# CCO design patterns

- The following slides contain design patterns for CCO and BFO to be vetted and translated into Mermaid.

- In some cases, big design patterns need to be split into more simple patterns. In other cases, they need to be made more or less general.

- The sources of these design patterns are varied (papers, independent work of researchers, presentations). When possible, provenance of the images is shown. All credits are due to the authors of the respective patterns.
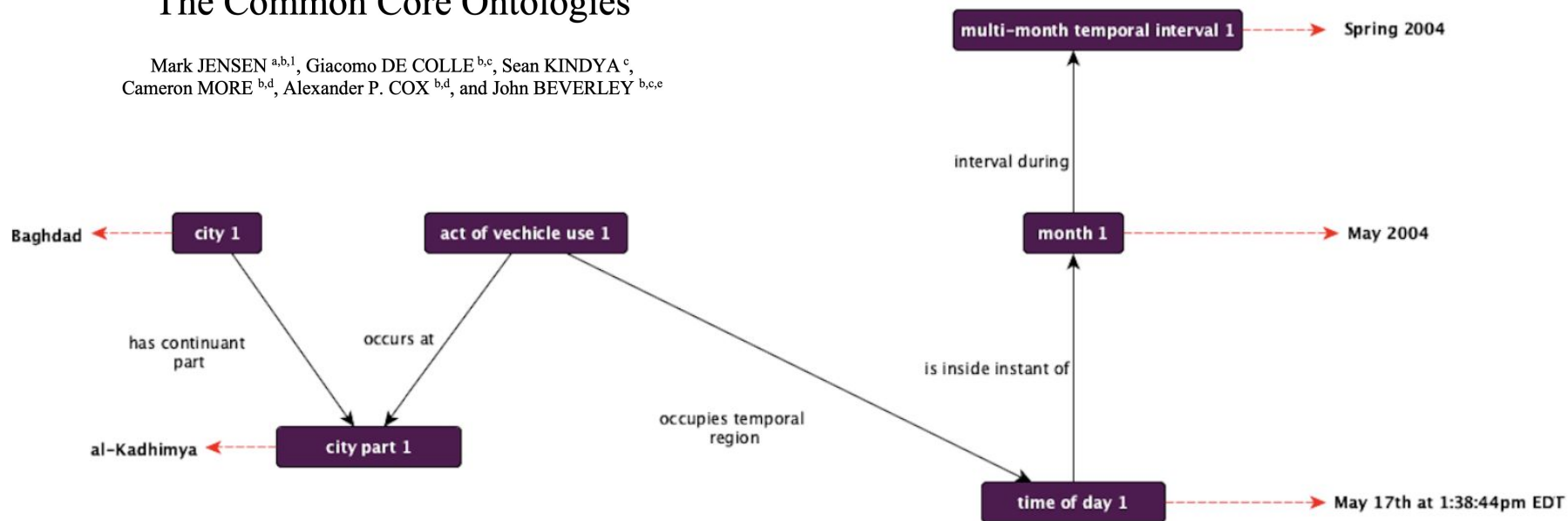
Mark JENSEN [a,b,1], Giacomo DE COLLE [b,c], Sean KINDYA [c], Cameron MORE [b,d], Alexander P. COX [b,d], and John BEVERLEY [b,c,e]
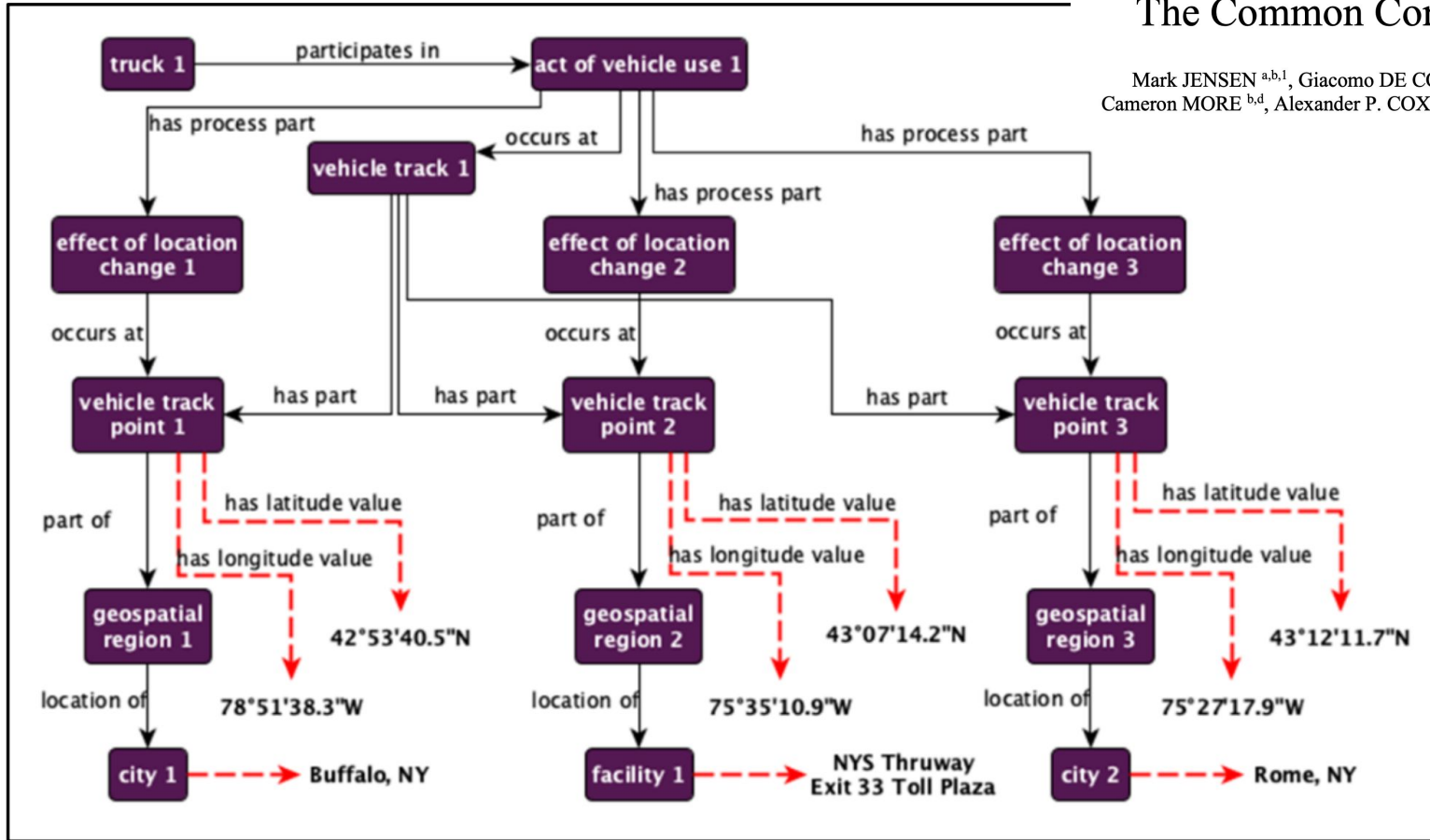
Figure 1*: Tracing a Truck across Geospatial Regions*

The Common Core Ontologies

Mark JENSEN [a,b,1], Giacomo DE COLLE [b,c], Sean KINDYA [c],
Cameron MORE [b,d], Alexander P. COX [b,d], and John BEVERLEY [b,c,e]

