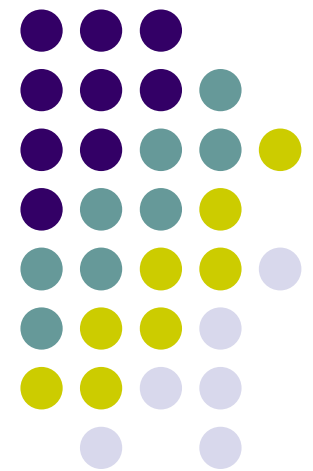


SparQL and the FMA

Non-Materialized Ontology Views

Todd Detwiler
UW - SIG





FMA SparQL Service

- Uses the FMA in OWL
 - N. F. Noy, D. L. Rubin. Translating the Foundational Model of Anatomy into OWL. 2007.
- Uses Jena API
- Uses persistent storage backend
- Does not use any OWL inference

SELECT Query



Enter SparQL query:

```
PREFIX dl: <http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#>
PREFIX rdfs:<http://www.w3.org/2000/01/rdf-schema#>
PREFIX rdf:<http://www.w3.org/1999/02/22-rdf-syntax-ns#>

SELECT ?esoph_continuity
WHERE
{
  dl:Esophagus dl:continuous_with ?esoph_continuity .
}
```

Submit Query



SELECT Query

Enter SparQL query:

```
PREFIX dl: <http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#>  
PREFIX rdfs:<http://www.w3.org/2000/01/rdf-schema#>  
PREFIX rdf:<http://www.w3.org/1999/02/22-rdf-syntax-ns#>
```

```
SELECT ?esoph_continuity  
WHERE  
{  
  dl:Esophagus dl:continuous_with ?esoph_continuity .  
}
```

Submit Query

SELECT Results

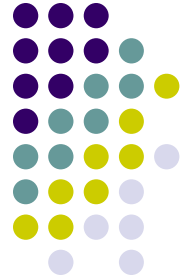


```
-----  
| esoph_continuity |  
=====
```

dl:Stomach	
dl:Pharynx	

```
-----
```

CONSTRUCT Query



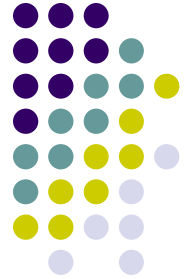
Enter SparQL query:

```
PREFIX dl: <http://bioontology.org/projects/ontologies/fma/fmaOw1D1Component_1_4_0#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>

CONSTRUCT
{
  dl:Heart dl:part ?object .
  dl:Heart dl:FMAID ?id .
}
WHERE
{
  dl:Heart dl:part ?object .
  dl:Heart dl:FMAID ?id .
}
```

Submit Query

CONSTRUCT Query



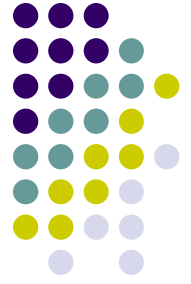
Enter SparQL query:

```
PREFIX dl: <http://bioontology.org/projects/ontologies/fma/fmaOw1D1Component_1_4_0#>  
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>  
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
```

```
CONSTRUCT  
{  
  dl:Heart dl:part ?object .  
  dl:Heart dl:FMAID ?id .  
}  
WHERE  
{  
  dl:Heart dl:part ?object .  
  dl:Heart dl:FMAID ?id .  
}
```

Submit Query

CONSTRUCT Results



```
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:dl="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#"
  xmlns="http://bioontology.org/projects/ontologies/fma/fmaOwlFullComponent_1_4_0#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:daml="http://www.daml.org/2001/03/daml+oil#" >
<rdf:Description rdf:about="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Heart">
  <dl:part rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Tricuspid_valve"/>
  <dl:part rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Mid_zone_of_heart"/>
  <dl:part rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Cavity_of_right_ventricle"/>
  <dl:part rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Left_ventricle"/>
  <dl:part rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Mitral_valve"/>
  <dl:part rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Systemic_capillary_bed_of_he"/>
  <dl:part rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Middle_cardiac_vein"/>
  <dl:part rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Right_coronary_artery"/>
  <dl:part rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Lymphatic_capillary_bed_of_r"/>
  <dl:part rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Small_cardiac_vein"/>
  <dl:part rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Left_side_of_heart"/>
  <dl:part rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Interventricular_septum"/>
  <dl:part rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Right_side_of_heart"/>
```


