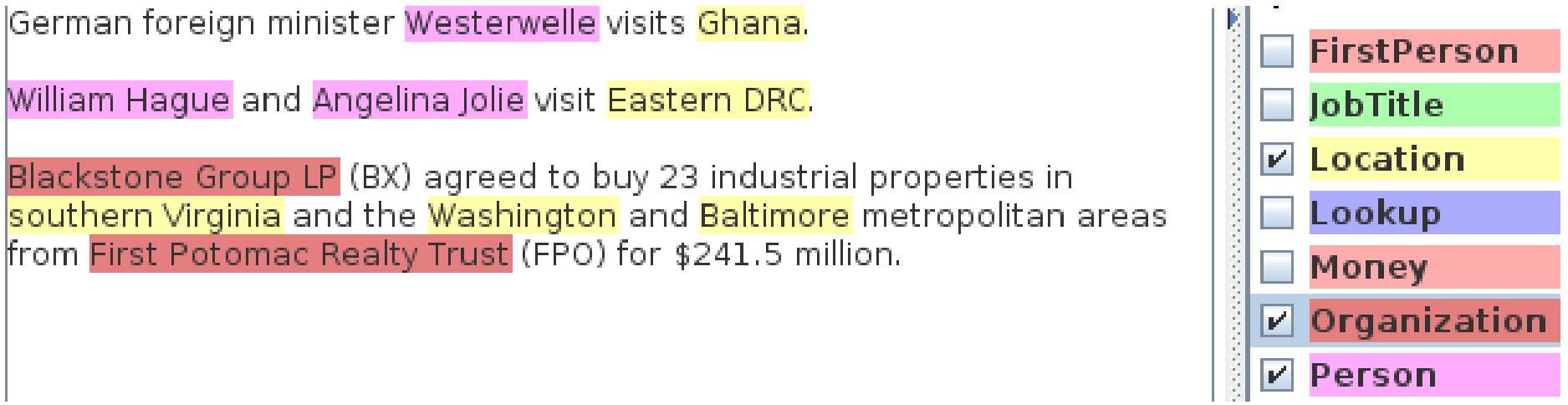
Module 9:
Semantic Annotation and Ontologies

About this tutorial

- This tutorial will be a mixture of explanation, demos and hands-on work
- Things for you to try yourself are in red
- It assumes basic familiarity with the GATE GUI and with ANNIE and JAPE; no Java expertise
- Your hands-on materials are in module-9-hands-on.zip which extracts to module-9-hands-on/
  From: http://gate.ac.uk/wiki/TrainingCourseJune2013/
- Completing the hands-on tasks will help you in the exam....

ANNIE Annotations



- We know the type of named entity but nothing more
- What kind of organization is Blackstone Group LP?
- What is the job of William Hague?
- Where is Eastern DRC, what does DRC stand for?

  => only semantics: choice of annotation type name
  => some knowledge hidden deep in JAPE & Code

Need More Semantics:

- To co-reference DRC with “Democratic Republic of Congo”
- To avoid scattered knowledge in JAPE/Java?
  Cities are locations, cities have zip codes, ...
- To disambiguate: which “Washington” (state / city)?
- To use extracted information to allow for queries like:
  - European politicians who visited an African country?
  - Politicians and actors travelling together?
- To use extracted information to add information to our own Database/Knowledgebase:
  - Add information about the buying-agreement to our data about Blackstone Group and First Potomac Realty Trust
  - Connect with trading information or other data we have

Semantic Annotation: Basic Idea/Vision

- Link annotations to concepts in a knowledge base.
- The annotated text is a “Mention” of a concept in the KB
- We can use the knowledge associated with Mentions in our IE pipeline: e.g. Persons have JobTitles, Cities have zip codes
- We can use the knowledge associated with Mentions for “Semantic Search”
- We can use semantically annotated documents to add new facts to our knowledge base

=> We need some way to represent knowledge

Knowledge Base

Would want to represent knowledge for this domain:

- Westerwelle:
  has job Foreign minister of Germany → a politician
  Germany → a country, in Europe
  Member of the Free Democratic Party
  Free Democratic Party → a political party
  Political party → an organization
  …
- Blackstone Group L.P. → a private equity company
  has NYSE symbol: BX
  based in: New York City
  New York City → a city
  located in: New York State which is located in USA
  ...

Ontology

Use an ontology!
A formal way to represent knowledge as:

- Concepts of a domain or a set of domains
  “Agelina Jolie”, “Ghana”
- Relationships between concepts
  “New York City is located in New York State”
- Hierarchies of Concepts and Relationships
  “New York City is a City which is a Location”
- Associated Data
  “Blackstone Group has NYSE symbol BX”
- => most widely used formalism is RDF/OWL

OWL Ontologies - RDF(S)

- Based on RDF(S) - Resource Description Framework (Schema):
  - Everything is identified by an URI
  - Everything can be expressed as triples of the form *Subject Predicate Object*:

```
:NewYork rdf:type :City .
:City rdfs:subClassOf :Location .
:Location a rdfs:Class .
:BlackstoneGroup :hasNyseSymbol "BX" .
```

  - Simple vocabulary to express things:

    `rdf:type` = "belongs to a class"

    `rdf:Class` = "the class of all classes"

    `"BX"` = the literal string "BX"

OWL Ontologies - URIs

- Nearly everything represented by URI (not blank nodes and literal values):
  http://my.ontology/locations#NewYorkCity
- URIs can look like URLs
- Often many URIs share the same prefix:
  http://my.ontology/locations#NewYorkState
  http://my.ontology/people#AngelinaJolie
- Common part http://my.ontology/ is "Base URI", can abbreviate: locations#NewYorkState, people#AngelinaJolie
- Namespace + Fragement identifier
  loc: = http://my.ontology/locations#
  → loc:NewYork means http://my.ontology/locations#NewYork
  ":" alone can be used to indicate "default namespace"
  If default namespace is http://my.ontology/#
  → :Class1 really means http://my.ontology/#Class1

OWL Ontologies - RDF(S)

- All resources identified by URIs
  Different URIs may refer to the same resource
- Resources that are “Individuals” can be grouped into “Classes” and relate to other things and to values by “Properties”.
- Values represented through “Literals”:
  “BX” - a string (untyped literal)
  “New York State”@en – string with language tag (untyped)
  “Guido Westerwelle”^^xsd:string – typed literal
  “24”^^xsd:integer
- :A rdf:type :B – :A is contained in class :B
  :B rdf:type rdfs:Class – :B is an RDFS Class
  :B rdfs:subClassOf :C – all members of :B are in :C

=> Application may do class membership subsumption

OWL Ontologies

- Extend the vocabulary of RDF(S): more semantics, e.g.
  `owl:DatatypeProperty`
  `owl:Class` (different to rdfs:Class)
  `owl:sameAs`
  `owl:FunctionalProperty`, `owl:inverseOf`, `...`
- (!) Reasoning/Inference: infer all derivable new facts from asserted facts
- Arbitrary RDFS/OWL is undecidable: restrict language!
  OWL Full = RDFS + semantics → undecidable, incomplete
  OWL DL = decidable+complete but hard/slow
  OWL Lite = better than OWL DL (but still hard): GATE!
- OWL2: profiles EL, DL, QL, RL have better trade-off between expressiveness and performance

OWL Ontologies

- OWL: Web Ontology Language
- Classes/Concepts and Individuals/Instances
- Properties:
  DatatypeProperty: individual → literal
  ObjectProperty: individual → individual
  AnnotationProperty: resource → literal, but no inference
- Inference/Reasoning:
  - Inheritance/Subsumption (classes and properties)
  - "Restrictions": domain, range, allValuesFrom, hasValue …infer class membership, property values (but: does not really "restrict" anything)
  Open World Assumption: what is not asserted, we do not now
  Non Unique Name Assumption: different names may be used for same entity
- Classes can have more than one parent, Individuals can belong to more than one class → OWL Ontologies are graphs, not trees
- Can be written down as RDF/XML, Turtle ...

OWL Ontologies – Inference Examples

- `:prop1 a owl:ObjectProperty .`
  `:prop1 rdfs:domain :Class1 .`
  `:A :prop1 :B .`
  → `:A` must be a member of `:Class1`
- `:prop1 rdfs:range :Class2 .`
  `:A prop1 :D .`
  → `:D` must be a member of `:Class2`
- `:prop2 a owl:FunctionalProperty .`
  `:A :prop2 :B .`
  `:A :prop2 :C .`
  → `:B` and `:C` must be the same!

Different literal values: inconsistent (but not in GATE)

OWL Ontologies – Inference Examples


- ```
  :prop3 a owl:TransitiveProperty .
  :A :prop3 :B .
  :B :prop3 :C .
  → :A :prop3 :C .
  ```
- ```
  :prop4 a owl:ObjectProperty .
  :prop5 rdfs:subPropertyOf :prop4 .
  :A :prop5 :B .
  → :A :prop4 :B .
  ```
- ```
  :prop6 owl:inverseOf :prop5 .
  → :B :prop6 :A .
  ```
  ```

OWL vs. Object Oriented

- Similar terminology but very different!
- Classes are not prototypes but merely sets of individuals defined by intension (rule) or extension (enumeration)
- Properties are “global” by default
- No real inheritance of property/value from classes to individuals
- No “real” restrictions/limitations but inference / inconsistency
- Inference often goes in a direction that is surprising or unexpected

OWL: Inference of values

- Cannot just add the property to the class and “inherit” in individual!
  (can add annotation property, but this will not be used to infer anything for the individuals of the class)
- Use a `owl:hasValue` “Restriction”:

```
:Human a owl:Class ;
       rdfs:subClassOf [
              a owl:Restriction ;
              owl:onProperty :numberOfLegs ;
              owl:hasValue 2
       ] .
:Person0213 a :Human .
→ :Person0213 :numberOfLegs 2 .
```

Ontologies in GATE

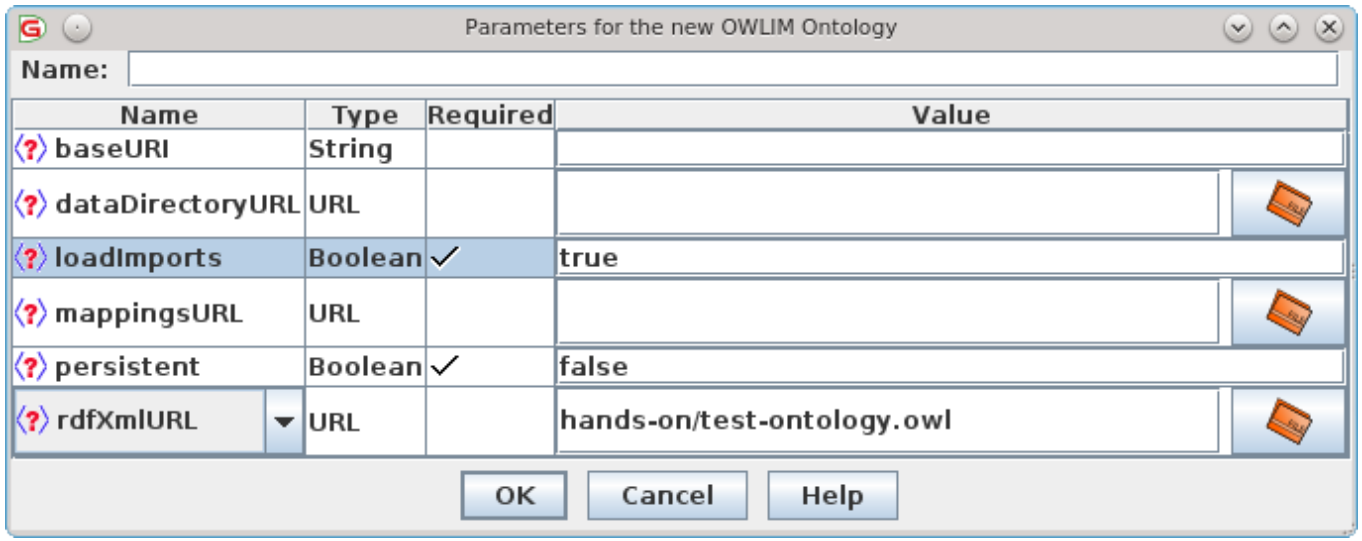
- Can use OWL-Lite ontologies as language resources (→ Plugin Ontology)
- Ontology Editor, Ontology Annotation Tool, Relation Annotation Tool (→ Plugin Ontology_Tools)
- Ontology-enabled JAPE, JAPE Plus
- LKB Gazetteer (→ Plugin Gazetteer_LKB)
  OntoRoot Gazetteer (→ Plugin Gazetteer_Ontology_Based)
- Ontology-based evaluation (→ Plugin Ontology_BDM_Computation)
- Java API for ontology manipulation, triple manipulation, SPARQL queries
- Simple CLI commands for ontology handling, querying, SPARQL

GATE Ontology Implementation

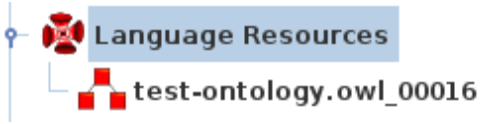
- Based on Sesame and the OWLIM-Lite SAIL (Storage and Inference Layer) implementation from Ontotext
- Fast in memory repository, scales to millions of statements (depending on RAM)
- In addition to local file ontology, can connect to server:
  - OWLIM Lite
  - OWLIM SE/Enterprise: commercial product, persistent and scalable implementation for huge (billion triples) ontologies
- Supports “almost OWL-Lite”
- Java API represents OWL concepts (ontology, property, literal) as Java objects
  Also provides support for SPARQL and manipulating Triples directly

Load Ontology

- Need plugin `Ontology`
- For Editor, also need plugin `Ontology_Tools`
- Language Resource → New → OWLIM Ontology



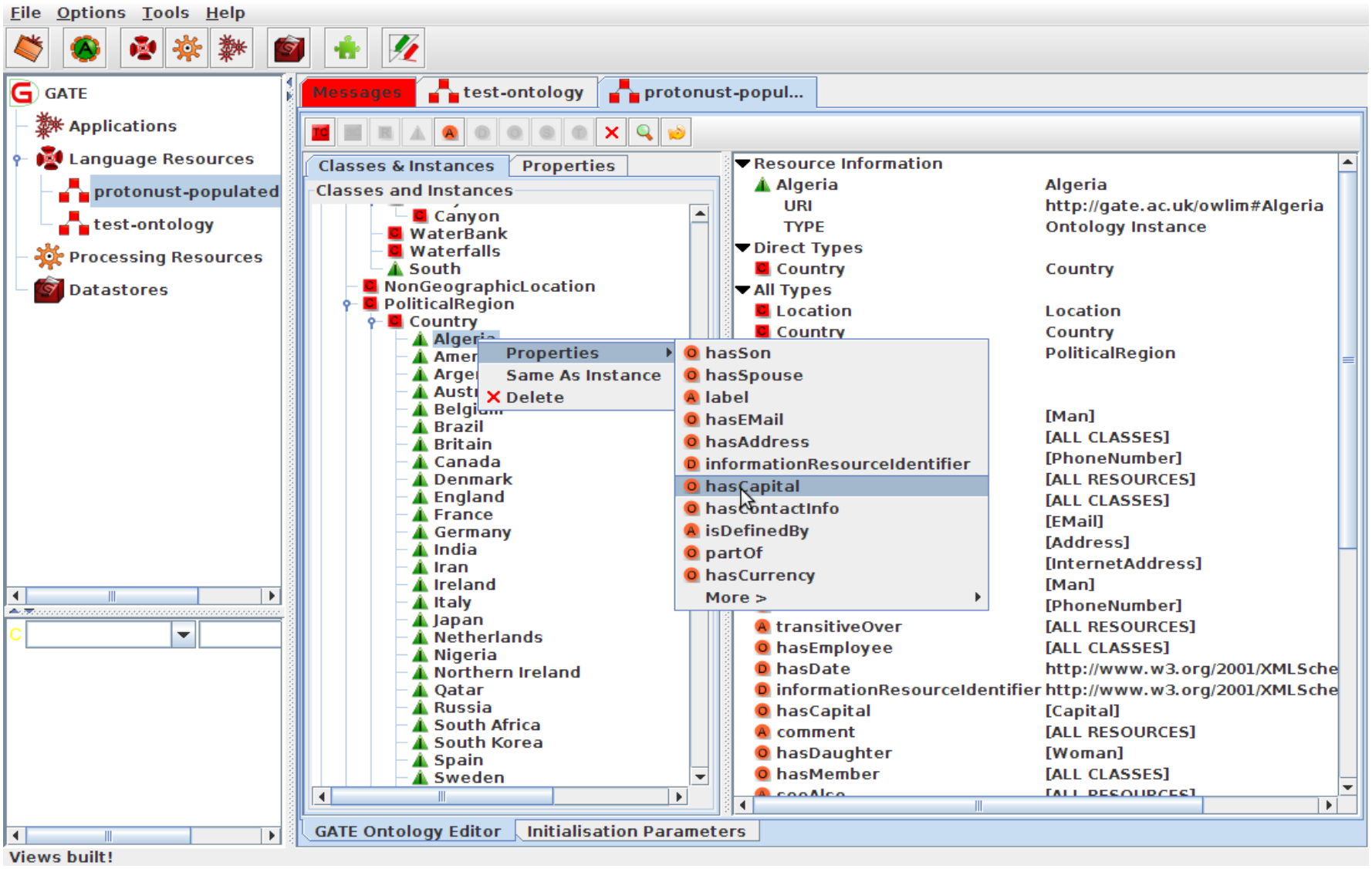
- Loaded:



Ontology Viewer/Editor

- Basic viewing of ontologies
- Some edit functionalities:
  - create new concepts and instances
  - define new properties and property values
  - deletion
- Some limitations of what's supported, basically chosen from practical needs for semantic annotation
- Not a Protégé replacement

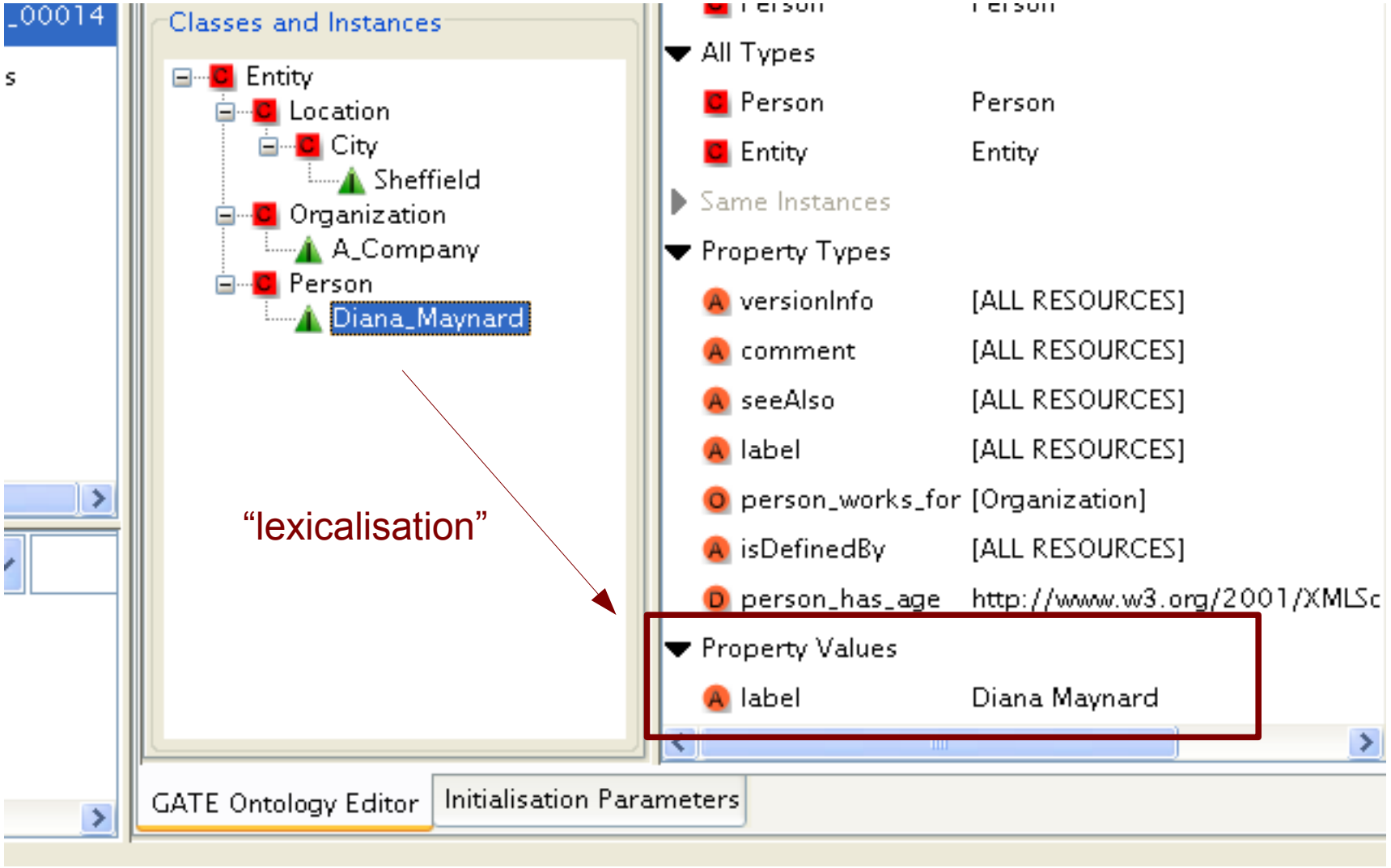
Ontology Editor



URIs, Labels, Comments

- The names of classes, properties or instances shown in the GUI are the fragment identifiers of their URIs
  http://gate.ac.uk/example#Person → "Person"
- URIs and fragment identifiers cannot contain spaces and certain other characters: use underscore or "encode" (%20)
- To also store the correctly spelled name (or several), the annotation property "label" is often used:
  - right click on the class/instance → Properties → label, enter the value in the dialogue box (cannot chose type or language!)
- The **comment** property is often used for documentation purposes, also a string
- Comments and labels are **annotation properties**: no inference but can be used with properties and classes too

New label


Classes and Instances
Entity
Location
City
Sheffield
Organization
A_Company
Person
Diana_Maynard
"lexicalisation"
All Types
Person Person
Entity Entity
Same Instances
Property Types
versionInfo [ALL RESOURCES]
comment [ALL RESOURCES]
seeAlso [ALL RESOURCES]
label [ALL RESOURCES]
person_works_for [Organization]
isDefinedBy [ALL RESOURCES]
person_has_age http://www.w3.org/2001/XMLSc
Property Values
label Diana Maynard
GATE Ontology Editor
Initialisation Parameters

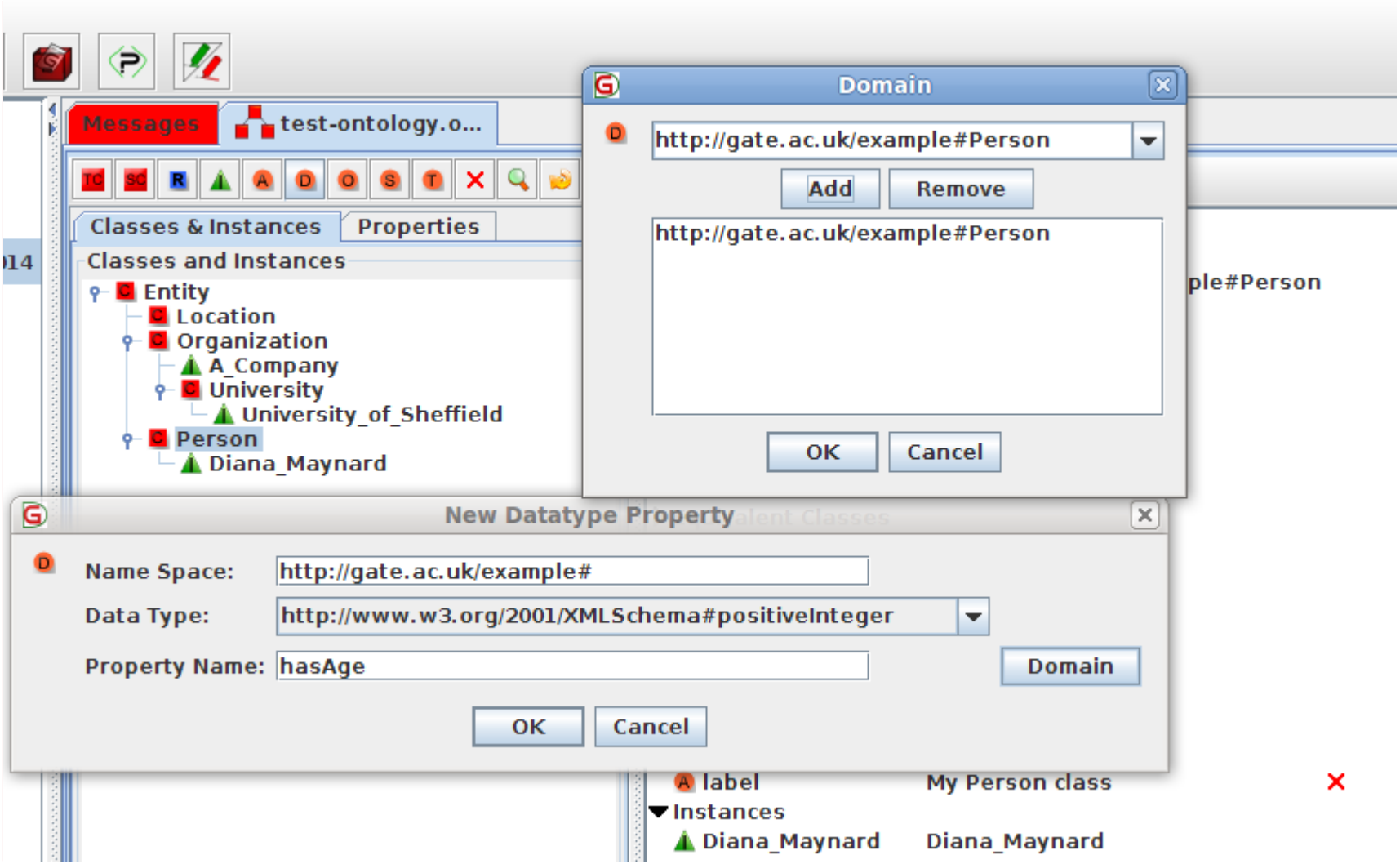
Hands-on 1: classes and individuals

- Load the Ontology and Ontology_Tools plugins
- Language Resource → New → OWLIM Ontology
  - For RdfXmlURL use **`test-ontology.owl`**
  - This loads a small ontology of Entity, Location, etc.
- Double-click on the ontology LR to open the Viewer
- Create a subclass of “Location” called “City” and then add the city where you live as an instance of “City”
