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Towards Formal Semantics for ODRL Policies: Defining Expressive Access Policies for Linked Data using the ODRL Ontology

Simon Steyskal & **Axel Polleres**
WU Wien, Austria

Twitter: @AxelPolleres

web: <http://www.polleres.net>

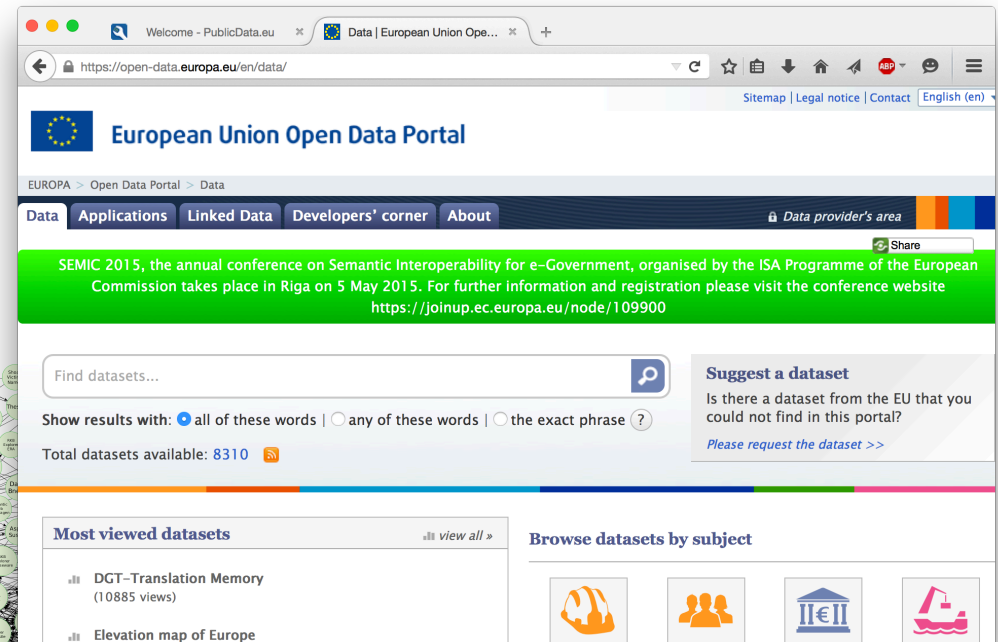
Agenda

- 1 Motivation
- 2 Introducing ODRL
- 3 Example Policies
- 4 Reasoning over ODRL Policies

Open Data on the Web is great.. But not all data is, or ever will be open.

A lot of activity in terms of standardization (in W3C) focused on

- Formats (RDF)
- Publishing best practices (Linked Data)



Welcome - PublicData.eu x Data | European Union Op...

https://open-data.europa.eu/en/data/

Sitemap | Legal notice | Contact | English (en)

European Union Open Data Portal

EUROPA > Open Data Portal > Data

Data Applications Linked Data Developers' corner About Data provider's area

SEMIC 2015, the annual conference on Semantic Interoperability for e-Government, organised by the ISA Programme of the European Commission takes place in Riga on 5 May 2015. For further information and registration please visit the conference website <https://joinup.ec.europa.eu/node/109900>

Find datasets...

