Spatial Network Analysis of Religious Landscape Based on Cross-Reference Ontology and Graph Database

Ya-Wen Lin[1*], Li-Xing Hong[2] and Wei-Hsiu Lin[3]
Department of Information Management, Fu-Jen Catholic University, Taiwan[1]
Fu Jen Academia Catholica, Fu Jen Catholic University, Taiwan[2]
Department of Chinese Literature, Shin Hsin University, Taiwan[3]
**Corresponding Author: 154327@mail.fju.edu.tw*

Received 18 December 2022; received in revised form 27 December 2022; accepted 29 December 2022

Abstract

The Department of Religious Studies of Fu Jen Catholic University and the Digital Culture Research Center of the Academia Sinica have cooperated in the "Project for Religious Landscape Survey" since 2017, initially establishing a database of multi-religious landscapes in Taiwan. This study aims to explore the relationship between the development of various religious landscapes and society, economy, and environment by combining the "Daoist Ritual" ontology and multi-period religious landscape data. Since the traditional Relational Database Management System (RDBMS) must pre-define the association logic between tables, RDBMS is not suitable for dealing with diverse or highly variable data structures and analysis models. Therefore, this study employs a graph database management system to migrate religious landscape survey data from the original RDBMS into a graph database model. Since graph databases can support both structured and unstructured data without predefining the structure and relationships of tables, this flexible and extensible property graph model allows future collection of religion-related data from other sources. Taking "Xinzhuang Leifa Temple" in as an example, this study discusses how to integrate ontology into graph database, so as to provide reference for the application of depth and breadth of religious survey data, and further expand research topics related to religious issues.

Keywords: Religious landscape, graph database, ontology, geospatial analysis

1. Introduction

The religious culture in Taiwan is diverse and abundant, and the local developments of each religious sect have their own characteristics. Since 2017, the Department of Religious Studies at Fu Jen Catholic University has cooperated with Academia Sinica Center for Digital Cultures and the Museum of World Religions to conduct the "Project for Religious Landscape Survey (PRLS)". The PRLS started from Xinzhuang District, New Taipei City to investigate the cultural and historical background of local religious buildings. Now PRLS has gradually expanded to a total of 21 counties and cities in Taiwan. As PRLS has comprehensively recorded the religious landscape database in Taiwan, it can provide indicative data sources for religion-related research in Taiwan.[1]

PRLS has long used relational databases to store, process and manage data. Since the development of religion in Taiwan, it has presented a diverse and free ecology, which has formed an intricate relationship with changes in population, society, economy, and environment. As a result, we are faced with larger and more diverse collections of religion-related data. Furthermore, large datasets are notoriously difficult to store in relational databases, as query execution time increases with table size and number of joins (Robinson et al., 2015). Therefore, the current traditional relational database may not be suitable for future exploration and analysis of large amounts of religious data and complex relationships.

Historically, a relational database is the most popular data storage method, that is, different types of data items are stored in different entities, and the relationship between entities must be defined in advance to link two related data tables. However, with the increasing diversification of data sources and the gradual accumulation of data volume, the data structure becomes more complex in general. Predefined interrelated entity data limits the application of data and often cannot meet actual business needs (Jordan, 2014; Robinson et al., 2015). Over the past decade, NoSQL has emerged to address these challenges.

With the innovation and rapid development of digital humanities tools, graph databases, as one of the NoSQL databases emphasizing the relationship between data, have become valuable analytical tools in the field of digital humanities in recent years.[2] Since a graph database represents a

[1] See "GIS for Religious Landscape in Taiwan" (GISRL); URL: https://gisrl.ascdc.sinica.edu.tw established by Academia Sinica Center for Digital Cultures.

[2] For example, the "Chinese Historical Christian Database" established by Boston University was developed using the open source technology of a graph database. It

densely connected relational network under a variable structure, the flexibility of the graph model allows arbitrarily adding new data nodes, properties, or relationships without disrupting the existing relational network structure (Jordan, 2014; Robinson et al., 2015).

This study conducted a pilot study on a graph database using a single religious landscape, and selected the "Xinzhuang Leifa Temple" as the research site. First, use the Neo4j graph database to transpose the religious landscape survey data and "Daoist Ritual" ontology related to "Xinzhuang Leifa Temple" into the data model of the graph database, and then analyze the geographical, cultural, and historical relationships of "Xinzhuang Leifa Temple". Afterwards, the religious landscape survey data will be reconstructed into a graph database based on this study.

In other words, this study intends to expand the religious landscape graph database on the abovementioned basis, and re-establish the original religious landscape survey data according to the structure of the expanded graph database. Moreover, it is also possible to add multimedia records to the expanded graph database, such as religion-related literature and historical materials, important figures, and religious ceremonies and activities, thereby improving the data nodes, properties, and relationships of different religions. Finally, this study expects to explore the geographical, cultural, and historical contextual relationship of different religions in Taiwan from a new perspective, and to provide analytical tools for further religious studies.

2. Literature Review

2.1 Graph Database

Almost anything in the world can be modeled as a graph (Robinson et al., 2015). In the traditional concept, a "graph" is a combination of a set of vertices and edges, namely, the relationships between nodes and connection nodes; in general, there is an interrelationship between two or more nodes (Kemper, 2014; Robinson et al., 2015). The graph theory was proposed by Swiss mathematician Leonhard Euler in the 18th century. Mathematically, the graph theory studies the relationships between graph structures and various objects. Basically, graph models have clear start and end nodes, and the relationship between nodes can be directional or non-directional. Based on the graph theory, a graph database stores data in the form of nodes, edges, and properties (Kemper, 2015; Barrasa et al., 2021).