- Add yourself as an individual of the class “Person”
- Add a label with your full name
- Save the ontology (right click on ontology in resources pane and select “Save as”
- Keep the ontology open for the next hands on

Datatype Properties

- Datatype properties link individuals to data values
- Datatype properties can (but do not have to) be of type boolean, date, int, ...
- Available datatypes taken from XMLSchema
- To define a new data property in the Ontology Editor
  - Select an ontology class and click on the D button
  - Choose the desired datatype from the list (e.g. xsd:int)
  - Provide the property name (e.g. hasAge)
  - Specify the domain (the class of the individuals having this property) (no domain: domain is owl:Thing)
  - If more than one class is listed as a domain, this asserts that any individual having that property must be a member of the intersection of those classes

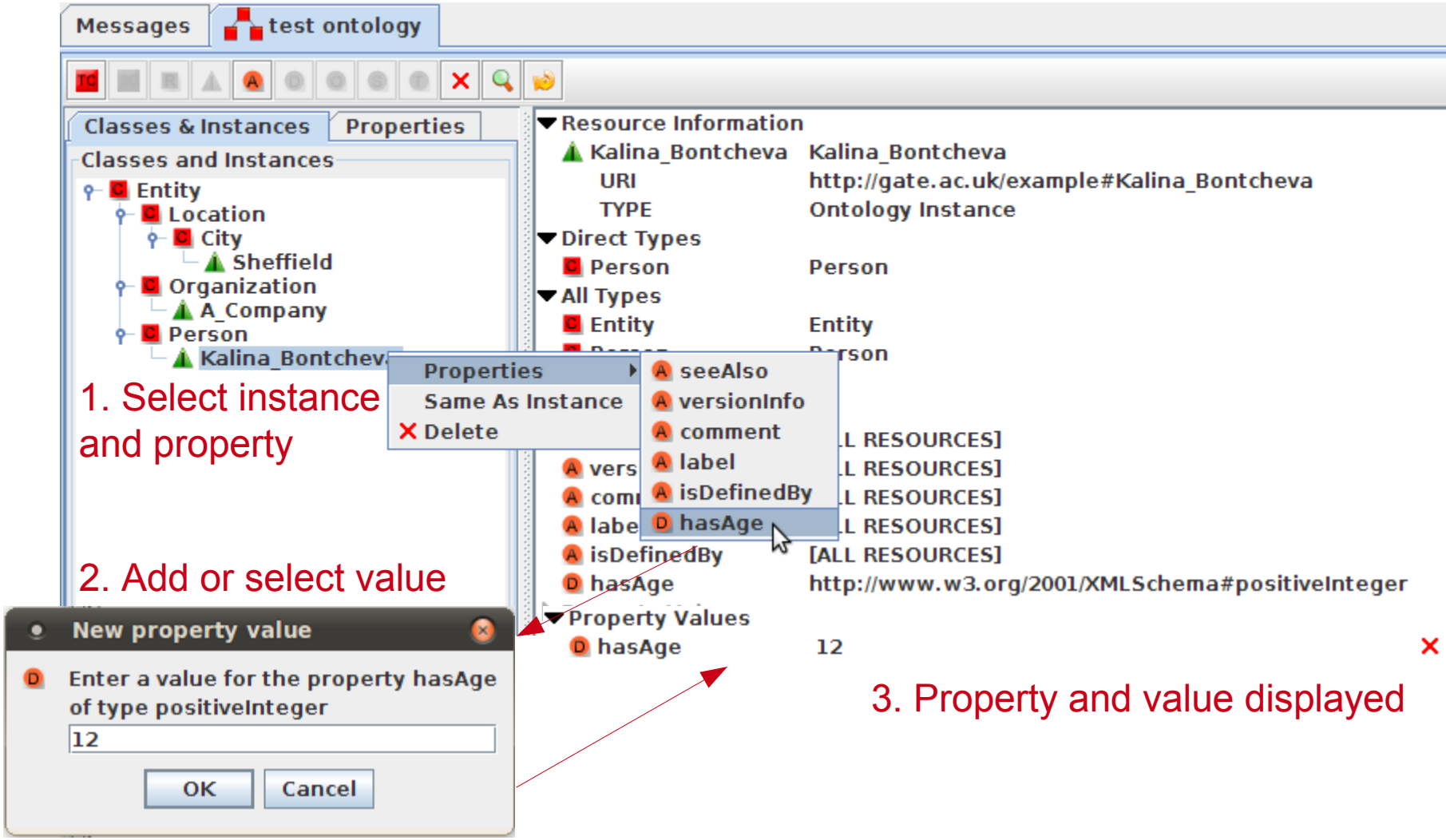
Adding a new property



Adding a DatatypeProperty Value

- To add a value for an instance, right click on the instance and select “Properties” and then the name of the property for which you want to add a value.
- If the property is not listed, then you haven't defined it yet for the concept to which your instance belongs
- Enter the value in the popup box
  GATE does some basic type checking (not OWL!)
- You should now see the property and its value listed in the right hand pane
- The same property can be added multiple times with different values (but not the same value)
  GATE does not prevent you from doing this for functional properties → inconsistent ontology!

Adding a property value

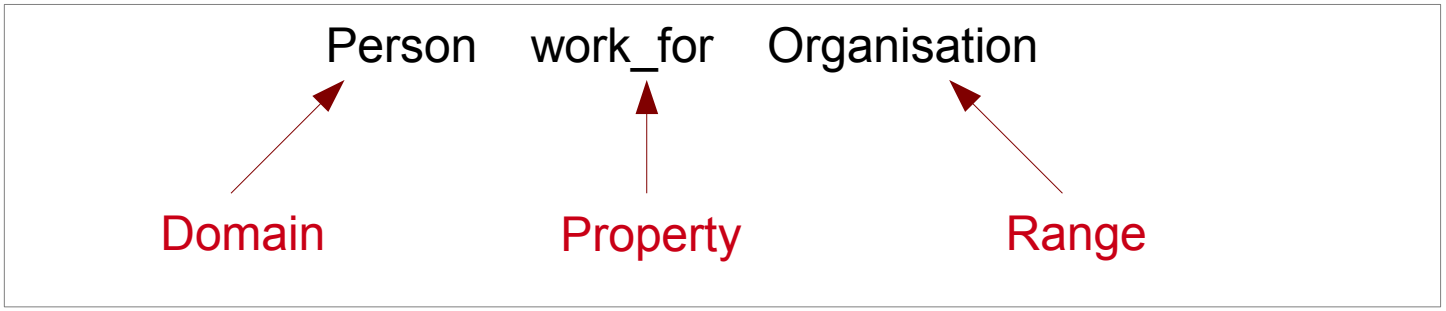


Hands-on 2: Datatype properties

- Use the ontology from the previous exercise
- Add a datatype property “hasAge” with domain “Person” and domain “xsd:nonNegativeInteger”
- Add a value for the hasAge property to the instance of Person that refers to you (you can make it up if you don't want to reveal your real age!)
- Add an instance of Organization denoting the organization you work for (make one up if you like)
- Save the ontology (with the same name as before)
- Keep everything open for the next hands-on

Object Properties

- Object properties describe relationships between individuals, e.g. people work for organisations
- Domain is the subject of the relation (the thing it applies to)
- Range is the object of the relation (the possible ”values”)



Similar to domains, multiple classes for a range will assert that the value will belong to the intersection of all specified classes.

Creating new Object Properties

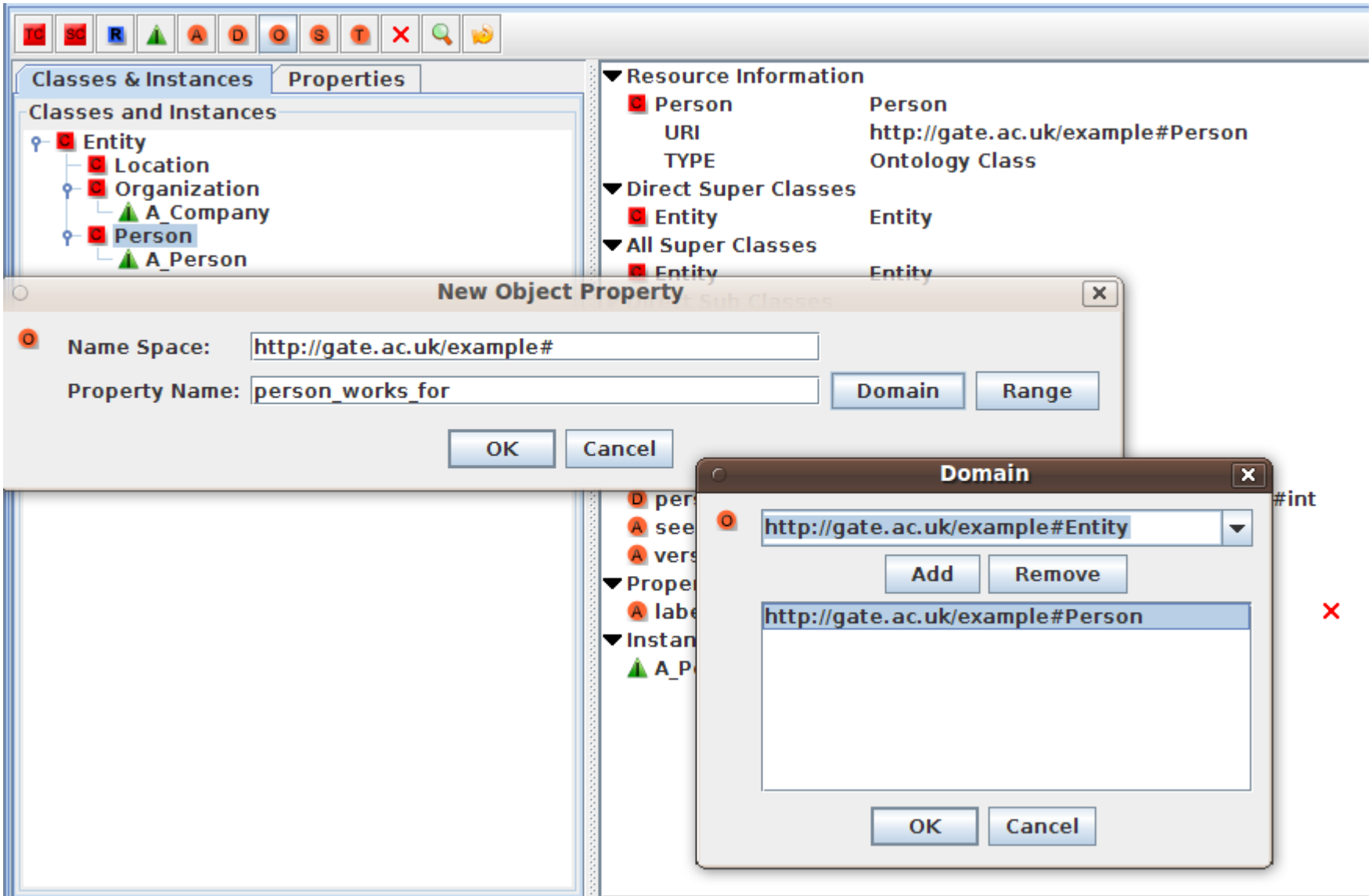
To define a new object property:

- Click on the O button
- Provide a property name and (optionally) domain / range

To set the value of an object property for an instance:

- Right-click on the instance
- Select Properties and then the name of the relevant property
- From the drop down list of instances, choose the correct instance as a value and add to the list of values
  GATE does not prevent adding multiple values for a functional property: → individuals are same or ontology inconsistent!

New Object Property



Hands-on 3: Object properties

- Use the entity ontology you saved in the previous exercise
- Add an object property “worksFor” to model that persons work for organizations: which domain / range?
- Add a property value so you work for the organization you added earlier
- Right click the ontology and choose “Load”
  As file select “employs.turtle”
  As file format choose “turtle”
  This loads a file that contains:

```
:employs owl:inverseOf :worksFor .
```

- Click the organization instance and check that “employs” got automatically inferred from “worksFor”
- Save the ontology

Using Ontologies on a Server

- Use the ConnectSesameOntology LR
- Can connect to any remote Sesame repository, but GATE only fully supports OWLIM with ruleset owl-max
- Parameters repositoryID and repositoryLocation:
  http://uid:pwd@host.com:8080/openrdf-sesame/repositories/someid
  repositoryID: someid
  repositoryLocation: http://uid:pwd@host.com:8080/openrdf-sesame
- Do NOT use the editor/viewer or other GUI tools with this unless the ontology is small!
- Mainly for use with the Java API
- If not an OWLIM/owl-max repository, some things may still be possible with the Java API

Ontology Design Principles

- There are many ways to encode a domain in an ontology – use your application needs as a guide. Keep it simple: only model what is needed, not what is true.
- Ontology authoring is often iterative and evolves with your text analysis application
- Classes vs. instances: this can vary, but as a rough guide, proper nouns are usually instances, common nouns are usually classes.
  Dilemma: OWL-Lite cannot treat something as both a Class and an Instance
- Level of granularity: what subclasses do you need? (e.g do organisations need subclasses such as government, education, charity?)
- Domains and ranges: really only useful when the inference is needed!
  Similar for local range restrictions (`allValuesFrom`, `someValuesFrom`)
- Properties: subproperties, transitive properties, inverse properties can be useful
- Literals: make sure literals are always typed or never typed

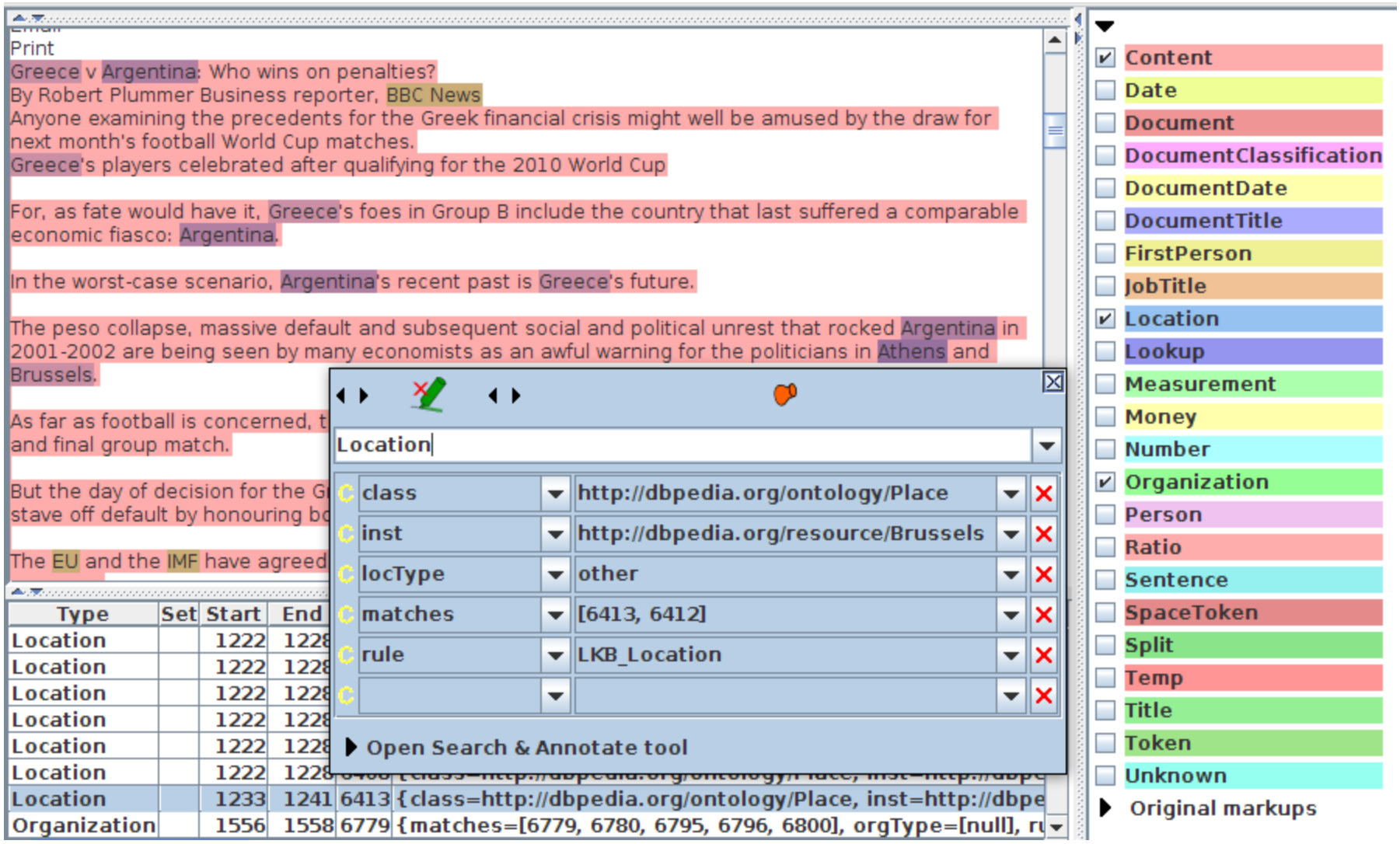
Semantic Annotation

- Link text mentions to ontology resources:
  Mention annotations have a feature (inst) with the URI of the resource
- Usually linking to individuals, may link to classes
- Use:
  - Information Extraction (OBIE: Ontology-Based Information Extraction): e.g. match a Vegetable with a Plant in JAPE, add knowledge useful for IE
  - Semantic Search
  - Knowledge Acquisition:
    Ontology Population: add facts to given structure
    Ontology Learning: find structure of ontology too

Semantic Annotation

- Match lexical information (e.g. value of rdfs:label property) with text / word stems / lemmata
- Must disambiguate between possible alternatives
  “bank” (river) vs. “bank” (institution)
  “G. Bush” (father) vs. “G. Bush” (son) vs. “G. Bush” (not related)
  → Knowlege from the ontology may be useful here
- Link disambiguated mentions to ontology via URI

Semantic Annotation



Ontology Learning / Population

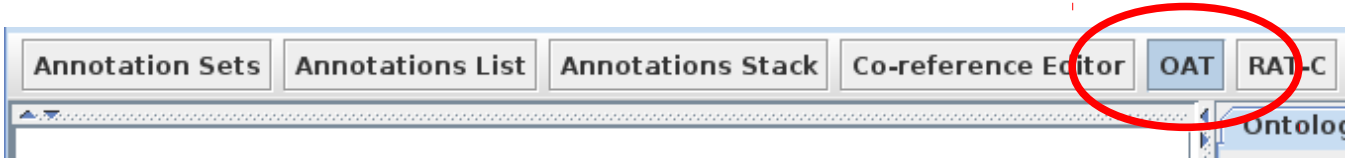
- Ontology Population: add new facts to a given ontology. The ontology structure and many classes and individuals are already there:
  "Westerwelle visits Ghana"
  → :GWesterwelle01 :actorOf :Event001 .
  :Event001 a :VisitingEvent .
  :Event001 :destination :Ghana .
  …
- Ontology Learning: also create or extend the structure of the ontology.

Semantic Annotation: How

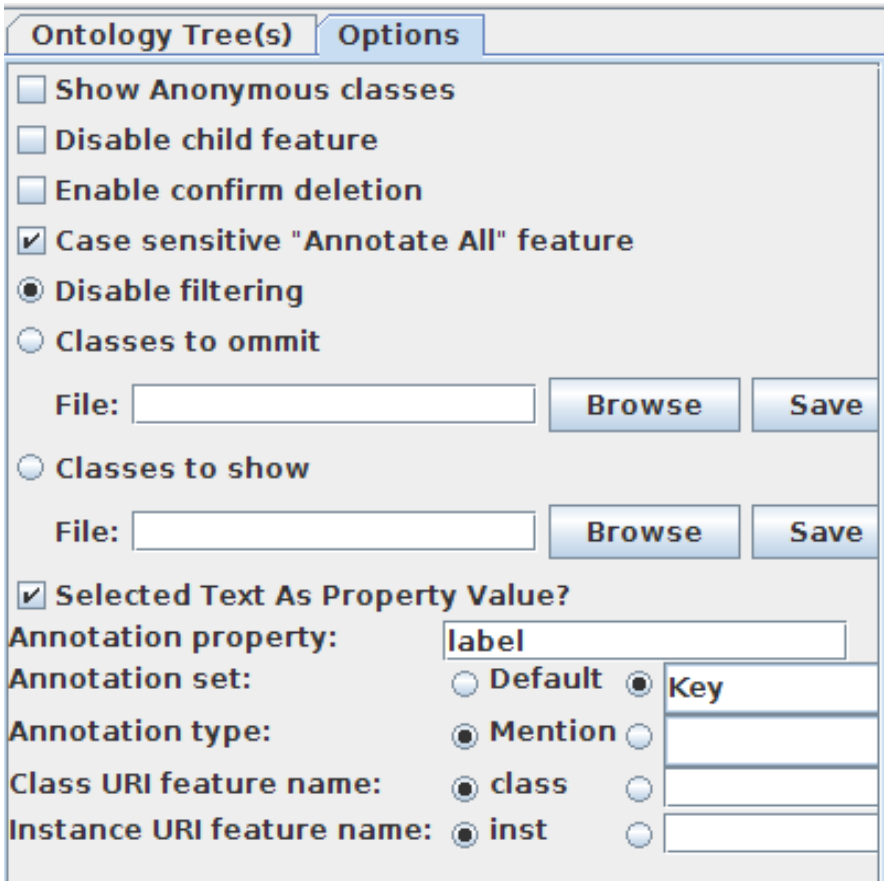
- Manually
  GATE: ontology based annotation using OAT/RAT
  (Ontology Annotation Tool, Relation Annotation Tool)
- Automatically
  - Gazetteer/rule/pattern based
    GATE: OntoRoot gazetteer, LKB gazetteer, JAPE, ...
  - Classifier (ML) based
  - Combination of the two

Manual semantic annotation: OAT

- Shows document and ontology class hierarchy side-by-side
- Interactive creation of annotations that link to the ontology class/instance
- Allows on-the-fly instance creation
- Used to create evaluation or training corpus
- Plugin: Ontology_Tools
  Adds a button “OAT” in the document view

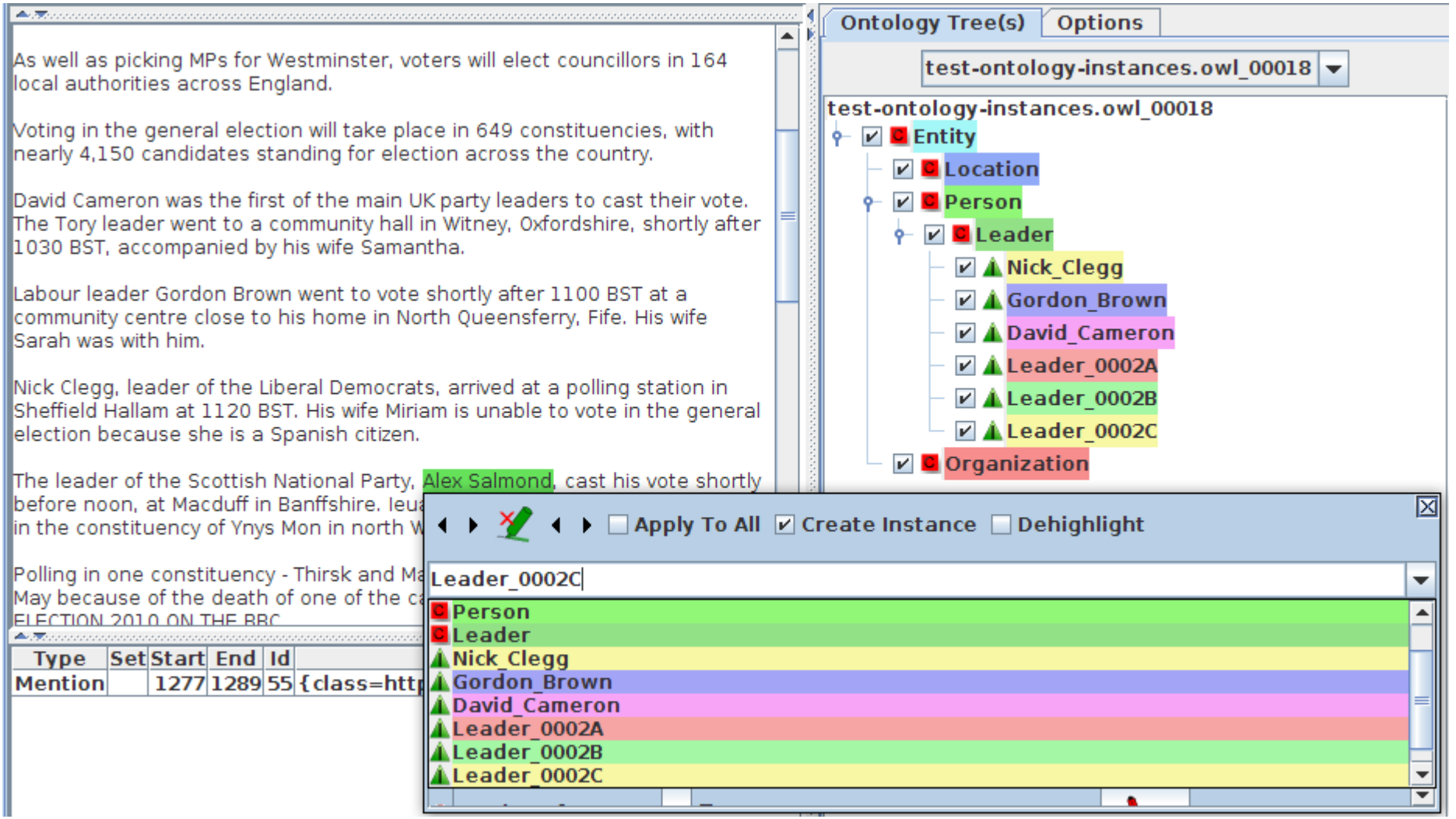


OAT: Options Tab

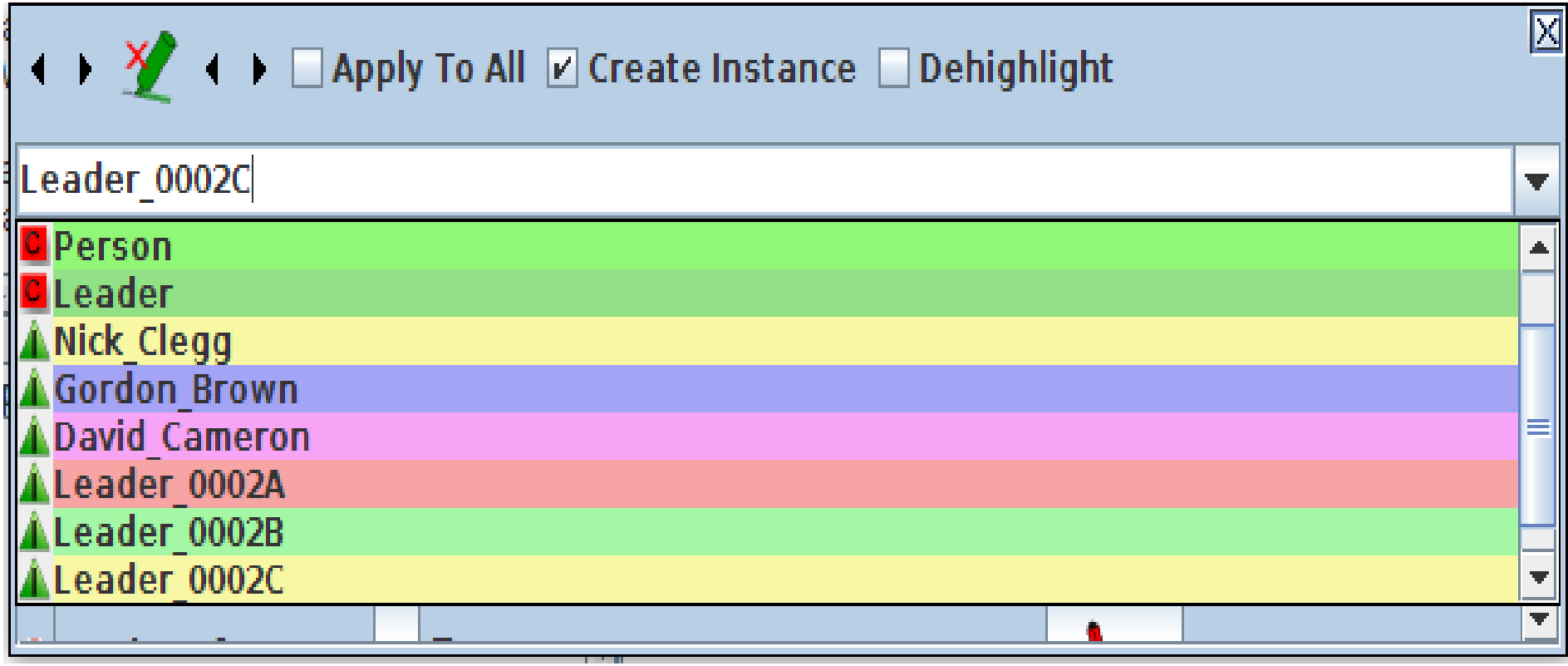


- Customisation has to be done for each document
- To ensure that any new instances automatically have a label (the string you selected in the document), tick Select text as property value.
- To put all annotations into a set other than Default, change accordingly
- By default, OAT creates:
- Annotations of type Mention
- class feature with the class URI
- inst feature with the instance URI

OAT


As well as picking MPs for Westminster, voters will elect councillors in 164 local authorities across England.
Voting in the general election will take place in 649 constituencies, with nearly 4,150 candidates standing for election across the country.
David Cameron was the first of the main UK party leaders to cast their vote. The Tory leader went to a community hall in Witney, Oxfordshire, shortly after 1030 BST, accompanied by his wife Samantha.
Labour leader Gordon Brown went to vote shortly after 1100 BST at a community centre close to his home in North Queensferry, Fife. His wife Sarah was with him.
Nick Clegg, leader of the Liberal Democrats, arrived at a polling station in Sheffield Hallam at 1120 BST. His wife Miriam is unable to vote in the general election because she is a Spanish citizen.
