Managing Time Dimension in the Archaeological Urban Information System of the Historical Heritage of Rome and Verona

A. Belussi[1], S. Migliorini[1], P. Grossi[1],
A. De Tommasi[2], M. Serlorenzi[2], P. Basso[1]

[1]University of Verona, Verona, Italy

[2]*Soprintendenza speciale per i beni archeologici di Roma*, Rome, Italy

Outline

- Goals of this work
- The standard ISO 19108 "Temporal Schema"
- Time in archaeology: temporal information in the data model of the SITA@Rome/SITA@VeRone projects.
- Using ISO 19108 for describing the temporal information of SITAR/SITAVR data model
- Dealing with time vagueness in ISO 19108: an approach based on fuzzy sets theory
- Time vagueness in the data model of the SITAR/SITAVR project

Goals

- Analyse the standard ISO 19108 in order to identify the different features for time representation that it provides.
- Identify in the data model of the SITAR/VR project the temporal properties and model them using ISO 19108 features.
- Dealing explicitly with time vagueness in the data model, in order to have a correct description of the knowledge about time and eventually apply reasoning tools for automatic inference of new information.

ISO 19108

SCOPE

This International Standard defines concepts for describing **temporal characteristics** of **geographic information**.

It depends upon **existing information technology standards** for the **interchange** of temporal information.

It provides a basis for defining **temporal feature attributes**, **feature operations, and feature associations**, and for defining the temporal aspects of **metadata** about geographic information.

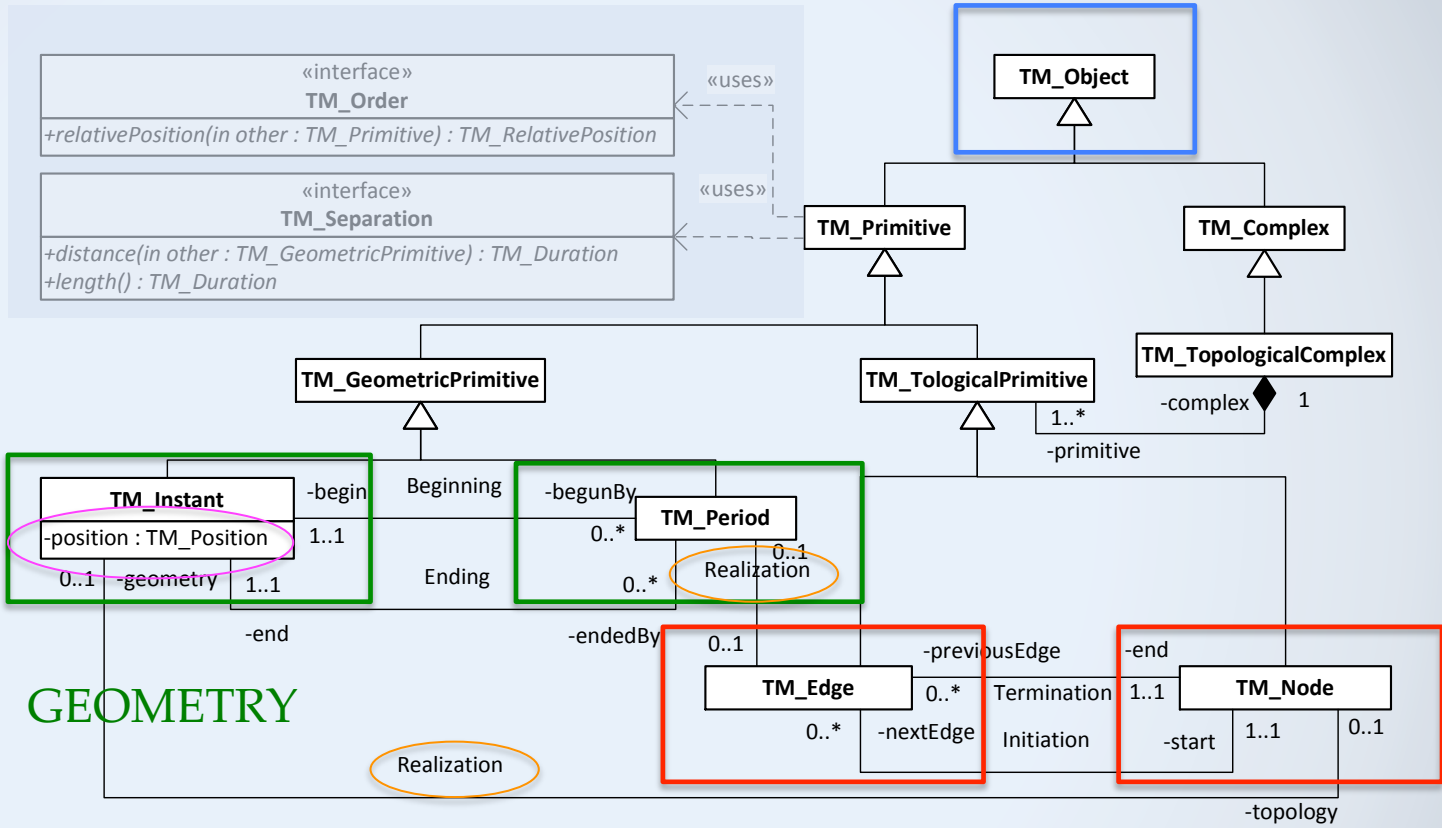
Since this standard is concerned with the temporal characteristics of geographic information as they are abstracted from the real world, it emphasises **valid time** rather than transaction time.

