

# Visual storytelling of Song Ci and the poets in the social–cultural context of Song dynasty<sup>☆</sup>

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## ABSTRACT

Song Ci is treasured in traditional Chinese culture, which indicates social and cultural evolution in ancient times. Despite the efforts by historians and litterateurs in investigating the characteristics of Song Ci, it is still unclear how to effectively distribute and promote Song Ci in the public sphere. The complexity and abstraction of Song Ci hamper the general public from closely reading, analyzing, and appreciating these excellent works. By means of a set of visual analysis methods, e.g. the spatio-temporal visualization, we exploit visual storytelling to explicitly present the latent and abstract features of Song Ci. We apply straightway visual charts and lighten the burden of understanding the stories, in order to achieve an effective public distribution. The effectiveness and aesthetics of our work are demonstrated by a user study of three participants with different backgrounds. The result reveals that our story is effective in the distribution, understanding, and promotion of Song Ci.

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## 1. Introduction

Ci is one of the important traditional Chinese poetry forms (Fong, 2014). The oldest textual existence of Ci is from a Dunhuang manuscript back to the 8th century AD, and Ci reached its peak during the Song Dynasty, from 960 to 1279. Song Ci is a significant part of traditional Chinese culture. The study of Song Ci provides important clues to investigate the social–cultural context and the evolution of civilization in ancient times. How to better distribute and promote Song Ci has always been an issue of public concern.

Existing studies and professional works reveal the following challenges in the distribution of Song Ci in the public sphere:

**C1.** In traditional historical-humanistic research, researchers often apply a case study approach through *close reading* based on literature theories to deeply analyze the literary characteristics of Song Ci, which is not actionable in mass communication.

**C2.** Song Ci contains a variety of attributes, such as names of the tunes to which Ci is composed, poet, sentiment, ideogram, style, and genre, etc. Song Ci is an informational cultural system

with great potential for scholarly exploration. Existing high-dimensional data displays are usually too complicated to be widely distributed. Thus, it is challenging to present multidimensional data visually that conforms to the public preferences.

**C3.** When creating Song Ci, the poets were often influenced by their life experiences and the historical context when they were alive. To analyze Song Ci in the Social–cultural context in ancient times, researchers need to consider and connect with others, mostly the poet's friends, in the fields such as politics and literature. The influence of a specific social or political event on the poets also deserves a close investigation. Analyzing data outside of the Song Ci works is also struggling with complex data preparation and analyzing processes.

Existing researches have provided design patterns in digital humanity storytelling, especially spatio-temporal multimedia narratives (Tebeau, 2013; Armstrong and Patti, 2020; Valtolina, 2016), most of the studies, however, focus on western social–cultural context. It is unclear how to apply spatio-temporal narrative design in the eastern context. Handful studies are exploring this field though, such as the comparison between official record and romance version of the Three Kingdoms by Zhang et al. (Zhang et al., 2021). Telling a multimedia story driven by poem data is still challenging. And it has not been fully explored to integrate various social–cultural facts and sources into spatio-temporal narratives in the Chinese context.

In order to deal with the dilemmas above, we apply both *distant reading* and *close reading* to analyze and illustrate Song Ci textual data from various levels of perspective. A set of visual

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analysis methods are proposed, including the spatio-temporal visual analysis of the poet's life trajectory and the historical context, the linked visualization of text and ideogram, and the visualization of the names and the tunes of Song Ci. For better public distribution, in selecting visualization forms, we choose understandable and straightforward forms to help the audiences read our story without difficulty.

## 2. Related work

This section reviews the relevant existing studies from three main aspects: digital humanity visualization, digital storytelling in cultural and historical context, spatio-temporal visual analysis, and textual visual analysis.

### 2.1. Digital humanity visualization

In recent years, more and more professional works and scholarly studies have combined digital humanities and visualization, among which one of the most representative ones is the VIS4DH Workshop (Bradley et al., 2018) held since 2016.

