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Exploring Historical Australian Expeditions with Time-Layered Cultural Maps

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Abstract: The Australian Time Layered Cultural Map platform was created to help digital humanities scholars investigate how online geospatial tools could provide exemplars to their humanities colleagues on how historical collections and cultural data could be extended and re-examined with geospatial tools. The project discussed here investigated how Recogito/TMT could effectively extract spatial and temporal data from pure text-based historical information and generate time-layered interactive maps of that spatio-temporal data using accessible and user-friendly software. The target audience was humanities scholars relatively new to geospatial technologies and relevant programming systems. The interactive maps were created with two free, open-source web applications and one commercial GIS (Geographic Information System) mapping application. The relative pros and cons of each application are discussed. This paper also investigates simple workflows for extracting spatiotemporal data into RDF (Resource Description Framework) format to be used as Linked Open Data.

Keywords: GIS; Linked Open Data; digital humanities; TLCMap; recogito; RDF; geovisualization; cultural mapping; historical maps; annotation

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1. Introduction

The Time-Layered Cultural Map of Australia (TLCMap) is an online research platform that aims to provide researcher-driven national-scale infrastructure for humanities focusing on mapping, time series, and data integration and to expand the use of Australian cultural and historical data usage [1]. Given the emphasis on building tools and projects for nascent digital humanities scholars, the approach and methodology for building the TLCMap infrastructure is to use, extend, and redeploy existing systems wherever possible rather than develop project-specific software. The focus is to identify appropriate systems and embed them as extendable prototypes and case studies into the TLCMap infrastructure. The TLCMap development team re-purposes existing systems in line with the TLCMap project objectives to improve interoperability between systems and evaluate them within the infrastructure.

The main objective of the TLCMap is to provide examples and exemplars of mapping tools adopted, adapted, and extended to educate and support digital humanities projects for academics who are not necessarily well-versed in either programming or mapping tools and systems. This project aimed to compare tools developed for beginners and scholars of non-geospatial disciplines, particularly for those who primarily teach and research in humanities and have a particular interest in cultural data that can be mapped and spatially visualized.

We note here that humanities scholars, such as archaeologists, cultural geographers, and philosophers, may view maps differently to programmers and geospatial experts; for them, these are not only tools but also external cognitive artefacts that reveal individual interpretation and shared cultural values [2]. Hence cultural maps may require the layering of different and contested interpretations, symbolic as well as functional motifs, and may be predicated on orientation and navigation not only in a physical environment but also in, with or against, a socially organized and culturally learned mindset [3].

For example, in a related project to the one discussed here, we have developed desktop 3D environments and 3D head-mounted-VR ready environments multimedia museum room examples (in the Unity game engine) to demonstrate to humanities scholars how videos, maps, images, and 3D models could dynamically interact to show different layers and aspects of inferred and proven knowledge over time [4].

The authors and others have also shown how a GeoJSON format can produce mixed reality maps in two Microsoft HoloLens with sound, 3D digital models, and interactive narratives of a 19th ship journey [5]. Each player sees a different mixed reality view of the same historical journey while inside a physical maritime museum and exhibition. They have to travel the mixed reality map and uncover and move 3D mixed reality artefacts to experience the 'view' of the other player.

Our team has further explored and demonstrated the importance of Linked Open Data in integrating interrogable online 3D models with Linked Open Data [6]. Linking historical maps and annotations through Recogito to either mixed reality or to headset VR through these or similar workflows would be of great interest to humanities scholars, with the proviso that lucid showcases and simple workflows and reusable content would be of great value to non-programmers with a humanities background.

There is earlier work demonstrating how to convert historical diaries and gazetteers into maps [7], but this project attempted to create a simple workflow that showed humanities scholars how to convert historical narratives into online geospatial technologies with free online tools such as Recogito. A later step beyond the scope of this study would be to develop reusable exemplars demonstrating to humanities scholars how to further transform historical narratives of diaries and other 2D artefacts into rich and immersive experiences.

Recogito: The Mapping of Text

At the time of writing this paper, several mapping systems were identified, and prototyping developments were made available online (http://tlcmap.org/systems.php, accessed on 26 February 2023). One such prototyping system was and is TextMapText/Recogito (Recogito/TMT), which facilitates the mapping corpora of texts. It merges the functionalities of a prototype of TextMapText (https://c21ch.newcastle.edu.au/textmaptext/goldfields/, accessed on February 2023) and the functionalities of the online semantic annotation platform Recogito (https://recogito.pelagios.org/, accessed on 26 February 2023) developed by the Pelagios project (https://pelagios.org/, accessed on 26 February 2023). TextMapText can automatically extract place names in the text and display them on a side-by-side parallel map, while Recogito supports the manual or semi-automatic annotation of text or images.

Recogito is a well-established and easy-to-use open-source platform for annotating geographical information in text or images (including those served as IIIF protocol documents). It also allows users to download annotation results in various formats and to display results via interactive maps. Since its first appearance in 2015 [8], Recogito has proven to be an effective annotation platform both for individual researchers as well as for teams developing cultural heritage projects [9–12].

However, there are issues in the immediate and unmediated deployment of Recogito's annotation outputs to the TLCMap project. An important issue is the lack of gazetteers that meet the requirements of Australian cultural heritage and humanities research and teaching. The gazetteer deployed in Recogito most relevant to Australian cultural heritage and humanities studies is GeoNames, but it does not provide fine-grained toponyms covering regional and outback Australian geographical regions, nor is it relevant to projects based on Australian historical events. Even when focused on the metropolitan area, there are few places with relevant and comprehensive usable information in this particular gazetteer.

2. Methods

To overcome such issues and create more suitable workflows and examples for Australia-wide humanities research needs, the TLCMap project developed a contextually customized instance of Recogito to suit the particular needs of Australian gazetteers (referred to here and elsewhere as Recogito/TMT to distinguish it from the original Pelagios-developed Recogito project). However, the ultimate goal of Recogito/TMT is to contribute to Recogito as part of the collaborative open-source development community rather than duplicate or compete with it.

Currently, the Gazetteer of Historical Australian Placenames (GHAP) (http://tlcmap.org/guides/gazetteer.php, accessed on 26 February 2023) is built from the Australian National Placenames Survey (ANPS). The aim of the Australian National Placenames Survey (ANPS) is to prepare a national database of geographical names. It forms a supplement to the National Gazetteer and will be a database formed on established principles within the disciplines of history, geography, linguistics, cultural studies, and surveying; the mapping (https://www.anps.org.au/, accessed on 26 February 2023) data has been deployed in Recogito/TMT. The GHAP aggregated Australia-wide place names (including both up-to-date and old place names) from state government and other sources have more than 300,000 place names across Australia, which is of great value to time-layered mapping cultural heritage scholars and teachers.

