



PROV-O: PROV's OWL Ontology

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prov:actedOnBehalfOf

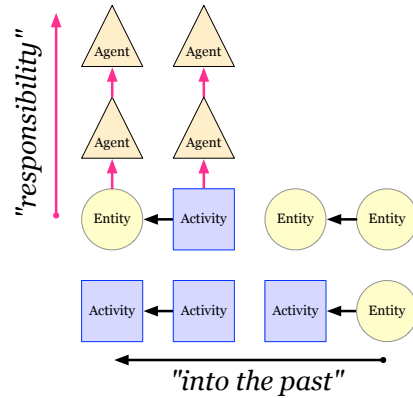
<prov-o_team> .

<<http://www.w3.org/ns/prov#>>

- A lightweight OWL-RL ontology
 - Encodes PROV-DM’s “abstract model” in RDF
 - Provenance information *interchange*
 - Domain-neutral
- Designed to be extensible
 - Dublin Core profile
 - the Provenance Vocabulary extension (<http://purl.org/net/provenance/ns#>)
 - PML 3.0

Overview

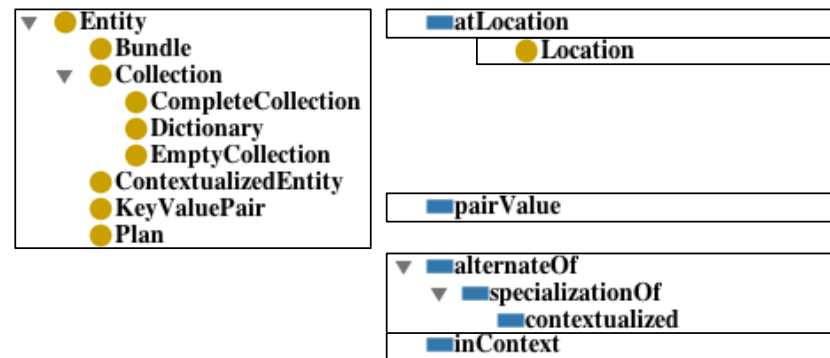
Part 1:



```

:swissair_Flight_111_crash
  a prov:Activity;
  prov:used <http://dbpedia.org/
  prov:startedAtTime "2012-09-02T01:31:06
  prov:atLocation <http://dbpedia.org/
  .
  
```

Part 2:



GET <http://www.w3.org/ns/prov#>

- Latest editor's draft:
 - <http://bit.ly/prov-o-html>
 - <http://bit.ly/prov-o> (OWL file)
- Latest public draft:
 - curl -H "Accept: text/html" -L <http://www.w3.org/ns/prov#>
 - curl -H "Accept: application/rdf+xml" -L <http://www.w3.org/ns/prov#>
 - curl -H "Accept: text/turtle" -L <http://www.w3.org/ns/prov#>

Namespaces

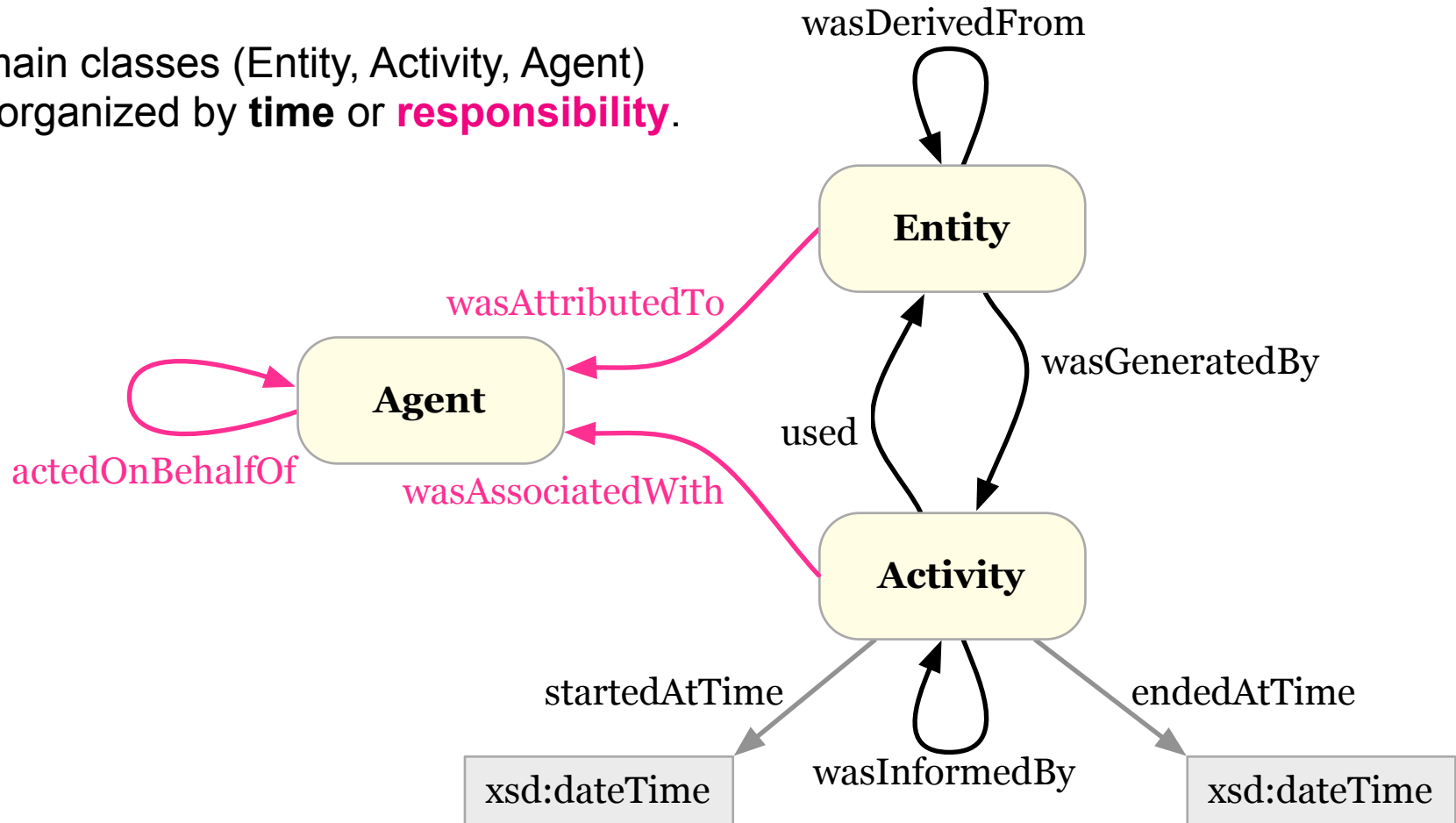
- @prefix rdfs: <<http://www.w3.org/2000/01/rdf-schema#>> .
 - @prefix xsd: <<http://www.w3.org/2001/XMLSchema#>> .
 - @prefix owl: <<http://www.w3.org/2002/07/owl#>> .
 - @prefix prov: <<http://www.w3.org/ns/prov#>> .
 - @prefix : <<http://example.com/>> .
-
- “When in doubt, prefix.cc.” (e.g. <http://prefix.cc/rdfs>)