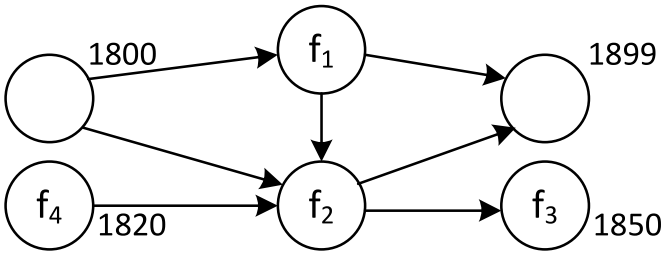
ISO 19108

- **Temporal objects** instances of TM_Object class are the basic concept of the standard.
- The standard allows one to represent both "geometry" and "topology" of a temporal object.
  - **Geometry** defines two primitives: instants and periods on the time axis (geometric primitives)
  - **Topology** defines two primitives: temporal nodes (abstraction of instants) and temporal edges (abstraction of periods) and allows to represent temporal relations among them.
  - The two approaches for representing temporal data can be combined defining instants as **realizations** of nodes and periods as realization of edges.
- **Calendars** are modelled for defining **temporal positions** of instants in different ways. All defined calendars have to specify a method for the conversion of a calendar date into a Julian date.

ISO 19108

Standard for representing temporal data – Instants and periods (UML class diagram)