Show results with: all of these words | any of these words | the exact phrase

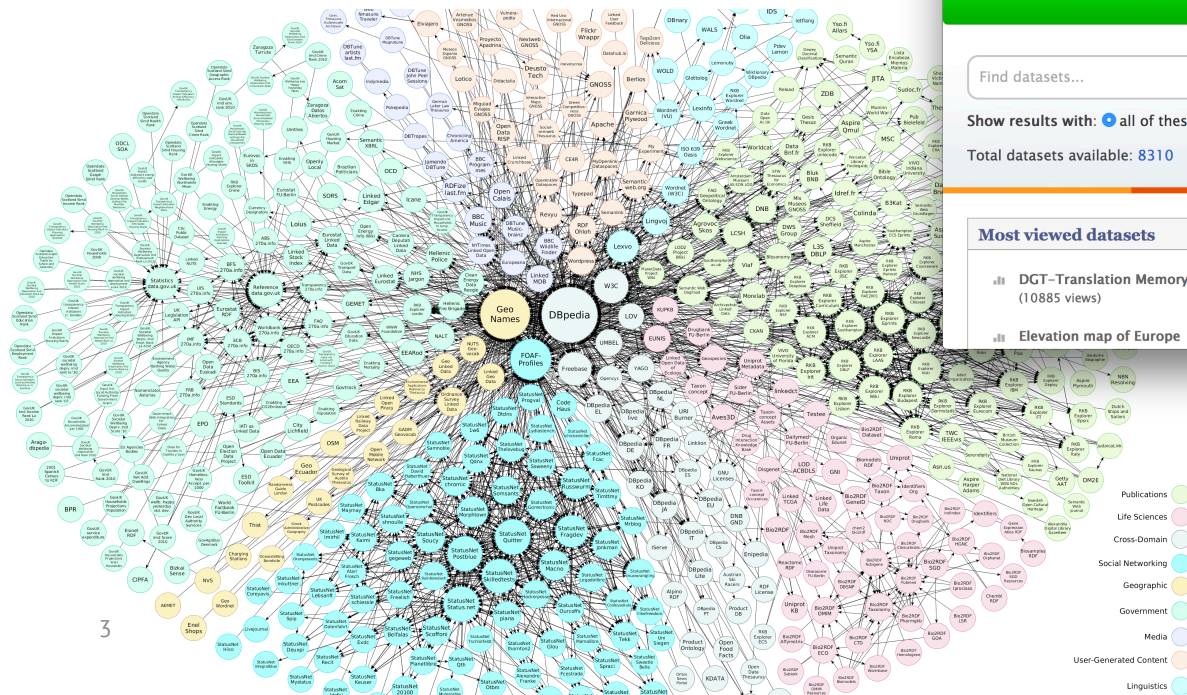
Total datasets available: 8310

Suggest a dataset
Is there a dataset from the EU that you could not find in this portal?
[Please request the dataset >>](#)

Most viewed datasets [view all >](#)

