

Relatively speaking – temporal alignment for archaeological data



Ceri Binding
Hypermedia Research Unit, University of Glamorgan, Wales

<http://hypermedia.research.glam.ac.uk/>

Textual formats representing time periods

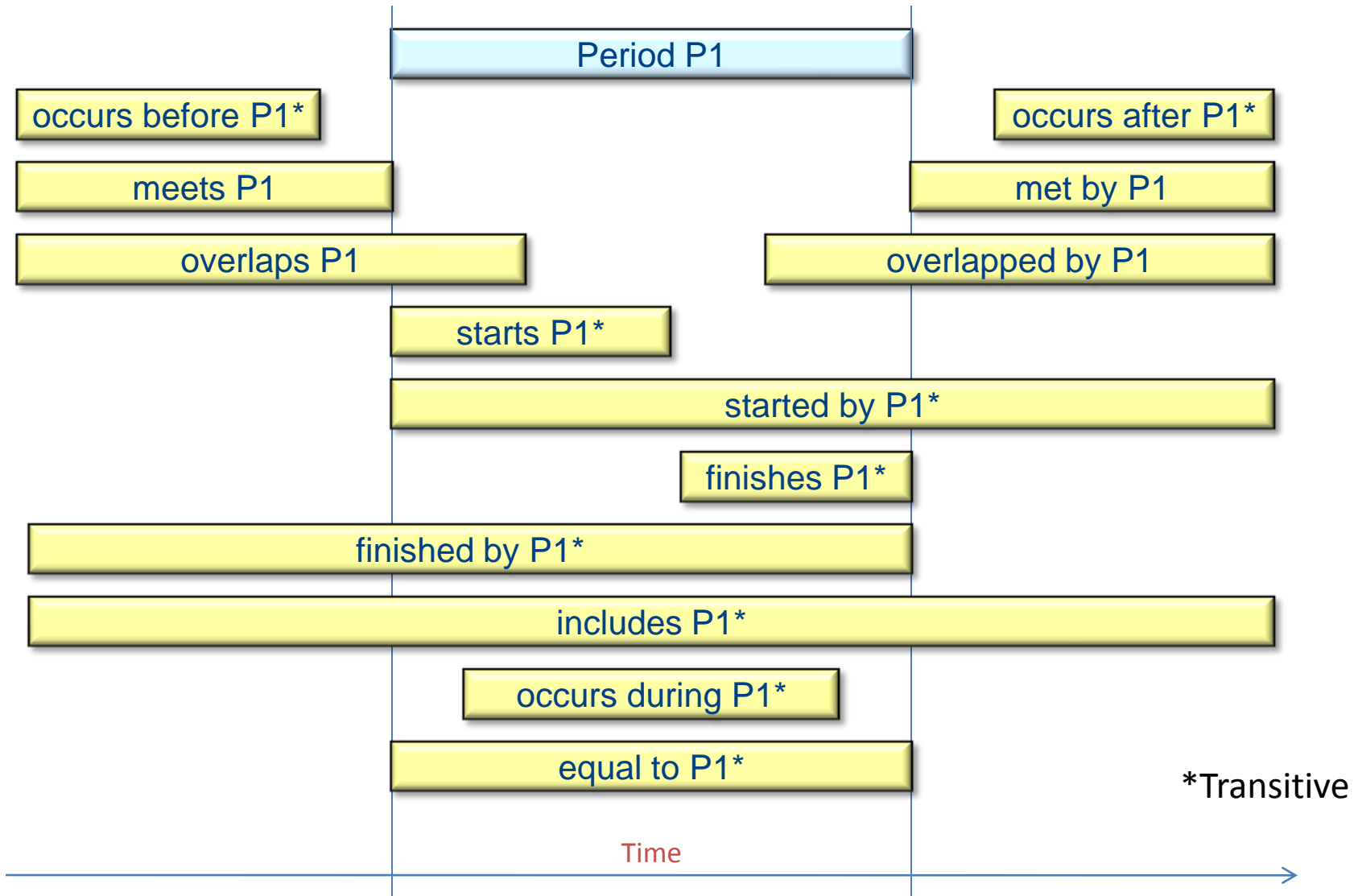
Period type	Examples
Centuries	MLC2-C3 LC2/EC3 1 st century?
BC / AD years	AD 341-6 c. AD 270
3 age system	Iron Age Bronze Age BA Neolithic?
Monarchs / Emperors	Georgian Antonine Vespasian
Cultural styles	Beaker
Prefixes (pre, post, early, mid, late etc.) and combinations	Early C3 LBA 2 nd /early 1 st BC