A second limitation of Recogito is that although Recogito annotation results can be exported as KML or GeoJSON to be viewed directly in format-compatible mapping or GIS applications, no time element is included in the annotation output. Hence, no timeline can be generated in a displayed map. The TLCMap team is in the process of adding the time elements annotation function to the Recogito/TMT platform. Before that can be realized, a workaround approach for adding time elements uses currently available *Tag* or *Comment* fields to record time information relevant to the geographical annotations.

This paper will demonstrate the use of Recogito/TMT as an intermediate tool for generating data for building time-layered maps of cultural heritage studies. Essential data elements are place names, place coordinates, and time-based information relevant to those places. Data output from Recogito/TMT can be downloaded as a CSV or KML file for further manipulation and for management to generate time-layered maps for interactive visualization. The underlying data set then links to the TLCMap ontology [13] and is transformed into the RDF format so that it can be published as Open Linked Data in future implementations.

2.1. Building Interactive Time-Layered Maps

Sir John Forrest (Figure S1) was the first premier of Western Australia and is regarded as the founder of modern Western Australia [14–16]. He was also a famous explorer and is still considered one of the foremost explorers in Australian colonial history. Under his leadership, three expeditions into the interior of Western Australia were conducted between 1869 and 1874. The three expeditions were recorded in the form of a journal and a static map (see Figures 1 and 2) in his book *Explorations in Australia* [15]. The book is of great historical value for the study of Sir John Forrest, for the history of Western Australia, and for Australian history in general.

6th.
Made an early start; reached Guildford at twelve o'clock, where we rested an hour. Then resuming, reached Perth at 4 p.m., and reported personally the results of the expedition, having been absent 113 days, in which time I travelled by computation over 2000 miles.

Figure 1. Text of the last day of the expedition, extracted from John Forrest's book "Explorations in Australia."

This paper demonstrates a novel way to represent the book as interactive time-layered maps to the general public and humanity researchers (as opposed to presenting them with plain text and static maps). The test case generated for this project was based on Chapter Two of *Explorations in Australia.* This book recorded John Forrest's first expedition into inner Western Australia during his attempt to search for the remains of a former exploring party led by Dr. Leichardt.

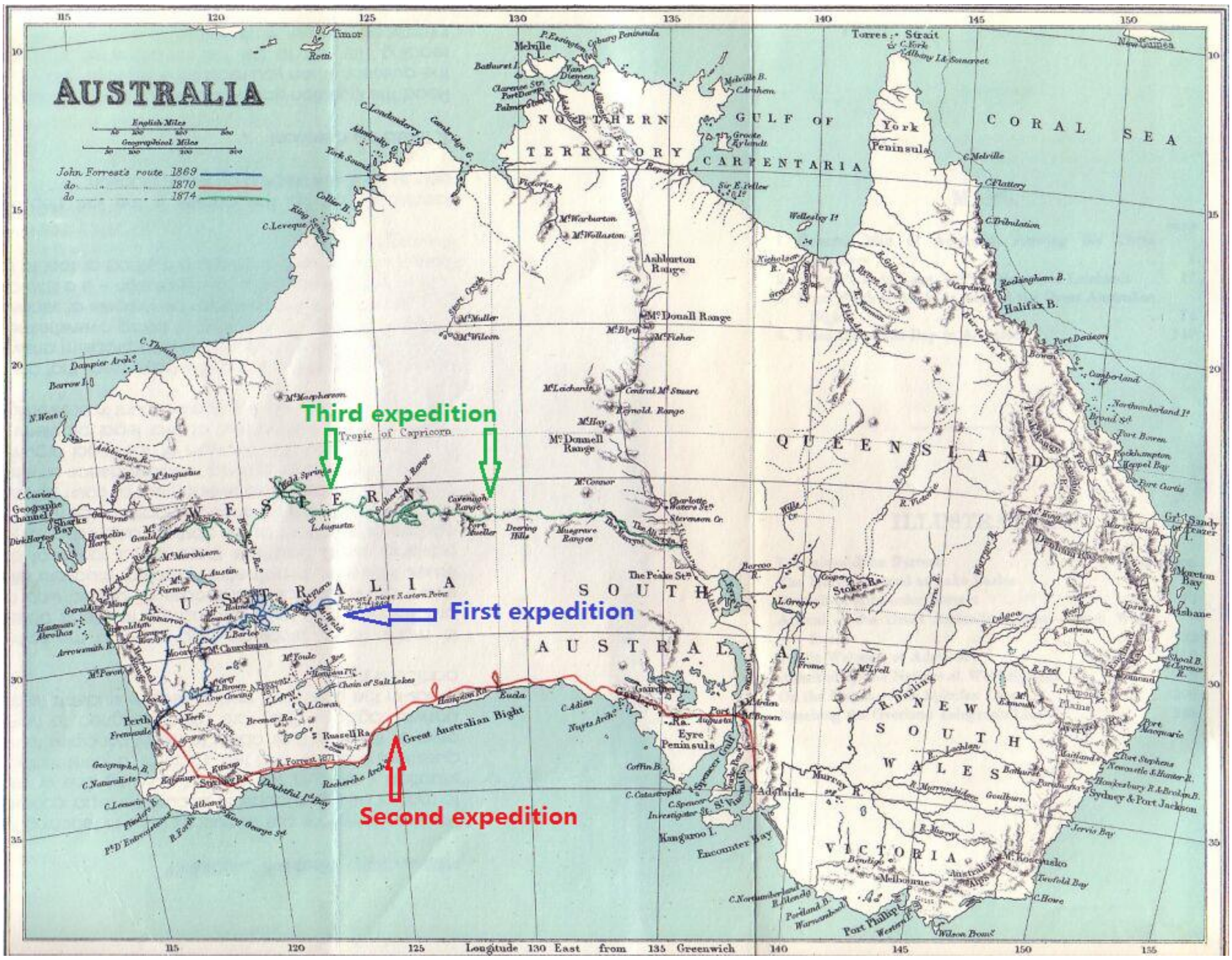

Figure 2. General Map of Australia, showing the Three Journeys (source: Project Gutenberg [16]).

2.2. Extracting Location and Time Elements through Recogito/TMT Annotation

We sought to present the expedition as an interactive narrative adventure. Day One is 17 April 1869, when the party arrived in Newcastle. John Forrest returned to Perth on 6 August 1869. This date concluded on the last day of the journey (Figure 1 shows the last day of the journey recorded by the journal).

The journal is formatted in a TXT file and uploaded into Recogito/TMT. The annotation is focused on the places that Sir John Forrest visited each day and tagged with the date information. For example, the text in Figure 1 recorded John Forrest leaving the campsite on the day of 6 August 1869. First, he reached Guilford and then finally arrived in Perth. Guilford and Perth are the place names annotated in Recogito/TMT, and the date information is added in the tag field (see the orange rectangle mark in Figure 3).