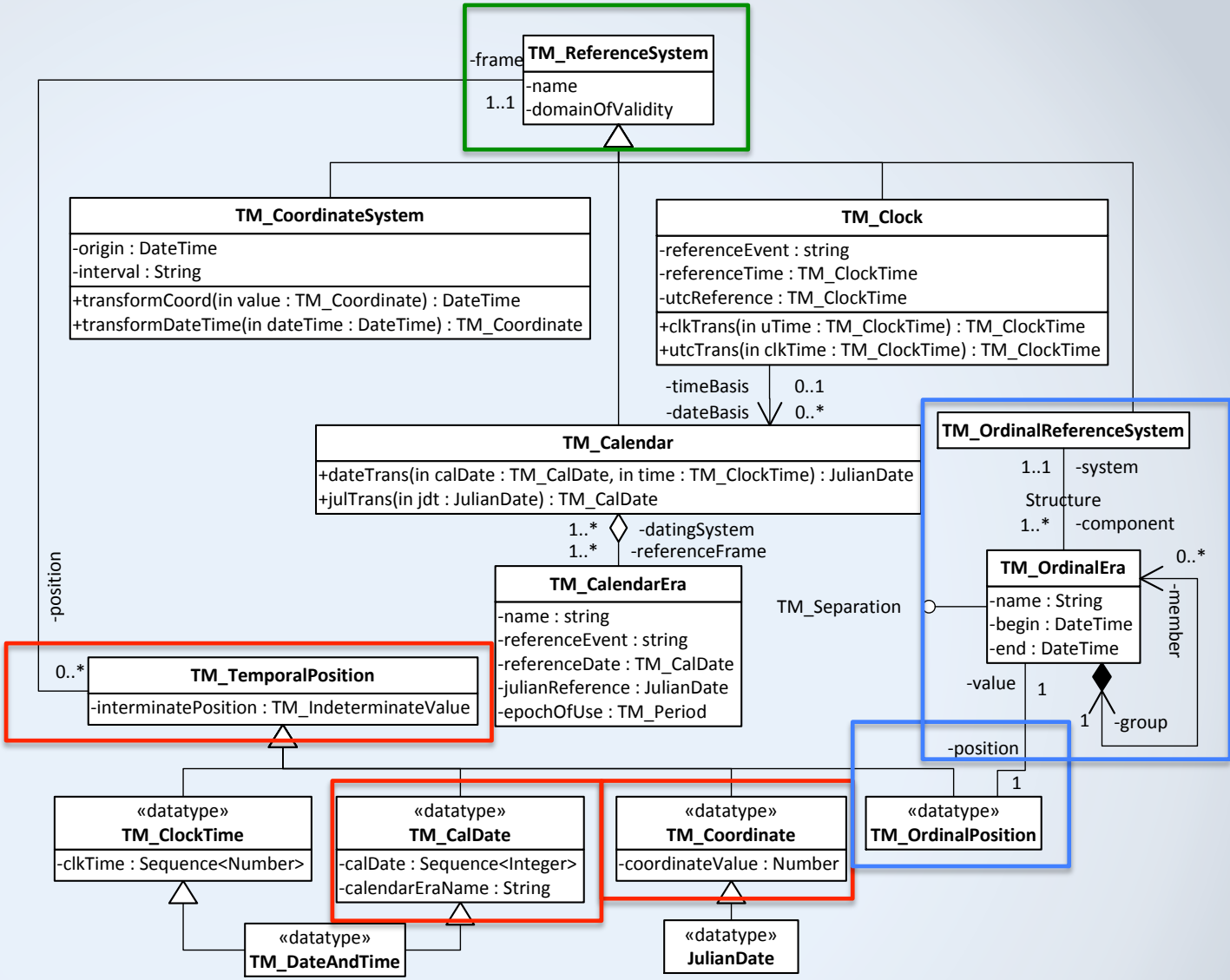




TOPOLOGY

ISO 19108

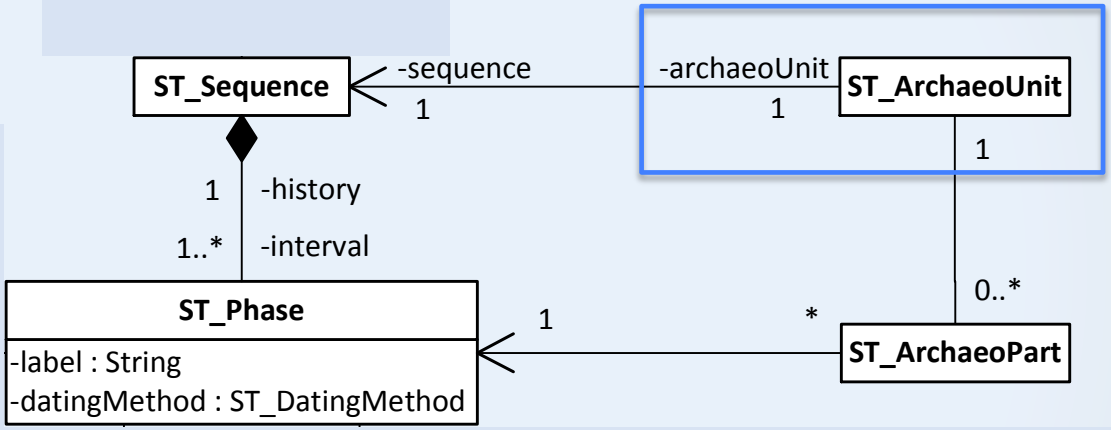
Standard for representing temporal data – Calendars and temporal positions (UML class diagram)