Data cleansing – assigning date ranges

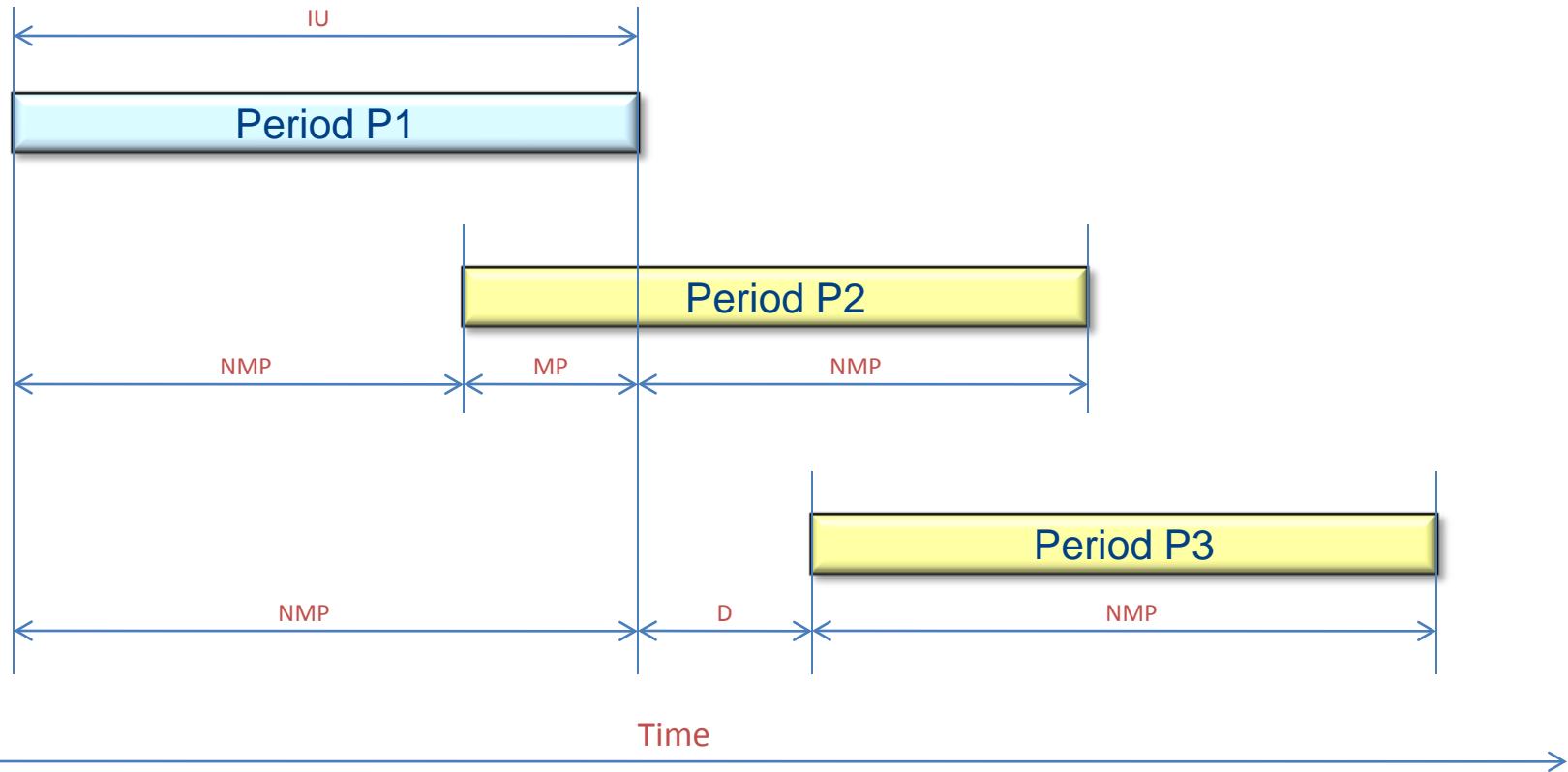
Object ID	Dating	MIN_START_YEAR	MAX_END_YEAR
1519	AD 354-64	354	364
1520	1st century AD	1	100
1538	2nd century	101	200
1548	1st century	1	100
1562	AD 367-75	367	375
1563	AD 348-50	348	350
1567	Mid 1st century AD	33	66
1571	First half 1st centu	1	50
1572	Mid first century AD	33	66
1580	c. AD 270	270	270
1583	First half first cen	1	50
1584	First half first cen	1	50
1591	AD 341-6	341	346
1593	AD 287-93	287	293
1594	AD 43-44	43	44
1595	Medieval	1066	1540
1627	2nd century AD	101	200
1631	?1st century	1	100
1635	AD 354-64	354	364
1664	AD 330-5	330	335
1681	Medieval	1066	1540
1701	Romano-British	43	410
1704	Modern?	1901	2100
2136	2nd/early 1st C BC	1	200
98157	post-mediaeval	1540	1901



