Ubiquitous AI Demands A New Type Of Database Sharding

Forbes published the following article by Dr. Jans Aasman, Franz Inc.’s CEO.

The notion of sharding has become increasingly crucial for selecting and optimizing database architectures. In many cases, sharding is a means of horizontally distributing data; if properly implemented, it results in near-infinite scalability. This option enables database availability for business continuity, allowing organizations to replicate databases among geographic locations. It’s equally useful for load balancing, in which computational necessities (like processing) shift between machines to improve IT resource allocation.

However, these use cases fail to actualize sharding’s full potential to maximize database performance in today’s post-big data landscape. There’s an even more powerful form of sharding, called “hybrid sharding,” that drastically improves the speed of query results and duly expands the complexity of the questions that can be asked and answered. Hybrid sharding is the ability to combine data that can be partitioned into shards with data that represents knowledge that is usually un-shardable.

This hybrid sharding works particularly well with the knowledge graph phenomenon leveraged by the world’s top data-driven companies. Hybrid sharding also creates the enterprise scalability to query scores of internal and external sources for nuanced, detailed results, with responsiveness commensurate to that of the contemporary AI age.

Read the full article at Forbes.

Franz Inc. to Present at The Global Graph Summit and Data Day Texas

Dr. Jans Aasman, CEO, Franz Inc., will be presenting, "Creating Explainable AI with Rules" at the Global Graph Summit, a part of Data Day Texas. The abstract for Dr. Aasman's presentation:

> *"There's a fascinating dichotomy in artificial intelligence between statistics and rules, machine learning and expert systems. Newcomers to artificial intelligence (AI) regard machine learning as innately superior to brittle rules-based systems, while the history of this field reveals both rules and probabilistic learning are integral components of AI. This fact is perhaps nowhere truer than in establishing* explainable AI*, which is central to the long-term business value of AI front-office use cases."*

> *"The fundamental necessity for explainable AI spans regulatory compliance, fairness, transparency, ethics and lack of bias – although this is not a complete list. For example, the effectiveness of counteracting financial crimes and increasing revenues from advanced machine learning predictions in financial services could be greatly enhanced by deploying more accurate deep learning models. But all of this would be arduous to explain to regulators. Translating those results into explainable rules is the basis for more widespread AI deployments producing a more meaningful impact on society."*

The Global Graph Summit is an independently organized vendor-neutral conference, bringing leaders from every corner of the graph and linked-data community for sessions, workshops, and its well-known before and after parties. Originally launched in January 2011 as one of the first NoSQL / Big Data conferences, Data Day Texas each year highlights the latest tools, techniques, and projects in the data space, bringing speakers and attendees from around the world to enjoy the hospitality that is uniquely Austin. Since its inception, Data Day Texas has continually been the largest independent data-centric event held within 1000 miles of Texas.

The Importance of FAIR Data in Earth Science

Franz's CEO, Jans Aasman's recent Marine Technology News:

Data's valuation as an enterprise asset is most acutely realized over time. When properly managed, the same dataset

supports a plurality of use cases, becomes almost instantly available upon request, and is exchangeable between departments or organizations to systematically increase its yield with each deployment.

These boons of leveraging data as an enterprise asset are the foundation of GO FAIR's Findable Accessible Interoperable Reusable (FAIR) principles profoundly impacting the data management rigors of geological science. Numerous organizations in this space have embraced these tenets to swiftly share information among a diversity of disciplines to safely guide the stewardship of the earth.

According to Dr. Annie Burgess, Lab Director of Earth Science Information Partners (ESIP), the "most pressing global challenges cannot be solved by a single organization. Scientists require data collected across multiple disciplines, which are often managed by many different agencies and institutions." As numerous members of the earth science community are realizing, the most effectual means of managing those disparate data according to FAIR principles is by utilizing the semantic standards underpinning knowledge graphs.

Read the full article at Marine Technology News

Harnessing the Internet of

Things with JSON-LD

Franz's CEO, Jans Aasman's recent IoT Evolution Article:

Conceptually, the promise of the Internet of Things is almost halcyon. Its billions of sensors are all connected, continuously transmitting data to support tailored, cost-saving measures maximizing revenues in applications as diverse as smart cities, smart price tags, and predictive maintenance in the Industrial Internet.

Practically, the data management necessities of capitalizing on this promise by the outset of the next decade are daunting. The vast majority of these datasets are unstructured or semi-structured. The data modeling challenges of rectifying their schema for integration are considerable. The low latency action required to benefit from their data implies machine intelligence largely elusive to today's organizations.

……

The self-describing, linked data approach upon which JSON-LD is founded excels at the low latent action resulting from machine to machine communication in the IoT. The nucleus of the linked data methodology—semantic statements and their unique Uniform Resource Identifiers (URIs)—are read and understood by machines. This characteristic aids many of the IoT use cases requiring machine intelligence; by transmitting IoT data via the JSON-LD format organizations can maximize this boon. Smart cities provide particularly compelling

examples of the machine intelligence fortified by this expression of semantic technology.

Read the full article at IoT Evolution

SHACL – Shapes Constraint Language in AllegroGraph

SHACL is a SHApe Constraint Language. It specifies a vocabulary (using triples) to describe the shape that data should have. The *shape* specifies things like the following simple requirements:

- How many triples with a specified subject and predicate should be in the repository (e.g. at least 1, at most 1, exactly 1).
- What the nature of the object of a triple with a specified subject and predicate should be (e.g. a string, an integer, etc.)

See the specification for more examples.

SHACL allows you to validate that your data is conforming to desired requirements.

For a given validation, the shapes are in the *Shapes Graph* (where *graph* means a collection of triples) and the data to be validated is in the *Data Graph* (again, a collection of triples). The SHACL vocabularly describes how a given shape is linked to *targets* in the data and also provides a way for a Data Graph to specify the Shapes Graph that should be used for validatation. The result of a SHACL validation describes

whether the Data Graph conforms to the Shapes Graph and, if it does not, describes each of the failures.

Namespaces Used in this Document

Along with standard predefined namespaces (such as rdf: for <http://www.w3.org/1999/02/22-rdf-syntax-ns#> and rdfs: for <http://www.w3.org/2000/01/rdf-schema#>), the following are used in code and examples below:

```
prefix fr: <https://franz.com#>
prefix sh: <http://www.w3.org/ns/shacl#>
prefix franz: <https://franz.com/ns/allegrograph/6.6.0/>
```

A Simple Example

Suppose we have a *Employee* class and for each Employee instance, there must be exactly one triple of the form

```
emp001 hasID "000-12-3456"
```

where the object is the employee's ID Number, which has the format is [3 digits]-[2 digits]-[4 digits].

This TriG file encapsulates the constraints above:

```
@prefix sh: <http://www.w3.org/ns/shacl#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

<https://franz.com#Shapes> {
 <https://franz.com#EmployeeShape>
  a sh:NodeShape ;
  sh:targetClass <https://franz.com#Employee> ;
  sh:property [
    sh:path <https://franz.com#hasID> ;
    sh:minCount 1 ;
    sh:maxCount 1 ;
    sh:datatype xsd:string ;
           sh:pattern   "^[0-9][0-9][0-9]-[0-9][0-9]-
```

```
[0-9][0-9][0-9][0-9]$" ;
  ] .
}
```

It says that for instances of fr:Employee (sh:targetClass <https://franz.com#Employee>), there must be exactly 1 triple with predicate (path) fr:hasID and the object of that triple must be a string with pattern [3 digits]-[2 digits]-[4 digits] (sh:pattern "^[0-9][0-9][0-9]-[0-9][0-9]-[0-9][0-9][0-9][0-9]$").

This TriG file defines the Employee class and some employee instances:

```
@prefix fr: <https://franz.com#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .

{
 fr:Employee
  a rdfs:Class .
 fr:emp001
  a fr:Employee ;
  fr:hasID "000-12-3456" ;
  fr:hasID "000-77-3456" .
 fr:emp002
  a fr:Employee ;
  fr:hasID "00-56-3456" .
 fr:emp003
  a fr:Employee .
 }
```

Recalling the requirements above, we immediately see these problems with these triples:

1. *emp001* has two *hasID* triples.
2. The value of *emp002*‘s ID has the wrong format (two leading digits rather than 3).
3. *emp003* does not have a *hasID* triple.

We load the two TriG files into our repository, and end up

with the following triple set. Note that all the employee triples use the default graph and the SHACL-related triples use the graph <https://franz.com#Shapes> specified in the TriG file.

s	p	o	g
Employee	rdf:type	rdfs:Class	
emp001	rdf:type	Employee	
emp001	hasID	"000-12-3456"	
emp001	hasID	"000-77-3456"	
emp002	rdf:type	Employee	
emp002	hasID	"00-56-3456"	
emp003	rdf:type	Employee	
EmployeeShape	property	_:b7A1D241Ax1	Shapes
_:b7A1D241Ax1	pattern	"^[0-9][0-9][0-9]-[0-9][0-9]-[0-9][0-9][0-9][0-9]$"	Shapes
_:b7A1D241Ax1	datatype	xs:string	Shapes
_:b7A1D241Ax1	maxCount	"1"	Shapes
_:b7A1D241Ax1	minCount	"1"	Shapes
_:b7A1D241Ax1	path	hasID	Shapes
EmployeeShape	targetClass	Employee	Shapes
EmployeeShape	rdf:type	NodeShape	Shapes

Now we use **agtool shacl-validate** to validate our data:

```
bin/agtool shacl-validate --data-graph default  --shapes-graph
https://franz.com#Shapes shacl-repo-1
Validation report:              Does not conform
Created:                        2019-06-27T10:24:10
Number of shapes graphs:        1
Number of data graphs:          1
Number of NodeShapes:           1
Number of focus nodes checked: 3

3 validation results:
Result:
 Focus node:           <https://franz.com#emp001>
 Path:                 <https://franz.com#hasID>
 Source Shape:         _:b7A1D241Ax1
                   Constraint                    Component:
<http://www.w3.org/ns/shacl#MaxCountConstraintComponent>
 Severity:             <http://www.w3.org/ns/shacl#Violation>

Result:
 Focus node:           <https://franz.com#emp002>
 Path:                 <https://franz.com#hasID>
 Value:                "00-56-3456"
 Source Shape:         _:b7A1D241Ax1
```

```
                    Constraint                    Component:
<http://www.w3.org/ns/shacl#PatternConstraintComponent>
 Severity:             <http://www.w3.org/ns/shacl#Violation>

Result:
 Focus node:           <https://franz.com#emp003>
 Path:                 <https://franz.com#hasID>
 Source Shape:         _:b7A1D241Ax1
                    Constraint                    Component:
<http://www.w3.org/ns/shacl#MinCountConstraintComponent>
 Severity:             <http://www.w3.org/ns/shacl#Violation>
```

The validation fails with the problems listed above. The **Focus node** is the subject of a triple that did not conform. **Path** is the predicate or a property path (predicates in this example). **Value** is the offending value. **Source Shape** is the shape that established the constraint (you must look at the shape triples to see exactly what **Source Shape** is requiring).

