# Jena

Tong Zhao

# Apache Jena API

- Developers: 2000-2009 HP Labs

  2009-now  Apache Software Foundation (vote: 10+7-)

  Vote: http://mail-archives.apache.org/mod_mbox/incubator-general/201011.mbox/%3C4CEC31E4.9080401@apache.org%3E

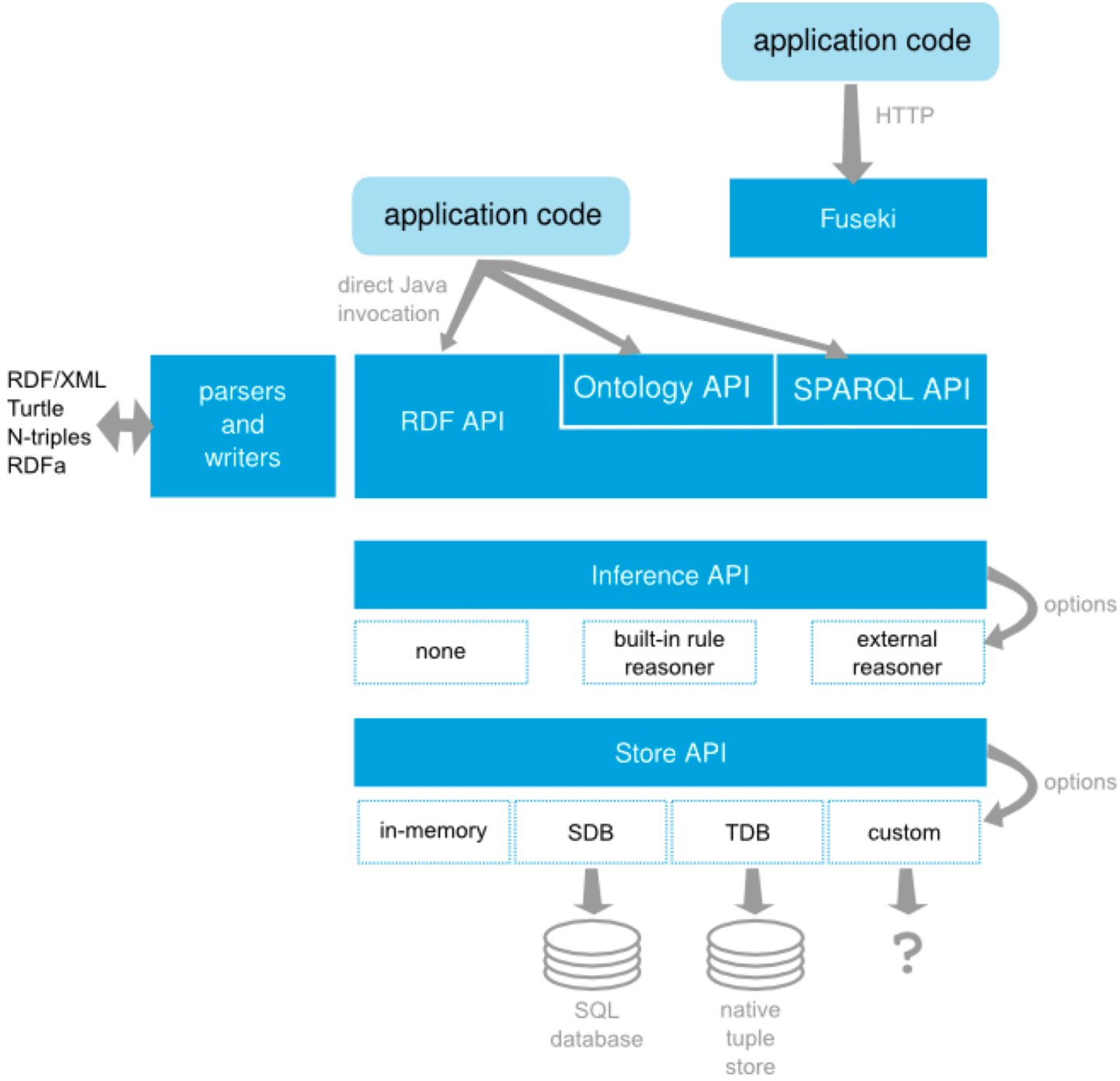
- Open source Semantic Web framework for Java.
- Read and write to RDF graphs.
- Graphs in Jena are represented as an abstract “model”.
- Model can be queried through SPARQL.