PROV-O at a glance

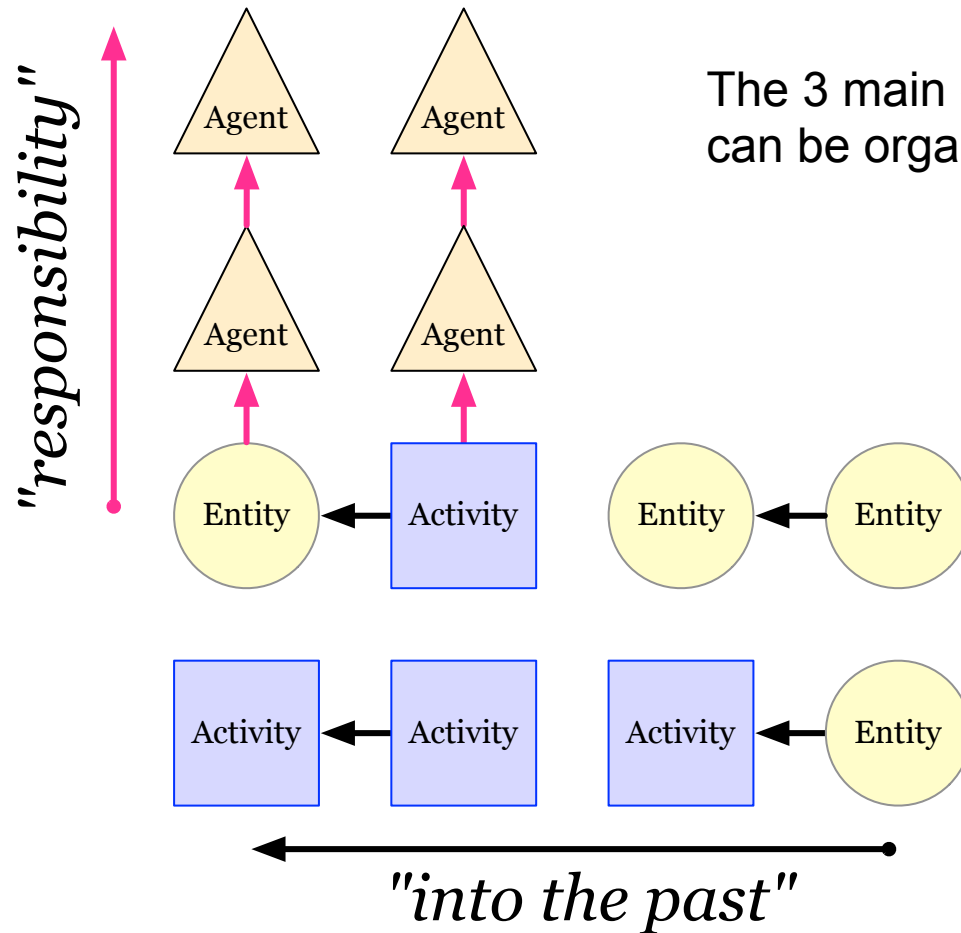
- **Starting point** terms
 - The basis for the rest of the ontology
 - 3 classes + 9 properties
 - Simple, binary relations
- **Expanded** terms
 - 5 classes + 16 properties
 - Adds subclasses and subproperties
- Terms to **Qualify** relationships
 - Describes 14 binary Starting + Expanded relationships
- **Collections**

(1/4) Starting Points

The 3 main classes (Entity, Activity, Agent) can be organized by **time** or **responsibility**.



(1/4) Starting Points



The 3 main classes (Entity, Activity, Agent) can be organized by **time** or **responsibility**.

- actedOnBehalfOf
- wasAttributedTo
- wasAssociatedWith
- used, wasDerivedFrom
- wasInformedBy, wasGeneratedBy
- startedAtTime, endedAtTime