We revise our employee data with the following SPARQL expresssion, deleting one of the emp001 triples, deleting the emp002 triple and adding a new one with the correct format, and adding an emp003 triple.

```
prefix fr: <https://franz.com#>

DELETE DATA {fr:emp002 fr:hasID "00-56-3456" } ;

INSERT DATA {fr:emp002 fr:hasID "000-14-1772" } ;

DELETE DATA {fr:emp001 fr:hasID "000-77-3456" } ;

INSERT DATA {fr:emp003 fr:hasID "000-54-9662" } ;
```

Now our employee triples are

s	p	o	g
emp002	hasID	"000-14-1772"	
emp003	hasID	"000-54-9662"	
Employee	rdf:type	rdfs:Class	
emp001	rdf:type	Employee	
emp001	hasID	"000-12-3456"	
emp002	rdf:type	Employee	
emp003	rdf:type	Employee	

We run the validation again and are told our data conforms:

```
% bin/agtool shacl-validate --data-graph default  --shapes-graph https://franz.com#Shapes shacl-repo-1
Validation report:             Conforms
Created:                       2019-06-27T10:32:19
Number of shapes graphs:       1
Number of data graphs:         1
Number of NodeShapes:          1
Number of focus nodes checked: 3
```

When we refer to this example in the remainder of this document, it is to the un-updated (incorrect) triples.

SHACL API

The example above illustrates the SHACL steps:

1. Have a data set with triples that should conform to a shape
2. Have SHACL triples that express the desired shape
3. Run SHACL validation to determine if the data conforms

Note that SHACL validation does not modify the data being validated. Once you have the conformance report, you must modify the data to fix the conformance problems and then rerun the validation test.

The main entry point to the API is **agtool shacl-validate**. It takes various options and has several output choices. Online help for **agtool shacl-validate** is displayed by running agtool shacl-validate --help.

In order to validate triples, the system must know:

1. What tripes to examine
2. What rules (SHACL triples) to use
3. What to do with the results

Specifying what triples to examine

Two arguments to **agtool shacl-validate** specify the triples to evaluate: --data-graph and --focus-node. Each can be specified multiple times.

- The --data-graph argument specifies the graph value for triples to be examined. Its value must be an IRI or default. Only triples in the specified graphs will be examined. default specifies the default graph. It is also the default value of the --data-graph argument. If no value is specified for --data-graph, only triples in the default graph will be examined. If a value for --data-graph is specified, triples in the default graph will only be examined if --data-graph default is also specified.
- The --focus-node argument specifies IRIs which are subjects of triples. If this argument is specified, only triples with these subjects will be examined. To be examined, triples must also have graph values specified by --data-graph arguments. --focus-node does not have a default value. If unspecified, all triples in the specified data graphs will be examined. This argument can be specified multiple times.

The --data-graph argument was used in the simple example above. Here is how the --focus-node argument can be used to restrict validation to triples with subjects <https://franz.com#emp002>and <https://franz.com#emp003> and to ignore triples with subject <https://franz.com#emp001> (applying **agtool shacl-validate** to the orignal non-conformant data):

```
% bin/agtool shacl-validate --data-graph default  \
  --shapes-graph https://franz.com#Shapes \
  --focus-node https://franz.com#emp003 \
  --focus-node https://franz.com#emp002 shacl-repo-1
Validation report:            Does not conform
Created:                      2019-06-27T11:37:49
```

```
Number of shapes graphs:       1
Number of data graphs:         1
Number of NodeShapes:          1
Number of focus nodes checked: 2

2 validation results:
Result:
 Focus node:           <https://franz.com#emp003>
 Path:                 <https://franz.com#hasID>
 Source Shape:         _:b7A1D241Ax2
                  Constraint                  Component:
<http://www.w3.org/ns/shacl#MinCountConstraintComponent>
 Severity:             <http://www.w3.org/ns/shacl#Violation>

Result:
 Focus node:           <https://franz.com#emp002>
 Path:                 <https://franz.com#hasID>
 Value:                "00-56-3456"
 Source Shape:         _:b7A1D241Ax2
                  Constraint                  Component:
<http://www.w3.org/ns/shacl#PatternConstraintComponent>
 Severity:             <http://www.w3.org/ns/shacl#Violation>
```

Specifying What Shape Triples to Use

Two arguments to **agtool shacl-validate**, analogous to the two arguments for data described above, specify Shape triples to use. Further, following the SHACL spec, data triples with predicate <http://www.w3.org/ns/shacl#shapeGraph> also specify graphs containing Shape triples to be used.

The arguments to **agtool shacl-validate** are the following. Each may be specified multiple times.

- The --shapes-graph argument specifies the graph value for shape triples to be used for SHACL validation. Its value must be an IRI or default. default specifies the default graph. The --shapes-graph argument has no default value. If unspecified, graphs specified by data triples with

the <http://www.w3.org/ns/shacl#shapeGraph> predicate will be used (they are used whether or not --shapes-graph has a value). If --shapes-graph has no value and there are no data triples with the <http://www.w3.org/ns/shacl#shapeGraph> predicate, the data graphs are used for shape graphs. (Shape triples have a known format and so can be identified among the data triples.)

- The --shape argument specifies IRIs which are subjects of shape nodes. If this argument is specified, only shape triples with these subjects and subsiduary triples to these will be used for validation. To be included, the triples must also have graph values specified by the --shapes-graph arguments or specified by a data triple with the <http://www.w3.org/ns/shacl#shapeGraph> predicate. --shape does not have a default value. If unspecified, all shapes in the shapes graphs will be used.

Other APIs

There is a lisp API using the function validate-data-graph, defined next:

validate-data-graphdb &key data-graph-iri/s shapes-graph-iri/s shape/s focus-node/s verbose conformance-only? function

Perform SHACL validation and return a validation-report structure.

The validation uses data-graph-iri/s to construct the dataGraph. This can be a single IRI, a list of IRIs or NIL, in which case the default graph will be used. The shapesGraph can be specified using the shapes-graph-iri/s parameter which can also be a single IRI or a list of IRIs. If shape-graph-iri/s is not specified, the SHACL processor will first look to

create the shapesGraph by finding triples with the predicate sh:shapeGraph in the dataGraph. If there are no such triples, then the shapesGraph will be assumed to be the same as the dataGraph.

Validation can be restricted to particular shapes and focus nodes using the shape/s and focus-node/s parameters. Each of these can be an IRI or list of IRIs.

If conformance-only? is true, then validation will stop as soon as any validation failures are detected.

You can use validation-report-conforms-p to see whether or not the dataGraph conforms to the shapesGraph (possibly restricted to just particular shape/s and focus-node/s).

The function validation-report-conforms-p returns t or nil as the validation struct returned by validate-data-graph does or does not conform.

validation-report-conforms-preport
function

Returns t or nil to indicate whether or not REPORT (a validation-report struct) indicates that validation conformed. There is also a REST API. See HTTP reference.

Validation Output

The simple example above and the SHACL examples below show output from **agtool validate-shacl**. There are various output formats, specified by the --output option. Those examples use the plain format, which means printing results descriptively. Other choices include json, trig, trix, turtle, nquads, rdf-n3, rdf/xml, and ntriples. Here are the simple example (uncorrected) results using ntriples output:

% bin/agtool shacl-validate --output ntriples --data-graph

```
default --shapes-graph https://franz.com#Shapes shacl-repo-1

_:b271983AAx1
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.w3.org/ns/shacl#ValidationReport> .
_:b271983AAx1     <http://www.w3.org/ns/shacl#conforms>
"false"^^<http://www.w3.org/2001/XMLSchema#boolean> .
_:b271983AAx1      <http://purl.org/dc/terms/created>
"2019-07-01T18:26:03"^^<http://www.w3.org/2001/XMLSchema#dateT
ime> .
_:b271983AAx1      <http://www.w3.org/ns/shacl#result>
_:b271983AAx2 .
_:b271983AAx2
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.w3.org/ns/shacl#ValidationResult> .
_:b271983AAx2     <http://www.w3.org/ns/shacl#focusNode>
<https://franz.com#emp001> .
_:b271983AAx2     <http://www.w3.org/ns/shacl#resultPath>
<https://franz.com#hasID> .
_:b271983AAx2   <http://www.w3.org/ns/shacl#resultSeverity>
<http://www.w3.org/ns/shacl#Violation> .
_:b271983AAx2
<http://www.w3.org/ns/shacl#sourceConstraintComponent>
<http://www.w3.org/ns/shacl#MaxCountConstraintComponent> .
_:b271983AAx2     <http://www.w3.org/ns/shacl#sourceShape>
_:b271983AAx3 .
_:b271983AAx1      <http://www.w3.org/ns/shacl#result>
_:b271983AAx4 .
_:b271983AAx4
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.w3.org/ns/shacl#ValidationResult> .
_:b271983AAx4     <http://www.w3.org/ns/shacl#focusNode>
<https://franz.com#emp002> .
_:b271983AAx4     <http://www.w3.org/ns/shacl#resultPath>
<https://franz.com#hasID> .
_:b271983AAx4   <http://www.w3.org/ns/shacl#resultSeverity>
<http://www.w3.org/ns/shacl#Violation> .
_:b271983AAx4
<http://www.w3.org/ns/shacl#sourceConstraintComponent>
<http://www.w3.org/ns/shacl#PatternConstraintComponent> .
_:b271983AAx4     <http://www.w3.org/ns/shacl#sourceShape>
```

```
_:b271983AAx3 .
_:b271983AAx4 <http://www.w3.org/ns/shacl#value> "00-56-3456"
.
_:b271983AAx1      <http://www.w3.org/ns/shacl#result>
_:b271983AAx5 .
_:b271983AAx5
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.w3.org/ns/shacl#ValidationResult> .
_:b271983AAx5     <http://www.w3.org/ns/shacl#focusNode>
<https://franz.com#emp003> .
_:b271983AAx5     <http://www.w3.org/ns/shacl#resultPath>
<https://franz.com#hasID> .
_:b271983AAx5   <http://www.w3.org/ns/shacl#resultSeverity>
<http://www.w3.org/ns/shacl#Violation> .
_:b271983AAx5
<http://www.w3.org/ns/shacl#sourceConstraintComponent>
<http://www.w3.org/ns/shacl#MinCountConstraintComponent> .
_:b271983AAx5    <http://www.w3.org/ns/shacl#sourceShape>
_:b271983AAx3 .
```

You can have the triples added to the repository by specifying the --add-to-repo option true.