- DGT-Translation Memory (10885 views)
- Elevation map of Europe

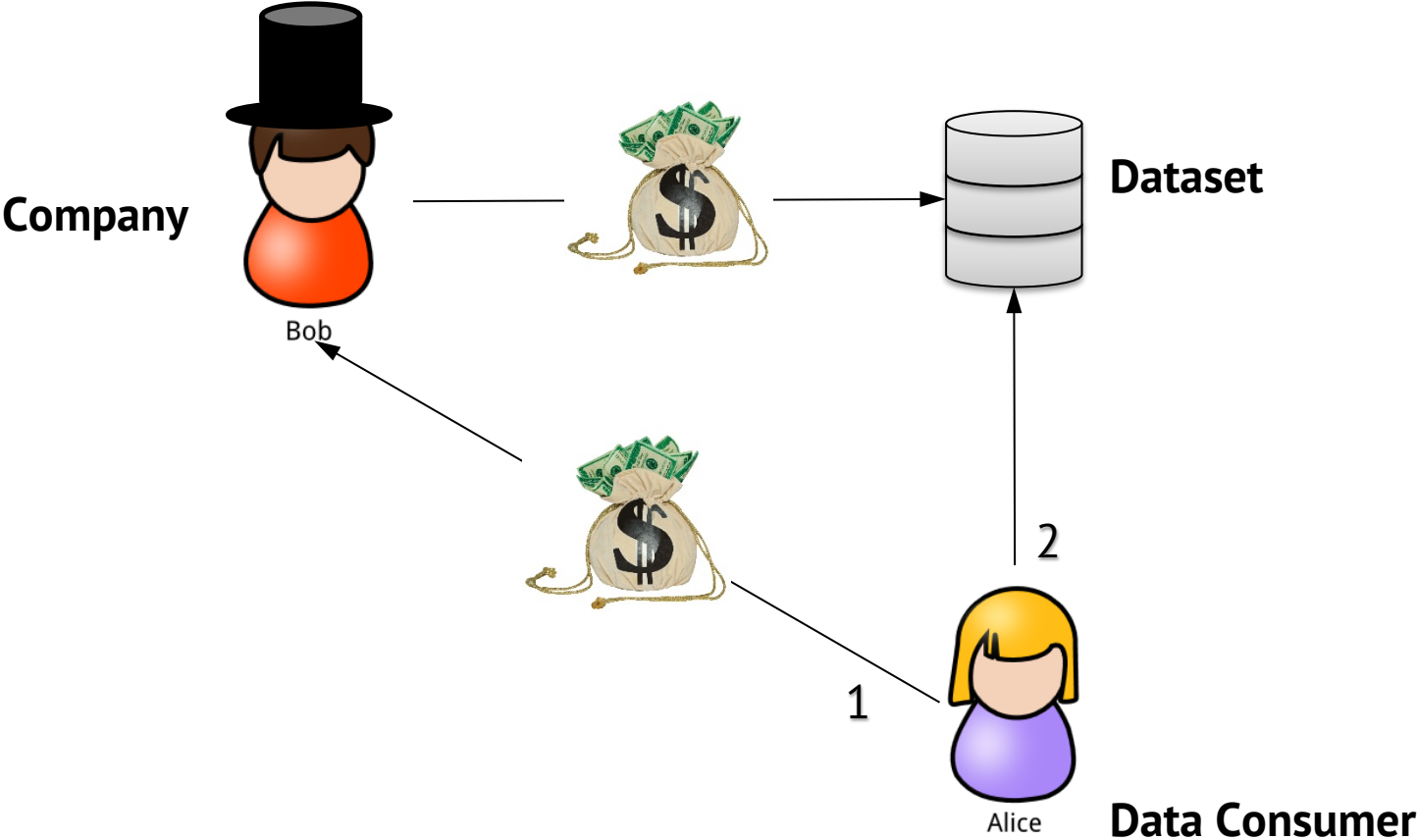
Browse datasets by subject



But: not all data is open. Different licenses, freemium usage models, API keys with different obligations to the user implied, etc.

Motivation

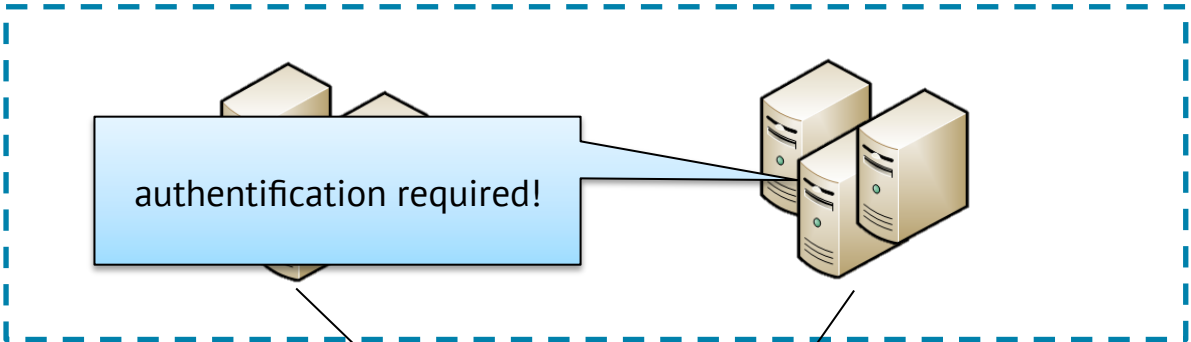
hypothesis: companies won't offer you data for free



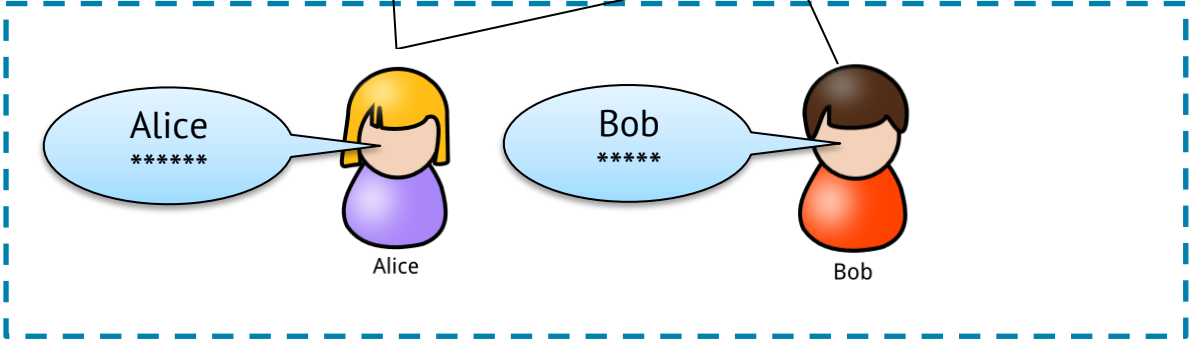
Motivation

from simple access conditions and machine-human interaction...

