

**Belussi, Alberto; Migliorini, Sara**

**A spatio-temporal framework for managing archaeological data. (A spatio-temporal framework for managing archeological data.)** (English) [Zbl 1419.68046](#)

*Ann. Math. Artif. Intell.* 80, No. 3-4, 175-218 (2017).

Summary: Space and time are two important characteristics of data in many domains. This is particularly true in the archaeological context where information concerning the discovery location of objects allows one to derive important relations between findings of a specific survey or even of different surveys, and time aspects extend from the excavation time, to the dating of archaeological objects. In recent years, several attempts have been performed to develop a spatio-temporal information system tailored for archaeological data. The first aim of this paper is to propose a model, called *Star*, for representing spatio-temporal data in archaeology. In particular, since in this domain dates are often subjective, estimated and imprecise, *Star* has to incorporate such vague representation by using fuzzy dates and fuzzy relationships among them. Moreover, besides to the topological relations, another kind of spatial relations is particularly useful in archeology: the stratigraphic ones. Therefore, this paper defines a set of rules for deriving temporal knowledge from the topological and stratigraphic relations existing between two findings. Finally, considering the process through which objects are usually manually dated by archeologists, some existing automatic reasoning techniques may be successfully applied to guide such process. For this purpose, the last contribution regards the translation of archaeological temporal data into a Fuzzy Temporal Constraint Network for checking the overall data consistency and reducing the vagueness of some dates based on their relationships with other ones.

**MSC:**

[68P15](#) Database theory

[68P05](#) Data structures

**Keywords:**

[data models for archaeological data](#); [fuzzy temporal interval](#); [fuzzy temporal constraint networks](#); [spatial data](#); [temporal data](#)

**Software:**

[PostGIS](#)

**Full Text:** [DOI](#)

**References:**

- [1] Abraham, T., Roddick, J.: Discovering Meta-Rules in Mining Temporal and Spatio-Temporal Data. In: 8th International Database Workshop, Data Mining, Data Warehousing and Client/Server Databases (IDW'97), pp. 30-41. Springer-Verlag, Hong Kong (1997)
- [2] Abraham, T; Roddick, JF, Survey of spatio-temporal databases, *GeoInformatica*, 3, 61-99, (1998)
- [3] Allen, JF, Maintaining knowledge about temporal intervals, *Commun. ACM*, 26, 832-843, (1983) · [Zbl 0519.68079](#)
- [4] Badaloni, S; Falda, M; Giacomini, M, Integrating quantitative and qualitative fuzzy temporal constraints, *AI Commun.*, 17, 187-200, (2004) · [Zbl 1098.68101](#)
- [5] Badaloni, S., Giacomini, M.: The Algebra  $IA^{\text{fuz}}$ : A Framework for Qualitative Fuzzy Temporal Reasoning. *Artif. Intell.* **170**(10), 872-908 (2006) · [Zbl 1131.68530](#)
- [6] Barceló, J.A.: Computational Intelligence in Archaeology. State of the Art. In: Proceedings of the 37Th International Conference Computer Applications & Qualitative Methods in Archaeology (CAA), pp. 11-21 (2010)
- [7] Basso, P., Belussi, A., Grossi, P., Migliorini, S.: Towards the Creation of an Archaeological Urban Information System: Data Modeling of the Historical Heritage of Verona. In: Proceedings of AGILE 2013, Workshop on Integrating 4D, GIS and Cultural Heritage, pp. 1-3 (2013)
- [8] Baxter, MJ, Archaeological data analysis and fuzzy clustering, *Archaeometry*, 51, 1035-1054, (2009)
- [9] Belussi, A., Migliorini, S.: Modeling Time in Archaeological Data: the Verona Case Study. Tech. Rep. RR 93/2014, Department

of Computer Science, University of Verona. <http://www.di.univr.it/report> (2014)