In the plain output information is provided about how many data graphs are examined, how many shape graphs were specified and node shapes are found, and how many focus nodes are checked. If zero focus nodes are checked, that is likely not what you want and something has gone wrong. Here we mis-spell the name of the shape graph (https://franz.com#shapes instead of https://franz.com#Shapes) and get 0 focus nodes checked:

```
% bin/agtool shacl-validate --data-graph default --shapes-
graph https://franz.com#shapes shacl-repo-1
Validation report:             Conforms
Created:                       2019-06-28T10:34:22
Number of shapes graphs:       1
Number of data graphs:         1
Number of NodeShapes:          0
Number of focus nodes checked: 0
```

SPARQL integration

There are two sets of magic properties defined: one checks for basic conformance and the other produces validation reports as triples:

- ?valid franz:shaclConforms (?dataGraph [?shapesGraph])
- ?valid franz:shaclFocusNodeConforms1 (?dataGraph ?nodeOrNodeCollection)
- ?valid franz:shaclFocusNodeConforms2 (?dataGraph ?shapesGraph ?nodeOrNodeCollection)
- ?valid franz:shaclShapeConforms1 (?dataGraph ?shapeOrShapeCollection [?nodeOrNodeCollection])
- ?valid franz:shaclShapeConforms2 (?dataGraph ?shapesGraph ?shapeOrShapeCollection [?nodeOrNodeCollection])
- (?s ?p ?o) franz:shaclValidationReport (?dataGraph [?shapesGraph])
- (?s ?p ?o) franz:shaclFocusNodeValidationReport1 (?dataGraph ?nodeOrNodeCollection) .
- (?s ?p ?o) franz:shaclFocusNodeValidationReport2 (?dataGraph ?shapesGraph ?nodeOrNodeCollection) .
- (?s ?p ?o) franz:shaclShapeValidationReport1 (?dataGraph ?shapeOrShapeCollection [?nodeOrNodeCollection]) .
- (?s ?p ?o) franz:shaclShapeValidationReport2 (?dataGraph ?shapesGraph ?shapeOrShapeCollection [?nodeOrNodeCollection]) .

In all of the above ?dataGraph and ?shapesGraph can be IRIs, the literal ‘default’, or a variable that is bound to a SPARQL collection (list or set) that was previously created with a function
like https://franz.com/ns/allegrograph/6.5.0/fn#makeSPARQLList or https://franz.com/ns/allegrograph/6.5.0/fn#lookupRdfList. If a collection is used, then the SHACL processor will create

a temporary RDF merge of all of the graphs in it to produce the data graph or the shapes graph.

Similarly, ?shapeOrShapeCollection and ?nodeOrNodeCollection can be bound to an IRI or a SPARQL collection. If a collection is used, then it must be bound to a list of IRIs. The SHACL processor will restrict validation to the shape(s) and focus node(s) (i.e. nodes that should be validated) specified.

The shapesGraph argument is optional in both of the shaclConforms and shaclValidationReport magic properties. If the shapesGraph is not specified, then the shapesGraph will be created by following triples in the dataGraph that use the sh:shapesGraph predicate. If there are no such triples, then the shapesGraph will be the same as the dataGraph.

For example, the following SPARQL expression

```
construct { ?s ?p ?o } where {
  # form a collection of focusNodes
bind(<https://franz.com/ns/allegrograph/6.6.0/fn#makeSPARQLList>(
    <http://Journal1/1942/Article25>,
    <http://Journal1/1943>) as ?nodes)
                          (?s             ?p             ?o)
<https://franz.com/ns/allegrograph/6.6.0/shaclShapeValidationReport1>
    ('default' <ex://franz.com/documentShape1> ?nodes) .
}
```

would use the default graph as the Data Graph and the Shapes Graph and then validate two focus nodes against the shape <ex://franz.com/documentShape1>.

SHACL Example

We build on our simple example above. Start with a fresh repository so triples from the simple example do not interfere with this example.

We start with a TriG file with various shapes defined on some classes.

```
@prefix sh: <http://www.w3.org/ns/shacl#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix fr: <https://franz.com#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .

<https://franz.com#ShapesGraph> {
fr:EmployeeShape
   a sh:NodeShape ;
   sh:targetClass fr:Employee ;
   sh:property [
     ## Every employee must have exactly one ID
     sh:path fr:hasID ;
     sh:minCount 1 ;
     sh:maxCount 1 ;
     sh:datatype xsd:string ;
            sh:pattern  "^[0-9][0-9][0-9]-[0-9][0-9]-
[0-9][0-9][0-9][0-9]$" ;
    ] ;
   sh:property [
     ## Every employee is a manager or a worker
     sh:path fr:employeeType ;
     sh:minCount 1 ;
     sh:maxCount 1 ;
     sh:datatype xsd:string ;
     sh:in ("Manager" "Worker") ;
    ] ;
    sh:property [
      ## If birthyear supplied, must be 2001 or before
      sh:path fr:birthYear ;
      sh:maxInclusive 2001 ;
      sh:datatype xsd:integer ;
    ] ;
    sh:property [
      ## Must have a title, may have more than one
      sh:path fr:hasTitle ;
      sh:datatype xsd:string ;
      sh:minCount 1 ;
```

```
    ] ;

    sh:or (
      ## The President does not have a supervisor
      [
        sh:path fr:hasTitle ;
        sh:hasValue "President" ;
      ]
      [
       ## Must have a supervisor
         sh:path fr:hasSupervisor ;
         sh:minCount 1 ;
         sh:maxCount 1 ;
         sh:class fr:Employee ;
      ]
      ) ;

    sh:or (
      # Every employee must either have a wage or a salary
      [
       sh:path fr:hasSalary ;
       sh:datatype xsd:integer ;
       sh:minInclusive 3000 ;
       sh:minCount 1 ;
       sh:maxCount 1 ;
      ]
      [
       sh:path fr:hasWage ;
       sh:datatype xsd:decimal ;
       sh:minExclusive 15.00 ;
       sh:minCount 1 ;
       sh:maxCount 1 ;
      ]
    )
    .
   }
```

This file says the following about instances of the class fr:Employee:

1. Every employee must have exactly one ID (object of fr:hasID), a string of the form NNN-NN-NNNN where

the Ns are digits (this is the simple example requirement).
2. Every employee must have exactly one fr:employeeType triple with value either “Manager” or “Worker”.
3. Employees may have a fr:birthYear triple, and if so, the value must be 2001 or earlier.
4. Employees must have a fr:hasTitle and may have more than one.
5. All employees except the one with title “President” must have a supervisor (specified with fr:hasSupervisor).
6. Every employee must either have a wage (a decimal specifying hourly pay, greater than 15.00) or a salary (an integer specifying monthly pay, greater than or equal to 3000).

Here is some employee data:

```
@prefix fr: <https://franz.com#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

{
 fr:Employee
  a rdfs:Class .

 fr:emp001
  a fr:Employee ;
  fr:hasID "000-12-3456" ;
  fr:hasTitle "President" ;
  fr:employeeType "Manager" ;
  fr:birthYear "1953"^^xsd:integer ;
  fr:hasSalary "10000"^^xsd:integer .

 fr:emp002
  a fr:Employee ;
  fr:hasID "000-56-3456" ;
  fr:hasTitle "Foreman" ;
  fr:employeeType "Worker" ;
```

```
 fr:birthYear "1966"^^xsd:integer ;
 fr:hasSupervisor fr:emp003 ;
 fr:hasWage "20.20"^^xsd:decimal .

fr:emp003
 a fr:Employee ;
 fr:hasID "000-77-3232" ;
 fr:hasTitle "Production Manager" ;
 fr:employeeType "Manager" ;
 fr:birthYear "1968"^^xsd:integer ;
 fr:hasSupervisor fr:emp001 ;
 fr:hasSalary "4000"^^xsd:integer .

fr:emp004
 a fr:Employee ;
 fr:hasID "000-88-3456" ;
 fr:hasTitle "Fitter" ;
 fr:employeeType "Worker" ;
 fr:birthYear "1979"^^xsd:integer ;
 fr:hasSupervisor fr:emp002 ;
 fr:hasWage "17.20"^^xsd:decimal .

fr:emp005
 a fr:Employee ;
 fr:hasID "000-99-3492" ;
 fr:hasTitle "Fitter" ;
 fr:employeeType "Worker" ;
 fr:birthYear "2000"^^xsd:integer ;
 fr:hasWage "17.20"^^xsd:decimal .

fr:emp006
 a fr:Employee ;
 fr:hasID "000-78-5592" ;
 fr:hasTitle "Filer" ;
 fr:employeeType "Intern" ;
 fr:birthYear "2003"^^xsd:integer ;
 fr:hasSupervisor fr:emp002 ;
 fr:hasWage "14.20"^^xsd:decimal .

fr:emp007
 a fr:Employee ;
```

```
  fr:hasID "000-77-3232" ;
  fr:hasTitle "Sales Manager" ;
  fr:hasTitle "Vice President" ;
  fr:employeeType "Manager" ;
  fr:birthYear "1962"^^xsd:integer ;
  fr:hasSupervisor fr:emp001 ;
  fr:hasSalary "7000"^^xsd:integer .
 }
```

Comparing these data with the requirements, we see these problems:

1. emp005 does not have a supervisor.
2. emp006 is pretty messed up, with (1) employeeType “Intern”, not an allowed value, (2) a birthYear (2003) later than the required maximum of 2001, and (3) a wage (14.40) less than the minimum (15.00).

