Franz Inc. Announces AllegroGraph Has No Log4j Security Exposure

Franz Inc. has clearly stated that all of its products including: AllegroGraph, Allegro CL, Allegro NFS and Gruff have no exposure to the security vulnerability from Log4j. Franz's products have never used Log4j, unlike other Java based graph databases and products that are vulnerable to this security exploit.

Apache Log4j is a Java-based logging utility and is part of the Apache Logging Services, a project of the Apache Software Foundation. As reported by Wired News, "A vulnerability in the widely used logging library has become a full-blown security meltdown, affecting digital systems across the internet. Hackers are already attempting to exploit it, but even as fixes emerge, researchers warn that the flaw could have serious repercussions worldwide."

According to Wired, "The problem lies in Log4j, a ubiquitous, open source Apache logging framework that developers use to keep a record of activity within an application. Security responders are scrambling to patch the bug, which can be easily exploited to take control of vulnerable systems remotely. At the same time, hackers are actively scanning the internet for affected systems. Some have already developed tools that automatically attempt to exploit the bug, as well as worms that can spread independently from one vulnerable system to another under the right conditions."

"Decades of working with intelligence and government agencies has instilled a 'security-first approach' in all of our technology development," said Dr. Jans Aasman, CEO of Franz, Inc. "This exploit has the potential to affect any type of business or organization. We want to assure all of our customers that their products from Franz are not at risk of exposure from Log4j."

Born from early architectural influence within national intelligence and defense agencies, AllegroGraph offers the highest level of security available from a graph database. Not only does AllegroGraph not use Log4j, but the product offers unrivaled security via Triple Attributes, which is designed to protect the most sensitive data within the flexible environment of a graph database.

Download AllegroGraph, Allegro CL, Allegro NFS, or Gruff.

Adding Properties to Triples in AllegroGraph

AllegroGraph provides two ways to add metadata to triples. The first one is very similar to what typical property graph databases provide: we use the named graph of triples to store meta data about that triple. The second approach is what we have termed *triple attributes*. An attribute is a key/value pair associated with an individual triple. Each triple can have any number of attributes. This approach, which is built into AllegroGraph's storage layer, is especially handy for security and bookkeeping purposes. Most of this article will discuss triple attributes but first we quickly discuss the named graph (i.e. fourth element or quad) approach.

1.0 The Named Graph for Properties

Semantic Graph Databases are actually defined by the W3C standard to store RDF as 'Quads' (Named Graph, Subject,

Predicate, and Object). The 'Triple Store' terminology has stuck even though the industry has moved on to storing quads. We believe using the named graph approach to store metadata about triples is richer model that the property graph database method.

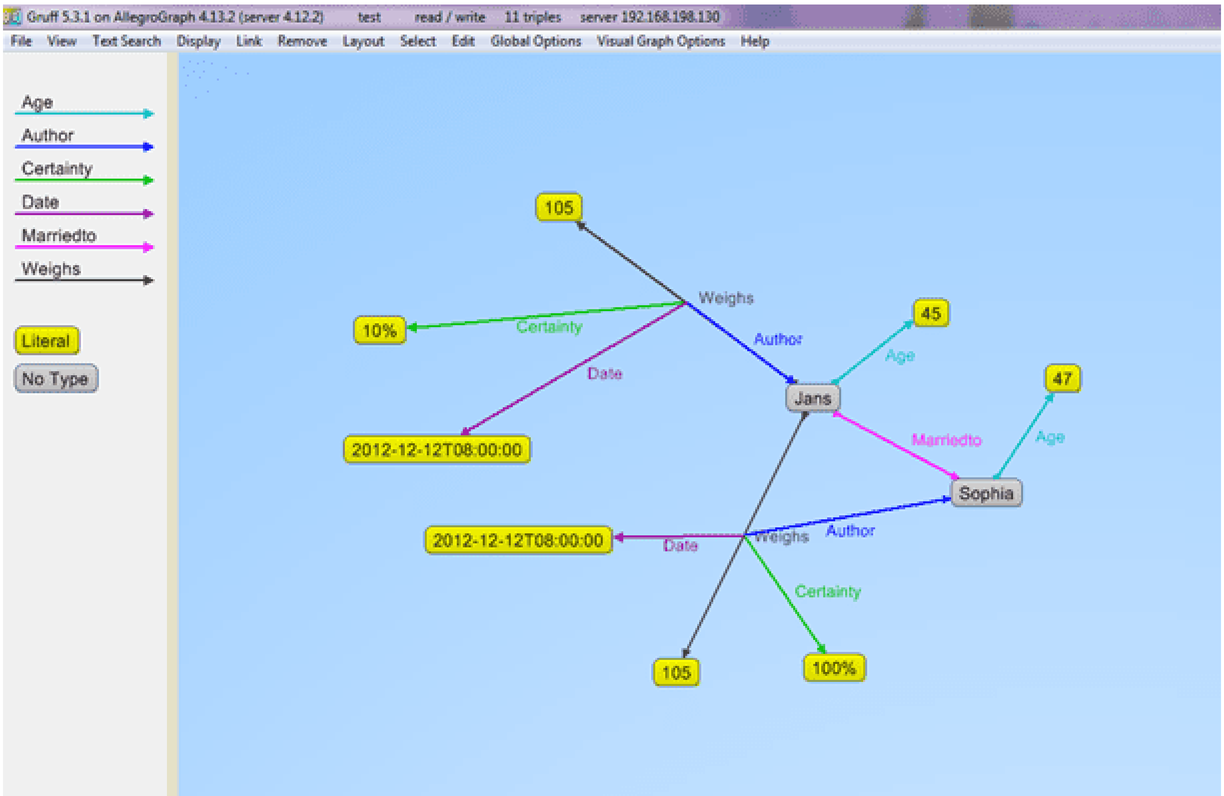
The best way to understand this is to give an example. Below we see two statements about Bruce weighing 105 kilos. The triple portions (subject, predicate, object) are identical but the named graphs (fourth elements) differ. They are used to provide additional information about the triples. The graph values are S1 and S2. By looking at these graphs we see that

- The author of the first triple (with graph S1) is Sophia and the author of the second (with graph S2) is Bruce (who is also the subject of the two triples).
- Sophia is 100% certain about her statement while Bruce is only 10% certain about his.

Using the named graph we can do even more than a property graph database, as the value of a graph can itself be a node, and is the subject of various triples which specify the original triple's author, date, and certainty. Additional triples tell us the ages of the authors and the fact that the authors are married.

Subject	Predicate	Object	Graph
Bruce	Weighs	105kg	S1
Bruce	Weighs	105kg	S2
Bruce	Age	45	None
Bruce	MarriedTo	Sophia	None
S1	Author	Sophia	None
S1	Date	2012-12-12T08:00:00	None
S1	Certainty	100 %	None
S2	Author	Bruce	None
S2	Date	2012-12-12T08:00:00	None
S2	certainty	10%	None
Sophia	Age	47	None

Here is the data displayed in Gruff, AllegroGraph's associated triple store browser:



Using named graphs for a triple's metadata is a powerful tool but it does have limitations: (1) only one graph value can be associated with a triple, (2) it can be important that metadata is stored directly and physically with the triple (with named graphs, the actual metadata is usually stored in additional triples with the graph as the subject, as in the example above), and (3) named graphs have competing uses and

may not be available for metadata.

2.0 The Triple Attributes approach

AllegroGraph uniquely offers a mechanism called *triple attributes* where a collection of user defined key/value pairs can be stored with each individual triple. The advantage of this approach is manyfold, but the original use case was designed for triple level security for an Intelligence agency.

By having triple attributes physically connected to the triples in the storage layer we can provide a very powerful and flexible mechanism to protect triples at the lowest possible level in AllegroGraph's architecture. Our first example below shows this use case in great detail. Other use cases are for example to add weights or costs to triples, to be used in graph algorithms. Or we can add a recorded time or expiration times to a triple and use that to provide a time machine in AllegroGraph or do automatic clean-up of old data.

Example with Attributes:

Subject – <http://dbpedia.org/resource/Arif_Babayev>
Predicate – <http://dbpedia.org/property/placeOfDeath>
Object – <http://dbpedia.org/resource/Baku>
Named Graph – <http://ex#trans@@1142684573200001>
Triple Attributes – {"securityLevel": "high", "department": "hr", "accessToken": ["E", "D"]}

This article provides an initial introduction to attributes and the associated concept of static filters, showing how they are set up and used. We start with a security example which also describes the basics of adding attributes to triples and

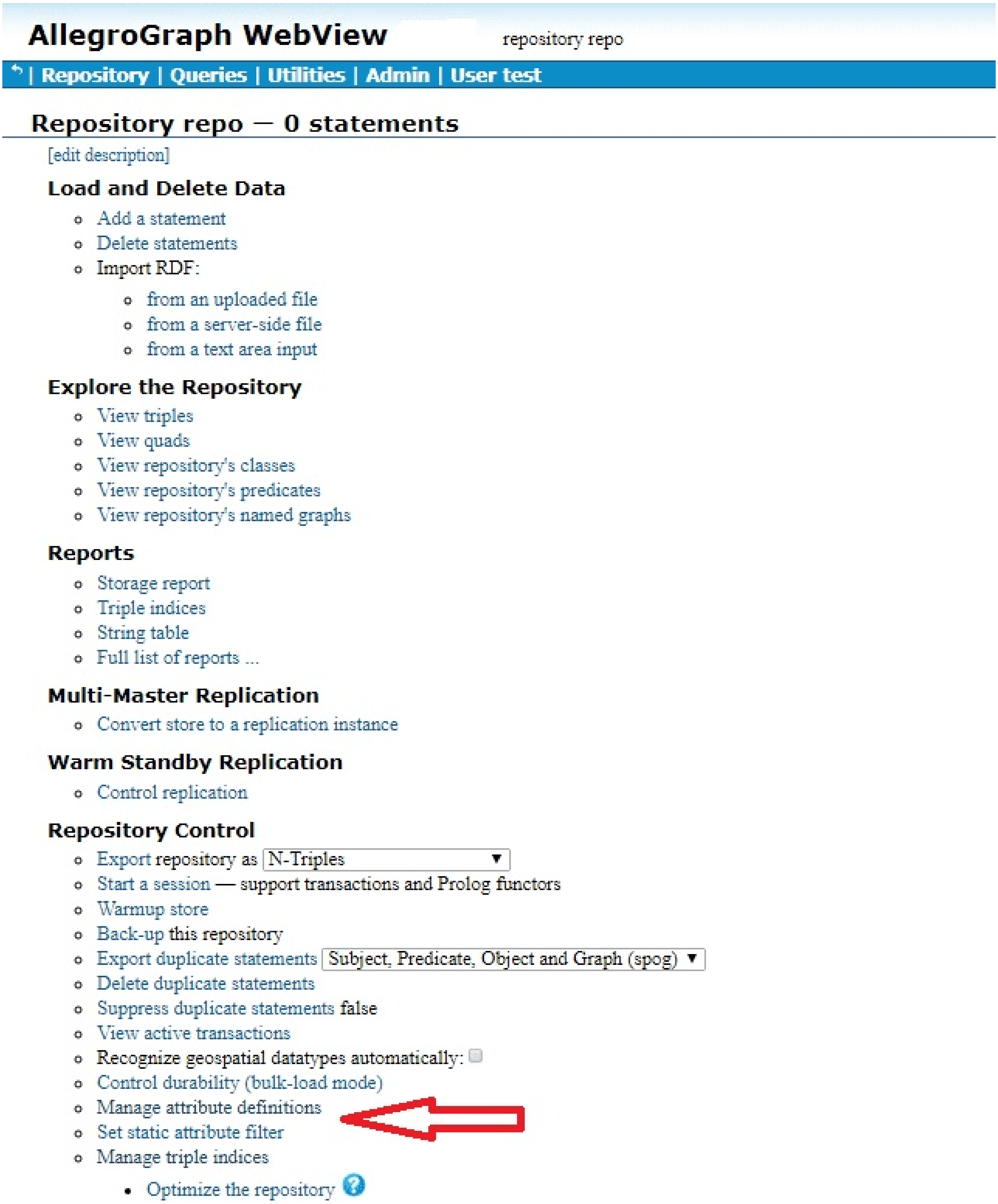
filtering query results based on attribute values. Then we discuss other potential uses of attributes.

