similarly, the birth year of individual "33" is unknown (uncertainty depicted with a red border).

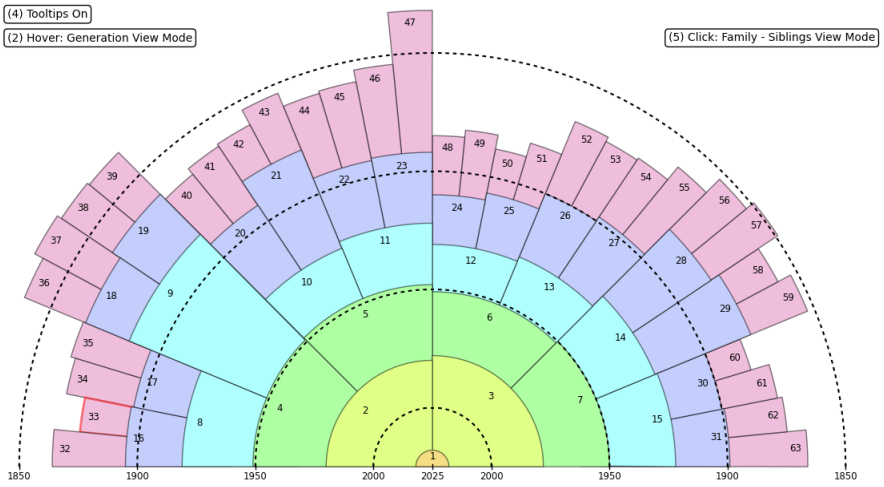

Figure 2 The static timeline fan chart uses a color scheme based on [1]. Birth years, drawn from one author's family history, are anonymized as numbers. Each wedge starts at the individual's birth year on the outermost arc.

To address these gaps, we present an interactive timeline-based fan chart that enhances genealogical analysis through two key innovations. First, we introduce interactive lifespan exploration, allowing users to hover over or select individuals to dynamically reveal lifespan data, compare overlapping lifetimes, and filter generational clusters to isolate specific time periods for study. This enhances the historical context by visually demonstrating lifespan overlap and shared experiences.

Second, we incorporate uncertainty representation, addressing the inherent ambiguity in genealogical records. Our visualization uses uncertainty bands and gradient shading to differentiate between precise and estimated dates, while interactive toggles enable users to switch between best estimates and known values. These features enhance historical interpretations by clearly distinguishing known from estimated data, ensuring a more accurate representation of genealogical uncertainty.

The remainder of this paper outlines several different interactive possibilities that we prototyped. The data used comes from the genealogical records of one of the authors and uses numbers instead of names for anonymity.

Note that for this paper we kept details about the individuals to a minimum to concentrate on the visualization. Additional details, such as the individual's sex, place of birth, marriage information, etc. would typically be added to the tooltips.

Uncertainty

With all time-based genealogical visualizations, it is important to indicate when some information is not known. In this case, Figure 3 shows how person "33"'s birth year is unknown. In our prototype we showcased this uncertainty with a red border.

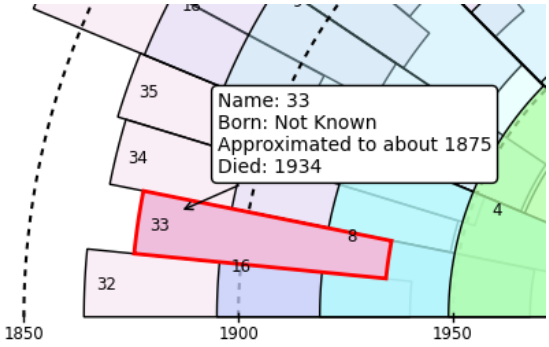

Figure 3 Person "33"'s birth year is unknown. It is showcased with a red border.

Hover Modes

One of the most effective ways for users to grasp complex data is through interaction. Hovering—moving the cursor over a specific segment of a visualization—often triggers a tooltip, a small text box that appears on demand to provide relevant details.