Graph databases are composed of nodes and relationships, so no matter how complex the relationship graph is, each data entity and its connection relationship can be converted and stored in the graph database for user query and analysis (Kemper, 2015). In order to make it easier to build, access, maintain, and manage graph databases, the graph database management system will be used for data optimization and operational availability (Robinson et al., 2015). Nowadays, the most popular graph database model is the "property graph model", which is a very common model for processing and managing graph data consisting of nodes, relationships, and properties to form various complex data models. Nodes can contain zero or more properties to explain the purpose or meaning of the node in the graph. A relationship has only one type and has directionality. While there must be start and end nodes in a relationship, the direction can be from one node to another node or refer back to the same node. Likewise, a relationship can contain zero or more properties, which represent certain characteristics connecting two nodes (Barrasa et al., 2021).

In general, a graph system can be analyzed using different graph algorithms to identify various graph patterns, such as shortest paths, community detection, and triangle counting. In particular, its application in social network analysis can help measure the clustering of graph data to determine the degree of cohesion among local groups (Pokorný et al., 2019). Due to technological advances in modern graph databases and graph processing software, large complex graphs with millions or billions of data can be easily constructed, which can be applied to build knowledge maps (Barrasa et al., 2021). In addition, graph data mining technology can be used to identify graph patterns in massive graph data (Pokorný et al., 2019). Graph models combine humanized data models and algorithms to easily identify hidden models, which can provide analysis that is close to the interpretation of human language, thus, they are becoming increasingly popular. The analysis of a graph model is equivalent to providing the decision-making behavior model of individuals or even groups. From a decision-making perspective, as some people are more susceptible to external influences than others, social infection is actually more counterintuitive than biological contagion; in terms of the spread of disease, each infection operates independently. However, social infection is significantly different, meaning the influence of one person on another is closely related, thus, the relationship between individual influence and group influence is closely related (Watts, 2004).

2.2 Ontology

Ontology is derived from philosophical theory, and its major concern is the nature of the

provides researchers with visualized quantitative data and serves as a new generation of digital humanities research tool for studying Christian institutions, organizations, and figures in China. The database version 1.0 was officially launched on July 27, 2022; URL: https://chcdatabase.com.

existence of an idea or entity and its interrelationship with other entities. However, in terms of computer science and information science, ontology is a collection of the conceptual definitions of knowledge, properties, entities, and relationships. Ontology uses vocabulary to describe the types of objects or concepts that exist in a specific field, as well as their properties and interrelationships, such as knowledge concepts, categories between data and entities, representations of properties and relationships, and naming and definitions, which constitute one, a large number of, or all of the knowledge in the domain of discourse (Gruber, 1993). In recent years, due to the vigorous development of artificial intelligence (AI), the acquisition of knowledge is key to building a powerful AI system. Inspired by philosophical ontology, some researchers began to regard computer ontology as an applied philosophy. As a result, the field of AI began to use ontologies to refer to theoretical and knowledge system components that model the world (Gruber, 2016).

Ontology engineering aims to probe into the methods and methodologies related to the construction of ontology, including the ontology development process, ontology life cycle, ontology construction methods, and methodology, as well as toolkits and languages that provide support for these aspects (De Nicola et al., 2019). Although an ontology knowledge base is the public's common perception of a specific field, there is no right or wrong or uniqueness in an ontology knowledge base (Van der Vet & Mars, 1998).

3. Data Collection

The main data source of this study is from PRLS. As of November 19, 2021, PRLS has collected a total of 11,420 records related to religious landscapes, including the location of religious buildings, text descriptions, and religious multimedia. Most of the data were collected from New Taipei City (4,345), followed by Taipei City (2,214) and Kaohsiung City (1,545). The distribution of the number of in each county and city is shown in Figure 1, and that of geographical distribution is shown in Figure 2.

Examining the religious identity of all religious landscapes, a religious landscape can be identified as more than one religion, for example, folk belief and Buddhism coexist in a religious landscape. For statistical convenience, we only counted a single religion identified in a religious landscape. The top five data volumes are folk beliefs (7747), Christianity (883), Buddhism (710), Taoism (590) and Catholicism (159), as shown in Figure 3.

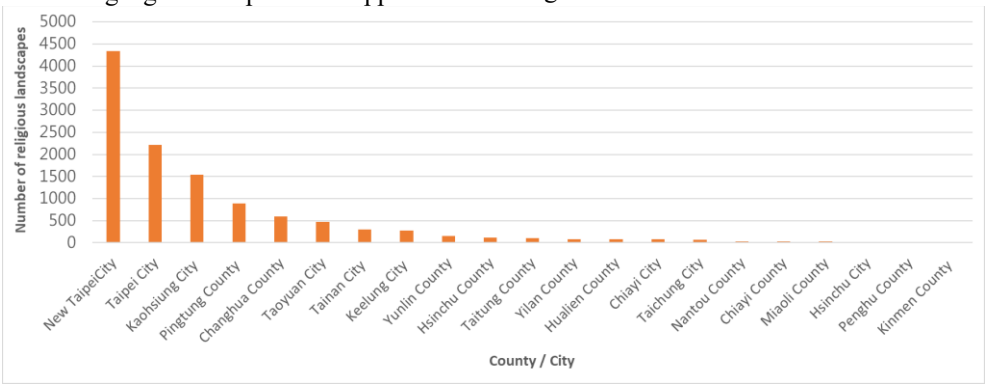

Figure 1: Number of Religious Landscapes in Each County and City in the RPLS Survey (as of November 19, 2021)