Figure 2: *Tracking Processes across Temporal and Spatial Granularities*

Figure 3: *Measuring Outcomes of an Artifact Model Prescription*
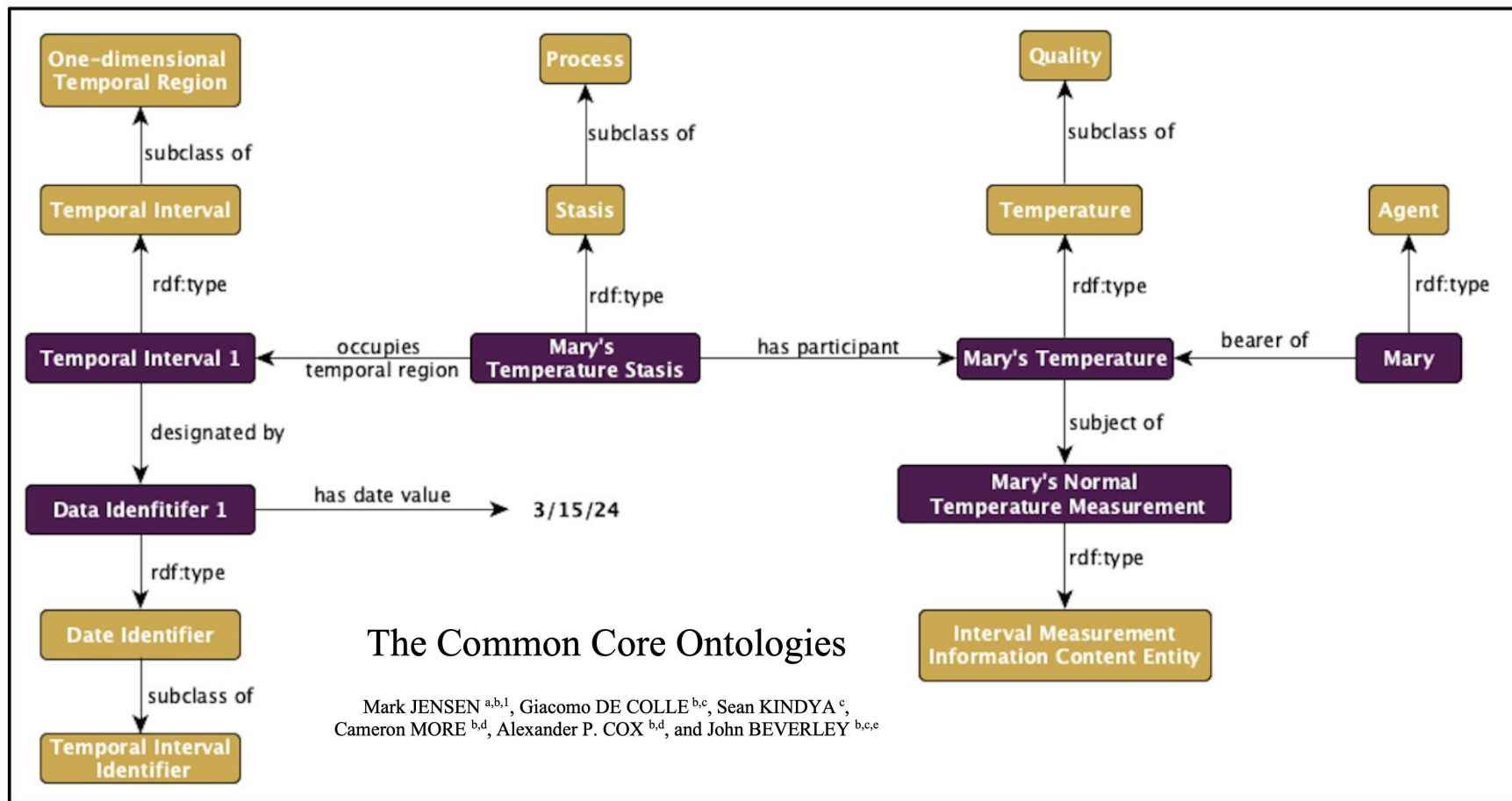
The Common Core Ontologies

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Figure 4: *Measuring Constancy over Time*

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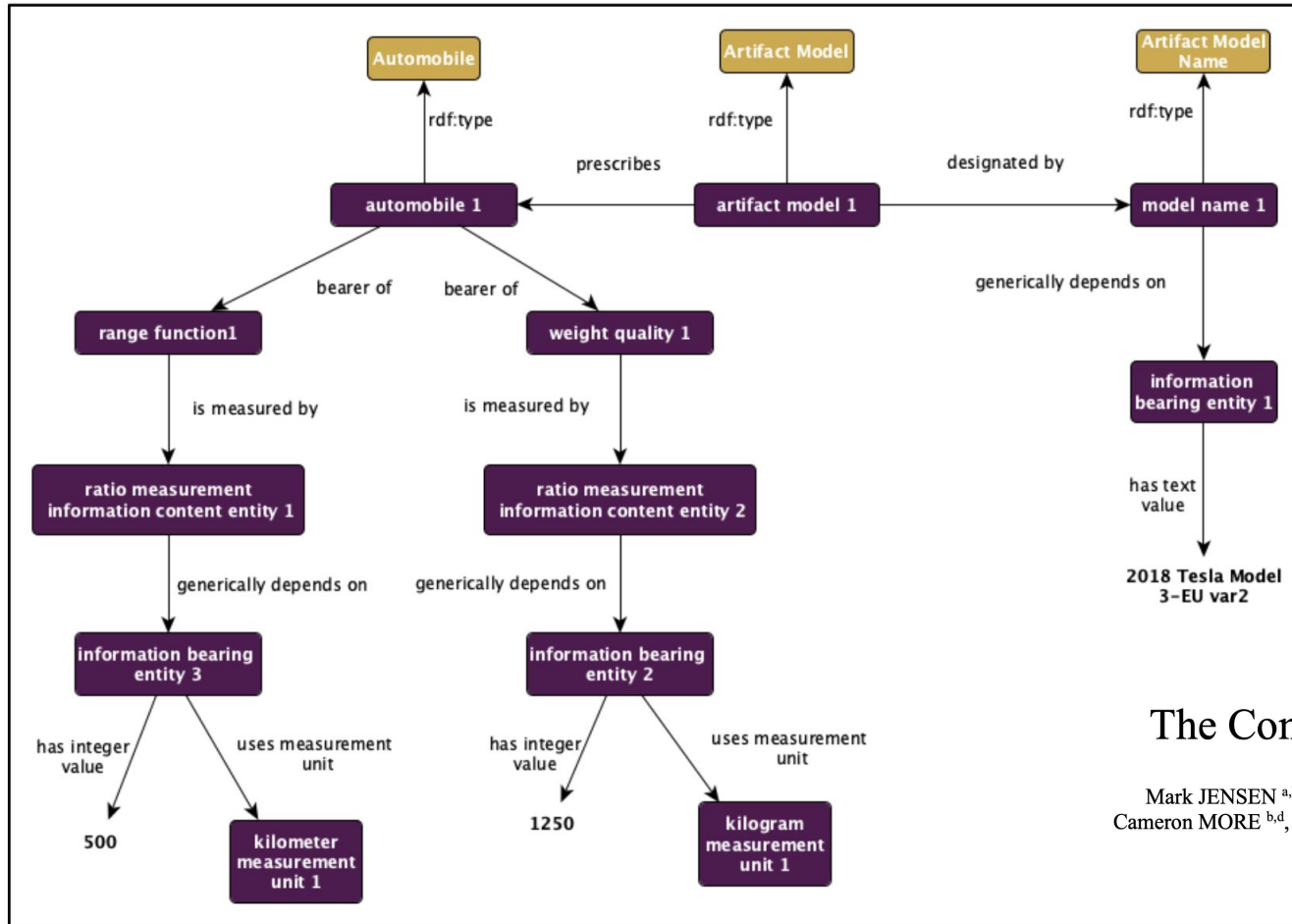
Basic Formal Ontology: Case Studies

J. Neil Otte[1], John Beverley[2], and Alan Ruttenberg[3]
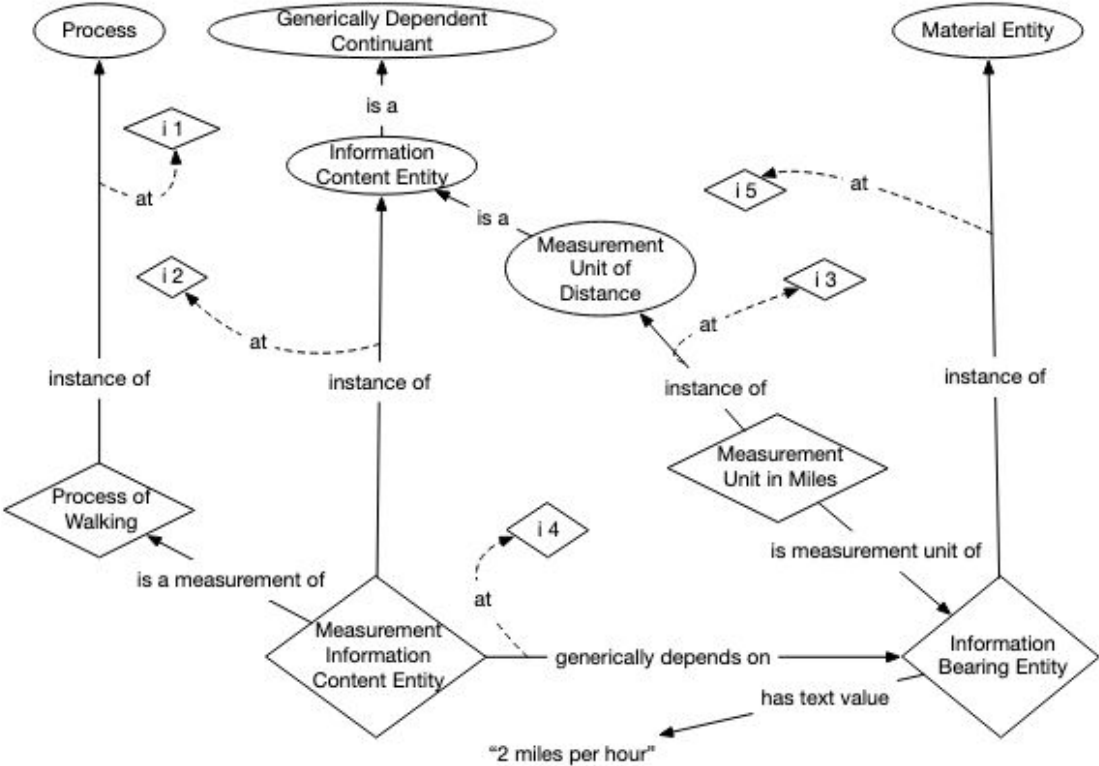
Figure 3: Relationships among Information Content Entities and Bearers