The topic discussion can be divided into three categories. The first is the discussion of interdisciplinary cooperation (Jänicke, 2016; Hinrichs et al., 2017; Schetinger et al., 2019). Visualization experts and digital humanity experts discuss how to better collaborate to develop digital human visualization. To be specific, it involves analyzing the current situation of collaboration (Lamqaddam et al., 2018; Coles, 2017), summarizing collaborative experience (Sharma et al., 2019; El-Assady et al., 2016), upgrading forms of collaboration (Windhager et al., 2017), etc. However, the topic mentioned above mainly focuses on the collaboration between domain experts, while our study mainly focuses on general users.

The second is the research of digital humanity theories. Bradley et al. (2018) proposed “slow analysis”, emphasizing the inconsistency of the goals of efficiency in the fields of humanities and computer science. d'Ignazio and Klein (2016) introduced “feminist theory” to digital humanities, arguing that there should be a focus on marginalized disciplines and groups. In this paper, we summarize some principles of the visualization design of digital humanities for public users.

The third is to use case analysis to analyze the latest visualization works of digital humanities (McNutt et al., 2020). Hohman et al. (2017) made a visual analysis of “Game of Thrones” from the perspective of color and dialogue. Castermans et al. (2017) visualized the endangered state of languages. Taking the Historical Dictionary of Bavarian Dialects in Austria as an example, Benito et al. (2017) analyzed the interrelation of entries in historical dictionaries. Besides, graph visualization and analysis techniques (Zhao et al., 2021a,b) are important for digital humanities analysis. Towards public users, this paper also makes use of case analysis to show the *Whole Song Ci* (2009) from the perspective of spatio-temporal visualization and textual visualization.

### 2.2. Digital storytelling in cultural and historical context

Story, or narratives, is an effective method to communicate information and convey meanings through a sequence of events (Segel and Heer, 2010). Digital storytelling is a novel storytelling method that integrates digital technologies into the conventional storytelling traditions (Chatterjee et al., 2019). Given its characteristics such as interactivity, plot-nonlinearity, and outcome-flexibility (Barber, 2016), in recent years, digital humanity scholars and practitioners are actively applying digital storytelling techniques (Rodrigues and Correia, 2021) to produce multiple types of stories for either pedagogical (Chatterjee et al., 2019),

archeological (Tebeau, 2013), scientific (Rodrigues and Correia, 2021), or public campaign/memorial purpose (Lavorel, 2017). According to the literature, the current digital storytelling practices in digital humanity include: computational techniques such as statistical analysis, text mining, data visualization, immersive rendering, and advanced programming (Armstrong and Patti, 2020); multiplatform distribution such as social media, mobile devices, and virtual museum (Lavorel, 2017); and multimedia/transmedia presentation such as oral histories, podcasting, animation, and long-term interactive narratives (Chatterjee et al., 2019; Barber, 2016; Armstrong and Patti, 2020). For example, one of the main patterns for digital humanity storytelling involves time-spatial narratives (Rodrigues and Correia, 2021; Earley-Spadoni, 2017) through implementing static and/or dynamic maps and time-lines, such as geo-location of semantic information in a certain physical place, social networks coordinated with immersive geo-visualizations (Bollini et al., 2013), multimedia cartographical analysis of cultural heritage data (Earley-Spadoni, 2017), and collaborative oral/aural historical display on small screens accommodating to the mobile-mantra (Tebeau, 2013; Valtolina, 2016).

### 2.3. Spatio-temporal visualization

In order to understand the background of a piece of Song Ci, it is essential to visualize the life experience of the historical figures, which contains a large amount of spatio-temporal data. Spatio-temporal visual analysis can help people understand the temporal variation of complex spatial information more comprehensively. Up to now, spatio-temporal visual analysis has been widely used (Bol, 2013; Chen et al., 2018, 2020).