DESCRIBE Query



Enter SparQL query:

```
PREFIX d1: <http://bioontology.org/projects/ontologies/fma/fmaOwlD1Component_1_4_0#>
PREFIX rdfs:<http://www.w3.org/2000/01/rdf-schema#>
PREFIX rdf:<http://www.w3.org/1999/02/22-rdf-syntax-ns#>

DESCRIBE ?ae
WHERE
{
  ?cn d1:name ?name .
  FILTER regex(?name, 'right lung', 'i') .
  (?ae d1:Synonym ?cn) UNION (?ae d1:Non_English_equivalent ?cn)
  UNION (?ae d1:Preferred_name ?cn) .
}
```

Submit Query



DESCRIBE Query

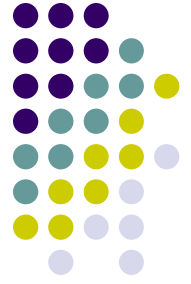
Enter SparQL query:

```
PREFIX dl: <http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#>  
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>  
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
```

```
DESCRIBE ?ae  
WHERE  
{  
  ?cn dl:name ?name .  
  FILTER regex(?name, 'right lung', 'i') .  
  {?ae dl:Synonym ?cn} UNION {?ae dl:Non_English_equivalent ?cn}  
  UNION {?ae dl:Preferred_name ?cn} .  
}
```

Submit Query

DESCRIBE Results



```
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:dl="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#"
  xmlns="http://bioontology.org/projects/ontologies/fma/fmaOwlFullComponent_1_4_0#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:daml="http://www.daml.org/2001/03/daml+oil#" >
<rdf:Description rdf:about="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Pleura_of_anterior_part_of_peripheral
<rdfs:subClassOf rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Pleura_of_anterior_part_of_perip
<rdfs:label xml:lang="en">Pleura of anterior part of peripheral diaphragmatic surface of right lung</rdfs:label>
<rdf:type rdf:resource="http://www.w3.org/2002/07/owl#Class"/>
<dl:Preferred_name rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#KB_INSTANCE_65998"/>
<dl:FMAID rdf:datatype="http://www.w3.org/2001/XMLSchema#string">52382</dl:FMAID>
<rdf:type rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Pleura_of_anterior_part_of_peripheral_d
</rdf:Description>
<rdf:Description rdf:about="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Intrasegmental_tributary_of_right_sup
<rdfs:label xml:lang="en">Intrasegmental tributary of right superior segmental vein</rdfs:label>
<dl:Preferred_name rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#KB_INSTANCE_06362"/>
<rdf:type rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Intrasegmental_tributary_of_superior_se
<dl:Synonym rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#su_incus_32436"/>
<dl:Synonym rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#KB_INSTANCE_06365"/>
<rdf:type rdf:resource="http://www.w3.org/2002/07/owl#Class"/>
<dl:tributary_of rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Right_superior_segmental_vein"/>
<dl:Synonym rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#KB_INSTANCE_06364"/>
<dl:FMAID rdf:datatype="http://www.w3.org/2001/XMLSchema#string">8686</dl:FMAID>
<dl:Non_English_equivalent rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#su_incus_37246"/>
<dl:Synonym rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#KB_INSTANCE_06363"/>
<rdfs:subClassOf rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Intrasegmental_tributary_of_supe
```

DESCRIBE Results

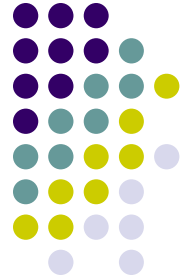


```
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:di="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#"
  xmlns="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#"
```

```
<rdf:Description rdf:about="...#Anterior_surface_of_lobe_of_right_lung">
  <rdfs:subClassOf rdf:resource="...#Anterior_surface_of_lobe_of_lung"/>
  <rdfs:label xml:lang="en">Anterior surface of lobe of right lung</rdfs:label>
  <rdf:type rdf:resource="...#Class"/>
  <di:Preferred_name rdf:resource="...#KB_INSTANCE_33014"/>
  <di:FMAID rdf:datatype="...#string">26298</di:FMAID>
  <rdf:type rdf:resource="...#Anterior_surface_of_lobe_of_lung"/>
</rdf:Description>
```

```
<di:tributary_of rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Right_superior_segmental_vein"/>
<di:Synonym rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#KB_INSTANCE_06364"/>
<di:FMAID rdf:datatype="http://www.w3.org/2001/XMLSchema#string">8686</di:FMAID>
<di:Non_english_equivalent rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#su_incus_37246"/>
<di:Synonym rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#KB_INSTANCE_06363"/>
<rdfs:subClassOf rdf:resource="http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#Intrasegmental_tributary_of_supe
```