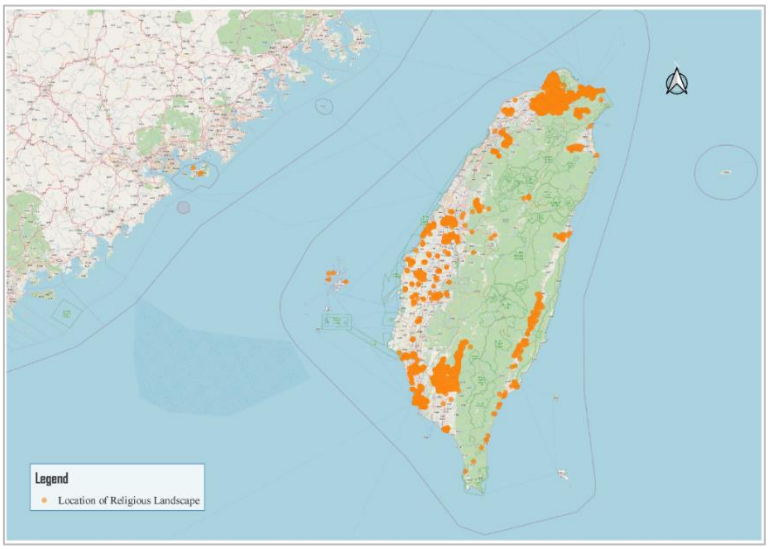

Figure 2: Geospatial Distribution of Religious Landscapes in the RPLS Survey (as of November 19, 2021)

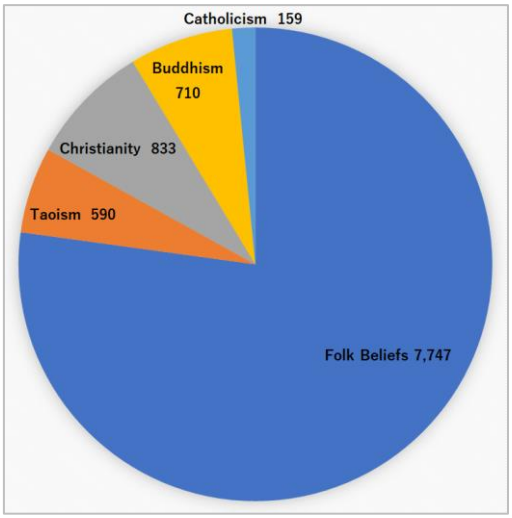

Figure 3. Top 5 religions in RPLS survey (as of November 19, 2021)

4. Methods

Currently, PRLS utilities a relational database to store collected religious landscape data in the form of tables, rows, and columns, as shown in Table 1. Each column is used to describe a different attribute of the religious landscape, and the rows corresponding to these columns may or may not be related. Regarding the data item in the "History" column, it describes the historical context of a specific religious landscape. Taking the brief history of "Guangxing Sanshan Guowang Temple" as an example, the religious belief was separated from the temple of "Jiuru Sanshan Guowang", so "Guangxing Sanshan Guowang" Temple" is related to "Jiuru Sanshan Guowang" temple. While it is observable from its text that this religious landscape shares a historical origin with other religious landscapes, because a relational database can only process structured and consistent data relationships, it cannot present the complex relationship background between the literature and history of religious landscapes.

Therefore, this study aims to construct a graph database in the form of knowledge representation in the domain of "Daoist Ritual"; meanwhile, a Web-based GIS prototype system is developed to evaluate the possibility of systematized graph datasets to represent religious landscapes in spatial and relational networks.

Table 1: Extraction of Partial Religious Landscape Records from RPLS

Name	Religious Identity	Worship	Source of Worship	History
Guangxing Sanshan Guowang Temple	Taoism, Folk beliefs	Sanshan guowang (Kings of three mountains)	Jiuru Sanshan Guowang Temple	The initiation of the worship of Sanshan Guowang (Kings of three mountains) occurred at approximately the same time as Mazu of Dalukuan; however, the religious belief was separated from the temple of Jiuru Sanshan Guowang (Kings of three mountains). In 1857, the Wuluo River flooded, which caused the Dalukuan to be divided into two villages. During the Japanese colonial period, the statue of Sanshan Guowang (Kings of three mountains) was moved to the new Dalukuan village and worshiped in private homes, as the Japanese government's imperialization movement prohibited villagers from worshiping gods. Initially, the Sanshan Guowang statue was enshrined in the home of Cheng Weihai, a villager. In order to avoid being caught by the Japanese police, he wrapped the statue in a flour sack and hung it from a beam in the kitchen to worship secretly. Afterwards, the statue of Sanshan Guowang was moved to the homes of other villagers, first was Chia-Li Yang, followed by the Chiu family, and eventually, the home of Tso-Hien Chung, the village head, in the 1960s. In 1969, Hsiu-Fa Hsu and Shou-Yu Chung initiated the construction of a temple and purchased the current Sanshan Guowang Temple site from Li ChenHsing and Lien-Shen Li.
Sanchong Daitian Temple	Folk beliefs	LiFu Chitose (Highness of Lee Family)	Highness of Five Families (Li, Hsing, Fan, Chu, Wu)- Dai Tian Temple, Gangweiliao, Liujiao Township, Chiayi County; Highness of Chi Family- Nan Kun Shen Dai Tian Temple	The origin of the Sanchong Daitian Temple can be traced back to the apparition of the god Lee Fu Chien Sui (Highness of Lee Family) at Daitian Temple in Gangweiliao, Liujiao Township, Chiayi County to help villagers. In 1968, Mr. Ya-Hsueh Huang, a believer in Sanchungpu, initially worshiped Lee Fu Chien Sui (Highness of the Lee Family) at home, and the believers were moved by the repeated apparition, power, and grace of God. In 1973, a statue of Lee Fu Chien Sui (Highness of the Lee Family) was dedicated to the public, while that of Wu Fu Chien was enshrined. The management committee to jointly manage Daitian Temple consisted of 16 people, including Lai-Wan Huang (son of Ya-Hsueh Huang). The original Daitian Temple was constructed on Sanchang Street as a place for people to pray for peace and happiness, but as the number of believers increased, they started to collect donations. The believers, including Ya-Hsueh Huang, Lai-Wan Huang, Chih-Ming Huang, Yi-Hsiung Chiu, Chin-Hsien Yeh, and Xi-Ching Liu, raised funds to jointly build a new temple, and in the 1980s, the temple was moved to Chunghsiao Road. Sanchong Daitian Temple has since been located here to provide salvation and was refurbished in 1999. (Source: Published by Sanchong District Office, Sanchong Temple History)
Sanchong Cihui Temple	Folk beliefs	SuFu WangYeah (Prince of Su Family)	Su Fu Wang Yeah (Prince of Su Family)- Lukang Fengtian Temple; The Three Female Generals of Nantianmen (Madem Chang, Shung, and Bai) - Lukang Fengchao Temple	In the early days, believers Xi-zhou Wu, Huo Wang, A-tie Lin, and many other philanthropists welcomed the statue of SuFu WangYeah (Prince of Su Family) in Lugang Fengtian Temple back to Lane 58, Chongyang South Road, and they set up a private altar, which enabled believers to worship the God, which was famous for being efficacious. In 1961, Ms. Xi Lin (known as A-Xiguan, a representative of public opinion in Taipei County), a local resident, was frail and sick, and she was dying. With the blessing from SuFu WangYeah (Prince of the Su Family) for her recovery, she set out to raise funds for the construction of Su Fu Wang Yeah (Prince of the Su Family) Temple. The believers strongly supported this idea, the Cihui Temple Management Committee was immediately established, and the construction started at the current site. The construction of the temple was completed in 1966. In 1987, Mr. Fa-Tsai Chen launched a fundraising campaign to rebuild the Cihui Temple, which contributed to the current appearance of the Cihui Temple. The Chihui Temple was established as the Chihui Temple Management Committee in early 1961 and reorganized into a foundation in 1969. (Source: Published by Sanchong District Office, Sanchong Temple History)