Basic Formal Ontology: Case Studies

J. Neil Otte[1], John Beverley[2], and Alan Ruttenberg[3]

Figure 4: Table Undergoing Change in Case 1

Basic Formal Ontology: Case Studies

J. Neil Otte[1], John Beverley[2], and Alan Ruttenberg[3]

Figure 5: Resignation and Assignment of 2C Teacher Roles in Case 2

Basic Formal Ontology: Case Studies

J. Neil Otte[1], John Beverley[2], and Alan Ruttenberg[3]
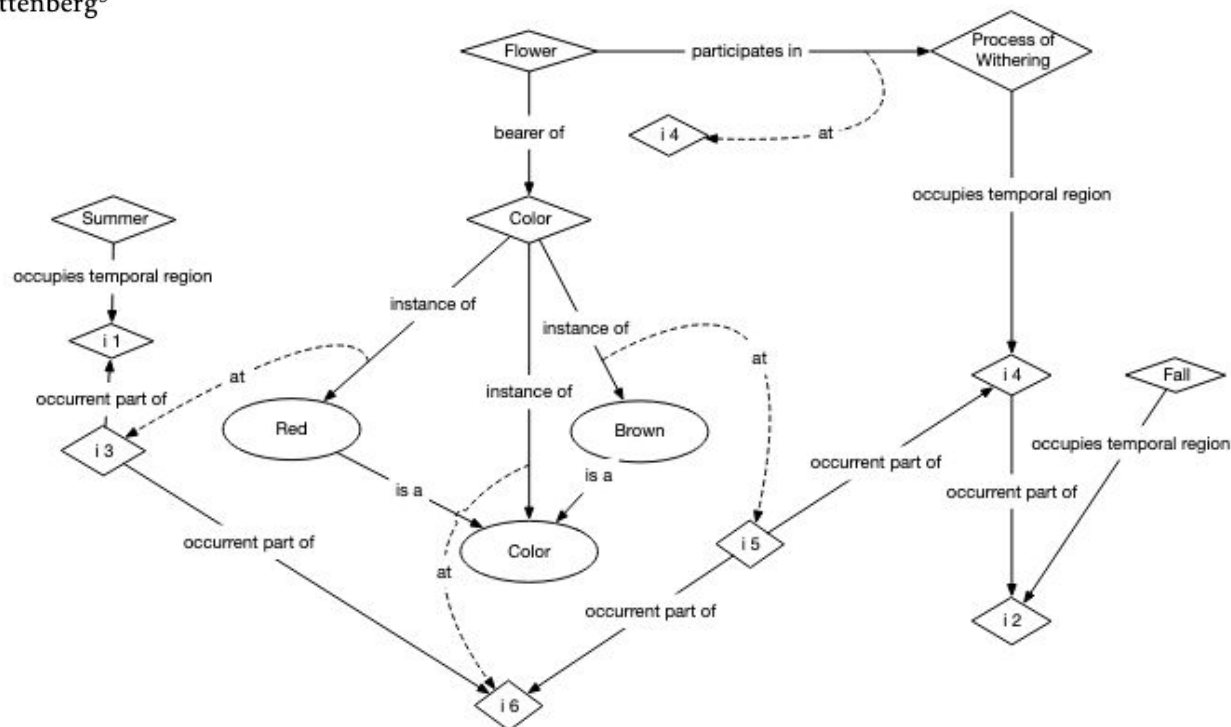
Figure 6: Petal Changing Color in Case 3

Basic Formal Ontology: Case Studies

J. Neil Otte[1], John Beverley[2], and Alan Ruttenberg[3]
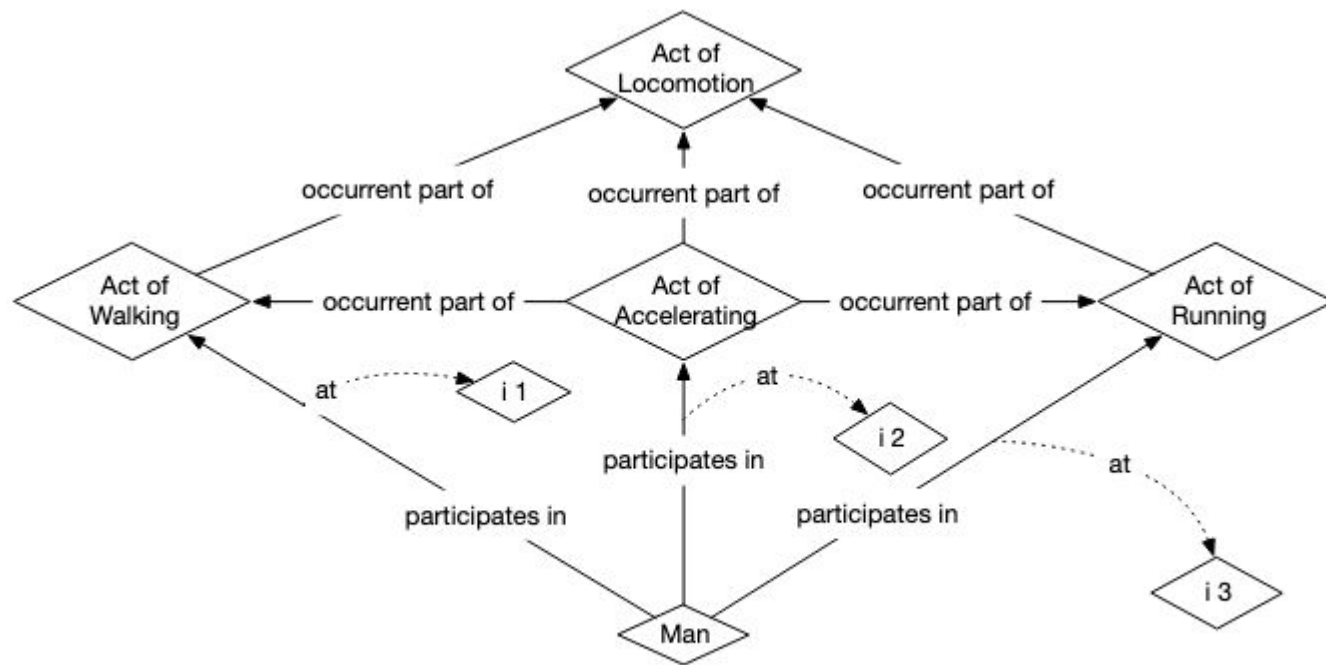
Figure 7: Man Moving with Increasing Speed in Case 4
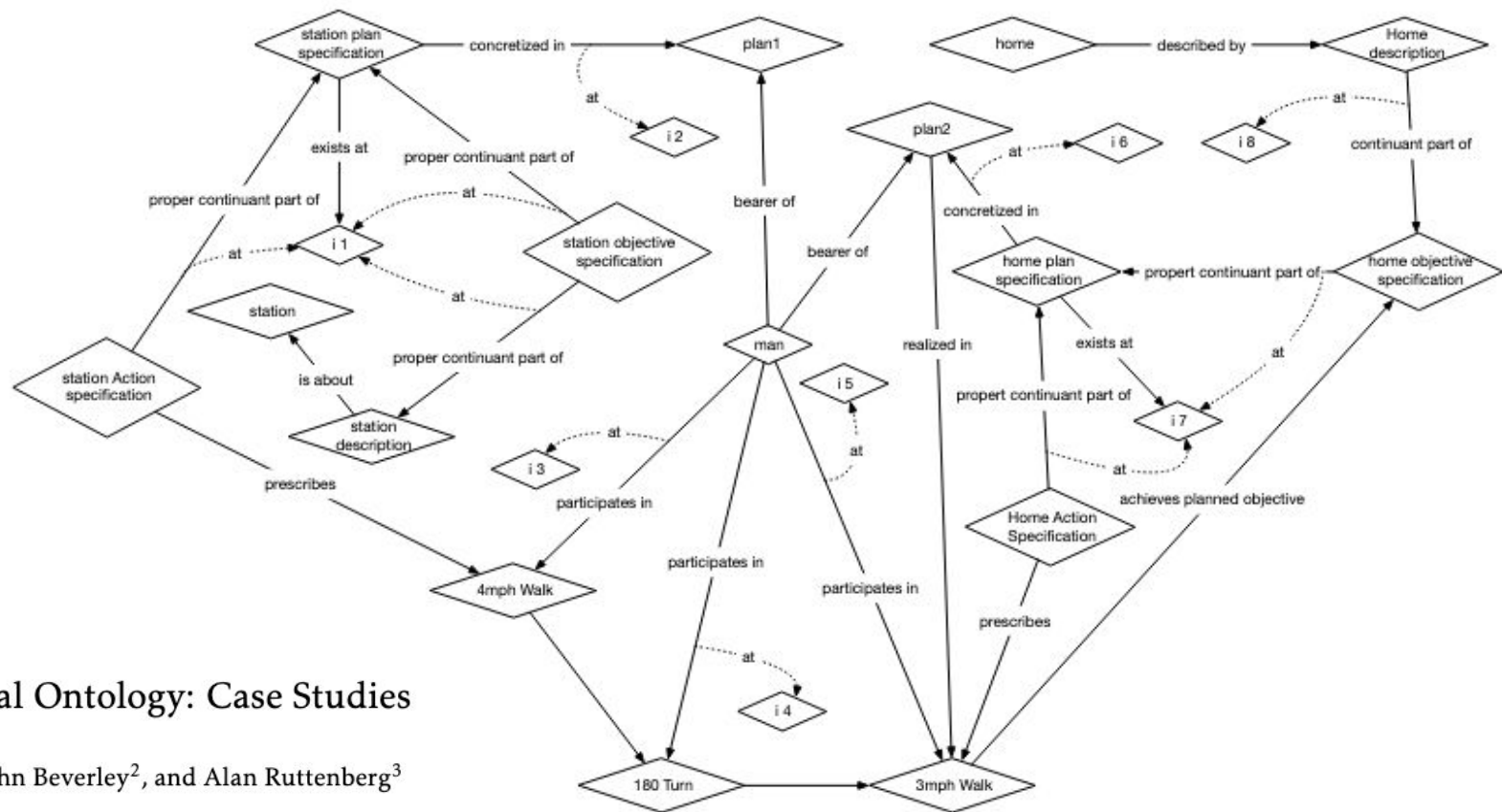
Basic Formal Ontology: Case Studies

