FIG WORKING WEEK 2023
28 May - 1 June 2023 Orlando Florida USA

Protecting Our World, Conquering New Frontiers

Orlando Working Week 2023

Temporal modelling consideration for geospatial data to support time-aware operations

TECHNOLOGICAL ADVANCES IN SPATIAL DATA HANDLING

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Presented by Sin Yi, Ho (Taiwan)

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Introduction

Background and significance of the selected topic
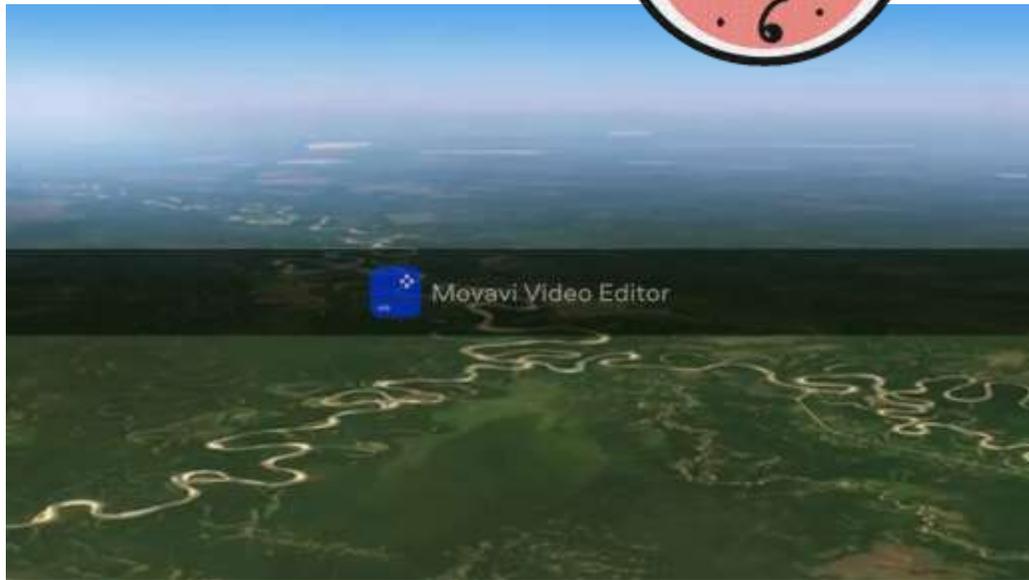
Introduction

*As the content of geographical data can be regarded as records at a specific time, an essential requirement for geographic data design is to include a temporal attribute and develop a strategy to correctly record its valid status. The integration of data from different resources must therefore consider the correct modelling and interpretation of time information to ensure the outcome is meaningful as far as the valid time is concerned. This paper argues those GIS operations require temporal consideration, defined as time-aware operations, must be redesigned with standardized temporal information, such that users will be aware of the time issues in their operation outcome to avoid wrong decision making.*

Introduction

☑ Taiwan e-Map
☑ Public Infrastructure Map
☑ Transportation Map
☑ Fire Hydrant Map

