

# a space-time datatype for historical place?

Karl Grossner, PhD  
Stanford University Libraries

Spatio-Temporal Technologies for the Arts and Humanities  
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# How data arrive...

- On the Berezina River, near Borisov; 26-29 November 1812
- West of Krasny, in early Spring 1813
- Likely between 6400 and 6800 BC
- The end of the 13th Baktun 
- At Cambridge, in the 1920s
- Beneath Orodruin, in Mordor, during the Third Age

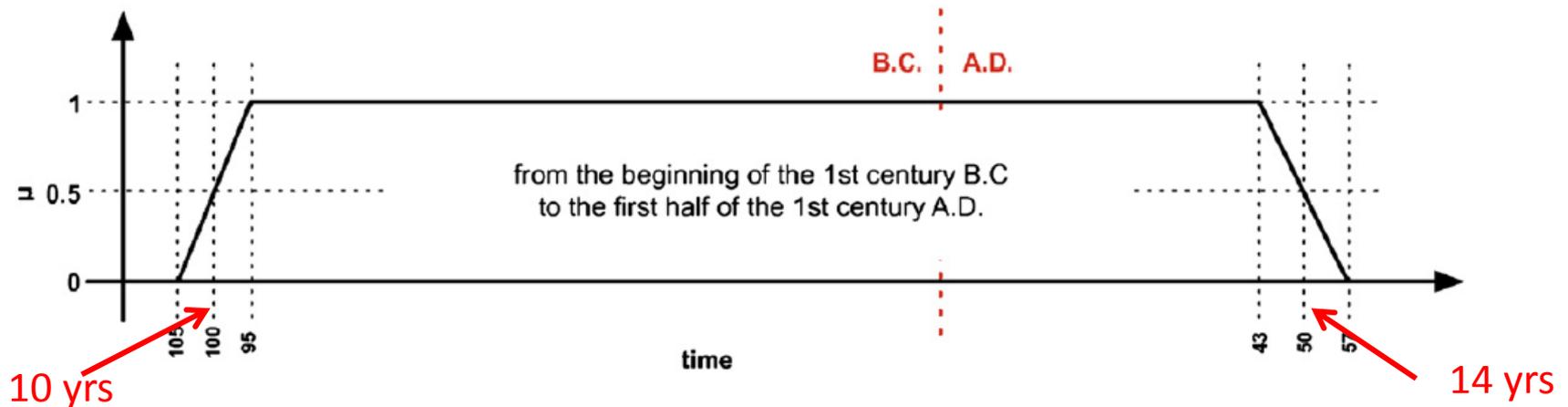
# Questions to drive formalisms

- What/who was contemporary with  $\mathbb{A}$  ?
- What/who was near or within  $\mathbb{A}$  ?
- 
-

# Determining relevance of **imprecise temporal intervals** for cultural heritage information retrieval

Tomi Kauppinen, Glauco Mantegari,  
Panu Paakkari, Heini Kuittinen,  
Eero Hyvonen, Stefania Bandini

Int. J. Human-Computer Studies 68 (2010) 549–560



The period “from around the beginning of the I century B.C. to the first half of the I century A.D.” represented as a fuzzy temporal interval.

$$\begin{aligned}
 T_{LR} &= (T_{begin}, T_{end}, T_{begin} - T_{fuzzybegin}, T_{fuzzyend} - T_{end})_{LR} \\
 &= (95B.C., 43A.D., \underline{10}, \underline{14})_{LR}
 \end{aligned}
 \tag{2}$$