2.1 Triple Attribute Basics: a Security Example

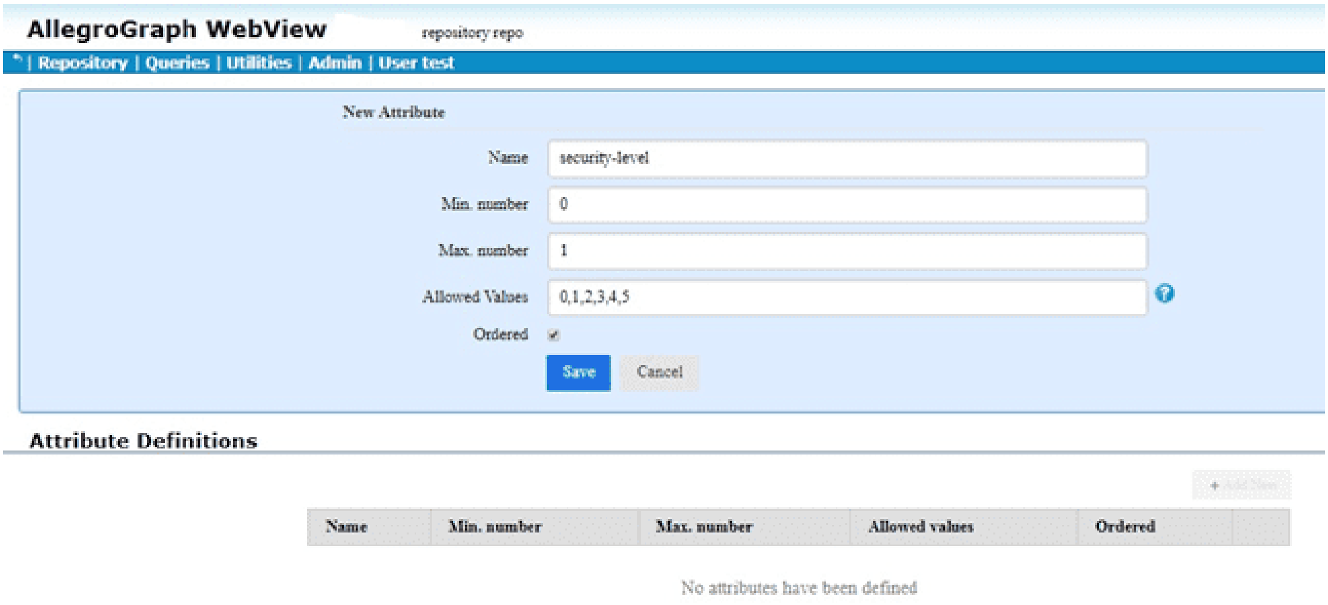
One important purpose of attributes, when they were added as a feature, was to allow for very fine triple-level security, so that triples would be visible or invisible to users according to the attributes of the triples and the permissions associated with the query being posed by the user.

Note that users as such do not have attributes. Instead, attribute values are assigned when a query is posed. This is an important point: it is natural to think that there can be an attribute SECURITY-LEVEL, and a triple can have attribute SECURITY-LEVEL=3, and USER1 can have an attribute SECURITY-LEVEL=2 and USER2 can have an attribute SECURITY-LEVEL=4, and the system can require that the user SECURITY-LEVEL attribute must be greater than the triple SECURITY-LEVEL for the triple to be visible to the user. But that is not how attributes work. The triples can have the attribute SECURITY-LEVEL=2 but users do not have attributes. Instead, the filter is made part of the query.

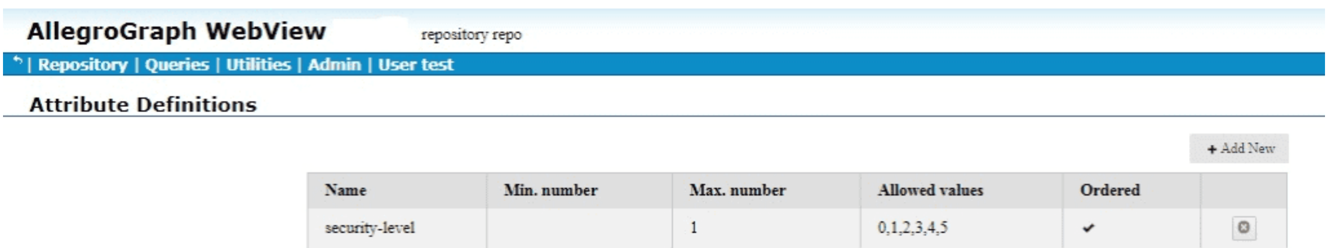
Here is a simple example. We define attributes and static attribute filters using AGWebView. We have a repository named repo. Here is a portion of its AGWebView page:



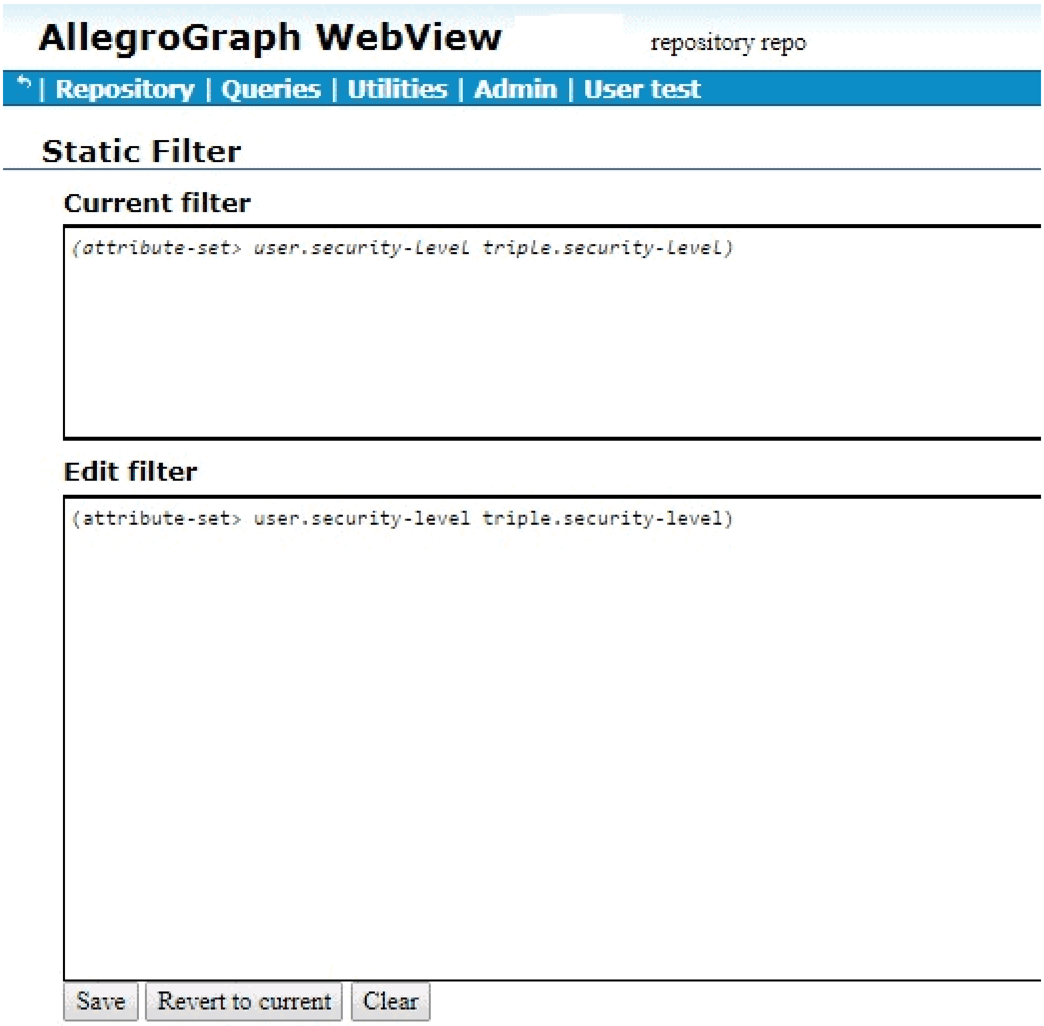
The red arrow points to the commands of interest: Manage attribute definitions and Set static attribute filter. We click on Set static attribute filter to define an attribute. We have filled in the attribute information (name *security-level*, minimum and maximum number allowed per triple, allowed values, and whether order or not (yes in our case):



We click Save and the attribute is defined:



Then we define a filter (on the Set static attribute filter page):



We defined the filter (attribute-set> user.security-level triple.security-level) and clicked Save (the definition appears in both the Edit and the Current fields). The filter says that the "user" security level must be greater than the triple security level. We put "user" in quotes because the user security level is specified as part of the query, and has no direct connection to any specific user.