ASK Query



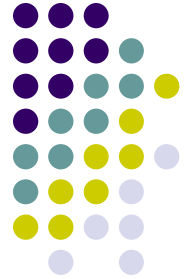
Enter SparQL query:

```
PREFIX dl: <http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#>
PREFIX rdfs:<http://www.w3.org/2000/01/rdf-schema#>
PREFIX rdf:<http://www.w3.org/1999/02/22-rdf-syntax-ns#>

ASK
WHERE
{
  dl:Esophagus dl:continuous_with dl:Stomach .
}
```

Submit Query

ASK Query



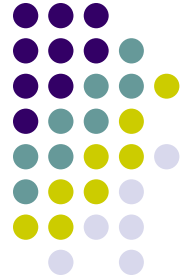
Enter SparQL query:

```
PREFIX dl: <http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#>  
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>  
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
```

```
ASK  
WHERE  
{  
  dl:Esophagus    dl:continuous_with dl:Stomach .  
}
```

Submit Query

ASK Results



true

DXBrain



[Home](#)

The DXBrain Project

• Brain Data Integration with XQuery

[Log Out](#)

Title (max 200 chars):

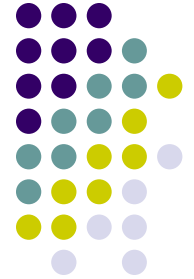
P50 all site labels, augmented with FMAIDs

Description (max 400 chars):

Query demonstrating integration of [CSM](#) and [FMA-OWL](#)

Query

```
let $csm_results :=
dxq:csm(
<results>
{
let $pnum := 50
for $p in $pw/patient
let $anm := $p/surgery/anatomytonamemap[preference=1]
where $p/pnum = $pnum
return
<patient>
{ $p/pnum }
{
for $anmel in $anm/anatomytonamemapelement
return
<site>
<site_label>{ $anmel/stimsite/site_label/text() } </site_label>
<name>{ $anmel/term/fullname/text() } </name>
</site>
}
}
</patient>
}
</results>
")
```



DXBrain and FMA Service

The DXBrain Project

Brain Data Integration with XQuery

[Home](#)

[Log Out](#)

```
let $fma_query :=
  concat(
    "PREFIX dl: <http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#>
    CONSTRUCT
    {
      ?ae dl:FMAID ?fmaid .
    }
    WHERE
    {
      ?cn dl:name ?name .
      FILTER (?name = '', $site_name, '') .
      ?ae dl:Preferred_name ?cn .
      ?ae dl:FMAID ?fmaid .
    }")
let $fma_identifier := dxq:xqueryWS($wsdlURL, $serviceName, $methodName, $fma_query)
```

```
<site_label {?aname|?site|?site_label|?site_label_text}></site_label>
<name>{?aname|?term|?fullname|?text}</name>
</site>
}
</patient>
}
</results>
")
```

DXBrain and FMA Results



```
<site>
  <site_label>10</site_label>
  <name>Middle part of postcentral gyrus</name>
  <rdf:Description rdf:about="...#Middle_part_of_postcentral_gyrus">
    <dl:FMAID rdf:datatype="...#string">70693</dl:FMAID>
  </rdf:Description>
</site>
<site>
  <site_label>20</site_label>
  <name>Posterior part of middle temporal gyrus</name>
  <rdf:Description rdf:about="...#Posterior_part_of_middle_temporal_gyrus">
    <dl:FMAID rdf:datatype="...#string">70707</dl:FMAID>
  </rdf:Description>
</site>
```



Query Composition

Q1:

```
CONSTRUCT
  { $subject $relation $object }
WHERE
  { $subject rdfs:subClassOf :Organ .
    $subject $relation $object .}
```

Q2 (Q1 + V1) :

```
CONSTRUCT
  { $sub obo:has_part $part .
    $sub rdfs:subClassOf $superClass .}
WHERE
  { :Heart %p $sub .
    FILTER (regex(%p,":regional_part*","ds")) .
    $sub :regionalPart $part .
    $sub rdfs:subClassOf $superClass .
    $sub rdfs:subClassOf :Organ .
    $sub $relation $obj .}
```