# Determining relevance of imprecise temporal intervals for cultural heritage information retrieval

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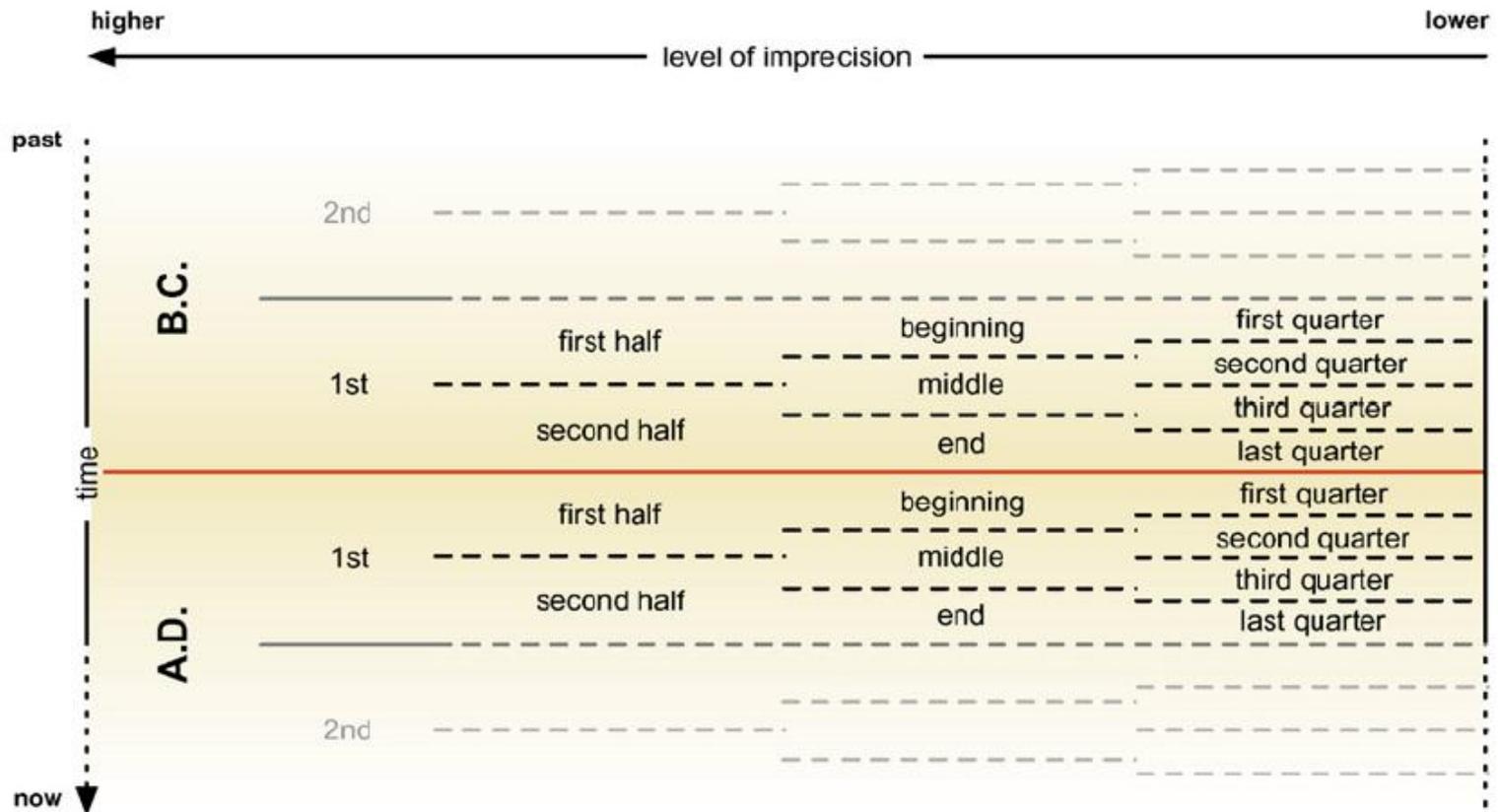


Fig. 3. A depiction of the possible references to absolute chronology showing different levels of imprecision.