SITAVR data model

ArchaeoUnit class

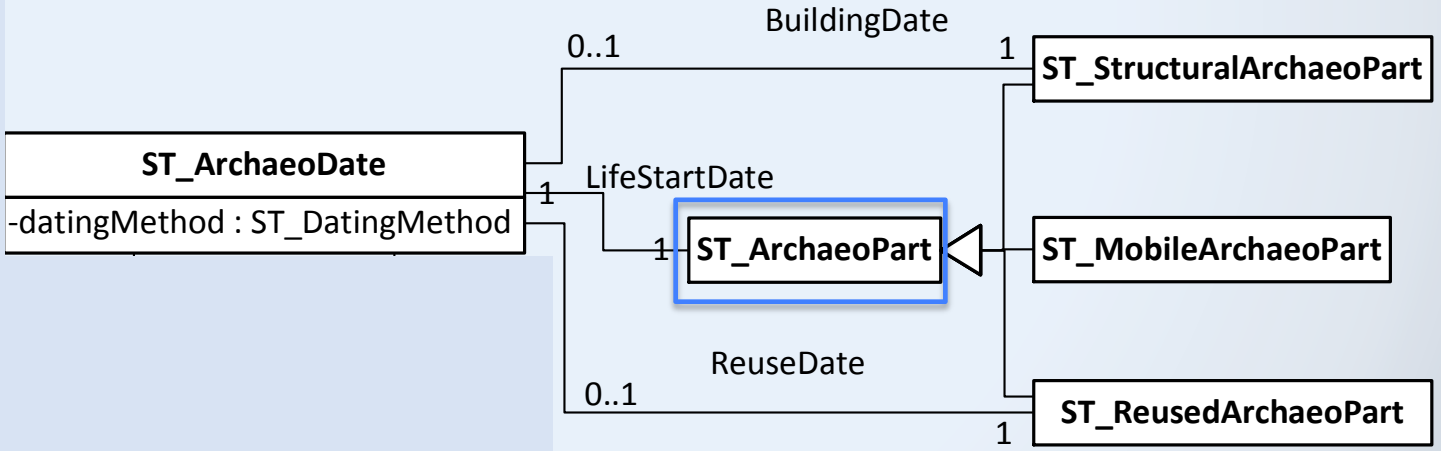
"a complex archaeological entity representing the union of finds of different archaeological contexts aimed to rebuild an ancient object"



SITAVR data model

ArchaeoPart class

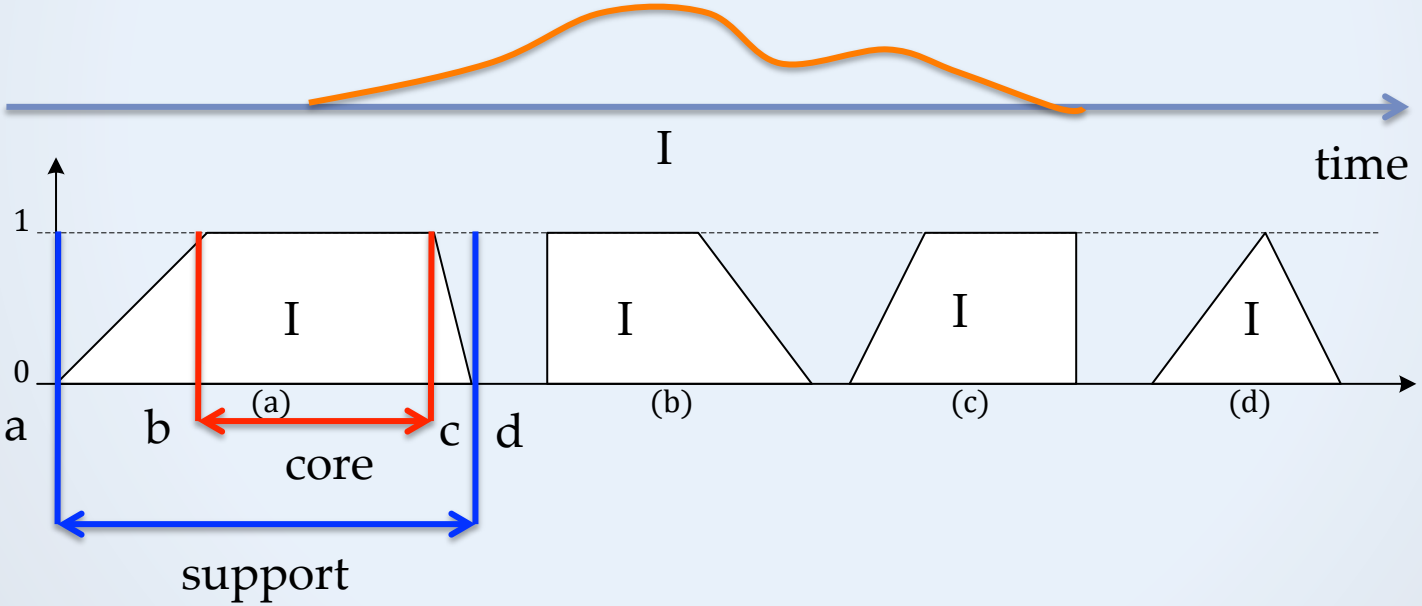
"archaeological elements, classified in a specific context by function, chronology etc. (structures, architectural elements, etc.)"



