

第四次实验

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一. 实验一：故障诊断领域知识推理

1. 原先推理结果：

```
Setting the number of threads...
Importing RDF data...
Number of tuples after import: 6
{ "head": { "vars": [ "Y" ] },
  "results": { "bindings": [
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/diagnosis#类型" } },
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/diagnosis#进出口温差 (°C)" } },
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/diagnosis#进出口压差 (Pa)" } }
  ] }
}
Importing rules from a file...
Number of tuples after materialization: 9
=====
<http://www.example.org/kse/diagnosis#类型> * 1
<http://www.example.org/kse/diagnosis#进出口温差 (°C)> * 1
<http://www.example.org/kse/diagnosis#进出口压差 (Pa)> * 1
<http://www.example.org/kse/diagnosis#进出口温差 (°C)> * 1
<http://www.example.org/kse/diagnosis#进出口压差 (Pa)> * 1
=====
The number of rows returned: 5
=====
Exporting facts to file '.\\final-facts3383790383263450969.ttl' ... done.
This is the end of the example!
```

图 1.原先推理编译结果

```
<http://www.example.org/kse/diagnosis#冷凝器1> <http://www.example.org/kse/diagnosis#进出口温差 (°C)> "25"^^<http://www.w3.org/2001/XMLSchema#decimal>
<http://www.example.org/kse/diagnosis#冷凝器1> <http://www.example.org/kse/diagnosis#进出口压差 (Pa)> "10000"^^<http://www.w3.org/2001/XMLSchema#integer>
<http://www.example.org/kse/diagnosis#冷凝器1> <http://www.example.org/kse/diagnosis#进出口温差 (°C)> "77"^^<http://www.w3.org/2001/XMLSchema#integer>
<http://www.example.org/kse/diagnosis#冷凝器2> <http://www.example.org/kse/diagnosis#类型> <http://www.example.org/kse/diagnosis#冷凝设备脏堵> .
<http://www.example.org/kse/diagnosis#冷凝器2> <http://www.example.org/kse/diagnosis#故障> <http://www.example.org/kse/diagnosis#冷凝设备脏堵> .
<http://www.example.org/kse/diagnosis#冷凝器2> <http://www.example.org/kse/diagnosis#进出口温差 (°C)> "15"^^<http://www.w3.org/2001/XMLSchema#decimal>
<http://www.example.org/kse/diagnosis#冷凝器2> <http://www.example.org/kse/diagnosis#进出口压差 (Pa)> "30000"^^<http://www.w3.org/2001/XMLSchema#integer>
<http://www.example.org/kse/diagnosis#冷凝器2> <http://www.example.org/kse/diagnosis#进出口温差 (°C)> "59"^^<http://www.w3.org/2001/XMLSchema#integer>
<http://www.example.org/kse/diagnosis#冷凝器2> <http://www.example.org/kse/diagnosis#类型> <http://www.example.org/kse/diagnosis#冷凝设备> .
```

图 2.原先推理 tuples 结果

2. 撰写规则：

- (1) 已知 Pa 转换为 Kpa 的转换公式 ($1\text{KPa}=1000\text{Pa}$)，求设备的进出口压差为多少 Kpa？
p:进出口压差 (KPa) [?X,?Z] :- p:进出口压差 (Pa) [?X,?Y], BIND((?Y / 1000) AS ?Z) .
- (2) 某冷凝设备进出口压差大于 20KPa，该冷凝设备存在“冷凝设备压差过大”故障。
p:故障[?X,p:冷凝设备压差过大] :- p:类型[?X,p:冷凝设备], p:进出口压差 (KPa) [?X,?Z], FILTER(?Z > 20) .

```
PREFIX p: <http://www.example.org/kse/diagnosis#>

p:进出口温差 (°C) [?X,?Z] :- p:进出口温差 (°C) [?X,?Y], BIND ((?Y - 32) / 1.8 AS ?Z) .
p:故障[?X,p:冷凝设备脏堵] :- p:类型[?X,p:冷凝设备], p:进出口温差 (°C) [?X,?Z], FILTER(?Z < 20) .

p:进出口压差 (KPa) [?X,?Z] :- p:进出口压差 (Pa) [?X,?Y], BIND((?Y / 1000) AS ?Z) .
p:故障[?X,p:冷凝设备压差过大] :- p:类型[?X,p:冷凝设备], p:进出口压差 (KPa) [?X,?Z], FILTER(?Z > 20) .
```