The leader of the Scottish National Party, Alex Salmond, cast his vote shortly before noon, at Macduff in Banffshire.
Polling in one constituency - Thirsk and Ma
May because of the death of one of the ca
ELECTION 2010 ON THE BBC
Type Set Start End Id
Mention 1277 1289 55 {class=http
Ontology Tree(s)
Options
test-ontology-instances.owl_00018
test-ontology-instances.owl_00018
Entity
Location
Person
Leader
Nick_Clegg
Gordon_Brown
David_Cameron
Leader_0002A
Leader_0002B
Leader_0002C
Organization
Apply To All
Create Instance
Dehighlight
Leader_0002C
Person
Leader
Nick_Clegg
Gordon_Brown
David_Cameron
Leader_0002A
Leader_0002B
Leader_0002C

OAT: The Editor Pop-up

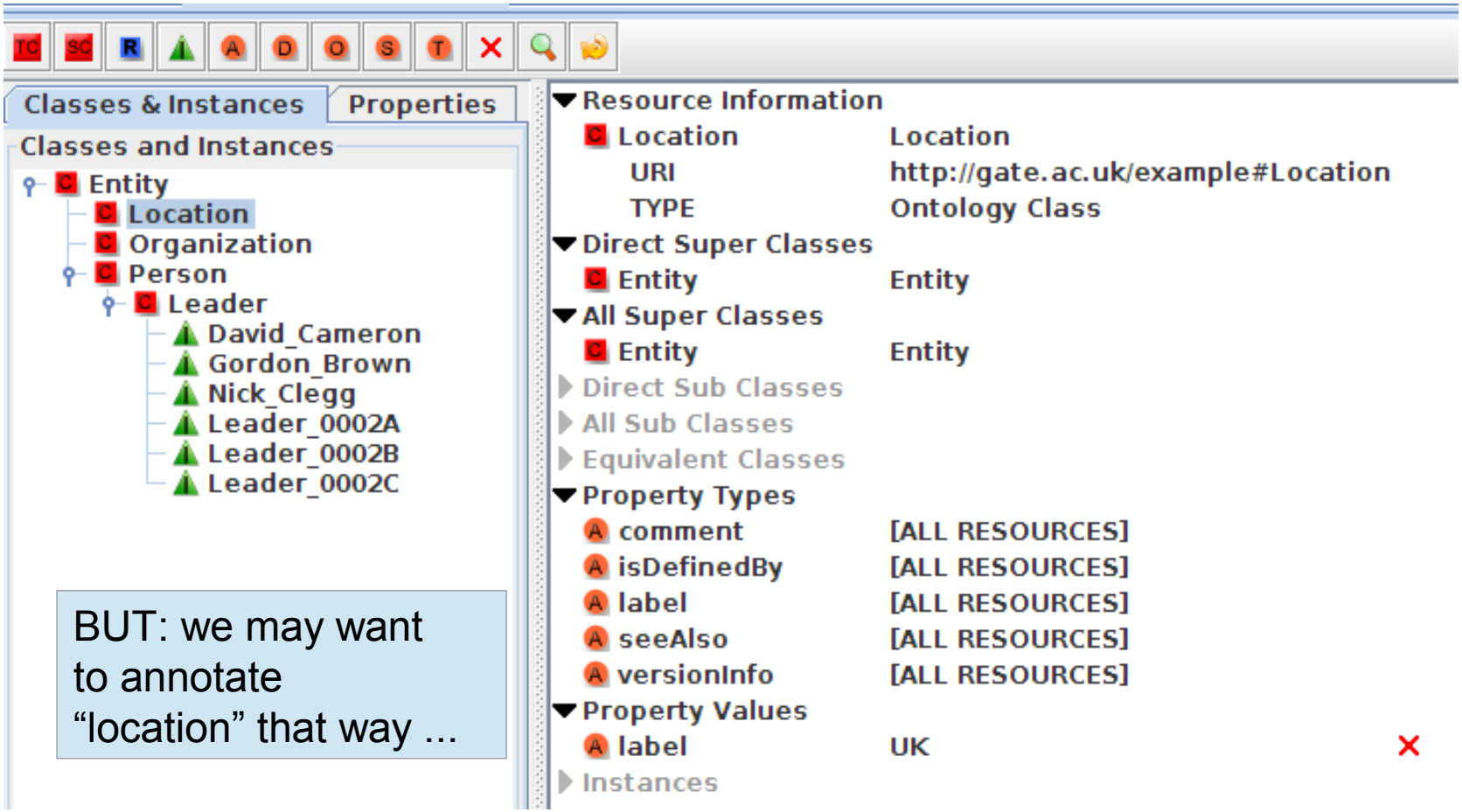


Annotating classes and instances

- Be careful about the difference between annotating classes and instances
- If you want to add UK to the ontology as an instance of a Location, you need to select “Create instance”
- Note that this will create a new instance in the ontology with a name like Location_00020. The string UK will appear as a label on that instance.
- If you just want to annotate UK with the class Location, then deselect “Create instance”

Annotating a class

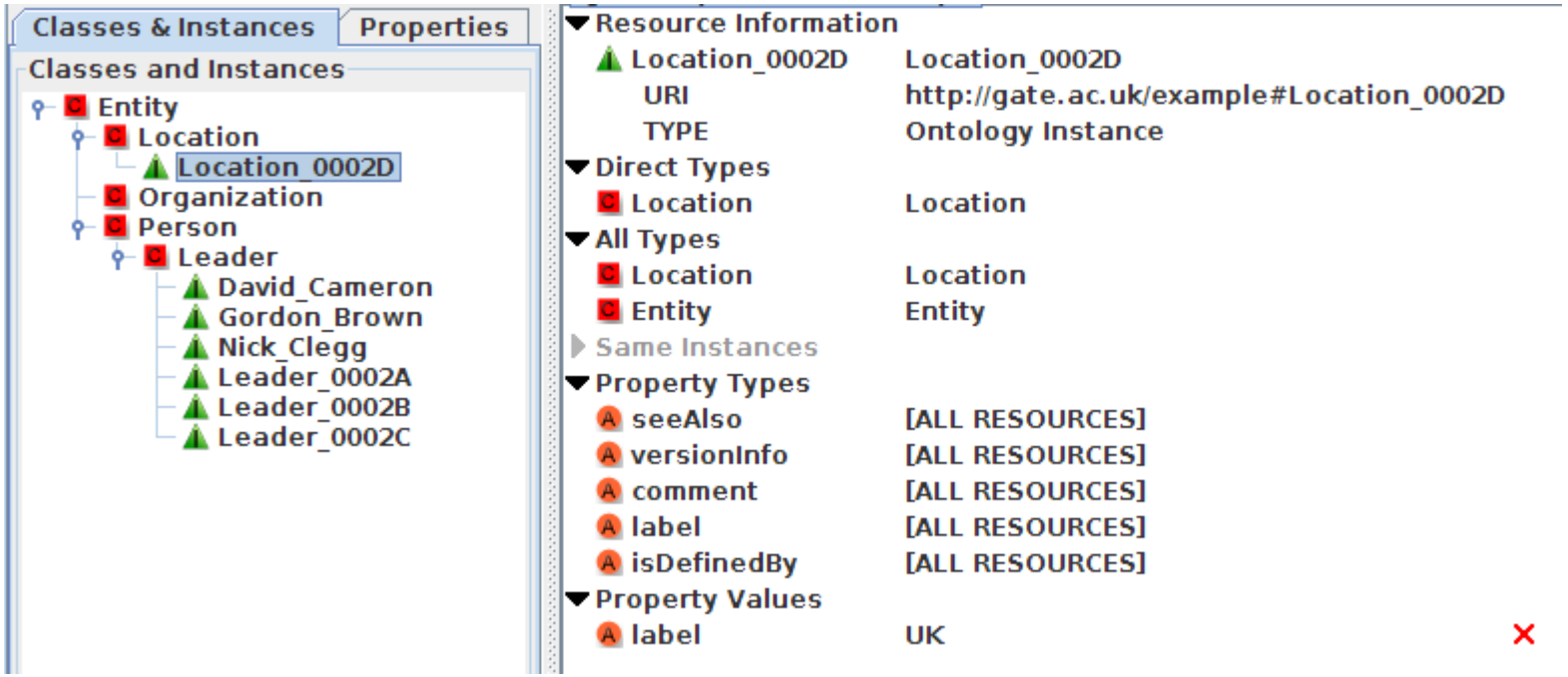
Annotating UK as a class will create a new label on the class with the text string → not what we want!



BUT: we may want to annotate "location" that way ...

Annotating an instance

Annotating UK as an instance will create a new instance of Location and set the label of the instance to the text string



Hands-on 4: using OAT

- Use the previously created ontology
- Load the document **voting-example.xml** (from hands-on)
- Select the OAT button from the doc viewer
- From the Options tab, set “Key” as the annotation set and tick “Select text as property value”
- Annotate every instance of UK in the text as an instance of a Location
- **Tip:** Make sure you select “Create instance” and “Apply to all” before choosing the target class
- Switch to the ontology viewer to see the new instance
- Examine the annotations created in Key and their features
- Save the ontology and the document

OAT: Comments

- The options to filter out some classes / only show some are useful when working with bigger ontologies
- Limitation: cannot annotate properties:

  → RAT (Relation Annotation Tool)

Relation Annotation Tool (RAT)

- RAT annotates a document with ontology instances and creates relations between annotations by means of ontology object properties.
- It is compatible with OAT, but focuses on relations between annotations modelled as object properties
- Plugin Ontology_Tools
- It is comprised of 2 viewers: **RATC** (RAT-Concept) and **RATI** (Rat-Instance).
- Buttons **RATC** and **RATI** in document editor work in tandem
- The RATC pane (on the RHS) looks similar to OAT. Click the checkbox beside a class to display the relevant instances.

RAT-I: Adding Instances and Properties

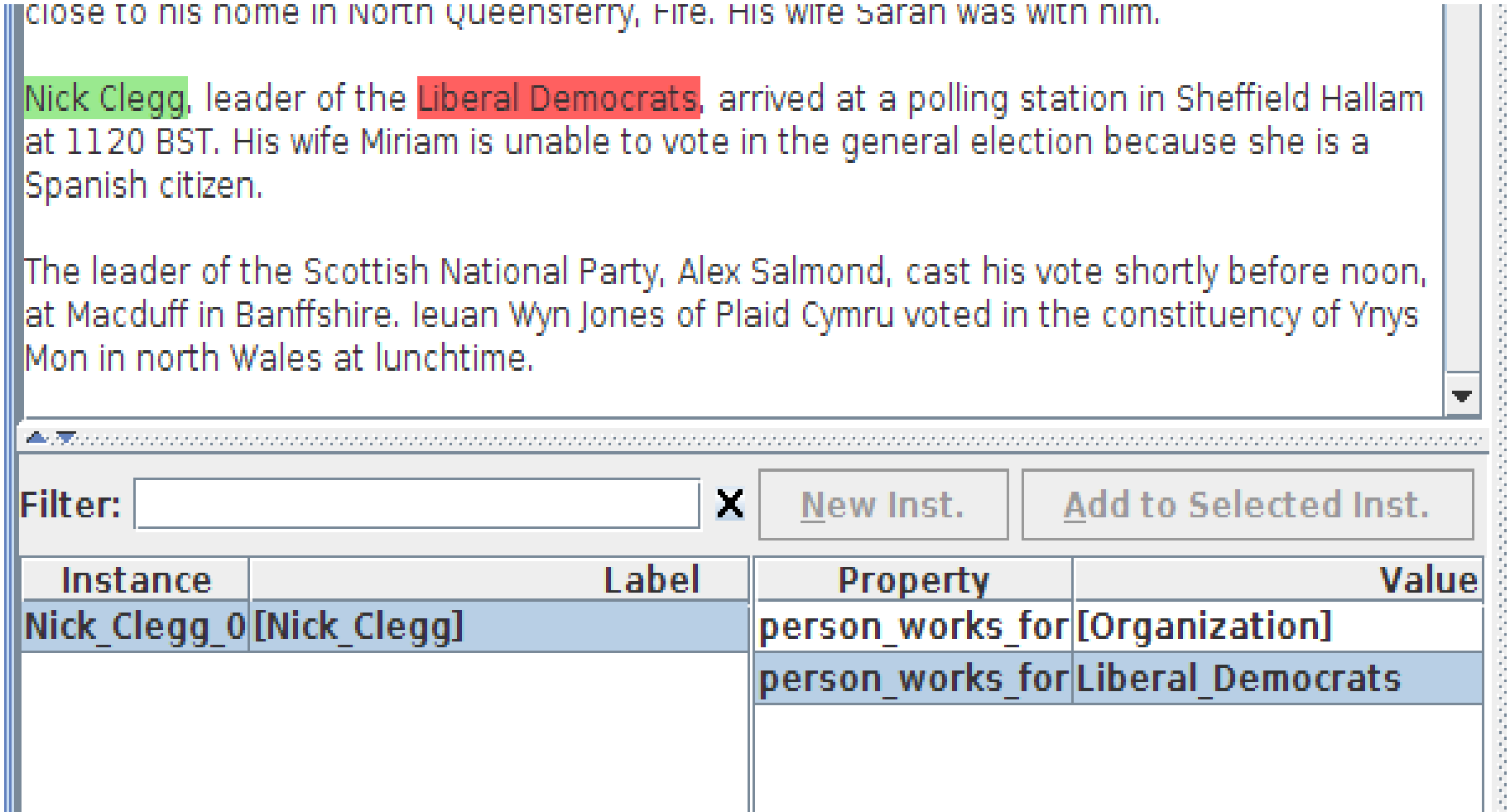
- The RAT-I view (lower horizontal pane) shows two columns: one for instances and one for properties
- To create a new instance, select an item in the ontology and then select the relevant text in the document
- Click “New instance”
- Any properties on the relevant class will be shown on the RHS of the table
- To add a property range, select a property and choose a value from the dropdown list
- Only object properties will be shown: it is not possible to add datatype properties in this way

Hands-on 5: RAT

- Use the document from the previous hands-on
- Load the ontology test-ontology-instances.owl and remove the old ontology
- Click on RAT-C or RAT-I to display the viewers
- Add a new instance **Liberal Democrats** to the class **Organization**
- Add a new instance **Nick Clegg** to the class **Leader**
- Select the **Nick Clegg** instance and add the value of the **person_works_for** property to **Liberal Democrats**
- Use the ontology viewer to check the results, then save the ontology (may need to select a different instance then Nick_Clegg to update view)

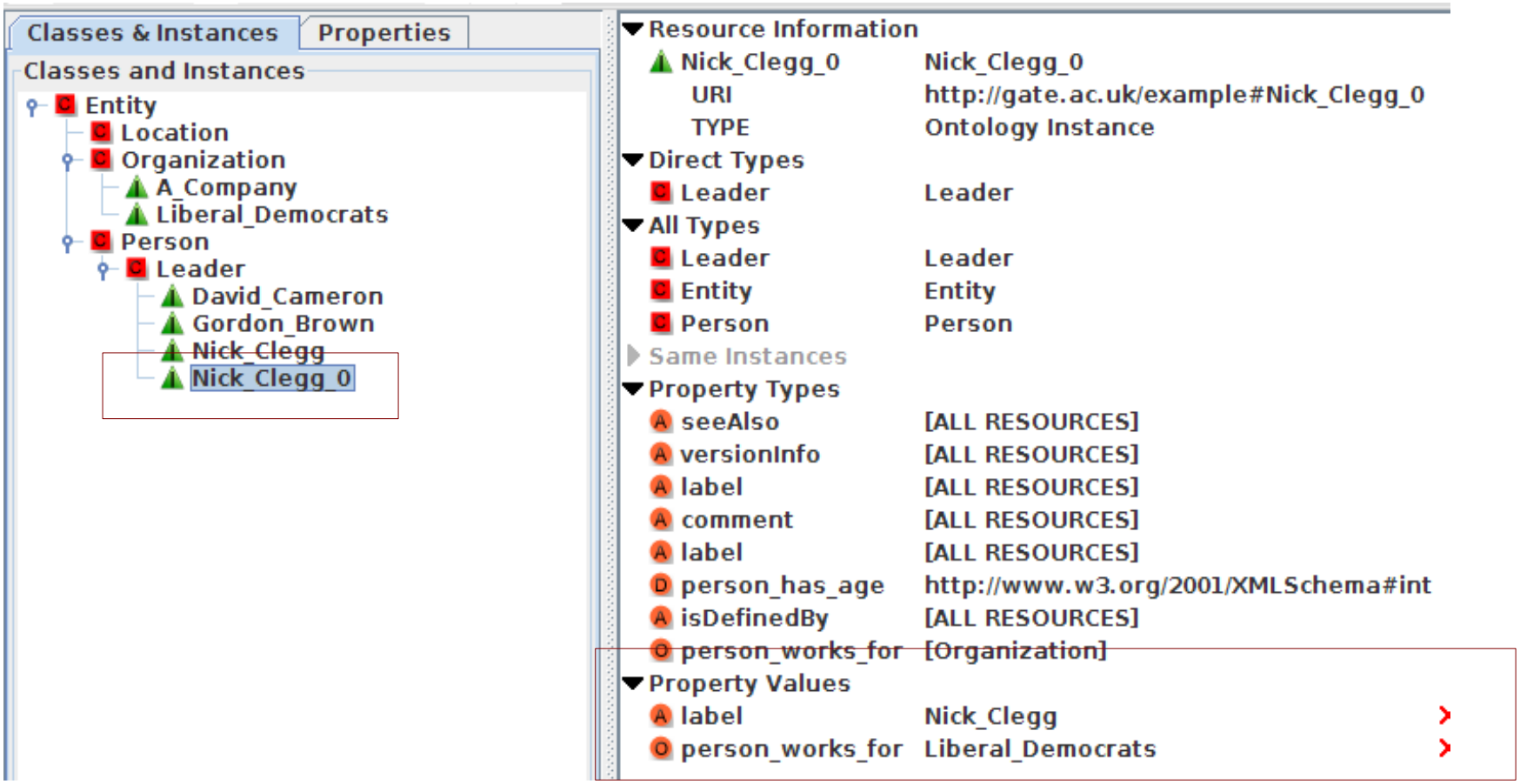
Adding a property value

- Your result should look something like this:



Checking the result

Check that the instance and property have been added correctly, by viewing it in the ontology editor



RAT Comments

- Tool to add individuals and object properties that model relationships between them based on document text
- Limitation: cannot model relations as individuals, but often we need to model n-ary relations, actions, events ..

OAT vs RAT

- In OAT, you have the option to annotate all mentions of the selected string in one go, e.g. the string “Liberal Democrats” as being the mention of the respective instance from the ontology. In RAT, you'll have to annotate each of the occurrences of this string over and over again
- OAT currently creates rather opaque instance URIs (e.g., Leader_0007A with label “David Cameron”), so once you have several automatically created instances of the same class, it becomes hard to distinguish which is which in OAT. RAT shows you all labels, not just the URI, so it's easier to select