(1/4) Starting Points example

```
:geneSequencing
  a prov:Activity;
  prov:startedAtTime "2012-04-25T01:30:00Z"^^xsd:dateTime;
  prov:used          :drosophilaSample-84;
  prov:wasAssociatedWith :lab-technician-GH-32;
  prov:endedAtTime    "2012-04-25T03:40:00Z"^^xsd:dateTime;
.

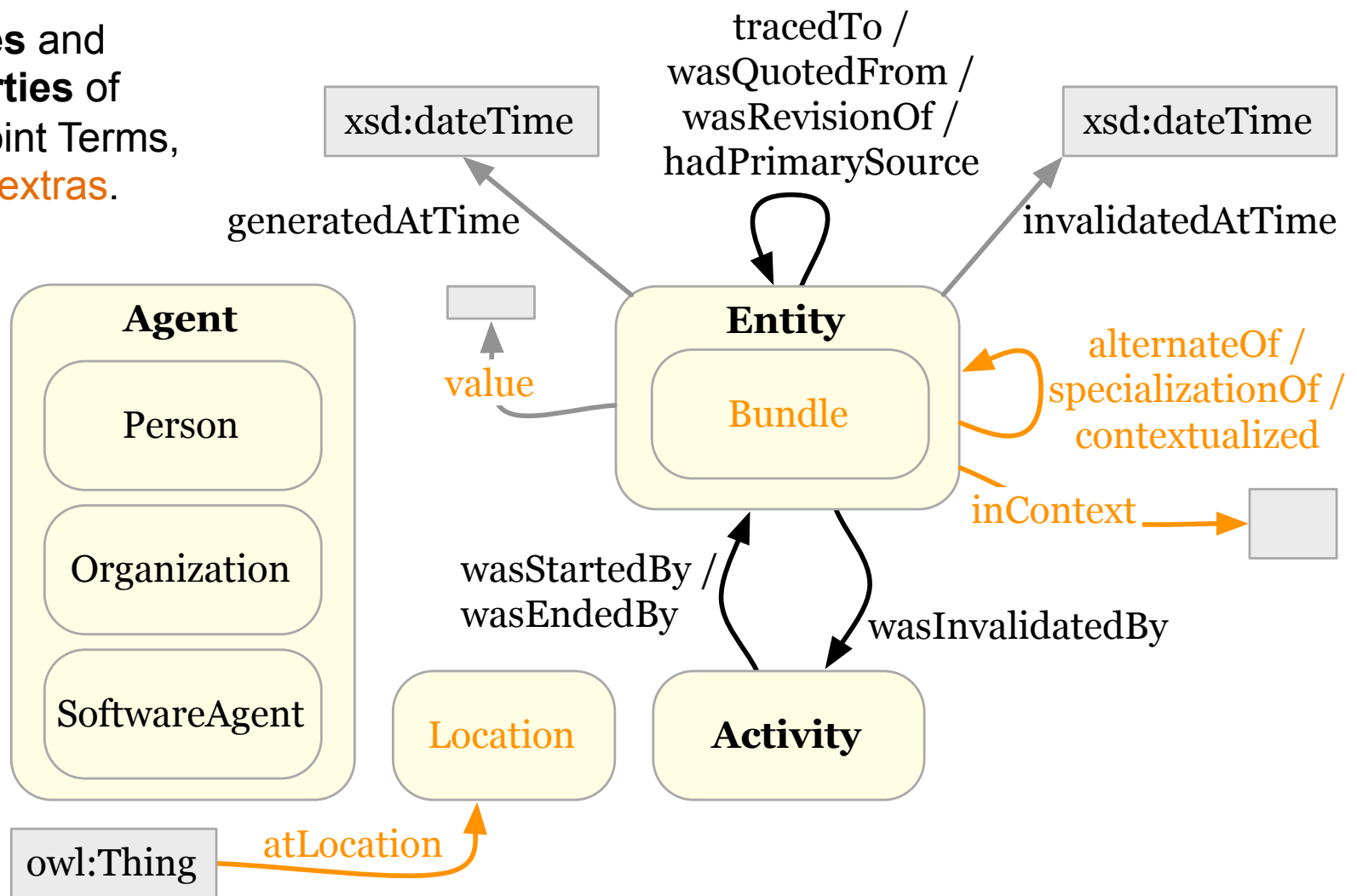
:drosophilaSample-84
  a prov:Entity;
  prov:wasAttributedTo :lab-technician-FE-56;
.

:lab-technician-GH-32 a prov:Agent .
:lab-technician-FE-56 a prov:Agent .
```

<> prov:wasQuotedFrom <<http://aquarius.tw.rpi.edu/prov-wg/prov-o#startedAtTime>> .

(2/4) Expanded Terms

Subclasses and subproperties of Starting Point Terms, plus a few **extras**.



Extended Terms (1/5):

prov:atLocation prov:Location

```
:swissair_Flight_111_crash
  a prov:Activity;
  prov:used          <http://dbpedia.org/resource/Swissair_Flight_111>;
  prov:startedAtTime "2012-09-02T01:31:00Z";
  prov:atLocation    <http://dbpedia.org/resource/Atlantic_ocean>;
.
```

Location can be geographic or non-geographic (directory, row, column, URL)

Extended Terms (2/5):

prov:value

```
:copied-string
  a prov:Entity;
  prov:value
    "2010-present: A. Scalia A. Kennedy C. Thomas R.B. Ginsburg S. Breyer
  prov:wasQuotedFrom
    <http://en.wikipedia.org/wiki/List_of_Justices_of_the_Supreme_Court_of
```

Extended Terms (3/5):

prov:specializationOf

“provenance of dynamic resources”

```
:copied-string
  a prov:Entity;
  prov:value
    "2010-present: A. Scalia A. Kennedy C. Thomas R.B. Ginsburg S. Breyer S. Al'
  prov:wasQuotedFrom :page-by-composition;
  <http://en.wikipedia.org/wiki/List_of_Justices_of_the_Supreme_Court_of_the_U
```

```
:page-by-composition
  a prov:Entity, :WikipediaPage;
  prov:specializationOf <http://en.wikipedia.org/wiki/List_of_Justices_of_the_!
  prov:wasGeneratedAtTime "2012-05-16T14:33"^^xsd:dateTime;
```

Extended Terms (3/5):

prov:specializationOf

“provenance of dynamic resources”

```
:activity_2
  a prov:Activity;
  prov:startedAtTime "2011-11-17T10:00:00"^^xsd:dateTime;
  prov:endedAtTime   "2011-11-17T17:00:00"^^xsd:dateTime;
  prov:wasAssociatedWith :bob;
```