- [10] Belussi, A., Migliorini, S., Basso, P., Grossi, P.: The Archaeological Urban Information System of the Historical Heritage of Verona. In: The 43Rd Annual Conference on Computer Applications and Quantitative Methods in Archaeology, pp. 1-1 (2015) · [Zbl 1098.68101](#)
- [11] Belussi, A., Migliorini, S., Grossi, P.: Managing Time Dimension in the Archaeological Urban Information System of the Historical Heritage of Rome and Verona. In: The 42Nd Annual Conference on Computer Applications and Quantitative Methods in Archaeology, pp. 235-244 (2014)
- [12] Calargun, S., Yazici, A.: Fuzzy Association Rule Mining from Spatio-Temporal Data. In: Proceedings of Computational Science and Its Applications - ICCSA 2008, Lecture Notes in Computer Science, vol. 5072, pp. 631-646. Springer, Berlin Heidelberg (2008)
- [13] Cariñena, P, Fuzzy temporal association rules: combining temporal and quantitative data to increase rule expressiveness, *WIREs Data Min. Knowl. Discovery*, 4, 64-70, (2014)
- [14] Clementini, E; Di Felice, P, A comparison of methods for representing topological relationships, *Inf. Sci. Appl.*, 3, 149-178, (1995)
- [15] Clementini, E; Di Felice, P, A model for representing topological relationships between complex geometric features in spatial databases, *Inf. Sci.*, 90, 121-136, (1996) · [Zbl 0895.68031](#)
- [16] Clementini, E., Felice, P.D., Oosterom, P.v.: A Small Set of Formal Topological Relationships Suitable for End-User Interaction. In: Proceedings of the 3rd International Symposium on Advances in Spatial Databases, SSD '93, pp. 277-295. Springer-Verlag, London, UK, UK (1993)
- [17] Combi, C., Montanari, A., Pozzi, G.: The T4Sql Temporal Query Language. ACM, New York, NY, USA (2007)
- [18] De Roo, B., Van de Weghe, N., Bourgeois, J., De Maeyer, P.: The Temporal Dimension in a 4D Archaeological Data Model: Applicability of the GeoInformation Standard. In: Innovations in 3D Geo-Information Sciences, Lecture Notes in Geoinformation and Cartography, pp. 33-55. Springer International Publishing (2014)
- [19] Dechter, R; Meiri, I; Pearl, J, Temporal constraint networks, *Artif. Intell.*, 49, 61-95, (1991) · [Zbl 0737.68070](#)
- [20] Egenhofer, MJ; Franzosa, R, Point-set topological spatial relations, *Int. J. Geogr. Inf. Syst.*, 2, 161-174, (1991)
- [21] Erwig, M.: Spatio-Temporal Databases: Flexible Querying and Reasoning, Chap. Toward Spatio-Temporal Patterns, pp. 29-53. Springer, Berlin, Heidelberg (2004)
- [22] Harris, E.C.: Principles of archaeological stratigraphy, 2nd edn. Academic Press (1989) · [Zbl 0737.68070](#)
- [23] ISO: ISO 19108 Geographic Information - Spatial Schema (2002)
- [24] ISO: ISO 19507:2012, Object Constraint Language (OCL) (2012) · [Zbl 0895.68031](#)
- [25] Jensen, C.S., Dyreson, C.E., Böhlen, M., Clifford, J., Elmasri, R., Gadia, S.K., Grandi, F., Hayes, P., Jajodia, S., Käfer, W., Kline, N., Lorentzos, N., Mitsopoulos, Y., Montanari, A., Nonen, D., Peressi, E., Pernici, B., Roddick, J.F., Sarda, N.L., Scalas, M.R., Segev, A., Snodgrass, R.T., Soo, M.D., Tansel, A., Tiberio, P., Wiederhold, G.: Temporal Databases: Research and Practice, Chap. The Consensus Glossary of Temporal Database Concepts — February 1998 Version, pp. 367-405. Springer, Berlin, Heidelberg (1998)
- [26] Katsianis, M; Tspidis, S; Kotsakis, K; Kousoulakou, A, A 3D digital workflow for archaeological intra-site research using GIS, *J. Archaeol. Sci.*, 35, 655-667, (2008)
- [27] Kemp, Z., Kowalczyk, A.: Incorporating the Temporal Dimension in a GIS. In: Worboys, M. (ed.) Innovations in GIS 1, pp 182-196. Taylor & Francis, London, UK (1994)
- [28] Koepfel, I., Ahlmer, S.: Integrating the Dimension of Time into AM/FM Systems. In: Proc. of AM/FM XVI Int. Annual Conference (1993) · [Zbl 0519.68079](#)
- [29] Koperski, K., Adhikary, J., Han, J.: Spatial Data Mining: Progress and Challenges. In: Proceedings of ACM SIGMOD Workshop on Research Issues on Data Mining and Knowledge Discovery (DMKD'96), pp. 1-10. ACM Press (1996)
- [30] Ladner, R; Petry, FE; Cobb, MA, Fuzzy set approaches to spatial data mining of association rules, *Trans. GIS*, 7, 123-138, (2003)
- [31] Li, J., Wu, S., Huang, G.: Handling Temporal Uncertainty in GIS Domain: A Fuzzy Approach. In: International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, vol. 34,4/w4, pp. 83-87 (2002)
- [32] Mörchen, F, Unsupervised pattern mining from symbolic temporal data, *SIGKDD Explor. Newsl.*, 9, 41-55, (2007)
- [33] Mörchen, F; Ultsch, A, Efficient mining of understandable patterns from multivariate interval time series, *Data Min. Knowl. Discov.*, 15, 181-215, (2007)
- [34] OSGeo: PostGIS 2.2.3dev Manual. Open Source Geospatial Foundation. <http://postgis.net/stuff/postgis-2.2.pdf> Accessed March 2016 (2015)
- [35] Raafat, H., Xiao, Q., Gauthier, D.A.: An extended relational database for remotely sensed image data management within GIS. *IEEE Trans. Geosci. Remote Sens.* \textbf{29}(4), 651-655 (1991). doi:10.1109/36.135827
- [36] Raafat, H., Yang, Z., Gauthier, D.A.: Relational spatial topologies for historical geographical information. *Int. J. Geogr. Inf. Syst.* \textbf{8}(2), 163-173 (1994). doi:10.1080/02693799408901992 · [Zbl 0519.68079](#)
- [37] Raju, G., Thomas, B., Tobgay, S., Kumar, T.: Fuzzy Clustering Methods in Data Mining: a Comparative Case Analysis. In: International Conference On Advanced Computer Theory and Engineering, 2008. ICACTE '08. pp. 489-493 (2008) · [Zbl 0737.68070](#)
- [38] Sanjaa, B., Tsoozol, P.: Fuzzy and Probability. In: International Forum on Strategic Technology, 2007. (IFOST 2007), pp.