- In OAT you can annotate a string as a mention of a class, without giving an instance

GATE: Automatic Semantic Annotation

- Ontology aware Gazetteers:
  - OntoRoot gazetteer
  - LKB Gazetteer
  - Other gazetteers, using inst/class features
- Ontology aware JAPE
- Semantic Enrichment: LKB Gazetteer, JAPE

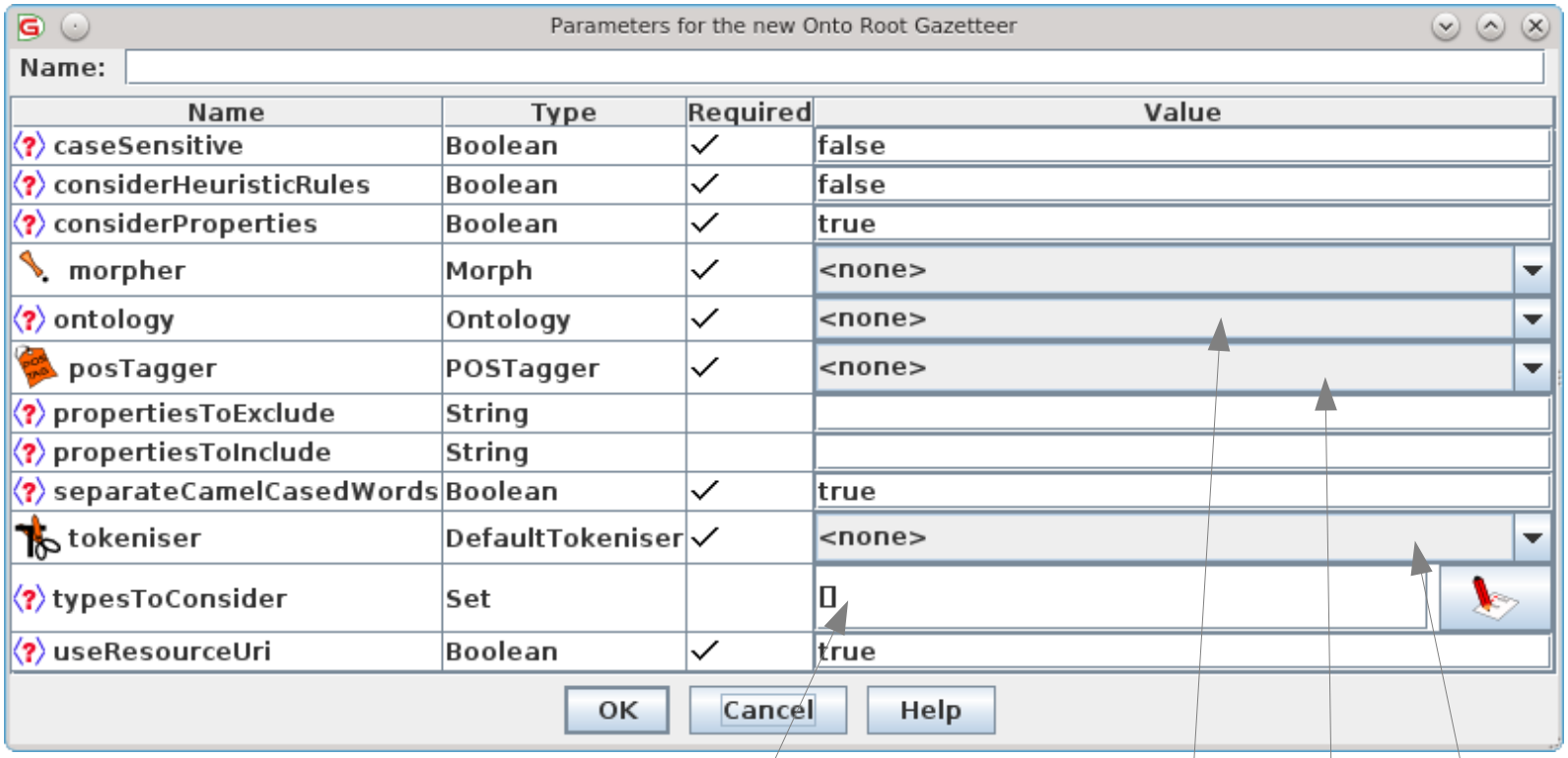
Ontology Lookup: OntoRoot Gazetteer

- Finds mentions in the text matching classes, instances, data property values and labels in the ontology
- Matching can be done between any morphological or typographical variant (e.g. upper/lower case, CamelCase)
- Converts CamelCase names, hyphens, underscores
- Morphological analysis is performed on both text and ontology, then matching is done between the two at the root level.
- Text is annotated with features containing the root and original string(s)
- Creates a gazetteer PR that can be used with the FlexibleGazetteerPR

OntoRoot Gazetteer

- Lives in the Gazetteer_Ontology_Based plugin
- Generates candidate gazetteer list from ontology
- Runs the Tokeniser, POS tagger, Morphological Analyser to create lemmas from the labels and the fragment identifiers of all classes and instances and then creates lists to match against the text
- Gordon_Brown, GordonBrown → Gordon Brown
- Note that the gazetteer produced is stored in memory only and cannot be edited
  → limited size!
- Must use tokeniser, sentence splitter, POS tagger and morphological analyser first: so we get “root” (lemma) feature!

Init-time OntoRoot params



!!! Must add “class”,”instance”,”property”
(bug in GATE 7.1, later: default)

Ontology LR

POS Tagger

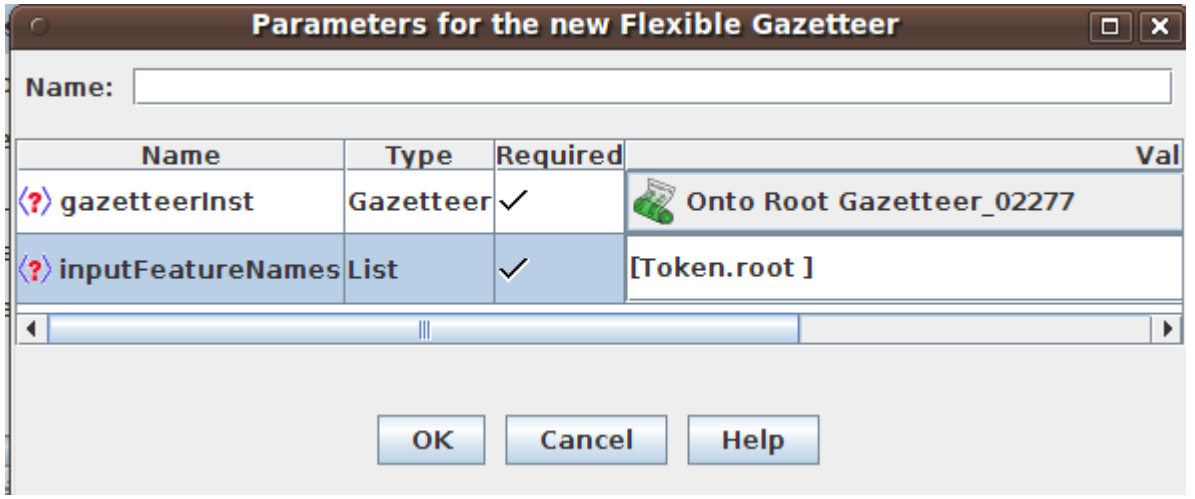
Tokeniser

Running the OntoRoot gazetter

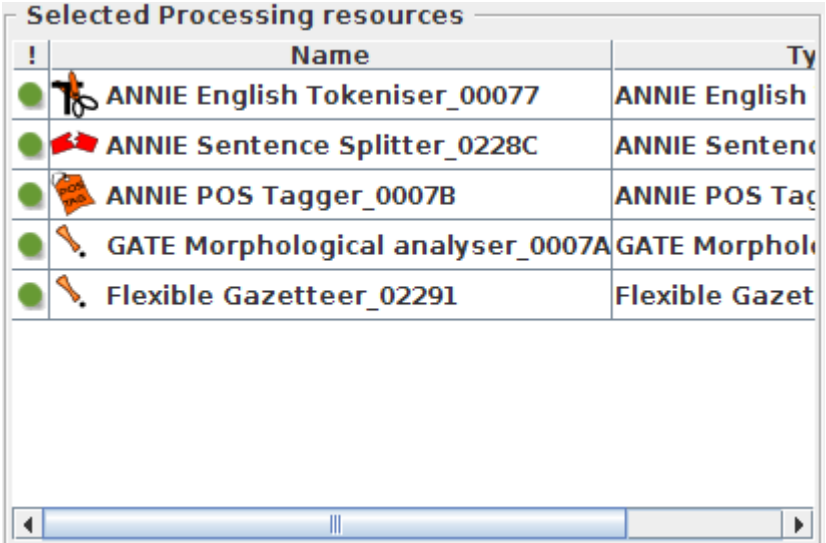
- If mostly matching proper names, then add to your application and run like the ANNIE gazetteer
- It will match against the document text as it is, which is not ideal if matching against terms (“leaders” should match “leader”: need lemma/root)
- To find root we need: Tokeniser, Sentence Splitter, POS tagger, and Morphological Analyser
- To match the root and not the text, use Flexible Gazetteer PR with OntoRoot as the embedded gazetteer
- Flexible Gazetteer delegates to OntoRoot Gazetteer: Flexible Gazetteer is the one that needs to be added to the application!
  → If Flexible Gazetteer is used, no need to add OntoRoot Gazetteer to application.

OntoRoot Application in GATE

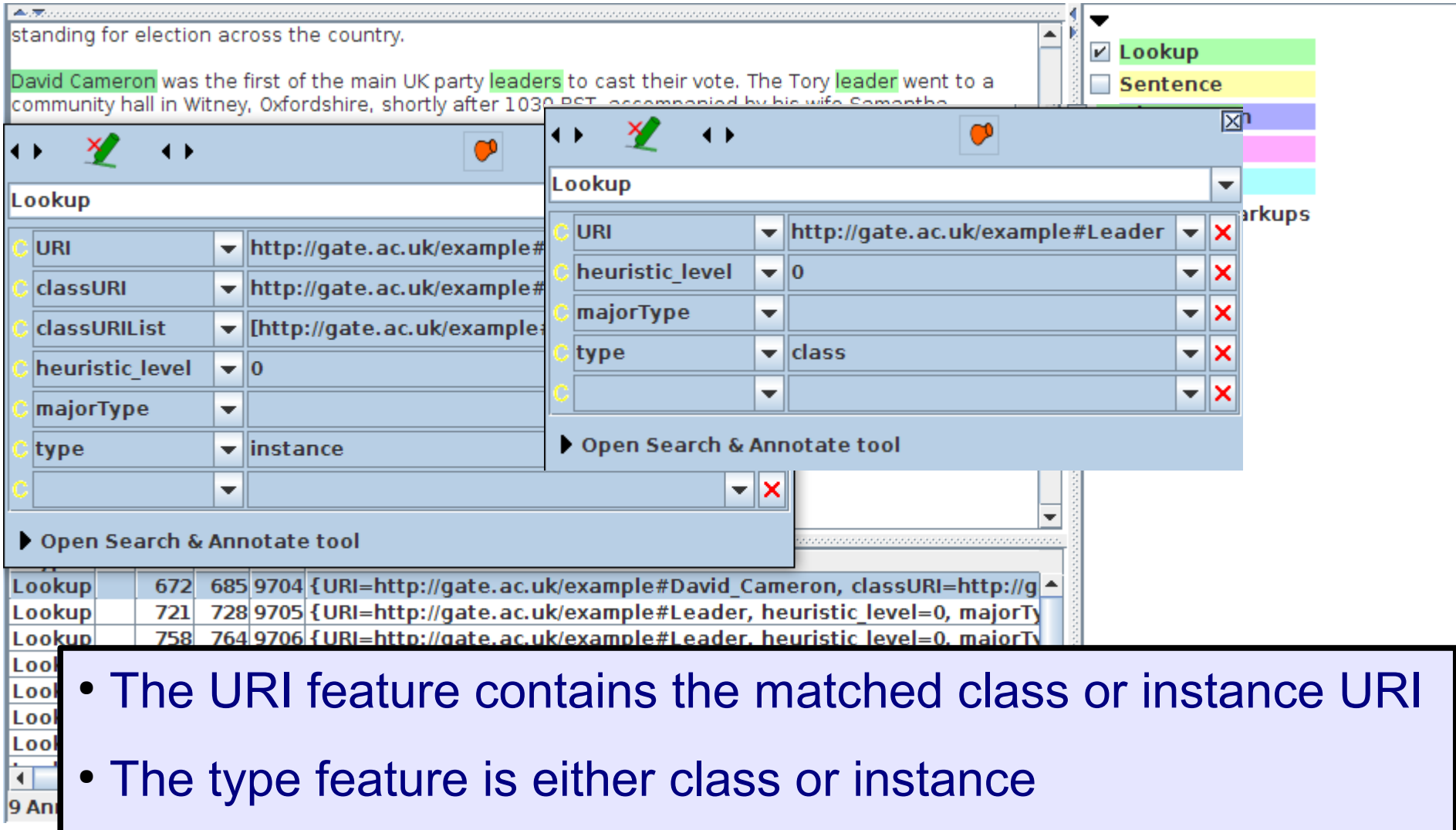
Create a Flexible Gazetteer with an OntoRoot inside it



Build a GATE application with the PRs shown



Output Example



- The URI feature contains the matched class or instance URI
- The type feature is either class or instance
- Instances have also features classURI and classURIList

Hands-on 6: OntoRootGazetteer

- Load Gazetteer_Ontology_Based plugin, ANNIE and Tools plugins
- Close any open ontologies, but keep the document you have open
  Load the ontology **test-ontology-instances.owl**
- Create a new corpus pipeline
- Create Document Reset, Tokeniser, Sentence Splitter, POS Tagger, and Morphological Analyser (all with defaults) and add to the pipeline in that order
- Create separate Tokeniser, POS Tagger, and Morphological Analyser PRs for OntoRoot Gaz, name them OR-Tokeniser etc.
- Create and configure OntoRootGazetteer: chose ontology and make sure the OR-... tokeniser, POS Tagger, Morpher are selected
- Add “class”, “instance” and “property” to typesToConsider
- Continue on next page

Hands-on 6: OntoRoot (contd.)

- Create a FlexibleGazetteer PR:
  - add Token.root to inputFeatureNames
  - choose the OntoRoot gazetteer as gazetteerInst
- Add Flexible Gazetteer to the pipeline
- Set the runtime parameter *setsToRemove* of the Document Reset to "Test"
- Set all the input and output sets in the pipeline to *Test*
- Create a corpus for document *voting-example.xml*
- Run the pipeline and inspect the resulting Lookup annotations in the ***Test*** annotation set
- Save your application and keep it open for later

Conventions in GATE

- We use “Mention” annotations to reflect the fact that the text mentions a particular instance or a class
- The Mention annotations have two special features:
  - *class* = class URI from the ontology
  - *inst* = instance URI from the ontology (if available)

  e.g. Mention {class=Leader, inst=Gordon_Brown}
- It's important **not** to use *class* and *inst* as features unless you're dealing with ontologies, as these are predefined names in several tools
- OntoRoot Gazetteer does not follow the conventions

Compatibility with OntoRootGazetteer

- The OntoRootGazetteer always puts the matching resource (class or individual) URI in a feature called “URI” and the kind of match in a feature called “type”. For individuals it also creates the features “classURI” and “classURIList”
- But GATE/JAPE requires these features to be called **class** and **inst**
- So we need a JAPE grammar to first change the names of these features

JAPE grammar to change feature names