Otherwise the data seems OK.

We load these two TriG files into an emply repository (which we have named **shacl-repo-2**). We specify the default graph for the data and the https://franz.com#ShapesGraph for the shapes. (Though not required, it is a good idea to specify a graph for shape data as it makes it easy to delete and reload shapes while developing.) We have 101 triples, 49 data and 52 shape. Then we run **agtool shacl-validate**:

```
% bin/agtool shacl-validate --shapes-graph https://franz.com#ShapesGraph --data-graph default shacl-repo-2
```

There are four violations, as expected, one for emp005 and three for emp006.

```
Validation report:             Does not conform
Created:                       2019-07-03T11:35:27
Number of shapes graphs:       1
Number of data graphs:         1
Number of NodeShapes:          1
Number of focus nodes checked: 7
```

```
4 validation results:
Result:
 Focus node:           <https://franz.com#emp005>
 Value:                <https://franz.com#emp005>
 Source Shape:         <https://franz.com#EmployeeShape>
                  Constraint                  Component:
<https://www.w3.org/ns/shacl#OrConstraintComponent>
 Severity:             <https://www.w3.org/ns/shacl#Violation>

Result:
 Focus node:           <https://franz.com#emp006>
 Path:                 <https://franz.com#employeeType>
 Value:                "Intern"
 Source Shape:         _:b19D062B9x221
                  Constraint                  Component:
<http://www.w3.org/ns/shacl#InConstraintComponent>
 Severity:             <http://www.w3.org/ns/shacl#Violation>

Result:
 Focus node:           <https://franz.com#emp006>
 Path:                 <https://franz.com#birthYear>
                                                  Value:
"2003"^^<http://www.w3.org/2001/XMLSchema#integer>
 Source Shape:         _:b19D062B9x225
                  Constraint                  Component:
<http://www.w3.org/ns/shacl#MaxInclusiveConstraintComponent>
 Severity:             <http://www.w3.org/ns/shacl#Violation>

Result:
 Focus node:           <https://franz.com#emp006>
 Value:                <https://franz.com#emp006>
 Source Shape:         <https://franz.com#EmployeeShape>
                  Constraint                  Component:
<http://www.w3.org/ns/shacl#OrConstraintComponent>
 Severity:             <http://www.w3.org/ns/shacl#Violation>

Fixing the data is left as an exercise for the reader.
```

Turn Customer Service Calls into Enterprise Knowledge Graphs

Franz's CEO, Jans Aasman's recent Destination CRM article:

The need for text analytics and speech recognition has broadened over the years, becoming more prevalent and essential in the sales, marketing, and customer service departments of various types of businesses and industries. The goal is simple for these contact center use cases: provide real-time assistance to human agents interacting with potential customers to close sales, initiate them, and increase customer satisfaction.

Until fairly recently, the rich array of unstructured data encompassing client texts, chats, and phone calls was obscured from contact centers and organizations due to the sheer arduousness of speech recognition and text analytics. When readily integrated into knowledge graphs, however, these same sources become some of the most credible for improving agent interactions and achieving business objectives.

Powered by the shrewd usage of organizational taxonomies, machine learning, natural language processing (NLP), and semantic search, knowledge graphs make speech recognition and text analytics immediately accessible, enabling real-time customer interactions that can maximize business objectives—and revenues.

Taxonomies

Taxonomies are the foundation of the knowledge graph approach to rapidly conveying results of speech recognition and text analytics for timely customer interactions. Agents need three types of information to optimize customer interactions: their

personas (such as an executive or a purchase department representative, for example), their reasons for contacting them, and their industries. Taxonomies are instrumental to performing these functions because they provide a hierarchy of relevant terms to organizations.

Read the full article at Destination CRM

Creating Explainable AI With Rules

Franz's CEO, Jans Aasman's recent Forbes article:

There's a fascinating dichotomy in artificial intelligence between statistics and rules, machine learning and expert systems. Newcomers to artificial intelligence (AI) regard machine learning as innately superior to brittle rules-based systems, while the history of this field reveals both rules and probabilistic learning are integral components of AI.

This fact is perhaps nowhere truer than in establishing explainable AI, which is central to the long-term business value of AI front-office use cases.

Granted, simple machine learning can automate backend processes. However, the full extent of deep learning or complex neural networks – which are much more accurate than basic machine learning – for mission-critical decision-making and action requires explainability.

Using rules (and rules-based systems) to explicate machine learning results creates explainable AI. Many of the far-reaching applications of AI at the enterprise level –

deploying it to combat financial crimes, to predict an individual's immediate and long-term future in health care, for example – require explainable AI that's fair, transparent and regulatory compliant.

Rules can explain machine learning results for these purposes and others.

Read the full article at Forbes

Webcast – Speech Recognition, Knowledge Graphs, and AI for Intelligent Customer Operations – April 3, 2019

Presenters – Burt Smith, N3 Results and Jans Aasman, Franz Inc.

In the typical sales organization the contents of the actual chat or voice conversation between agent and customer is a black hole. In the modern Intelligent Customer Operations center (e.g. N3 Results – www.n3results.com) the interactions between agent and customer are a source of rich information that helps agents to improve the quality of the interaction in real time, creates more sales, and provides far better analytics for management.

Join us for this Webinar where we describe a real world Intelligent Customer Operations center that uses graph based technology for taxonomy driven entity extraction, speech recognition, machine learning and predictive analytics to

improve quality of conversations, increase sales and improve business visibility.

View the recorded webinar.

Using JSON-LD in AllegroGraph – Python Example

The following is example #19 from our AllegroGraph Python Tutorial.

JSON-LD is described pretty well at https://json-ld.org/ and the specification can be found at https://json-ld.org/latest/json-ld/ .

The website https://json-ld.org/playground/ is also useful.

There are many reasons for working with JSON-LD. The major search engines such as Google require ecommerce companies to mark up their websites with a systematic description of their products and more and more companies use it as an easy serialization format to share data.

The benefit for your organization is that you can now combine your documents with graphs, graph search and graph algorithms. Normally when you store documents in a document store you set up your documents in such a way that it is optimized for direct retrieval queries. Doing complex joins for multiple types of documents or even doing a shortest path through a mass of object (types) is however very complicated. Storing JSON-LD objects in AllegroGraph gives you all the benefits of

a document store *and* you can semantically link objects together, do complex joins and even graph search.

A second benefit is that, as an application developer, you do not have to learn the entire semantic technology stack, especially the part where developers have to create individual triples or edges. You can work with the JSON data serialization format that application developers usually prefer.

In the following you will first learn about JSON-LD as a syntax for semantic graphs. After that we will talk more about using JSON-LD with AllegroGraph as a document-graph-store.

Setup

You can use Python 2.6+ or Python 3.3+. There are small setup differences which are noted. You do need *agraph-python-101.0.1* or later.

Mimicking instructions in the Installation document, you should set up the virtualenv environment.

1. Create an environment named *jsonld*:

```
python3 -m venv jsonld
```

or

```
python2  -m virtualenv jsonld
```

2. Activate it:

Using the Bash shell:

```
source jsonld/bin/activate
```

Using the C shell:

```
source jsonld/bin/activate.csh
```

3. Install *agraph-python*:

```
pip install agraph-python
```

And start **python**:

```
python
[various startup and copyright messages]
>>>
```

We assume you have an AllegroGraph 6.5.0 server running. We call **ag_connect**. Modify the *host*, *port*, *user*, and *password* in your call to their correct values:

```
from franz.openrdf.connect import ag_connect
with ag_connect('repo', host='localhost', port='10035',
                user='test', password='xyzzy') as conn:
    print (conn.size())
```

If the script runs successfully a new repository named *repo* will be created.

JSON-LD setup

We next define some utility functions which are somewhat different from what we have used before in order to work better with JSON-LD. **createdb()** creates and opens a new repository and **opendb()** opens an existing repo (modify the values of *host*, *port*, *user*, and *password* arguments in the definitions if necessary). Both return repository connections which can be used to perform repository operations. **showtriples()** displays triples in a repository.

```
import os
import json, requests, copy

from franz.openrdf.sail.allegrographserver import
AllegroGraphServer
from franz.openrdf.connect import ag_connect
from franz.openrdf.vocabulary.xmlschema import XMLSchema
from franz.openrdf.rio.rdfformat import RDFFormat

# Functions to create/open a repo and return a
RepositoryConnection
# Modify the values of HOST, PORT, USER, and PASSWORD if
necessary

def createdb(name):
                                                    return
ag_connect(name,host="localhost",port=10035,user="test",passwo
rd="xyzzy",create=True,clear=True)

def opendb(name):
                                                    return
ag_connect(name,host="localhost",port=10035,user="test",passwo
rd="xyzzy",create=False)

def showtriples(limit=100):
    statements = conn.getStatements(limit=limit)
    with statements:
        for statement in statements:
             print(statement)
```

Finally we call our **createdb** function to create a repository and return a *RepositoryConnection* to it:

```
conn=createdb('jsonplay')
```

Some Examples of Using JSON-LD

In the following we try things out with some JSON-LD objects that are defined in json-ld playground: jsonld

The first object we will create is an *event dict*. Although it is a Python dict, it is also valid JSON notation. (But note that not all Python dictionaries are valid JSON. For example, JSON uses null where Python would use None and there is no magic to automatically handle that.) This object has one key called @context which specifies how to translate keys and values into predicates and objects. The following @context says that every time you see ical: it should be replaced by http://www.w3.org/2002/12/cal/ical#, xsd: by http://www.w3.org/2001/XMLSchema#, and that if you see ical:dtstart as a key than the value should be treated as an xsd:dateTime.

```
event = {
  "@context": {
    "ical": "http://www.w3.org/2002/12/cal/ical#",
    "xsd": "http://www.w3.org/2001/XMLSchema#",
    "ical:dtstart": { "@type": "xsd:dateTime" }
      },
    "ical:summary": "Lady Gaga Concert",
     "ical:location": "New Orleans Arena, New Orleans, Louisiana, USA",
    "ical:dtstart": "2011-04-09T20:00:00Z"
}
```