Data Publisher



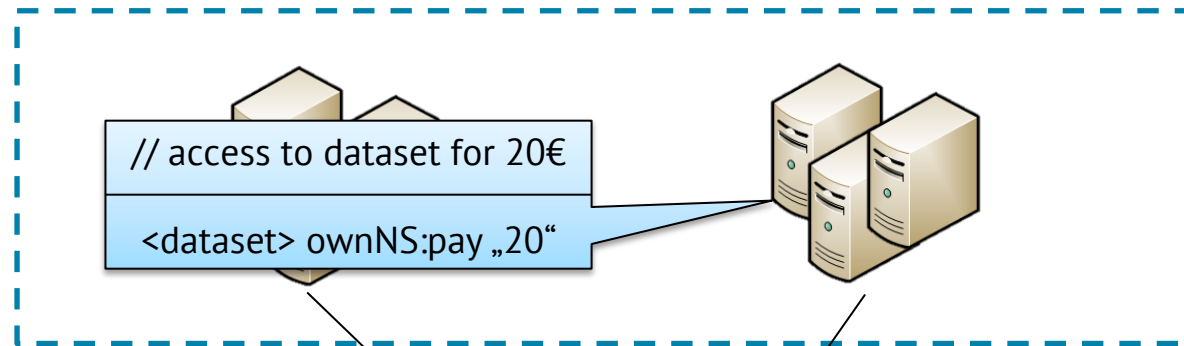
Data Consumer



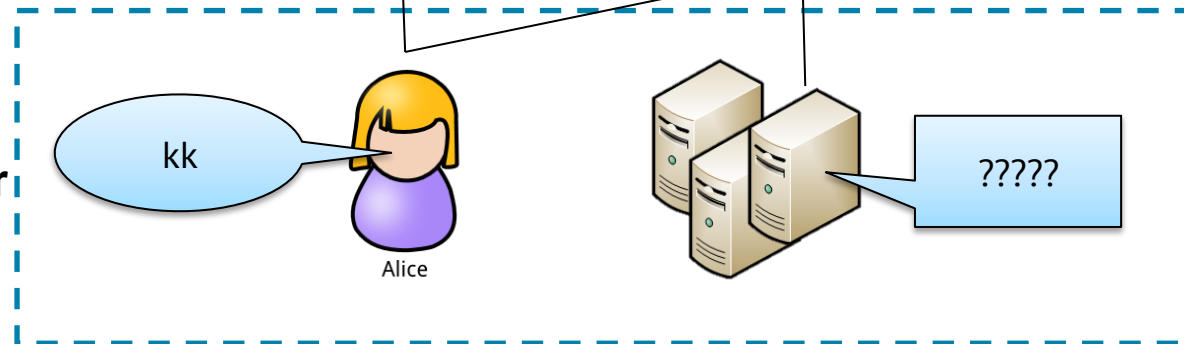
Motivation

... to high-level policies and machine-machine interaction!