Period alignment - relationships



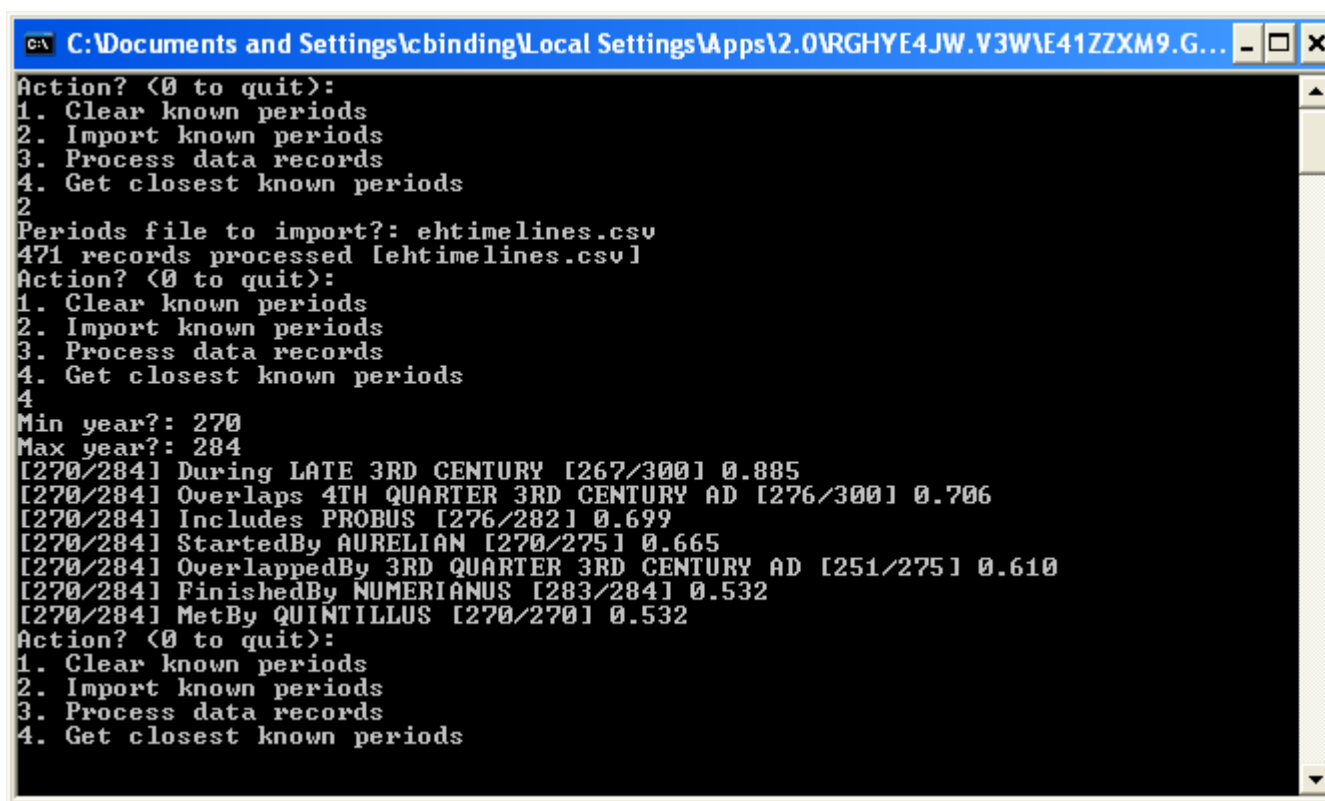
Period comparison – closeness calculation



$$\text{Match}(P1, P2) = W1 (MP / IU) + W2 (IU / (NMP + IU)) + W3 (IU / (D + IU))$$

Period alignment – data processing

- Align data *relative to* closest period concepts from English Heritage ‘Timelines’ thesaurus