141-143 (2007)

- [39] Sarda, N.L.: HSQL: A Historical Query Language. In: Temporal Databases, pp. 110-140 (1993) · [Zbl 0833.68012](#)
- [40] Snodgrass, R.T. (ed.): The TSQL2 Temporal Query Language Kluwer Academic Publishers (1995) · [Zbl 0859.68014](#)
- [41] Snodgrass, R.T., Boehlen, M.H., Jensen, C.S., Steiner, A.: Adding transaction time to SQL/temporal. Change proposal, ANSI X3H2-96-502r2, ISO/IEC JTC1/SC21/ WG3 DBL MAD-147r2 (1996)
- [42] Snodgrass, R.T., Boehlen, M.H., Jensen, C.S., Steiner, A.: Adding valid time to sql/temporal. Change proposal, ANSI X3H2-96-501r2, ISO/IEC JTC1/SC21/ WG3 DBL MAD-146r2 (1996)
- [43] Vila, L; Godo, L, On fuzzy temporal constraint networks, *Mathware and Soft Computing*, 3, 315-334, (1994) · [Zbl 0833.68012](#)
- [44] Worboys, MF, A unified model for spatial and temporal information, *Comput. J.*, 37, 36-34, (1994)

This reference list is based on information provided by the publisher or from digital mathematics libraries. Its items are heuristically matched to zbMATH identifiers and may contain data conversion errors. It attempts to reflect the references listed in the original paper as accurately as possible without claiming the completeness or perfect precision of the matching.