Peter Bol (Benito et al., 2017) applied geospatial analysis to the social networks of the main figures in Neo-Confucianism. VAIroma (Cho et al., 2015) constructed relevant spatio-temporal visualizations based on Wikipedia text, giving researchers a deeper understanding of Roman history and historical figures. Li et al. (2018) proposed a semantic, spatial and temporal visualization named SpaceTimeCube, assisting users to understand the spatial and temporal variations in semantics. Unlike previous work, our study presents the ups and downs in the poet's life experience combined with his migration trajectory. At the same time, it supports time-based filtering and comparison, allowing a comparison of the Ci poets in different periods and places.

### 2.4. Textual visual analysis

In the stage of text processing, general word segmentation methods aim at the modern languages (Mikolov et al., 2013; Salton and Buckley, 1988), which is quite different from ancient languages in terms of vocabulary and grammatical composition (Qiu and Huang, 2008). When processing ancient texts, Electronic Documents of the Han Dynasty applied the hidden Markov model to segment words and tag the part of speech in some documents of the pre-Qin period (Zhiyong et al., 2014). Shi et al. (2010) use a conditional random field model to perform these tasks on Zuo Zhuan. The main data source of this paper is the *Whole Song Ci*, a Chinese ancient book. We use the ancient Chinese dictionary as the medium, taking Jieba Chinese text segment to perform word segmentation on the ancient Chinese texts, which has achieved satisfactory results.

In the stage of text visualization, the technology and form of textual visualization have been well developed. Word cloud and topic visualization are simple visualization methods to engage the audience. TagCloud (Viégas and Wattenberg, 2008) is a classical text visualization analysis method based on word frequency. It arranges keywords according to certain rules (such as word frequency), whose size indicates the importance or frequency of the

word. Taking advantage of advanced natural language processing, complex interaction technologies, and context information, Word Cloud Explorer (Heimerl et al., 2014) was able to support the text analysis tasks effectively. InfoSky (Andrews et al., 2002) is a classic static visualization method that projects documents in a document set into stars in the Milky Way Galaxy, showing the hierarchical and structural relationships among various topics. ThemeRiver (Havre et al., 2002) represents temporal dynamic information statically. It takes a river as a metaphor, compares time to a river flowing from left to right, and uses different color bands to represent different themes.

Given that our audiences are the general public, the word cloud and other common text visualization forms are applied to facilitate understanding. However, different from the previous works, our study focuses on the relationship analysis of Song Ci texts and the poets behind them.

### 3. Background

#### 3.1. Data description

Our study is mainly based on two data sets: the Whole Song Ci and the PoetLifeMap (PoetLifeMap, 2017). The Whole Song Ci is the main data source, containing all the text data of Song Ci in 319 years during the Song Dynasty. It contains 21000 pieces of Ci, 1300 names of the tunes to which Ci is composed, and 1330 poets, which contribute to data dimensions together with ideogram and sentiment. The PoetLifeMap contains detailed chronologies, trajectories, works, and the time and place of creating of 70 litterateurs in the Tang and Song dynasties. In this paper, we use these data as external information to assist in a deeper analysis of the text of Song Ci.

#### 3.2. Task analysis

Our target users are those who are interested in Song Ci without a professional background. They have a certain degree of understanding of Song Ci, such as knowing Su Shi, Wang Anshi, and other famous poets, but have little knowledge of their background and other information.

During the six-month research process, we cooperated with an expert, who is a post-doctoral student studying ancient Chinese literature (E1), and three other target users (TU1-3). We held regular meetings to determine design requirements, iterate system design, and evaluate the final work.

After a mass of discussion, we developed four main design principles:

- P1** The multimedia story should be driven by the poem data that contains various social-cultural facts and materials (E1).
- P2** The dimension of presenting data should not be over-complicated (TU1-3).
- P3** Visualizations should be simple and easy to understand (E1, TU1-3).
- P4** The overall design should be appealing and attract the audience (E1, TU1-3).

Under the premise of the above design principles, three design tasks are formulated:

- T1 Visualization of various cultural and historical facts related to the poetry**, showing how the background context influenced the poets and their poems.
- T2 Visualization of poet's spatio-temporal trajectory**, showing the life trajectory of the poet and the number of works in different periods and different places.
- T3 Visualization of poet's life background**, presenting the ups and downs of the poet's life and the corresponding historical background.