Valid Time
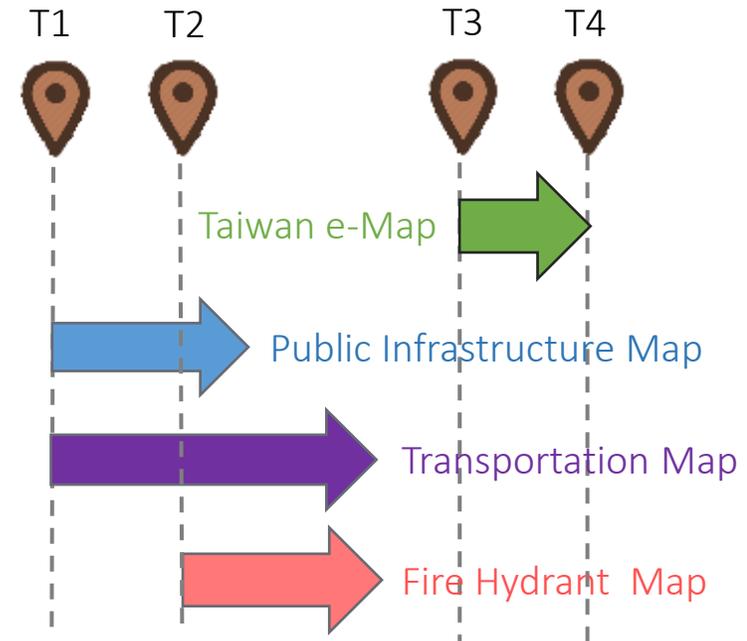
T1   T2   T3   T4

Taiwan e-Map
Public Infrastructure Map
Transportation Map
Fire Hydrant Map

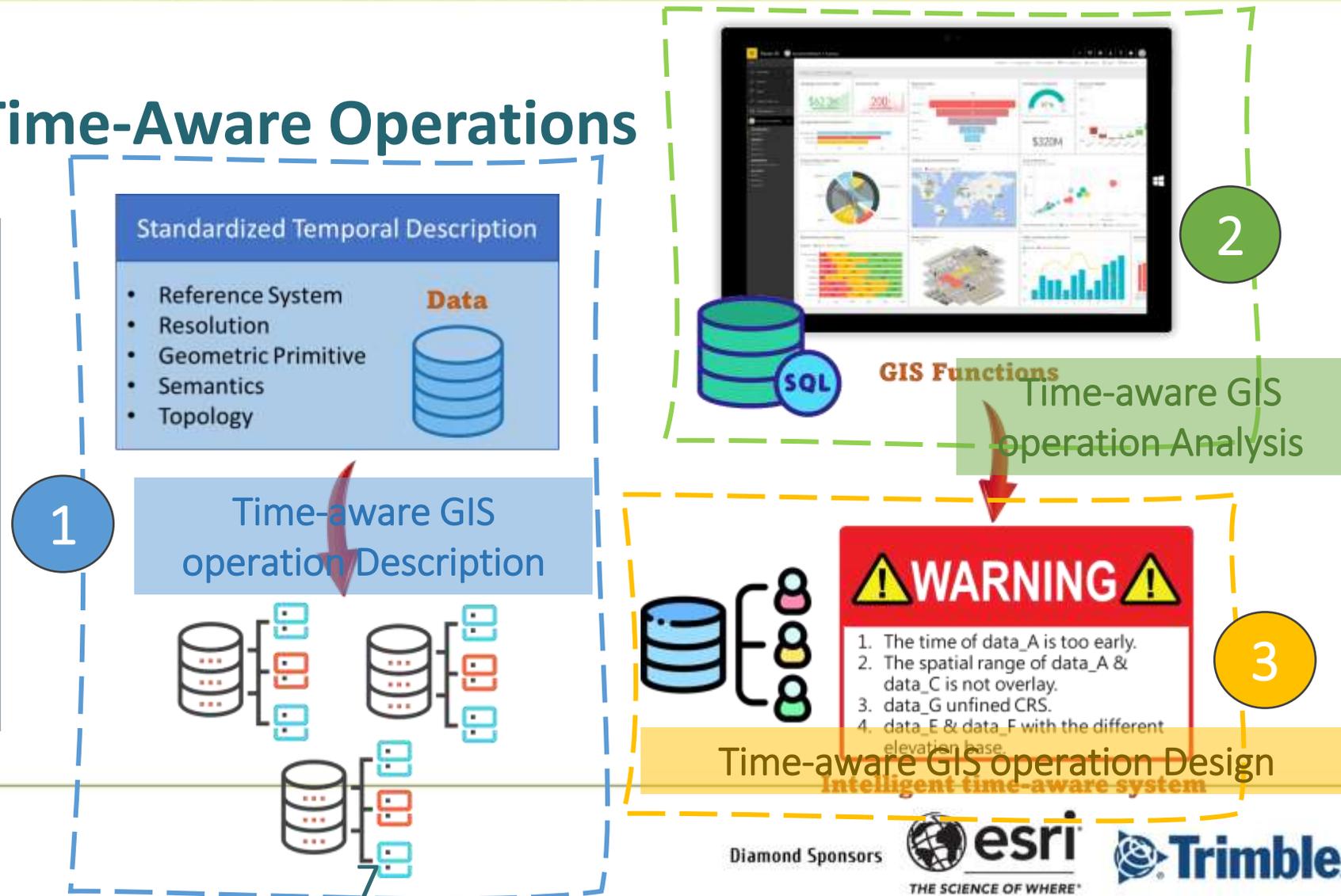# The Framework of Time-Aware Operations

Time-aware GIS operation description, analysis, design

The Framework of Time-Aware Operations

Two Requirements:
- Standardized Temporal Model Based-on Valid time.

