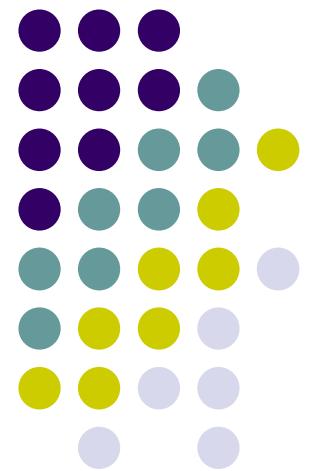


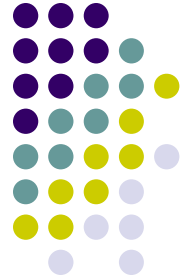
# Path Expressions in SparQL

Adding regular paths to ARQ via  
custom function

Todd Detwiler  
UW - SIG



# Sample Closure Query



```
PREFIX dl: <http://bioontology.org/projects/ontologies/fma/fmaOwIDComponent_1_4_0#>  
PREFIX ext:<java:edu.washington.sig.arq.>
```

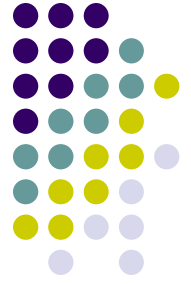
```
SELECT ?c  
WHERE  
{  
  dl:Heart ext:Closure (dl:regional_part ?c) .  
}
```



# Sample Closure Result

```
-----  
| c |  
-----  
| dl:Heart |  
| dl:Right_auricle |  
| dl:Mid_zone_of_heart |  
| dl:Outflow_part_of_left_ventricle |  
| dl:Right_atrium |  
| dl:Right_ventricle |  
| dl:T9_part_of_heart |  
| dl:Right_atrium_proper |  
| dl:Inflow_part_of_right_atrium |  
| dl:Inflow_part_of_right_ventricle |  
| dl:Mid_zone_of_left_ventricle |  
| dl:T8_part_of_heart |  
| dl:Basal_zone_of_heart |  
| dl:Inflow_part_of_left_ventricle |  
| dl:Outflow_part_of_right_ventricle |  
| dl:Left_atrium |  
| dl:Outflow_part_of_right_atrium |  
| dl:Left_auricle |  
| dl:T7_part_of_heart |  
| dl:Left_ventricle |  
| dl:Apical_zone_of_heart |  
| dl:Left_atrium_proper |  
| dl:Left_side_of_heart |  
| dl:Outflow_part_of_left_atrium |  
| dl:Inflow_part_of_left_atrium |  
| dl:Right_side_of_heart |  
| dl:T10_part_of_heart |  
-----
```

# Getting Edges in Closure



```
PREFIX dl: <http://bioontology.org/projects/ontologies/fma/fmaOwIDComponent_1_4_0#>  
PREFIX ext:<java:edu.washington.sig.arq.>
```

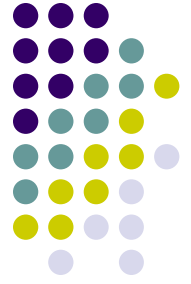
```
SELECT ?c ?d  
WHERE  
{  
  dl:Heart ext:Closure (dl:regional_part ?c) .  
  dl:Heart ext:Closure (dl:regional_part ?d) .  
  ?c dl:regional_part ?d .  
}
```



# Edges in Closure Results

c	d
dl:Heart	dl:Mid_zone_of_heart
dl:Heart	dl:T9_part_of_heart
dl:Heart	dl:T8_part_of_heart
dl:Heart	dl:Basal_zone_of_heart
dl:Heart	dl:T7_part_of_heart
dl:Heart	dl:Apical_zone_of_heart
dl:Heart	dl:Left_side_of_heart
dl:Heart	dl:Right_side_of_heart
dl:Heart	dl:T10_part_of_heart
dl:Mid_zone_of_heart	dl:Right_ventricle
dl:Mid_zone_of_heart	dl:Mid_zone_of_left_ventricle
dl:Mid_zone_of_heart	dl:Outflow_part_of_right_atrium
dl:Right_atrium	dl:Right_auricle
dl:Right_atrium	dl:Right_atrium_proper
dl:Right_atrium	dl:Inflow_part_of_right_atrium
dl:Right_atrium	dl:Outflow_part_of_right_atrium
dl:Right_ventricle	dl:Inflow_part_of_right_ventricle
dl:Right_ventricle	dl:Outflow_part_of_right_ventricle
dl:Right_atrium_proper	dl:Inflow_part_of_right_atrium
dl:Right_atrium_proper	dl:Outflow_part_of_right_atrium
dl:Basal_zone_of_heart	dl:Inflow_part_of_right_atrium