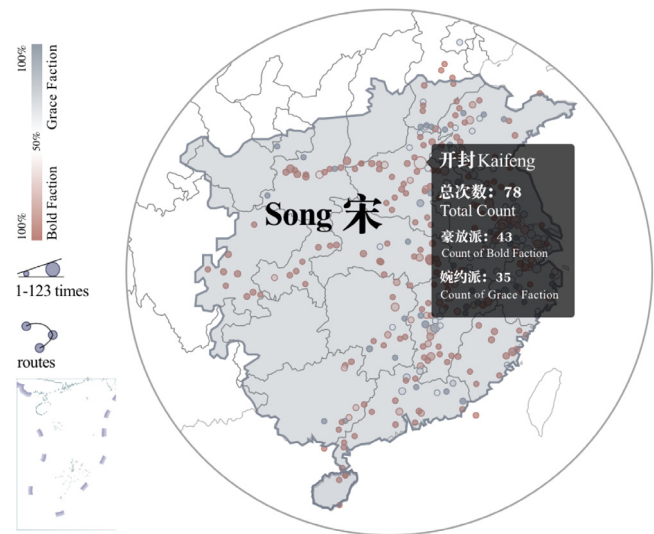


Fig. 1. The migration of the poets in Song Dynasty.

**T4 Visualization of Song Ci's textual attributions**, including the dimensions of word frequency, ideogram, sentiment, and names of the tunes to which Ci are composed, etc.

### 4. Visualization

Based on the design tasks, we proposed a visualization story aiming to introduce and promote Song Ci in the public sphere, which is composed with the visualizations of poets' migration trajectory, life track changes, and with the visual analysis of their Song Ci works. The code is available at <https://github.com/panrusheng/quansongcivis>.

#### 4.1. Map view

The map view is applied to analyze and illustrate the poet's migration patterns (Fig. 1) (T2). We choose the authoritative map of the Song Dynasty. The dots indicate where poets once stayed, and the size encodes the total count that poets passed by. Different color represents different faction poets belong to, while the transparency indicates the proportion of poets. The red refers to the Bold Faction, and the blue denotes the Grace Faction. If more than half of the poets come from Bold Faction, the color is mapped to red, and vice versa.

When a dot of location is selected, the user can see the trajectories linking through it. If the mouse hovers on the dot, it will show the name of the location and the exact count that poets stayed, with different factions in detail.

Users can also opt-in/out of the poets based on their interests by using the tree filter in the side box. We segment and organize the group of poets in chronological sequence to improve the efficiency of users' visual exploration and analysis.

#### 4.2. Life vicissitudes view

Life track visualization abstracts and illustrates the poet's life through a line chart (Fig. 2) (T3). In the chart, the rising part refers poet's passing imperial examinations and getting a promotion, while the falling part refers to the demotion and impeachment. Gray represents poets belonging to the graceful and restrained school, and red represents poets belonging to the bold and unconstrained school. The background for the upper part indicates the



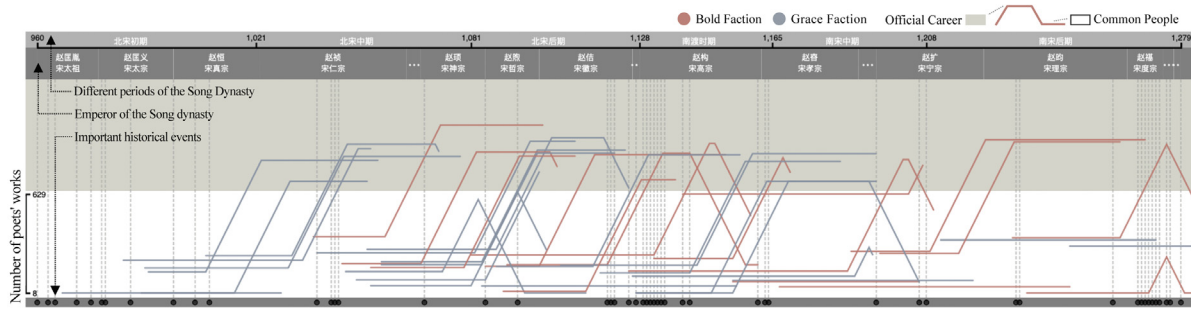


Fig. 2. The timeline of the poets in Song Dynasty.