Let us try it out (the subjects are blank nodes so you will see different values):

```
>>> conn.addData(event)
>>> showtriples()
(_:b197D2E01x1, <http://www.w3.org/2002/12/cal/ical#summary>, "Lady Gaga Concert")
(_:b197D2E01x1, <http://www.w3.org/2002/12/cal/ical#location>, "New Orleans Arena, New Orleans, Louisiana, USA")
(_:b197D2E01x1, <http://www.w3.org/2002/12/cal/ical#dtstart>, "2011-04-09T20:00:00Z"^^<http://www.w3.org/2001/XMLSchema#dateTime>)
```

Adding an @id and @type to Objects

In the above we see that the JSON-LD was correctly translated into triples but there are two immediate problems: first each subject is a blank node, the use of which is problematic when linking across repositories; and second, the object does not have an RDF type. We solve these problems by adding an @id to provide an IRI as the subject and adding a @type for the object (those are at the lines just after the *@context* definition):

```
>>> event = {
  "@context": {
      "ical": "http://www.w3.org/2002/12/cal/ical#",
      "xsd": "http://www.w3.org/2001/XMLSchema#",
      "ical:dtstart": { "@type": "xsd:dateTime" }
        },
      "@id": "ical:event-1",
      "@type": "ical:Event",
      "ical:summary": "Lady Gaga Concert",
       "ical:location": "New Orleans Arena, New Orleans,
Louisiana, USA",
      "ical:dtstart": "2011-04-09T20:00:00Z"
  }
```

We also create a test function to test our JSON-LD objects. It is more powerful than needed right now (here we just need *conn,addData(event)* and *showTriples()* but **test** will be useful in most later examples. Note the *allow_external_references=True* argument to *addData()*. Again, not needed in this example but later examples use external contexts and so this argument is required for those.

```
def
test(object,json_ld_context=None,rdf_context=None,maxPrint=100
,conn=conn):
    conn.clear()
    conn.addData(object, allow_external_references=True)
    showtriples(limit=maxPrint)
```

```
>>> test(event)
(<http://www.w3.org/2002/12/cal/ical#event-1>,
<http://www.w3.org/2002/12/cal/ical#summary>, "Lady Gaga
Concert")
(<http://www.w3.org/2002/12/cal/ical#event-1>,
<http://www.w3.org/2002/12/cal/ical#location>, "New Orleans
Arena, New Orleans, Louisiana, USA")
(<http://www.w3.org/2002/12/cal/ical#event-1>,
<http://www.w3.org/2002/12/cal/ical#dtstart>,
"2011-04-09T20:00:00Z"^^<http://www.w3.org/2001/XMLSchema#date
Time>)
(<http://www.w3.org/2002/12/cal/ical#event-1>,
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>,
<http://www.w3.org/2002/12/cal/ical#Event>)
```

Note in the above that we now have a proper subject and a type.

Referencing a External Context Via a URL

The next object we add to AllegroGraph is a person object. This time the @context is not specified as a JSON object but as a link to a context that is stored at http://schema.org/. Also in the definition of the function test above we had this parameter in addData:allow_external_references=True. Requiring that argument explicitly is a security feature. One should use external references only that context at that URL is trusted (as it is in this case).

```
person = {
  "@context": "http://schema.org/",
  "@type": "Person",
  "@id": "foaf:person-1",
  "name": "Jane Doe",
  "jobTitle": "Professor",
  "telephone": "(425) 123-4567",
  "url": "http://www.janedoe.com"
}
```

```
>>> test(person)
(<http://xmlns.com/foaf/0.1/person-1>,
<http://schema.org/name>, "Jane Doe")
(<http://xmlns.com/foaf/0.1/person-1>,
<http://schema.org/jobTitle>, "Professor")
(<http://xmlns.com/foaf/0.1/person-1>,
<http://schema.org/telephone>, "(425) 123-4567")
(<http://xmlns.com/foaf/0.1/person-1>,
<http://schema.org/url>, <http://www.janedoe.com>)
(<http://xmlns.com/foaf/0.1/person-1>,
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>,
<http://schema.org/Person>)
```

Improving Performance by Adding Lists

Adding one person at a time requires doing an interaction with the server for each person. It is much more efficient to add lists of objects all at once rather than one at a time. Note that addData will take a list of dicts and still do the right thing. So let us add a 1000 persons at the same time, each person being a copy of the above person but with a different @id. (The example code is repeated below for ease of copying.)

```
>>> x = [copy.deepcopy(person) for i in range(1000)]
>>> len(x)
1000
>>> c = 0
>>> for el in x:
    el['@id']= "http://franz.com/person-" + str(c)
    c= c + 1
>>> test(x,maxPrint=10)
(<http://franz.com/person-0>, <http://schema.org/name>, "Jane
Doe")
(<http://franz.com/person-0>,  <http://schema.org/jobTitle>,
"Professor")
(<http://franz.com/person-0>,  <http://schema.org/telephone>,
"(425) 123-4567")
(<http://franz.com/person-0>,    <http://schema.org/url>,
```

```
<http://www.janedoe.com>)
(<http://franz.com/person-0>,
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>,
<http://schema.org/Person>)
(<http://franz.com/person-1>, <http://schema.org/name>, "Jane
Doe")
(<http://franz.com/person-1>,  <http://schema.org/jobTitle>,
"Professor")
(<http://franz.com/person-1>,  <http://schema.org/telephone>,
"(425) 123-4567")
(<http://franz.com/person-1>,    <http://schema.org/url>,
<http://www.janedoe.com>)
(<http://franz.com/person-1>,
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>,
<http://schema.org/Person>)
>>> conn.size()
5000
>>>
```

```
x = [copy.deepcopy(person) for i in range(1000)]
len(x)

c = 0
for el in x:
    el['@id']= "http://franz.com/person-" + str(c)
    c= c + 1

test(x,maxPrint=10)

conn.size()
```

Adding a Context Directly to an Object

You can download a context directly in Python, modify it and then add it to the object you want to store. As an illustration we load a person context from json-ld.org (actually a fragment of the schema.org context) and insert it in a person object. (We have broken and truncated some output lines for clarity and all the code executed is repeated below for ease of copying.)

```
>>>
context=requests.get("https://json-ld.org/contexts/person.json
ld").json()['@context']
>>> context
{'Person': 'http://xmlns.com/foaf/0.1/Person',
 'xsd': 'http://www.w3.org/2001/XMLSchema#',
 'name': 'http://xmlns.com/foaf/0.1/name',
 'jobTitle': 'http://xmlns.com/foaf/0.1/title',
 'telephone': 'http://schema.org/telephone',
 'nickname': 'http://xmlns.com/foaf/0.1/nick',
 'affiliation': 'http://schema.org/affiliation',
  'depiction': {'@id': 'http://xmlns.com/foaf/0.1/depiction',
'@type': '@id'},
  'image': {'@id': 'http://xmlns.com/foaf/0.1/img', '@type':
'@id'},
  'born': {'@id': 'http://schema.org/birthDate', '@type':
'xsd:date'},
 ...}
>>> person = {
  "@context": context,
  "@type": "Person",
  "@id": "foaf:person-1",
  "name": "Jane Doe",
  "jobTitle": "Professor",
  "telephone": "(425) 123-4567",
}
>>> test(person)
(<http://xmlns.com/foaf/0.1/person-1>,
<http://xmlns.com/foaf/0.1/name>, "Jane Doe")
(<http://xmlns.com/foaf/0.1/person-1>,
<http://xmlns.com/foaf/0.1/title>, "Professor")
(<http://xmlns.com/foaf/0.1/person-1>,
<http://schema.org/telephone>, "(425) 123-4567")
(<http://xmlns.com/foaf/0.1/person-1>,
 <http://www.w3.org/1999/02/22-rdf-syntax-ns#type>,
 <http://xmlns.com/foaf/0.1/Person>)
>>>


context=requests.get("https://json-ld.org/contexts/person.json
ld").json()['@context']
# The next produces lots of output, uncomment if desired
```

```
#context

person = {
  "@context": context,
  "@type": "Person",
  "@id": "foaf:person-1",
  "name": "Jane Doe",
  "jobTitle": "Professor",
  "telephone": "(425) 123-4567",
}
test(person)
```

Building a Graph of Objects

We start by forcing a key's value to be stored as a resource. We saw above that we could specify the value of a key to be a date using the xsd:dateTime specification. We now do it again for foaf:birthdate. Then we created several linked objects and show the connections using Gruff.

```
context = { "foaf:child": {"@type":"@id"},
            "foaf:brotherOf": {"@type":"@id"},
            "foaf:birthdate": {"@type":"xsd:dateTime"}}

p1 = {
    "@context": context,
    "@type":"foaf:Person",
    "@id":"foaf:person-1",
    "foaf:birthdate": "1958-04-09T20:00:00Z",
    "foaf:child": ['foaf:person-2', 'foaf:person-3']
}

p2 = {
    "@context": context,
    "@type":"foaf:Person",
    "@id":"foaf:person-2",
    "foaf:brotherOf": "foaf:person-3",
    "foaf:birthdate": "1992-04-09T20:00:00Z",
}
```

