

Modeling Associations through Intensional Attributes

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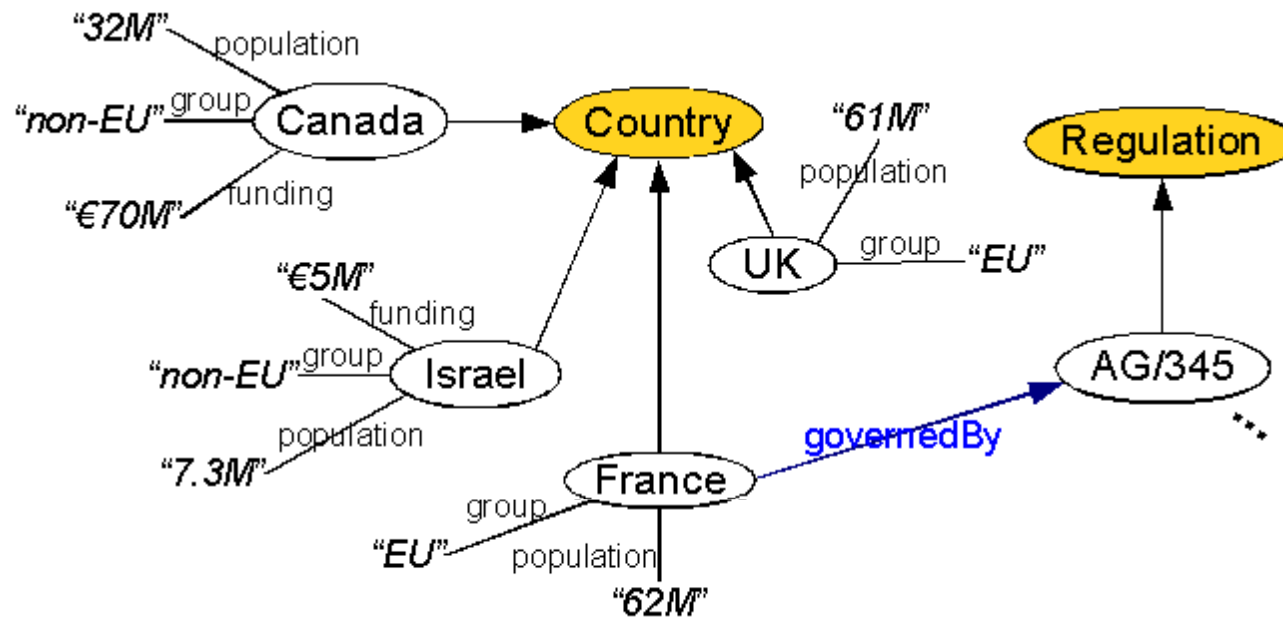
with Andrea Presa, Yannis Velegrakis and Flavio Rizzolo

Andrea Presa and Yannis Velegrakis and Flavio Rizzolo and Siarhei Bykau. Modeling Associations through Intensional Attributes. In Laender, A.H.F. et al. Conceptual Modeling - ER 2009. Lecture Notes in Computer Science, Vol. 5829, Springer 2009, pp. 315-330.

Attributes in Ontologies

- Ontology:
 - ◆ Classes/Instances
 - ◆ Properties $\langle d, p, r \rangle$
 - ✓ d – domain
 - ✓ p – name
 - ✓ r – range (either a class or an instance)
 - ◆ Comments