Fig. 3. The word frequency statistics of the Whole Song Ci.

official stage, and the one for the lower part indicates the civilian stage. The line chart starts with the number of poets' works.

The life track visualization also provides background information of the historical context (T1). The upper part of the timeline shows different periods of the Song Dynasty, while the dots on the timeline highlight the featured historical events. These events include the accession of emperors, diplomacy, politics, and military affairs, all of which are believed to impact the poet's life experience. Users can explore the introduction of a poet and background events at a certain time, with the trajectories of the poet's life highlighted on the map.

#### 4.3. Textual analysis view

Song Ci textual analysis and visualization aim at displaying multi-levels of characteristics through distant reading and close reading such as word cloud view (Fig. 3), ideogram and sentiment view (Fig. 4), names of the tunes view (Fig. 5) (T4).

##### 4.3.1. Word cloud view

We first present the overall word frequency of the Whole Song Ci through word cloud and then provide more detailed statistics of the word frequency from dimensions of style and age. The size of the word in the word cloud refers to the word frequency, and the specific number can be seen via hovering (Fig. 3).

##### 4.3.2. Ideogram and sentiment view

The excellence of Song Ci lies in its superb utilization of ideograms and borrowing real-world images to express one's mind. The use of the ideograms and the referred sentiment help users understand the poet's writing style.

We select ten poets respectively in the graceful and restrained school and the bold and unconstrained school and analyze the

ideograms in their works (Fig. 4). Thirty typical ideograms including *cloud*, *lotus* and *building* are extracted. We find the graphics in the Whole Collection of Paintings of the Song Dynasty that correspond with the ideograms and reshape these graphics into icons to represent the ideograms. The colored proportion in the outer circle of the ideogram represents the amount of sentiment that the poet expresses via the ideogram. The tree diagram illustrates the relationship between the poets and the ideograms.

##### 4.3.3. Cipai view

Cipai determines the formation of a certain Song Ci, prescribing its rhyme schemes and tonal patterns, each bearing the name of a musical air.

We try to visualize the rhyme and tone by encoding the level and oblique tones of Song Ci with the dots and lines and adding the ideograms mentioned in the poem in the corresponding position. We also invite an experienced broadcaster to read these Song Ci in standard mandarin Chinese to provide *seeable, readable, and audible Song Ci* (Fig. 5).

In the audio part, the sentence-breaking technique is adopted. The preliminary results are checked and corrected manually to ensure the accuracy of traditional Chinese text. Moreover, the automatic reading of Song Ci sentence by sentence is finally realized.

In the visualization of tunes, considering that the ideograms might overlap, we add priority of display in a smart selection of the ideogram among overlappings.

Besides, some tones correspond to multiple works. The delay function module is applied to avoid conflicts in rhythm animation and audio playback during user interaction.

## 5. Evaluation

We conducted a user study to verify that our work meets the design principles presented in Section 3.2. The user study was divided into two sections. In the first section, through the Think Aloud method, we observed how the target users read our story and generated knowledge. In the second section, we conducted a series of in-depth interviews to collect their detailed comments on our work.

### 5.1. Participants and procedure

**Participants:** we recruited three target users (all Ci lovers) to participate in the experiment:

- U1:** Female, 34 years old, major in accounting, financial analyst.
- U2:** Male, 24 years old, major in finance, investment analyst.
- U3:** Female, 22 years old, major in digital media, doctoral candidate.