Here are some triples in a nqx file *fr.nqx*. The first triple has no attributes and the other three each has a security-level attribute value.

<http://www.franz.com#emp0>

<http://www.franz.com#position> “intern” .

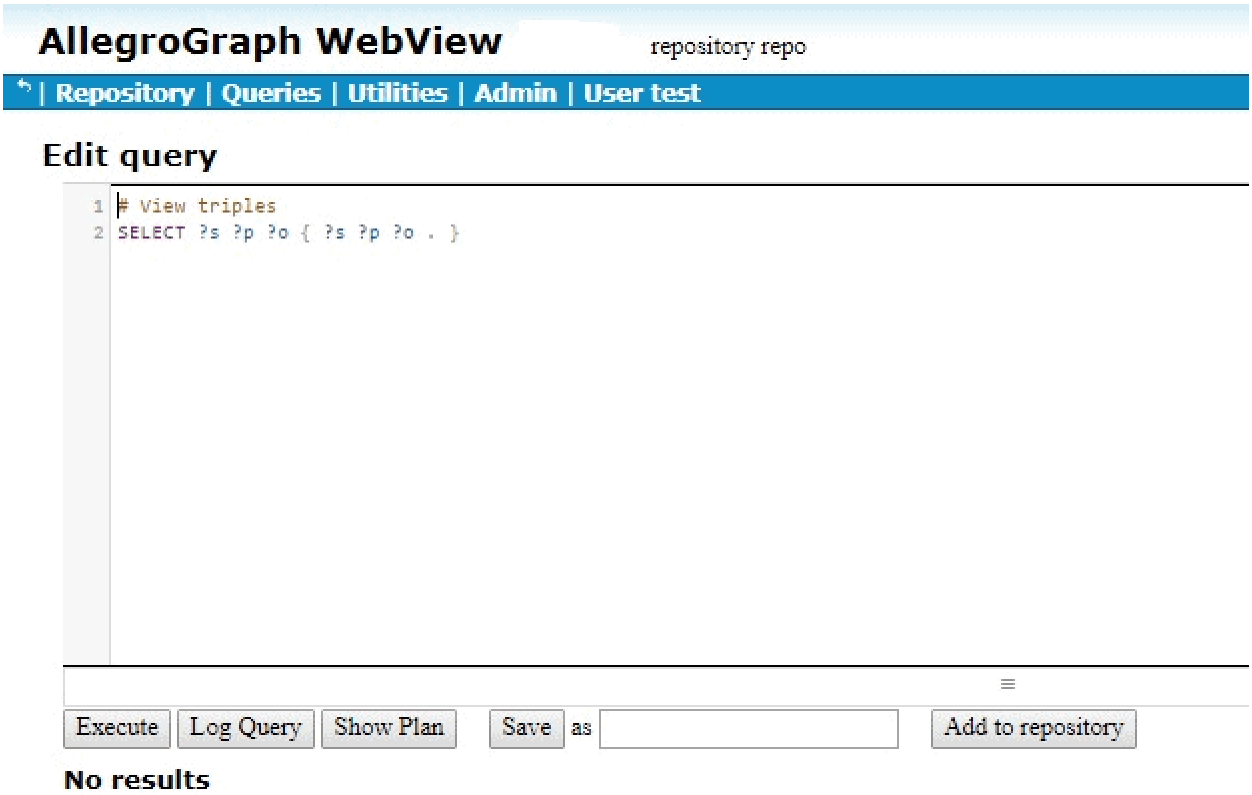
<http://www.franz.com#emp1> <http://www.franz.com#position> “worker” {“security-level”: “2”} .

<http://www.franz.com#emp2> <http://www.franz.com#position> “manager” {“security-level”: “3”} .

<http://www.franz.com#emp3> <http://www.franz.com#position> “boss” {“security-level”: “4”} .

We load this file into a repository which has the security-level attribute defined as above and the static filter mentioned above also defined. (Triples with attributes can also be entered directly when using AGWebView with the Import RDF from a text area input command).

Once the triples are loaded, we click View triples in AGWebView and we see no triples:



This result is often surprising to users just beginning to work with attributes and filters, who may expect the first triple, abbreviated to [emp0 position intern], to be visible, but the system is doing what it is supposed to do. It will only show triples where the security-level of the user posing the query is greater than the security level of the triple. The user has no security level and so the comparison fails, even with triples that have no security-level attribute value. We will describe below how to ensure you can see triples with no attributes.

So we need to specify an attribute value to the user posing the query. (As said above, users do not themselves have attribute values. But the attribute value of a user posing a query can be specified as part of the query.) "User" attributes are specified with a prefix like the following:

```
prefix franzOption_userAttributes: <franz:%7B%22security-
```

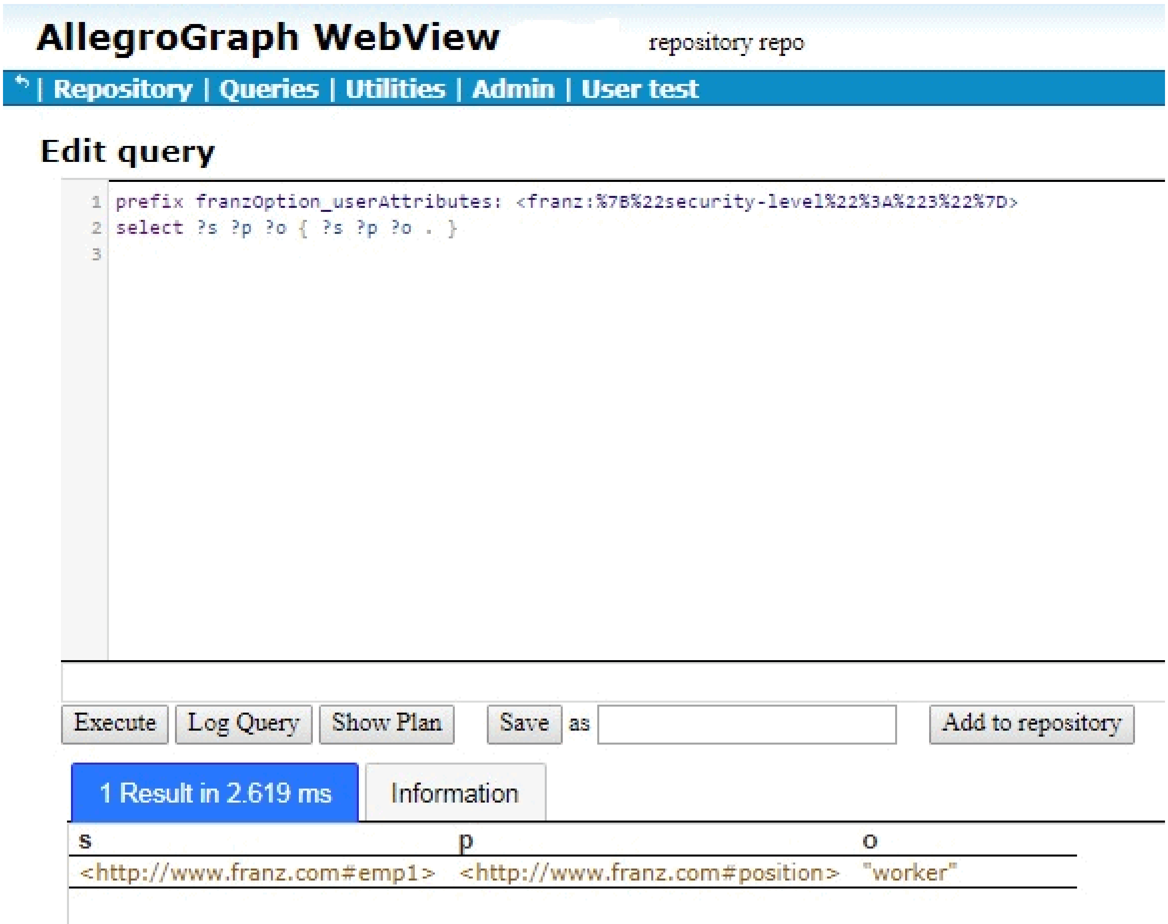
level%22%3A%223%22%7D>

so the query should be

```
prefix franzOption_userAttributes: <franz:%7B%22security-level%22%3A%223%22%7D>

select ?s ?p ?o { ?s ?p ?o . }
```

We will show the results below, but first what are all the % signs and numbers doing there? Why isn’t the prefix just prefix franzOption_userAttributes: <franz:{“security-level”:”3″}>? The issue is that {“security-level”:”3″} won’t read correctly. It must be URL encoded. We do this by going to https://www.urlencoder.org/ (there are other websites that do this as well) and put {“security-level”:”3″} in the first box, click Encode and get %7B%22security-level%22%3A%223%22%7D. We then paste that into the query, as shown above.

When we try that query in AGWebView, we get one result:



If we encode {"security-level":"5″} to get the query

```
prefix franzOption_userAttributes: <franz:%7B%22security-level%22%3A%225%22%7D>
select ?s ?p ?o { ?s ?p ?o . }
```