The annotation output (see the top table in Figure 4, Table S1) provides the essential elements: location (latitude and longitude), and time (date), in order to create the time-layered map. Other output also includes QUOTE_TRANSCRIPTION, which is the place name extracted from the text, and VOCAB_LABEL, which is the relevant name from the gazetteer. The two names differ in some cases where the place name has changed over time, and the current name recorded in the gazetteer is varied from the historical one (e.g., a place named Baylup in the text is recorded as Bailup in the gazetteer GHAP). A Unique Resource Identifier (URI) for each gazetted place name is also outputted to link to the gazetteer source website for more information.

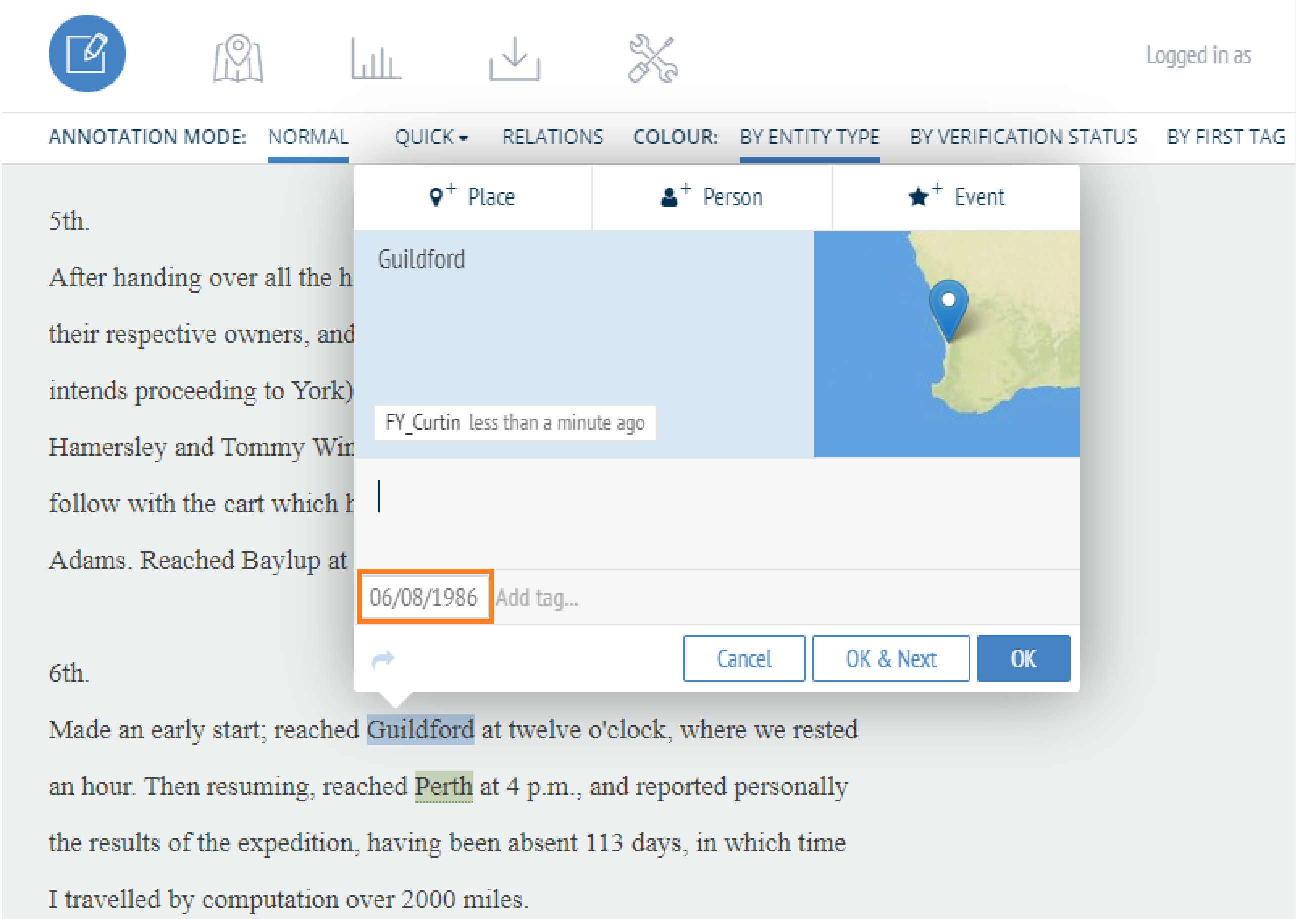

Figure 3. Annotating place names in Recogito/TMT.

In total, 69 unique place names, consisting of more than half of the whole journey, were initially annotated with the gazetteer. The annotation results were also provided in the KML format for downloading. The file can be loaded into Google Earth for viewing and further editing. Another 24 places where John Forrest camped without a name but recorded with latitude and longitude information were manually added using the Google Earth application. A further 33 campsites were also manually added using Google Earth based on the distance and angle information from other known locations described by John Forrest. The places annotated in Recogito/TMT serve as the foundation to map the entire journey.

2.3. Producing a Time-Layered Map with TimeMapper

Suitable for beginners, TimeMapper (https://timemapper.okfnlabs.org/, accessed on 26 February 2023) is an open-source project from the Open Knowledge Foundation Labs. It is a web-based tool used for building interactive time maps. TimeMapper provides a Google Sheets template for users to download. It includes a few columns that TimeMapper understands, and the top row of each column is self-explanatory. The required fields are Title and Description, StartDate, and Locations. Other fields are optional. The middle table shown in Figure 4 illustrates which Google Sheet columns were used and how the data was compiled from the Recogito/TMT annotations output. The bottom part of Figure 4 is the interactive time map generated in TimeMapper (Supplementary File S1).