Fuzzy temporal instant

From temporal instants to fuzzy temporal instants.

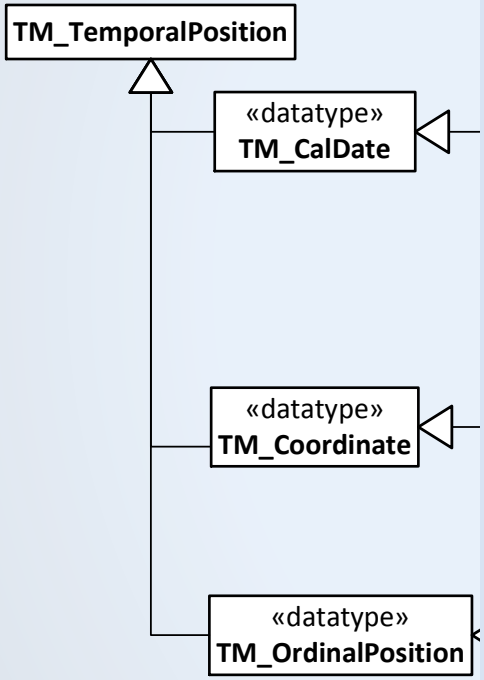
From one coordinate to a characteristic function.

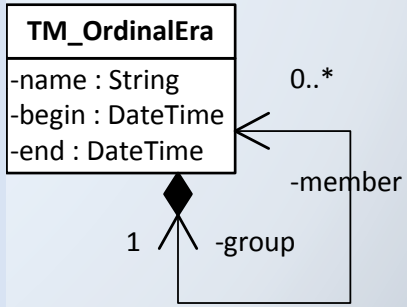


Simplified approach: reduce the function to a trapeze.