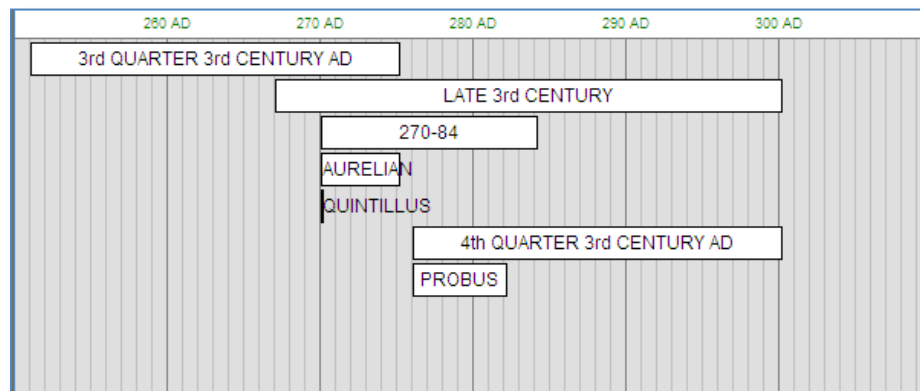


```
C:\Documents and Settings\cbinding\Local Settings\Apps\2.0\RGHYE4JW.V3W\E41ZZXM9.G...
Action? (0 to quit):
1. Clear known periods
2. Import known periods
3. Process data records
4. Get closest known periods
2
Periods file to import?: ehtimelines.csv
471 records processed [ehtimelines.csv]
Action? (0 to quit):
1. Clear known periods
2. Import known periods
3. Process data records
4. Get closest known periods
4
Min year?: 270
Max year?: 284
[270/284] During LATE 3RD CENTURY [267/300] 0.885
[270/284] Overlaps 4TH QUARTER 3RD CENTURY AD [276/300] 0.706
[270/284] Includes PROBUS [276/282] 0.699
[270/284] StartedBy AURELIAN [270/275] 0.665
[270/284] OverlappedBy 3RD QUARTER 3RD CENTURY AD [251/275] 0.610
[270/284] FinishedBy NUMERIANUS [283/284] 0.532
[270/284] MetBy QUINTILLUS [270/270] 0.532
Action? (0 to quit):
1. Clear known periods
2. Import known periods
3. Process data records
4. Get closest known periods
```

Period alignment - results

Records aligned relative to closest “known” periods

Data record (dates deduced from labels)			Calculated closest matching known periods				
Data Label	From	To	Relationship	Concept Label	From	To	Closeness
1555-1623?	1555	1623	overlaps	JAMES I AND VI	1567	1625	0.895
			occurs during	POST MEDIEVAL	1540	1901	0.838
			includes	ELIZABETHAN	1558	1603	0.814
			overlapped by	2 nd HALF 16 th CENTURY AD	1551	1600	0.808
AD270-284	270	284	occurs during	LATE 3 rd CENTURY	267	300	0.885
			overlaps	4 th QUARTER 3 rd CENTURY AD	276	300	0.706
			includes	PROBUS	276	282	0.699
			started by	AURELIAN	270	275	0.665
			overlapped by	3 rd QUARTER 3 rd CENTURY AD	251	275	0.610
			met by	QUINTILLUS	270	270	0.532



Rediscovering links to known periods

Data record – dates deduced from labels				Relationship	Closest ‘known’ period match - based on dates			
ID	Label	From	To		ID	Label	From	To
1315	AD 228-31	228	231	occurs during	136122	ALEXANDER SEVERUS	222	235
1316	AD 364-78	364	378	overlapped by	900014	3RD QUARTER 4TH CENTURY AD	351	375
1317	AD 69-79	69	79	equal to	136087	VESPASIAN	69	79
1318	AD 270-4	270	274	equal to	136164	TETRICUS I	270	274
1319	AD 275-402	275	402	includes	134825	4TH CENTURY AD	300	399
1320	AD 341-6	341	346	occurs during	900013	2ND QUARTER 4TH CENTURY AD	326	350
1321	AD 268-70	268	270	equal to	136154	CLAUDIUS II GOTHICUS	268	270
1322	AD 367-75	367	375	finishes	900014	3RD QUARTER 4TH CENTURY AD	351	375
1324	AD 270-84	270	284	occurs during	135952	LATE 3RD CENTURY	266	299
1327	AD 383-8	383	388	occurs during	900015	4TH QUARTER 4TH CENTURY AD	376	399
1328	AD 330-40	330	340	occurs during	900013	2ND QUARTER 4TH CENTURY AD	326	350
1337	Post-medieval	1540	1901	equal to	134746	POST MEDIEVAL	1540	1901
1370	Medieval	1066	1540	equal to	134745	MEDIEVAL	1066	1540
1371	AD 1943	1943	1943	occurs during	134848	SECOND WORLD WAR	1939	1945

Periods have an implicit spatial context...