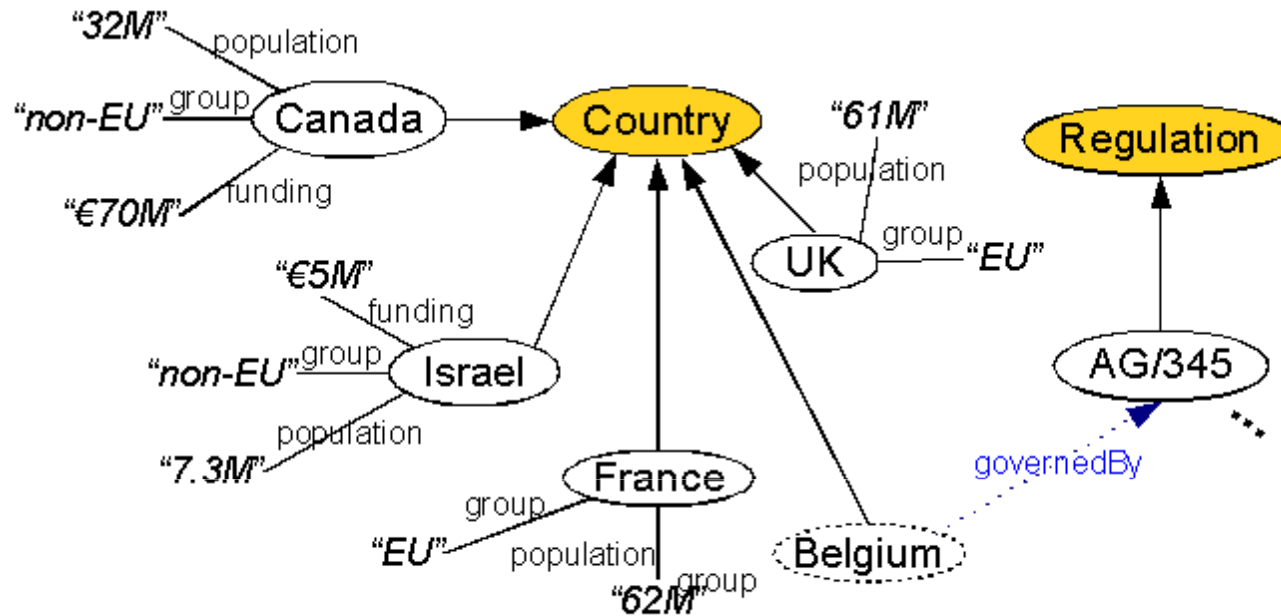
Explicit Creation of Attributes



<France, governedBy, AG/345>

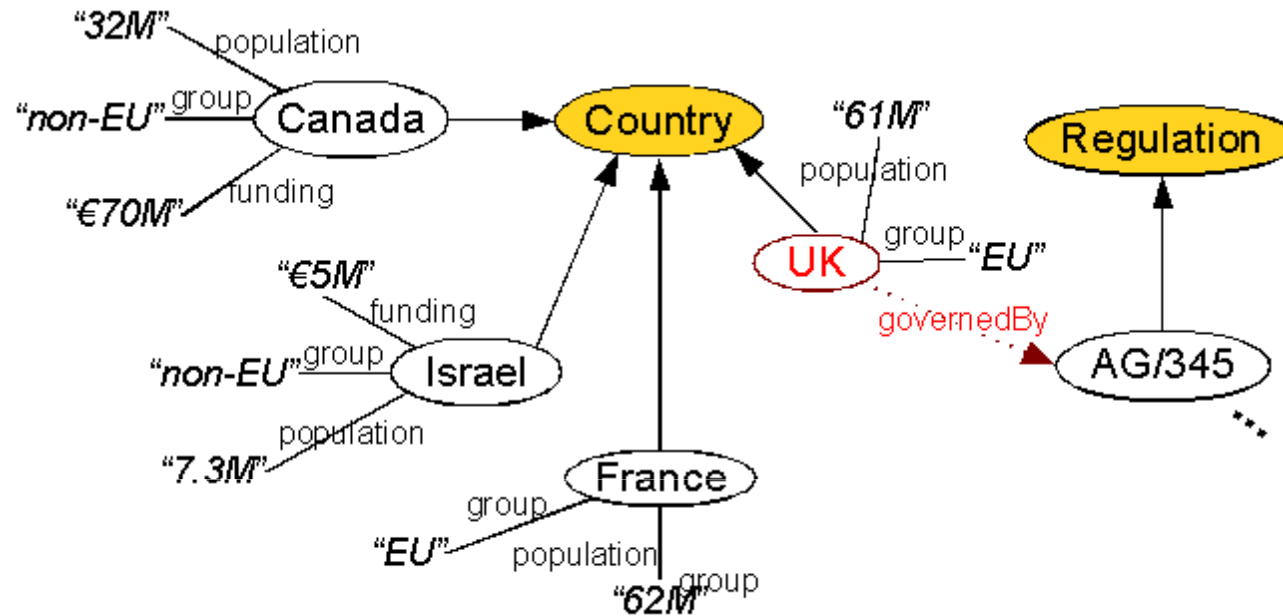
What if there are tens of countries?

Future Data Assignment



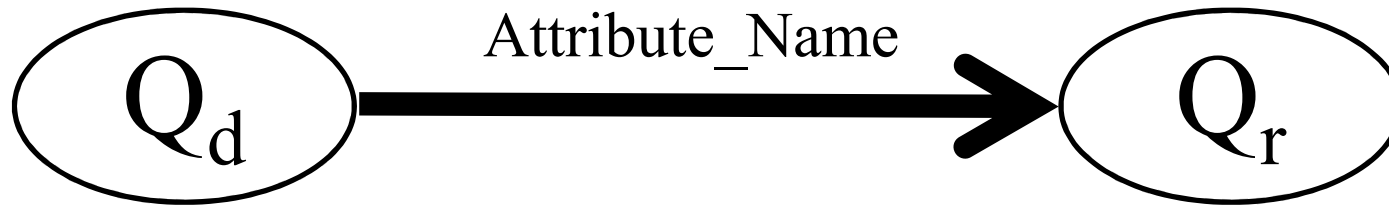
Administrator should carefully check future data

Security Privileges for Attributes

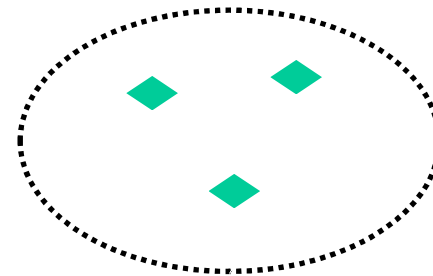
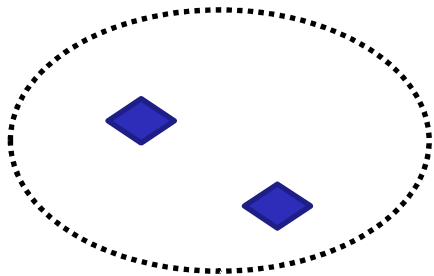
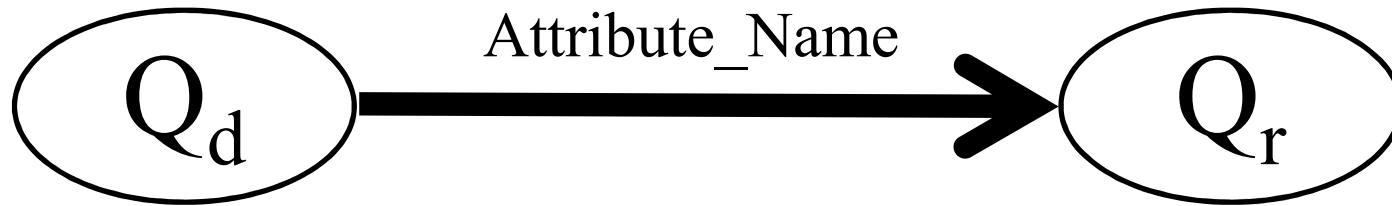