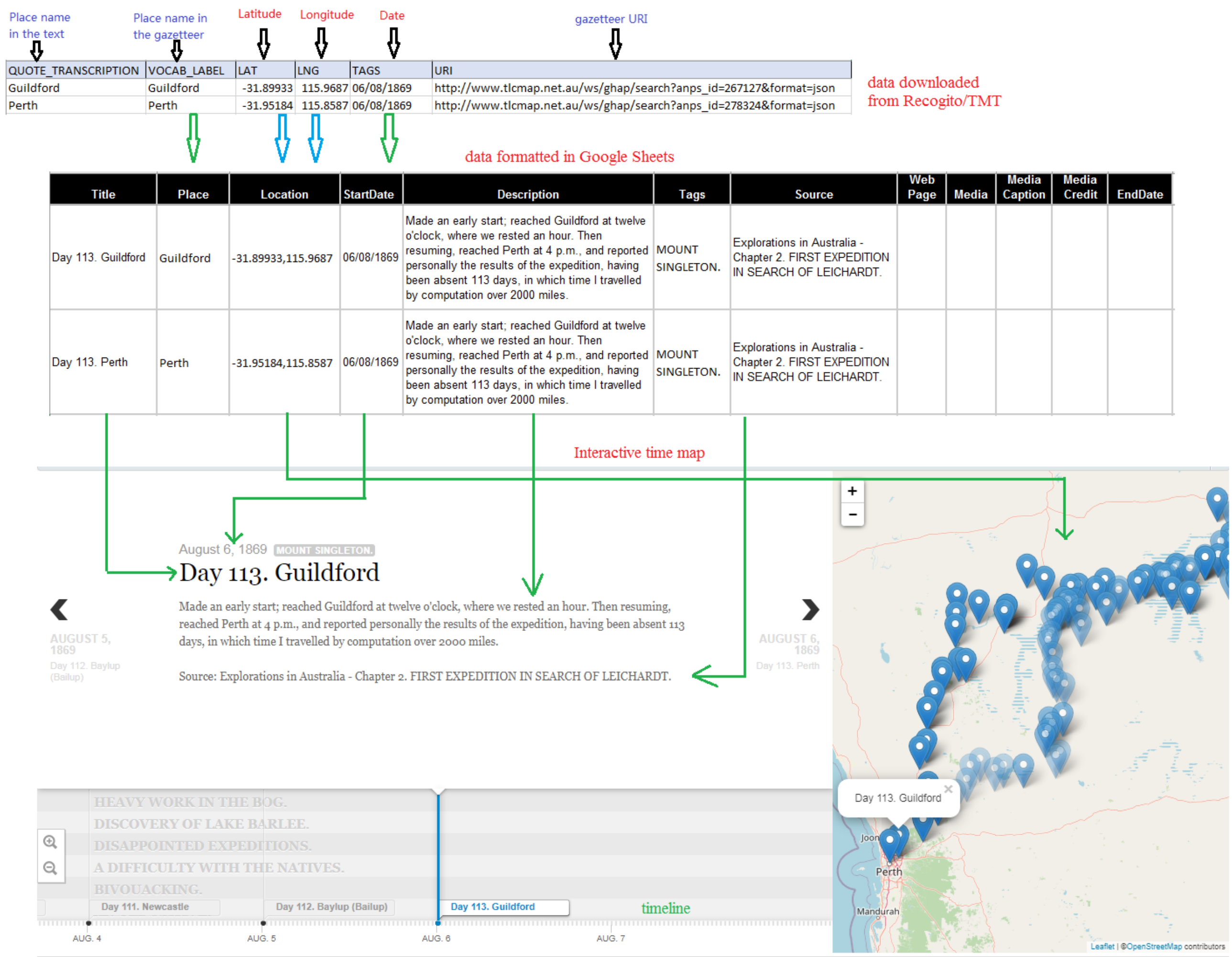

Figure 4. Workflow showing data downloaded from Recogito/TMT to an interactive time map built in TimeMapper.

In the Latitude/Longitude fields in Recogito/TMT, the output is combined into one single column, i.e., location, in a Google Sheet (Table S2). Each location value is created with a location mark on the map (see the bottom right part of Figure 5). The Title field in the Google Sheet is a compilation of the number of days and the place name so readers can immediately know when and where the journey is on the current interface, and the Description field is the journal content of the day. The bottom left part of Figure 4 is the timeline created from the StartDate field. There are three ways readers can navigate the time map. First, one can optionally use the left/right arrow to browse the days either in a forward or backward chronological direction. Secondly, one can navigate via the timeline. The third option is to click on the location marks on the map.

2.4. Produce a Time-Layered Map with Tour Builder

Tour Builder (Tour Builder (Supplementary File S2) was an interactive storytelling tool that connects people to places using Google Maps and multimedia content. The current version was retired in July 2021. New versions of creation tools will work on top of Google Earth globe for dynamic storytelling instead of showing a static picture of the planet. https://tourbuilder.withgoogle.com/, accessed on 26 February 2023) was a web-based tool provided by Google until 15 July 2021, providing a very easy way to add a sequence of locations, texts, photos, and videos on a Google Map. Tour Builder offered similar functionality for demonstrating interactive time maps as TimeMapper. Although now obsolete, Tour Builder is a useful case study with interesting features.