# Cycles in Closure Queries



```
PREFIX dl: <http://bioontology.org/projects/ontologies/fma/fmaOwIDComponent_1_4_0#>  
PREFIX ext:<java:edu.washington.sig.arq.>
```

```
SELECT ?c  
WHERE  
{  
  dl:Esophagus ext:Closure (dl:continuous_with ?c) .  
}
```

# Results of Closure with Cycles

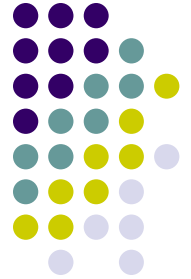


```
-----  
| c |  
=====
```

dl:Small_intestine
dl:Stomach
dl:Pharynx
dl:Esophagus

```
-----
```

# Closure with Bound Subjects



```
PREFIX dl:
<http://bioontology.org/projects/ontologies/fma/fmaOwlDIComponent_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#>
PREFIX ext:<java:edu.washington.sig.arq.>
```

```
SELECT ?ear_part
WHERE
{
  dl:Ear ext:Closure (dl:part ?ear_part).
  ?ear_part ext:Closure (rdfs:subClassOf dl:Organ) .
}
```





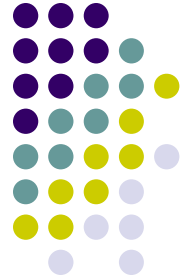
# Bound Subjects Results

```
-----  
| ear_part |  
=====
```

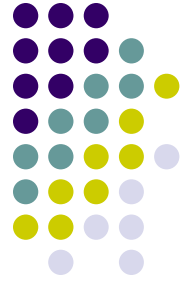
dl:Tympanic_membrane
dl:Extrinsic_auricular_muscle
dl:Incus
dl:Auricularis_superior
dl:Anterior_ligament_of_pinna
dl:Oblique_muscle_of_auricle
dl:Tragicus
dl:Articular_capsule_of_incudomalleolar_joint
dl:Stapes
dl:Intrinsic_auricular_muscle
dl:Lateral_ligament_of_malleus
dl:Antitragicus
dl:Superior_ligament_of_malleus
dl:Anterior_ligament_of_malleus
dl:Posterior_ligament_of_incus
dl:Tectorial_membrane_of_atlanto_occipital_joint
dl:Auricularis_posterior
dl:Posterior_ligament_of_pinna

```
-----
```