For the hover interaction, we present three modes: Individual Mode, which highlights a specific person and their descendants; Parental Mode, which shows both parents together; and Generational Mode, which emphasizes relationships across generations.

Individual Hover Mode

Figure 4 shows the individual hover mode with the cursor placed over person "47." The result is a tooltip for additional details as well as the direct descendancy lineage.

Specifically, person 47 is shown in full opacity with their direct descendants, individuals “23,” “11,” “5,” “2,” and “1” shown with 75% opacity, and all other individuals shown with 25% opacity.

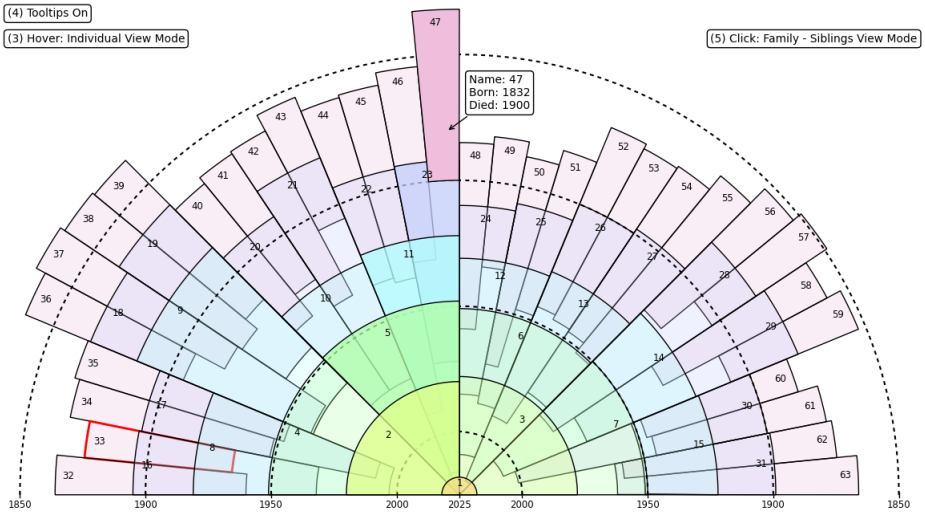

Figure 4 Example of individual hover mode with person “47” being the focus of the hover.

By hovering over person “47”, one can see that person “47” did not live much longer after their child, person “23,” was born and that person “47” was not alive when their grandchild, person “11” was born.

Parental Hover Mode

With parental hover mode, one can see the parents of direct descendants. Figure 5 shows that persons “47” and “46” were the parents of person “23.” Viewing both parents together highlights that person “47” was significantly older than person “46” when person “23” was born. Person “47” being much older also died sooner and did not see much of their child’s life in comparison to person “46.”

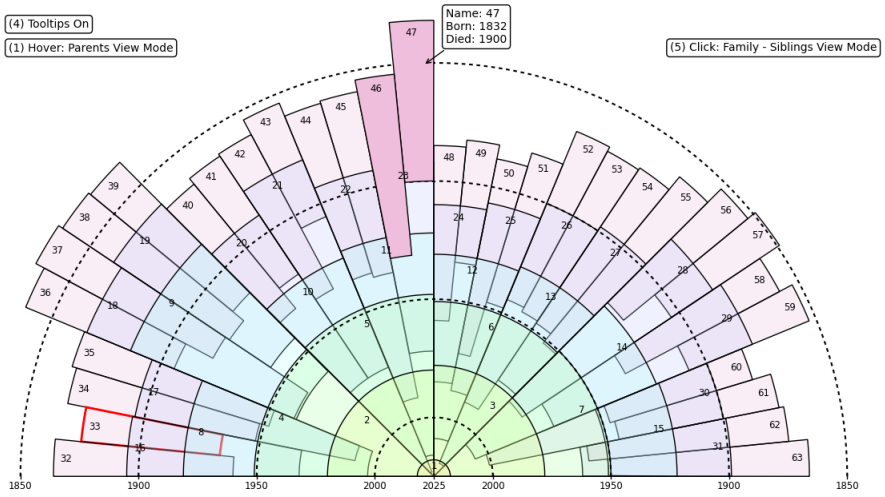

Figure 5 Example of parental hover mode with person "47" being the focus of the hover, showing that person "46" was the other parent of person "23."