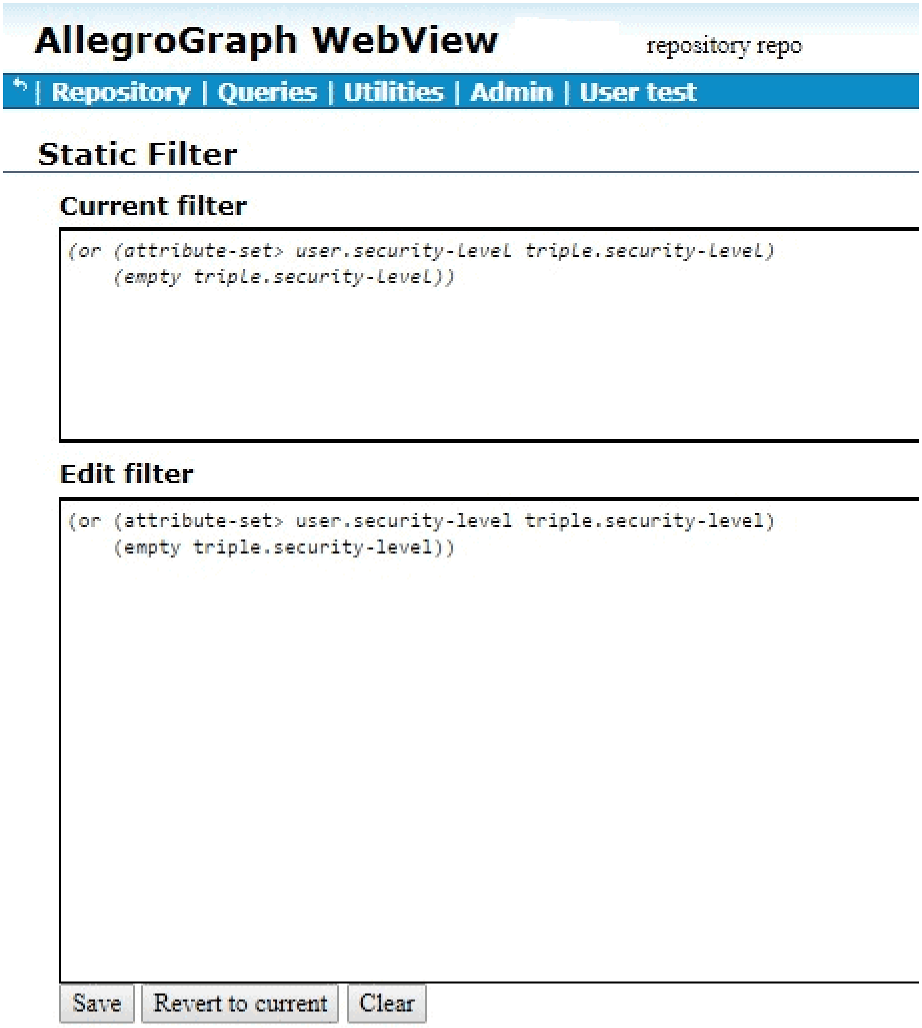
we get three results:

emp3	position	"boss"
emp2	position	"manager"
emp1	position	"worker"

since now the "user" security-level is greater than that of any triples with a security-level attribute. But what about the triple with subject emp0, the triple with no attributes? It does not pass the filter which required that the user attribute be greater than the triple attribute. Since the triple has no attribute value so the comparison failed.

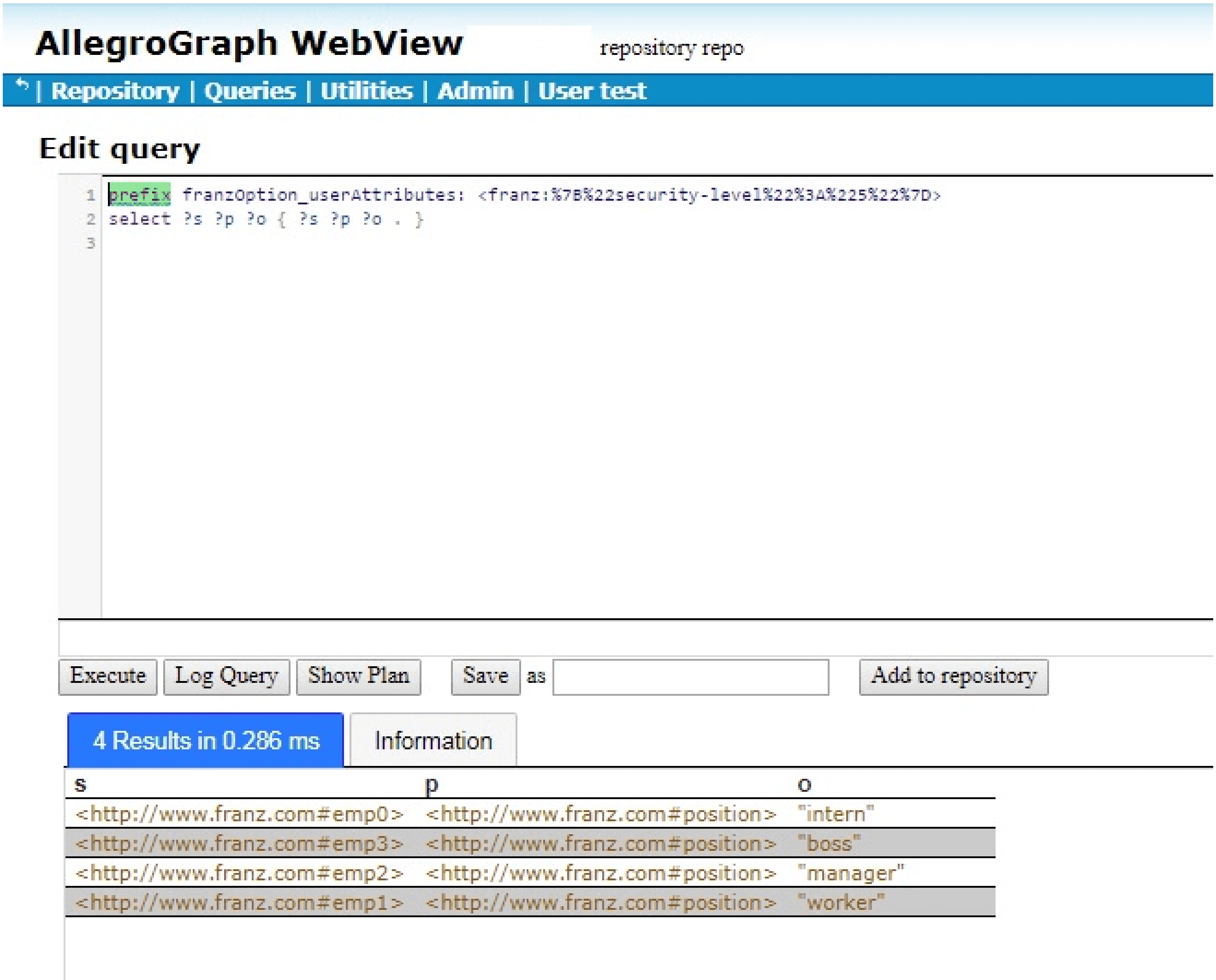
Let us redefine the filter to:

```
(or (attribute-set> user.security-level triple.security-level)
    (empty triple.security-level))
```



Now a triple will pass the filter if either (1) the “user” security-level is greater than the triple security-level or

(2) the triple does not have a security-level attribute. Now the query from above where the user has attribute security-level:"5" will show all the triples with security-level less than 5 and with no attributes at all. That happens to be all four triples so far defined:



The triple

emp0 position "intern"

will now appears as a result in any query where it satisfies the SPARQL select regardless of the security-level of the “user”.

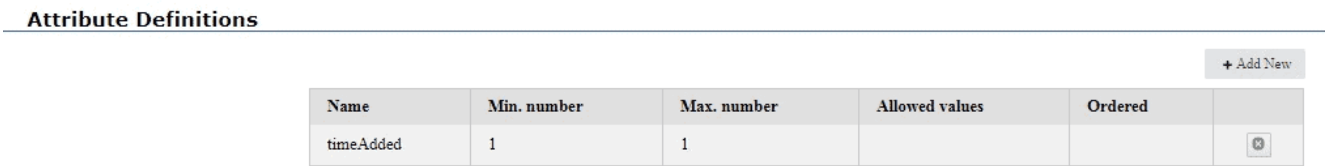
It would be a useful feature that we could associate attributes with actual users. However, this is not as simple as it sounds. Attributes are features of repositories. If I have a REPO1 repository, it can have a bunch of defined attributes and filters but my REPO2 may know nothing about them and its triples may not have any attributes at all, and no attributes are defined, and (as a result) no filters. But users are not repository-linked objects. While a repository can be made read-only or unreadable for a user, users do not have finer repository features. So an interface for providing users with attributes, since it would only make sense on a per-repository basis, requires a complicated interface. That is not yet implemented (though we are considering how it can be done).

Instead, users can have specific prefixes associated with them and that prefix and be included in any query made by the user.

But if all it takes to specify “user” attributes is to put the right line at the top of your SPARQL query, that does not seem to provide much security. There is a feature for users “Allow user attributes via SPARQL PREFIX franzOption_userAttributes” which can restrict a user’s ability to specify “user” attributes in a query, but that is a rather blunt instrument. Instead, the model is that most users (outside of trusted administrators) are not actually allowed to pose SPARQL queries directly. Instead, there is an intermediary program which takes the query a user requests and, having determined the status of the user and what attribute values should be given to the user, modifies the query with the appropriate franzOption_userAttributes prefixes and then sends the query on to the server, following which it captures the results and sends them back to the requesting user. That intermediate program will store the prefix suitable for a user and thus associate “user” attributes with specific users.

2.2 Using attributes as additional data

Although triple security is one powerful use of attributes, security is far from the only use. Just as the named graph can serve as additional data, so can attributes. SPARQL queries can use attribute values just as static filters can filter out triples before displaying them. Let us take a simple example: the attribute timeAdded. Every triple we add will have a timeAdded attribute value which will be a string whose contents are a datetime value, such as “2017-09-11T:15:52”. We define the attribute:



Name	Min. number	Max. number	Allowed values	Ordered	
timeAdded	1	1			

Now let us define some triples:

<http://www.franz.com#emp0>
<http://www.franz.com#callRank> “2” {“timeAdded”: “2019-01-12T10:12:45” } .
<http://www.franz.com#emp0>
<http://www.franz.com#callRank> “1” {“timeAdded”: “2019-01-14T14:16:12” } .
<http://www.franz.com#emp0>
<http://www.franz.com#callRank> “3” {“timeAdded”: “2019-01-11T11:15:52” } .