.

```
tool:bob-2011-11-17 prov:specializationOf :bob .
```

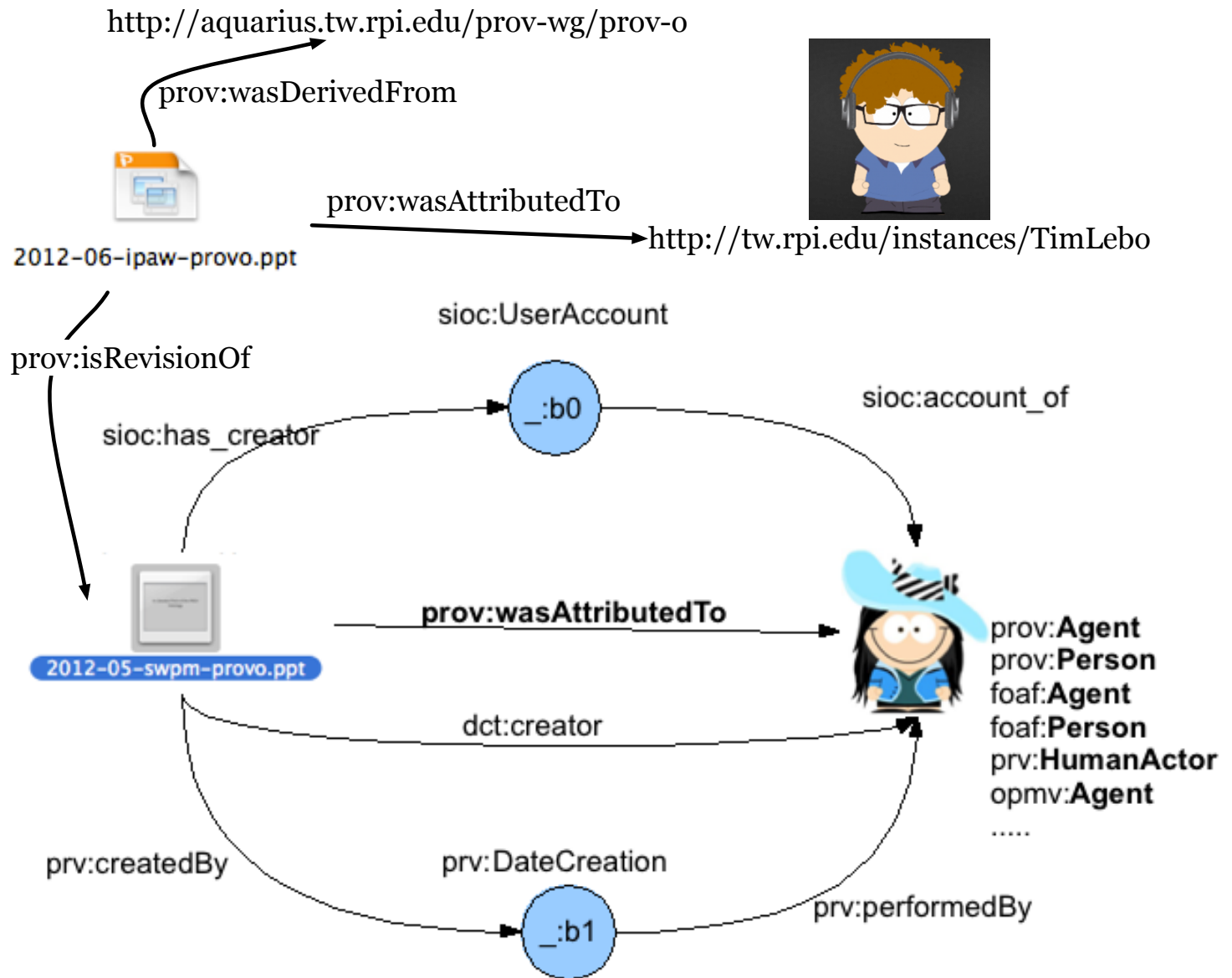
Extended Terms: **prov:Bundle** (4/5) provenance of provenance with a single Class!

```
bob:bundle1 {  
  :report1  
  a my:Report, prov:Entity;  
  my:version "1";  
  prov:generatedAtTime "2012-05-24T10:00:01"^^xsd:dateTime;  
  .  
}
```

```
bob:bundle1  
  a prov:Bundle;  
  prov:generatedAtTime "2012-05-24T10:30:00"^^xsd:dateTime;  
  prov:wasAttributedTo :Bob;  
  .
```

Extended Terms (5/5): prov:contextualized, prov:inContext

```
:run2 {  
  :activity_2  
    a prov:Activity;  
    prov:startedAtTime "2011-11-17T10:00:00"^^xsd:dateTime;  
    prov:endedAtTime   "2011-11-17T17:00:00"^^xsd:dateTime;  
    prov:wasAssociatedWith :bob;  
  .  
}  
  
tool:analysis_01 {  
  tool:bob-2011-11-17  
    a prov:Agent, prov:ContextualizedEntity;  
    prov:contextualized :bob;  
    prov:inContext      :run2;  
    perf:rating         perf:very-slow;  
  .  
}
```

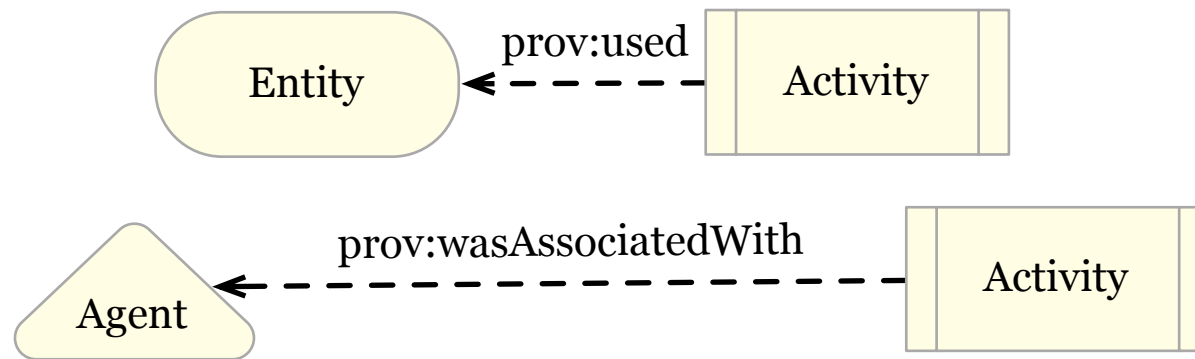



```
<> a :Slides;
prov:wasDerivedFrom [ a :Slides;
    prov:wasAttributedTo :Jun_Zhao
].
```

```
prefix prv: http://purl.org/net/provenance/ns#
prefix prov: http://www.w3.org/ns/prov#
prefix sioc: http://rdfs.org/sioc/ns#
prefix opmv: http://purl.org/net/opmv/ns#
prefix dct: http://purl.org/dc/terms/
prefix foaf: http://xmlns.com/foaf/0.1/
```