V1:

```
PREFIX obo: < http://purl.org/obo/owl/>
CONSTRUCT
  { $sub obo:has_part $part .
    $sub rdfs:subClassOf $superClass .}
WHERE
  { :Heart %p $sub .
    FILTER (regex(%p,":regionalPart*","ds")) .
    $sub :regionalPart $part .
    $sub rdfs:subClassOf $superClass .}
```



Sample Dataset

sub	rel	obj
<http://example.org/book/book7>	<http://purl.org/dc/elements/1.1/title>	"Harry Potter and the Deathly Hallows"
<http://example.org/book/book7>	<http://purl.org/dc/elements/1.1/creator>	"J.K. Rowling"
_:b0	<http://www.w3.org/2001/vcard-rdf/3.0#FN>	"J.K. Rowling"
_:b0	<http://www.w3.org/2001/vcard-rdf/3.0#N>	_:b1
<http://example.org/book/book6>	<http://purl.org/dc/elements/1.1/title>	"Harry Potter and the Half-Blood Prince"
<http://example.org/book/book6>	<http://purl.org/dc/elements/1.1/creator>	"J.K. Rowling"
_:b1	<http://www.w3.org/2001/vcard-rdf/3.0#Family>	"Rowling"
_:b1	<http://www.w3.org/2001/vcard-rdf/3.0#Given>	"Joanna"
<http://example.org/book/book5>	<http://purl.org/dc/elements/1.1/title>	"Harry Potter and the Order of the Phoenix"
<http://example.org/book/book5>	<http://purl.org/dc/elements/1.1/creator>	"J.K. Rowling"
<http://example.org/book/book4>	<http://purl.org/dc/elements/1.1/title>	"Harry Potter and the Goblet of Fire"
<http://example.org/book/book3>	<http://purl.org/dc/elements/1.1/title>	"Harry Potter and the Prisoner Of Azkaban"
<http://example.org/book/book3>	<http://purl.org/dc/elements/1.1/creator>	_:b0
<http://example.org/book/book2>	<http://purl.org/dc/elements/1.1/title>	"Harry Potter and the Chamber of Secrets"
<http://example.org/book/book2>	<http://purl.org/dc/elements/1.1/creator>	_:b0
<http://example.org/book/book1>	<http://purl.org/dc/elements/1.1/title>	"Harry Potter and the Philosopher's Stone"
<http://example.org/book/book1>	<http://purl.org/dc/elements/1.1/creator>	"J.K. Rowling"



View Query

```
PREFIX books: <http://example.org/book/>
PREFIX dc:    <http://purl.org/dc/elements/1.1/>
CONSTRUCT
{
  ?sub dc:creator ?obj .
  ?sub2 dc:title ?obj2 .
}
WHERE
{
  ?sub dc:creator ?obj .
  ?sub2 dc:title ?obj2 .
  FILTER regex(?obj2, "Prince")
}
```



View Query Results

```
@prefix dc:      <http://purl.org/dc/elements/1.1/> .
@prefix :       <http://example.org/book/> .
@prefix books:  <http://example.org/book/> .
@prefix ns:     <http://example.org/ns#> .
@prefix vcard:  <http://www.w3.org/2001/vcard-rdf/3.0#> .

:book3
  dc:creator _:b2 .

:book2
  dc:creator _:b2 .

:book7
  dc:creator "J.K. Rowling" .

:book5
  dc:creator "J.K. Rowling" .

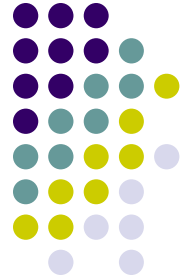
:book6
  dc:creator "J.K. Rowling" ;
  dc:title "Harry Potter and the Half-Blood Prince" .

:book1
  dc:creator "J.K. Rowling" .
```



Query on View

```
PREFIX books: <http://example.org/book/>
PREFIX dc:    <http://purl.org/dc/elements/1.1/>
CONSTRUCT
{
  ?sub ?rel ?obj .
}
WHERE
{
  ?sub dc:creator ?bound_obj .
  FILTER regex(?bound_obj, "J.K. Rowling")
  ?sub ?rel ?obj
}
```