## Deducing event chronology in a cultural heritage documentation system

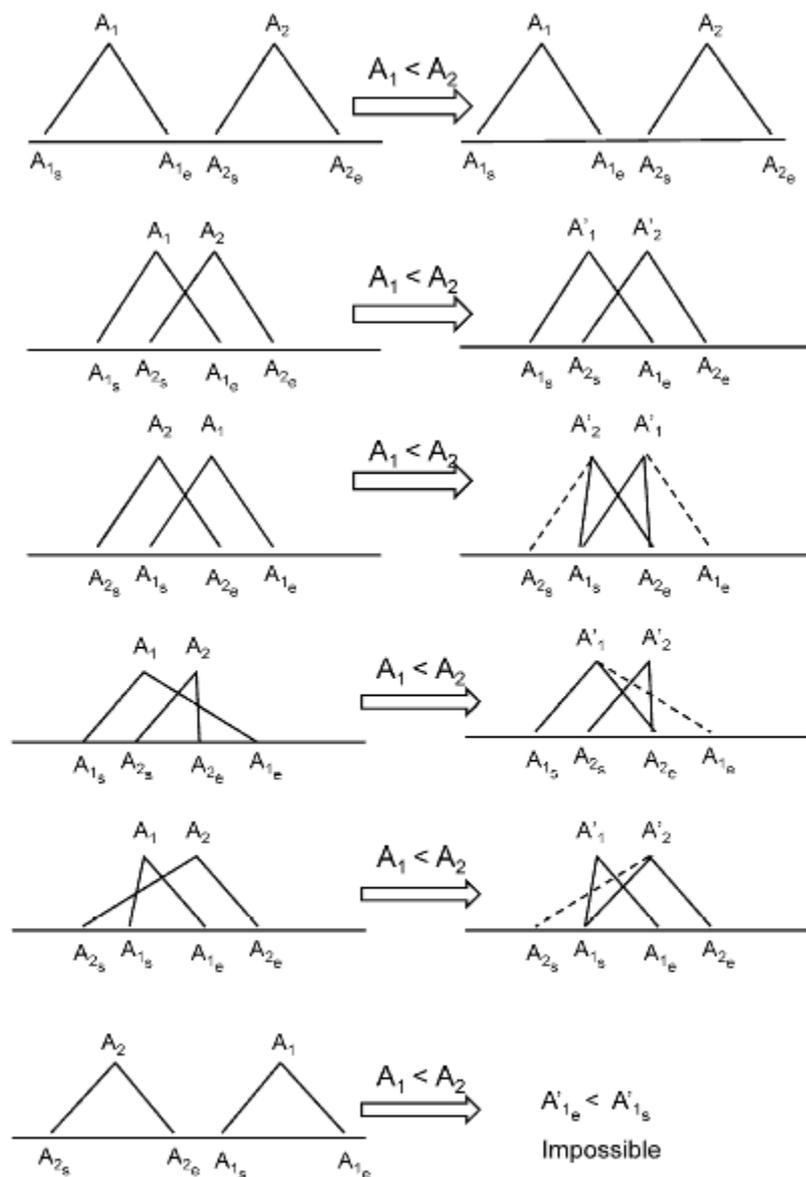
Jon Holmen and Christian-Emil Ore

CAA 2009 Proceedings

- an algebra
- “stored story object”