Generational Hover Mode

Figure 6 and Figure 7 show examples of the generational hover mode. The emphasis on the generational hover mode is that the user can readily see how people lived relative to each other in time.

Figure 6 shows the fifth generation away from the focus person – the focus person's great-great-grandparents. Although all the individuals shown are in the same generation, this view shows some individuals lived during different periods of time. For example, person "47" was born in 1832 and died in 1900. Person "47" was the older person in his generation and died before anyone else. In comparison, person "48" is likely the youngest person in the generation (although we do not know when person "33" was born) and died last in 1972 – 72 years after person "47."

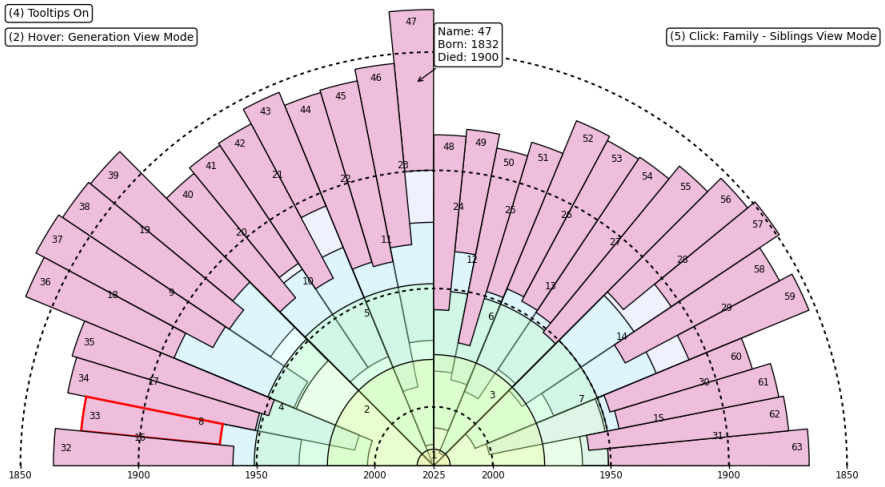

Figure 6 Generational hover mode, showing the fifth generation.

Figure 7 shows the third generation away from the focus person – the focus person's great-grandparents. In this case, we can see the person "9" was the oldest – born in 1886 but was not the first to die. Person "15" was the first to die, just 1 year his child (person "7") was born. (person "15" died in war.) On the other hand, person "10" just recently died in year 2023.

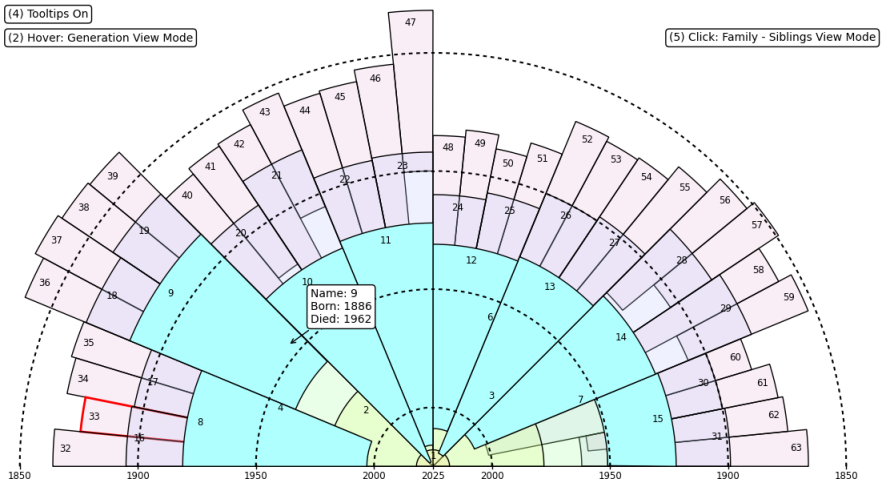

Figure 7 Generational hover mode, showing the third generation.