Query Composition

CONSTRUCT

```
{  
  ?sub ?rel ?obj .  
}
```

WHERE

```
{  
  ?sub dc:creator ?obj .  
  ?sub2 dc:title ?obj2 .  
  FILTER regex(?obj2, "Prince")
```

```
  ?sub dc:creator ?bound_obj .  
  FILTER regex(?bound_obj, "J.K. Rowling") .
```

(how do we get everything there is in view about ?sub?)

```
}
```



Rewritten View Query

```
PREFIX books: <http://example.org/book/>
PREFIX dc:    <http://purl.org/dc/elements/1.1/>
CONSTRUCT {?sub ?rel ?obj}
WHERE
{
  {
    ?sub ?rel ?obj
    FILTER (?rel = dc:creator)
  }
  UNION
  {
    ?sub ?rel ?obj
    FILTER (?rel = dc:title && regex(?obj, "Prince"))
  }
}
```

Rewritten Query Composition



```
PREFIX dc:    <http://purl.org/dc/elements/1.1/>
```

```
CONSTRUCT {?sub ?rel ?obj}
```

```
WHERE
```

```
{
```

```
{
```

```
  ?sub ?rel ?obj .
```

```
  FILTER (?rel = dc:creator)
```

```
} UNION {
```

```
  ?sub ?rel ?obj .
```

```
  FILTER (?rel = dc:title && regex(?obj, "Prince"))
```

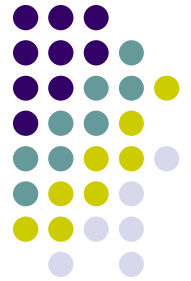
```
}
```

```
  ?sub dc:creator ?bound_obj .
```

```
  FILTER (?bound_obj = ?obj && regex(?bound_obj, "J.K. Rowling"))
```

```
}
```

Rewritten Query Composition



```
PREFIX dc:    <http://purl.org/dc/elements/1.1/>
CONSTRUCT {?sub ?rel ?obj}
WHERE
{
  {
    ?sub ?rel ?obj .
    FILTER (?rel = dc:creator)
  } UNION {
    ?sub ?rel ?obj .
    FILTER (?rel = dc:title && regex(?obj, "Prince"))
  }
  ?sub dc:creator ?bound_obj .
  FILTER (?bound_obj = ?obj && regex(?bound_obj, "J.K. Rowling"))
}
```

Problem:

?bound_obj = ?obj



Rewritten Query Results

```
@prefix dc:      <http://purl.org/dc/elements/1.1/> .
@prefix :       <http://example.org/book/> .
@prefix ns:     <http://example.org/ns#> .
@prefix vcard:  <http://www.w3.org/2001/vcard-rdf/3.0#>
```

```
:book7
```

```
    dc:creator "J.K. Rowling" .
```

```
:book5
```

```
    dc:creator "J.K. Rowling" .
```

```
:book6
```

```
    dc:creator "J.K. Rowling" ;
    dc:title "Harry Potter and the Half-Blood Prince" .
```

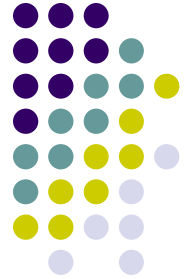
```
:book1
```

```
    dc:creator "J.K. Rowling" .
```

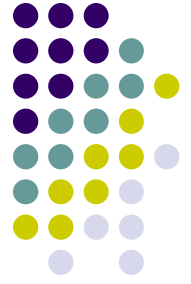
Questions?



Additional Slides



Query Rewrite



```
PREFIX books: <http://example.org/book/>
PREFIX dc:
<http://purl.org/dc/elements/1.1/>
CONSTRUCT
{
  ?sub dc:creator ?creator .
  ?sub dc:title ?title .
}
WHERE
{
  books:book7 ?relation ?object .
  ?sub ?relation ?object .
  ?sub dc:creator ?creator .
  ?sub dc:title ?title .
}
```

```
PREFIX books: <http://example.org/book/>
PREFIX dc:
<http://purl.org/dc/elements/1.1/>
CONSTRUCT { ?sub ?rel ?obj . }
WHERE
{
  books:book7 ?relation ?object .
  ?sub ?relation ?object .
  ?sub ?rel ?obj FILTER (?rel = dc:creator)
}
UNION
{
  books:book7 ?relation ?object .
  ?sub ?relation ?object .
  ?sub ?rel ?obj FILTER (?rel = dc:title) .
}
}
```