J. Neil Otte[1], John Beverley[2], and Alan Ruttenberg[3]

Figure 8: Man Walking to Station, then Home in Case 5
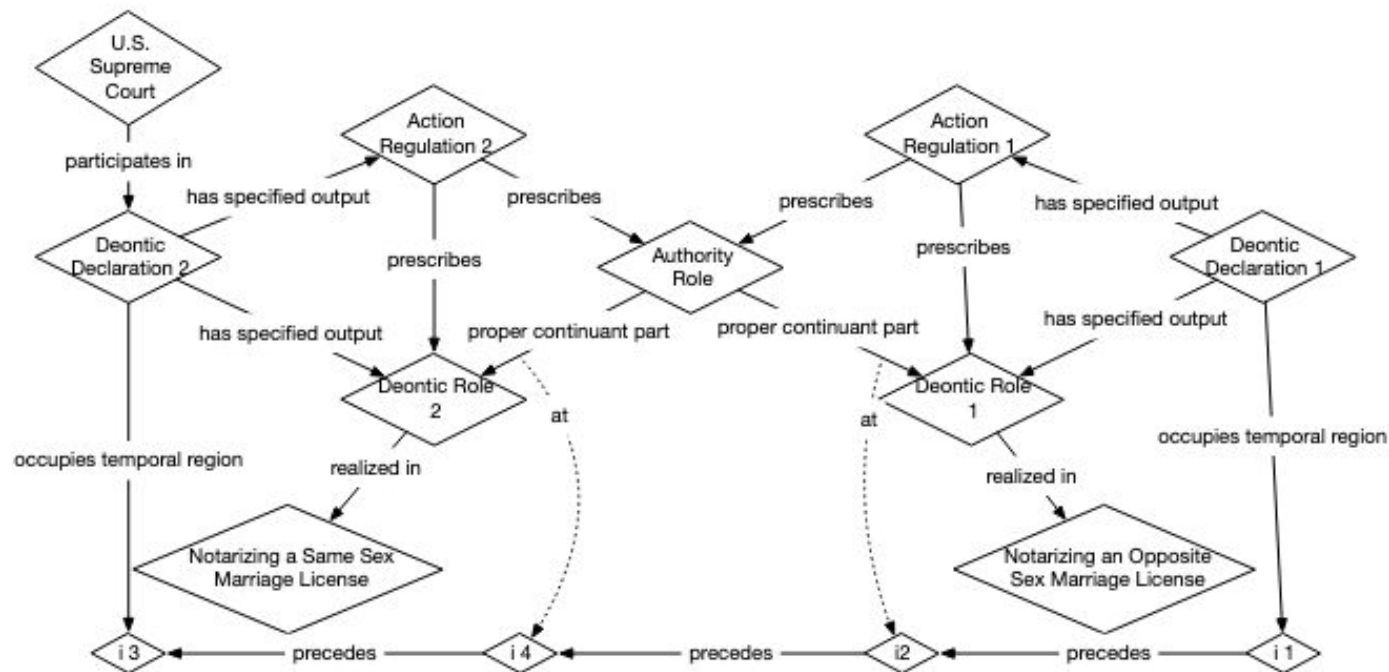
Figure 9: Changing Deontic Roles in Case 6

Basic Formal Ontology: Case Studies

J. Neil Otte[1], John Beverley[2], and Alan Ruttenberg[3]

Starting and ending a process
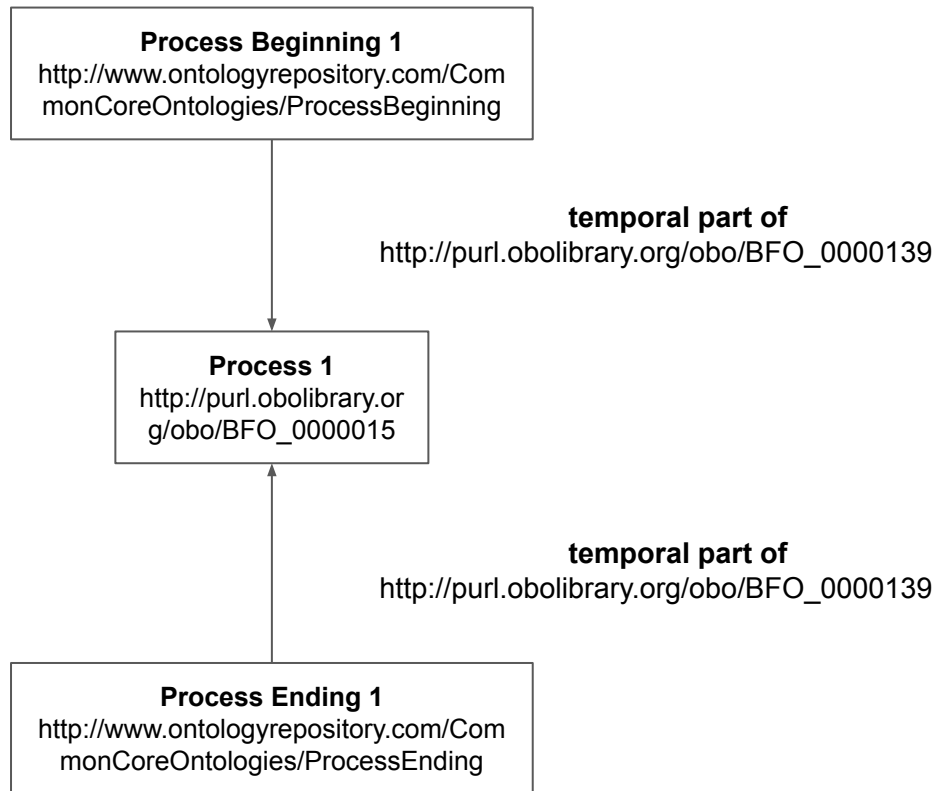
Process Beginning 1
http://www.ontologyrepository.com/CommonCoreOntologies/ProcessBeginning

temporal part of
http://purl.obolibrary.org/obo/BFO_0000139

Process 1
http://purl.obolibrary.org/obo/BFO_0000015

temporal part of
http://purl.obolibrary.org/obo/BFO_0000139

Process Ending 1
http://www.ontologyrepository.com/CommonCoreOntologies/ProcessEnding

The boxes depict instances of classes with the corresponding IRI. Arrows are relations of the corresponding IRI.