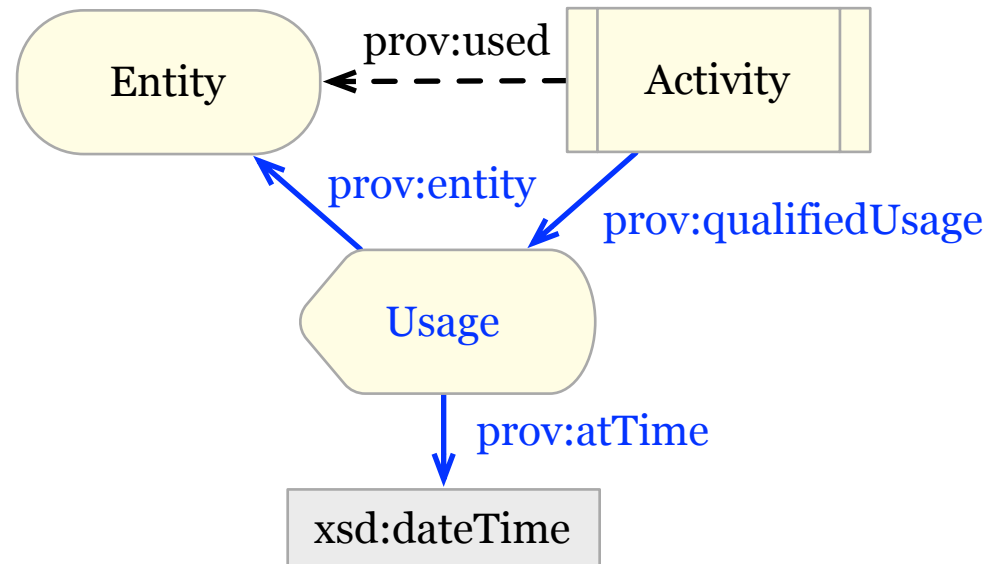
(3/4) Terms to Qualify

- Starting point and Expanded relations are binary:

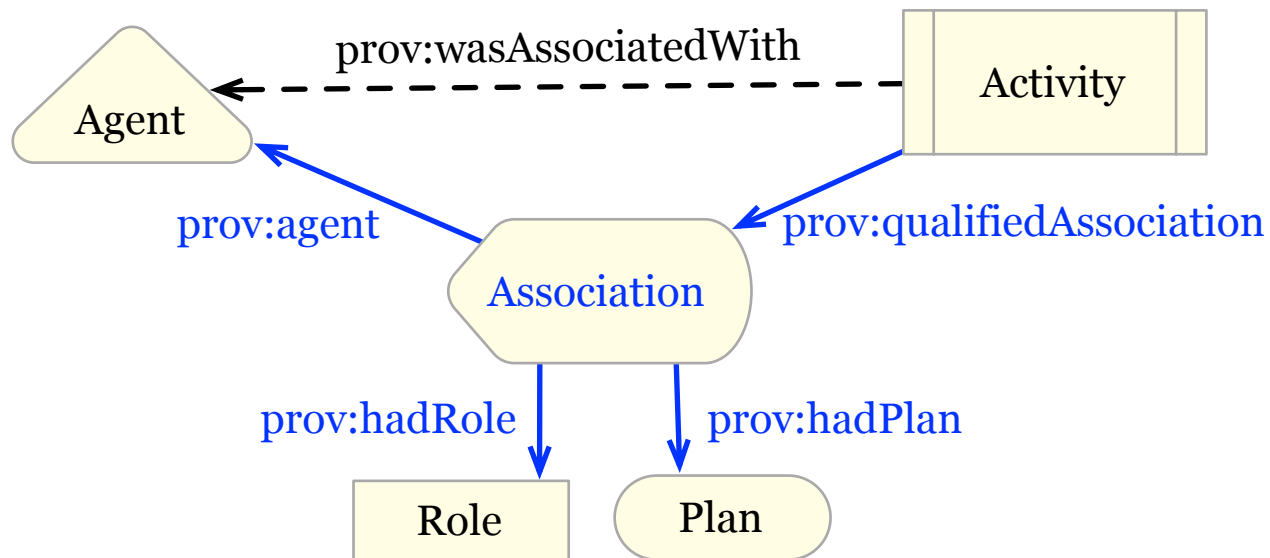


- But we may want to provide more details about that *use*, or *association*...
 - *When* and *where* did the Activity use the Entity?
 - *How* did the Agent perform in the Activity?

(3/4) Qualifying *Usage*



(3/4) Qualifying Association



(3/4) Qualifying *Association*:

prov:hadRole prov:Role and prov:hadPlan prov:Plan

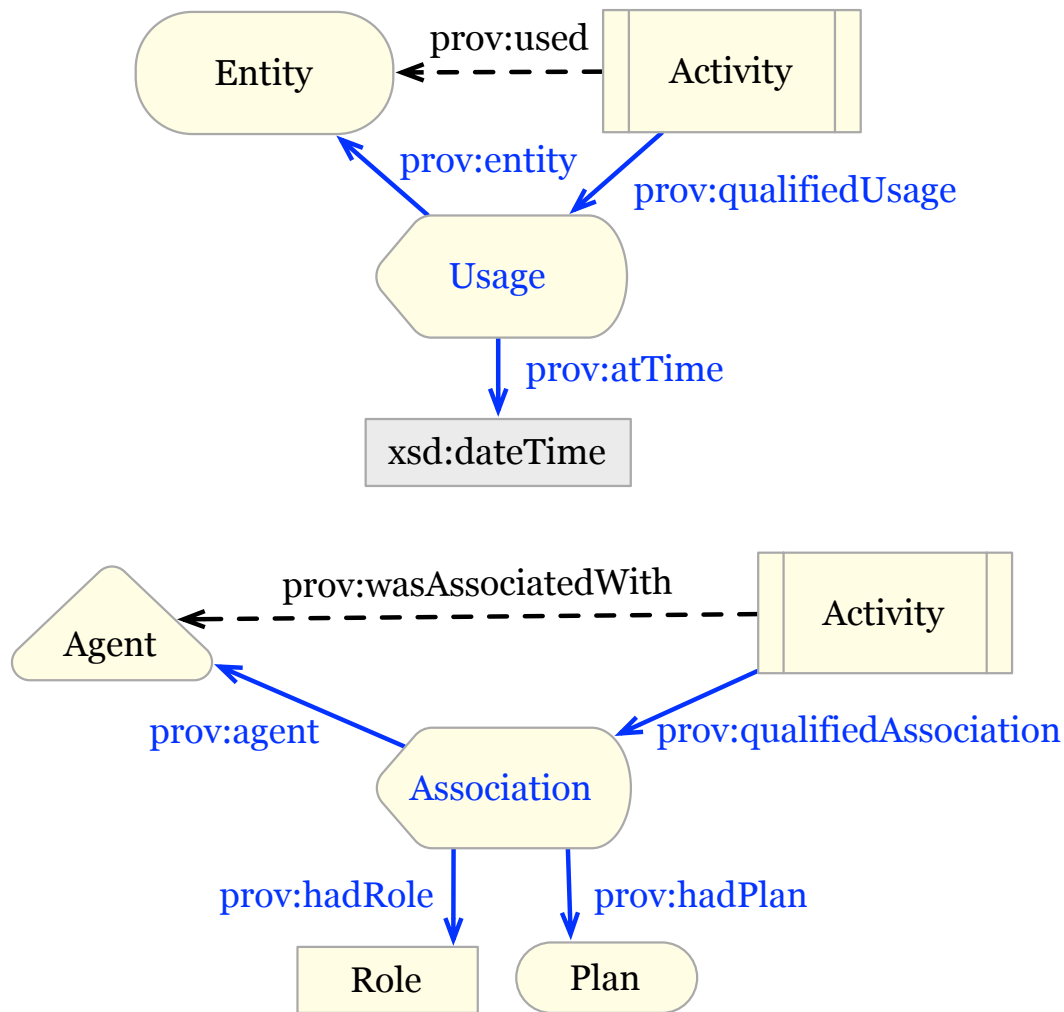
```
:illustrating
  a prov:Activity;
  prov:wasAssociatedWith :derek,
                        :steve;
  prov:qualifiedAssociation [
    a prov:Association;
    prov:agent :derek;
    prov:hadRole :illustrationist;
  ];
  prov:qualifiedAssociation [
    a prov:Association;
    prov:agent :steve;
    prov:hadRole :stylist;
    prov:hadPlan :style-guide;
    rdfs:comment "Steve helped Derek conform with the publisher's style guide."@en;
  ];
.

:derek a prov:Person, prov:Agent, prov:Entity .
:steve a prov:Person, prov:Agent, prov:Entity .

:illustrationist a prov:Role .
:stylist a prov:Role .

:style-guide a prov:Plan, prov:Entity .
```