- Redesign the Workflow of Time-Aware Operations.

Standardized Temporal Description
- Reference System
- Resolution
- Geometric Primitive
- Semantics
- Topology

Data

Time-aware GIS operation Description

Time-aware GIS operation Analysis

GIS Functions

⚠ WARNING ⚠
1. The time of data_A is too early.
2. The spatial range of data_A & data_C is not overlay.
3. data_G unfined CRS.
4. data_E & data_F with the different elevation base.

Time-aware GIS operation Design

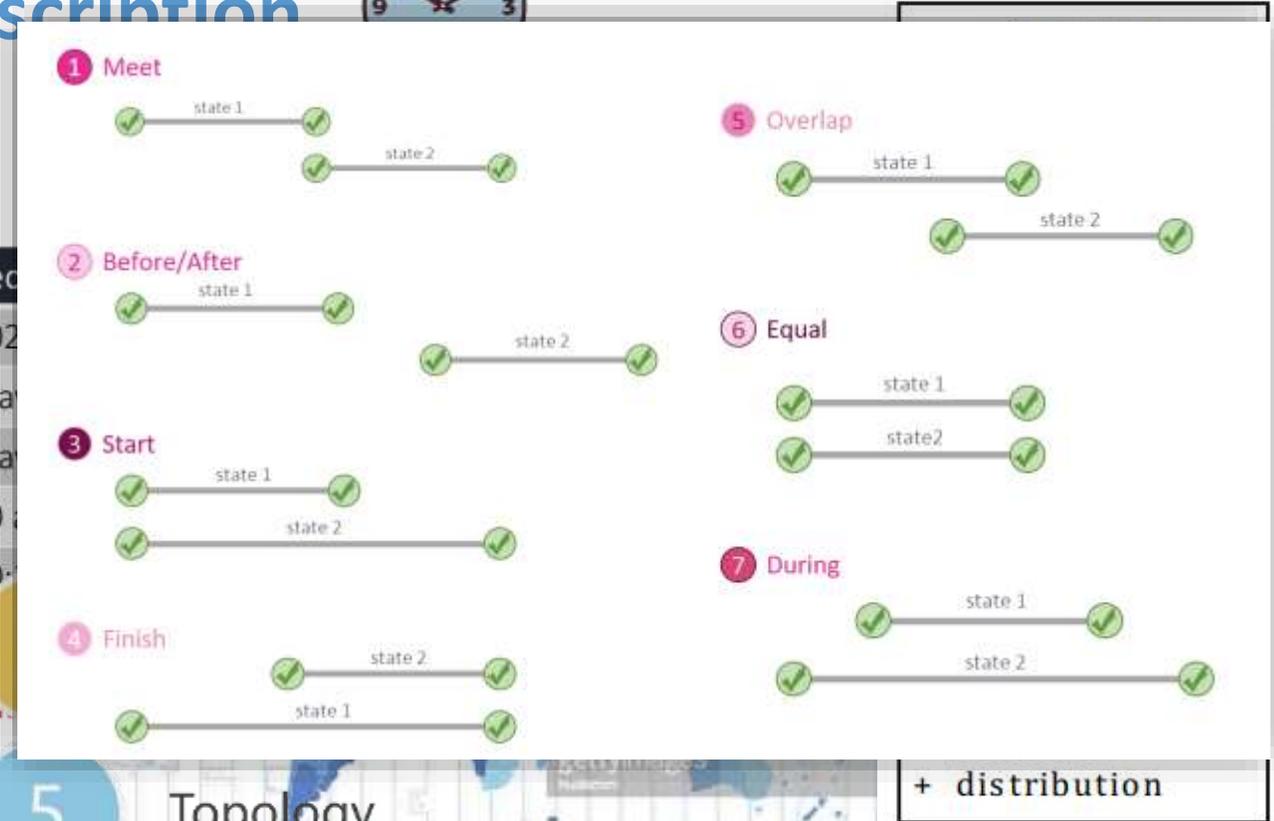Intelligent time-aware system

Time-aware GIS Operation Description

Standardized Temporal Description

- Time Reference System
- Resolution
- Geometric Primitive
- Semantics
- Topology