There are no privileges to modify UK data

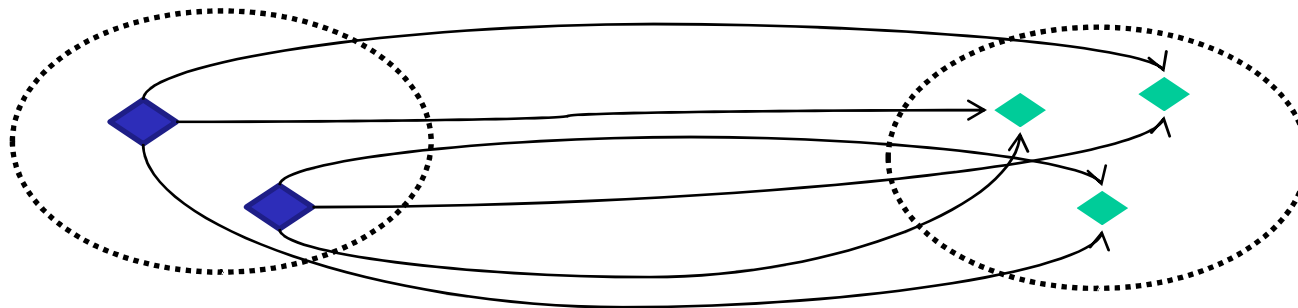
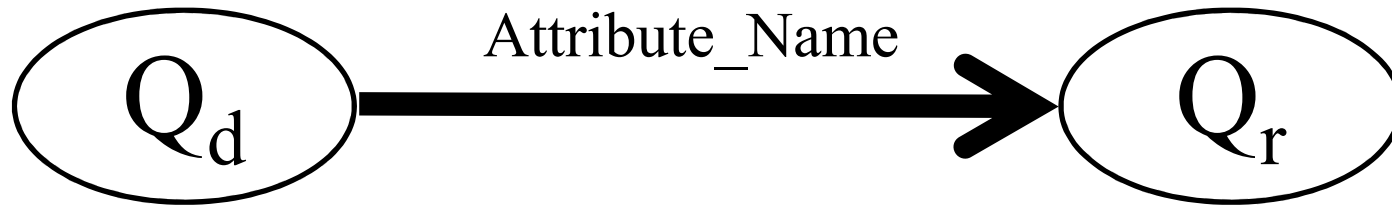
Intensional Attributes



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Intensional Attributes



Related Work

- Derived Concepts in DL [Baader03]
- Virtual/Materialized View in Databases[Lenzerini02]
- Queries as data values in commercial DBs [Stonebraker87][Gawlik04]
- Metadata management [Buneman02][Srivatstava07]

Intensional Knowledge Base

- Intensional Knowledge Base:

- ◆ Set of Classes – C

- ◆ Set of Instances – I

- ◆ Set of Literals – L

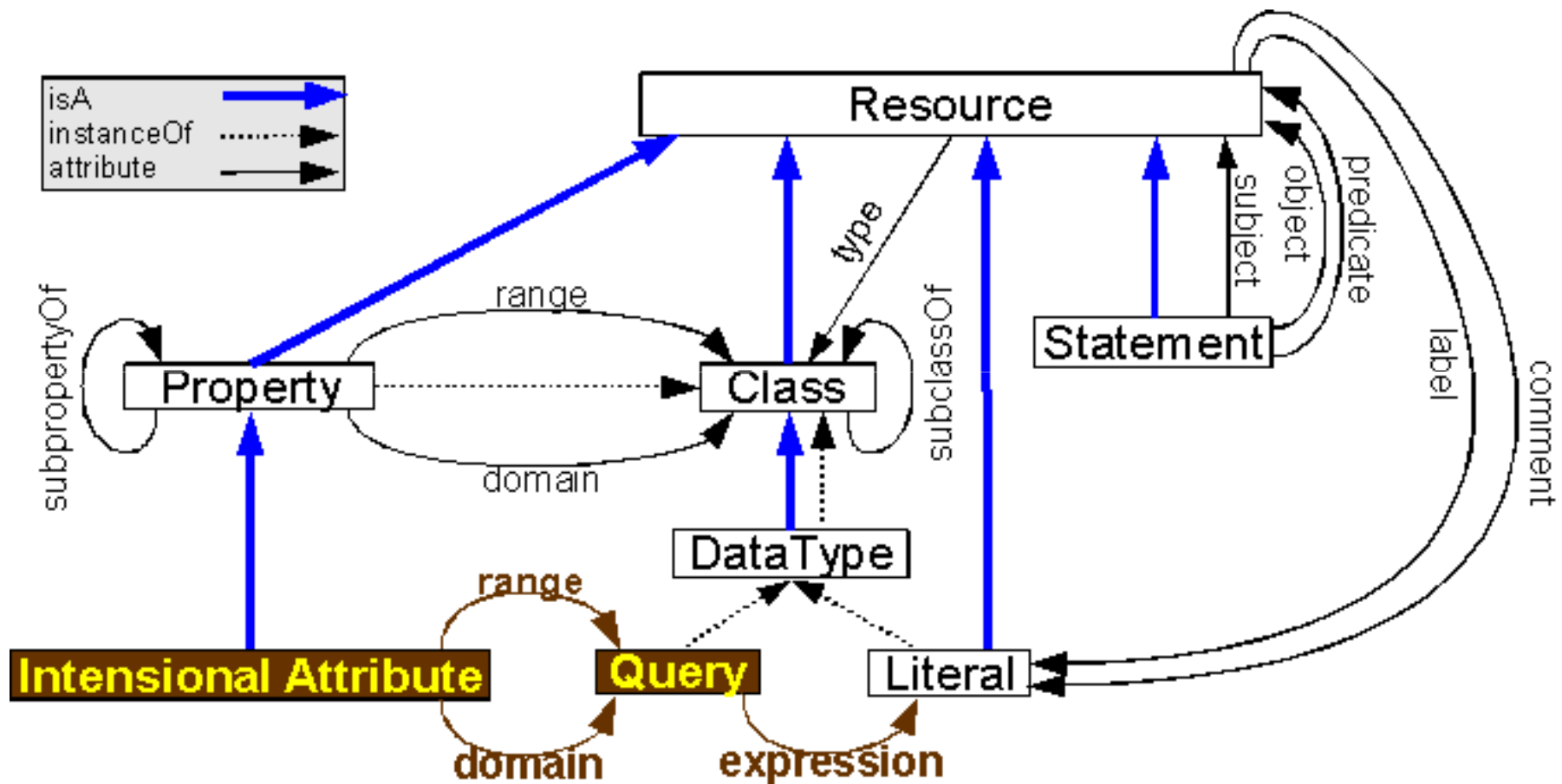
- ◆ Set of Names – N

- ◆ Set of Attributes - $A \subseteq ((C \times N \times C) \cup (I \times N \times (I \cup L)))$