4.1 The Knowledge Ontology in Graph Database

This study first transforms the relational database of religious landscapes into a graph database according to the ontology of "Daoist Ritual", as shown in Figure 4, which describes the hierarchical relationship between Taoism and rituals through vocabulary. Then, each entity in the "Daoist Ritual" ontology is classified as each node in the graph database. Based on the definition of each entity, vocabulary is used as keywords to discover data related to a particular religious landscape and to identify its relationship to other religious landscapes. Finally, the above nodes, relationships, and properties are combined into a property graph model to facilitate subsequent exploration of the historical and cultural relationships between different religious landscapes.

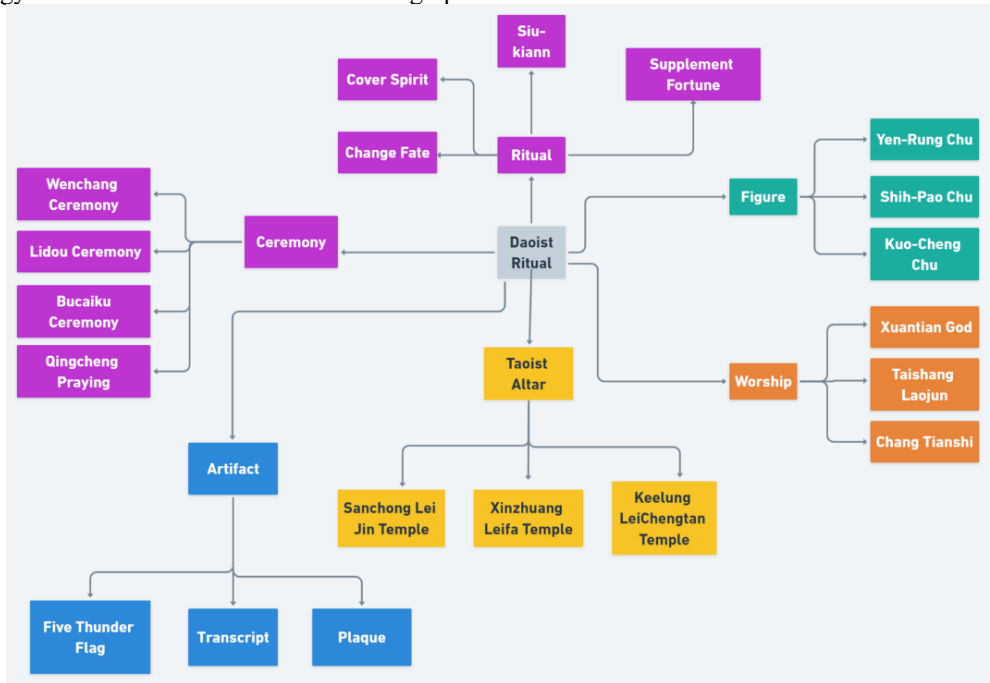

Figure 4: "Daoist Ritual" Ontology

This study establishes a property graph model based on the ontology of "Daoist Ritual". We start from the "Taoist Altars" node and choose "Xinzhuang Leifa Temple" as the religious landscape for demonstration. Tracing the history of "Xinzhuang Leifa Temple", it possesses an artifact called "Transcript", which was copied from "Keelung LeiChengtan Temple". Since "Transcript" is one of "Artifact" node in the "Daoist Ritual" ontology, we add an "Artifact" node in property graph model. Then, "Xinzhuang Leifa Temple" and "Keelung LeiChengtan Temple" established a relationship through the "Transcript" node, which suggests that the transcript started from the "Keelung LeiChengtan Temple" node. After the transcript was "copied (COPY_FROM)", a "BELONG" relationship was established with "Xinzhuang Leifa Temple", and this relationship eventually ended at the "Xinzhuang Leifa Temple" node, as shown in Figure 5.