First and Last Moments of Temporal Regions
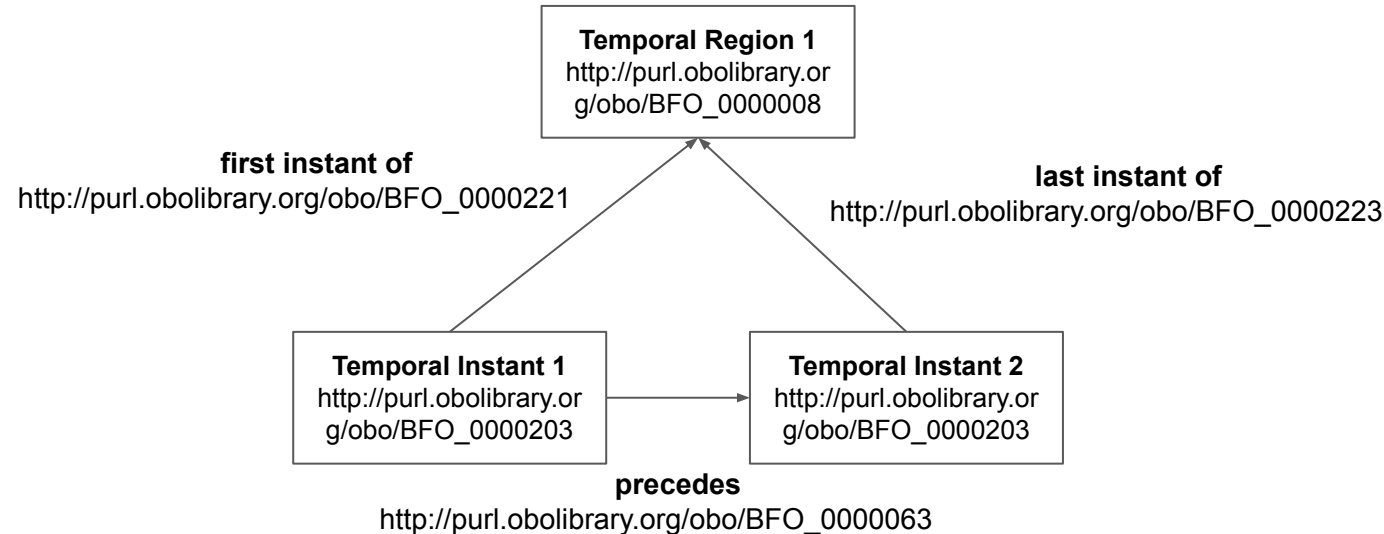
Temporal Region 1
http://purl.obolibrary.or
g/obo/BFO_0000008

first instant of
http://purl.obolibrary.org/obo/BFO_0000221

last instant of
http://purl.obolibrary.org/obo/BFO_0000223

Temporal Instant 1
http://purl.obolibrary.or
g/obo/BFO_0000203

Temporal Instant 2
http://purl.obolibrary.or
g/obo/BFO_0000203

precedes
http://purl.obolibrary.org/obo/BFO_0000063

The boxes depict instances of classes with the corresponding IRI. Arrows are relations of the corresponding IRI.

Tracking spatiotemporal and temporal information for processes

occupies temporal region
http://purl.obolibrary.org/obo/BFO_0000199

Temporal Region 1
http://purl.obolibrary.org/obo/
BFO_0000008

Process 1
http://purl.obolibrary.org/obo/BFO_0000015

Spatiotemporal Region 1
http://purl.obolibrary.org/obo/
BFO_0000011

occupies spatiotemporal region
http://purl.obolibrary.org/obo/BFO_0000200

The boxes depict instances of classes with the corresponding IRI. Arrows are relations of the corresponding IRI.

Starting and ending processes in time

The boxes depict instances of classes with the corresponding IRI. Arrows are relations of the corresponding IRI.

occupies temporal region
http://purl.obolibrary.org/obo/BFO_0000199

Process Beginning 1
http://www.ontologyrepository.com/CommonCoreOntologies/ProcessBeginning

Temporal Instant 1
http://purl.obolibrary.org/obo/BFO_0000203

temporal part of
http://purl.obolibrary.org/obo/BFO_0000139

first instant of
http://purl.obolibrary.org/obo/BFO_0000221

occupies temporal region
http://purl.obolibrary.org/obo/BFO_0000199

Process 1
http://purl.obolibrary.org/obo/BFO_0000015

Temporal Region 1
http://purl.obolibrary.org/obo/BFO_0000008

temporal part of
http://purl.obolibrary.org/obo/BFO_0000139

last instant of
http://purl.obolibrary.org/obo/BFO_0000223

Process Ending 1
http://www.ontologyrepository.com/CommonCoreOntologies/ProcessEnding

Temporal Instant 2
http://purl.obolibrary.org/obo/BFO_0000203

occupies temporal region
http://purl.obolibrary.org/obo/BFO_0000199

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Separating space and time information from spacetime information

Temporal Region 1
http://purl.obolibrary.org/obo/BFO_0000008

Spatial Region 1
http://purl.obolibrary.org/obo/BFO_0000006

temporally projects onto
http://purl.obolibrary.org/obo/BFO_0000153

spatially projects onto
http://purl.obolibrary.org/obo/BFO_0000216

Spatiotemporal Region 1
http://purl.obolibrary.org/obo/BFO_0000011

The boxes depict instances of classes with the corresponding IRI. Arrows are relations of the corresponding IRI.

Inserting dates

rdfs:subclassOf

rdfs:subclassOf

Calendar date identifier (class)
http://www.ontologyrepository.com/CommonCoreOntologies/CalendarDateIdentifier

Date Identifier (class)
http://www.ontologyrepository.com/CommonCoreOntologies/DateIdentifier

Temporal Interval Identifier (class)
http://www.ontologyrepository.com/CommonCoreOntologies/TemporalIntervalIdentifier

rdf:type

Calendar Date Identifier 1 (e.g. "Tuesday")
http://www.ontologyrepository.com/CommonCoreOntologies/CalendarDateIdentifier

designates
http://www.ontologyrepository.com/CommonCoreOntologies/designates

Temporal Region 1
http://purl.obolibrary.org/obo/BFO_0000008

generically depends on
http://purl.obolibrary.org/obo/BFO_0000084

Information Bearing Entity 1
http://www.ontologyrepository.com/CommonCoreOntologies/InformationBearingEntity

has datetime value
http://www.ontologyrepository.com/CommonCoreOntologies/has_datetime_value

datetime value 1

The white boxes depict instances of classes with the corresponding IRI. Arrows are relations of the corresponding IRI. Gray boxes depict classes with the corresponding IRI..
Diamonds depict instances of datatypes. Rounded boxes are classes with the corresponding IRI.

Measurement Data

The white boxes depict instances of classes with the corresponding IRI. Arrows are relations of the corresponding IRI. Gray boxes depict classes with the corresponding IRI..
Diamonds depict instances of datatypes. Rounded boxes are classes with the corresponding IRI.

Measurement Information Content Entity 1 (e.g. "Mass of Pencil")
http://www.ontologyrepository.com/CommonCoreOntologies/MeasurementInformationContentEntity

generically depends on
http://purl.obolibrary.org/obo/BFO_0000084

Information Bearing Entity 1
http://www.ontologyrepository.com/CommonCoreOntologies/InformationBearingEntity

has decimal value
http://www.ontologyrepository.com/CommonCoreOntologies/has_datetime_value

integer value 1 (e.g. "8.4")

uses measurement unit
http://www.ontologyrepository.com/CommonCoreOntologies/uses_measurement_unit

Gram Measurement Unit
http://www.ontologyrepository.com/CommonCoreOntologies/MeasurementUnitOfMass

rdf:type

Measurement Unit of Mass (Class)
http://www.ontologyrepository.com/CommonCoreOntologies/MeasurementUnitOfMass