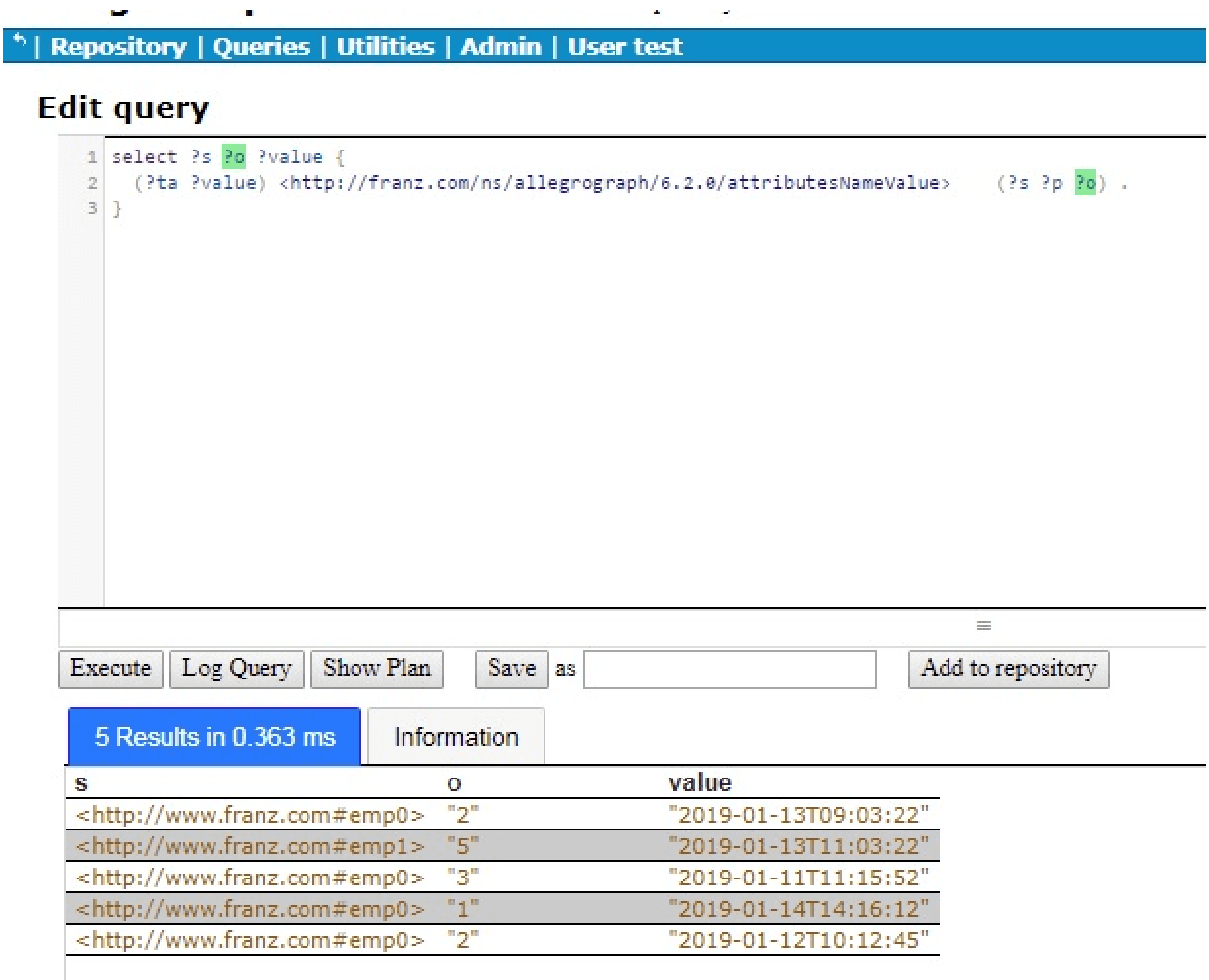
```
    <http://www.franz.com#emp1>
<http://www.franz.com#callRank> "5" {"timeAdded":
"2019-01-13T11:03:22" } .
    <http://www.franz.com#emp0>
<http://www.franz.com#callRank> "2" {"timeAdded":
"2019-01-13T09:03:22" } .
```

We have a call center with employees making calls. Each call has a ranking from 1 to 5, with 1 the lowest and 5 the highest. We have data on five calls, four from emp0 and one from emp1. Each triples has a timeAdded attribute with a string containing a dateTime value. We load these into a empty repository named at-test where the timeAdded attribute is defined as above:

SPARQL queries can use the attribute magic properties (see https://franz.com/agraph/support/documentation/current/triple-attributes.html#Querying-Attributes-using-SPARQL). We use the attributesNameValue magic property to see the subject, object, and attribute value:

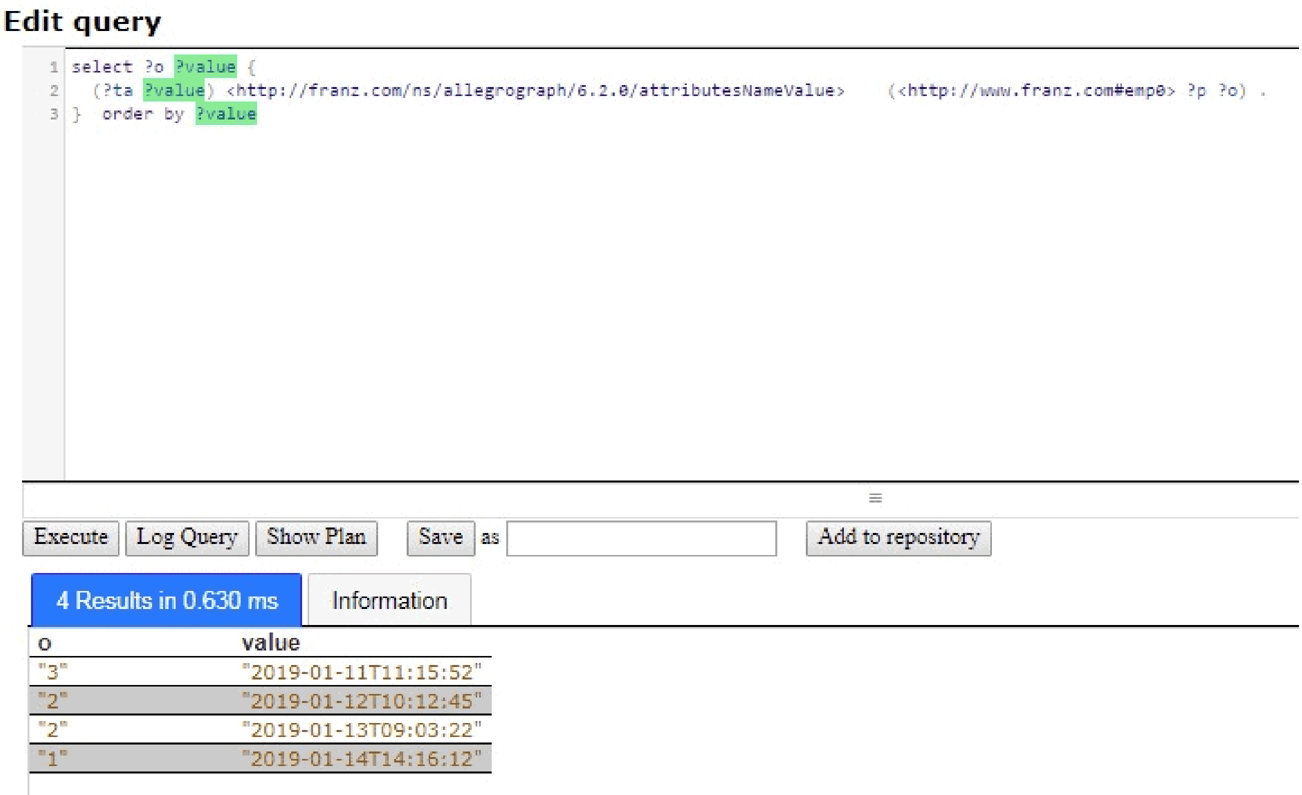
```
    select ?s ?o ?value {
                                        (?ta    ?value)
```

```
<http://franz.com/ns/allegrograph/6.2.0/attributesNameValue>
  (?s ?p ?o) .
     }
```



But we are really interested just in emp0 and we would like to see the results ordered by time, that is by the attribute value, so we restrict the query to emp0 as the subject and order the results:

```
     select ?o ?value {
                                              (?ta      ?value)
<http://franz.com/ns/allegrograph/6.2.0/attributesNameValue>
  (<http://www.franz.com#emp0> ?p ?o) .
     }  order by ?value
```



There are the results for emp0, who is clearly having difficulties because the call rankings have been steadily falling over time.

Another example using timeAdded is employee salary data. In the Human Resources data, the salary of an employee is stored:

emp0 hasSalary 50000

Now emp0 gets a raise to 55000. So we delete the triple above and add the triple

emp0 hasSalary 55000

But that is not satisfactory because we have lost the salary

history. If the boss asks “How much was emp0 paid initially?” we cannot answer. There are various solutions. We could define a salary change object, with predicates effectiveDate, previousSalary, newSalary, and so on:

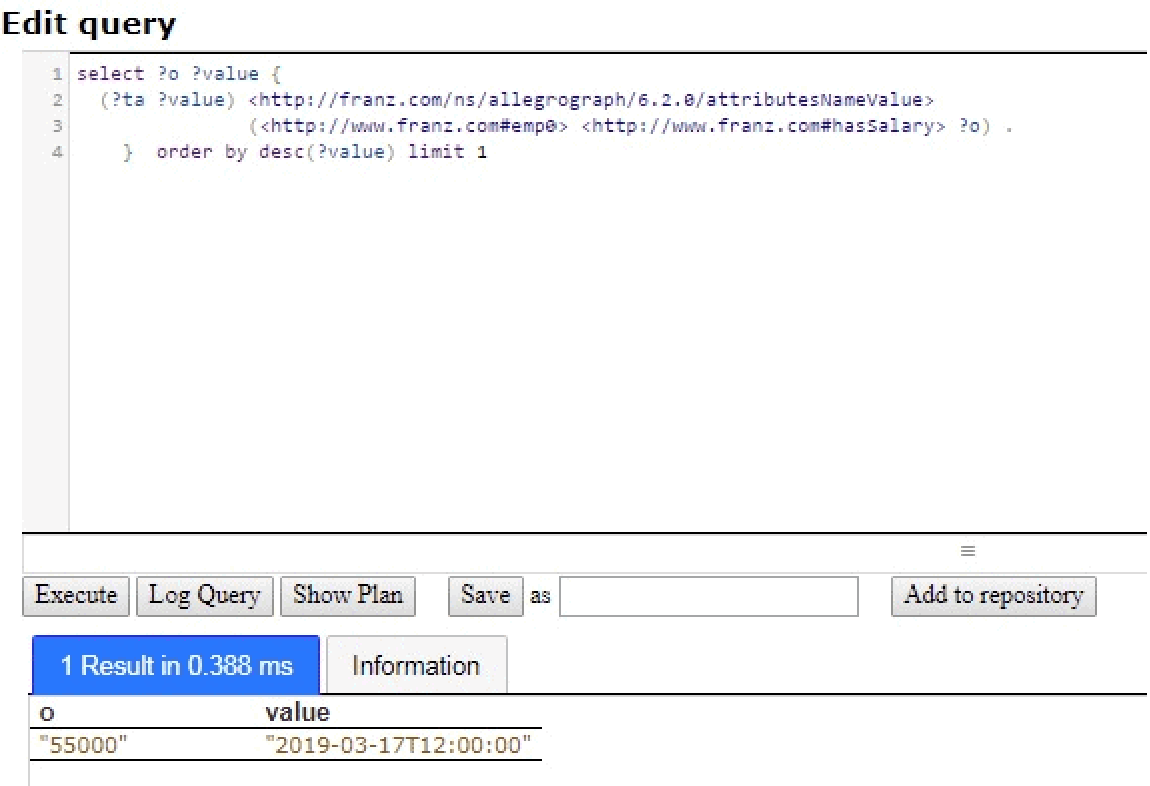
```
salaryChange017 forEmployee emp0
salaryChange017 effectiveDate “2019-01-12T10:12:45”
salaryChange017 oldSalary “50000”
salaryChange017 newSalary “55000”


emp0 hasSalaryChange salaryChange017
```

and that would work fine, but perhaps it is more setup and effort than is needed. Suppose we just have hasSalary triples each with a timeAdded attribute. Then the current salary is the latest one and the history is the ordered list. Here that idea is worked out:

```
<http://www.franz.com#emp0>  <http://www.franz.com#hasSalary>
“50000”^^<http://www.w3.org/2001/XMLSchema#integer>
{“timeAdded”: “2017-01-12T10:12:45” } .
<http://www.franz.com#emp0>  <http://www.franz.com#hasSalary>
“55000”^^<http://www.w3.org/2001/XMLSchema#integer>
{“timeAdded”: “2019-03-17T12:00:00” } .
```