Data

Resolution	Rec
Year	202
Month	Ma
Day	Ma
Hour	10
Minute	10-
Second	

1 Time Reference System
Reference base for time recording

2 Resolution
The minimum unit for time recording

3 Geometric Primitive
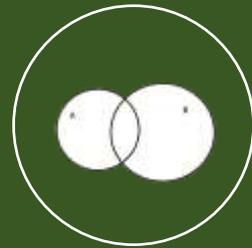Geometric representation for time recording

5 Topology
The relationships between two time recordings

1 Meet — state 1 / state 2

2 Before/After — state 1 / state 2

3 Start — state 1 / state 2

4 Finish — state 2 / state 1

5 Overlap — state 1 / state 2

6 Equal — state 1 / state2

7 During — state 1 / state 2

+ distribution

Time-aware GIS Operation De

📍 **Time Instant**

📍 **Time Period: Start/End time** 📍

Primitive	Topology	Valid Time
Time instant vs. time instant	Equal	Yes (The time point)
	Before/ After	No
Time instant vs. time period	Before/ After	No
	Start	Yes (The start time)
	Finish	Yes (The end time)
	During	Yes (The time during the period)
Time period vs. time period	Before/ After	No
	Meet	No
	Start	Yes (From the same start time point of the two states to the end of the state with the shorter occurrence time)
	Finish	Yes (From the state that occurs later to the end of the same time point of the two states)
	During	Yes (Simultaneous occurrence of two states)
	Overlap	Yes (Only overlap period)
	Equal	Yes (From the start to the end)

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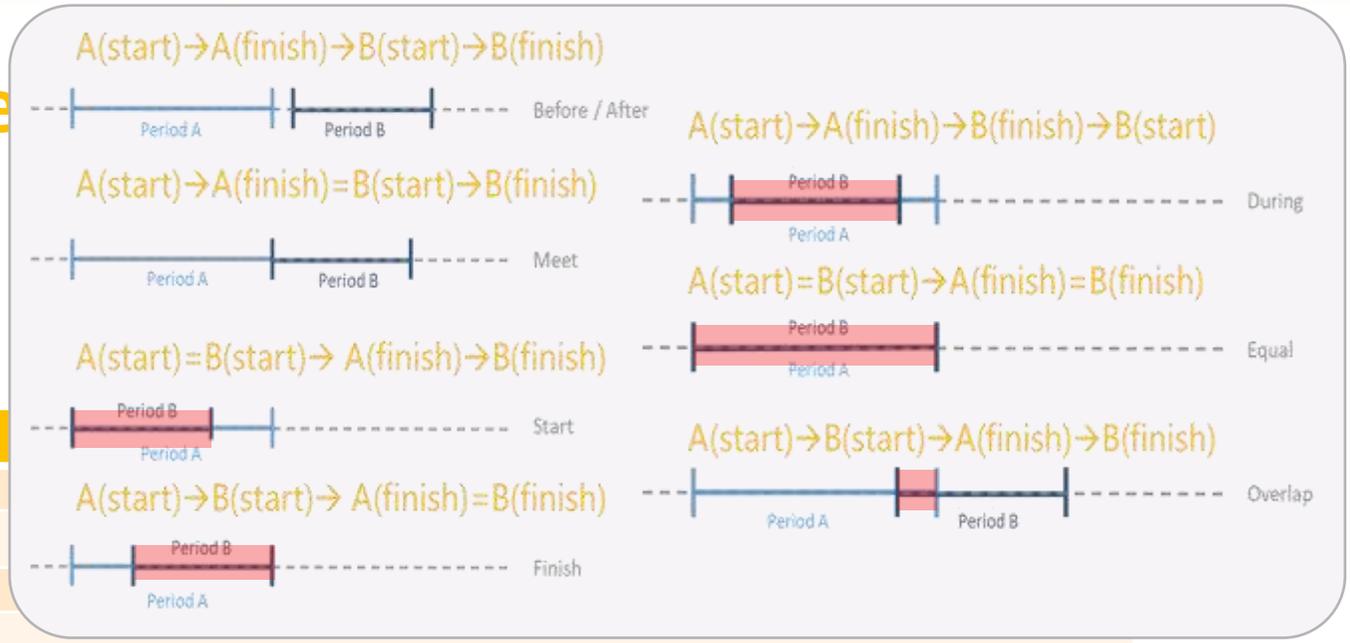
Scenario analysis