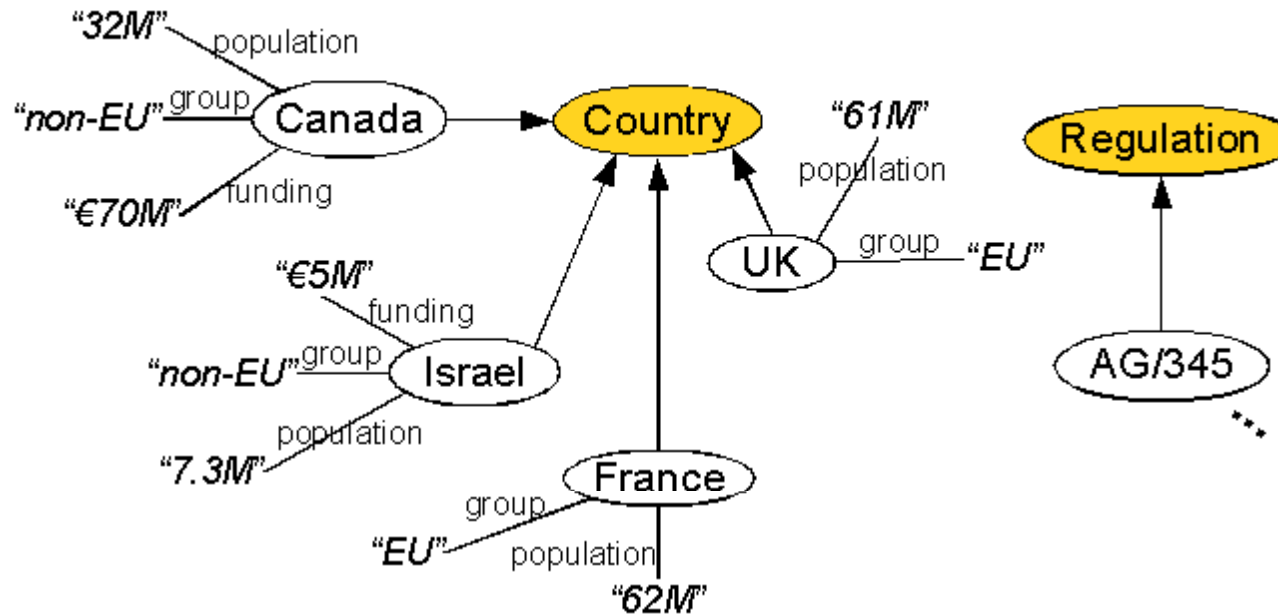
- ◆ Intensional Attributes - $\langle Q_d, n, Q_r \rangle$

- Canonical Intensional Knowledge Base

RDF Extension

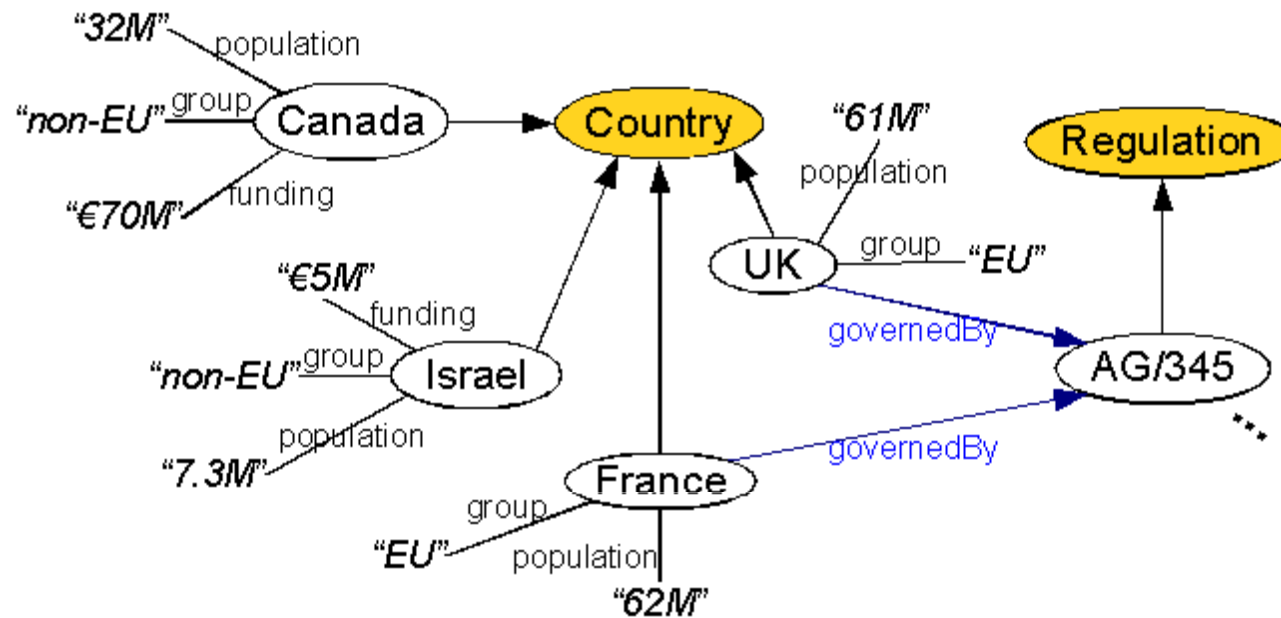


Intensional Attribute with Individual



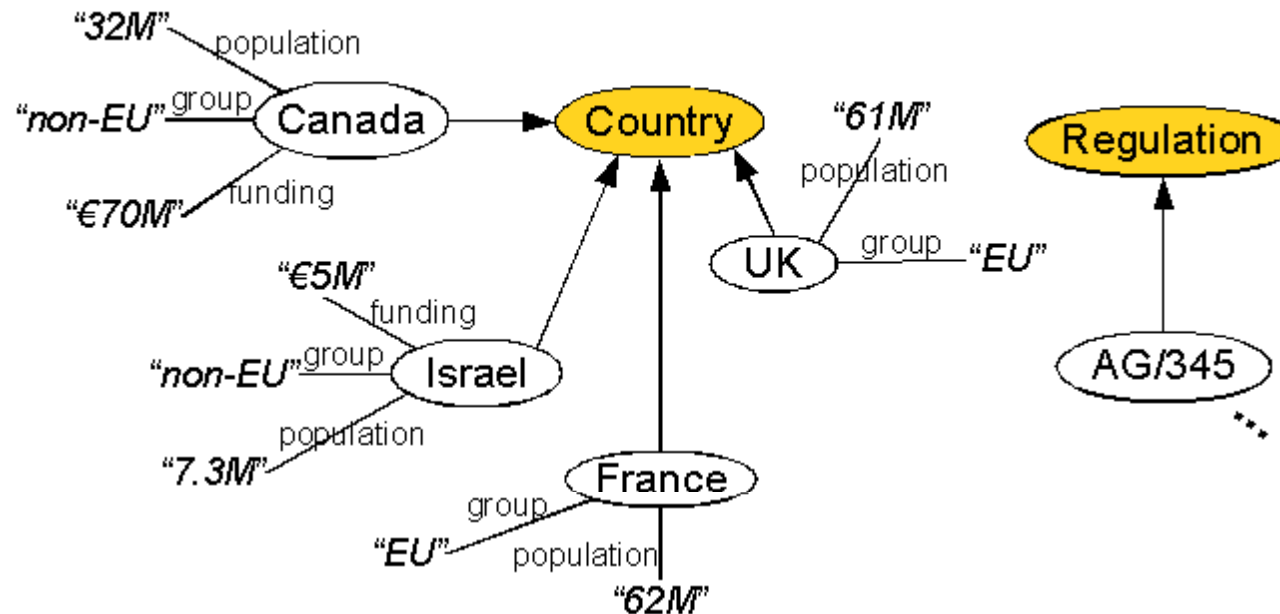
All EU countries are governed by AG/345 regulation