Click Mode

For the click mode, we show a sibling view in Figure 8. The other numbers are shown with the addition of the letter "S" to indicate "sibling."

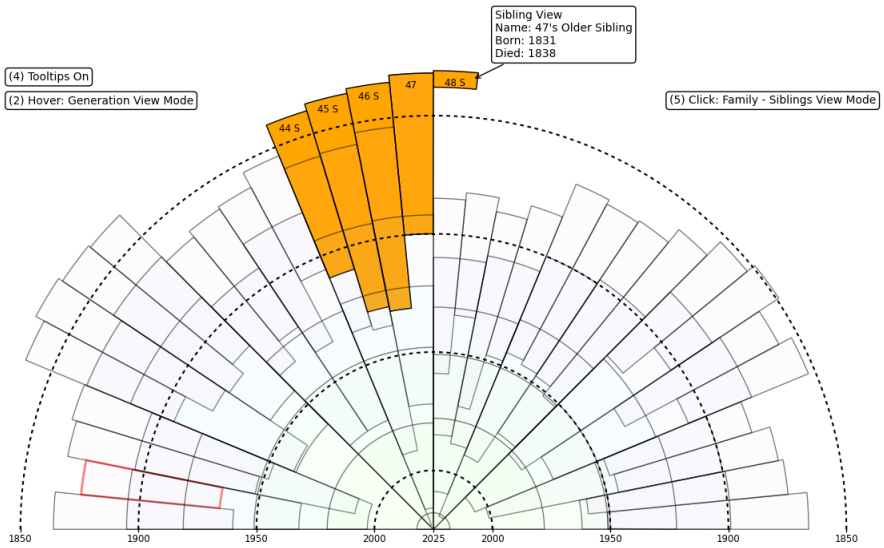

Figure 8 Results of person "47" when clicked. Person "47"'s siblings are show on top of the existing fan chart.

Figure 8 illustrates the sibling view when individual "47" is clicked. The opacity of non-sibling individuals is reduced for clarity, while siblings are labeled with an "S" to

explicitly indicate their relationship. This view helps users quickly identify sibling connections without cluttering the chart. By visually isolating siblings, this interaction makes it easier to analyze family structures while preserving context from the broader genealogical dataset.

While this implementation focuses on siblings, additional click modes could be explored in future work, such as visualizing an individual's spouses or displaying all of their children within the fan chart.

Double Click Mode

Double-clicking an individual has been explored in many fan chart visualizations. In general, double-clicking changes the focus of the fan chart to the double-clicked individual, making the double-clicked individual the center of the fan chart. This is the common case and need not be explored here.

Summary

In this work, we have demonstrated that interactive timeline-based fan charts offer new possibilities for visualizing genealogical data by incorporating temporal context and interactivity. Our approach enhances traditional static fan charts through dynamic lifespan visualization, hover-based interactions, and click-based filtering, providing users with deeper insights into familial structures across time. These techniques make it easier to identify relationships, recognize patterns in lifespans, and explore historical context within genealogical datasets.

Our prototype illustrates the effectiveness of multiple interactive features, including individual, parental, and generational hover modes, as well as sibling-focused click interactions. These functionalities address key limitations of existing static timeline charts by providing intuitive ways to explore uncertainty in birth years, highlight overlapping lifespans, and improve the clarity of genealogical relationships.

While this work establishes a strong foundation for interactive genealogical visualization, several enhancements remain for future exploration. Expanding filtering capabilities to include user-defined annotations and customizable views could further refine the user experience. Additionally, integrating external historical datasets would allow researchers to place individuals in broader historical contexts. We also envision improvements in uncertainty visualization, enabling users to interactively adjust confidence levels in estimated dates. By continuing to refine these techniques, interactive fan charts have the potential to become a standard tool for genealogical research, improving how family histories are analyzed, understood, and shared.

References

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