In Red Dwarf Series 6 '*Out of Time*', the crew obtain a time drive, and travel to the medieval period...



Lister: "We're still where we were!"

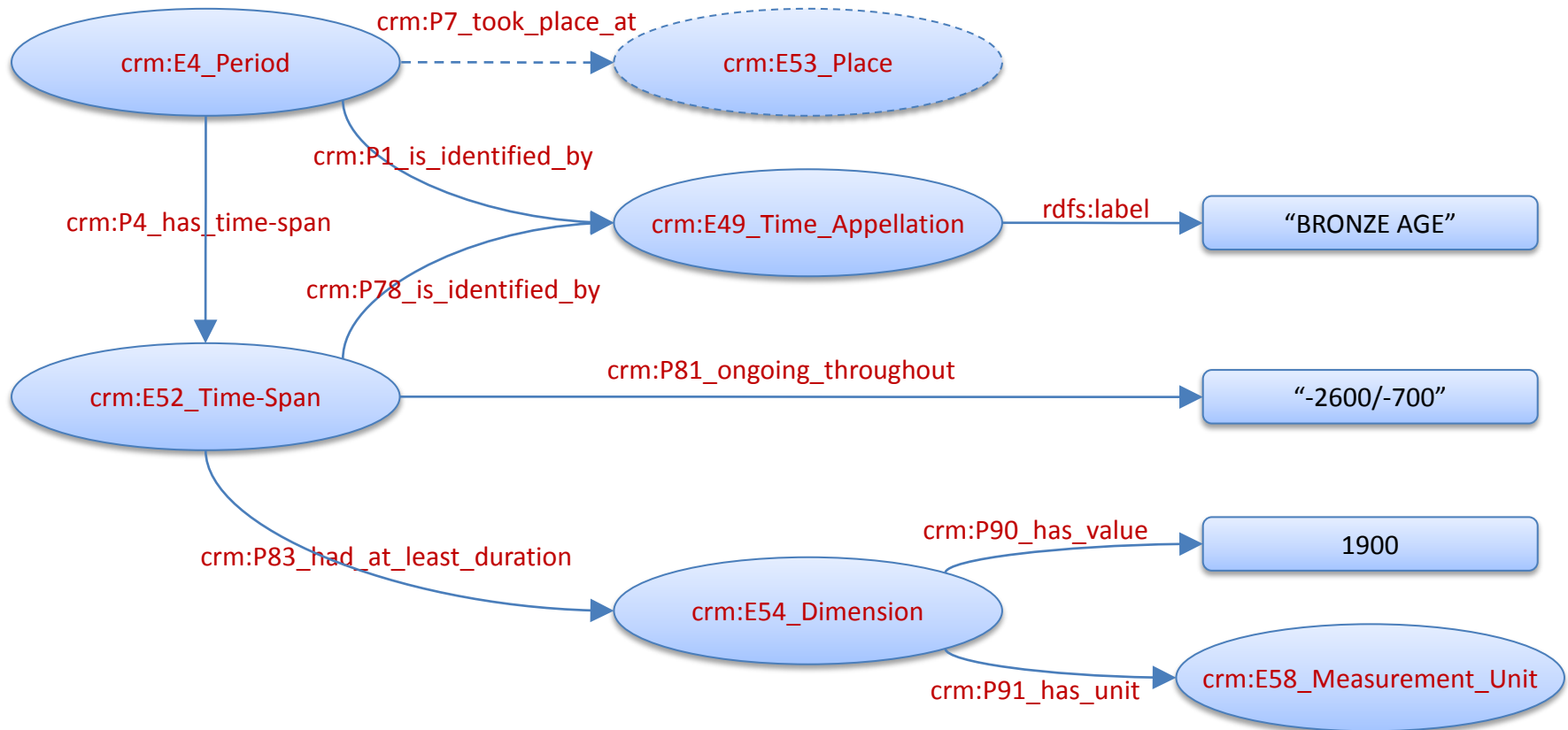
Kryten: "Of course. We're still in deep space sir, only now we're in deep space in the 15th century. Isn't it wonderful?"