(3/4) The Qualification Pattern



Trace
Derivation
Quotation
Revision
Source
Start
Usage
Communication
Generation
End
Invalidation
Association
Attribution
Delegation

(3/4) Qualifying Terms:

prov:atLocation prov:Location (Again!)

```
:post9821
  a prov:Entity, sioc:Post;
  prov:wasGeneratedBy :publicationActivity1123;
→ prov:atLocation    :more-crime-happens-in-cities;
  prov:qualifiedGeneration [
    a prov:Generation;
    prov:activity      :publicationActivity1123;
    prov:atTime        "2011-07-16T01:52:02Z"^^xsd:dateTime;
→   prov:atLocation <http://dbpedia.org/resource/Madrid>;
  ];
.

:publicationActivity1123      a prov:Activity.
:more-crime-happens-in-cities a prov:Location.
<http://dbpedia.org/resource/Madrid> a prov:Location.
```

Location can be geographic or non-geographic (directory, row, column, URL)

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(4/4) Collection

```
:todays-us-supreme-court
  a prov:Collection, :RobertsCourt;

prov:qualifiedGeneration [
  a prov:Generation;
  dcterms:date "2012"^^xsd:gYear; # The generation is being qualified to be in
];                                # prov:generatedAtTime and prov:atTime speci

prov:hadMember
  <http://dbpedia.org/resource/John_Glover_Roberts,_Jr.>,
  <http://dbpedia.org/resource/Antonin_Scalia>,
  <http://dbpedia.org/resource/Anthony_Kennedy>,
  <http://dbpedia.org/resource/Clarence_Thomas>,
  <http://dbpedia.org/resource/Ruth_Bader_Ginsburg>,
  <http://dbpedia.org/resource/Stephen_Breyer>,
  <http://dbpedia.org/resource/Samuel_Alito>,
  <http://dbpedia.org/resource/Sonia_Sotomayor>,
  <http://dbpedia.org/resource/Elena_Kagan>;

prov:wasDerivedFrom :the-first-us-supreme-court;

dcterms:description :copied-string;
```

(4/4) Dictionary (a kind of Collection)

```
:todays-us-supreme-court-as-dictionary
  a prov:Dictionary, :RobertsCourt;

  prov:qualifiedGeneration [
    a prov:Generation;
    dcterms:date "2012"^^xsd:gYear;
  ];

  prov:hadMember [
    a prov:KeyValuePair;
    prov:pairKey   "chief";
    prov:pairValue <http://dbpedia.org/resource/John_Glover_Roberts,_Jr.>;
  ], [
    a prov:KeyValuePair;
    prov:pairKey   "seat 9";
    prov:pairValue <http://dbpedia.org/resource/Antonin_Scalia>;
  ], [
    a prov:KeyValuePair;
    prov:pairKey   "seat 4";
    prov:pairValue <http://dbpedia.org/resource/Anthony_Kennedy>;
  ], [
```

(4/4) Deriving Dictionaries

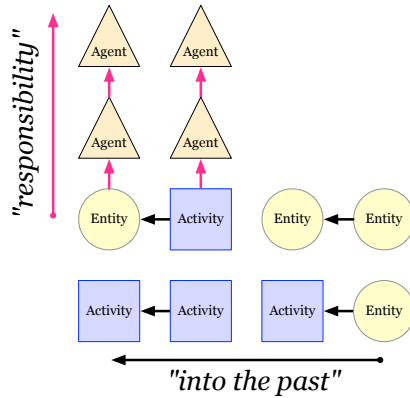
```
:todays-us-supreme-court-as-dictionary
  a prov:Dictionary, :RobertsCourt;

  prov:qualifiedGeneration [
    a prov:Generation;
    dcterm:date "2012"^^xsd:gYear;
  ];

  prov:wasDerivedFrom      :court-in-2010-with-stevens-seat-3-empty;
  prov:derivedByInsertionFrom :court-in-2010-with-stevens-seat-3-empty;
  prov:qualifiedInsertion [
    a prov:Inseration;
    prov:dictionary :court-in-2010-with-stevens-seat-3-empty;
    prov:inserted [
      a prov:KeyValuePair;
      prov:pairKey  "seat 3"^^xsd:string;
      prov:pairValue <http://dbpedia.org/resource/Elena_Kagan>;
    ];
  ];
];
```

Overview

Part 1:

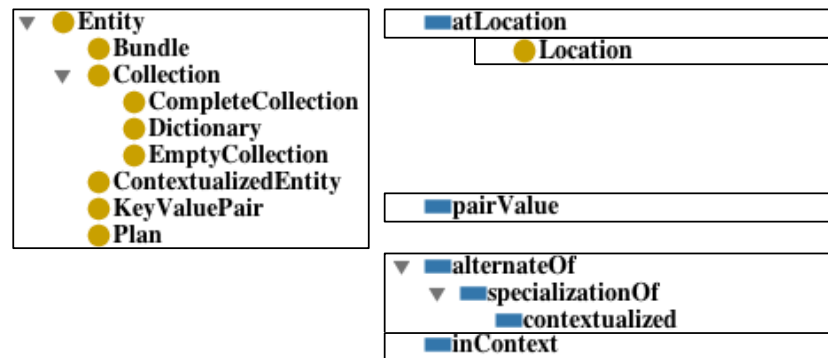


```

:swissair_Flight_111_crash
  a prov:Activity;
  prov:used <http://dbpedia.org/
  prov:startedAtTime "2012-09-02T01:31:06
  prov:atLocation <http://dbpedia.org/

```

Part 2:



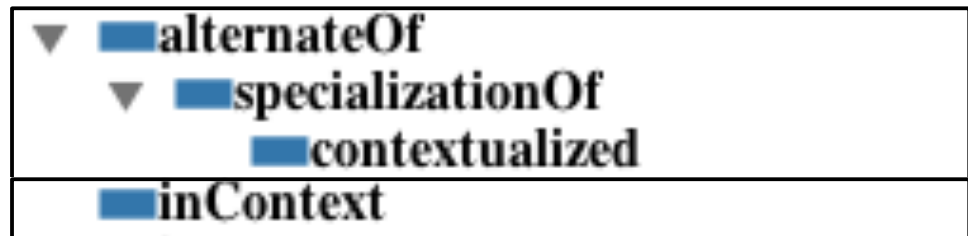
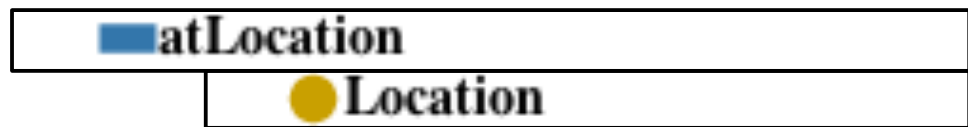
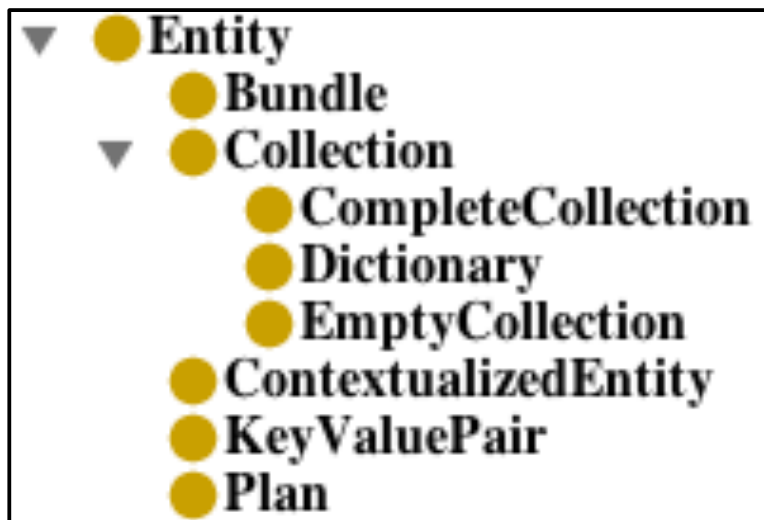
The Main Three Classes (1/5)

● **Activity**

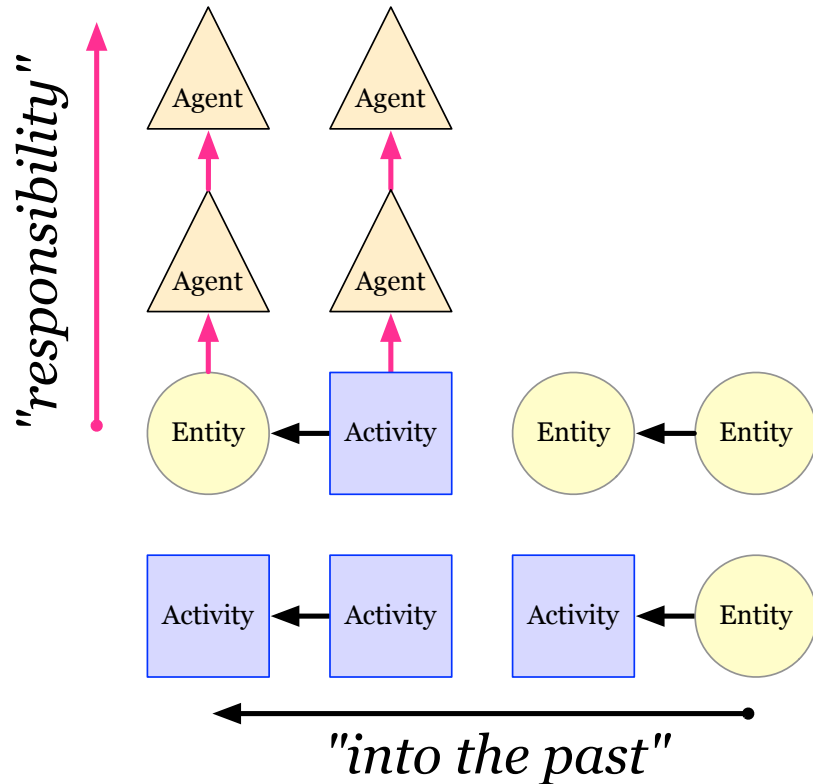
▼ ● **Agent**
 ● **Organization**
 ● **Person**
 ▼ ● **SoftwareAgent**
 ● **ProvenanceService**

▼ ● **Entity**
 ● **Bundle**
 ▼ ● **Collection**
 ● **CompleteCollection**
 ● **Dictionary**
 ● **EmptyCollection**
 ● **ContextualizedEntity**
 ● **KeyValuePair**
 ● **Plan**

Properties of prov:Entity (2/5)