Similarly, the above process was followed to establish the property graph model of the node of "Figure". The "Figure" related to "Xinzhuang Leifa Temple" includes "Shih-Pao Chu", "Yen-Rung Chu", and "Kuo-Cheng Chu". According to the content among the above three people described in the ontology, various religious landscapes related to the "Figure" of "Xinzhuang Leifa Temple" are constructed, as shown in Figure 6. In the end, the property model was expanded from the original 3 nodes to 12 nodes and the 4 religious landscapes were connected through the "Figure" node.

Although relationships do exist in relational databases, they are only used as a way of joining tables. To make matters worse, the relational model became overloaded with huge join tables, sparse rows, and extensive null-checking logic, making the overall structure of the dataset even more complex and inconsistent (Robinson et al., 2015). Since data related to religion is usually larger and more diverse. This increase in historical relationships translates into increased connectivity in related religious landscapes, which impacts performance and makes it difficult for us to scale our existing databases in response to changing religious research needs. Therefore, the graph data model is powerful and flexible, and its inherent expressiveness makes graph databases more useful for real-world problems.

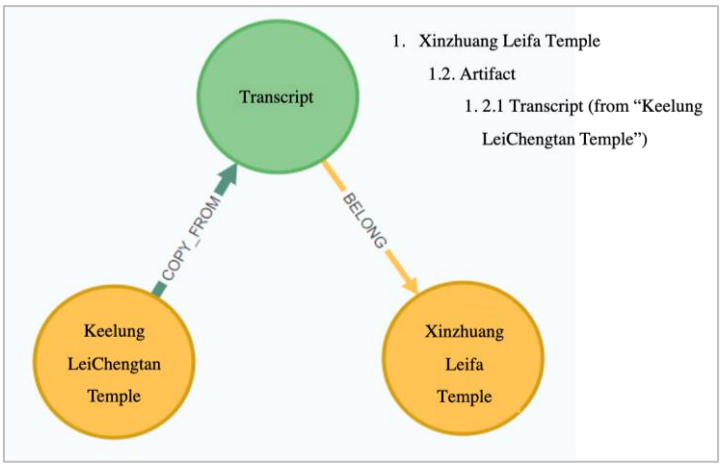

Figure 5: Property Graph Model Corresponds to the "Artifact" Node in "Daoist Ritual" Ontology

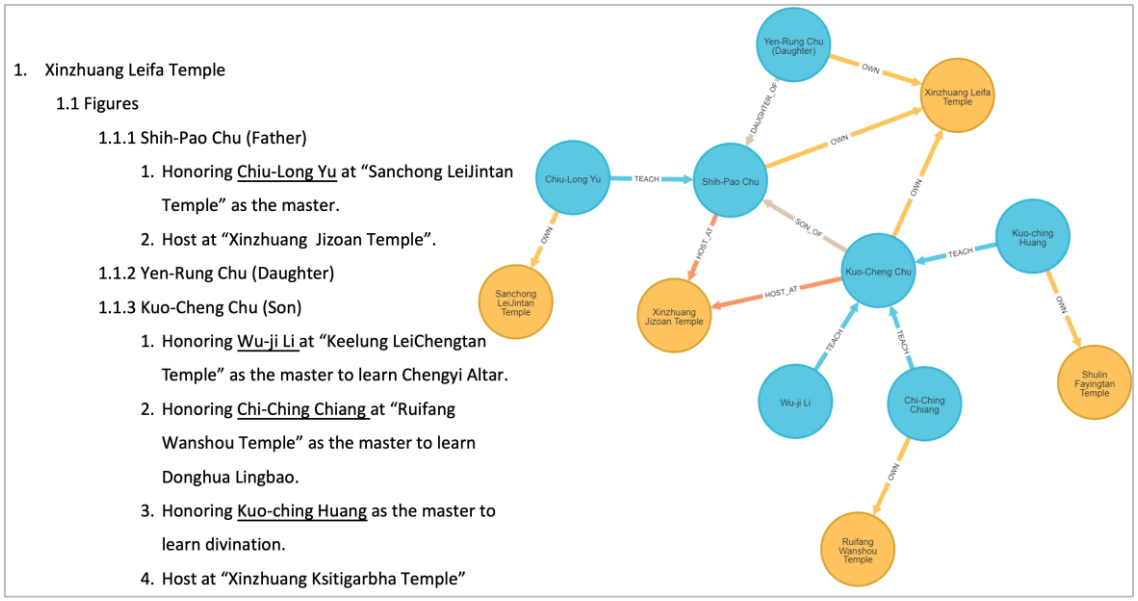

Figure 6: Property Graph Model Corresponds to the "Figure" Node in "Daoist Ritual" Ontology

Finally, this study transforms the overall "Daoist Ritual" ontology of "Xinzhuang Leifa Temple" into a property graph model, as shown in Figure 7, where "Xinzhuang Leifa Temple" is related to eight other religious landscapes, including the connections of different nodes, such as "Artifact", "Figure", "Ritual", and "Ceremony". The model subsequently applied the "Daoist Ritual" ontology to more religious landscapes to better understand the mutual humanity, historical changes, and relationship networks of each religious landscape. For Neo4j Cyber syntax, please refer to Figure 8.