# RDF and SPARQL

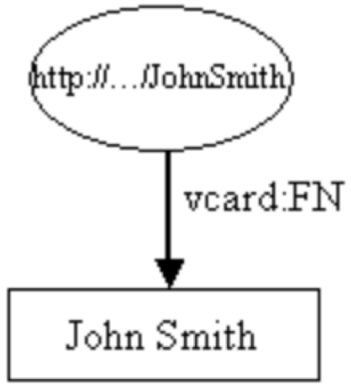
- “The Resource Description Framework (RDF) is a family of World Wild Web Consortium (W3C) specifications originally designed as a metadata data model”
- “SPARQL is an RDF query language --  that is, a semantic query language for databases.”

------Wikipedia

# Framework Architecture



# Examples: creating a simple model




```
// some definitions
static String personURI    = "http://somewhere/JohnSmith";
static String fullName     = "John Smith";

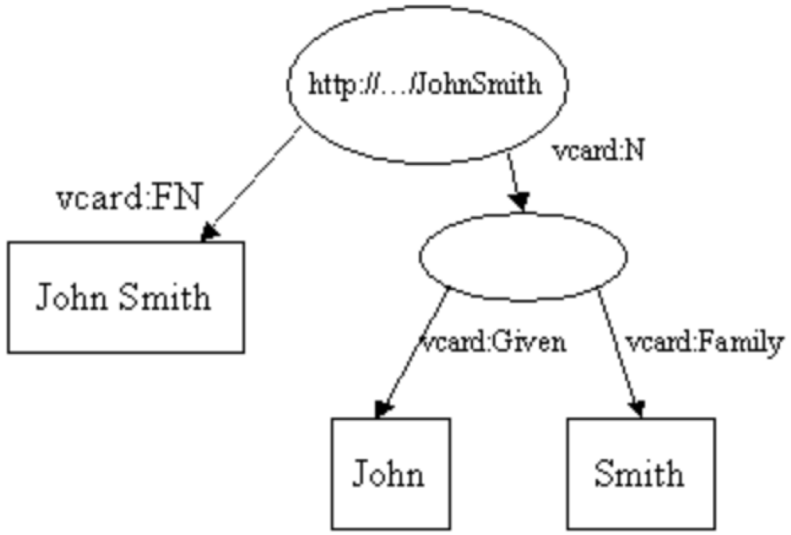
// create an empty Model
Model model = ModelFactory.createDefaultModel();

// create the resource
Resource johnSmith = model.createResource(personURI);

// add the property
 johnSmith.addProperty(VCARD.FN, fullName);
```

```
Resource johnSmith =
        model.createResource(personURI)
             .addProperty(VCARD.FN, fullName);
```

# Examples: creating a model

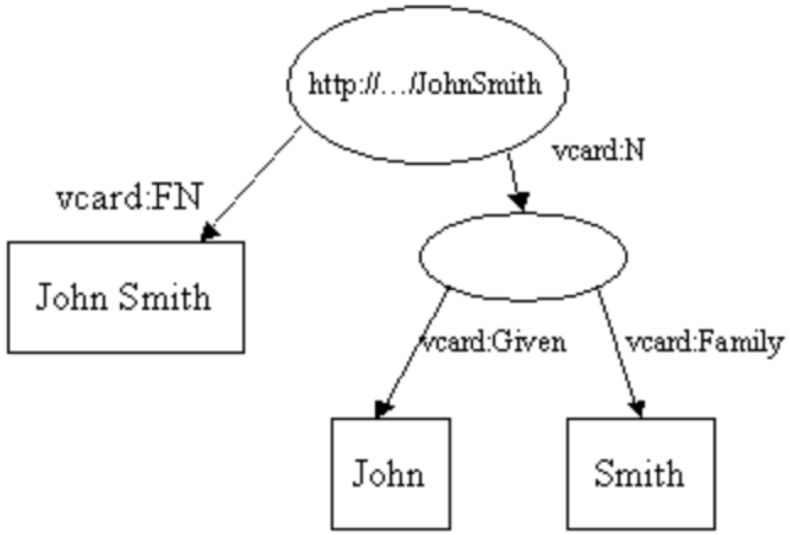



```
// some definitions
String personURI    = "http://somewhere/JohnSmith";
String givenName    = "John";
String familyName   = "Smith";
String fullName     = givenName + " " + familyName;

// create an empty Model
Model model = ModelFactory.createDefaultModel();

// create the resource
//   and add the properties cascading style
Resource johnSmith
  = model.createResource(personURI)
         .addProperty(VCARD.FN, fullName)
         .addProperty(VCARD.N,
                      model.createResource()
                           .addProperty(VCARD.Given, givenName)
                           .addProperty(VCARD.Family, familyName));
```