```
Phase: LookupRename
Input: Lookup
Options: control = appelt

Rule: RenameLookup
(
  {Lookup.type == instance}

):match
-->
:match{
  for (Annotation lookup : matchAnnots) {
    FeatureMap theFeatures = lookup.getFeatures();
    theFeatures.put(
       "class", theFeatures.get("classURI"));
    theFeatures.put("inst", theFeatures.get("URI"));
  }
}
```

finds all Lookups which OntoRoot gazetteer created from ontology instances

add a new feature **class** with the value of the original classURI feature

do the same for inst

Ontology Aware JAPE

- JAPE transducers have a run-time parameter which is an ontology
- [Note that the ANNIE NE Transducer] does not have this parameter, so you cannot use it for ontology-aware JAPE]
- By default it is left blank, so not used during LHS matching
- When an ontology is provided, the **class** feature can be used on the LHS of a JAPE rule
- When matching the **class** value, the ontology is checked for subsumption: any subclass on the left side of "==" matches
- e.g. {Lookup.class == Person} will match a Lookup annotation with **class** feature, whose value is either Person or any subclass of it

Ontology-aware JAPE example

```
Phase: OntoMatching
Input: Lookup
Options: control = appelt

Rule: PersonLookup
(
  {Lookup.class == Person}

):person
-->
:person.Mention =
   {class = :person.Lookup.class,
    inst = :person.Lookup.inst}
```

Matches the class Person or any of its subclasses

Adds class and instance information as features on the Mention annotation

Ontology-aware JAPE example

Ontology-aware JAPE applies only to a feature named “class” and only if the PR's ontology parameter is set.

```
{Lookup.class == “http://example.com/stuff#Person”}
```

Matches this class or any subclass in the ontology

```
{Lookup.class == “Person”}
```

If the string is not a full URI, JAPE adds the default namespace from the ontology, looks up that class in the ontology, and matches it or any subclasses. Be very careful if your ontology uses more than one namespace!

These rules apply equally to the string in the JAPE rule and in the value of the annotation's class feature.

Templates to simplify namespaces

Template declarations can be used to simplify namespaces.

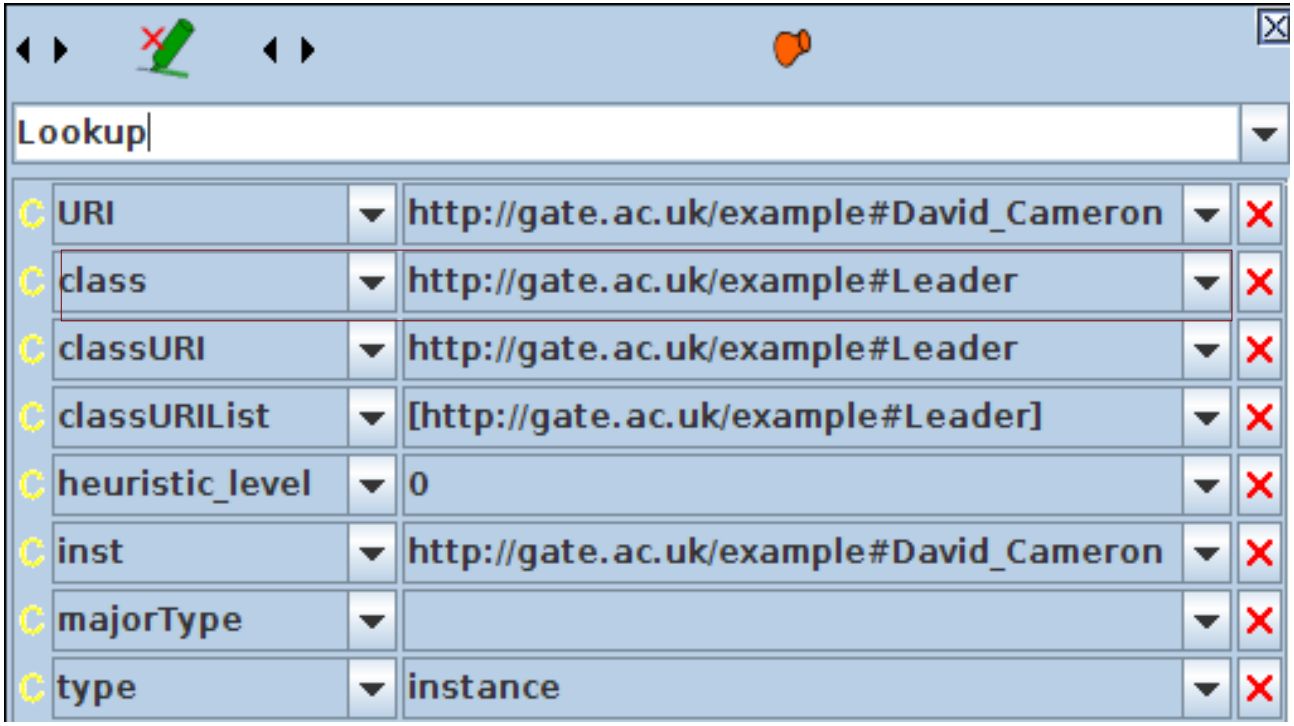
```
Template: protont =
  “http://proton.semanticweb.org/2005/04/protont#${n}”
...
{Lookup.class == [protont n=Person]}
...
{Lookup.class == [protont n=Location]}
```

If you switch to a newer version of PROTON, you only need to change the Template declarations, not every JAPE LHS. (See the GATE User Guide http://gate.ac.uk/userguide/sec:jape:templates for more details and examples.)