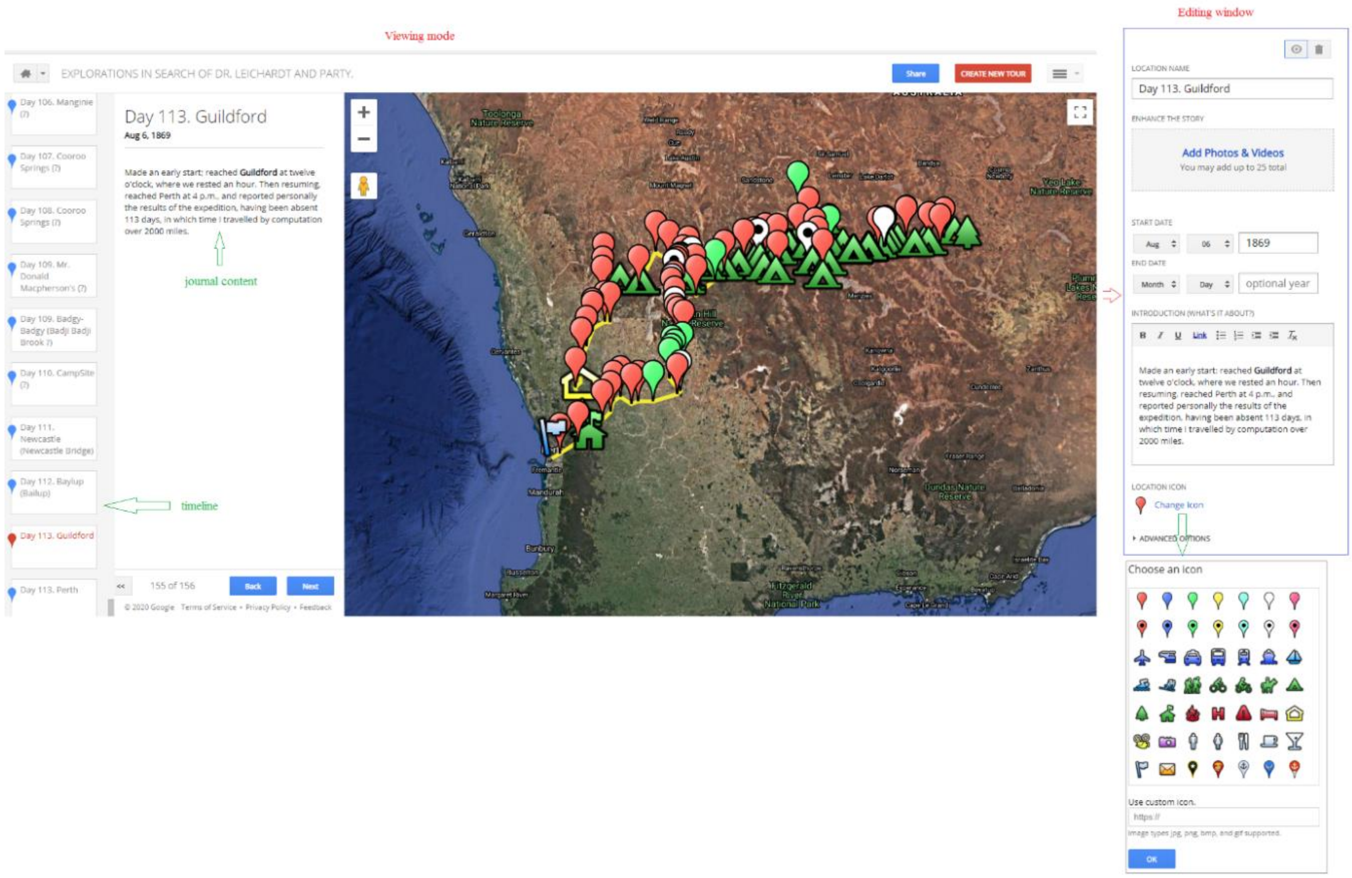

Figure 5. Interactive time map built with Tour Builder.

On the left side of Figure 5 is the timeline, where users can scroll up and down to view the days and click on any date of interest. Another way to navigate was to click on the blue Back and Next buttons in the next section, where users could display their texts, photos, videos, etc. Users could also click on the specified location on the map and navigate through the whole journey. The map section was the last and main section of Tour Builder, occupying more than half of the interface.

The content in Figure 5 was based on the same data compiled in the Google Sheet for use in TimeMapper. TimeMapper could directly import all the location data from a Google Sheet once it was finished editing and published to be shared. Unlike TimeMapper, Tour Builder required manually creating locations one by one, as well as editing texts and other content. See the right-hand side of Figure 5, which shows the editing window for creating and editing each date's contents. Although it was possible to bulk-create locations and content on Tour Builder, it provided more flexibility than TimeMapper when formatting content and locations. For example, instead of a unique blue marker in TimeMapper, location symbology and color could be changed by activating the Change Icon window (see bottom right part of Figure 5), and it also provided users with a custom icon if a URL is provided.

Please note that we include this deprecated software here as it has accessible features that may appear on future related software.

2.5. Producing a Time-Layered Map with Esri Story Map Journal

We also explored using a commercial web-based tool from the well-known mapping software provider Esri to showcase the same journey. The generated interactive time map is based on the Story Map Journal (https://enterprise.arcgis.com/en/portal/latest/use/story-map-journal.htm, accessed on 26 February 2023) template, which allows scholars and students to create multimedia stories, including the use of texts, photos, and maps, etc. The map is demonstrated in Figure 6. Unlike the previous two interactive maps, the timeline generated with the Story Map Journal provided both manual and automatic play functions. For example, click on the play button on the timeline (at the bottom of Figure 6) to automatically show every multimodal step of the journey. Content such as texts, photos, videos, hyperlinks, etc., can be formatted into the left-hand side panel or into pop-ups that will be shown by clicking on individual symbols on the map.

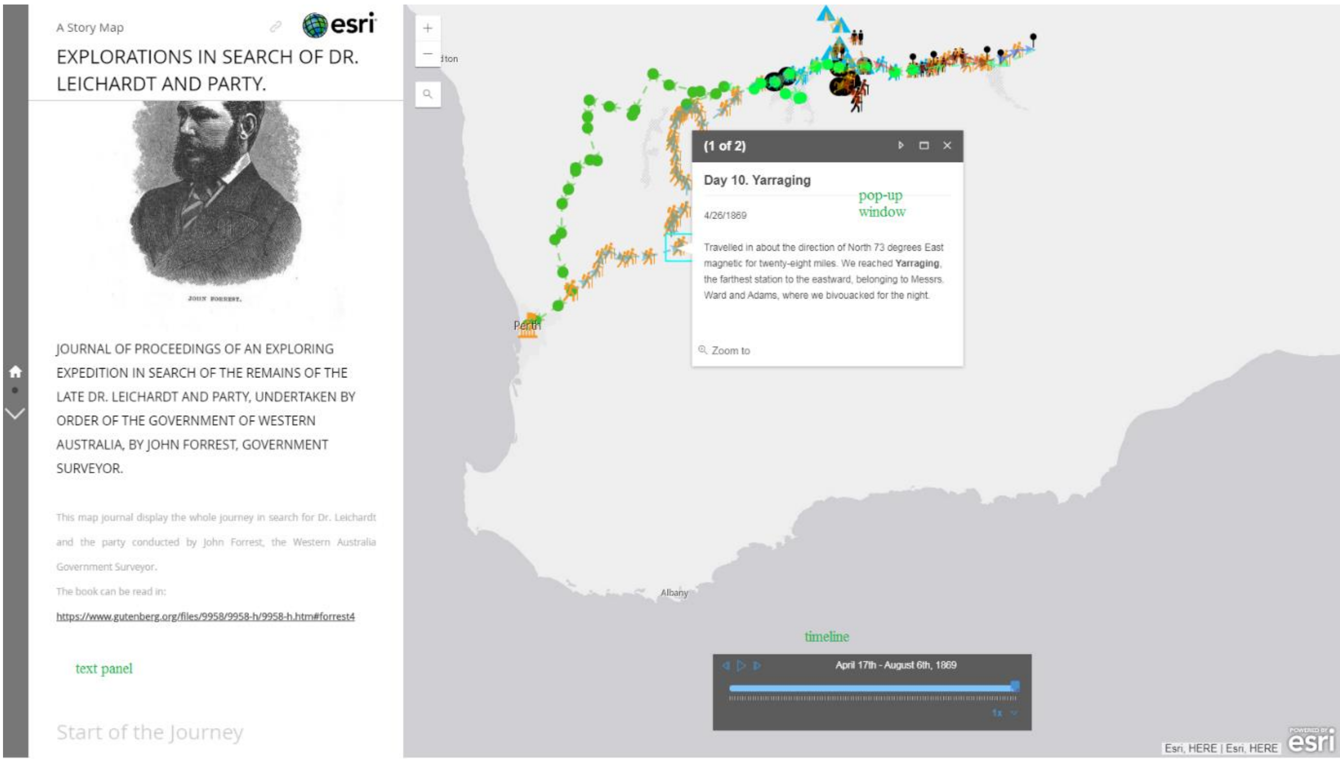

Figure 6. Interactive map built with Story Map Journal.