# Examples: reading & writing



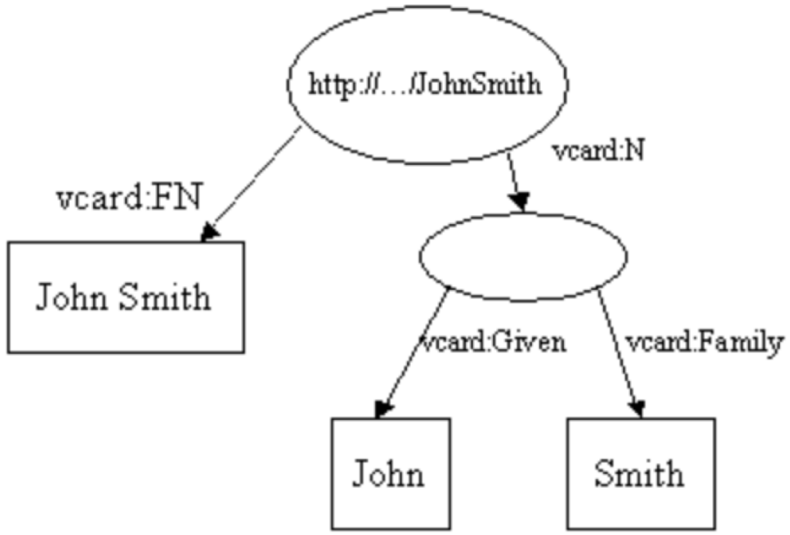

```
 // create an empty model
 Model model = ModelFactory.createDefaultModel();

 // use the FileManager to find the input file
 InputStream in = FileManager.get().open( inputFileName );
if (in == null) {
    throw new IllegalArgumentException(
                                    "File: " + inputFileName + " not found");
}

// read the RDF/XML file
model.read(in, null);

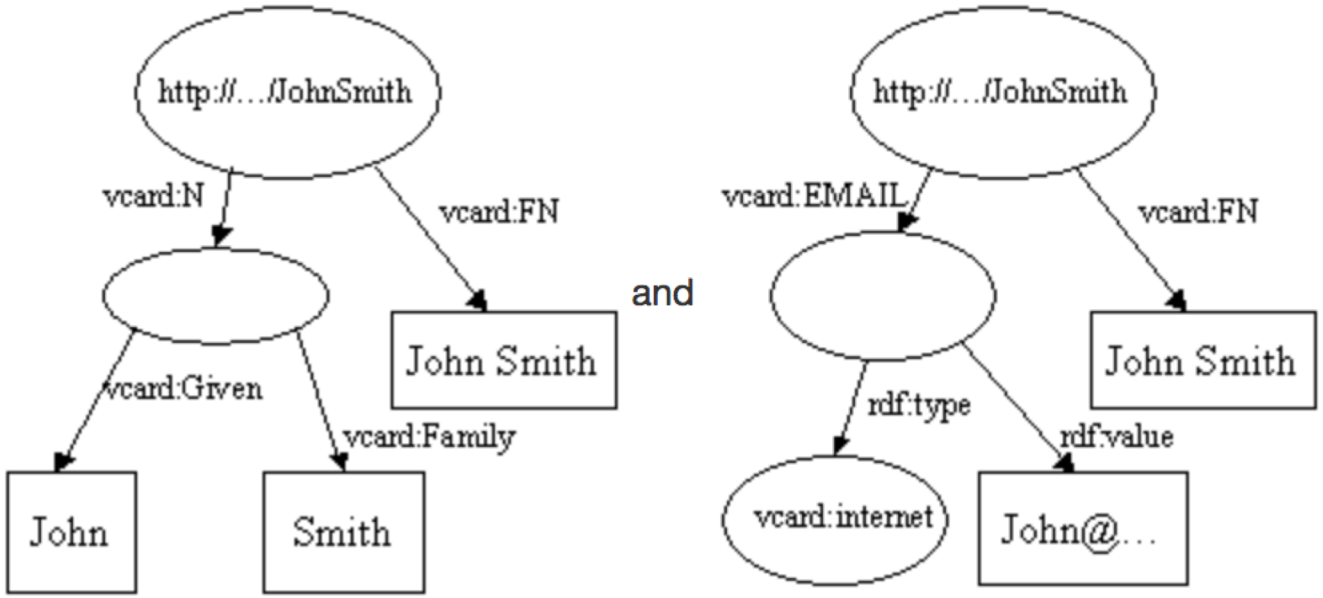
// write it to standard out
model.write(System.out);
```