21
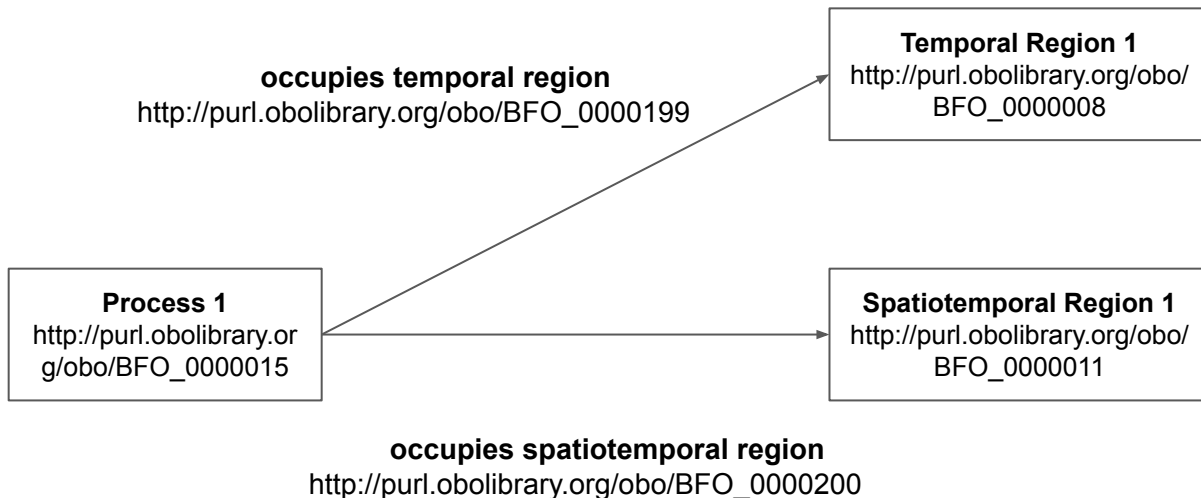
Sites and spatial regions

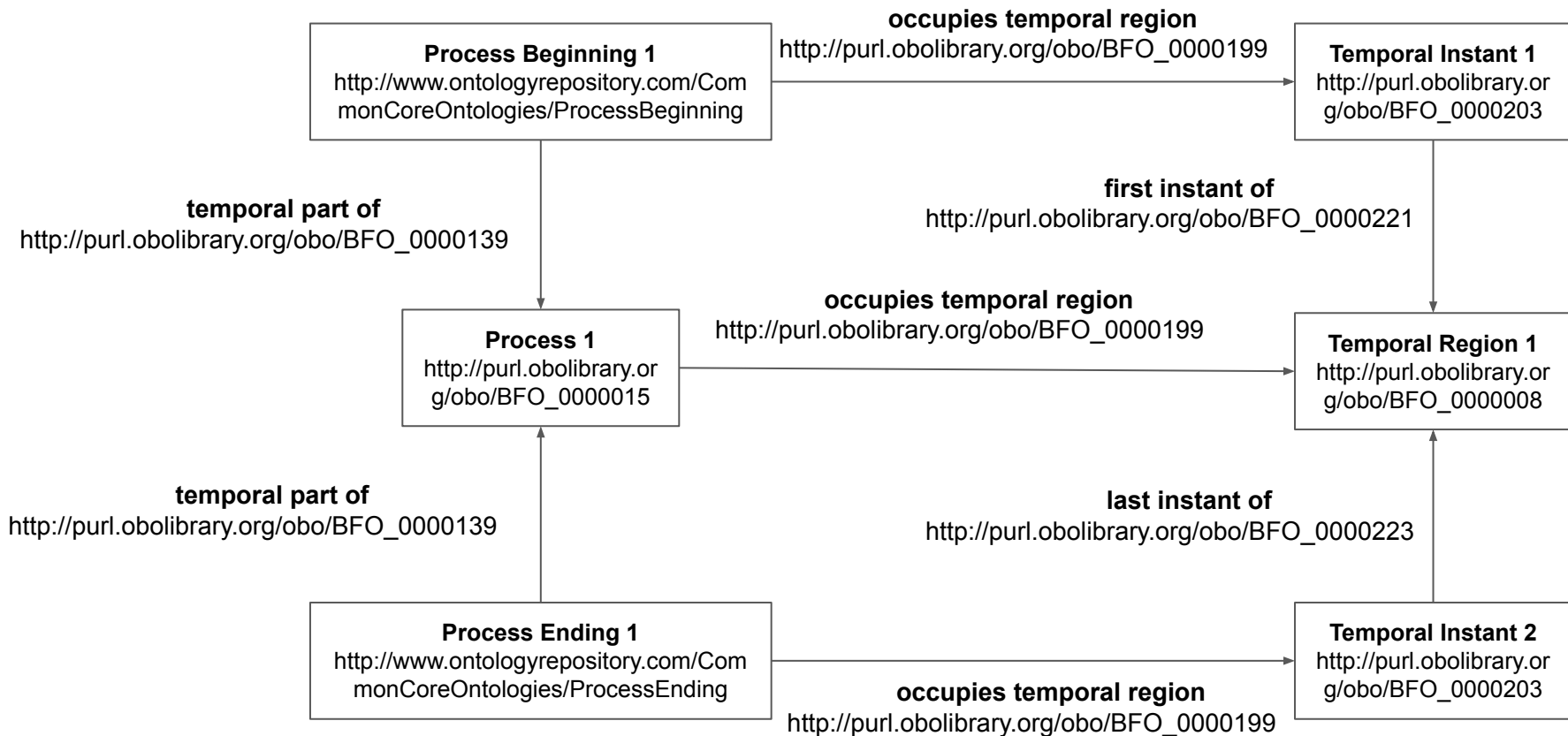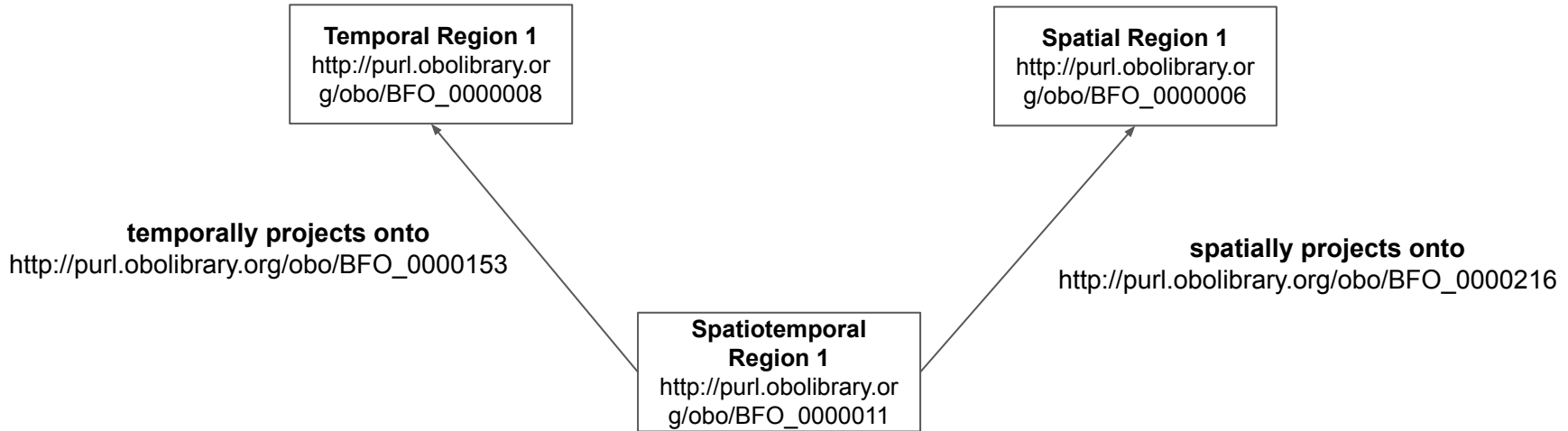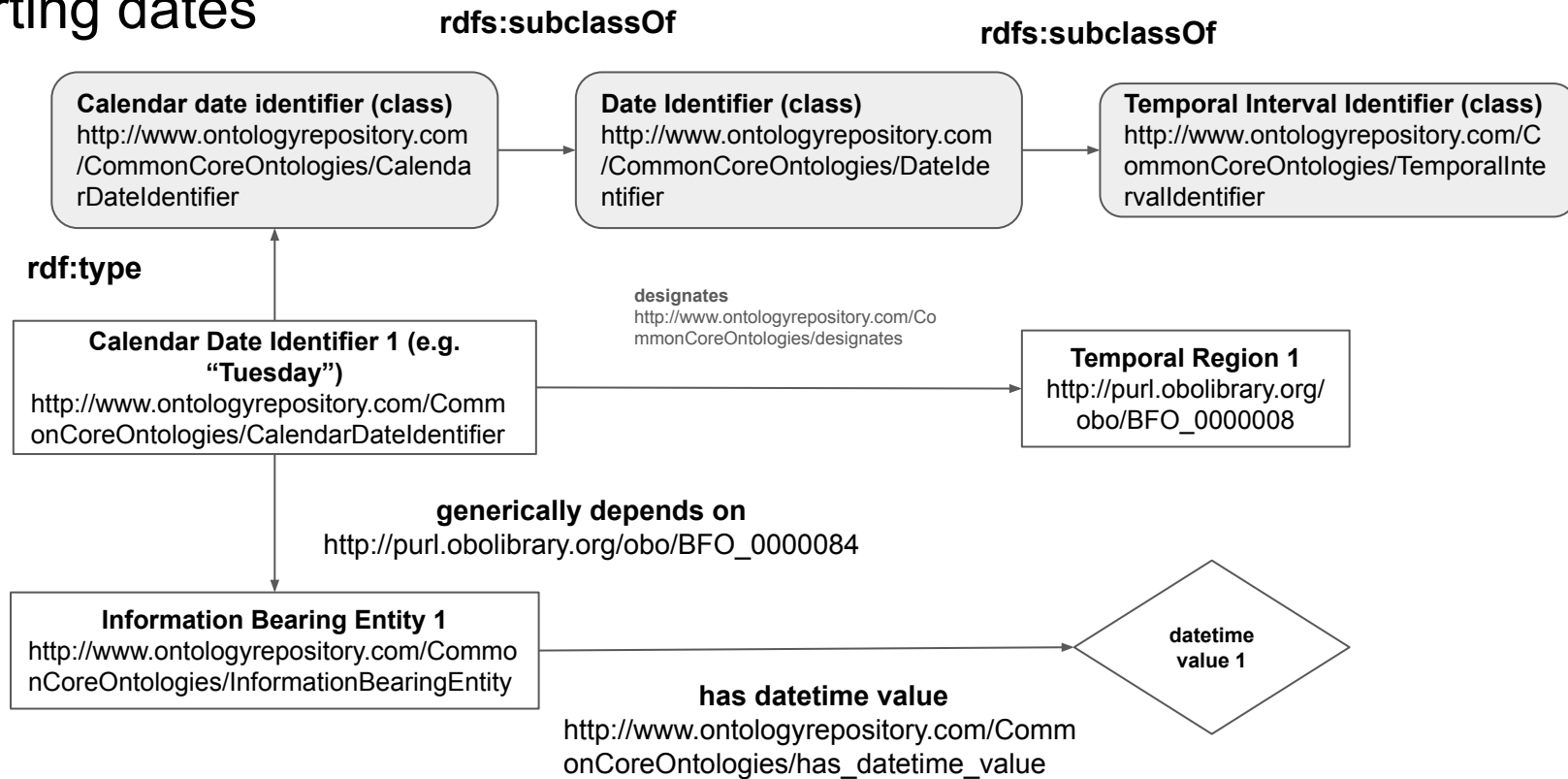The boxes depict instances of classes with the corresponding IRI. Arrows are relations of the corresponding IRI.

```
┌─────────────────────┐    occupies spatial region       ┌─────────────────────┐
│  Site 1 (e.g. "United│  http://purl.obolibrary.org/obo/BFO_0 │                     │
│     States")        │  000210                          │   Spatial region 1  │
│ http://purl.obolibrary.org/o │──────────────────────▶  │ http://purl.obolibrary.org/o │
│   bo/BFO_0000029    │                                  │   bo/BFO_0000006    │
└─────────────────────┘                                  └─────────────────────┘
```