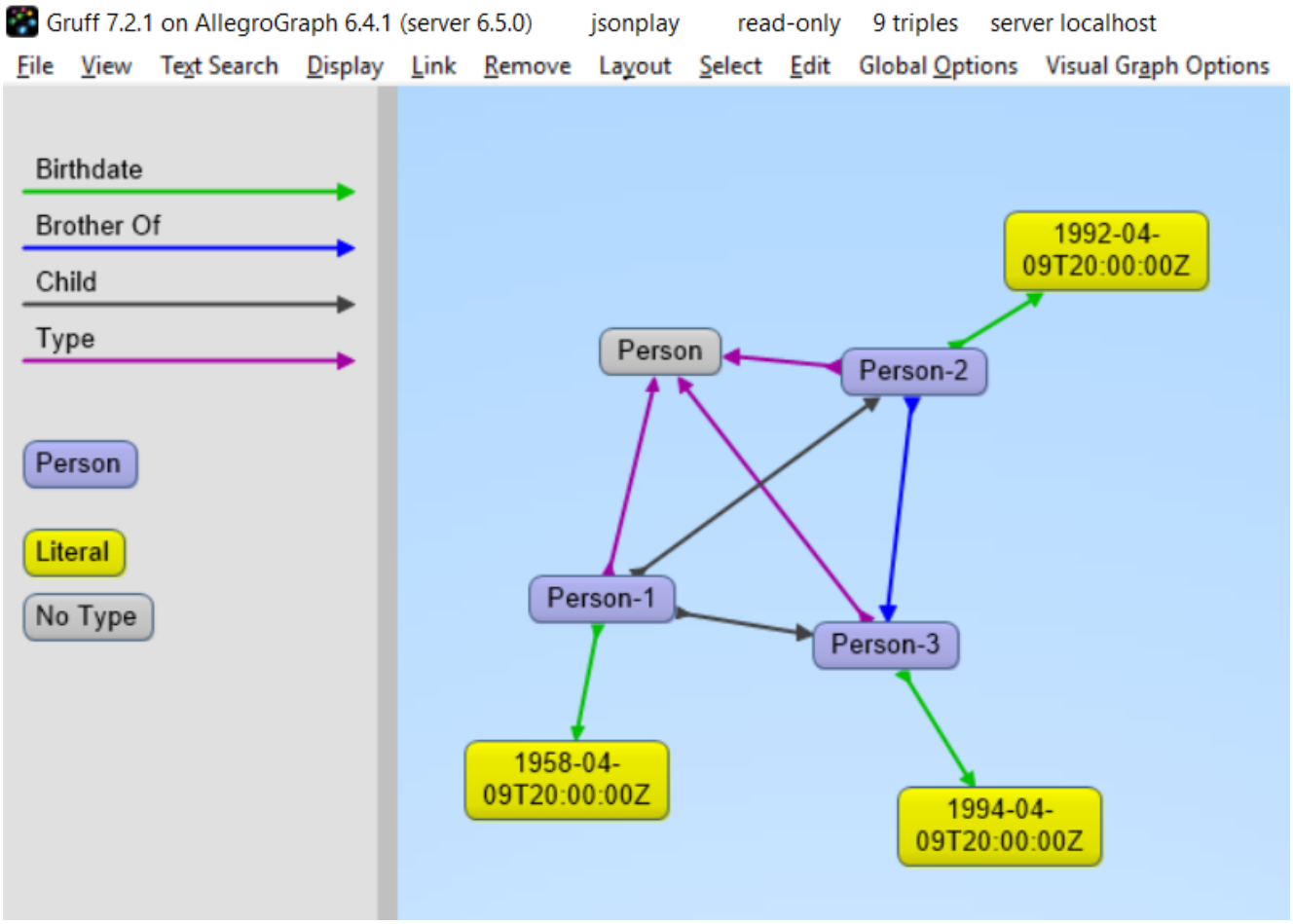
```
p3 = {"@context": context,
    "@type":"foaf:Person",
    "@id":"foaf:person-3",
    "foaf:birthdate": "1994-04-09T20:00:00Z",
}

test([p1,p2,p3])


>>> test([p1,p2,p3])
(<http://xmlns.com/foaf/0.1/person-1>,
<http://xmlns.com/foaf/0.1/birthdate>,
"1958-04-09T20:00:00Z"^^<http://www.w3.org/2001/XMLSchema#date
Time>)
(<http://xmlns.com/foaf/0.1/person-1>,
<http://xmlns.com/foaf/0.1/child>,
<http://xmlns.com/foaf/0.1/person-2>)
(<http://xmlns.com/foaf/0.1/person-1>,
<http://xmlns.com/foaf/0.1/child>,
<http://xmlns.com/foaf/0.1/person-3>)
(<http://xmlns.com/foaf/0.1/person-1>,
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>,
<http://xmlns.com/foaf/0.1/Person>)
(<http://xmlns.com/foaf/0.1/person-2>,
<http://xmlns.com/foaf/0.1/brotherOf>,
<http://xmlns.com/foaf/0.1/person-3>)
(<http://xmlns.com/foaf/0.1/person-2>,
<http://xmlns.com/foaf/0.1/birthdate>,
"1992-04-09T20:00:00Z"^^<http://www.w3.org/2001/XMLSchema#date
Time>)
(<http://xmlns.com/foaf/0.1/person-2>,
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>,
<http://xmlns.com/foaf/0.1/Person>)
(<http://xmlns.com/foaf/0.1/person-3>,
<http://xmlns.com/foaf/0.1/birthdate>,
"1994-04-09T20:00:00Z"^^<http://www.w3.org/2001/XMLSchema#date
Time>)
(<http://xmlns.com/foaf/0.1/person-3>,
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>,
<http://xmlns.com/foaf/0.1/Person>)
```

The following shows the graph that we created in Gruff. Note

that this is what JSON-LD is all about: connecting objects together.



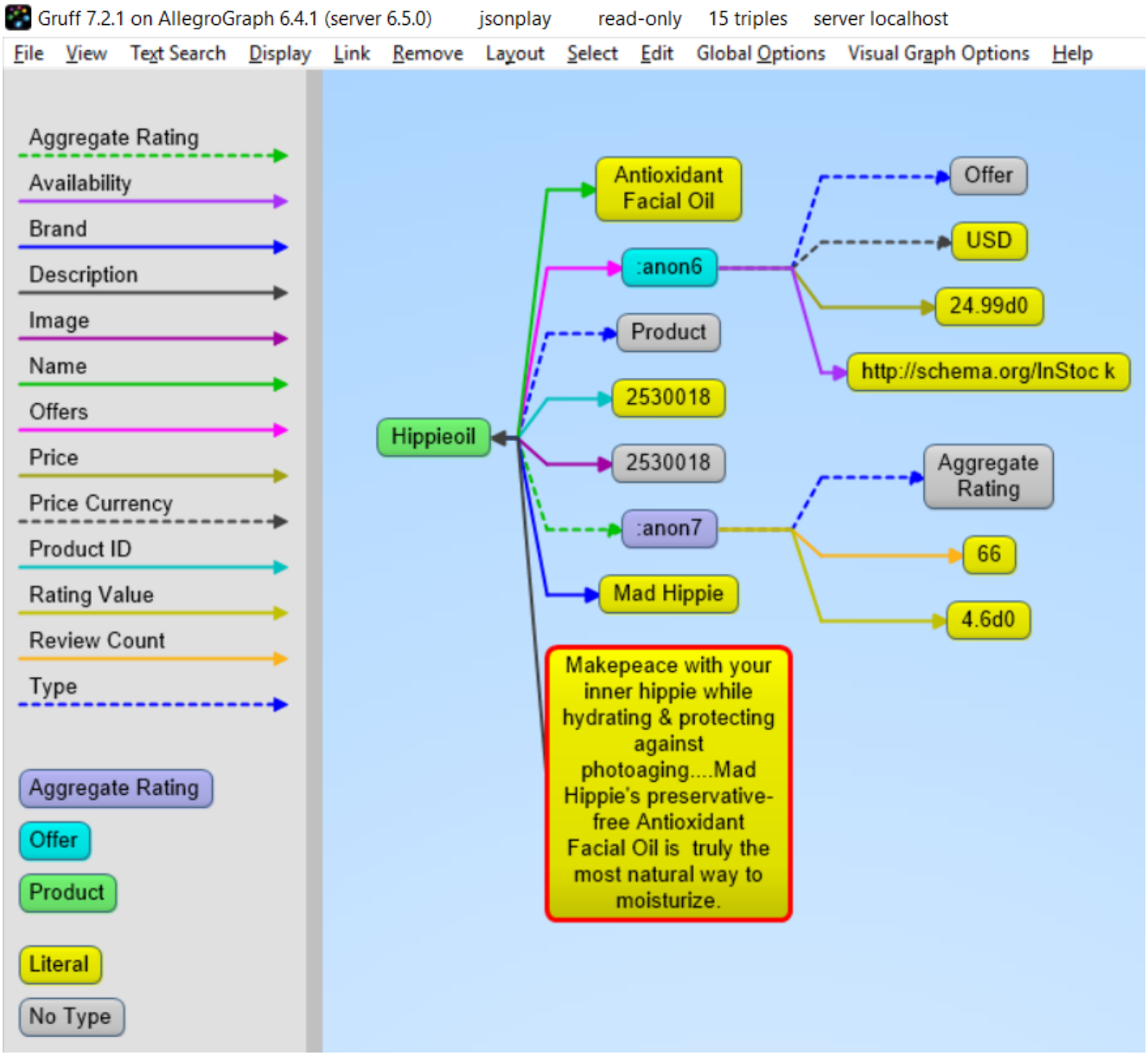
JSON-LD Keyword Directives can be Added at any Level

Here is an example from the wild. The URL https://www.ulta.com/antioxidant-facial-oil?productId=xlsImpprod18731241 goes to a web page advertising a facial oil. (We make no claims or recommendations about this product. We are simply showing how JSON-LD appears in many places.) Look at the source of the page and you'll find a JSON-LD object similar to the following. Note that @ directives go to any level. We added an *@id* key.

```
hippieoil = {"@context":"http://schema.org",
 "@type":"Product",
 "@id":"http://franz.com/hippieoil",
```

```
 "aggregateRating":
    {"@type":"AggregateRating",
     "ratingValue":4.6,
     "reviewCount":73},
      "description":"""Make peace with your inner hippie while hydrating & protecting against photoaging....Mad Hippie's preservative-free Antioxidant Facial Oil is truly the most natural way to moisturize.""",
     "brand":"Mad Hippie",
     "name":"Antioxidant Facial Oil",
     "image":"https://images.ulta.com/is/image/Ulta/2530018",
     "productID":"2530018",
     "offers":
        {"@type":"Offer",
         "availability":"http://schema.org/InStock",
         "price":"24.99",
         "priceCurrency":"USD"}}


test(hippieoil)
```