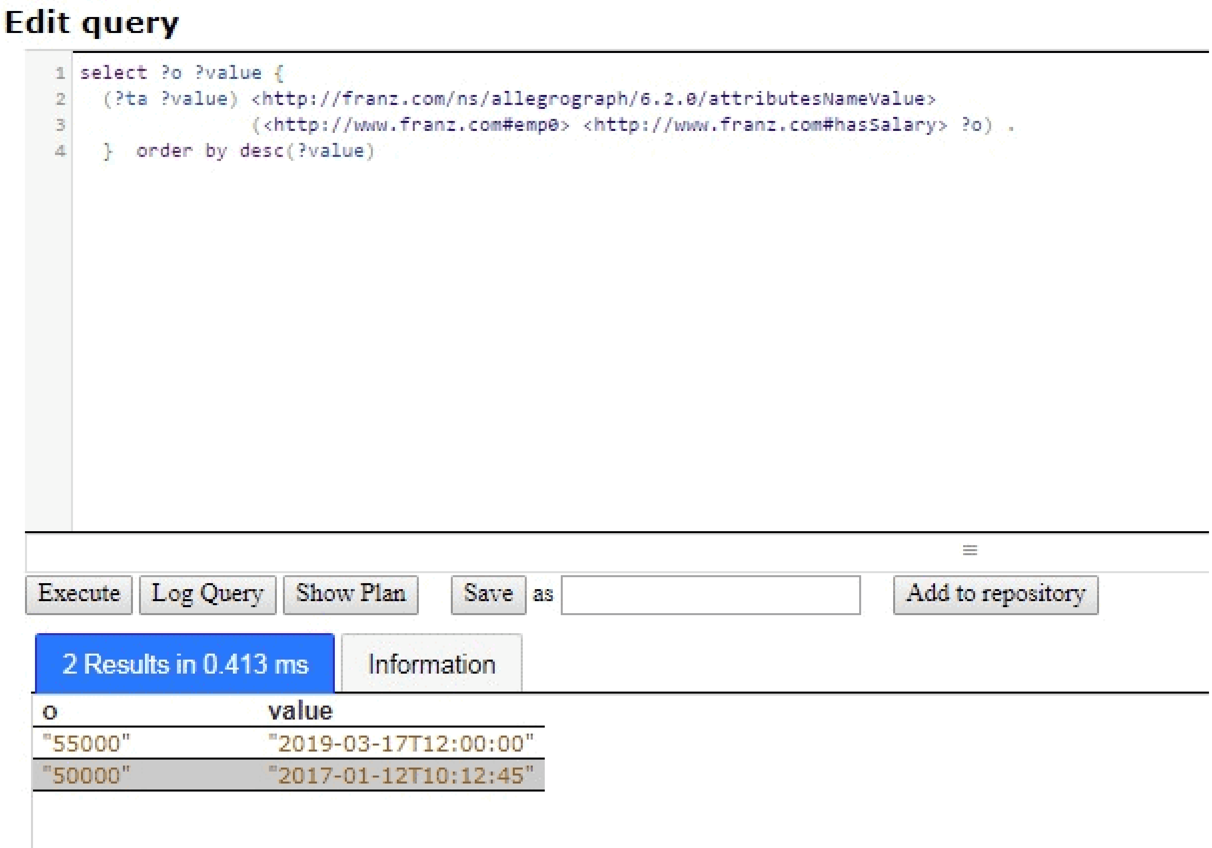
What is the current salary? A simple SPARQL query tells us:

```
select ?o ?value {
    (?ta ?value)
<http://franz.com/ns/allegrograph/6.2.0/attributesNameValue>
    (<http://www.franz.com#emp0>
<http://www.franz.com#hasSalary> ?o) .
  }  order by desc(?value) limit 1
```



The salary history is provided by the same query without the LIMIT:

```
select ?o ?value {
                                        (?ta     ?value)
<http://franz.com/ns/allegrograph/6.2.0/attributesNameValue>

                          (<http://www.franz.com#emp0>
<http://www.franz.com#hasSalary> ?o) .
       }  order by desc(?value)
```



This method of storing salary data may not easily support more complex questions which might be easily answered if we went the salaryChange object route mentioned above but if you are not looking to ask those questions, you should not do the extra work (and the risk of data errors) required.

You could use the graph of each triple for the timeAdded. All the examples above would work with minor tweaks. But there are many uses for the named graph of a triple. Attributes are available and using them for one purpose does not restrict their use for other purposes.

Unraveling the Quandary of Access Layer versus Storage Layer Security

InfoSecurity – February 2019

Dr. Jans Aasman was quoted in this article about how AllegroGraph's Triple Attributes provide Storage Layer Security.

With horizontal standards such as the General Data Protection Regulation (GDPR) and vertical mandates like the Fair Credit Reporting Act increasing in scope and number, information security is impacted by regulatory compliance more than ever.

Organizations frequently decide between concentrating protection at the access layer via role-based security filtering, or at the storage layer with methods like encryption, masking, and tokenization.

The argument is that the former underpins data governance policy and regulatory compliance by restricting data access according to department or organizational role. However, the latter's perceived as providing more granular security implemented at the data layer.

> *A hybrid of access based security and security at the data layer—implemented by triple attributes—can counteract the weakness of each approach with the other's strength, resulting in information security that* ***Franz*** *CEO Jans Aasman characterized as "fine-grained and flexible enough" for any regulatory requirements or security model.*

The security provided by this semantic technology is considerably enhanced by the addition of ***key-value pairs*** *as JSON objects, which can be arbitrarily assigned to triples within databases. These key-value pairs provide a second security mechanism "embedded in the storage, so you cannot cheat," Aasman remarked.*

When implementing HIPPA standards with triple attributes, "even if you're a doctor, you can only see a patient record if all your other attributes are okay," Aasman mentioned.

"We're talking about a very flexible mechanism where we can add any combination of key-value pairs to any triples, and have a very flexible language to specify how to use that to create flexible security models," Aasman said.

Read the full article at InfoSecurity.

Going Beyond Blockchain with Directed Acyclic Graphs (DAG)

Crypto Slate – January 2019

by Dr. Jans Aasman, CEO, Franz Inc.

If organizations could only augment blockchain's strengths—its immutability, security, and decentralization—while addressing its latency and scalability issues, it could become the vaunted enterprise tool it was initially intended. That day will soon come courtesy of Directed Acyclic Graphs (DAGs).

Blockchain's premise is straightforward, utilitarian, and more lucrative than that of any other new technology to recently emerge. This distributed ledger system promises near real-time updates of transactions between remote parties for trustworthy, impenetrable peer-to-peer networks, eliminating the need (and expense) of middlemen.

Read the full article at Crypto Slate.

Venture Beat Features Montefiore's Healthcare project with AllegroGraph

From VentureBeat August 2018

This article discusses Montefiore's PALM project that uses AllegroGraph:

> *Montefiore is one of the largest employers in New York State. It's also one of the busiest health care complexes – hundreds of thousands of patients pass through its sprawling campuses, which include Montefiore Medical Center, the Albert Einstein College of Medicine, and Montefiore Medical Park.*
>
> *Those logistical challenges catalyzed the development of Montefiore's Patient-centered Analytical Learning Machine (PALM), a machine learning platform built from the ground up to predict and prevent life-threatening medical conditions and minimize wait times.*

> *PALM juggles lots of datasets — electronic medical records, insurance billing codes, drug databases, and clinical trial results, to name a few. And its analytical models recently expanded to handle voice, images, and sensor inputs from internet of things devices.*
>
> *Core to the semantic graph model are triplestores, which are a type of database optimized for filing away and retrieving triples. They're an entity composed of subject-predicate-object — "John has tuberculosis," for example — which PALM builds dynamically, as needed. Along the way, the system uses a frame data language, or FDL, to resolve ambiguities, like when some electronic records refer to medication by its brand instead of by its scientific name (e.g., "Advil" or "Motrin" instead of ibuprofen).*

Read the full article over at Venture Beat.

Navigating time in knowledge graphs

Franz's CEO, Jans Aasman, recently wrote the following article for InfoWorld.

> *The temporal benefits of cognitive knowledge graphs can affect almost any business problem, including basic issues of data management such as data quality, data cleansing, and*

integration

The concept of time presents several distinct challenges for data management, particularly as it applies to databases or stores. Those difficulties are related to the nature of time, which is ongoing, and its expressions in repositories. The former means data are relevant both at state (a point in time) and over periods of time, which increases the complexity.

Read the Full Article

Optimizing Fraud Management with AI Knowledge Graphs

From Global Banking and Finance Review – July 12, 2018

This article discusses Knowledge Graphs for Anti-Money Laundering (AML), Suspicious Activity Reports (SAR), counterfeiting and social engineering falsities, as well as synthetic, first-party, and card-not-present fraud.

By compiling fraud-related data into an AI knowledge graph, risk management personnel can also triage those alerts for the right action at the right time. They also get the additive benefit of reusing this graph to decrease other risks for security, loans, or additional financial purposes.

Dr. Aasman goes on to note:

By incorporating AI, these threat maps yields a plethora of information for actually preventing fraud. Supervised *learning methods can readily identify what events constitute fraud and which don't; many of these involve classic machine learning. Unsupervised learning capabilities are influential in determining normal user behavior then pinpointing anomalies contributing to fraud. Perhaps the most effective way AI underpins risk management knowledge graphs is in predicting the likelihood—and when—a specific fraud instance will take place. Once organizations have data for customers, events, and fraud types over a length of time (which could be in as little as a month in the rapidly evolving financial crimes space), they can compute the co-occurrence between events and fraud types.*

Read the full article over at Global Banking and Finance Review.