Site of a Process

Process 1 (e.g. "Presidential elections)
http://purl.obolibrary.org/obo/BFO_0000015

occurs at
http://www.ontologyrepository.com/CommonCoreOntologies/occurs_at

Site 1 (e.g. "United States)
http://purl.obolibrary.org/obo/BFO_0000029

The boxes depict instances of classes with the corresponding IRI. Arrows are relations of the corresponding IRI.

Location of Independent Continuants
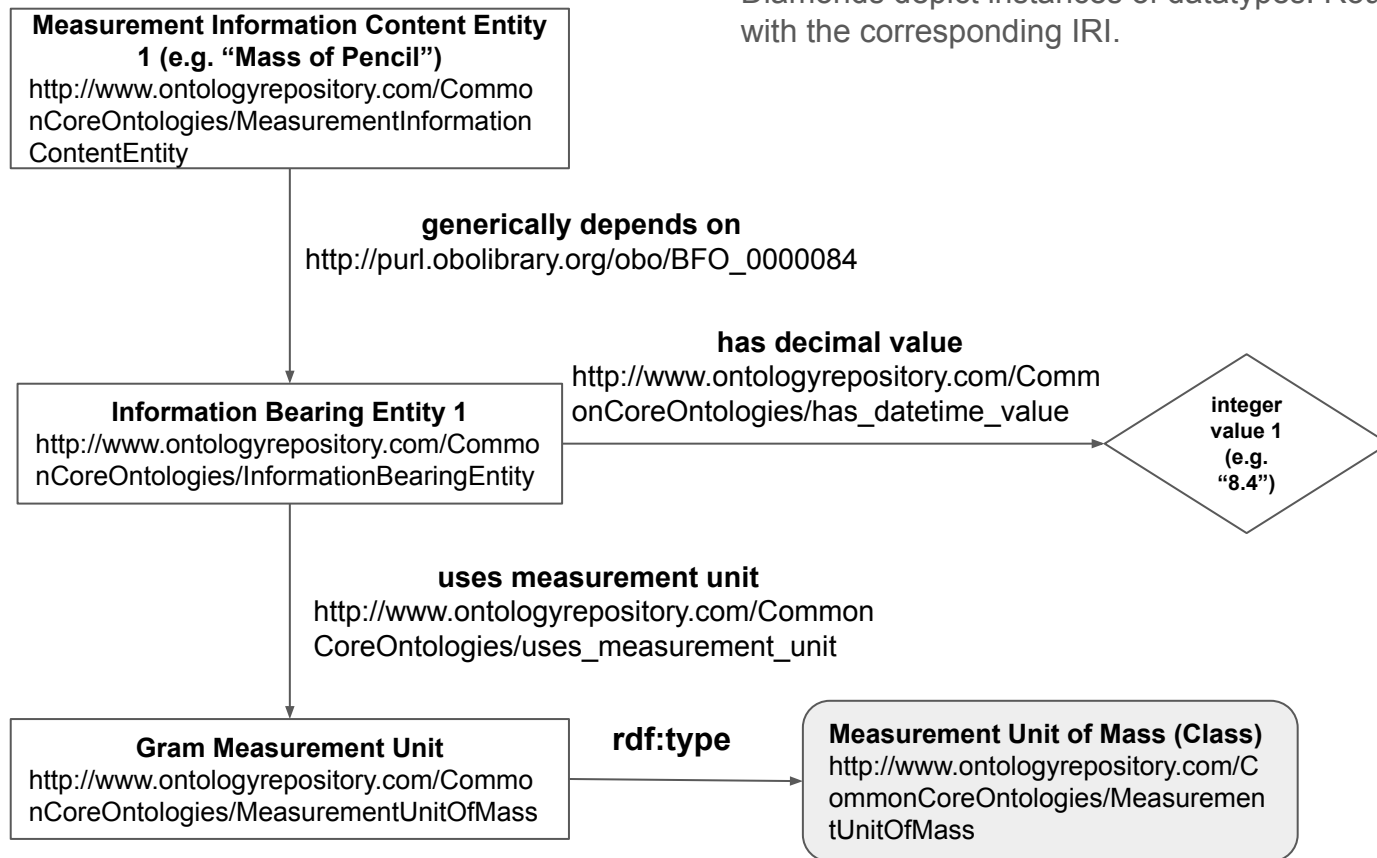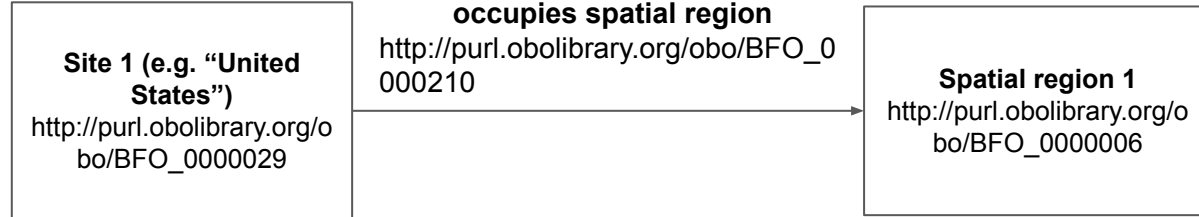

The boxes depict instances of classes with the corresponding IRI. Arrows are relations of the corresponding IRI.