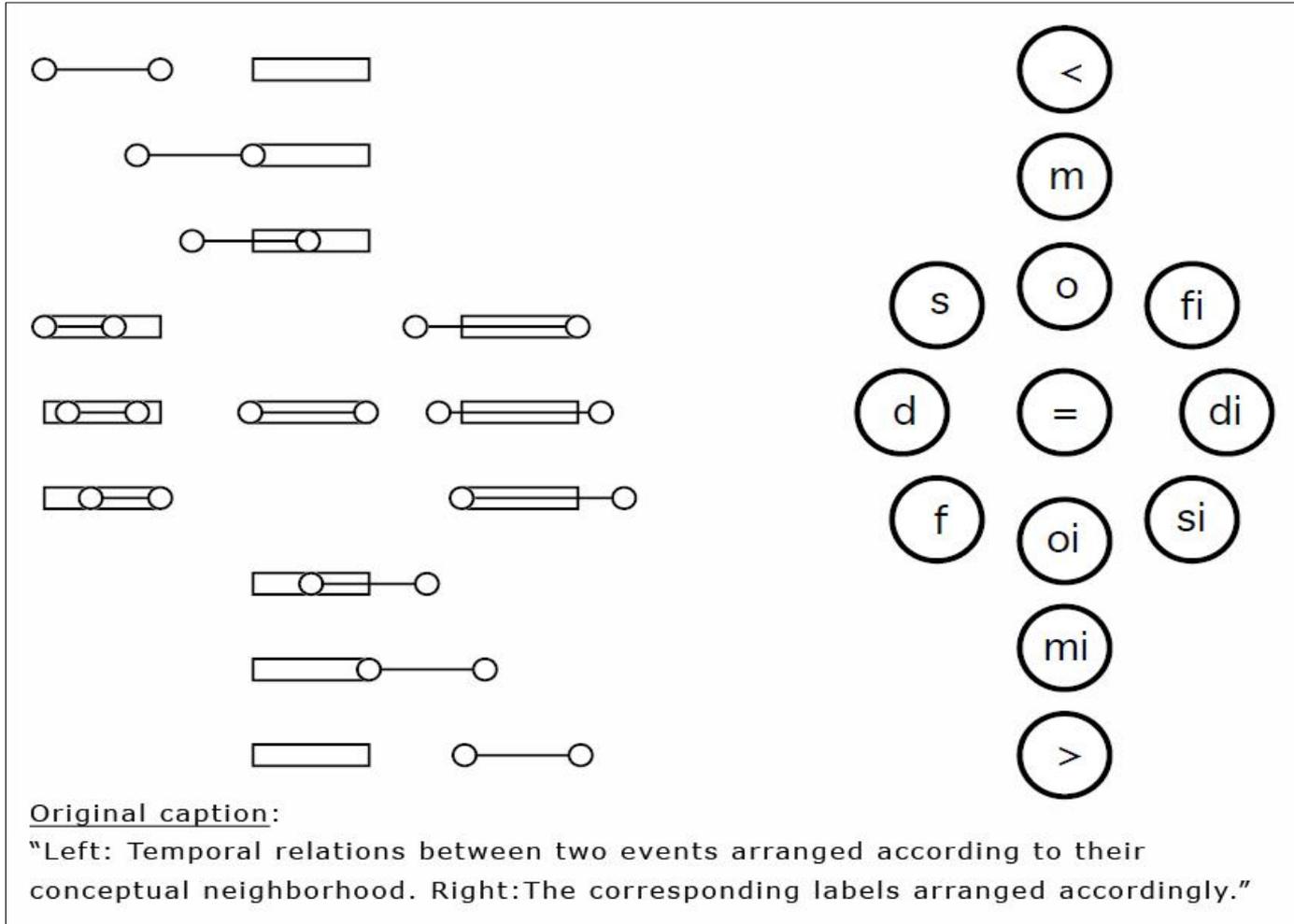
At the University of Tours, France, a system for documenting the preindustrial Tours is being developed (Lefebvre 2008). This system is based on the so called OH\_FET Model (Social Use, Space, and Time). The motivation behind our system and theirs is overlapping although the angle of attack seems to be different.

However, in our opinion **it would be very beneficial to compare the two systems more systematically and establish a common set of tools for documenting the past.**