The Most Secure Graph Database Available

Triples offer a way of describing model elements and relationships between them. In come cases, however, it is also convenient to be able to store data that is associated with a triple as a whole rather than with a particular element. For instance one might wish to record the source from which a triple has been imported or access level necessary to include it in query results. Traditional solutions of this problem include using graphs, RDF reification or triple IDs. All of these approaches suffer from various flexibility and performance issues. For this reason AllegroGraph offers an alternative: triple attributes.

Attributes are key-value pairs associated with a triple. Keys refer to attribute definitions that must be added to the store before they are used. Values are strings. The set of legal values of an attribute can be constrained by the definition of that attribute. It is possible to associate multiple values of a given attribute with a single triple.

Possible uses for triple attributes include:

- *Access control: It is possible to instruct AllegroGraph to prevent an user from accessing triples with certain attributes.*
- *Sharding: Attributes can be used to ensure that related triples are always placed in the same shard when AllegroGraph acts as a distributed triple store.*

Like all other triple components, attribute values are immutable. They must be provided when the triple is added to the store and cannot be changed or removed later.

To illustrate the use of triple attributes we will construct an artificial data set containing a log of information about contacts detected by a submarine at a single moment in time.

Managing attribute definitions

Before we can add triples with attributes to the store we must create appropriate attribute definitions.
First let's open a connection

```
from franz.openrdf.connect import ag_connect

conn = ag_connect('python-tutorial', create=True, clear=True)
```

Attribute definitions are represented by **`AttributeDefinition`** objects. Each definition has a name, which must be unique, and a few optional properties (that can also be passed as constructor arguments):

- *`allowed_values`: a list of strings. If this property is set then only the values from this list can be used for the defined attribute.*
- *`ordered`: a boolean. If true then attribute value comparisons will use the ordering defined by `allowed_values`. The default is false.*
- *`minimum_number`, `maximum_number`: integers that can be used to constrain the cardinality of an attribute. By default there are no limits.*

Let's define a few attributes that we will later use to demonstrate various attribute-related capabilities of AllegroGraph. To do this, we will use the **`setAttributeDefinition()`** method of the connection object.

```
from franz.openrdf.repository.attributes import AttributeDefinition

# A simple attribute with no constraints governing the set
# of legal values or the number of values that can be
# associated with a triple.
tag = AttributeDefinition(name='tag')

# An attribute with a limited set of legal values.
# Every bit of data can come from multiple sources.
# We encode this information in triple attributes,
# since it refers to the tripe as a whole. Another
# way of achieving this would be to use triple ids
# or RDF reification.
source = AttributeDefinition(
    name='source',
    allowed_values=['sonar', 'radar', 'esm', 'visual'])
```

```
# Security level - notice that the values are ordered
# and each triple *must* have exactly one value for
# this attribute. We will use this to prevent some
# users from accessing classified data.
level = AttributeDefinition(
    name='level',
    allowed_values=['low', 'medium', 'high'],
    ordered=True,
    minimum_number=1,
    maximum_number=1)

# An attribute like this could be used for sharding.
# That would ensure that data related to a particular
# contact is never partitioned across multiple shards.
# Note that this attribute is required, since without
# it an attribute-sharded triple store would not know
# what to do with a triple.
contact = AttributeDefinition(
    name='contact',
    minimum_number=1,
    maximum_number=1)

# So far we have created definition objects, but we
# have not yet sent those definitions to the server.
# Let's do this now.
conn.setAttributeDefinition(tag)
conn.setAttributeDefinition(source)
conn.setAttributeDefinition(level)
conn.setAttributeDefinition(contact)

# This line is not strictly necessary, because our
# connection operates in autocommit mode.
# However, it is important to note that attribute
# definitions have to be committed before they can
# be used by other sessions.
conn.commit()
```

It is possible to retrieve the list of attribute definitions from a repository by using the **getAttributeDefinitions()** method:

```
for attr in conn.getAttributeDefinitions():
    print('Name: {0}'.format(attr.name))
    if attr.allowed_values:
        print('Allowed values: {0}'.format(
            ', '.join(attr.allowed_values)))
        print('Ordered: {0}'.format(
            'Y' if attr.ordered else 'N'))
    print('Min count: {0}'.format(attr.minimum_number))
    print('Max count: {0}'.format(attr.maximum_number))
```

```
    print()
```

Notice that in cases where the maximum cardinality has not been explicitly defined, the server replaced it with a default value. In practice this value is high enough to be interpreted as ‘no limit’.

```
Name: tag
Min count: 0
Max count: 1152921504606846975

Name: source
Allowed values: sonar, radar, esm, visual
Min count: 0
Max count: 1152921504606846975
Ordered: N

Name: level
Allowed values: low, medium, high
Ordered: Y
Min count: 1
Max count: 1

Name: contact
Min count: 1
Max count: 1
```

Attribute definitions can be removed (provided that the attribute is not used by the static attribute filter, which will be discussed later) by calling **deleteAttributeDefinition()**:

```
conn.deleteAttributeDefinition('tag')
defs = conn.getAttributeDefinitions()
print(', '.join(sorted(a.name for a in defs)))
```

```
contact, level, source
```

Adding triples with attributes

Now that the attribute definitions have been established we can demonstrate the process of adding triples with attributes. This can be achieved using various methods. A common element of all these methods is the way in which triple attributes are represented. In all cases dictionaries with attribute names as

keys and strings or lists of strings as values are used.
When **addTriple()** is used it is possible to pass attributes in a keyword parameter, as shown below:

```
ex = conn.namespace('ex://')
conn.addTriple(ex.S1, ex.cls, ex.Udaloy, attributes={
    'source': 'sonar',
    'level': 'low',
    'contact': 'S1'
})
```

The **addStatement()** method works in similar way. Note that it is not possible to include attributes in the **Statement** object itself.

```
from franz.openrdf.model import Statement

s = Statement(ex.M1, ex.cls, ex.Zumwalt)
conn.addStatement(s, attributes={
    'source': ['sonar', 'esm'],
    'level': 'medium',
    'contact': 'M1'
})
```

When adding multiple triples with **addTriples()** one can add a fifth element to each tuple to represent attributes. Let us illustrate this by adding an aircraft to our dataset.

```
conn.addTriples(
    [(ex.R1, ex.cls, ex['Ka-27'], None,
      {'source': 'radar',
       'level': 'low',
       'contact': 'R1'}),
     (ex.R1, ex.altitude, 200, None,
      {'source': 'radar',
       'level': 'medium',
       'contact': 'R1'})])
```

When all or most of the added triples share the same attribute set it might be convenient to use the `attributes` keyword parameter. This provides default values, but is completely ignored for all tuples that already contain attributes (the dictionaries are not merged). In the example below we add a triple representing an aircraft carrier and a few more triples that specify its position. Notice that the first triple has a lower security level and multiple sources. The common ‘contact’ attribute could be used to ensure that all this data will remain on a single shard.

```
conn.addTriples(
    [(ex.M2, ex.cls, ex.Kuznetsov, None, {
        'source': ['sonar', 'radar', 'visual'],
        'contact': 'M2',
        'level': 'low',
     }),
     (ex.M2, ex.position, ex.pos343),
     (ex.pos343, ex.x, 430.0),
     (ex.pos343, ex.y, 240.0)],
    attributes={
       'contact': 'M2',
       'source': 'radar',
       'level': 'medium'
    })
```

Another method of adding triples with attributes is to use the NQX file format. This works both with **addFile()** and **addData()** (illustrated below):

```
from franz.openrdf.rio.rdfformat import RDFFormat

conn.addData('''
    <ex://S2> <ex://cls> <ex://Alpha> \
    {"source": "sonar", "level": "medium", "contact": "S2"} .
    <ex://S2> <ex://depth> "300" \
    {"source": "sonar", "level": "medium", "contact": "S2"} .
    <ex://S2> <ex://speed_kn> "15.0" \
    {"source": "sonar", "level": "medium", "contact": "S2"} .
''', rdf_format=RDFFormat.NQX)
```

When importing from a format that does not support attributes, it is possible to provide a common set of attribute values with a keyword parameter:

```
from franz.openrdf.rio.rdfformat import RDFFormat

conn.addData('''
    <ex://V1> <ex://cls> <ex://Walrus> ;
              <ex://altitude> 100 ;
              <ex://speed_kn> 12.0e+8 .
    <ex://V2> <ex://cls> <ex://Walrus> ;
              <ex://altitude> 200 ;
              <ex://speed_kn> 12.0e+8 .
    <ex://V3> <ex://cls> <ex://Walrus> ;
              <ex://altitude> 300;
              <ex://speed_kn> 12.0e+8 .
    <ex://V4> <ex://cls> <ex://Walrus> ;
              <ex://altitude> 400 ;
```

```
                <ex://speed_kn> 12.0e+8 .
        <ex://V5> <ex://cls> <ex://Walrus> ;
                <ex://altitude> 500 ;
                <ex://speed_kn> 12.0e+8 .
        <ex://V6> <ex://cls> <ex://Walrus> ;
                <ex://altitude> 600 ;
                <ex://speed_kn> 12.0e+8 .
    ''', attributes={
        'source': 'visual',
        'level': 'high',
        'contact': 'a therapist'})
```

The data above represents six visually observed Walrus-class submarines, flying at different altitudes and well above the speed of light. It has been highly classified to conceal the fact that someone has clearly been drinking while on duty – after all there are only four Walrus-class submarines currently in service, so the observation is obviously incorrect.