Case : Map Overlay

Scenario analysis-Case : Map Overlay
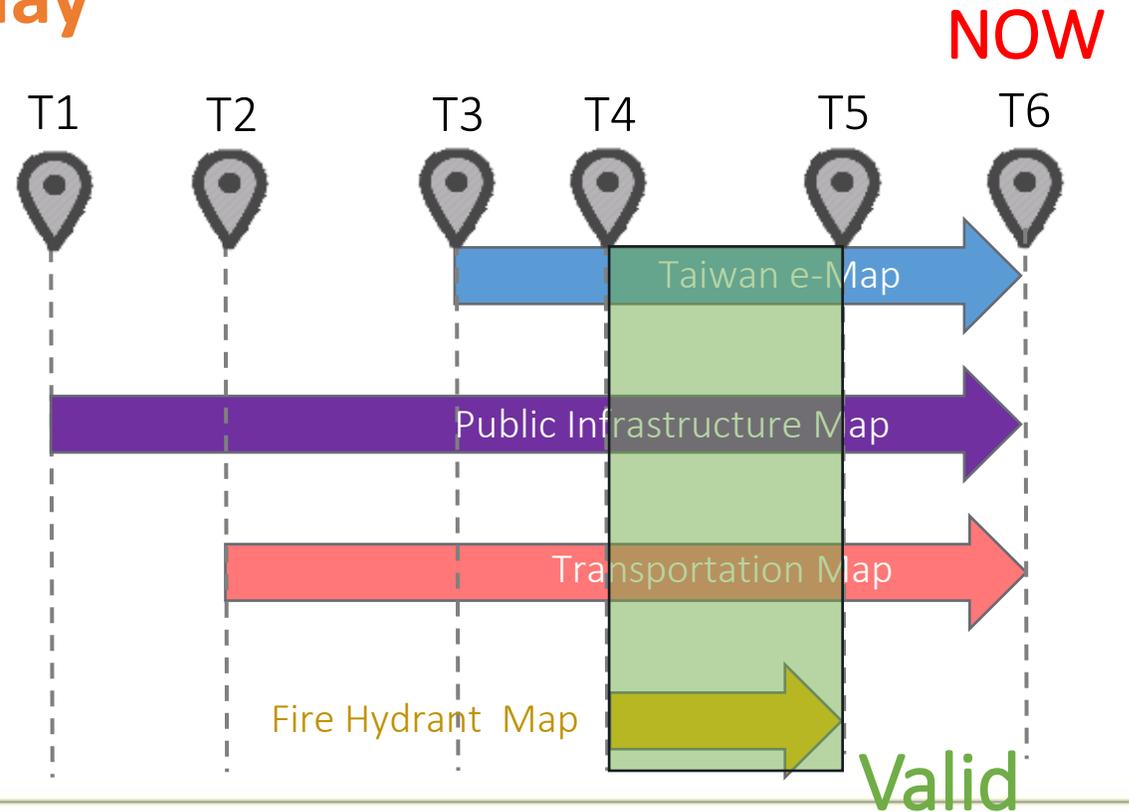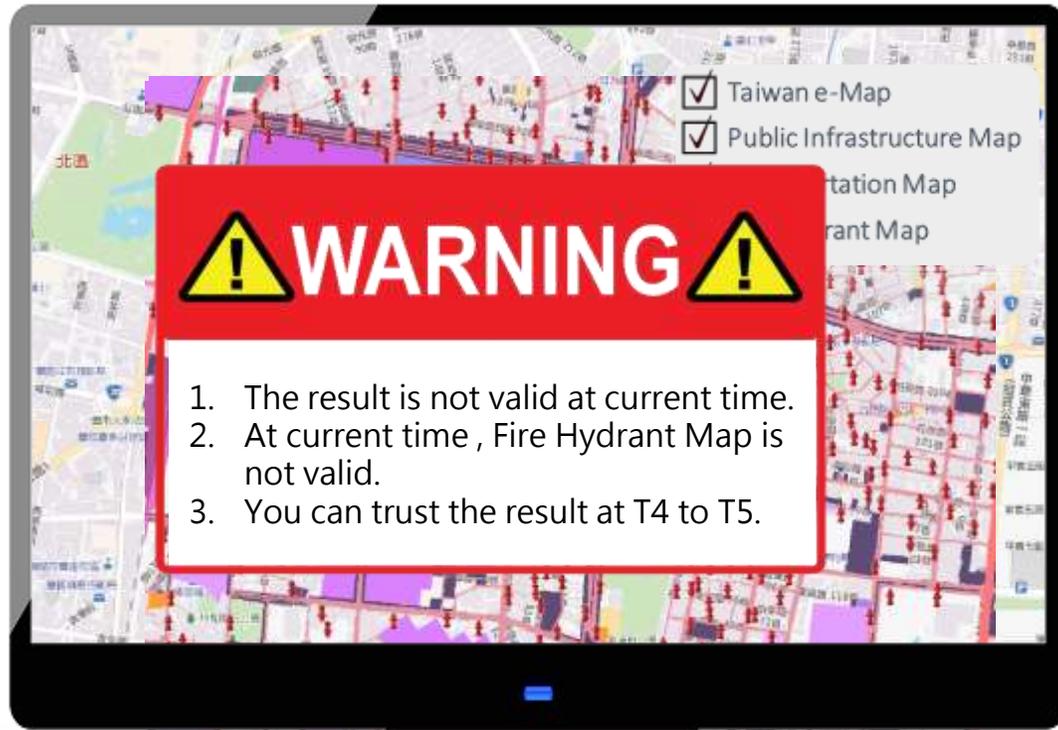
Conclusion