```
Template: protont =
  “http://proton.semanticweb.org/2006/05/protont#${n}”
...
```

Matching subclasses

David Cameron was the first of the main UK party leaders...



The rule matches because Leader is a subclass of Person

Hands-on 7: ontology-aware JAPE

- Load the JAPE transducer *rename-lookup-features.jape* and add to the end of your existing pipeline
  Set the input and output sets for it to *Test*
- Run the modified pipeline to see how the Lookup annotations for individuals in Test now have class features
- Load the JAPE transducer *person-onto-matching.jape* and add it to the end of the pipeline as before.
  - Set the input and output sets for it to *Test*
  - Select the ontology as the run-time param
- Run the modified pipeline to see how it creates new *Mention* annotations
- Save the application with a new name and close it

LKB Gazetteer

- The LKB gazetteer is used to do ontology-based gazetteer lookup against very large ontologies, e.g. DBPedia, GeoNames and other Open Linked Data ontologies
- Uses a SPARQL query to create a gazetteer list from the ontology

```
SELECT DISTINCT ?label ?inst ?class
WHERE {
    ?inst rdf:type dbp:Country .
    ?inst foaf:name ?label .
    FILTER (lang(?label) = "en")
}
```

- Internally retrieves the result rows and converts them to gazetteer entries with inst and class features
- Creates a cache file that will load fast subsequently

LKB: Continued

- Lives in plugin Gazetteer_LKB
- LKB does not use the GATE ontology language resources. Instead, it uses its own mechanism to load and process ontologies.
- Set up your dictionary first. The dictionary is a folder with some configuration files. Use the samples at GATE_HOME/plugins/Gazetteer_LKB/samples as a guide or download a pre-built dictionary from ontotext.com/kim/lkb_gazetteer/dictionaries.
- The dictionary directory defines which repository to connect to, which SPARQL queries to use to initialise the gazetteer, etc.
- For details see

  http://gate.ac.uk/userguide/sec:gazetteers:lkb-gazetteer

Other Gazetteers

- Often ontologies are huge
  → need gazetteers that can deal with very large gazetteer lists, do not want to re-create list too often
- Often we need to use specific SPARQL queries, need to process/clean labels or property values before using for the gazetteer

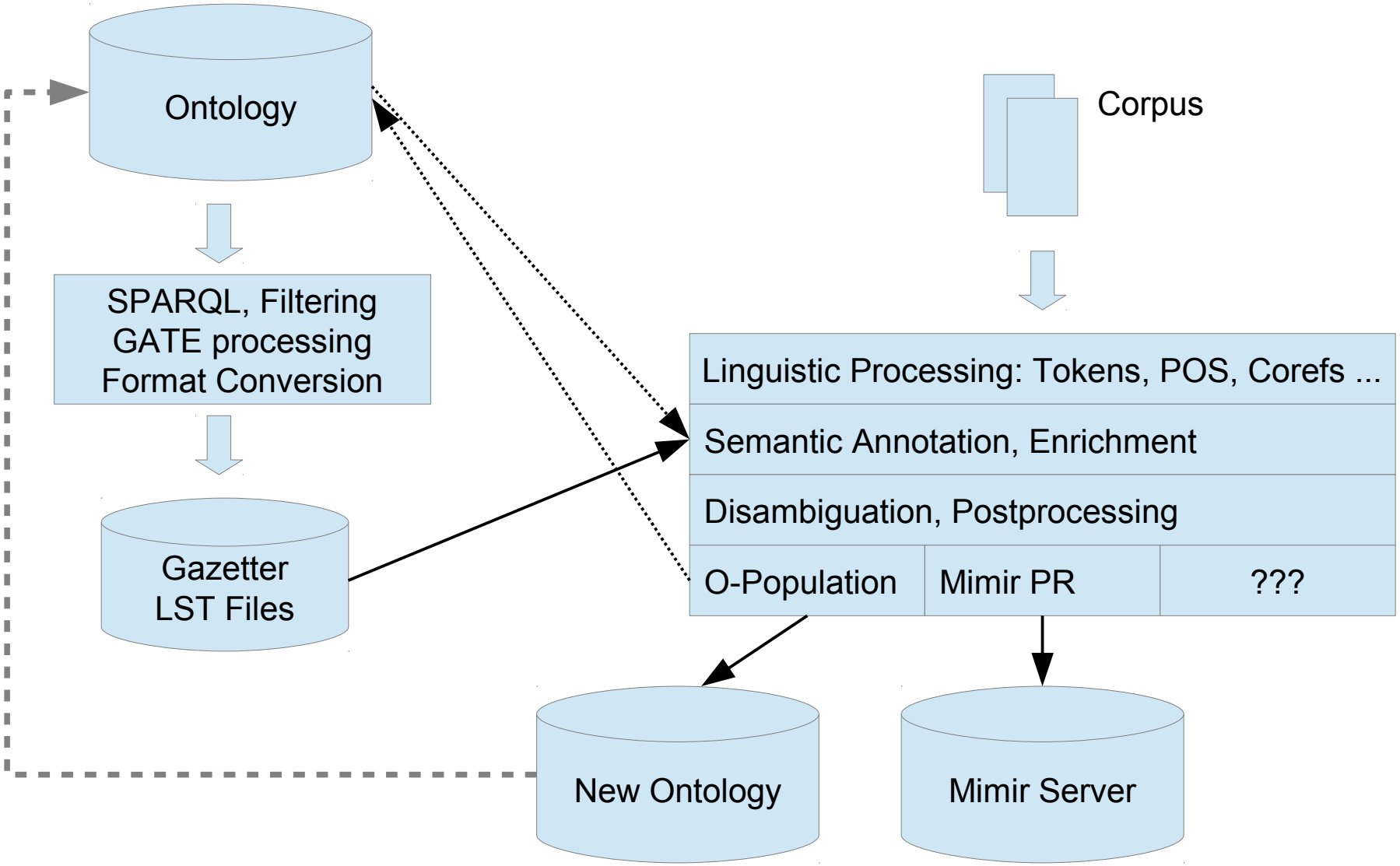
=> Separate preprocessing pipeline to create large gazetteer files with inst and class features

- Use a gazetteer that can handle large files:
  LKB Gazetteer with list files (not SPARQL):
  GATE version > 7.1 can handle class and inst features
  ExtendedGazetteer from StringAnnotation plugin
  (http://code.google.com/p/gateplugin-stringannotation/)
  can handle arbitrary features

Semantic Enrichment

- Add additional knowledge to semantically annotated mentions
- Simplest: add features
  e.g. add the name of the country, zip code for a city
  → if we have city names to disambiguate, may use zip code to disambiguate!
- Use Java API in JAPE RHS, Groovy or own PR
- SemanticEnrichment PR from the Gazetteer_LKB plugin
  - SPARQL Endpoint (not GATE Ontology LR)
  - Run SPARQL query for each URI in inst
  - add query result to 'connections' feature

The Big Picture



GATE Mímir

- Server-based, index large numbers of GATE documents
  - Text (Tokens)
  - Annotations and their features
  - Semantics: links to ontologies
- Can combine any of these into complex queries
  SPARQL can be used to semantic annotations based on the ontology:

```
(European Union) &
{Person sparql = "SELECT ?inst {
     ?inst :partyMember :LabourPartyUK .
     ?inst :birthPlace ?x .
     ?x :locatedIn :Wales . }"
}
```

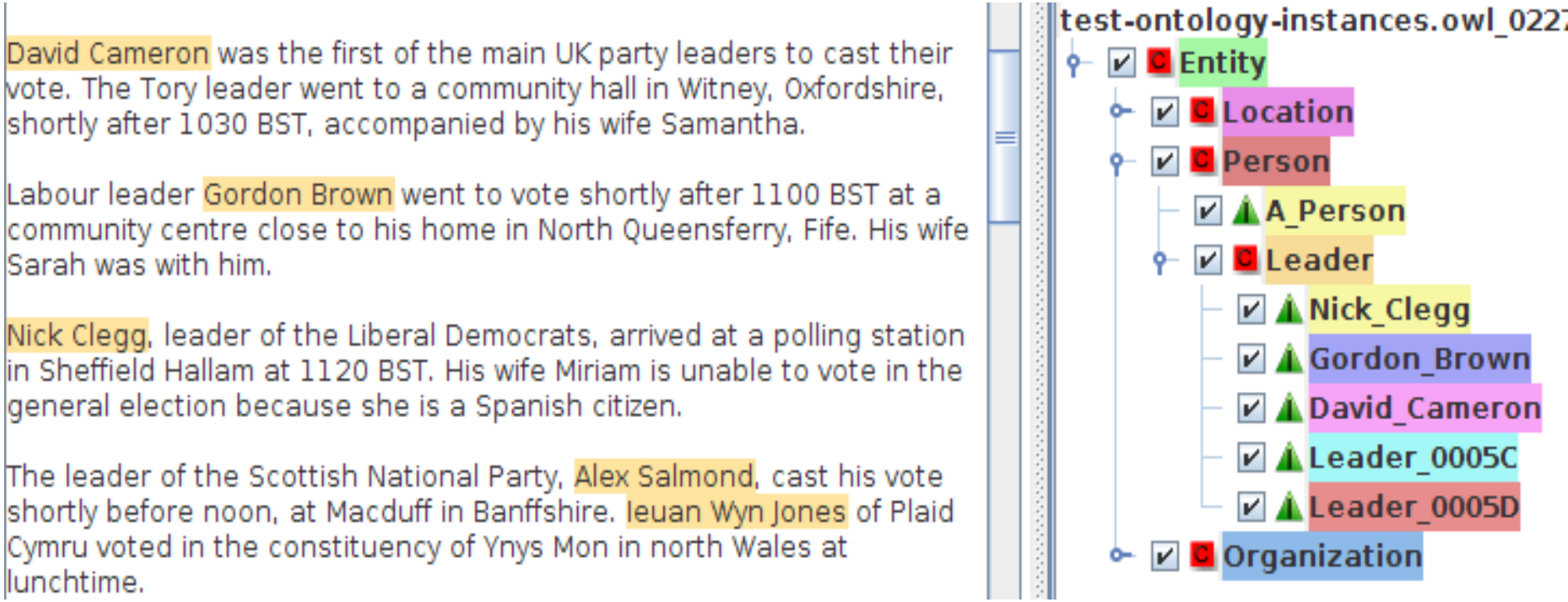
Performance Evaluation

- Mention annotations can be evaluated against a gold standard by matching the classes or instances
- However, traditional IE evaluation measures (Precision and Recall) don't take into account the class hierarchy
- Some mistakes can be “more wrong” than others
  - Nick Clegg → Person (not Leader) – still logically correct
  - Nick Clegg → Location – wrong
- We need a way of dealing with this, to give some credit for these kind of situations

Balanced Distance Metric

- BDM measures the closeness of two concepts in an ontology or taxonomy
- It produces a real number between 0 and 1
- The more closely related the two concepts are in an ontology, the greater their BDM score is
- It is dependent on a number of features:
  - the length of the shortest path connecting the two concepts
  - the depth of the two concepts in the ontology
  - size and density of the ontology

1: Use OAT to create gold standard



By convention, change the OAT default to put the annotations in the Key set.
It is already configured to create Mentions with class and inst features.

2: Compute BDM

- Located in the Ontology_BDM_Computation plugin
- Can be run in a non-corpus pipeline
  Runtime parameters:
  - input ontology
  - output txt file
- For each pair of classes in the ontology, it calculates a number of statistics
- Since BDM is symmetric for any two concepts, the resulting file contains only one entry per pair, despite one being called key

key=http://gate.ac.uk/example#Entity,
response=http://gate.ac.uk/example#Location, bdm=0.0,
msca=http://gate.ac.uk/example#Entity, cp=0, dpk=0, dpr=1, n0=1.6666666,
n1=1.6666666, n2=2.0, bran=1.8000001

3: Calculate BDM-aware measures

- The IAA plugin computes precision, recall, and F-measure over a corpus
  BDM statistics file can optionally be used to make BDM-aware
- Corpus Quality Assurace VR for a corpus can calculate and show precision, recall and F-measure (strict+lenient) over a corpus and for each document in a corpus.
  BDM statistics file can optionally be used to calculate BDM-aware and traditional measures.

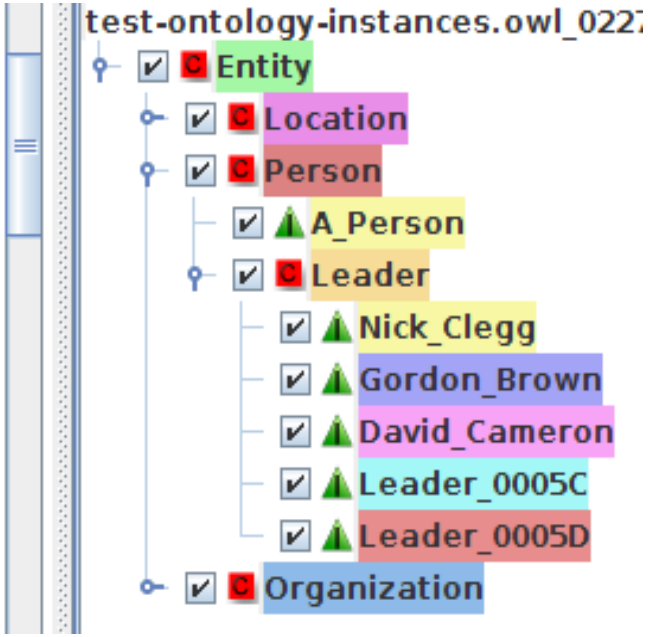
Our example text again

David Cameron was the first of the main UK party leaders to cast their vote. The Tory leader went to a community hall in Witney, Oxfordshire, shortly after 1030 BST, accompanied by his wife Samantha.

Labour leader Gordon Brown went to vote shortly after 1100 BST at a community centre close to his home in North Queensferry, Fife. His wife Sarah was with him.

Nick Clegg, leader of the Liberal Democrats, arrived at a polling station in Sheffield Hallam at 1120 BST. His wife Miriam is unable to vote in the general election because she is a Spanish citizen.

The leader of the Scottish National Party, Alex Salmond, cast his vote shortly before noon, at Macduff in Banffshire. Ieuan Wyn Jones of Plaid Cymru voted in the constituency of Ynys Mon in north Wales at lunchtime.



Clegg is marked as a Person, instead of Leader

Salmond is missing

Results

- Traditional scores for the example:
  - Match = 2, Only A (missing) = 2, Only B (spurious) = 1, Overlap (Partial) = 0
  - Recall = 0.50, Precision = 0.67, F1 = 0.57
- BDM-sensitive scores:
  - Recall = 0.60, Precision = 0.81, F1 = 0.69

Further materials

Ontology design: principles:http://lsdis.cs.uga.edu/SemWebCourse/OntologyDesign.ppt

BDM: http://gate.ac.uk/userguide/sec:eval:bdmplugin

Semantic Annotation:

K. Bontcheva, B. Davis, A. Funk, Y. Li and T. Wang. Human Language Technologies. Semantic Knowledge Management, John Davies, Marko Grobelnik, and Dunja Mladenic (Eds.), Springer, 37-49, 2009.

K.Bontcheva, H.Cunningham, A.Kiryakov and V.Tablan. Semantic Annotation and Human Language Technology. Semantic Web Technology: Trends and Research. John Wiley and Sons Ltd. 2006.

D. Maynard, Y. Li and W. Peters. NLP Techniques for Term Extraction and Ontology Population. Bridging the Gap between Text and Knowledge - Selected Contributions to Ontology Learning and Population from Text, P. Buitelaar and P. Cimiano (editors). IOS Press, 2007.

QUESTIONS?