The creation of the interactive time maps in Story Map Journal requires the users to first create an ArcGIS Online web map based on the locations and time data. Then the users embed the web map in the Story Map Journal template together with other multimedia inputs for further editing. The symbology options for display locations are far greater than the two tools demonstrated previously. There are more custom formatting options available if users have programming skills.

2.6. Comparison and Discussion

We have outlined how Sir John Forrest's first expedition into interior Western Australia, as described in his book, can be visualized as interactive time-layered maps using three different web-based mapping tools (Table 1).

TimeMapper is freely available and very easy to use. Users only need to work with spreadsheets in order to add and edit data such as time, location, and journal content. Then TimeMapper can automatically create a neat and attractive interface for a general audience. TimeMapper focuses on storytelling based on photos and texts through a period. Therefore, the timeline and content sections occupy most of the interface, while the map takes up a relatively small portion of the screen, and there are no options available for its customization.

Tour Builder was also free for the public to use and was very easy to use. However, each location and its relevant information had to be created and inputted manually, which could be daunting if the project included a large number of locations. However, because users needed to edit the individual locations separately, it also provided them with more customization options than TimeMapper to suit their needs. The main focus of Tour Builder was the map, so the map section took up the majority of the interface, in contrast to TimeMapper.

Table 1. Comparison of story mapping solutions.

Features	Time Mapper	Esri Story Map Journal	Google Tour Builder
Range of features	Not as many as Story Map Journal	Impressive, but the new version currently has fewer features	Not as many as Story Map Journal
Longevity	Still available	Currently supported but replaced by a new version	2013–2021 then deprecated
Price	Free	Requires a license to share	Free
Code accessibility	Available on GitHub	Developers could access source code in the web application	Current status unclear
Customization	Limited	Powerful	Less limited than TimeMapper

Esri Story Map Journal is a GIS application that aims at providing web mapping solutions for geospatial professionals and developers. Therefore, it has very powerful customization abilities that allow users to develop interactive maps to better suit their specific needs. However, the tool does require a certain level of geospatial knowledge and mapping skills, which could be a barrier to the general public or humanities scholars' adoption of the tool. It also requires the purchase of a valid license to create and share story maps, a potential barrier to researchers on tight budgets.

With the experience of using these three applications to represent Sir John Forrest's expedition, we conclude that each application has disadvantages and advantages. Both TimeMapper and TourBuilder are free to use, so they are publicly available and easier to share.

Both tools' user interfaces are user-friendly, and users can easily understand how to use them. The downside is limited customization ability, automation is not available, resulting in tedious and repetitive work, and maintenance is not guaranteed (for example, TourBuilder is deprecated). Esri Story Map Journal, on the other hand, allows the user to have more control over how they want to present their story. There are abundant styling options and powerful customization and automation abilities (if the user knows how to program).

However, this depends on the user's familiarity with Esri Story Map Journal and GIS skill level. The user might find it difficult to get started. It also has an access issue due to its being a proprietary application; for example, our story map is no longer accessible due to expired access rights. Nevertheless, whichever tool is chosen for presenting the interactive time-layered map, the foundational components are the location and time elements data needed to be extracted from historical documents or scholarly literature. Recogito/TMT provides a very useful tool for humanities scholars and cultural heritage researchers to deploy their specific datasets.

3. Converting Time-Layered Map Data into RDF Format

3.1. Related Work

Cultural Heritage is an active research domain, especially regarding the application of Semantic Web technologies and Linked Data in the last decade [9], and research efforts are continuing. For example, in a recent publication, Nishanbaev, Champion, and McMeekin [17] performed a comparative evaluation survey for cultural heritage researchers and professionals interested in applying GIS tools to analyze and visualize spatio-temporal data embedded in cultural heritage data and publishing (non)spatial cultural heritage data according to Linked Data principles. The comparative evaluation focused on geospatial data conversion tools that do not require computer programming skills (which can otherwise cause reluctance or even rejection of the tools when used by cultural heritage researchers). The paper also discussed a framework that can interlink the generated RDF data with existing RDF data. The research identified several relevant and easy-to-use tools for cultural heritage researchers and professionals.

Hyvönen [18] presented a national data infrastructure based on Semantic Web technologies and Linked Data principles. The focus was on Finland's Digital Humanities community, researchers, and any interested members of the public, where humanities research data and publications are presented in a structured, standardized format and are openly available.

Hyvönen [19] also presented a summary of generations of research and development in applying Semantic Web technologies in the digital humanities domain. The first generation can be traced back ten years when Semantic Web technologies and standards were used to tackle syntactic, schematic, and semantic barriers to achieve Cultural Heritage (CH) data interoperability and integration and to publish CH data as Linked Data to the online semantic portal, which enables further linkages to broader data. Hyvönen [19] pointed out that currently, Semantic Web technologies applications for CH are in their second generation. In this generation, the research aims to develop CH data analysis technologies and tools that currently target particular domains and are used independently by domain experts in a generalizable way so common humanities researchers can easily adapt them to perform CH data analysis and tackle specific research problems. A key goal is for the generalized data analysis tools to eliminate the burden of data format transformations. They can easily consume Linked Data and data services provided by the online semantic portal. Hyvönen [19] also envisions a future third generation where not only can CH data be semantically searched, integrated, and presented to researchers for easy analysis relevant to their research problems, but the system itself can automatically identify research problems, address them or even solve them, and then be able to explain its reasoning process or solution to researchers.

However, these future possibilities, and even the second-generation goals, cannot be realized without a common requisite: the availability of harmonized linked data derived from the first generation. The following sections demonstrate the transformation of the showcase data into RDF format so it can be published online as Linked Data in the future. Such practice follows recent trends in CH research and contributes to semantic CH.

3.2. TLCMap Ontology Model

Recogito's primary aim is to link data through a common reference, i.e., through an online gazetteer. The annotation output from Recogito in RDF format includes a unique ID for each annotated place and its relevant gazetteer URI; see Figure 7 showing the annotated place "Guildford", which has been used in the above interactive map examples. The RDF output is based on the W3C Open Annotation Collaboration (OAC) ontology [20]. Typically each annotation includes a body and a target (see blue rectangles in Figure 7), and the body is quite often related to the target. However, the output is hard to understand without any context. It does not include location information (i.e., latitude and longitude coordinates) and the time elements essential for building time-layered maps. Therefore, the design of TLCMap ontology aims to be compatible with the Recogito-linked data paradigm and capable of including location and time element data. TLCMap ontology is a lightweight ontology and is based on existing standard ontologies.