Intensional Attribute with Individual



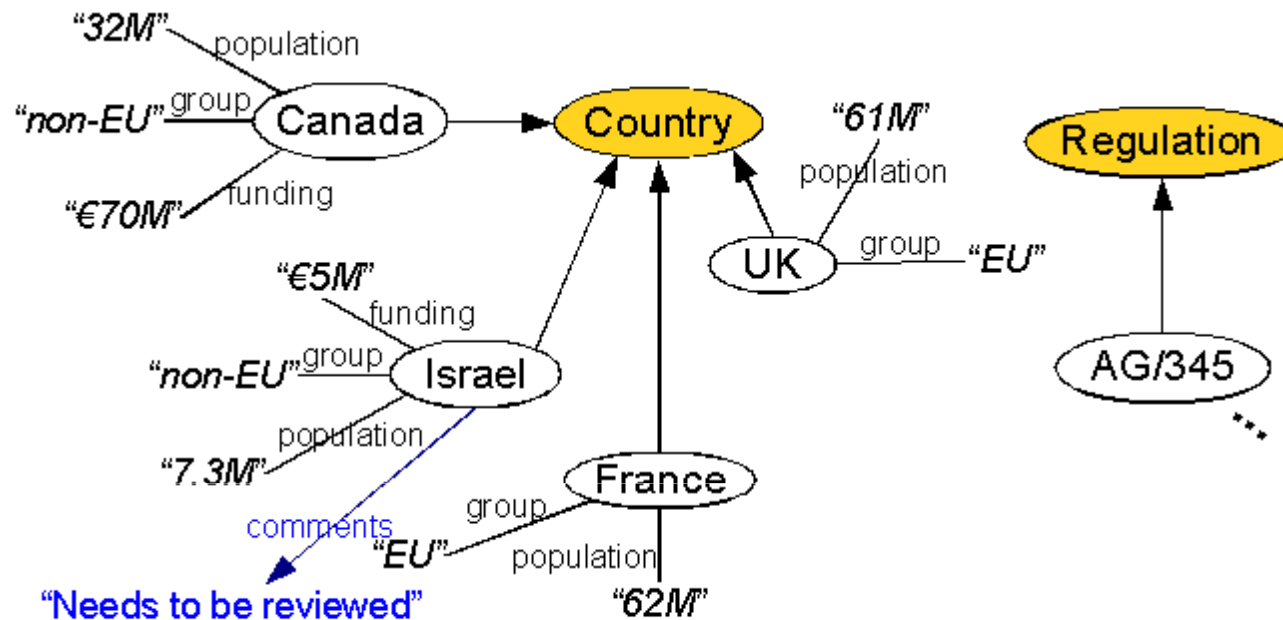
Q1: select ?x where {? rdf:type Country . ?x group "EU"}

Intensional Attribute with Atomic Range



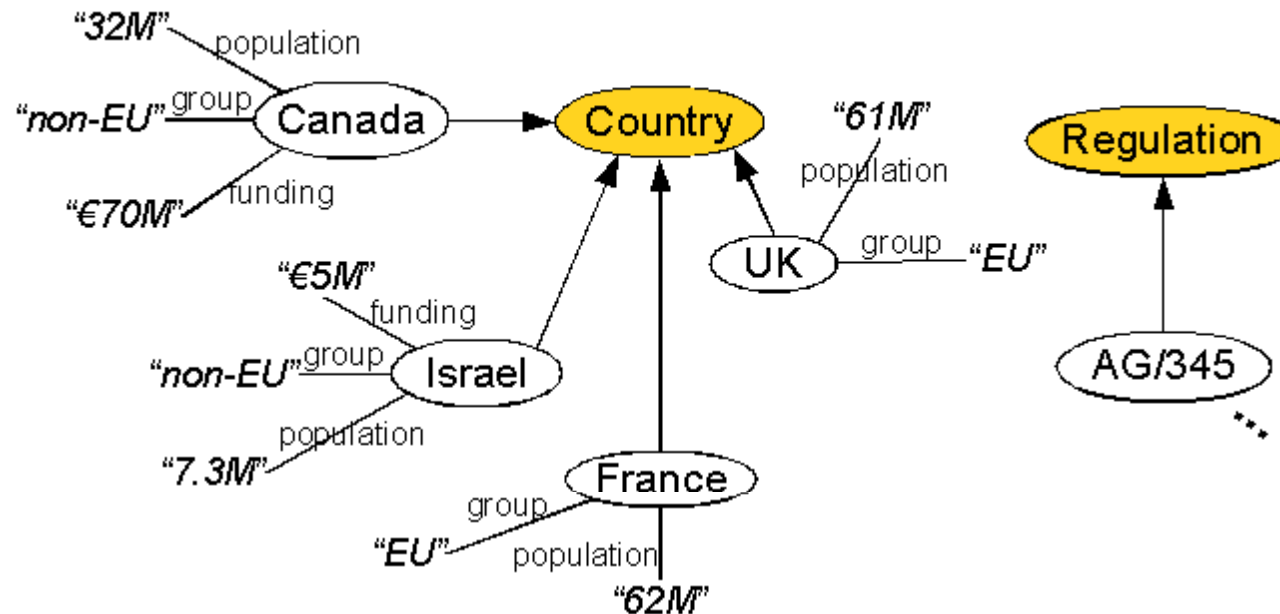
All countries with population less than 20M have to be reviewed