Summary

Conclusion

Temporal modelling consideration for geospatial data
to support time-aware operations

1. Provides a vision for a temporal recording framework, through the topology predefined to enable GIS function operations time aware.

2. Avoid wrong judgments and connect different time versions through identification attributes.

3. Successfully applied to map overlay and provide the basis for the development of time-aware systems.

4. Not only improving the correctness of the overall operation but also considering the quality of the spatial operation and the fitness of the results

Standardized Temporal Description
- Reference System
- Resolution
- Geometric Primitive
- Semantics
- Topology

Data

GIS Functions

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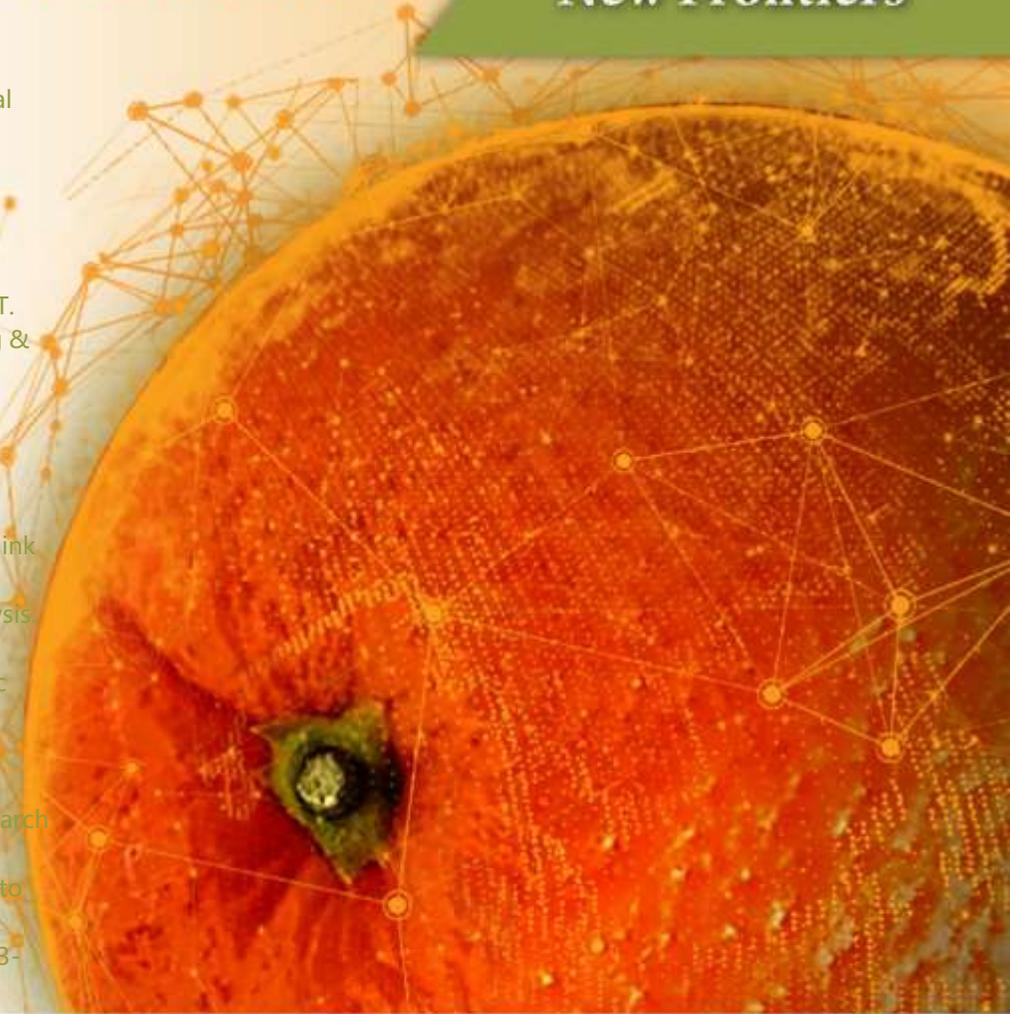4. data_E & data_F with the different elevation base.