Rimmer: "So we're still three million years away from Earth?"

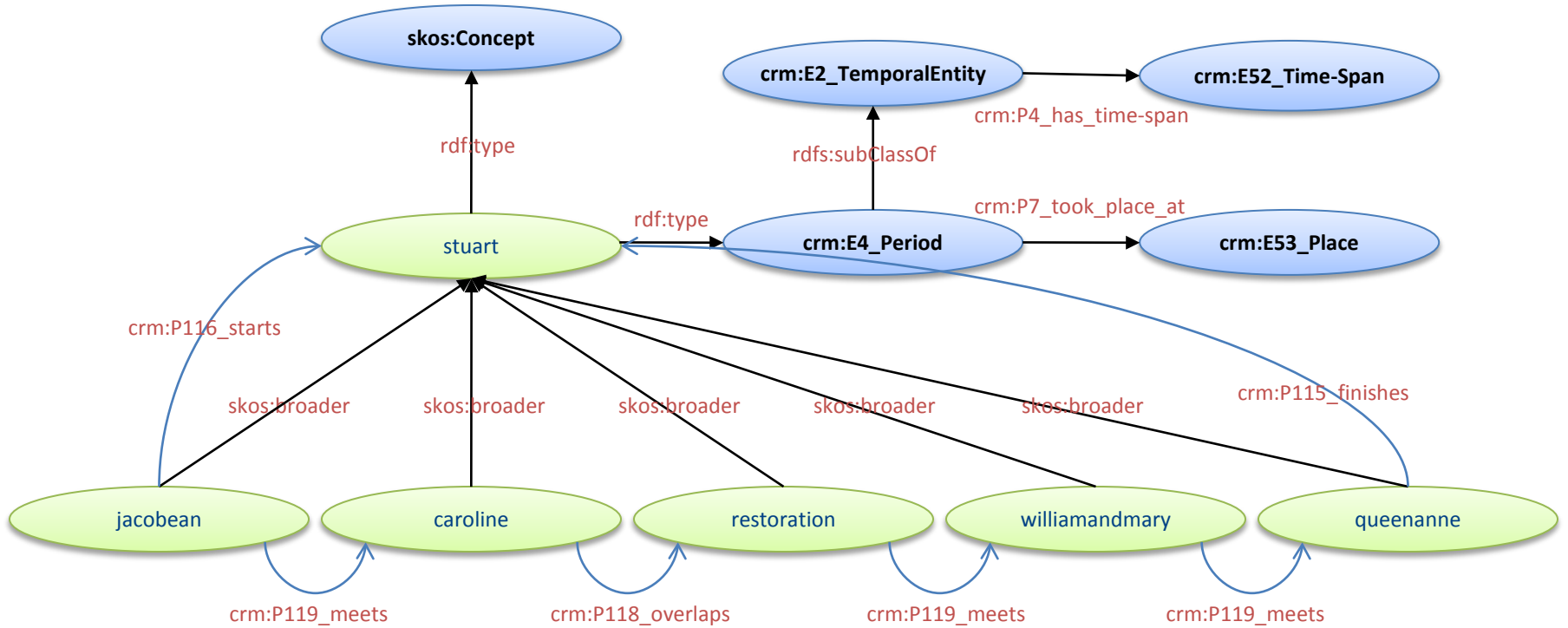
Kryten: "Well, yes."

Modelling time periods with CIDOC CRM

period_id	period_label	min_start_year	max_end_year
134723	BRONZE AGE	-2600	-700



SKOS concepts + CIDOC CRM entities



STELLAR

<http://hypermedia.research.glam.ac.uk/kos/stellar/>

```
STELLAR.Console v1.0
(type HELP for instructions)
STELLAR.Console>help
For information on a particular command type HELP command
DBNAMES      List databases in a directory
DBTABLES    List tables in a database
DBCOLUMNS  List columns in a database table
DBROWCOUNT Count rows in a database table
TAB2DB      Import tab delimited file to database table
CSU2DB      Import comma delimited file to database table
SQL2CSU     Run SQL, export result to CSU file
SQL2TAB     Run SQL, export result to tab delimited file
CSU2RDF     Convert comma delimited file to RDF file (via template)
TAB2RDF     Convert tab delimited file to RDF file (via template)
SQL2RDF     Run SQL, export result to RDF file (via template)
TEMPLATES   Display list of possible templates to use
CSUSTATS    Display statistics for comma delimited file
RDFSTATS    Display statistics for RDF file
EXIT        Exit the application
STELLAR.Console>_
```

```
59, EARLY NEOLITHIC,-4000,-3300
60, MIDDLE NEOLITHIC,-3300,-2900
61, LATE NEOLITHIC,-2900,-2200
8, BRONZE AGE,-2600,-700
62, EARLY BRONZE AGE,-2600,-1600
63, MIDDLE BRONZE AGE,-1600,-1200
64, LATE BRONZE AGE,-1200,-700
9, IRON AGE,-800,43
```