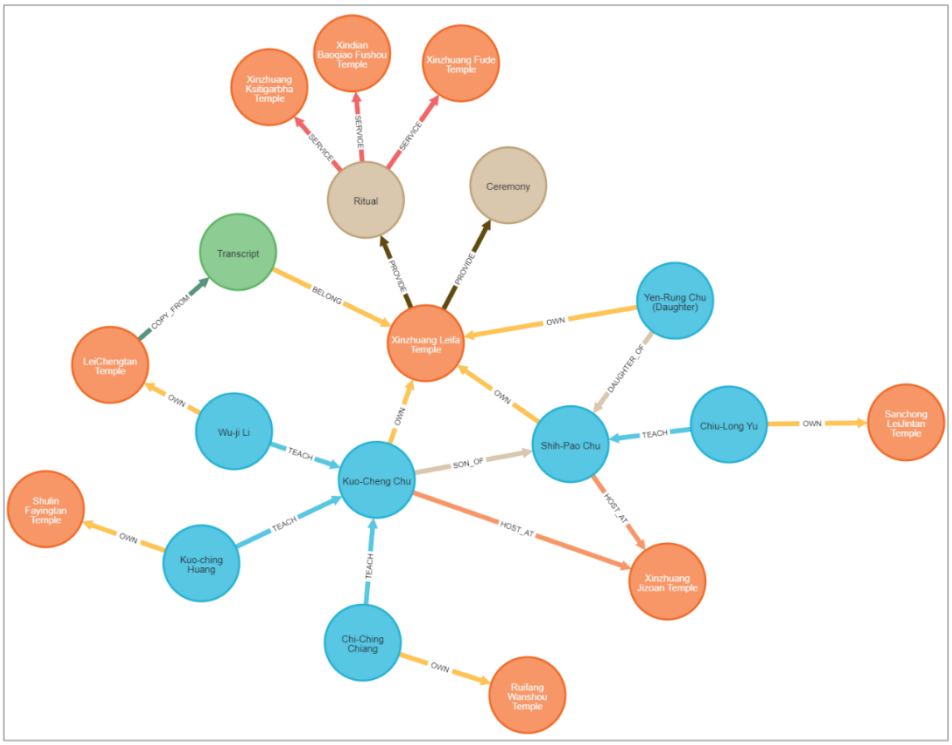

Figure 7: Property Graph Model – Xinzhuang Leifa Temple

```
CREATE (RL_362:Landscape {title:"Xinzhuang Leifa Temple", code:362, label:'Taoism', city:'Xinzhuang', x:121.45150, y:25.05121})
    CREATE (pZhu_362:Person {name:'Shih-Pao Chu'})
    CREATE (pZhu_362_2:Person {name:'Yen-Rung Chu (Daughter)'})
    CREATE (pZhu_362_3:Person {name:'Kuo-Cheng Chu'})
    CREATE (oCopy_362:Object {name:'Transcript'})
    CREATE (rAll_362:Ritual {name:'Ritual'})
    CREATE (cAll_362:Ceremony {name:'Ceremony'})
    CREATE (pZhu_362)-[:OWN]->(RL_362),
    (pZhu_362_2)-[:OWN]->(RL_362),
    (pZhu_362_3)-[:OWN]->(RL_362),
    (oCopy_362)-[:BELONG]->(RL_362),
    (pZhu_362_2)-[:DAUGHTER_OF]->(pZhu_362),
    (pZhu_362_3)-[:SON_OF]->(pZhu_362)

CREATE (RL_1155:Landscape {title: "Sanchong LeiJintan Temple", code:1155, label:"Taoism", city: "Sanchong", x:121.49287, y:25.06522})
    CREATE (pYu_1155:Person {name:' Chiu-Long Yu'})
    CREATE (pYu_1155)-[:OWN]->(RL_1155),
    (pYu_1155)-[:TEACH]->(pZhu_362)

CREATE (RL_78:Landscape {title:"Xinzhuang Jizoan Temple", code:78, label:"Taoism", city:"Xinzhuang", x:121.45673, y:25.03779})
    CREATE (pZhu_362)-[:HOST_AT]->(RL_78),
    (pZhu_362_3)-[:HOST_AT]->(RL_78)

CREATE (RL_11989:Landscape {title:" LeiChengtan Temple", code:11989, label:"Taoism", city:"Keelung", x:121.73728, y:25.13130})
    CREATE (pLee_11989:Person {name:'Wu-ji Li'})
    CREATE (pLee_11989)-[:OWN]->(RL_11989),
    (RL_11989)-[:COPY_FROM]->(oCopy_362),
    (pLee_11989)-[:TEACH {subject:[' Chengyi Altar']}]->(pZhu_362_3)

CREATE (RL_10175:Landscape {title:"Ruifang Wanshou Temple", code:10175, label:"Taoism", city: "Ruifang", x:121.79647, y:25.09076})
    CREATE (pJiang_10175:Person {name:'Chi-Ching Chiang'})
    CREATE (pJiang_10175)-[:OWN]->(RL_10175),
    (pJiang_10175)-[:TEACH {subject:['Donghua Lingbao']}]->(pZhu_362_3)

CREATE (RL_0:Landscape {title: "Shulin Fayingtan Temple", code:0, label:"Taoism", city: "Shulin"})
   CREATE (pHuang_0:Person {name:'Kuo-ching Huang'})
   CREATE (pHuang_0)-[:OWN]->(RL_0),
   (pHuang_0)-[:TEACH {subject:['divination']}]->(pZhu_362_3)

CREATE (RL_80:Landscape {title:"Xinzhuang Ksitigarbha Temple", code:80, label:"Taoism", city:"Xinzhuang", x:121.45544, y:25.03974})
   CREATE (RL_362)-[:PROVIDE]->(rAll_362),
   (RL_362)-[:PROVIDE]->(cAll_362),
   (rAll_362)-[:SERVICE]->(RL_80)

CREATE (RL_591:Landscape {title:"Xinzhuang Fude Temple", code:591, label:"Taoism", city:"Xinzhuang", x:121.44912, y:25.05057})
   CREATE (rAll_362)-[:SERVICE]->(RL_591)

CREATE (RL_7007:Landscape {title: "Xindian Baoqiao Fushou Temple", code:7007, label:"Taoism", city: "Xindian", x:121.55270, y:24.97909})
   CREATE (rAll_362)-[:SERVICE]->(RL_7007)
```