Reference

- Allen, J. F. (1983). Maintaining knowledge about temporal intervals. Communications of the ACM, 26(11), 832-843.
- Bittner, T., Donnelly, M., & Smith, B. (2009). A spatio-temporal ontology for geographic information integration. International Journal of Geographical Information Science, 23(6), 765-798.
- Campos, P. G., Díez, F., & Cantador, I. (2013). Time-aware recommender systems: a comprehensive survey and analysis of existing evaluation protocols. User Modeling and User-Adapted Interaction, 24(1-2), 67-119. doi:10.1007/s11257-012-9136-x
- Consortium, O. G. (2021). OGC city geography markup language (CityGML) 3.0 conceptual model users guide. In: Open Geospatial Consortium (OGC).
- He Weixin, Chen Yiru, & Liu Qihui. (2004). Construction of Cadastral Database with Tenses.Journal of Taiwan Land Research, 7(2), 47-69. (In Chinese)
- Hui, L. (2021). Temporal GIS Key Technology and Application of Large-Scale Distribution Network Based on The base state with amendment model. Paper presented at the 2021 China International Conference on Electricity Distribution (CICED).
- ISO. (2002). ISO 19108: 2002–Geographic information–Temporal schema. International Organization for Standardization (ISO), Geneva.
- Kraak, M.-J. (2003). The space-time cube revisited from a geovisualization perspective. Paper presented at the Proc. 21st International Cartographic Conference.
- Li, Z., Ji, M., Lee, J.-G., Tang, L.-A., Yu, Y., Han, J., & Kays, R. (2010). Movemine: Mining moving object databases. Paper presented at the Proceedings of the 2010 ACM SIGMOD International Conference on Management of data.

Reference

- Nan, L., Renyi, L., Guangliang, Z., & Jiong, X. (2006). A spatial-temporal system for dynamic cadastral management. Journal of environmental management, 78(4), 373-381.
- Peuquet, D. J. (1999). Time in GIS and geographical databases. Geographical information systems, 1, 91-103.
- Radhakrishna, V., Kumar, P. V., Janaki, V., & Aljawarneh, S. (2016). A computationally efficient approach for temporal pattern mining in IoT. Paper presented at the 2016 International conference on engineering & MIS (ICEMIS).
- Su Yuting, & Hong Junghong. (2015). Discussion on the integrated display interface of spatio-temporal geographic information. Paper presented at the Annual Conference and Symposium of Taiwan Geographic Information System. (In Chinese)
- Tylenda, T., Angelova, R., & Bedathur, S. (2009). Towards time-aware link prediction in evolving social networks. Paper presented at the Proceedings of the 3rd workshop on social network mining and analysis.
- Xiao Shilun. (2010). Forgotten time—the challenge of time in digital archiving geographic information. Paper presented at the Geographic Information Symposium. (In Chinese)
- Yuan, Q., Cong, G., Ma, Z., Sun, A., & Thalmann, N. M.-. (2013). Time-aware point-of-interest recommendation. Paper presented at the Proceedings of the 36th international ACM SIGIR conference on Research and development in information retrieval.
- Zhang, J.-D., & Chow, C.-Y. (2015). TICRec: A probabilistic framework to utilize temporal influence correlations for time-aware location recommendations. IEEE Transactions on Services Computing, 9(4), 633-646.

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Thank you for the criticism of the experts

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