Delimited (CSV) data



STELLAR Template



```
<crm:P115F.finishes rdf:resource="http://tempuri/star/concept#134718"/>
<crm:P116B.is_started_by rdf:resource="http://tempuri/star/concept#134735"/>
<crm:P117B.includes rdf:resource="http://tempuri/star/concept#134736"/>
<crm:P115B.is_finished_by rdf:resource="http://tempuri/star/concept#134737"/>
<crm:P118B.is_overlapped_in_time_by rdf:resource="http://tempuri/star/concept#134734"/>
<crm:P118F.overlaps_in_time_with rdf:resource="http://tempuri/star/concept#134822"/>
<crm:P120F.occurs_before rdf:resource="http://tempuri/star/concept#136079"/>
<crm:P119F.meets_in_time_with rdf:resource="http://tempuri/star/concept#134738"/>
<crm:P120B.occurs_after rdf:resource="http://tempuri/star/concept#134733"/>
</crm:E4.Period>
<crm:E4.Period rdf:about="http://tempuri/star/concept#134723">
  <rdfs:label>BRONZE AGE</rdfs:label>
  <crm:P4F.has_time-span>
    <crm:E52.Time-Span>
      <rdfs:label>-2500/-700</rdfs:label>
    <crm:P81F.ongoing_throughout>
```

RDF data

- Convert delimited data to RDF conforming to specific ontological model, via “templates”