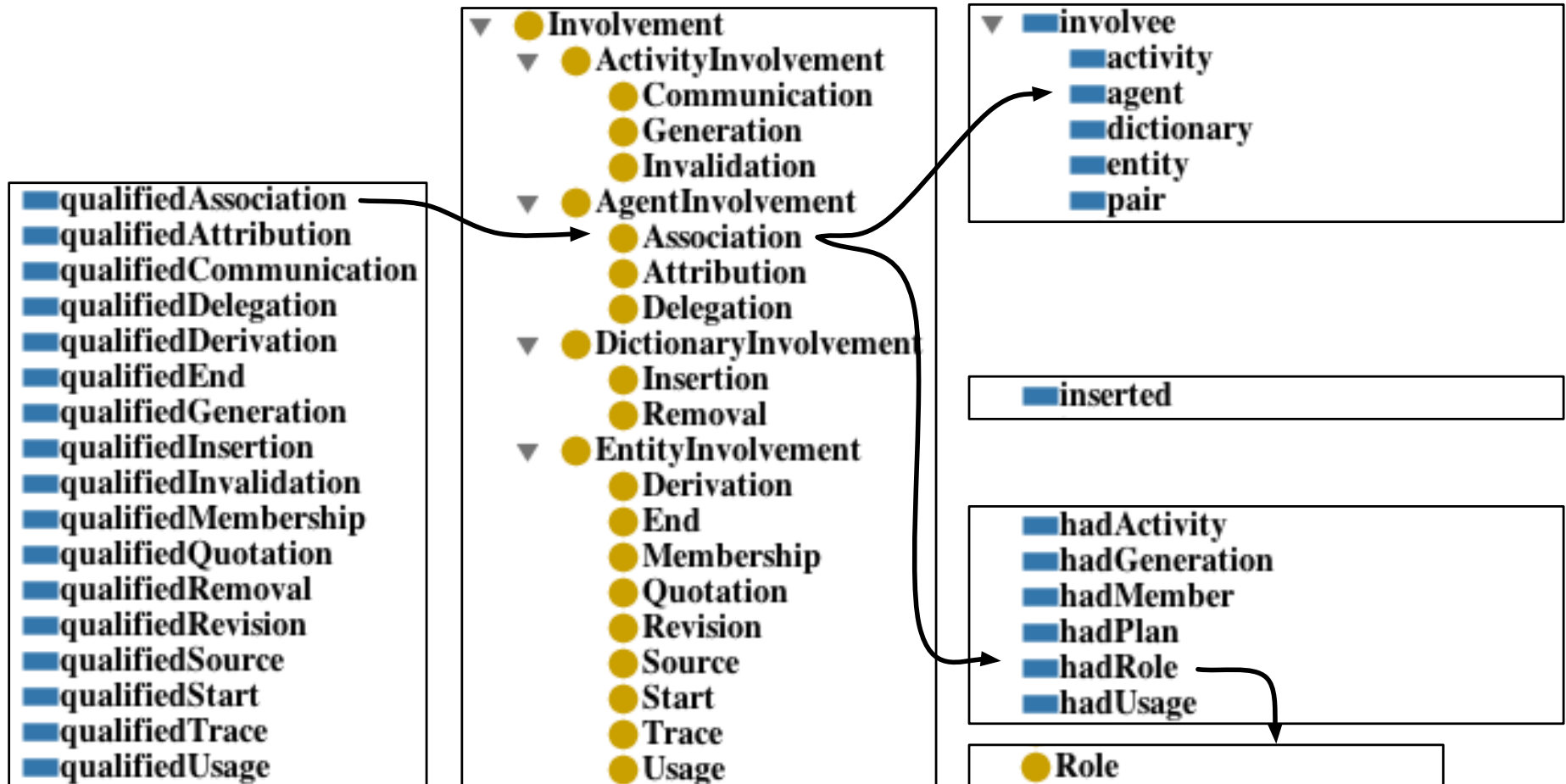


Relating the “Main Three” (3/5)



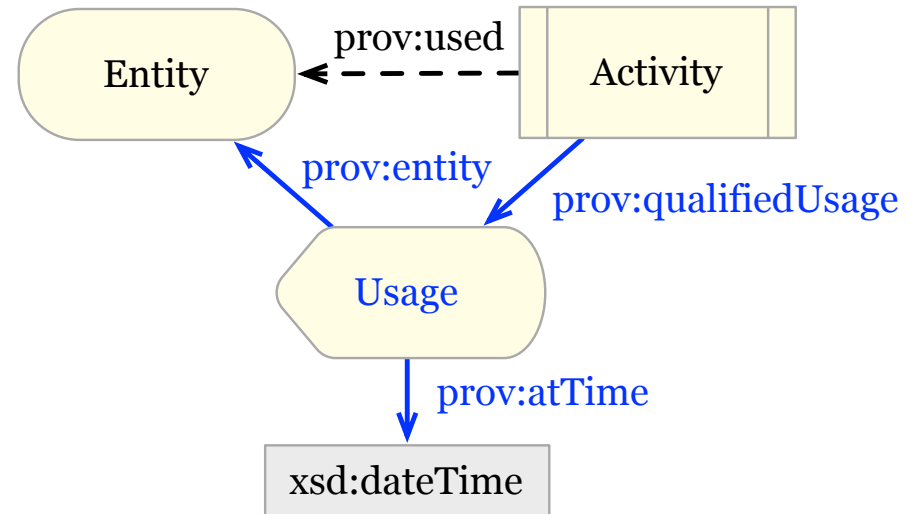
- ▼ **involved**
 - actedOnBehalfOf**
 - generated**
- ▼ **tracedTo**
 - wasAttributedTo**
 - ▼ **wasDerivedFrom**
 - derivedByInsertionFrom**
 - derivedByRemovalFrom**
 - hadPrimarySource**
 - wasQuotedFrom**
 - wasRevisionOf**
- used**
- wasAssociatedWith**
- wasEndedBy**
- wasGeneratedBy**
- wasInformedBy**
- wasInvalidatedBy**
- wasStartedBy**

Qualification Pattern (4/5)



Organizing Qualifications (5/5)

- ▼ ● Involvement
 - ▼ ● ActivityInvolvement
 - Communication
 - Generation
 - Invalidation
 - ▼ ● AgentInvolvement
 - Association
 - Attribution
 - Delegation
 - ▼ ● DictionaryInvolvement
 - Insertion
 - Removal
 - ▼ ● EntityInvolvement
 - Derivation
 - End
 - Membership
 - Quotation
 - Revision
 - Source
 - Start
 - Trace
 - Usage



- ▼ ● InstantaneousEvent
 - End
 - Generation
 - Invalidation
 - Start
 - Usage

Getting to know PROV - the W3C Provenance Specifications
(ISWC2012 Boston)
11/12 November, 2012
TBD