The TLCMap ontology builds upon the OAC ontology model and is extended to incorporate the OGC GeoSPARQL [21] ontology and W3C Time [22] ontology to express location information and time element information. The TLCMap ontology model shown in Figure 8 demonstrates that the annotation includes a target, a body, and time.

3.3. Convert Time Map Data to RDF Format based on the Ontology

Based on the defined ontology model, the time-layered map data can be mapped to the ontology and transformed into RDF format. The same annotation, "Guildford" is shown in Figure 9. The top part of the figure is the information on the annotation itself which is labeled as “Guildford” and indicates it is an instance of the Annotation class. It has a URI, a creator, a date created, and also a relevant body, a target, and time elements (see all the information inside the yellow box). The bottom left part of Figure 9 shows the relevant information of the body, which is linked to a gazetteer and is a point geometry belonging to the Geometry class in the GeoSPARQL ontology, and therefore has latitude and longitude information. The middle bottom part is the target of the annotation, which points to the original document, i.e., the book written by John Forrest. The remaining part of the figure is the time information related to the annotation.

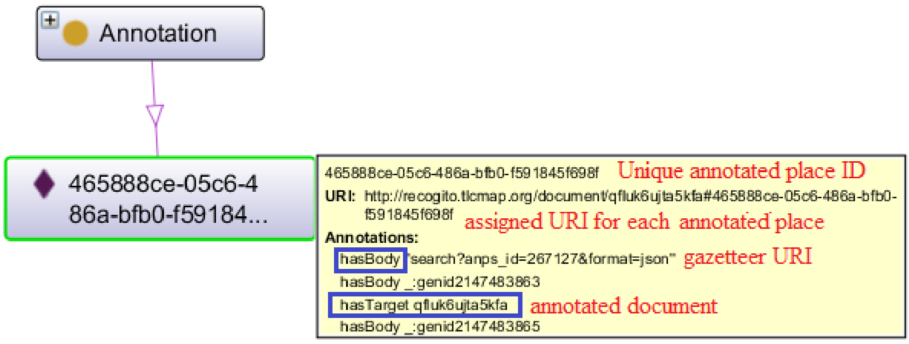

Figure 7. Annotation “Guildford” in the form of RDF downloaded from Recogito/TMT.

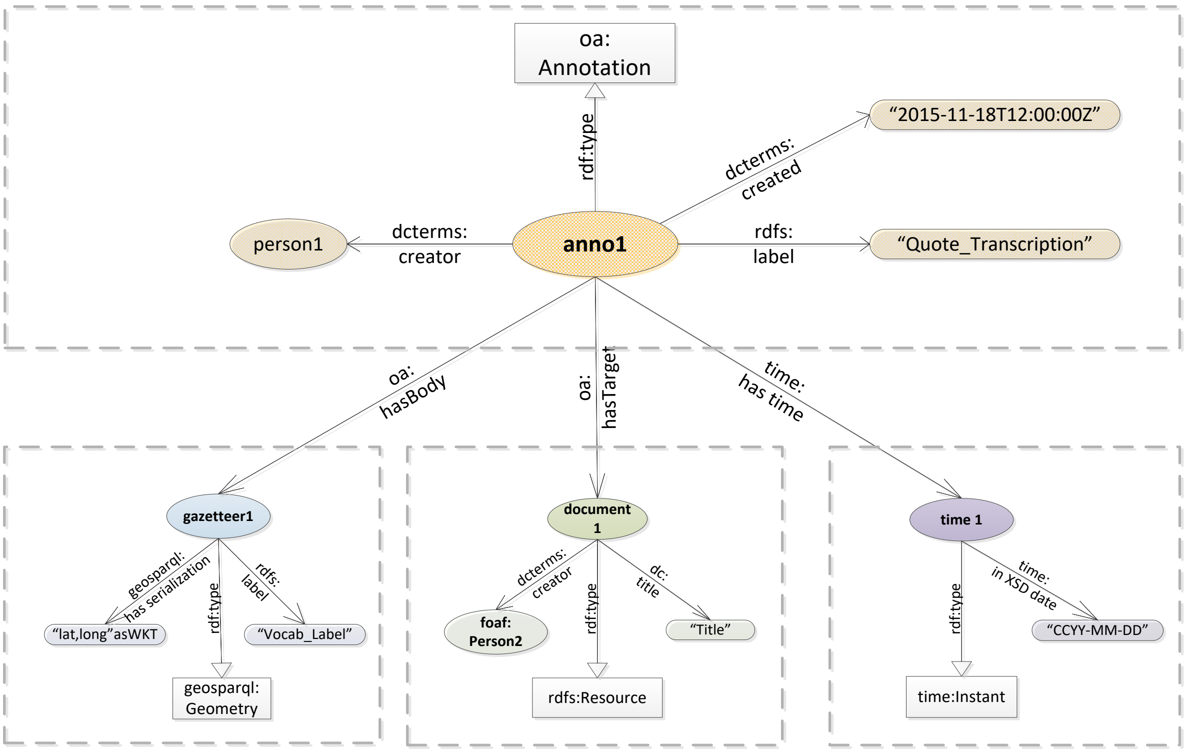

Figure 8. TLCMap ontology model extends based on the Open Annotation Collaboration ontology model.

The time-layered map data converted into RDF, based on the simple TLCMap ontology, is given explicit semantics for each part of the data. Their relationships are also specifically identified.

3.4. Uncertain Data with Digital Humanities Datasets

The Time Layered Culture Map project’s main objective is to provide examples and exemplars of geospatial data-related projects [1] so that humanities scholars can more easily adopt and adapt such technologies and platforms to their own research goals without a great deal of programming. However, it must be acknowledged that many of the related datasets are not certain [23], for humanities research is often focused on providing a range of interpretations but requires specific solutions [24] with more "expressiveness" than the solutions offered in the natural sciences [25].