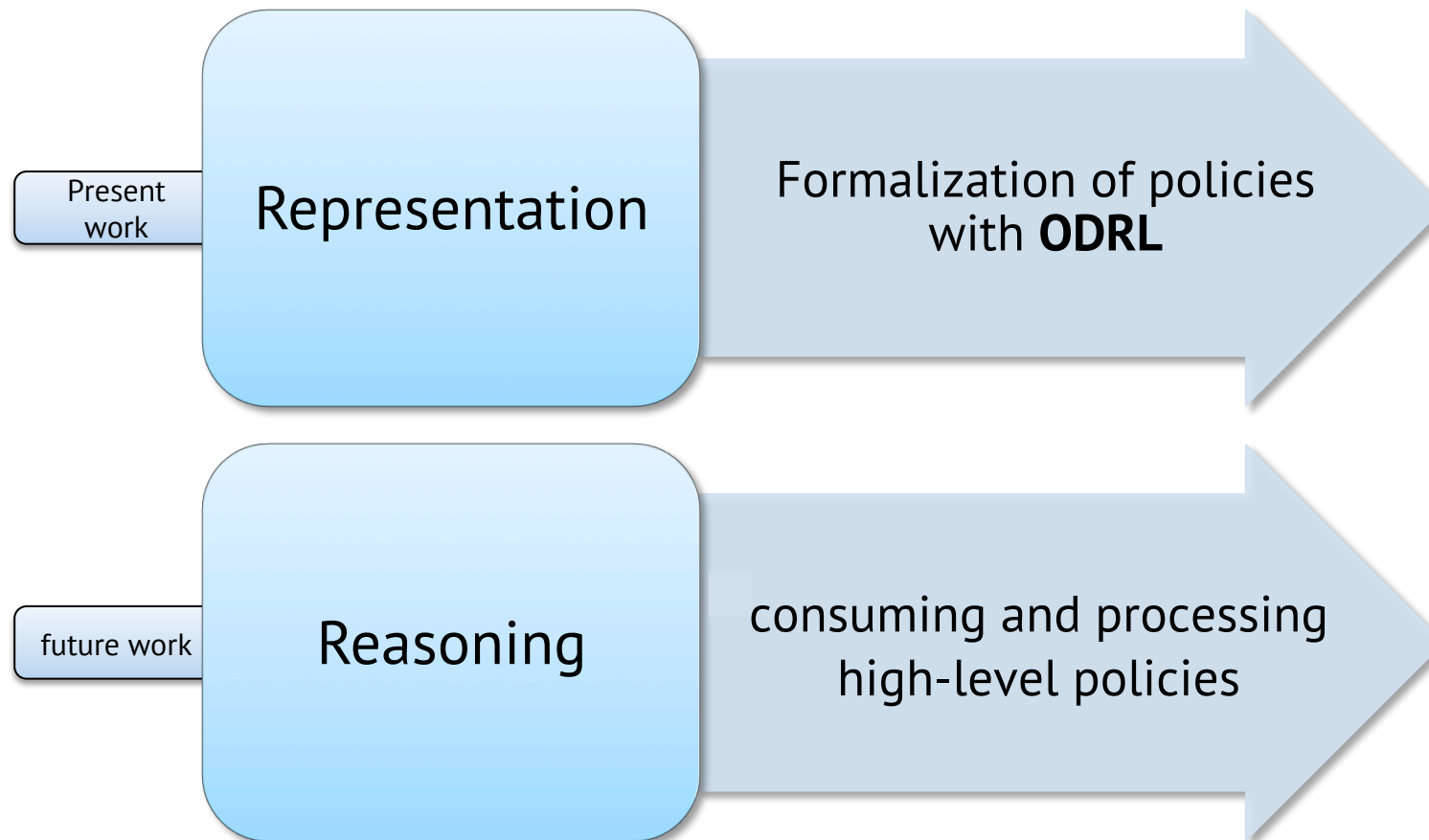
Data Publisher



Data Consumer



Goal: Representation & Reasoning



Representation:

ODRL

Obvious candidate ...

- Originally an XML representation of policies concerning digital rights management
- RDF representation & ontology (ODRL 2.1 Ontology) → final draft just published by W3C community group.

Linked Data Rights v2.0 Rodríguez-Doncel et al.



Linked Data Rights v2.0:
Extension of ODRL for Licensing Linked Data



<http://purl.oclc.org/NET/ldr/ns#>

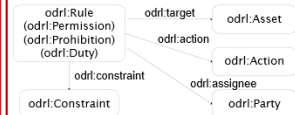
Linked Data Rights

The Linked Data Rights 2.0 (LDR) ontology provides the vocabulary for creating access policies and rights expressions for Linked Data resources. Linked Data assets (RDF triples, graphs, datasets, mappings...) can be object of protection by the intellectual property law, the database law or its access or publication be restricted by other legal reasons (personal data protection, security reasons, etc.) or simply by the publisher policies. Publishing a rights expression along with the digital asset allows the rightsholder waiving some or all of the IP and database rights (leaving the work in the public domain), permitting some operations if certain conditions are satisfied (like giving attribution to the author) or simply reminding the audience that some rights are reserved. It updates the LDR 1.0 presented at ISWC2013 in October.

Features

- ★ Extends the ODRL2.0 Ontology making a profile for Linked Data
- ★ Supports W3C Linked Data Platform resources and SPARQL methods
- ★ Supports Intellectual Property Rights, Database Rights and protection of Personal Data.
- ★ Suitable for declarative and enforceable policies alike (licenses / access control)
- ★ Implements the informative Extended Relations of ODRL2.0

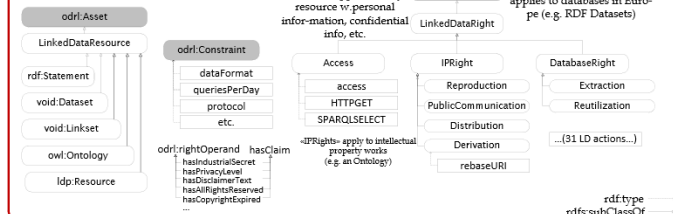
ODRL2.0



«An action is (permitted /prohibited / obliged) to be acted by the party over the asset, provided that the constraint holds»