Intensional Attribute with Atomic Range



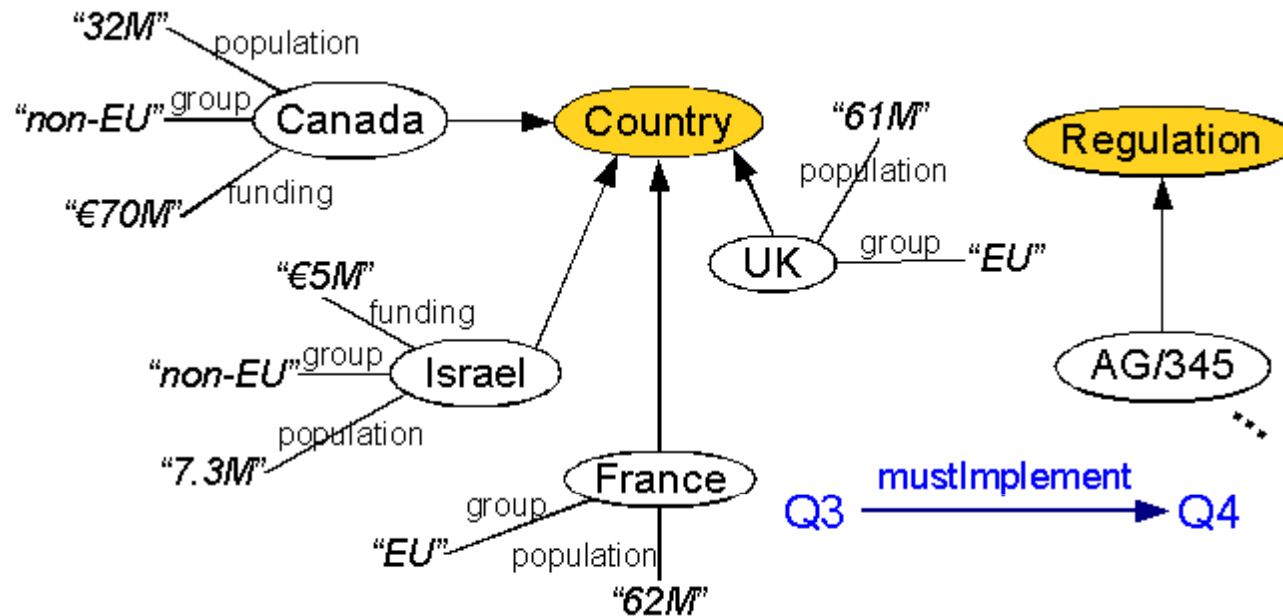
Q2: select ?x where
{?x rdf:type Country . ?x population ?p .
FILTER (?p <= 20M)}

Intensional Attribute with two Queries



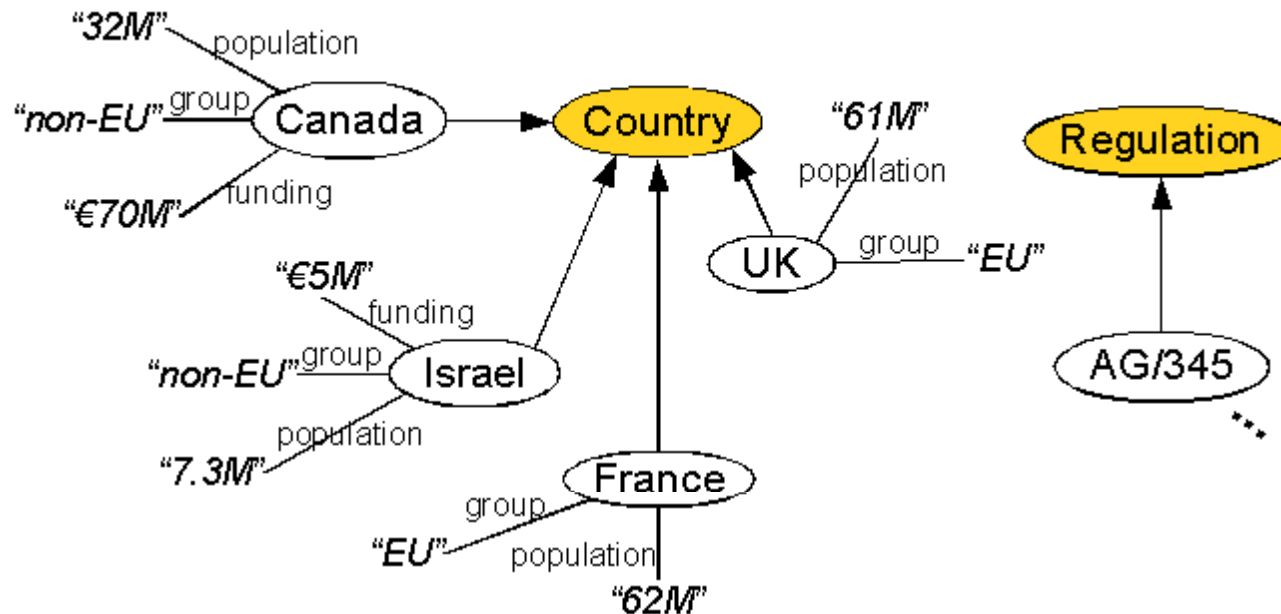
All countries must implement all EMR regulations