**Figure 4.** Deduction rule for  $A_1 < A_2$ , where  $A_1$   $A_2$  are two points in time modeled as intervals.

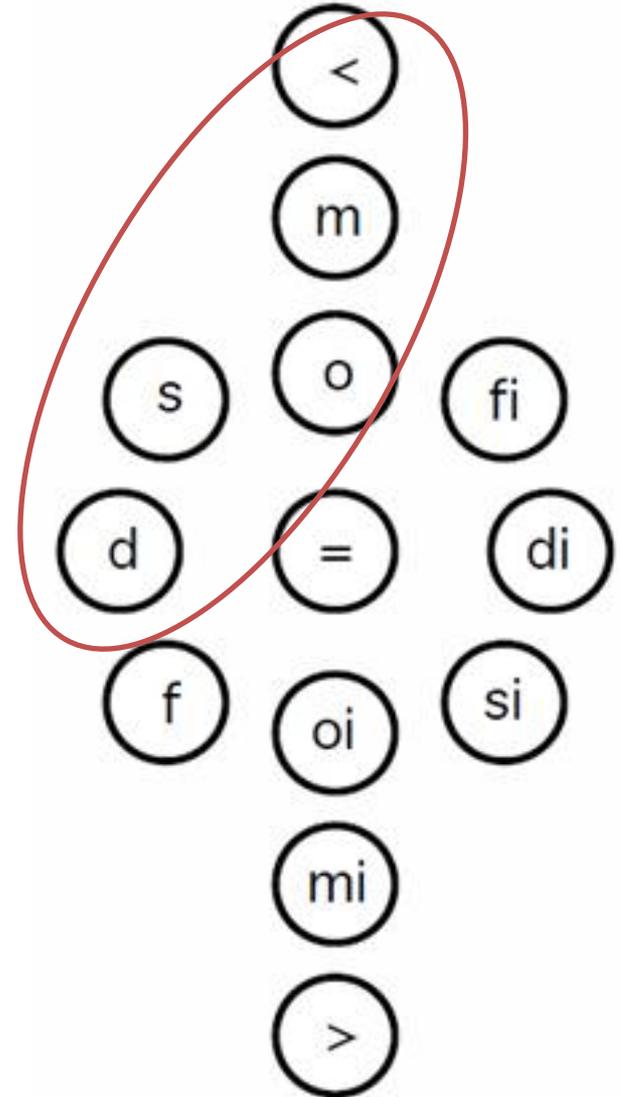
# Semi-intervals



**sb** =

'True if p1 ends before p2 ends'

-- ol	older (<, m, o, fi, di)
-- hh	head to head with (si, =, s)
-- yo	younger (d, f, oi, mi, >)
-- sb	survived by (<, m, o, s, d)
-- tt	tail to tail with (fi, =, f)
-- sv	survives (di, si, oi, mi, >)
-- pr	precedes (<, m)
-- bd	born before death of (<, m, o, fi, di, si, =, s, d, f, oi)
-- db	died after birth of (o, fi, di, si, =, s, d, f, oi, mi, >)
-- sd	succeeds (mi, >)
-- ob	older and survived by (<, m, o)
-- oc	older contemporary of (o, fi, di)
-- sc	surviving contemporary of (di, si, oi)
-- bc	survived by contemporary of (o, s, d)
-- yc	younger contemporary of (d, f, oi)
-- ys	younger and survives (oi, mi, >)



```

-- ol      older (<, m, o, fi, di)
-- hh      head to head with (si, =, s)
-- yo      younger (d, f, oi, mi, >)
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-- tt      tail to tail with (fi, =, f)
-- sv      survives (di, si, oi, mi, >)
-- pr      precedes (<, m)
-- bd      born before death of
            (<, m, o, fi, di, si, =, s, d, f, oi)
-- db      died after birth of
            (o, fi, di, si, =, s, d, f, oi, mi, >)
-- sd      succeeds (mi, >)
-- ob      older and survived by (<, m, o)
-- oc      older contemporary of (o, fi, di)
-- sc      surviving contemporary of (di, si, oi)
-- bc      survived by contemporary of (o, s, d)
-- yc      younger contemporary of (d, f, oi)
-- ys      younger and survives (oi, mi, >)

```

```

-- ol      older (<, m, o, fi, di)
CREATE OR REPLACE FUNCTION ol(period, period)
RETURNS boolean AS
$$
    SELECT first($1) < first($2)
$$ LANGUAGE 'sql' IMMUTABLE STRICT COST 1;
COMMENT ON FUNCTION ol(period, period)
IS 'True if p1 starts before p2';

-- hh      head to head with (si, =, s)
CREATE OR REPLACE FUNCTION hh(p1 period, p2 period)
RETURNS boolean AS
$$
    SELECT first($1) = first($2)
$$ LANGUAGE 'sql' IMMUTABLE STRICT COST 1;
COMMENT ON FUNCTION hh(period, period)
IS 'True if p1 has the same start time as p2';

-- yo      younger (d, f, oi, mi, >)
CREATE OR REPLACE FUNCTION yo(p1 period, p2 period)
RETURNS boolean AS
$$
    SELECT first($1) > first($2)
$$ LANGUAGE 'sql' IMMUTABLE STRICT COST 1;
COMMENT ON FUNCTION yo(period, period)
IS 'True if p1 starts after p2';

-- sb      survived by (<, m, o, s, d)
CREATE OR REPLACE FUNCTION sb(p1 period, p2 period)
RETURNS boolean AS
$$
    SELECT last($1) < last($2)
$$ LANGUAGE 'sql' IMMUTABLE STRICT COST 1;
COMMENT ON FUNCTION sb(period, period)
IS 'True if p1 ends before p2 ends';