W3C Community Group - Open Digital Rights Expression

Model



Examples

```

Licensing an ontology as CC-BY
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdf: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix dr: <http://purl.oclc.org/NET/ldr/ns#> .
@prefix cc: <http://creativecommons.org/licenses/by/3.0/> .

dr:license a dr:License ;
dr:license cc:cc-by .

Waiving rights for a RDF dataset
@prefix void: <http://www.w3.org/ns/void#> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix dr: <http://purl.oclc.org/NET/ldr/ns#> .
@prefix void: <http://www.w3.org/ns/void#> .

void:dataset a void:Dataset ;
void:dataset dr:license dr:license .

Offering a mapping for an amount of money
@prefix gr: <http://purl.org/goodrelations/> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix dr: <http://purl.oclc.org/NET/ldr/ns#> .
@prefix void: <http://www.w3.org/ns/void#> .
@prefix gr: <http://purl.org/goodrelations/> .

gr:gr a gr:GoodRelation ;
gr:gr dr:license dr:license .

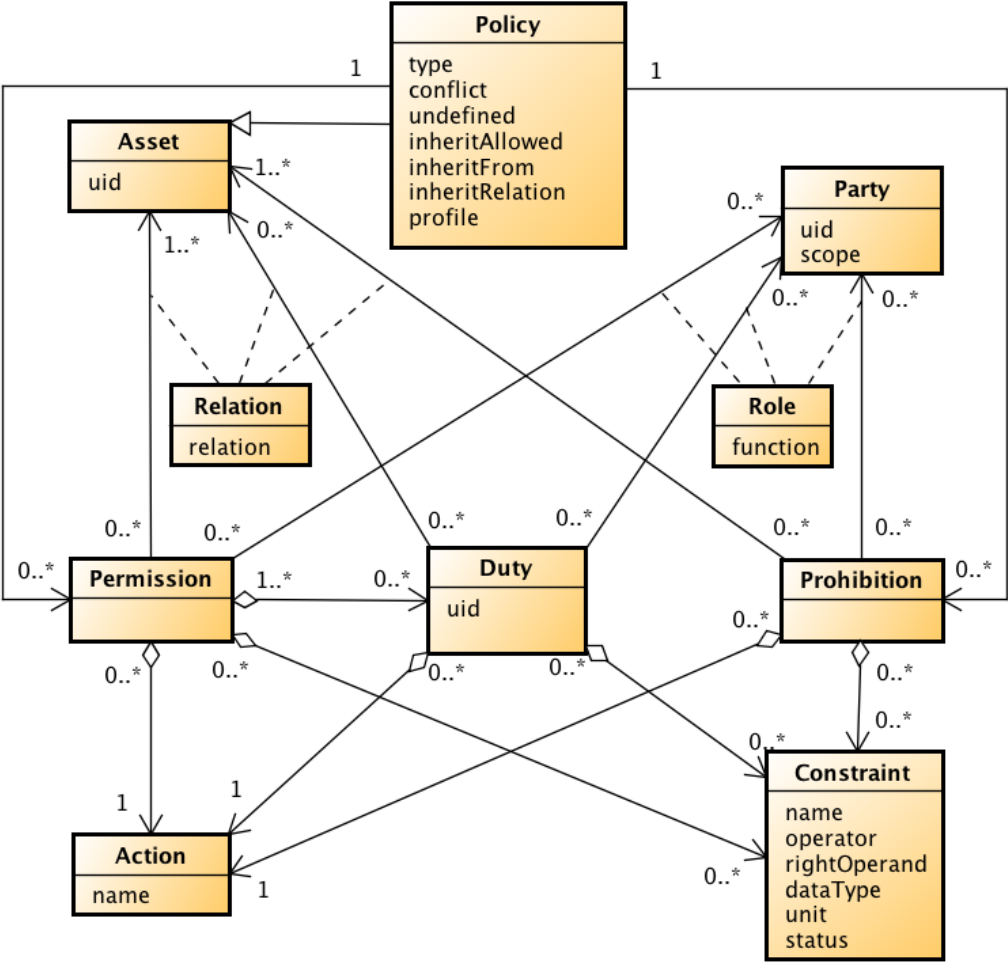
Declaring the confidentiality of a statement
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix dr: <http://purl.oclc.org/NET/ldr/ns#> .
@prefix void: <http://www.w3.org/ns/void#> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix dr: <http://purl.oclc.org/NET/ldr/ns#> .
@prefix void: <http://www.w3.org/ns/void#> .

```

Other Resources

- ★ A Java API: <http://proddon.github.io/odrlapi/>
- ★ Dataset with RDF licenses: <http://datahub.io/dataset/rdflicense>
- ★ Access control demo: <http://conditional.linkeddata.es/>

ODRL Core Model 2.0



ODRL Concepts 1/5

Policy

Policy

A **Policy** is the central entity that forms ODRL policy expressions. It can refer to **Permissions** and **Prohibitions** which hold for that **Policy** and be further distinguished into several subtypes such as:

Offer

A **Policy** which proposes terms of usage from an **Assigner** to possible **Assignees**.

Alice allows anyone who pays her 20€ to read her dataset.

Agreement

A **Policy** which contains all terms of usage between both an **Assigner** and an **Assignee** about an **Asset**.