Figure 8: Neo4j Cyber Syntax – The Property Graph Model of "Xinzhuang Leifa Temple"

4.2 A Prototype of the New Web-based GIS for Religious Landscape

Through a preliminary study on the "Xinzhuang Leifa Temple" graph database, it is confirmed that the property graph model could better express the relationship between religious landscapes; however, it cannot present the geospatial relationship between religious landscapes. This study further analyzed the heatmap of the religious landscape "Taoism", as shown in Figure 9. According to survey data of PRLS, Taoism is mainly concentrated in northern Taiwan, such as Taipei City, New Taipei City, and Keelung City, and is mostly distributed in the border areas between Taipei City and New Taipei City. In central Taiwan, Taoism is concentrated in Changhua City and Yuanlin City in Changhua County. In southern Taiwan, Taoism is concentrated in Kaohsiung City and Pingtung City. The distribution of Taoism" religious landscape shows that there is a phenomenon of regional aggregation in the religious landscape. To this end, this study takes the "Xinzhuang Leifa Temple" graph database as an example to establish a new geographic information system (Web-based GIS) based on the religious landscape network.

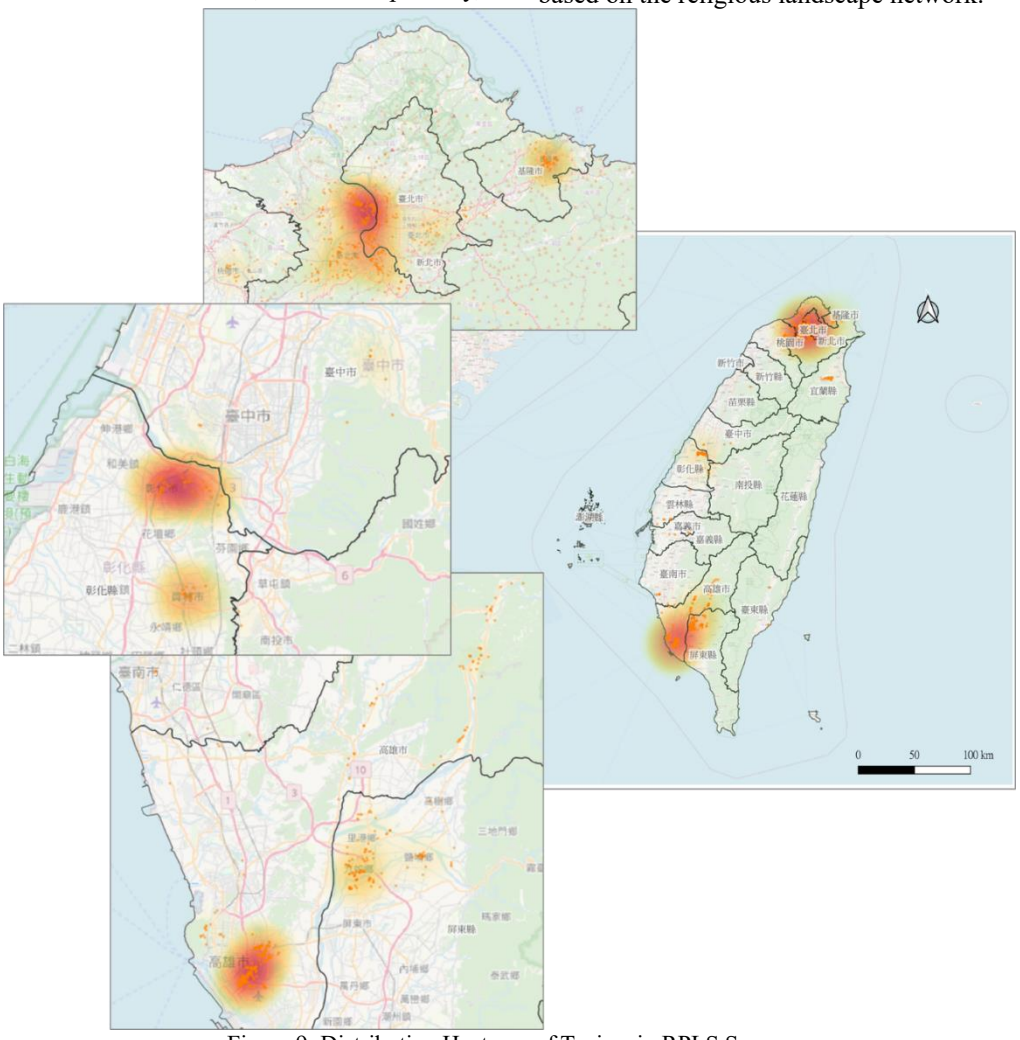

Figure 9: Distribution Heatmap of Taoism in RPLS Survey

The schematic diagram of the prototype system is shown in Figure 10, which may serve as a reference for future related research to explore more relationships with religious landscapes from the aspects of geographical location and geospatial models, such as multi-dimensional spatial analysis with social networks to introduce the historical development and changes of various religions landscapes for in-depth study of the interrelationships between religious developments and social, economic, and environmental changes.