```

# Semi-intervals

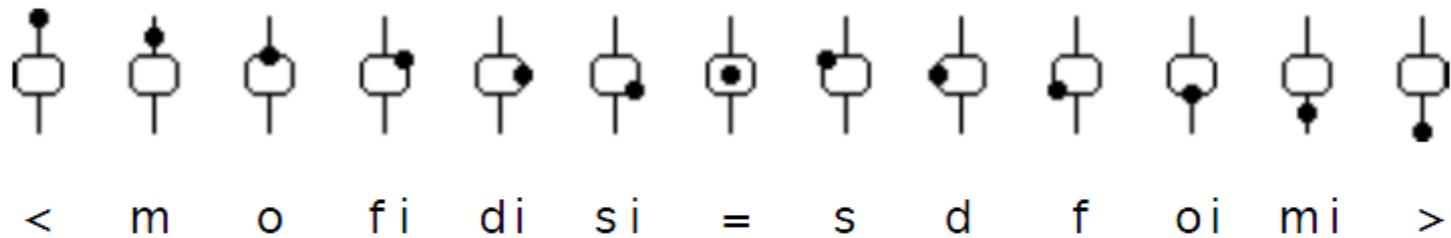


Figure 5: The thirteen qualitative relations between intervals depicted by icons.

# Event object?

```
In <information-object> it is asserted [by <actor>]
that with
(<n%> | unspecified) confidence, <event> occurred
  AT TIME {
    (throughout | sometime during) <interval>, in
    <calendar>}
  AT LOCATION {
    [(the <sector> region of) | nearby |
    (within | at | [approx.] <#> <units> <direction> of)
    [the <feature type>],]
    (<named place> | (<latitude/longitude> | <geometry>))
    [, having <URI>]}
```

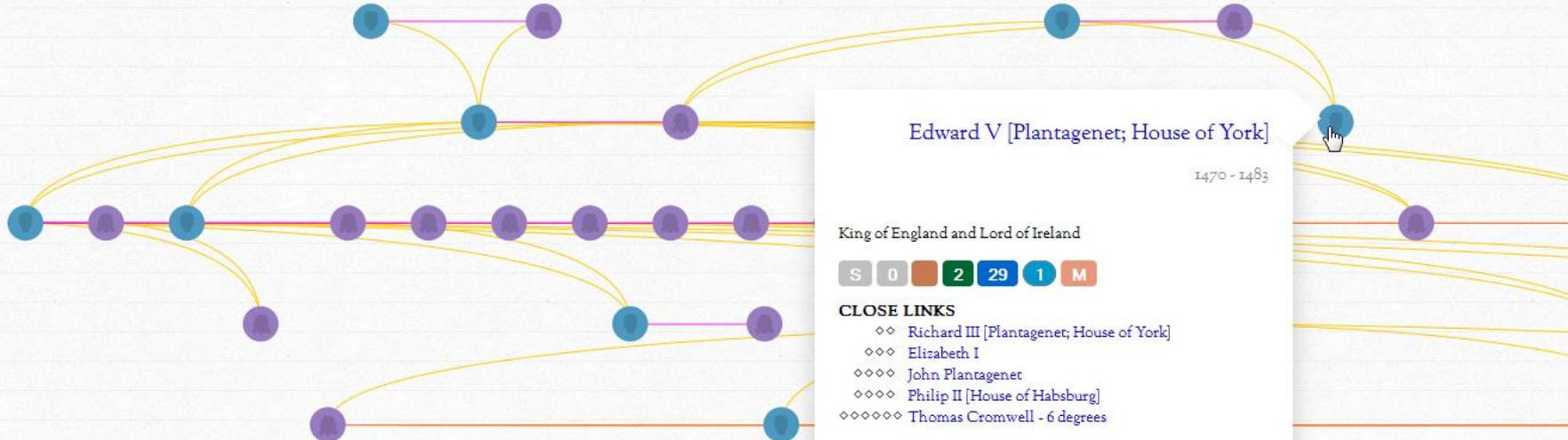
# Two current exemplars

- Kindred Britain
  - BEF, AFT, ABT, BEF ABT
  - Is early 1832 concurrent with April 1832?
- Çatalhöyük (late Neolithic settlement)
  - Space is time (levels and phases)
  - Temporal topology of Harris matrices