图 3.规则撰写

3. 观察新的推理结果：

```
Setting the number of threads...
Importing RDF data...
Number of tuples after import: 6
{ "head": { "vars": [ "Y" ] },
  "results": { "bindings": [
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/diagnosis#类型" } },
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/diagnosis#进出口温差 (°C)" } },
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/diagnosis#进出口压差 (Pa)" } }
  ] }
}
Importing rules from a file...
Number of tuples after materialization: 12
=====
<http://www.example.org/kse/diagnosis#类型> * 1
<http://www.example.org/kse/diagnosis#进出口温差 (°C)> * 1
<http://www.example.org/kse/diagnosis#进出口压差 (Pa)> * 1
<http://www.example.org/kse/diagnosis#进出口温差 (°C)> * 1
<http://www.example.org/kse/diagnosis#进出口压差 (Pa)> * 1
<http://www.example.org/kse/diagnosis#进出口压差 (KPa)> * 1
=====
The number of rows returned: 6
=====
Exporting facts to file '.\\final-facts73504038080808081950.ttl' ... done.
This is the end of the example!
```

图 4.新的推理编译结果

```

example.org/kse/diagnosis#冷凝器1> <http://www.example.org/kse/diagnosis#进出口压差 (KPa) > "10"^^<http://www.w3.org/2001/XMLSchema#decimal> .
example.org/kse/diagnosis#冷凝器1> <http://www.example.org/kse/diagnosis#进出口温差 (℃) > "25"^^<http://www.w3.org/2001/XMLSchema#decimal> .
example.org/kse/diagnosis#冷凝器1> <http://www.example.org/kse/diagnosis#进出口压差 (Pa) > "10000"^^<http://www.w3.org/2001/XMLSchema#integer> .
example.org/kse/diagnosis#冷凝器1> <http://www.example.org/kse/diagnosis#进出口温差 (°F) > "77"^^<http://www.w3.org/2001/XMLSchema#integer> .
example.org/kse/diagnosis#冷凝器1> <http://www.example.org/kse/diagnosis#类型> <http://www.example.org/kse/diagnosis#冷凝设备> .
example.org/kse/diagnosis#冷凝器2> <http://www.example.org/kse/diagnosis#故障> <http://www.example.org/kse/diagnosis#冷凝设备压差过大> .
example.org/kse/diagnosis#冷凝器2> <http://www.example.org/kse/diagnosis#故障> <http://www.example.org/kse/diagnosis#冷凝设备堵塞> .
example.org/kse/diagnosis#冷凝器2> <http://www.example.org/kse/diagnosis#进出口压差 (KPa) > "30"^^<http://www.w3.org/2001/XMLSchema#decimal> .
example.org/kse/diagnosis#冷凝器2> <http://www.example.org/kse/diagnosis#进出口温差 (℃) > "15"^^<http://www.w3.org/2001/XMLSchema#decimal> .
example.org/kse/diagnosis#冷凝器2> <http://www.example.org/kse/diagnosis#进出口压差 (Pa) > "30000"^^<http://www.w3.org/2001/XMLSchema#integer> .
example.org/kse/diagnosis#冷凝器2> <http://www.example.org/kse/diagnosis#进出口温差 (°F) > "59"^^<http://www.w3.org/2001/XMLSchema#integer> .
example.org/kse/diagnosis#冷凝器2> <http://www.example.org/kse/diagnosis#类型> <http://www.example.org/kse/diagnosis#冷凝设备> .

```

图 5.新的推理 tuples 结果

二. 实验二：金融领域知识

1. 观察原先推理结果：

```

Number of tuples after import: 5
{ "head": { "vars": [ "Y" ] },
  "results": { "bindings": [
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/finance#worksFor" } },
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/finance#employeeOf" } },
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/finance#firstName" } },
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/finance#lastName" } }
  ] }
}
Importing rules from a file...
Number of tuples after materialization: 7

<http://www.example.org/kse/finance#worksFor> * 1
<http://www.example.org/kse/finance#employeeOf> * 1
<http://www.example.org/kse/finance#firstName> * 1
<http://www.example.org/kse/finance#lastName> * 1
<http://www.example.org/kse/finance#contractorFor> * 1
<http://www.example.org/kse/finance#fullName> * 1

The number of rows returned: 6

Exporting facts to file '.\final-facts887120562911703071.ttl' ... done.
This is the end of the example!

```

图 1.原先编译结果

```

<http://www.example.org/kse/finance#张三> <http://www.example.org/kse/finance#employeeOf> <http://www.example.org/kse/finance#万达集团> .
<http://www.example.org/kse/finance#张三> <http://www.example.org/kse/finance#worksFor> <http://www.example.org/kse/finance#万达集团> .
<http://www.example.org/kse/finance#李四> <http://www.example.org/kse/finance#contractorFor> <http://www.example.org/kse/finance#万达集团> .
<http://www.example.org/kse/finance#李四> <http://www.example.org/kse/finance#worksFor> <http://www.example.org/kse/finance#万达集团> .
<http://www.example.org/kse/finance#peter> <http://www.example.org/kse/finance#fullName> "PeterGreen" .
<http://www.example.org/kse/finance#peter> <http://www.example.org/kse/finance#lastName> "Green" .
<http://www.example.org/kse/finance#peter> <http://www.example.org/kse/finance#firstName> "Peter" .