Alice allows Bob to read her dataset if he pays her 20€.

ODRL Concepts 1/5

Policy

Request

A **Policy** which proposes terms of usage from an **Assignee** to an **Assigner** (owner of the **Asset**).

Bob wants to pay Alice 20€ if she allows him to read her dataset.

Ticket

A **Policy** which proposes terms of usage to any holder of a valid **Ticket**.

Dataset XY is accessible till May 2015 to any holder of a valid ticket.

Set

A **Policy** which defines **Prohibitions, Permissions** and/or **Duties** for a certain **Asset**.

Dataset XY is licensed under CC-BY. (i.e. duty to attribute asset owner)

Privacy

A **Policy** which defines terms of usage over personal information.

Alice grants Bob to distribute her personal data but only for the purpose of contacting Alice. Furthermore he has to delete the asset after 30 days.

ODRL Concepts 2/5

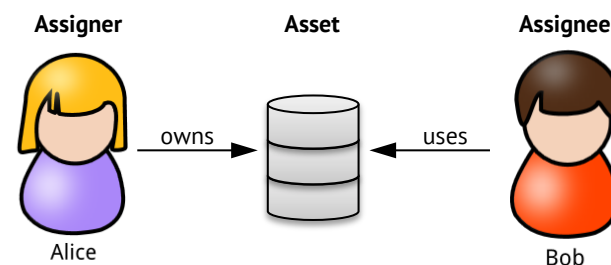
Asset and Party

Asset

An **Asset** is the entity whose terms of usage are restricted by its surrounding policy expression. In the domain of *Linked Data* an **Asset** usually represents a dataset or parts of a dataset (triples) .

Party

A **Party** can be distinguished into **Assigners** (the parties who propose the policy statements) and **Assignees** (the ones who receive the policy statements).



ODRL Concepts 3/5

Permission, Prohibition, and Duty

Permission

A **Permission** specifies **Actions** which are allowed to be executed on a certain **Asset**.

Alice allows Bob to read her dataset.

Prohibition

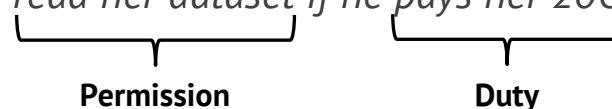
Prohibitions are used to forbid specific **Actions** on an **Asset** and cannot refer to **Duties**.

Alice prohibits Bob to distribute her dataset.

Duty

Duties define **Actions** that have to be performed so that surrounding **Permissions** or **Policies** become valid.

Alice allows Bob to read her dataset if he pays her 20€.



ODRL Concepts 4/5

Action

Action

Actions are operations on **Assets** that a potential **Assignee** is allowed (if related to a **Permission**), is prohibited (if related to a **Prohibition**) or has (if related to a **Duty**) to perform. In a Linked Data scenario actions could be:

aggregate – can be used to express the action of querying different datasets and aggregate the retrieved data.

read – the act of obtaining data from the asset (e.g. via SPARQL query).

copy - the action of copying data is fundamental when defining copyright restrictions and necessary for certain license definitions.

write - can be used to represent SPARQL INSERT queries, since it specifies the action of writing to an asset.

<custom> - although there are many preproposed **Actions** that can be used out of the box, new actions which might fit the intended semantics more precisely can easily be added to the ontology.

ODRL Concepts 5/5

Constraint

Constraint

Constraints offer the possibility to restrict and limit the scope of **Permissions**, **Prohibitions** and **Duties**, using a simple mathematical structure with two operands and one operator:

The number of query requests must be less or equal than 100.

operand operator operand

Additionally a specific **Purpose** of the constrained **Action** can be defined:

Reading from a dataset using ASK queries shall be restricted to 100 executions.

action purpose constraint

Access Policy Examples 1/7

Restricting access to specific parties and assets

Listing 1

```
@prefix odr1: <http://w3.org/ns/odrl/2/> .
@prefix : <http://www.example.com/> .

:policy1 a odr1:Agreement ;
  odr1:permission [
    a odr1:Permission;
    odr1:action odr1:read;
    odr1:target :dataset1, :dataset2;
    odr1:assigner :owner;
    odr1:assignee :alice
  ].
```


Access Policy Examples 2/7

Limiting number of allowed requests

Listing 2

```
@prefix spin: <http://spinrdf.org/sp/> .
@prefix odr1: <http://w3.org/ns/odr1/2/> .
@prefix : <http://www.example.com/> .

:policy2 a odr1:Agreement ;
  odr1:permission [
    a odr1:Permission;
    odr1:assigner :owner;
    odr1:assignee :alice;
    odr1:action odr1:read;
    odr1:target :dataset1;
    odr1:constraint [
      a odr1:Constraint;
      odr1:purpose spin:Ask;
      odr1:operator odr1:lteq;
      odr1:count "100"^^xsd:integer;
      odr1:status "42"^^xsd:integer].].
```