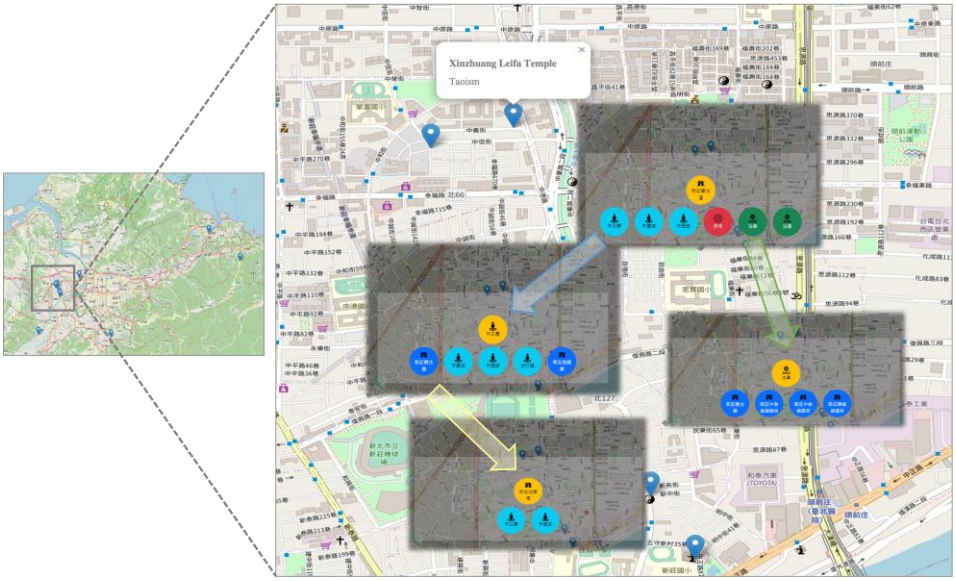

Figure 10: The Prototype of New Web-based GIS for Religious Landscape

5. Conclusion and Suggestions

This study investigated the feasibility of presenting religious landscape survey data through a graph database. Taking the "Xinzhuang Leifa Temple" in the ontology of "Daoist Ritual" as an example, this study successfully analyzed more relationships between this religious landscape and other religious landscapes, which cannot be represented by a relational database. This study thus concluded that presenting the relevant data of the religious landscape survey in the framework of a graph database can expand new forms for discussion and analysis. As historical text content can be presented from the graph database, it can convey the cultural and historical changes in the religious landscape. Moreover, if the spatial environment and time series information are connected in series, the behavior context of the religious landscape change process can be inferred more comprehensively.

With the assistance of multi-period landscape survey data and multi-dimensional environmental space analysis, future studies may determine the social, economic, and environmental factors that affect the development of religion and comprehensively investigate the factors influencing the development of religion and environmental change. Future studies may explore whether living environment conditions or the availability of spatial resources have an impact on the formation, change, and competition of religious development, which can facilitate an understanding of the reasons why religious believers gathered or migrated.

Acknowledgements

The study has been carried out as part of the Humanities and Social Sciences Benchmark Project "Religious Landscapes, Healing, and Society" funded by the Ministry of Education of the Republic of China (Taiwan). Moreover, we would like to thank Associate Professor Chao-Jan Chang from the Department of Religion of Fu Jen Catholic University for providing relevant research materials such as the ontology of "Daoist Ritual" for the preliminary analysis and construction of the graph database.

References

Barrasa, J., Hodler, Amy E. & Webber, J. 2021. *Knowledge Graphs Data in Context for Responsive Businesses*. O'Reilly Media, Inc.

De Nicola, A., Missikoff, M. & Navigli, R. (2009). A software engineering approach to ontology building. *Information Systems*, *34*(2), 258-275.

Gruber T. (2016) *Ontology*. In: Liu L., Özsu M. (eds) *Encyclopedia of Database Systems. Springer*, New York, NY.

Gruber, T. (1993). A translation approach to portable ontology specifications, *Knowledge Acquisition*, *5*(2), 199-220.

Jordan, G. 2014. *Practical Neo4j*. Apress.

Kemper, C. 2015. *Beginning Neo4j: Create Relationships and Grow Your Application with Neo4j*. Apress.

Pokorný, J., Valenta, M., & Troup, M. 2019. Graph Pattern Index for Neo4j Graph Databases. In C. Quix and J. Bernardino (Eds.): Data Management Technologies and Applications, 7th International Conference, DATA 2018, *Communications in Computer and Information Science* 862 (pp. 69–90). Springer.

Robinson, I., Webber J., & Eifrem, E. 2015. *Graph Databases* (2nd Edition). O'Reilly Media, Inc.

Van der Vet, P.E. & Mars, N.J. (1998). Bottom-up construction of ontologies, *IEEE Transaction on Knowledge and Data Engineering*, *10*(4), 513-526.

Watts, D. 2004. *Six Degrees: The Science of a Connected Age*, W. W. Norton & Company.

Ye, X. & Andris, C. 2021. Spatial social networks in geographic information science, *International Journal of Geographical Information Science*, *35*(12), 2375-2379.

About Authors

Ya-Wen Lin is a is an Assistant Professor in the Department of Information Management at Fu Jen Catholic University in Taiwan. Her research interests include geoinformatics, network economy and data analysis.

Li-Xing Hong is an Associate Professor in the Department of Music, the Holistic Education Center and Associate Research Fellow in Fu Jen Academia Catholica, Fu Jen Catholic University in Taiwan. His main areas of research are Catholic Sacred Music, the interrelation between music and literature, and educational technology.

Wei-Hsiu Lin is a is a Ph.D. student in Department of Chinese Literature, Shin Hsin University in Taiwan. Her research interests include folkloristics, rhyming literature, and traditional drama.