JSON-LD @graphs

One can put one or more JSON-LD objects in an RDF named graph. This means that the fourth element of each triple generated from a JSON-LD object will have the specified graph name. Let’s show in an example.

```
context = {
        "name": "http://schema.org/name",
        "description": "http://schema.org/description",
        "image": {
             "@id": "http://schema.org/image", "@type": "@id"
},
```

```
        "geo": "http://schema.org/geo",
        "latitude": {
              "@id": "http://schema.org/latitude", "@type":
"xsd:float" },
        "longitude": {
             "@id": "http://schema.org/longitude",  "@type":
"xsd:float" },
        "xsd": "http://www.w3.org/2001/XMLSchema#"
    }

place = {
    "@context": context,
    "@id": "http://franz.com/place1",
    "@graph": {
        "@id": "http://franz.com/place1",
        "@type": "http://franz.com/Place",
        "name": "The Empire State Building",
         "description": "The Empire State Building is a 102-
story landmark in New York City.",
                                                    "image":
"http://www.civil.usherbrooke.ca/cours/gci215a/empire-state-bu
ilding.jpg",
        "geo": {
               "latitude": "40.75",
               "longitude": "73.98" }
        }}
```

and here is the result:

```
>>> test(place, maxPrint=3)
(<http://franz.com/place1>,  <http://schema.org/name>,  "The
Empire State Building", <http://franz.com/place1>)
(<http://franz.com/place1>,  <http://schema.org/description>,
"The Empire State Building is a 102-story landmark in New York
City.", <http://franz.com/place1>)
(<http://franz.com/place1>,    <http://schema.org/image>,
<http://www.civil.usherbrooke.ca/cours/gci215a/empire-state-bu
ilding.jpg>, <http://franz.com/place1>)
>>>
```

Note that the fourth element (graph) of each of the triples is

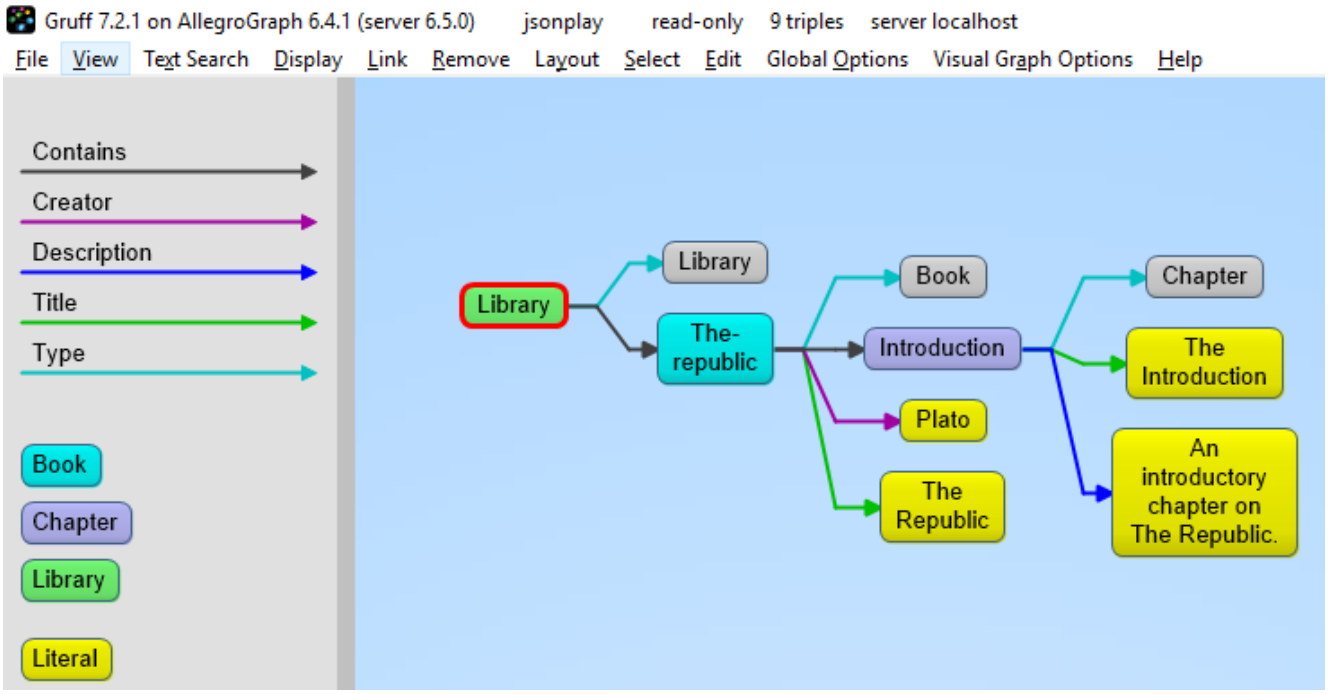
<http://franz.com/place1>. If you don’t add the @id the triples will be put in the default graph.

Here a slightly more complex example:

```
library = {
  "@context": {
    "dc": "http://purl.org/dc/elements/1.1/",
    "ex": "http://example.org/vocab#",
    "xsd": "http://www.w3.org/2001/XMLSchema#",
    "ex:contains": {
      "@type": "@id"
    }
  },
  "@id": "http://franz.com/mygraph1",
  "@graph": [
    {
      "@id": "http://example.org/library",
      "@type": "ex:Library",
      "ex:contains": "http://example.org/library/the-republic"
    },
    {
      "@id": "http://example.org/library/the-republic",
      "@type": "ex:Book",
      "dc:creator": "Plato",
      "dc:title": "The Republic",
                                              "ex:contains":
"http://example.org/library/the-republic#introduction"
    },
    {
                                                  "@id":
"http://example.org/library/the-republic#introduction",
      "@type": "ex:Chapter",
       "dc:description": "An introductory chapter on The
Republic.",
      "dc:title": "The Introduction"
    }
  ]
}
```

With the result:

```
>>> test(library, maxPrint=3)
(<http://example.org/library>,
<http://example.org/vocab#contains>,
<http://example.org/library/the-republic>,
<http://franz.com/mygraph1>) (<http://example.org/library>,
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>,
<http://example.org/vocab#Library>,
<http://franz.com/mygraph1>)
(<http://example.org/library/the-republic>,
<http://purl.org/dc/elements/1.1/creator>,
"Plato",<http://franz.com/mygraph1>)
>>>
```



JSON-LD as a Document Store

So far we have treated JSON-LD as a syntax to create triples. Now let us look at the way we can start using AllegroGraph as a combination of a document store and graph database at the same time. And also keep in mind that we want to do it in such a way that you as a Python developer can add documents such as dictionaries and also retrieve values or documents as dictionaries.

Setup

The Python source file jsonld_tutorial_helper.py contains various definitions useful for the remainder of this example. Once it is downloaded, do the following (after adding the path to the filename):

```
conn=createdb("docugraph")
from jsonld_tutorial_helper import *
addNamespace(conn,"jsonldmeta","http://franz.com/ns/allegrograph/6.4/load-meta#")
addNamespace(conn,"ical","http://www.w3.org/2002/12/cal/ical#")
```

Let's use our event structure again and see how we can store this JSON document in the store as a document. Note that the addData call includes the keyword: json_ld_store_source=True.

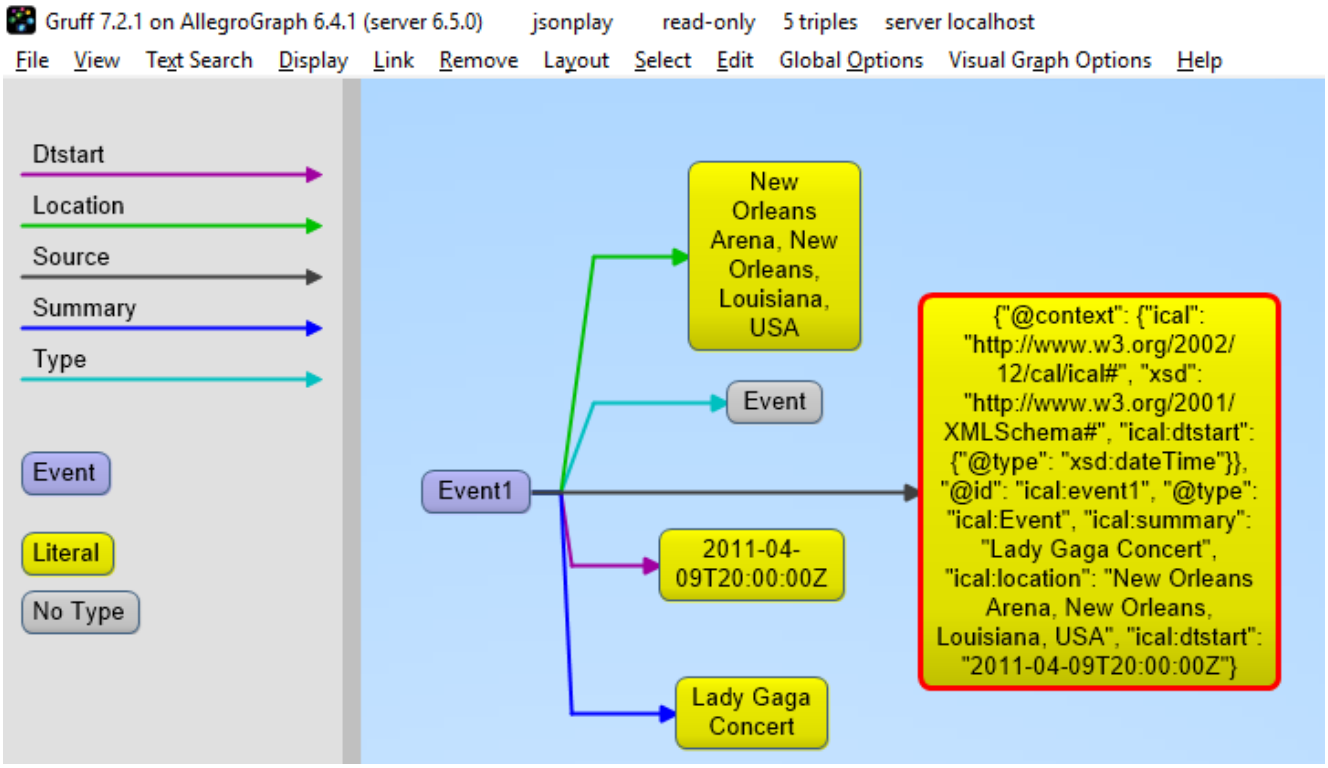
```
event = {
  "@context": {
    "@id": "ical:event1",
    "@type": "ical:Event",
    "ical": "http://www.w3.org/2002/12/cal/ical#",
    "xsd": "http://www.w3.org/2001/XMLSchema#",
    "ical:dtstart": { "@type": "xsd:dateTime" }
      },
    "ical:summary": "Lady Gaga Concert",
    "ical:location":
    "New Orleans Arena, New Orleans, Louisiana, USA",
    "ical:dtstart": "2011-04-09T20:00:00Z"
}
```

```
>>> conn.addData(event, allow_external_references=True,json_ld_store_source=True)
```

The *jsonld_tutorial_helper.py* file defines the function store as simple wrapper around addDatathat always saves the JSON source. For experimentation reasons it also has a parameter fresh to clear out the repository first.

```
>>> store(conn,event, fresh=True)
```

If we look at the triples in Gruff we see that the JSON source is stored as well, on the root (top-level *@id*) of the JSON object.