# Extending to Path Expressions

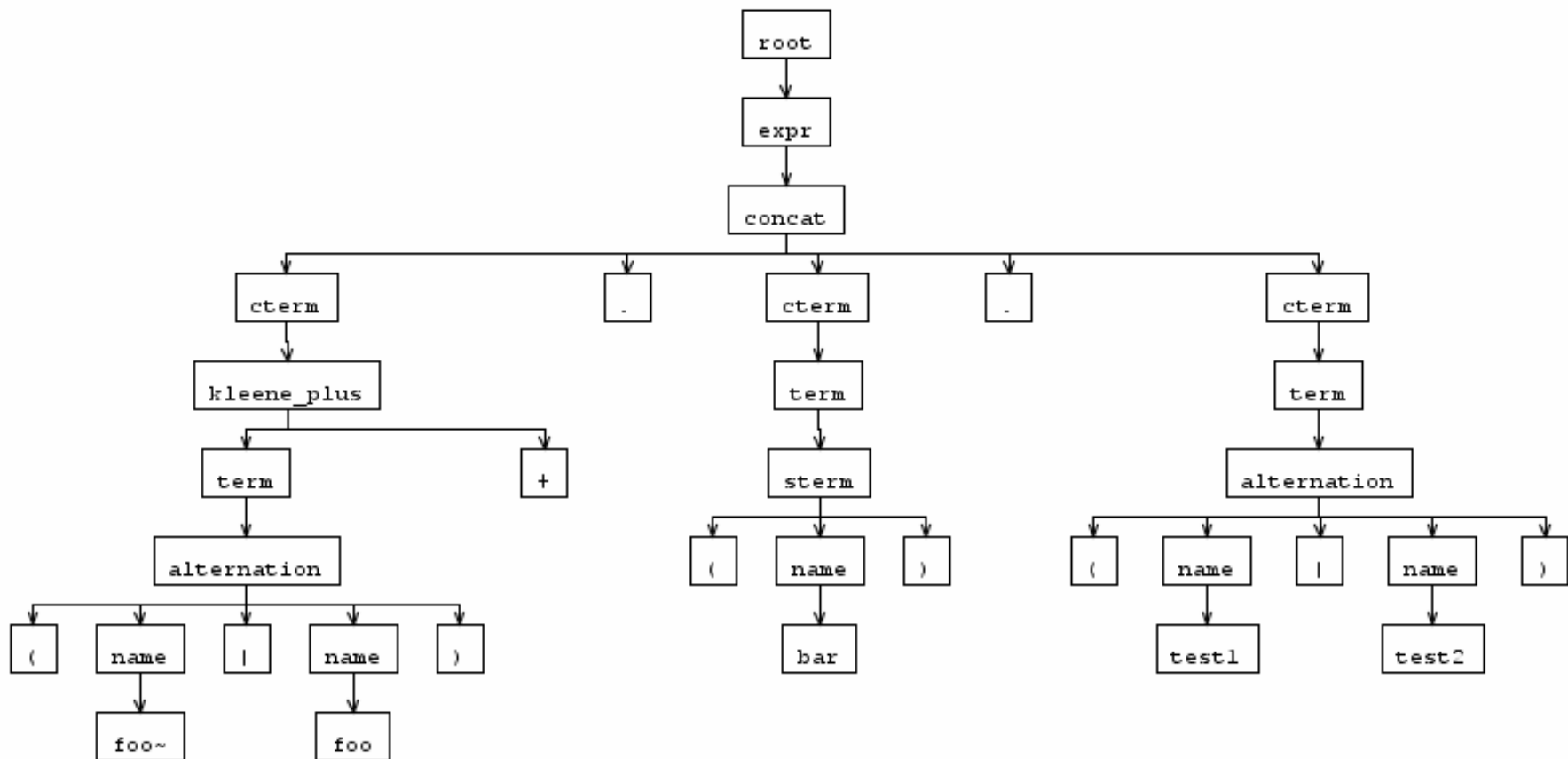


```
/*-----  
* LEXER RULES  
*-----*/  
WHITESPACE      :      ( '\t' | ' ' | '\r' | '\n' | '\u000C' )+      { $channel = HIDDEN; } ;  
REL_DELIN       :      "\";  
LBRACKET        :      '(';  
RBRACKET        :      ')';  
REL_NAME        :      (~(LBRACKET|RBRACKET|OR|PLUS|STAR|DOT))+ ;  
  
/*-----  
* PARSER RULES  
*-----*/  
expr            :      cterm|concat;  
concat          :      cterm (DOT cterm)+ -> ^(DOT cterm cterm+);  
name            :      REL_NAME;  
sterm           :      LBRACKET name RBRACKET -> name;  
alternation:    :      LBRACKET name (OR name)+ RBRACKET -> ^(OR name name+);  
term            :      sterms|alternation;  
kleene_star:    :      term STAR -> ^(STAR term);  
kleene_plus:    :      term PLUS -> ^(PLUS term);  
cterm           :      term | kleene_star | kleene_plus;
```