Introducing vagueness

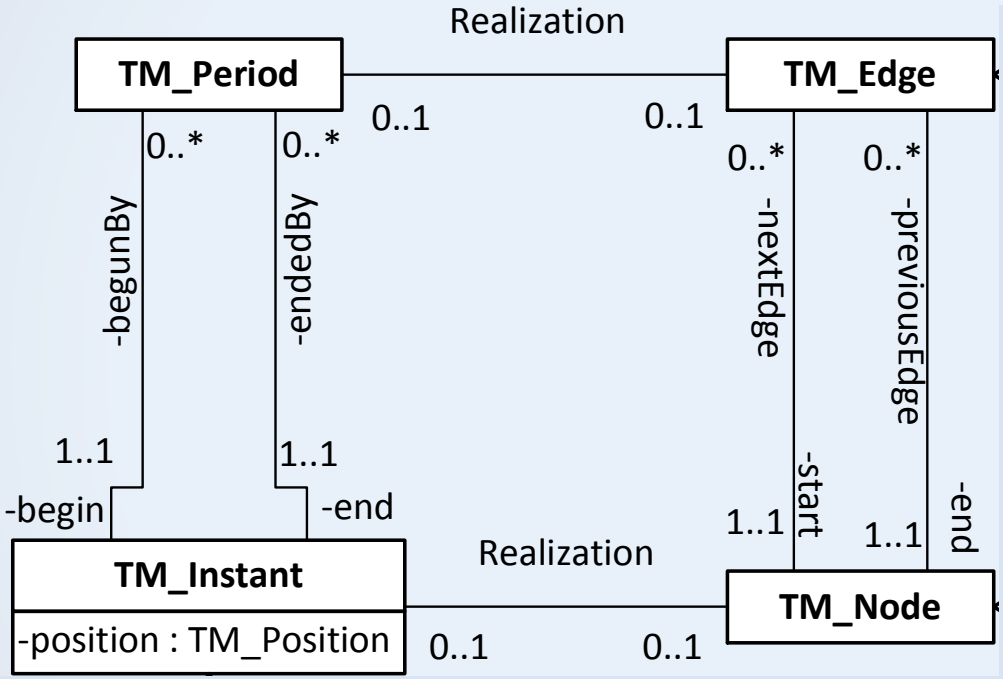
Fuzzy Temporal Positions



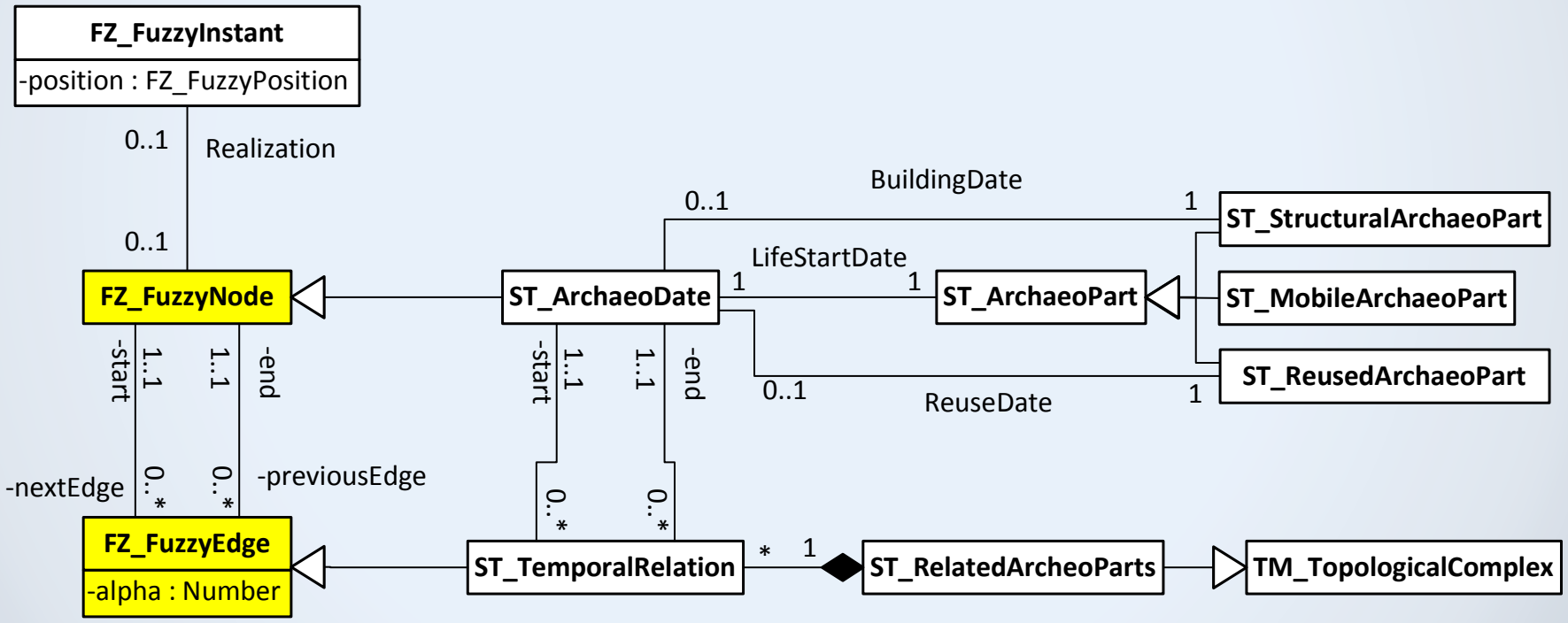


Introducing vagueness

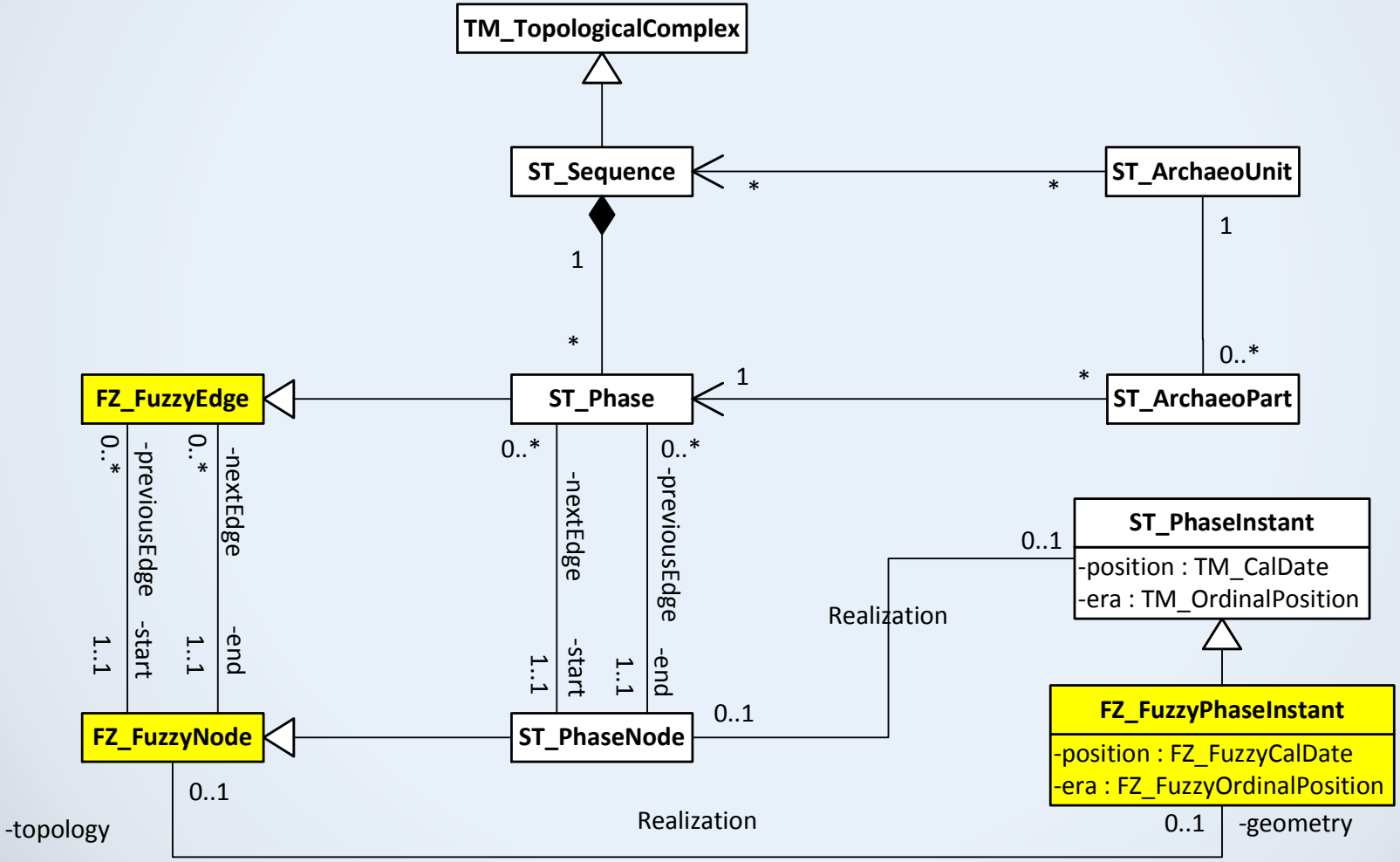
Fuzzy Temporal Topology



Vagueness in SITAR/VR



Vagueness in SITAR/VR



Reasoning on vagueness

Fuzzy temporal constraint networks [VG94][BFG04] can be derived from a dataset that is an instance of this model, so that known algorithms can be applied in order to obtain:

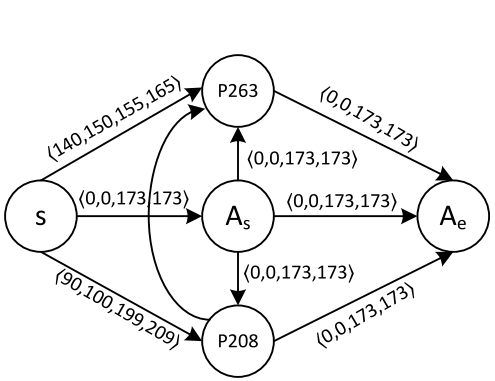
- A consistency check of the represented temporal scene
- The inference of more precise temporal information.

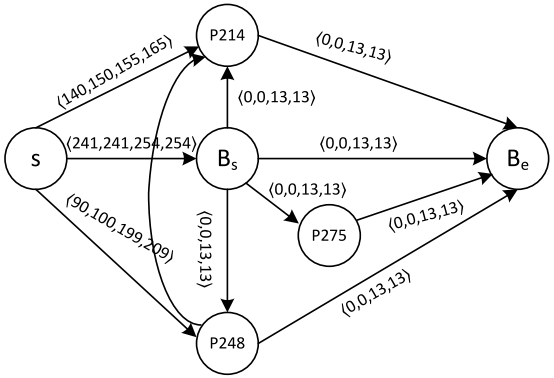
[BFG04] S. Badaloni, M. Falda, and M. Giacomin, "Integrating Quantitative and Qualitative Fuzzy Temporal Constraints," AI Communications, vol. 17, no. 4, pp. 187–200, 2004.
[VG94] L. Vila and L. Godo, "On Fuzzy Temporal Constraint Networks," Mathware and Soft Compunting, vol. 3, pp. 315–334, 1994

Reasoning on vagueness

Example: "Porta Borsari" an ancient roman gate in Verona

Archaeological Partition		LifeStartDate	Ph
P208	Foundation and North Tower	$\langle -110, -100, -1, +9\rangle[1]$ I B.C. $\pm$ 10 years	A
P263	Structures of eastern facade	$\langle -60, -50, -45, -35\rangle[1]$ Middle of I B.C. $\pm$ 10 years	A
P214	Front of the external facade	$\langle 35, 45, 50, 60\rangle[1]$ Middle of I A.C. $\pm$ 10 years	B
P248	External Foundations	$\langle -9, 1, 100, 110\rangle[1]$ I A.C. $\pm$ 10 years	B
P275	Internal Foundations	$\langle -10, 1, 50, 100\rangle[1]$ Middle of I A.C. $\pm$ 5 years	B
P250	Defensive structures	$\langle 401, 450, 500, 500\rangle[1]$ 2nd middle of V A.C.	C





Conclusion and future work

- ISO 19108 can help to represent the time dimension of archaeological data
- We showed a possible approach to link the data model of SITAR/VR project to the ISO standard
- However, in ISO 19108 a formal tool for representing vagueness is missing.
- We present an approach that aims to extend the standard with fuzzy concepts, this approach can be generalized.
- The use of the standard has to be tested also in other archaeological data models
- Other approaches for vagueness representation have to be included in the standard
- GeoUML tools could possibly be used for the conceptual modelling of archaeological data starting from the ISO 19108 standard.

Thank you

More details about this work in the technical report:

A. Belussi and S. Migliorini
"Modelling Time in Archaeological Data: the Verona Case Study,"
Department of Computer Science,
University of Verona, Tech. Rep. RR 93/2014, 2014.
Available at: http://www.di.univr.it/report