# Examples: reading & writing




```
<rdf:RDF
  xmlns:rdf='http://www.w3.org/1999/02/22-rdf-syntax-ns#'
  xmlns:vcard='http://www.w3.org/2001/vcard-rdf/3.0#'
 >
  <rdf:Description rdf:about='http://somewhere/JohnSmith'>
    <vcard:FN>John Smith</vcard:FN>
    <vcard:N rdf:nodeID="A0"/>
  </rdf:Description>
  <rdf:Description rdf:nodeID="A0">
    <vcard:Given>John</vcard:Given>
    <vcard:Family>Smith</vcard:Family>
  </rdf:Description>
</rdf:RDF>
```

# Examples: operations on models

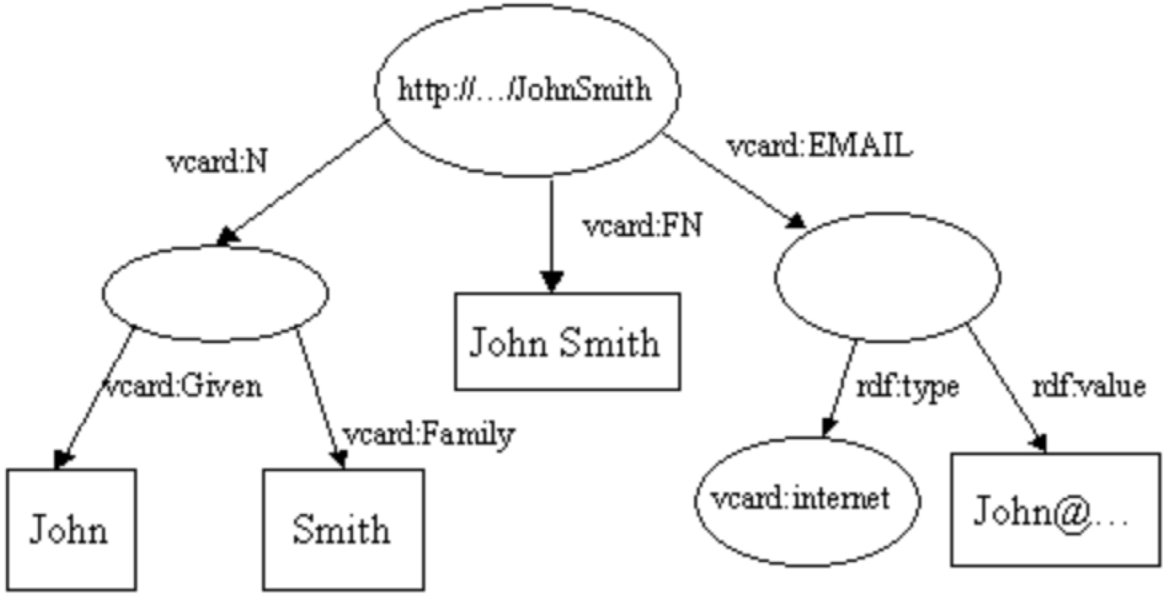



```
// read the RDF/XML files
model1.read(new InputStreamReader(in1), "");
model2.read(new InputStreamReader(in2), "");

// merge the Models
Model model = model1.union(model2);

// print the Model as RDF/XML
model.write(system.out, "RDF/XML-ABBREV");
```

# Examples: operations on models

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model1.read(new InputStreamReader(in1), "");
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// print the Model as RDF/XML
model.write(system.out, "RDF/XML-ABBREV");
```

# Statements (arc in RDF)

- Also called as triple.
- A statement has three parts:
  - Subject: the resource from which the arc leaves.
  - Predicate: the property that labels the arc.
  - Object: the resource or literal pointed to by the arc.