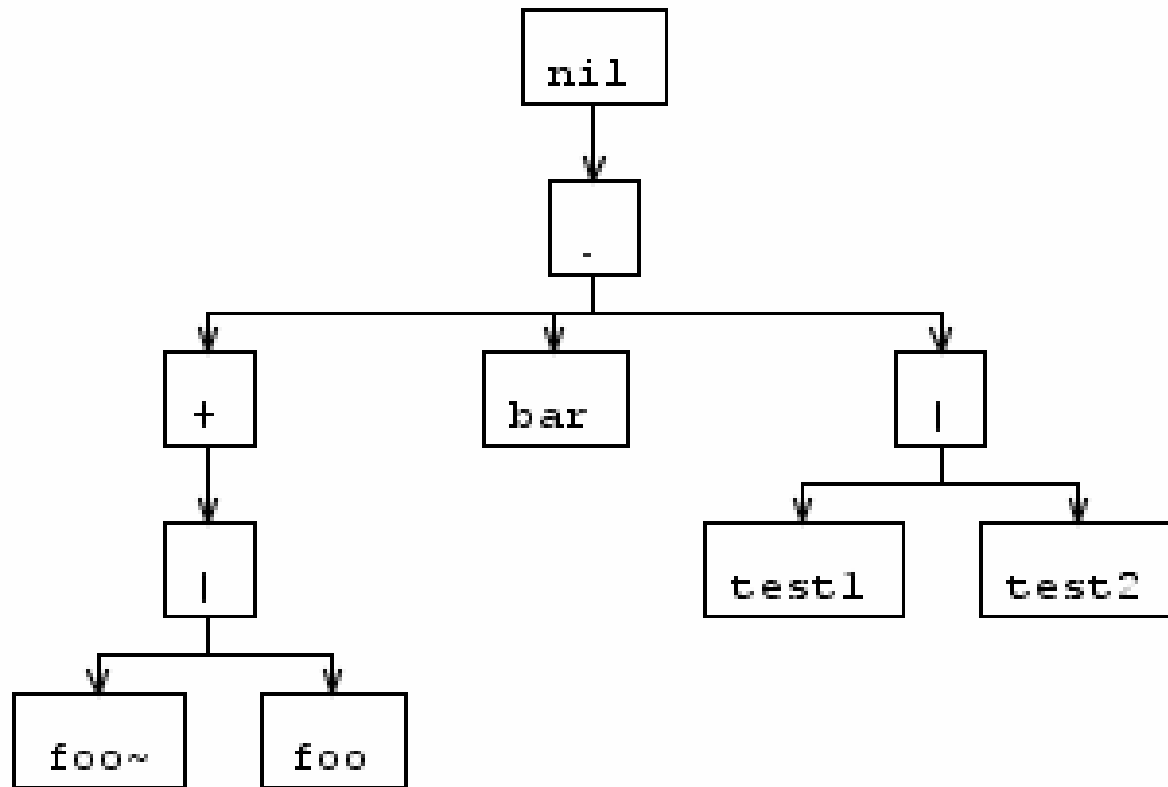
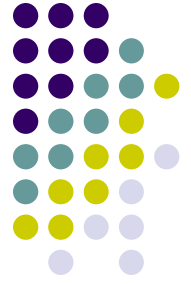


# Example Parse

INPUT: (foo~|foo)+.(bar).(test1|test2)



# Parse Tree Rewrite

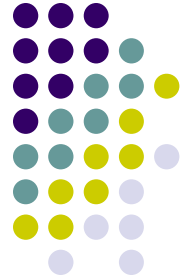


# Nodes “OnPath”



```
PREFIX dl: <http://bioontology.org/projects/ontologies/fma/fmaOwlDlComponent_1_4_0#>  
PREFIX ext:<java:edu.washington.sig.arq.>
```

```
SELECT ?heart_containments  
WHERE  
{  
  dl:Heart ext:OnPath ("(dl:regional_part|dl:constitutional_part)*.(dl:contains)"  
  ?heart_containments) .  
}
```



# Nodes “OnPath” Results

```
-----  
| heart_containments |  
=====
```

d1:Blood_in_left_ventricle
d1:Matrix_of_Golgi_vesicle
d1:Blood_in_right_ventricle
d1:Intracrystal_matrix_of_mitochondrion
d1:Blood_in_left_atrium
d1:Blood_in_coronary_artery
d1:Blood_in_right_atrium

```
-----
```

# With Property Restrictions



```
PREFIX nci: <http://ncicb.nci.nih.gov/xml/owl/EVS/Thesaurus.owl#>
PREFIX rdfs:<http://www.w3.org/2000/01/rdf-schema#>
PREFIX rdf:<http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl:<http://www.w3.org/2002/07/owl#>
PREFIX ext:<java:edu.washington.sig.arq.>
```

```
SELECT ?a ?b
WHERE
{
  ?a nci:Preferred_Name "Heart" .
  ?a ext:OnPath ("(rdfs:subClassOf|someValuesFrom)*" ?b) .
}
```

# Property Restriction Results



a	b
nci:Heart	_:b0
nci:Heart	nci:Heart
nci:Heart	nci:Organ
nci:Heart	nci:Anatomic_Structure_System_or_Substance
nci:Heart	_:b1
nci:Heart	nci:Anatomy_Kind