```

图 2.原先推理 tuples 结果

2. 取消注释，观察推理结果：

```

Setting the number of threads...
Importing RDF data...
Number of tuples after import: 5
{ "head": { "vars": [ "Y" ] },
  "results": { "bindings": [
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/finance#worksFor" } },
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/finance#employeeOf" } },
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/finance#firstName" } },
    { "Y": { "type": "uri", "value": "http://www.example.org/kse/finance#lastName" } }
  ] }
}
Importing rules from a file...
Number of tuples after materialization: 7

<http://www.example.org/kse/finance#worksFor> * 1
<http://www.example.org/kse/finance#employeeOf> * 1
<http://www.example.org/kse/finance#firstName> * 1
<http://www.example.org/kse/finance#lastName> * 1
<http://www.example.org/kse/finance#contractorFor> * 1
<http://www.example.org/kse/finance#fullName> * 1

The number of rows returned: 6

Import triples for incremental reasoning
Number of tuples after addition: 7
Exporting facts to file '.\final-facts3551741437132449066.ttl' ... done.
This is the end of the example!

```

图 3.之后的编译结果

```

<http://www.example.org/kse/finance#张三> <http://www.example.org/kse/finance#employeeOf> <http://www.example.org/kse/finance#万达集团> .
<http://www.example.org/kse/finance#张三> <http://www.example.org/kse/finance#worksFor> <http://www.example.org/kse/finance#万达集团> .
<http://www.example.org/kse/finance#李四> <http://www.example.org/kse/finance#employeeOf> <http://www.example.org/kse/finance#万达集团> .
<http://www.example.org/kse/finance#李四> <http://www.example.org/kse/finance#worksFor> <http://www.example.org/kse/finance#万达集团> .
<http://www.example.org/kse/finance#peter> <http://www.example.org/kse/finance#fullName> "PeterGreen" .
<http://www.example.org/kse/finance#peter> <http://www.example.org/kse/finance#lastName> "Green" .
<http://www.example.org/kse/finance#peter> <http://www.example.org/kse/finance#firstName> "Peter" .

```

图 4.之后的推理 tuples 结果

3. 结果分析:

(1) 源码变化:

源码引入了新的三元组。

```
// RDFox supports incremental reasoning. One can import facts into the store incrementally by
// calling DataStoreConnection.importDataFiles() with additional argument UpdateType.ADDITION.
System.out.println("Import triples for incremental reasoning");
try (InputStream inputStream = new BufferedInputStream(JRDFOxDemo_finance.class.getResourceAsStream( name: "data/finance_data_new.nt" ))
    datastoreConnection.importData(UpdateType.ADDITION, Prefixes.s_emptyPrefixes, inputStream);
}
// Adding the rules/facts changes the number of triples. Note that the store is updated incrementally.
System.out.println("Number of tuples after addition: " + getTriplesCount(dataStoreConnection, queryDomain: "IDB"));
```

图 5.源码变化

(2) 三元组变化:

原来“李四”与“万达集团”只有“worksFor”的关系。

```
1 <http://www.example.org/kse/finance#张三> <http://www.example.org/kse/finance#worksFor> <http://www.example.org/kse/finance#万达集团> .
2 <http://www.example.org/kse/finance#李四> <http://www.example.org/kse/finance#worksFor> <http://www.example.org/kse/finance#万达集团> .
3 <http://www.example.org/kse/finance#张三> <http://www.example.org/kse/finance#employeeOf> <http://www.example.org/kse/finance#万达集团> .
4
5 <http://www.example.org/kse/finance#peter> <http://www.example.org/kse/finance#firstName> "Peter" .
6 <http://www.example.org/kse/finance#peter> <http://www.example.org/kse/finance#lastName> "Green" .
7
```

图 6.原三元组构成

新三元组使得“李四”与“万达集团”增加了“employeeOf”的关系。

```
1 <http://www.example.org/kse/finance#李四> <http://www.example.org/kse/finance#employeeOf> <http://www.example.org/kse/finance#万达集团> .
2
```

图 7.新增三元组

(3) 新三元组与推理规则产生反应:

新三元组使得“NOT”后的三元组存在，否定失败，contractorFor 的三元组在推理结果中消失。

```
q:contractorFor[?X,?Y] :- q:worksFor[?X,?Y], NOT q:employeeOf[?X,?Y] .
```

图 8.产生作用的规则

(4) 否定失败非单调的性质

新消息可能会使之前推理出的三元组消失，即消息增多不一定使得推理后的三元组也增多，所以“否定失败”是非单调的。