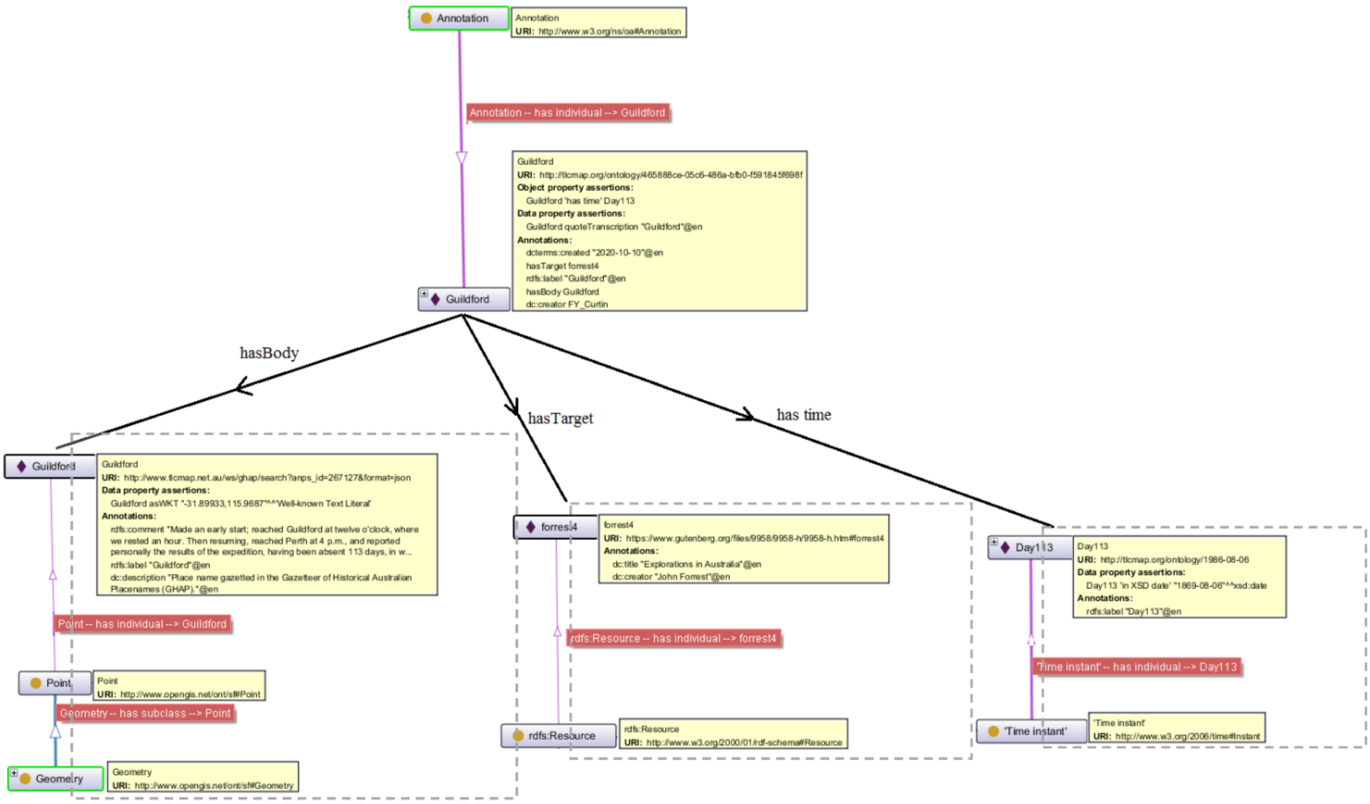

Figure 9. Convert location and time data into RDF format.

4. Conclusion and Future Work

This paper demonstrated the use of a central TLCMap infrastructure component, Recogito/TMT, to effectively annotate places within a cultural heritage document. The extracted location and time data were used to create interactive time-layered maps (The complete John Forrest's expedition in TimeMapper and Tour Builder can be seen via the below links. The example in the ArcGIS Story Map Journal cannot be made publicly available due to license issues. Please contact the authors if you are interested in discussing this further. TimeMapper: http://timemapper.okfnlabs.org/yu_feiyan/chapter2#153, accessed on 26 February 2023; Tour Builder: https://tourbuilder.withgoogle.com/builder#play/ahJzfmd3ZWItdG91cmJ1aWxkZXJyEQsSBFRvdXIYgIDggrbS1QkM, accessed on 26 February 2023, [As of July 2021 this application was no longer available]). The showcase demonstrated various interactive mapping tools available for cultural heritage researchers and humanists to create interactive time-layered maps based on their needs.

If budget is not a concern and you have programming skills, Esri is a great choice for building a complex and customized interactive map. However, the new version does not yet have the full features of the classic version. Otherwise, TimeMapper and Tour Builder are very intuitive and handy open-source tools for building time-layered maps without much mapping skills or programming skills required. However, Tour Builder was deprecated by Google (although one could still export tours to Google Earth).

There are new possible alternative solutions; for example, GeoStory, part of the GeoNode platform, can import KML and other formats (https://www.geosolutionsgroup.com/technologies/geonode/, accessed on 26 February 2023). There is also MapStory, a platform for "playable" maps of time dependant information (http://mapstory.org/ and https://github.com/MapStory/mapstory, accessed on 26 February 2023), as well as StoryMap JS (https://storymap.knightlab.com, accessed on 26 February 2023), an open-source project allowing journalists and humanities scholars to " . . . connect text and media items (images, video, or audio) to locations" [26]. Google Cloud has also recently announced Quick Builder, "a new low-code tool for you to build location-based experiences," but there is a new pricing system based on maploads [13].

Regardless as to which mapping tool is selected, the fundamental element of the creation of time-layered maps is the location and time-based data. Therefore, we consider Recogito/TMT to be the backbone of this activity. The core of Recogito/TMT is the gazetteer. The more accurate the gazetteer, the easier it is for cultural heritage researchers and humanists to annotate their documents and extract useful time and location data. We recommend Recogito/TMT continue adding gazetteers relevant to different research domains.

The digital humanities publications, with their often large collection of authors [27], show both the importance and the difficulty of developing similar projects. Providing access to a reliable tool based on accepted standards is of primary importance to us. We have briefly discussed the role of RDF in this project, but it is part of a wider concern, particularly in Australia, as to how to best link disparate documents, archives, disciplines, and research questions in a meaningful way for a wide range of research questions. Some of the issues have been outlined in [28], sources do not easily relate to the Linked Open Data paradigm, access to archives varies, and agreement on ontological modeling can be difficult to reach. There are interesting proposed solutions to some of these issues, such as "linked information spaces" [29] and the Linked Places Format [30], but there will still be some site or country-specific issues to contend with.

In terms of the project discussed here, the current gazetteer only records places on the Australian mainland. There is no gazetteer available for places, islands, and other maritime locations adjoining the Australian mainland. Far more important journeys and historical narratives could be added, given that Australia's early history is highly relevant to both people traveling from overseas and the trade and migration of indigenous people. Such a gazetteer would be very useful for researchers, allowing them to annotate maritime places or events.

There have been recent trends in cultural heritage research to utilize Semantic Web Technologies and Linked Open Data paradigms in order to semantically search, integrate, and present semantic-rich CH data. As a first step, this paper demonstrates the design of the TLCMap ontology model. It transforms the showcase data into RDF format based on the model designed for the particular audience of humanities scholars and students. This workflow enables time-layered map data to be presented in RDF format with explicit semantics and specific relationships. It can be published online as Linked Data in the future.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/ijgi12030104/s1, Figure S1: John Forrest; Table S1: Explorations in Australia; Table S2: GoogleSpreadsheet; Supplementary File S1: Tutorial-TimeMapper; Supplementary File S2: Tutorial-TourBuilder.

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