Intensional Attribute with two Queries



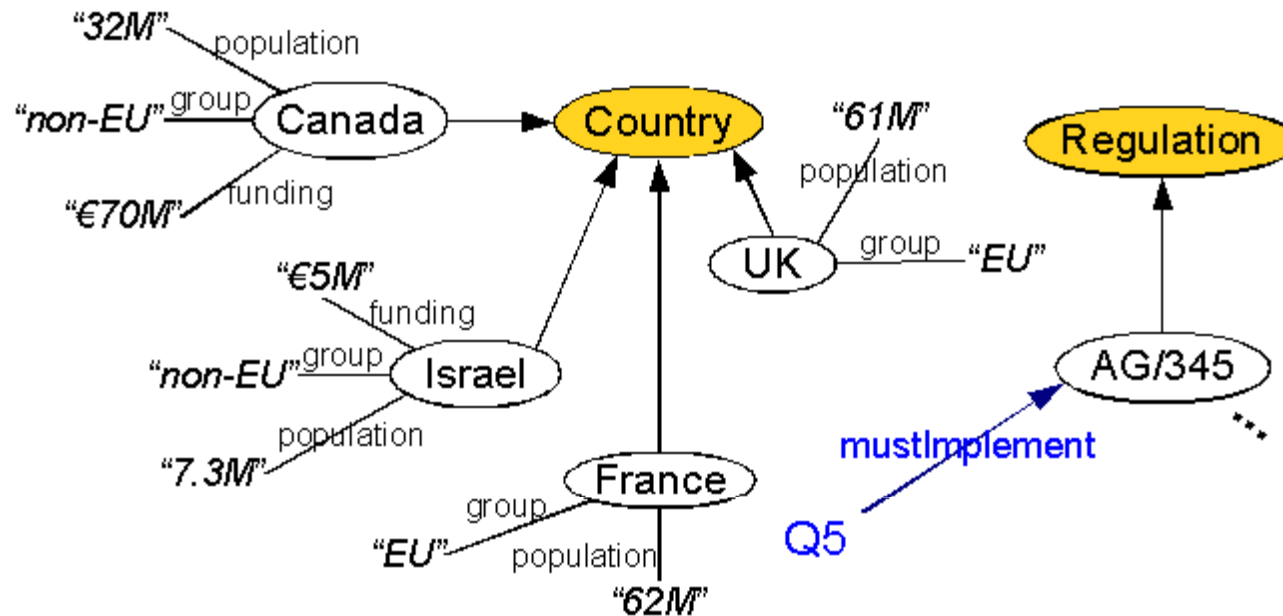
Q3: select ?x where {?x rdf:type Country }
Q4: select ?x where {?x rdf:type Regulation .
?x code "EMR"}

Intensional Attributes with the same Names



All countries with the fundings between 10 and 100M must implement AG/345 regulation

Intensional Attributes with the same Names



Q5: select ?x where {?x rdf:type Country .
 ?x funding ?f . FILTER (?f > 10M && ?f < 100M)}

Q6: select distinct ?x where {?x rdf:type ?y .
 FILTER (str(?x)="AG/345")}

Supporting Queries on Intensional Databases

- Materialized Approach
- Lazy Approach
- Indexed Approach

Indexed Approach

- Idea: find intensional attribute of a class/instance

- Indexed queries:

select ?o where{?o rdf:type c . Conds}

Conds: a set of conditions of the form:

 ?o attributeName ?v .

FILTER (?v <OP> attributeValue)

 where <OP> is =, <, ≤, > or ≥

Indexed Approach (cont.)

DTable			MTable			ETable			ITable	
Qd	Name	Qr	Q	Max	Cr	Attr	Value	Q	Cond	Q
Q1	governedBy	Q6	Q1	2	0	group	EU	Q2	population ≤ 00020	Q2
Q2	comment	Q7	Q2	1	0	hasURI	“AG/345”	Q6	___funding > 00010	Q5
Q3	mustImplement	Q4	Q3	1	0	hasURI	“EMR”	Q4	___funding > 00020	Q10
Q5	mustImplement	Q6	Q4	2	0	rdf:type	Country	Q1	___funding > 00100	Q12
...	...	...	Q5	1	0	rdf:type	Country	Q2	___funding < 00010	Q11
			Q6	1	0	rdf:type	Country	Q3	___funding < 00050	Q10
			...	...	...	rdf:type	Country	Q5	___funding < 00100	Q5
						rdf:type	Regulation	Q4	...	...
							

Canada:

rdf:type = Country
 group = non-EU
 funding = 70M
 population = 32M

Indexed Approach (cont.)

DTable			MTable			ETable			ITable	
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Q2	comment	Q7	Q2	1	1	hasURI	"AG/345"	Q6	---funding > 00010	Q5
Q3	mustImplement	Q4	Q3	1	1	hasURI	"EMR"	Q4	---funding > 00020	Q10
Q5	mustImplement	Q6	Q4	2	0	rdf:type	Country	Q1	---funding > 00100	Q12
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Candidates:
 <Q2,Q3,Q5>

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Indexed Approach (cont.)

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Indexed Approach (cont.)

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			Q6	1	0	rdf:type	Country	Q3	---funding < 00050	Q10
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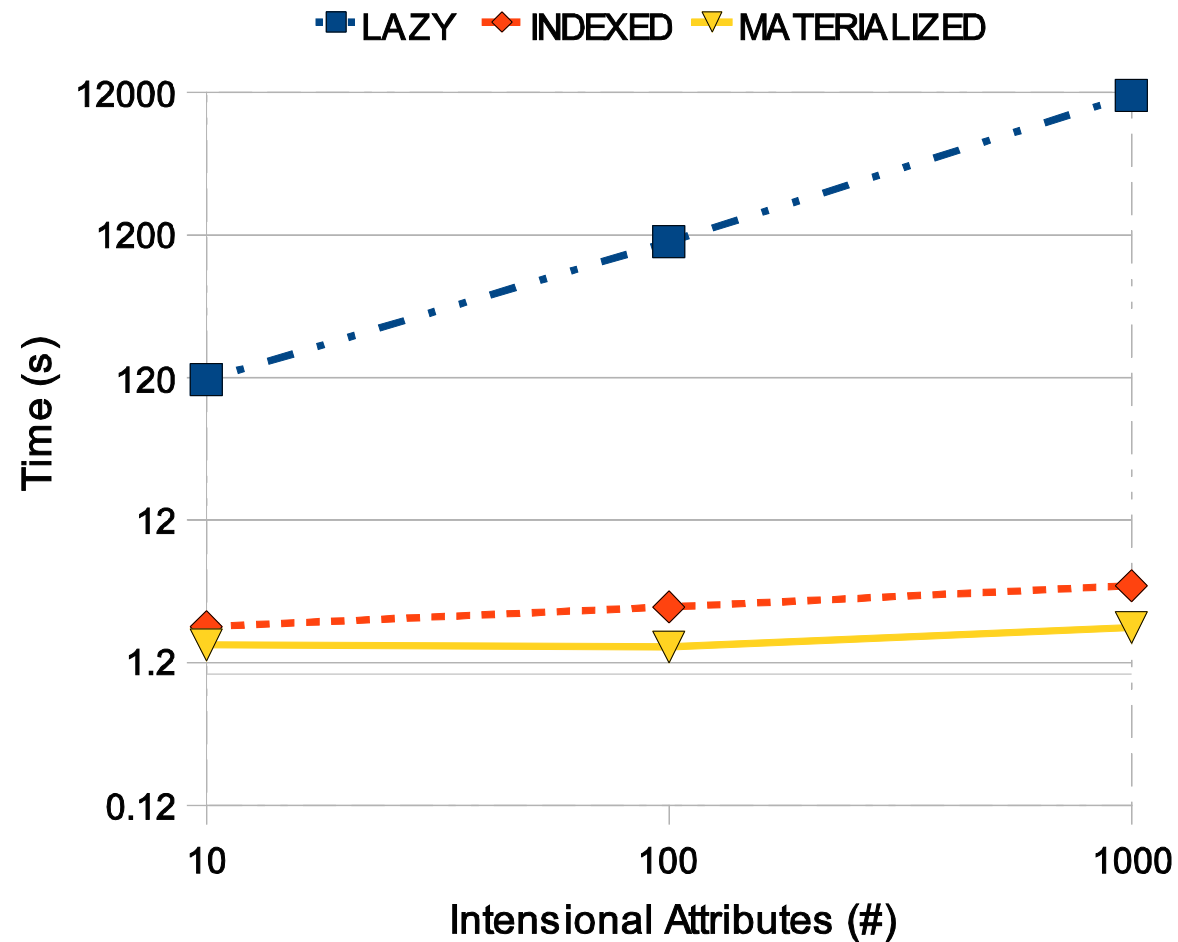
Candidates:
<Q3,Q5>