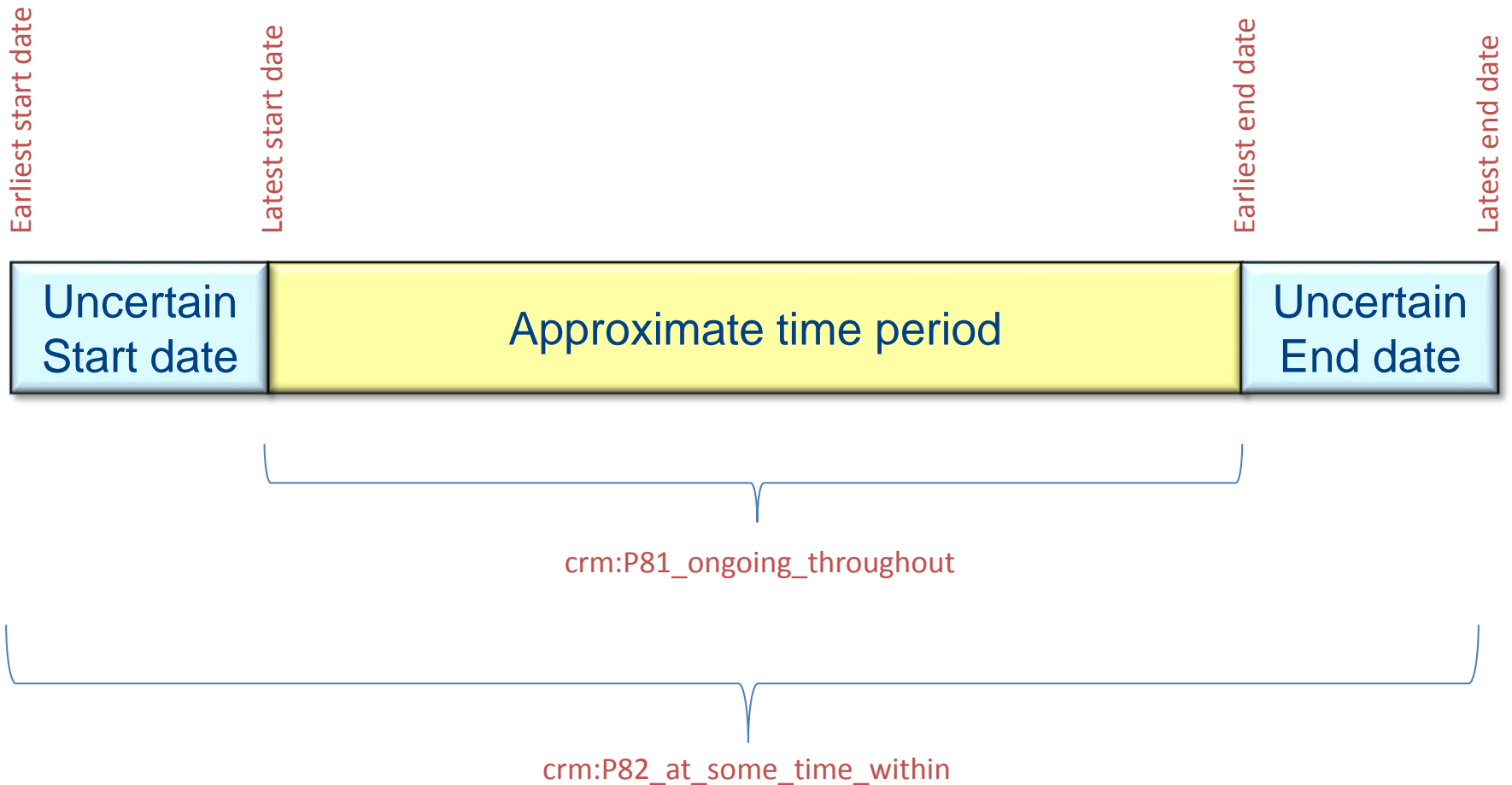
Timeline service + test client

Timeline service test client. Enter start and end years and press 'search'. Click on any result to search again using that start / end year. The graphical display shows the periods relative to each other on the timeline.

From year: To year:

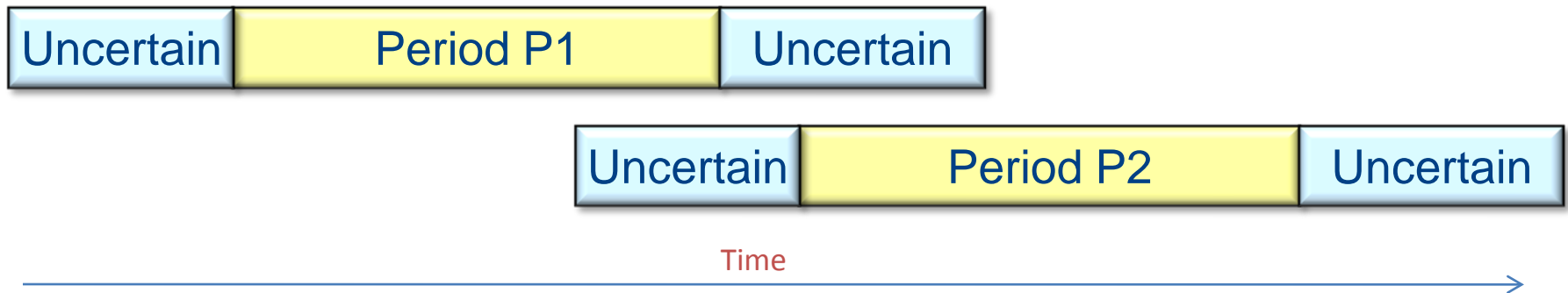
Relationship	Label	From year	To year
100 AD 200 AD 300 AD 400 AD 500 AD 600 AD 700 AD 800 AD 900 AD			
[Move Back] [Move Forward] [Zoom In] [Zoom Out] [Reset]			

Accommodating uncertainty



Revisit closeness calculation

- Revisit calculation of relationships and closeness to allow for uncertainty



- Period P1 **before** Period P2?
- Period P1 **meets** Period P2?
- Period P1 **overlaps** Period P2?
- Any or all of the above?

All are possible, so calculated closeness then becomes a *range* rather than a fixed value

Conclusions / future work

- Thesauri do not fully describe spatio-temporal nature of period concepts – supplementing with CRM entities and properties facilitates more accurate semantic modelling
- Possibly build approximation into time periods? (revisit closeness calculation)
- Put aligned time period concepts online as linked data?

Relatively speaking – temporal alignment for archaeological data



Ceri Binding
Hypermedia Research Unit, University of Glamorgan, Wales

<http://hypermedia.research.glam.ac.uk/>

<http://hypermedia.research.glam.ac.uk/kos/STELLAR/>

<http://hypermedia.research.glam.ac.uk/kos/STAR/>