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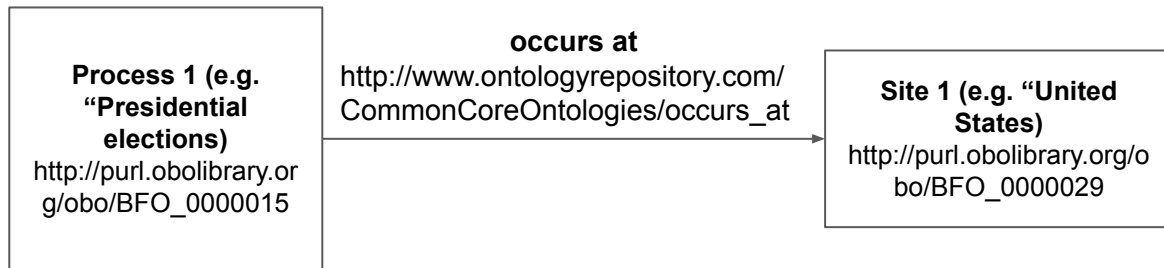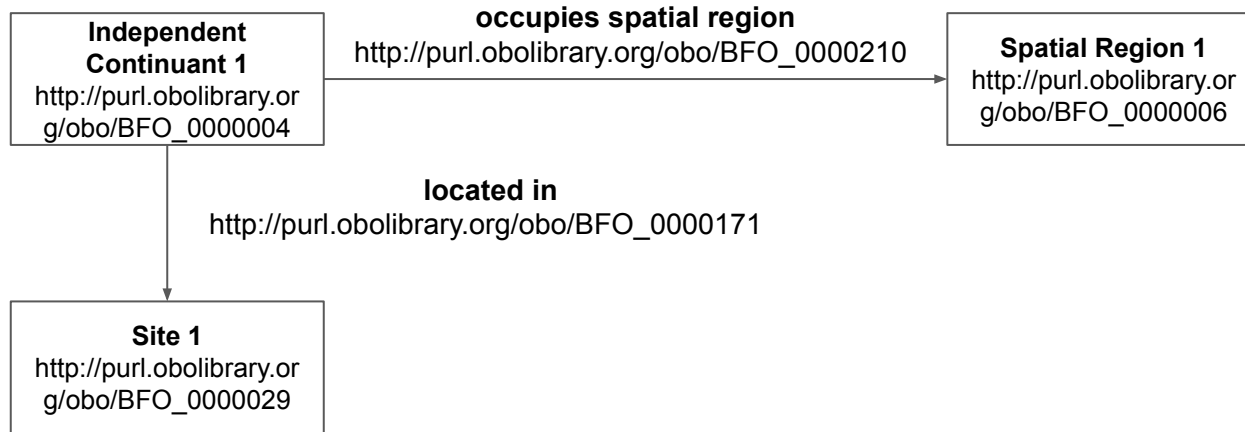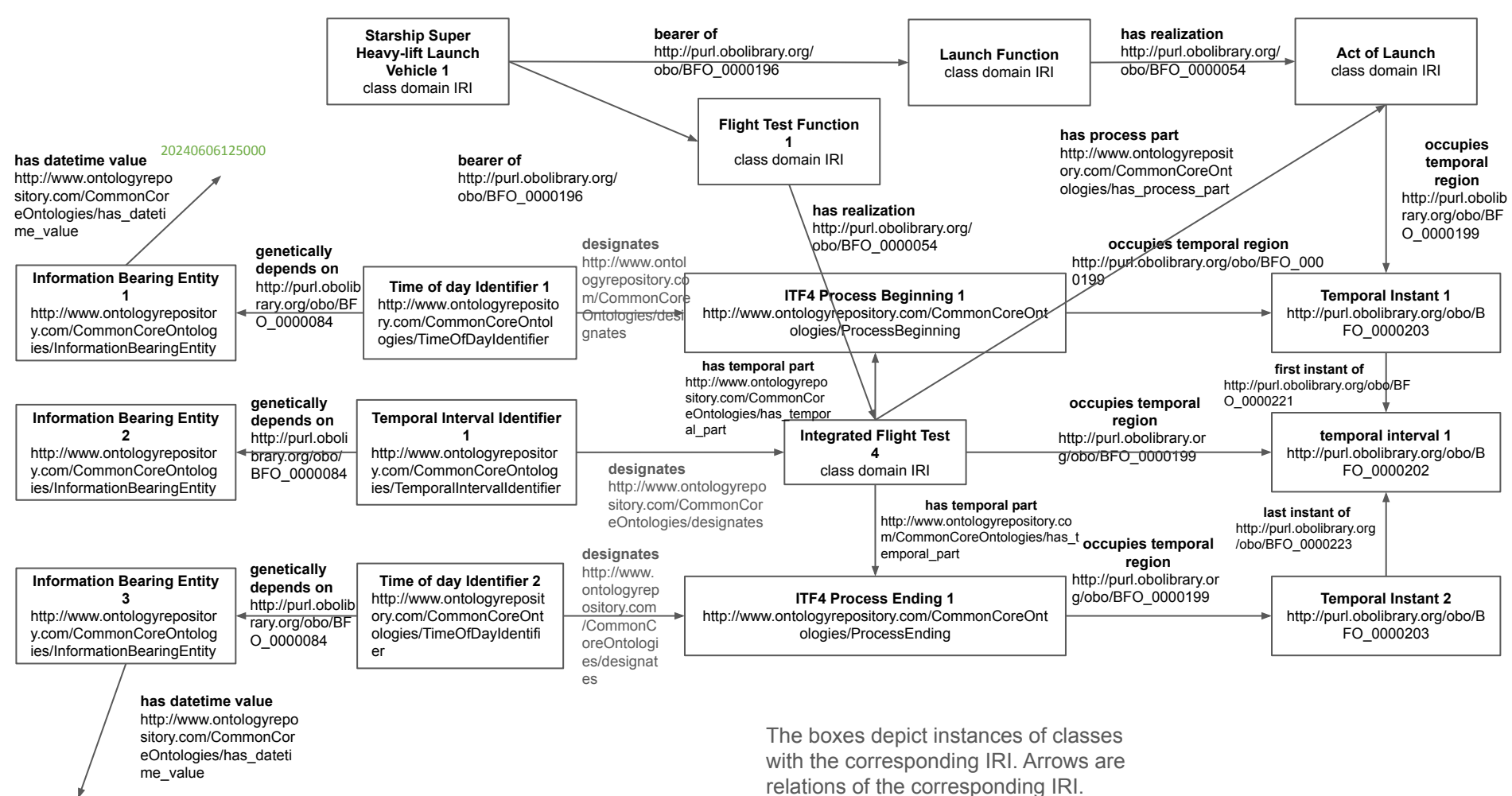
25

The boxes depict instances of classes with the corresponding IRI. Arrows are relations of the corresponding IRI.

Starship Super Heavy-lift Launch Vehicle 1
class domain IRI

bearer of
http://purl.obolibrary.org/obo/BFO_0000196

Flight Test Function 1
class domain IRI

has realization
http://purl.obolibrary.org/obo/BFO_0000054

participates in
http://purl.obolibrary.org/obo/BFO_0000056

9000

has integer value
http://www.ontologyrepository.com/CommonCoreOntologies/has_integer_value

is measured by ordinal
http://www.ontologyrepository.com/CommonCoreOntologies/is_measured_by_ordinal

has occurrent part
http://www.ontologyrepository.com/CommonCoreOntologies/has_occurrent_part

Information Bearing Entity 2
http://www.ontologyrepository.com/CommonCoreOntologies/InformationBearingEntity

genetically depends on
http://purl.obolibrary.org/obo/BFO_0000084

Max Velocity 2
http://www.ontologyrepository.com/CommonCoreOntologies/OrdinalMeasurementInformationContentEntity

Integrated Flight Test 4 Velocity
http://www.ontologyrepository.com/CommonCoreOntologies/Velocity

Integrated Flight Test 4
class domain IRI

has process part
http://www.ontologyrepository.com/CommonCoreOntologies/has_process_part

Information Bearing Entity 1
http://www.ontologyrepository.com/CommonCoreOntologies/InformationBearingEntity

genetically depends on
http://purl.obolibrary.org/obo/BFO_0000084

Max Velocity 1
http://www.ontologyrepository.com/CommonCoreOntologies/OrdinalMeasurementInformationContentEntity

Spacecraft Integrated Flight Test 4 velocity
http://www.ontologyrepository.com/CommonCoreOntologies/Velocity

has occurrent part
http://www.ontologyrepository.com/CommonCoreOntologies/has_occurrent_part

Spacecraft Integrated Flight Test 4
class domain IRI

participates in
http://purl.obolibrary.org/obo/BFO_0000056

has integer value
http://www.ontologyrepository.com/CommonCoreOntologies/has_integer_value

is measured by ordinal
http://www.ontologyrepository.com/CommonCoreOntologies/is_measured_by_ordinal

Starship Spacecraft 1
class domain IRI

1300