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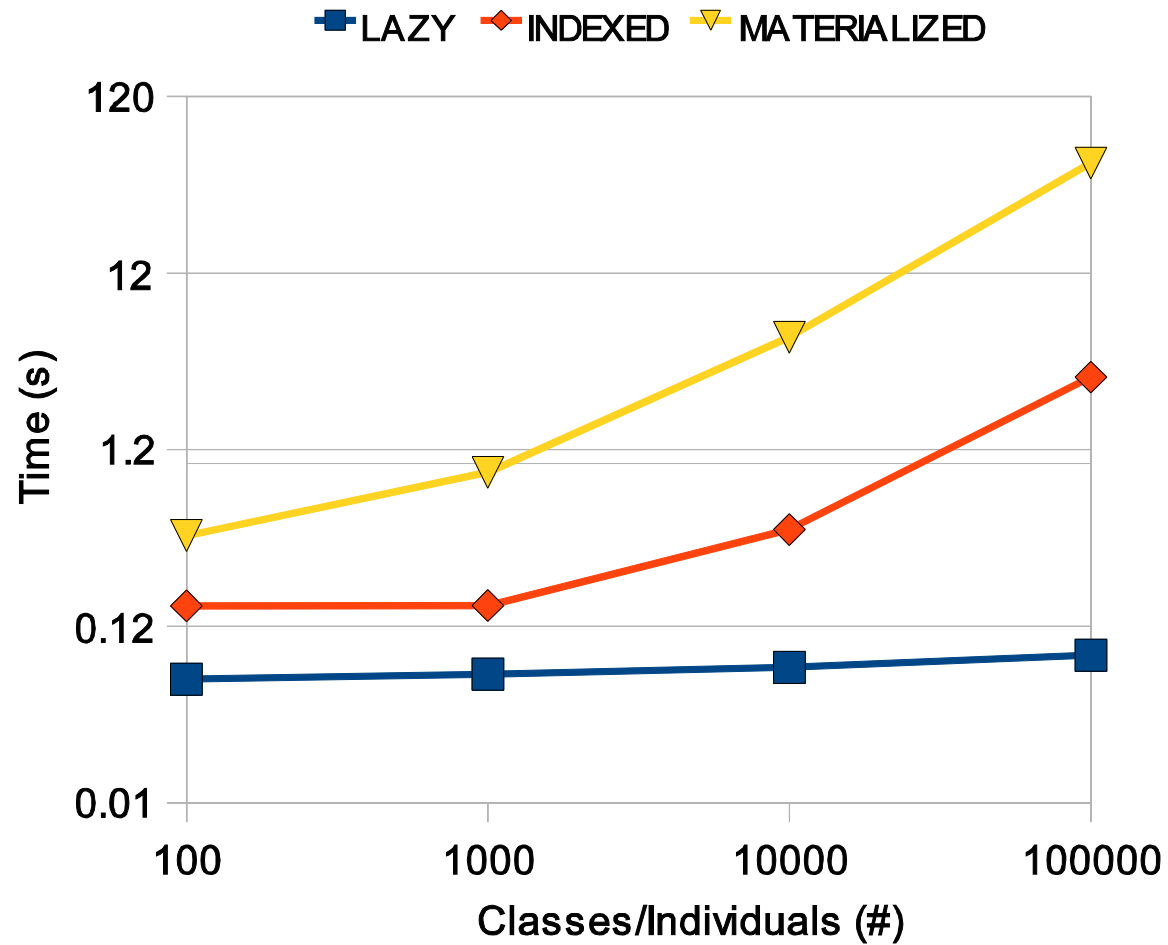
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			rdf:type	Country	Q5	___funding < 00100	Q5
						rdf:type	Regulation	Q4
							

Canada: <Q3, mustImplement, Q4>
 <Q5, mustImplement, Q6>

Find Attributes Graph



Insert Attribute Graph



Conclusion

- Intensional Attributes
- Intensional Knowledge Base
- Query evaluation:
 - ◆ Materialized
 - ◆ Lazy
 - ◆ Indexed

Thank you!
Questions?

Possible Approaches

- Defined Concepts in Description Logics [Borgida03]
 - ◆ use defined concepts instead of queries

- RDFS: $Q_d \rightarrow C_d, Q_r \rightarrow C_r$
 - ◆ Large number of such concepts
 - ◆ Security constraints
 - ◆ Some DLs do not support defined concepts

- OWL: use restrictions
 - ◆ `SubClassOf(intersectionOf(Country restriction(group value("EU")) restriction(governedBy value(AG/345)))`