```
// list the statements in the Model
StmtIterator iter = model.listStatements();

// print out the predicate, subject and object of each statement
while (iter.hasNext()) {
    Statement stmt      = iter.nextStatement();  // get next statement
    Resource  subject   = stmt.getSubject();     // get the subject
    Property  predicate = stmt.getPredicate();   // get the predicate
    RDFNode   object    = stmt.getObject();      // get the object
```

# Examples: querying a model

```
// select all the resources with a VCARD.FN property
ResIterator iter = model.listSubjectsWithProperty(VCARD.FN);
if (iter.hasNext()) {
    System.out.println("The database contains vcards for:");
    while (iter.hasNext()) {
        System.out.println("  " + iter.nextResource()
                                    .getProperty(VCARD.FN)
                                    .getString());
    }
} else {
    System.out.println("No vcards were found in the database");
}
```

```
The database contains vcards for:
  Sarah Jones
  John Smith
  Matt Jones
  Becky Smith
```

# Examples: querying a model

```
// select all the resources with a VCARD.FN property
// whose value ends with "Smith"
StmtIterator iter = model.listStatements(
    new SimpleSelector(null, VCARD.FN, (RDFNode) null) {
        public boolean selects(Statement s)
            {return s.getString().endsWith("Smith");}
    });
```

```
The database contains vcards for:
  John Smith
  Becky Smith
```

# ARQ: A SPARQL processor for Jena that allows you to use SPARQL RDF query language.

```
public ResultSet executeQuery(String queryString) throws Exception {
        Query query = QueryFactory.create(queryString) ;

        QueryEngineHTTP qexec = QueryExecutionFactory.createServiceRequest(this.service, query);
        qexec.addParam("apikey", this.apikey);
        ResultSet results = qexec.execSelect() ;
        return results;