Henry VIII

1491 - 1547

The family of Henry VIII



Edward V [Plantagenet; House of York]

1470 - 1483

King of England and Lord of Ireland

S 0 2 29 1 M

CLOSE LINKS

- ◇◇ Richard III [Plantagenet; House of York]
- ◇◇◇ Elizabeth I
- ◇◇◇◇ John Plantagenet
- ◇◇◇◇ Philip II [House of Habsburg]
- ◇◇◇◇◇ Thomas Cromwell - 6 degrees

Connect to



**KINDRED  
BRITAIN**  
 Nicholas Jenkins  
 Elijah Meeks  
 Scott Murray

K. Grossner

1430 - Deaths of iconographers Andrei Rublev and Daniil Chyorny  
 1431 - Joath of Arc burned at Rouen; Henry VI of England crowned king of France  
 1432 - Battle of San Romano; completion of Van Eyck's Ghent Altarpiece  
 1433 - Alnwick burned by Scottish raiders; Zheng He ends last expedition to the In  
 1434 - Cosimo de' Medici becomes ruler of Florence; first cargo of African slaves re

1420

1440

1480

1500

1520

1540

# Çatalhöyük

LEVELS		
Mellaart	South, 4040	
6500-6400	0, I, II	TP6
		South T - 4040.J
		South S - 4040.J
		South R - 4040.I
		South Q - 4040.H
		South P - 4040.H
6500-6400	VIA	South O - 4040.G
	VIB	South N - 4040.G
6700-6500	VII	South M - 4040.F
	VIII	South L - 4040.F
7300-6800	IX	South K
	X	South J
	XI	South I
	XII	South H
	Pre XII	G1, G2, G3, G4

Late

Middle

Early

***The Nature of  
Uncertainty in Historical  
Geographic Information***

Brandon Plewe  
(2002)

Also:  
*Representing Datum-level  
Uncertainty in Historical  
GIS (2003)*

**Table 2** Causes and types of assertion uncertainty

Cause	Spatial Location	Time/Date	Attribute Value	Type
Measurement Limitation	Lat/Lon from stars	Birth date from later memory	Temperature in whole degrees	imprecise
Lack of Evidence	Portion of boundary not described	No record of birthdate	Decennial Census (what was 1865 pop?)	imprecise unknown
Lack of Reference	'North of X River,' (where is X River?)	'The third year of the reign of X' (when X?)	'The son of X' (who was X?)	imprecise unknown
Questionable Evidence	'The great king ruled the lands of the five rivers'	'born when the moon was in Cancer'	'His army of 100,000 conquered all'	imprecise unknown
Ambiguous Evidence	'Along a large river' (which river?)	'The day of the great feast' (which feast?)	'The son of X' (which X?)	imprecise
Conflicting Evidence	A: 'to the X River' B: 'to the Y River'	A: 'in 1850' B: 'in 1851'	A: 'army of 20,000' B: 'army of 30,000'	imprecise
Misinterpretation	'All of Asia' (recorder: exc. Arabia, encoder: inc. Arabia)	'In the Industrial Age' (recorder: IA > 1820, encoder: IA > 1770)	'The income was high' (recorder: high > \$300, encoder: high > \$8000)	inaccurate
Transformation	People → Census tracts	Years → 'Information Age'	Income values → 'high,' 'low'	imprecise inaccurate
Encoding Error	Digitizing error	Entered wrong year	Typo in name	inaccurate

## spatial, spatial-temporal, temporal

Brandon Plewe,  
Utah

**Table 3** Types of uncertainty in the Uncertain Extent Set Model.  $p$  can be a point in either the spatial, spatiotemporal, or temporal attribute domains of Equation 2. In the validity function,  $m$  represents all possible membership values in  $M$  but those specified.