For the following part of the tutorial we want a little bit more data in our repository so please look at the helper file *jsonld_tutorial_helper.py* where you will see that at the end we have a dictionary named *obs* with about 9 diverse objects, mostly borrowed from the json-ld.org site: a person, an event, a place, a recipe, a group of persons, a product, and our hippieoil.

First let us store all the objects in a fresh repository. Then we check the size of the repo. Finally, we create a freetext index for the JSON sources.

```
>>> store(conn,[v for k,v in obs.items()], fresh=True)
>>> conn.size()
86
>>>
conn.createFreeTextIndex("source",['<http://franz.com/ns/alleg
```

```
rograph/6.4/load-meta#source>'])
>>>
```

Retrieving values with SPARQL

To simply retrieve values in objects but not the objects themselves, regular SPARQL queries will suffice. But because we want to make sure that Python developers only need to deal with regular Python structures as lists and dictionaries, we created a simple wrapper around SPARQL (see helper file). The name of the wrapper is runSparql.

Here is an example. Let us find all the roots (top-level *@ids*) of objects and their types. Some objects do not have roots, so None stands for a blank node.

```
>>> pprint(runSparql(conn,"select ?s ?type { ?s a ?type }"))
[{'s': 'cocktail1', 'type': 'Cocktail'},
 {'s': None, 'type': 'Individual'},
 {'s': None, 'type': 'Vehicle'},
 {'s': 'tesla', 'type': 'Offering'},
 {'s': 'place1', 'type': 'Place'},
 {'s': None, 'type': 'Offer'},
 {'s': None, 'type': 'AggregateRating'},
 {'s': 'hippieoil', 'type': 'Product'},
 {'s': 'person-3', 'type': 'Person'},
 {'s': 'person-2', 'type': 'Person'},
 {'s': 'person-1', 'type': 'Person'},
 {'s': 'person-1000', 'type': 'Person'},
 {'s': 'event1', 'type': 'Event'}]
>>>
```

We do not see the full URIs for ?s and ?type. You can see them by adding an appropriate *format*argument to **runSparql**, but the default is terse.

```
>>> pprint(runSparql(conn,"select ?s ?type { ?s a ?type }
limit 2",format='ntriples'))
[{'s':    '<http://franz.com/cocktail1>',    'type':
```

```
'<http://franz.com/Cocktail>'},
             {'s':             None,             'type':
'<http://purl.org/goodrelations/v1#Individual>'}]
>>>
```

Retrieving a Dictionary or Object

retrieve is another function defined (in *jsonld_tutorial_helper.py*) for this tutorial. It is a wrapper around SPARQL to help extract objects. Here we see how we can use it. The sole purpose of retrieve is to retrieve the JSON-LD/dictionary based on a SPARQL pattern.

```
>>> retrieve(conn,"{?this a ical:Event}")
[{'@type': 'ical:Event', 'ical:location': 'New Orleans Arena,
New Orleans, Louisiana, USA', 'ical:summary': 'Lady Gaga
Concert',  '@id':  'ical:event1',  '@context':  {'xsd':
'http://www.w3.org/2001/XMLSchema#',         'ical':
'http://www.w3.org/2002/12/cal/ical#',    'ical:dtstart':
{'@type':     'xsd:dateTime'}},     'ical:dtstart':
'2011-04-09T20:00:00Z'}]
>>>
```

Ok, for a final fun (if you like expensive cars) example: Let us find a thing that is “fast and furious”, that is worth more than $80,000 and that we can pay for in cash:

```
>>>
addNamespace(conn,"gr","http://purl.org/goodrelations/v1#")
>>> x = retrieve(conn, """{ ?this fti:match 'fast furious*';
                           gr:acceptedPaymentMethods gr:Cash ;
                           gr:hasPriceSpecification ?price .
                    ?price gr:hasCurrencyValue ?value ;
                           gr:hasCurrency "USD" .
                    filter ( ?value > 80000.0 ) }""")
>>> pprint(x)
[{'@context': {'foaf': 'http://xmlns.com/foaf/0.1/',
               'foaf:page': {'@type': '@id'},
               'gr': 'http://purl.org/goodrelations/v1#',
```

```
                'gr:acceptedPaymentMethods': {'@type': '@id'},
                'gr:hasBusinessFunction': {'@type': '@id'},
                'gr:hasCurrencyValue': {'@type': 'xsd:float'},
                'pto': 'http://www.productontology.org/id/',
                'xsd': 'http://www.w3.org/2001/XMLSchema#'},
  '@id': 'http://example.org/cars/for-sale#tesla',
  '@type': 'gr:Offering',
  'gr:acceptedPaymentMethods': 'gr:Cash',
  'gr:description': 'Need to sell fast and furiously',
  'gr:hasBusinessFunction': 'gr:Sell',
  'gr:hasPriceSpecification': {'gr:hasCurrency': 'USD',
                               'gr:hasCurrencyValue':
'85000'},
  'gr:includes': {'@type': ['gr:Individual', 'pto:Vehicle'],
                                                'foaf:page':
'http://www.teslamotors.com/roadster',
                  'gr:name': 'Tesla Roadster'},
  'gr:name': 'Used Tesla Roadster'}]
>>> x[0]['@id']
'http://example.org/cars/for-sale#tesla'
```

New!!! AllegroGraph v6.5 – Multi-model Semantic Graph and Document Database

Download – **AllegroGraph v6.5 and Gruff v7.3**

AllegroGraph – **Documentation**

Gruff – **Documentation**

Adding JSON/JSON-LD Documents to a Graph Database

Traditional document databases (e.g. MongoDB) have excelled at storing documents at scale, but are not designed for linking

data to other documents in the same database or in different databases. AllegroGraph 6.5 delivers the unique power to define many different types of documents that can all point to each other using standards-based semantic linking and then run SPARQL queries, conduct graph searches, execute complex joins and even apply Prolog AI rules directly on a diverse sea of objects.

AllegroGraph 6.5 provides free text indexes of JSON documents for retrieval of information about entities, similar to document databases. But unlike document databases, which only link data objects within documents in a single database, AllegroGraph 6.5 moves the needle forward in data analytics by semantically linking data objects across multiple JSON document stores, RDF databases and CSV files. Users can run a single SPARQL query that results in a combination of structured data and unstructured information inside documents and CSV files. AllegroGraph 6.5 also enables retrieval of entire documents.

There are many reasons for working with JSON-LD. The big search engines force ecommerce companies to mark up their webpages with a systematic description of their products and more and more companies use it as an easy serialization format to share data.

A direct benefit for companies using AllegroGraph is that they now can combine their documents with graphs, graph search and graph algorithms. Normally when you store documents in a document database you set up your documents in such a way that it is optimized for certain direct retrieval queries. Performing complex joins for multiple types of documents or even performing a shortest path through a mass of object (types) is too complicated. Storing JSON-LD objects in AllegroGraph gives users all the benefits of a document database AND the ability to semantically link objects together, run complex joins, and perform graph search queries.

Another key benefit for companies is that your application developers don’t have to learn the entire semantic technology stack, especially the part where developers have to create individual RDF triples or edges. Application developers love to work with JSON data as serialization for objects. In JavaScript the JSON format is syntactically identical to the code for creating JavaScript objects and in Python the most import data structure is the ‘dictionary’ which is also near identical to JSON.

Key AllegroGraph v6.5 Features:

- Support for loading JSON-LD and also some non-RDF data files, that is files which are not already organized into triples or quads. See Loading non-RDF data section in the Data Loading document for more information on loading non-RDF data files. Loading JSON-LD files is described along with other RDF formats in the Data Loading document. The section Supported RDF formats lists all supported RDF formats.

- Support for two phase commits (2PC), which allows AllegroGraph to participate in distributed transactions compromising a number of AllegroGraph and non-AllegroGraph databases (e.g. MongoDB, Solr, etc), and to ensure that the work of a transaction must either be committed on all participants or be rolled back on all participants. Two-phase commit is described in the Two-phase commit document.

- An event scheduler: Users can schedule events in the future. The event specifies a script to run. It can run once or repeatedly on a regular schedule. See the Event Scheduler document for more information.

- AllegroGraph is 100 percent ACID, supporting Transactions: Commit, Rollback, and Checkpointing. Full and Fast Recoverability. Multi-Master Replication
- Triple Attributes – Quads/Triples can now have attributes which can provide fine access control.
- Data Science – Anaconda, R Studio
- 3D and multi-dimensional geospatial functionality
- SPARQL v1.1 Support for Geospatial, Temporal, Social Networking Analytics, Hetero Federations
- Cloudera, Solr, and MongoDB integration
- JavaScript stored procedures
- RDF4J Friendly, Java Connection Pooling
- Graphical Query Builder for SPARQL and Prolog – Gruff
- SHACL (Beta) and SPIN Support (SPARQL Inferencing Notation)
- AGWebView – Visual Graph Search, Query Interface, and DB Management
- Transactional Duplicate triple/quad deletion and suppression
- Advanced Auditing Support
- Dynamic RDFS++ Reasoning and OWL2 RL Materializer
- AGLoad with Parallel loader optimized for both traditional spinning media and SSDs.

Numerous other optimizations, features, and enhancements. Read the release notes – https://franz.com/agraph/support/documentation/current/release-notes.html