}
```

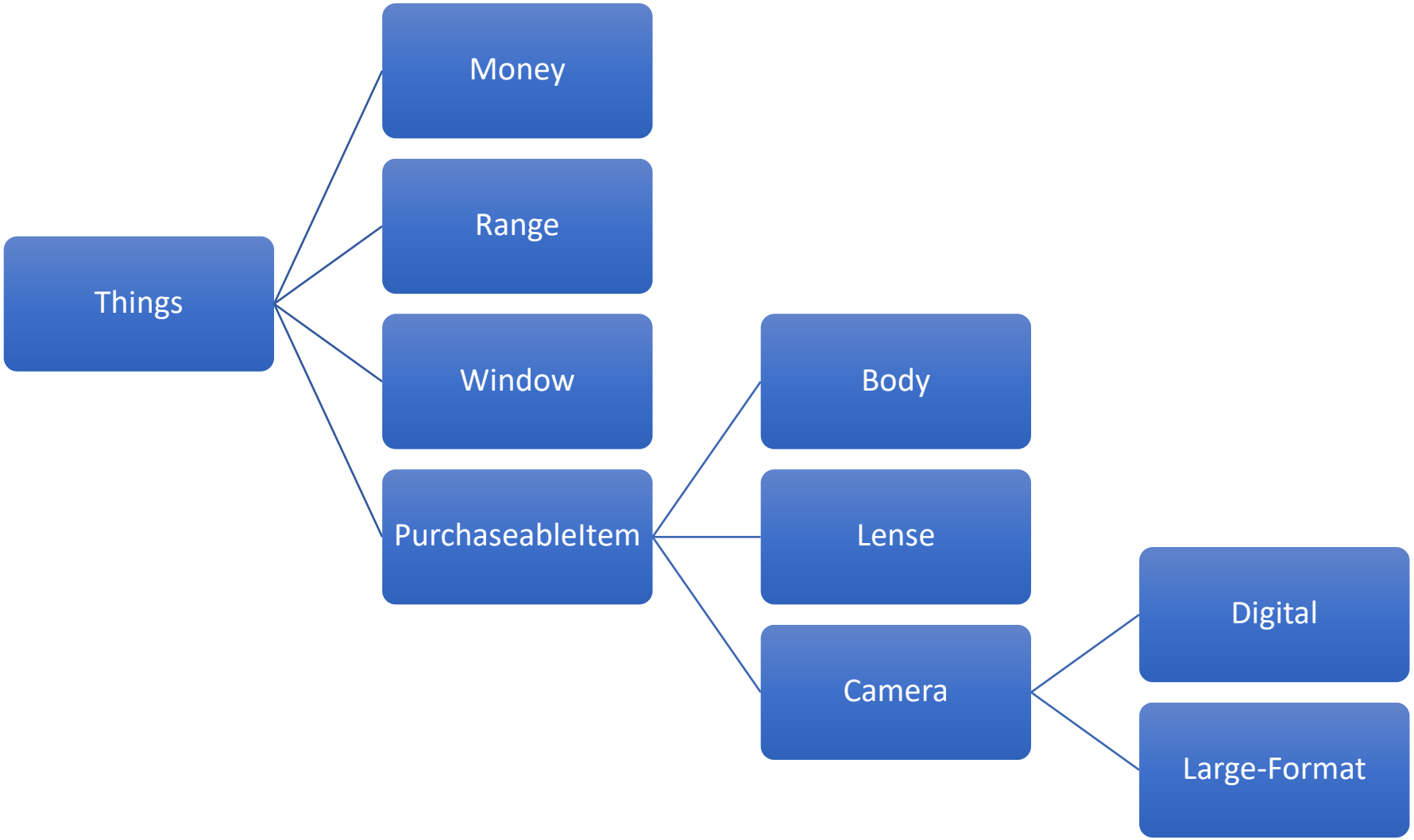
```
String query = "PREFIX omv: <http://omv.ontoware.org/2005/05/ontology#> " +
                        "SELECT ?ont ?name ?acr " +
                        "WHERE { ?ont a omv:Ontology; " +
                        "omv:acronym ?acr; " +
                        "omv:name ?name . " +
                        "}";

JenaARQTest test = new JenaARQTest(sparqlService,apikey);
ResultSet results = test.executeQuery(query);
```

# Containers

- Collection of things are called containers.
- The members of a container can be either literals or resources.
- There are 3 types of containers:
  - BAG: unordered collection.
  - SEQ: ordered collection.
  - ALT: unordered collection intended to represent alternatives.

Camera Ontology:
protege.cim3.net/file/pub/ontologies/camera/camera.owl



# BFS in Jena API

```java
public class BFSInRDFWithJena {

    public static List<List<Resource>> BFS( final Model model, final Queue<List<Resource>> queue, final int depth ) {
        final List<List<Resource>> results = new ArrayList<>();
        while ( !queue.isEmpty() ) {
            final List<Resource> path = queue.poll();
            results.add( path );
            if ( path.size() < depth ) {
                final Resource last = path.get( path.size() - 1 );
                final StmtIterator stmt = model.listStatements( null, RDFS.subClassOf, last );
                while ( stmt.hasNext() ) {
                    final List<Resource> extPath = new ArrayList<>( path );
                    extPath.add( stmt.next().getSubject().asResource() );
                    queue.offer( extPath );
                }
            }
        }
        return results;
    }

    public static void main( final String[] args ) throws IOException {
        final Model model = ModelFactory.createDefaultModel();
        try ( final InputStream in = BFSInRDFWithJena.class.getClassLoader().getResourceAsStream( "camera.owl" ) ) {
            model.read( in, null );
        }

        // setup the initial queue
        final Queue<List<Resource>> queue = new LinkedList<>();
        final List<Resource> thingPath = new ArrayList<>();
        thingPath.add( OWL.Thing );
        queue.offer( thingPath );

        // Get the paths, and display them
        final List<List<Resource>> paths = BFS( model, queue, 4 );
        for ( List<Resource> path : paths ) {
            System.out.println( path );
        }
    }
}
```

# BFS in Jena API