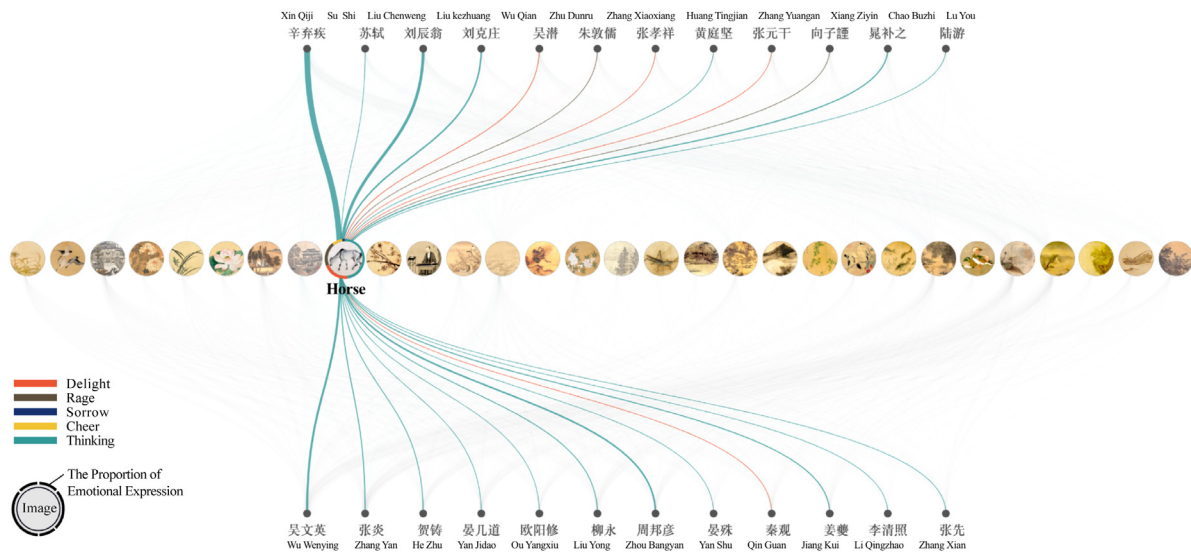


Fig. 4. The popular images and emotions of the typical poets.

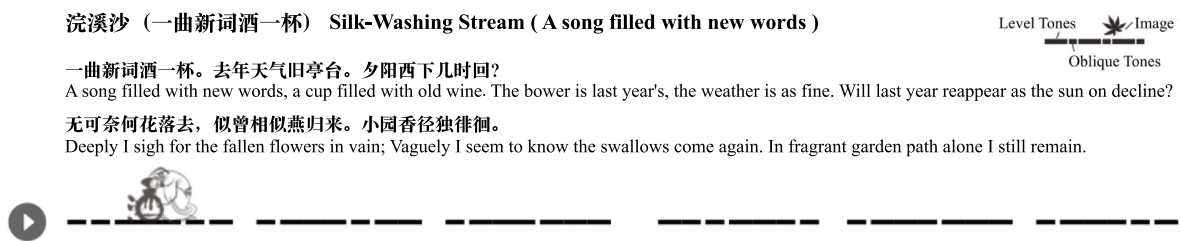


Fig. 5. Visualization of Cipai in Song Ci.

**Procedure:** The entire evaluation process consisted of the following three phases:

**Background investigation:** All participants were asked to fill the demographic questionnaires.

**Think Aloud:** Participants browsed the pages and said whatever they thought, felt, do or saw during the process.

**Interview participation:** Users reviewed and evaluated each visualization in terms of design, interaction, and effectiveness of information delivery.

Because the target users are in different regions, we deployed our system as a web application and conducted the user studies via remote video conferencing. The whole process was recorded in unlimited time, with U1 taking one hour, U2 one and a half hours, and U3 45 min.