Retrieving attribute values

We will now print all the data we have added to the store, including attributes, to verify that everything worked as expected. The only way to do that is through a SPARQL query using the appropriate magic property to access the attributes. The query below binds a literal containing a JSON representation of triple attributes to the *?a* variable:

```
import json

r = conn.executeTupleQuery('''
   PREFIX attr: <http://franz.com/ns/allegrograph/6.2.0/>
   SELECT ?s ?p ?o ?a {
       ?s ?p ?o .
       ?a attr:attributes (?s ?p ?o) .
   } ORDER BY ?s ?p ?o''')
with r:
    for row in r:
        print(row['s'], row['p'], row['o'])
        print(json.dumps(json.loads(row['a'].label),
                         sort_keys=True,
                         indent=4))
```

The result contains all the expected triples with pretty-printed attributes.

```
<ex://M1> <ex://cls> <ex://Zumwalt>
{
    "contact": "M1",
    "level": "medium",
    "source": [
        "esm",
        "sonar"
    ]
}
<ex://M2> <ex://cls> <ex://Kuznetsov>
{
    "contact": "M2",
    "level": "low",
    "source": [
        "visual",
        "radar",
        "sonar"
    ]
}
<ex://M2> <ex://position> <ex://pos343>
{
    "contact": "M2",
    "level": "medium",
    "source": "radar"
}
<ex://R1> <ex://altitude> "200"^^...
{
    "contact": "R1",
    "level": "medium",
    "source": "radar"
}
<ex://R1> <ex://cls> <ex://Ka-27>
{
    "contact": "R1",
    "level": "low",
    "source": "radar"
}
<ex://S1> <ex://cls> <ex://Udaloy>
{
    "contact": "S1",
    "level": "low",
    "source": "sonar"
}
<ex://S2> <ex://cls> <ex://Alpha>
{
    "contact": "S2",
    "level": "medium",
    "source": "sonar"
}
<ex://S2> <ex://depth> "300"
```

```
{
    "contact": "S2",
    "level": "medium",
    "source": "sonar"
}
<ex://S2> <ex://speed_kn> "15.0"
{
    "contact": "S2",
    "level": "medium",
    "source": "sonar"
}
<ex://V1> <ex://altitude> "100"^^...
{
    "contact": "a therapist",
    "level": "high",
    "source": "visual"
}
<ex://V1> <ex://cls> <ex://Walrus>
{
    "contact": "a therapist",
    "level": "high",
    "source": "visual"
}
<ex://V1> <ex://speed_kn> "1.2E9"^^...
{
    "contact": "a therapist",
    "level": "high",
    "source": "visual"
}
...
<ex://pos343> <ex://x> "4.3E2"^^...
{
    "contact": "M2",
    "level": "medium",
    "source": "radar"
}
<ex://pos343> <ex://y> "2.4E2"^^...
{
    "contact": "M2",
    "level": "medium",
    "source": "radar"
}
```

Attribute filters

Triple attributes can be used to provide fine-grained access control. This can be achieved by using static attribute filters.

Static attribute filters are simple expressions that control which triples are visible to a query based on triple attributes. Each repository has a single, global attribute filter that can be modified using **setAttributeFilter()**. The values passed to this method must be either strings (the syntax is described in the documentation of static attribute filters) or filter objects.
Filter objects are created by applying set operators to 'attribute sets'. These can then be combined using filter operators.
An attribute set can be one of the following:

- *a string or a list of strings: represents a constant set of values.*
- *TripleAttribute.name: represents the value of the name attribute associated with the currently inspected triple.*
- *UserAttribute.name: represents the value of the name attribute associated with current query. User attributes will be discussed in more detail later.*

Available set operators are shown in the table below. All classes and functions mentioned here can be imported from the `franz.openrdf.repository.attributes` package:

Syntax	Meaning
`Empty(x)`	True if the specified attribute set is empty.
`Overlap(x, y)`	True if there is at least one matching value between the two attribute sets.
`Subset(x, y)`, `x << y`	True if every element of *x* can be found in *y*
`Superset(x, y)`, `x >> y`	True if every element of *y* can be found in *x*
`Equal(x, y)`, `x == y`	True if *x* and *y* have exactly the same contents.

Syntax	Meaning
`Lt(x, y)`, `x < y`	True if both sets are singletons, at least one of the sets refers to a triple or user attribute, the attribute is ordered and the value of the single element of *x* occurs before the single value of *y* in the `lowed_values` list of the attribute.
`Le(x, y)`, `x <= y`	True if *y* < *x* is false.
`Eq(x, y)`	True if both *x* < *y* and *y* < *x* are false. Note that using the == Python operator translates to*Eqauls*, not *Eq*.
`Ge(x, y)`, `x >= y`	True if *x* < *y* is false.
`Gt(x, y)`, `x > y`	True if *y* < *x*.

Note that the overloaded operators only work if at least one of the attribute sets is a `UserAttribute` or `TripleAttribute` reference – if both arguments are strings or lists of strings the default Python semantics for each operator are used. The prefix syntax always produces filters.

Filters can be combined using the following operators:

<table>
<tr><th>Syntax</th><th>Meaning</th></tr>
<tr><td><code>Not(x)</code>, <code>~x</code></td><td>Negates the meaning of the filter.</td></tr>
<tr><td><code>And(x, y, ...)</code>, <code>x & y</code></td><td>True if all subfilters are true.</td></tr>
<tr><td><code>Or(x, y, ...)</code>, <code>x | y</code></td><td>True if at least one subfilter is true.</td></tr>
</table>

Filter operators also work with raw strings, but overloaded operators will only be recognized if at least one argument is a filter object.

Using filters and user attributes

The example below displays all classes of vessels from the dataset after establishing a static attribute filter which ensures that only sonar contacts are visible:

```
from franz.openrdf.repository.attributes import *

conn.setAttributeFilter(TripleAttribute.source >> 'sonar')
conn.executeTupleQuery(
    'select ?class { ?s <ex://cls> ?class } order by ?class',
    output=True)
```

The output contains neither the visually observed Walruses nor the radar detected ASW helicopter.

```
------------------
| class          |
==================
| ex://Alpha     |
| ex://Kuznetsov |
| ex://Udaloy    |
| ex://Zumwalt   |
------------------
```

To avoid having to set a static filter before each query (which would be inefficient and cause concurrency issues) we can employ user attributes. User attributes are specific to a particular connection and are sent to the server with each query. The static attribute filter can refer to these and compare them with triple attributes. Thus we can use code presented below to create a filter which ensures that a connection only accesses data at or below the chosen clearance level.

```
conn.setUserAttributes({'level': 'low'})
conn.setAttributeFilter(
    TripleAttribute.level <= UserAttribute.level)
conn.executeTupleQuery(
    'select ?class { ?s <ex://cls> ?class } order by ?class',
    output=True)
```

We can see that the output here contains only contacts with the access level of *low*. It omits the destroyer and Alpha submarine (these require *medium* level) as well as the top-secret Walruses.

```
------------------
| class          |
==================
| ex://Ka-27     |
| ex://Kuznetsov |
| ex://Udaloy    |
------------------
```

The main advantage of the code presented above is that the filter can be set globally during the application setup and access control can then be achieved by varying user attributes on connection objects.
Let us now remove the attribute filter to prevent it from interfering with other examples. We will use the **clearAttributeFilter()** method.

```
conn.clearAttributeFilter()
```

It might be useful to change connection’s attributes temporarily for the duration of a single code block and restore prior attributes after that. This can be achieved using the **temporaryUserAttributes()** method, which returns a context manager. The example below illustrates its use. It also shows how to use **getUserAttributes()** to inspect user attributes.

```
with conn.temporaryUserAttributes({'level': 'high'}):
    print('User attributes inside the block:')
    for k, v in conn.getUserAttributes().items():
        print('{0}: {1}'.format(k, v))
    print()
print('User attributes outside the block:')
for k, v in conn.getUserAttributes().items():
    print('{0}: {1}'.format(k, v))
```

```
User attributes inside the block:
level: high

User attributes outside the block:
level: low »
```

Semantic Graph Analytics Can

Propel The Advent of ‘Personalized Medicine’

From Health IT Outcomes:

Analyzing massive stores of medical data can be overwhelming. Still, it’s an important mission: data analysis could provide new, more tailored treatments. Terms like “personalized medicine,” “precision medicine,” and “individualized medicine” all refer to a data-driven approach toward to goal of customizing medical treatment for every patient’s unique genetic and molecular composition. However noble, that goal is somewhat limited.

Personalized medicine, often described as a way to provide “the right patient with the right drug at the right dose at the right time,” in fact goes beyond custom treatment — it encompasses the entire healthcare process, from prevention, to treatment, to disease management, and considers each patient as an individual.

Read the full article:

Franz Inc. and The Wroclaw Institute of Spatial Information and Artificial Intelligence (The Wroclaw

Institute) team up to deliver graph and A.I. solutions in Poland

A Wroclaw Institute News Release

OAKLAND, Calif. – March 15, 2016 – We are pleased to inform that Wroclaw Institute has been appointed as a partner by Franz Inc.– world's leading producer of semantic graph technologies. The agreement grants to Wroclaw Institute exclusive right to sell Franz's – AllegroGraph family of products for territory of Poland. AllegroGraph is best in class graph database, fully supporting W3C standards adopted by start-up's as well as vast number of Fortune 100 companies. AllegroGraph is a part of Big Data ecosystem as it could be integrated with Apache Hadoop and Amazon EC2.

The Wroclaw Institute CEO – Dr. Adam Iwaniak said "Partnership with Franz Inc. is a turning point for our company as semantic graph technology is gaining a lot of market attention in 'data tsunami' era. We are happy that we will be able to provide our customers with award winning solution to help them manage their complex data resources. Moreover I'd like to emphasize that as a company we made a big progress in leveraging RDF graphs technologies also on our basic market – geoinformatics".

"We are excited about the opportunity to work with Dr. Iwaniak and the Wroclaw Institute team to demonstrate why Graph Databases deliver new, real time decision making capabilities for the Enterprise." said Dr. Jans Aasman, CEO, Franz Inc., "Organizations across Poland will benefit from AllegroGraph's ability to link highly complex data, generating new knowledge and insight for a significant competitive advantage."

AllegroGraph is a database technology that enables businesses to extract sophisticated decision insights and predictive analytics from their highly complex, distributed data that can’t be answered with conventional databases. Unlike traditional relational databases, Franz’s product AllegroGraph employs a combination of semantic, graph and spatial technologies that process data with contextual and conceptual intelligence. AllegroGraph is able to run queries of unprecedented complexity to support predictive analytics that help companies make better, real-time decisions.

AllegroGraph is commonly used in defense and intelligence, banking, and insurance, pharmaceutical, and healthcare, Linked Data publishing, as well as by organization dealing with complex, constantly changing knowledge bases.

About Franz Inc.

Franz Inc. is a leading vendor of semantic technology tools featuring AllegroGraph – high-performance, scalable, disk-based graph database, provides the solid storage layer for powerful GeoTemporal Reasoning, Social Network Analytics and Ontology Modeling. Based in Oakland, California, Franz Inc. is an American owned company that delivers leading-edge development products that enable software developers to build flexible, scalable, semantic applications quickly and cost-effectively.

About The Wroclaw Institute

The Wroclaw Institute of Spatial Information and Artificial Intelligence is Wroclaw, Poland based technology company focused on knowledge engineering, data exploration and intelligent GIS providing products, services and solutions based on cutting-edge scientific and technological achievements.

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