```
15  public class BFSInRDFWithJena {
16
17      public static List<List<Resource>> BFS( final Model model, final Queue<List<Resource>> queue, final int depth ) {
18          final List<List<Resource>> results = new ArrayList<>();
19          while ( !queue.isEmpty() ) {
20              final List<Resource> path = queue.poll();
21              results.add( path );
22              if ( path.size() < depth ) {
23                  final Resource last = path.get( path.size() - 1 );
24                  final StmtIterator stmt = model.listStatements( null, RDFS.subClassOf, last );
25                  while ( stmt.hasNext() ) {
26                      final List<Resource> extPath = new ArrayList<>( path );
27                      extPath.add( stmt.next().getSubject().asResource() );
28                      queue.offer( extPath );
29                  }
30              }
31          }
32          return results;
33      }
34
35      public static void main( final String[] args ) throws IOException {
36          final Model model = ModelFactory.createDefaultModel();
```

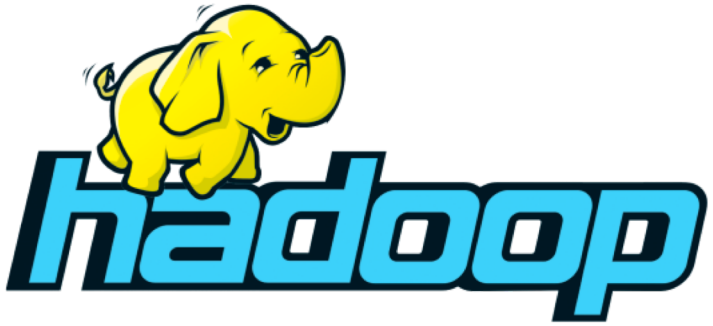
```
[http://www.w3.org/2002/07/owl#Thing]
[http://www.w3.org/2002/07/owl#Thing, http://www.xfront.com/owl/ontologies/camera/#PurchaseableItem]
[http://www.w3.org/2002/07/owl#Thing, http://www.xfront.com/owl/ontologies/camera/#Window]
[http://www.w3.org/2002/07/owl#Thing, http://www.xfront.com/owl/ontologies/camera/#Range]
[http://www.w3.org/2002/07/owl#Thing, http://www.xfront.com/owl/ontologies/camera/#Money]
[http://www.w3.org/2002/07/owl#Thing, http://www.xfront.com/owl/ontologies/camera/#PurchaseableItem, http://www.xfront.com/owl/ontologies/camera/#Camera]
[http://www.w3.org/2002/07/owl#Thing, http://www.xfront.com/owl/ontologies/camera/#PurchaseableItem, http://www.xfront.com/owl/ontologies/camera/#Lens]
[http://www.w3.org/2002/07/owl#Thing, http://www.xfront.com/owl/ontologies/camera/#PurchaseableItem, http://www.xfront.com/owl/ontologies/camera/#Body]
[http://www.w3.org/2002/07/owl#Thing, http://www.xfront.com/owl/ontologies/camera/#PurchaseableItem, http://www.xfront.com/owl/ontologies/camera/#Camera, http://www.xfront.com/
owl/ontologies/camera/#Digital]
[http://www.w3.org/2002/07/owl#Thing, http://www.xfront.com/owl/ontologies/camera/#PurchaseableItem, http://www.xfront.com/owl/ontologies/camera/#Camera, http://www.xfront.com/
owl/ontologies/camera/#Large-Format]
```

```
46
47          // Get the paths, and display them
48          final List<List<Resource>> paths = BFS( model, queue, 4 );
49          for ( List<Resource> path : paths ) {
50              System.out.println( path );
51          }
52      }
53  }
```

# Concurrency

```
Model model = . . . ;
model.enterCriticalSection(Lock.READ) ;  // or Lock.WRITE
try {
    ... perform actions on the model ...
    ... obey contract - no update operations if a read lock
} finally {
    model.leaveCriticalSection() ;
}
```

# Apache Jena Elephas




- A set of libraries that enable you to start writing Apache Hadoop based applications which work with RDF data.
- Under active development for about a year.
- Still in Beta stage.
- https://jena.apache.org/documentation/hadoop/index.html