## 5.2. Results

**Map View.** All participants believed that the map was a very intuitive visual representation of the poet's trajectory, and there was no cognitive difficulty (P1–P3). U1 said it is easy to tell by the size of the dots where the Ci writers most frequently visited, such as Hangzhou and Kaifeng, which were political and cultural centers of the time. U2 chose his favorite Ci writers Su Shi and Xin Qiji, and compared their trajectories, discovering that Su Shi had traveled far more than Xin Qiji. U3 pointed out that there was visual staggered when the view showed the trajectory, and the starting and ending points of the route cannot be clearly seen.

**Life Track Visualization.** All participants agreed that although the visualization took some time to understand, it provided richer contextual information (P1, P4). According to U1 and U3, it can be seen that most Ci writers in the Song Dynasty had been officials, and their Ci works were influenced by their official experience to

a certain extent. U1 pointed out that, as a whole, the number of Ci writers' works in the late Song Dynasty was less than that in the early period, which may be influenced by war. U2 found that Xin Qiji had wrote the most Ci works, 629, which he had not known before.

**Word Cloud.** All participants highly appreciated the word cloud view, which intuitively showed the high-frequency words in the Song Ci (P1–P4). U2 said that most of these high-frequency words fit his cognition, such as “*Dong Feng, Ren Jian* and *He Chu*”. These words can remind him of many familiar Ci works, such as Liu Yong's “*Jiu Xing He Chu*”. U1 compared the word clouds of the bold and unconstrained school and the graceful and restrained school, and found that the later mostly expressed the emotion of *missing*. U3 thinks that the gradual change of color in the ink style of word cloud was very consistent with the feeling brought by Song Ci.

**Ideogram and Sentiment visualization.** All participants agreed that the view was beautiful enough to keep them exploring for a long time (P1–P4). U2 still chose his favorite poet Su Shi to explore. It can be seen that Su Shi often used *wine*, *moon* and *cloud*. When using the ideogram of *wine*, what he expresses most is the feeling of *missing* (green accounts for the most). U1 thought this would give her inspiration for her poetry. U3 said the style of the ideogram drawing is simple and primitive, which was very harmonious with the whole work.

**Cipai visualization.** U1 believed that this visualization provided a comprehensive audio-visual enjoyment, making the beauty of Song Ci both visible and audible (P1–2, P4). U2 and U3 reported that the names and tunes were not the focus of their concern, so they made a rough review of this part.

### 5.3. Discussion

**Overall Evaluation.** In general, the user study verifies that our work satisfies the design principles. Three participants highly appreciated the design style of the whole work, which was highly consistent with the content conveyed. U1 indicated that her favorite view was the word cloud, and the sentiment visualization gave her much inspiration. U2 said that through this work, he had gained a better understanding of Su Shi's life and the style of his works. U3 thought the ideogram and sentiment visualization inspired her a lot in design.

**Limitations.** The encoding of life track visualization is complicated. For general users without a data visualization background, it took a certain amount of time to understand.

## 6. Conclusion

In this study, we develop a spatio-temporal multimedia narrative design pattern for eastern social-cultural contexts in digital humanity storytelling. We used a coherent and engaging data visualization story to communicate and promote Song of Songs to public users. It consists of a series of data visualizations to deliver Song Ci pieces and background knowledge to provide the users with a deeper understanding of Song Ci and the peripheral social-cultural and cultural backgrounds in ancient times.

Based on the approaches proposed in this paper to visualize the Song Ci, it is prone to migrate to the visualization on other Chinese poems and poets. For instance, visualizations on word cloud and poets' trajectory and vicissitude are universal methods that can be generalized to other Chinese poems. Tang poem is the most representative one, and ideogram and sentiment are also the key factors to analyze an excellent Tang poem. In addition, we plan to develop a visual analysis system for historians to help them solve problems in their research, such as uncertainty in historical spatio-temporal data, group analysis, etc.

### CRedit authorship contribution statement

**Wei Zhang:** Software, Design, Writing – original draft. **Qian Ma:** Software, Design, Writing – review & editing. **Rusheng Pan:** Software. **Wei Chen:** Supervision.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Ethical Approval

All procedures followed were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All participants provided written informed consent prior to enrolment in the user study.

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