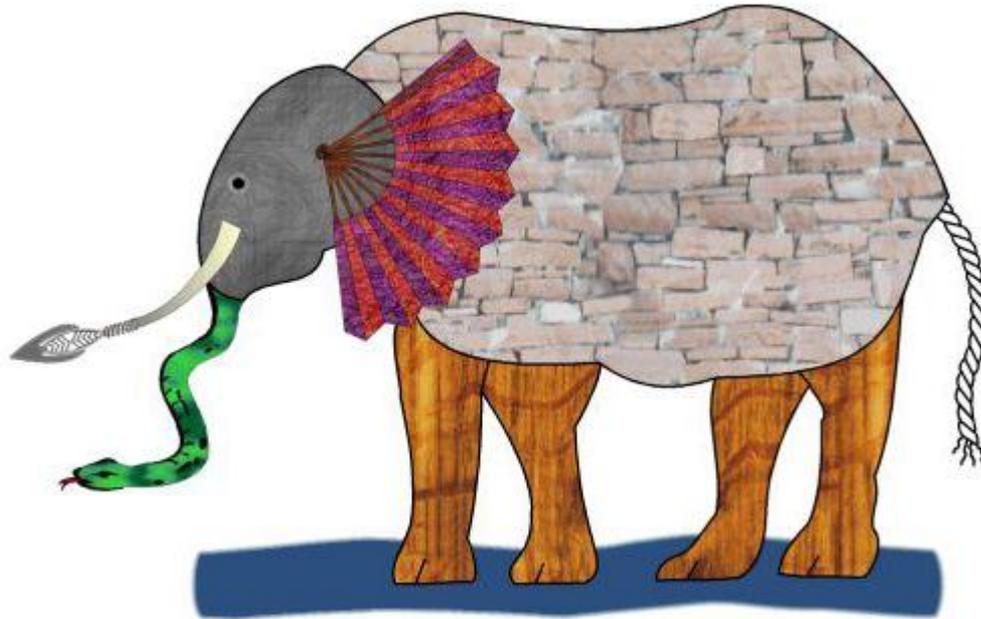
Inherent Uncertainty	Assertion Uncertainty	Validity Function	Interpretation
Exact	Known	$v(p, 1) = 1; v(p, m) = 0$	'I know this point is in $g'$
Vague	Known	$v(p, 0.5) = 1; v(p, m) = 0$	'I know this point is 50% part of $g'$
Indefinite	Known	$v(p, \omega) = 1; v(p, m) = 0$	'I know it is not possible to determine whether this point is part of $g$ or not'
Exact	Imprecise	$v(p, 1) = 0.7; v(p, 0) = 0.3; v(p, m) = 0$	'This point is probably in $g$ , but it may be out'
Vague	Imprecise	$v(p, 0.5) = 0.7; v(p, 0.3) = 0.3; v(p, m) = 0$	'This point is probably 50% part of $g$ , but it may be 30% part of $g'$
Indefinite	Imprecise	$v(p, \omega) = 0.7; v(p, 0) = 0.3; v(p, m) = 0$	'This point is probably impossible to determine, but it may be completely out of $g'$
Exact	Unknown	$v(p, 1) = \omega; v(p, 0) = \omega; v(p, m) = 0$	'This point is either in or out of $g$ , but I don't know which'
Vague	Unknown	$v(p, \omega) = \omega; v(p, m) = 0$	'I don't know how much this point is part of $g'$
Indefinite	Unknown	$v(p, \omega) = \omega; v(p, m) = \omega$	'I have no idea of the status of with this point'

# PostgreSQL Temporal Extension

- Extending the Period datatype...any takers?
  - <https://github.com/jeff-davis/PostgreSQL-Temporal>
- Is this something the NeDiMAH Space and Time Workshop can push forward?
- Perhaps the need more in RDF representation and semantic web reasoners?



Thank you  
Comments or questions?



[karlg@stanford.edu](mailto:karlg@stanford.edu)  
<http://kgeographer.org>  
@kgeographer