Access Policy Examples 3/7

Permit access only in specific time frames

Listing 3

```
@prefix spin: <http://spinrdf.org/sp/> .
@prefix odr1: <http://w3.org/ns/odr1/2/> .
@prefix : <http://www.example.com/> .

:policy3 a odr1:Agreement ;
  odr1:permission [
    a odr1:Permission;
    odr1:assigner :owner;
    odr1:assignee :alice;
    odr1:action odr1:read;
    odr1:target :dataset1;
    odr1:constraint [
      a odr1:Constraint;
      odr1:purpose spin:Ask;
      odr1:operator odr1:lteq;
      odr1:dateTime "2016-12-31"^^xsd:date
    ] .
```

Access Policy Examples 4/7

Representing license information (CC-BY-NC-SA)

Listing 4

```
@prefix odr1: <http://w3.org/ns/odr1/2/> .
@prefix : <http://www.example.com/> .

:policy4 a odr1:Set;
  odr1:permission [
    a odr1:Permission;
    odr1:action odr1:reproduce,
                odr1:distribute,
                odr1:derive;
    odr1:duty odr1:attribution,
              odr1:attachPolicy,
              odr1:shareAlike
  ] .
  odr1:prohibiton odr1:commercialize .
```

Villata et al. (ESWC 2014)

Access Policy Examples 5/7

Defining rights for derived data

Listing 5

```
@prefix odr1: <http://w3.org/ns/odrl/2/> .
@prefix : <http://www.example.com/> .

:policy5 a odr1:Set;
  odr1:permission [
    a odr1:Permission;
    odr1:action odr1:distribute;
    odr1:target :dataset;
    odr1:duty [
      a odr1:Duty;
      odr1:action odr1:nextPolicy;
      odr1:target :newPolicy ] .

:newPolicy a odr1:Set;
  odr1:permission [
    a odr1:Permission;
    odr1:action odr1:display;
    odr1:target :dataset] .
```

Access Policy Examples 6/7

Introducing payment duties

Listing 6

```
@prefix gr: <http://purl.org/goodrel/v1#> .
@prefix odr1: <http://w3.org/ns/odr1/2/> .
@prefix : <http://www.example.com/> .

:policy6 a odr1:Set;
  odr1:permission [
    a odr1:Permission;
    odr1:action odr1:read;
    odr1:target :dataset;
    odr1:duty [
      a odr1:Duty ;
      odr1:action odr1:pay ;
      odr1:constraint [
        a odr1:Constraint ;
        odr1:payAmount 50.00 ;
        odr1:operator odr1:eq ;
        odr1:unit <http://cvx.iptc.org/iso4217a:EUR>
      ] .
    ] .
  ] .
```

odr1:unit &
odr1:dataType
with ODRL 2.1

Access Policy Examples 7/7

Combining prohibitions and permissions

```
@prefix gr: <http://purl.org/goodrel/v1#> .
@prefix odr1: <http://w3.org/ns/odr1/2/> .
@prefix gn: <http://www.geonames.org/ontology#>.
@prefix : <http://www.example.com/> .
```

```
:policy7 a odr1:Set;
  odr1:permission [
    a odr1:Permission;
    odr1:action odr1:read;
    odr1:target :dataset;
    odr1:duty [
      a odr1:Duty;
      odr1:action odr1:pay;
      odr1:constraint [
        a odr1:Constraint ;
        odr1:payAmount 50.00 ;
        odr1:operator odr1:eq ;
        odr1:unit
          <http://cvx.iptc.org/iso4217a:EUR>
      ] .
    ] .
```

Listing 7

```
odr1:prohibition [
  a odr1:Prohibition;
  odr1:action odr1:distribute;
  odr1:target :dataset;
  odr1:constraint [
    a odr1:Constraint;
    odr1:operator odr1:eq;
    odr1:spatial [
      a gn:Feature.
      gn:countryCode "AT"
    ] .
  ] .
] .
```

Reasoning Tasks:

- As a first step, we look into implications between actions, permissions and duties associated with them which are ***not yet formally captured in ODRL***
- Next steps:
 - Consistency/Combinability of policies (for licences expressed in ODRL: **done** ;-) see last talk)
 - Alignment necessary in case policies refer to different RDF vocabularies?
 - E.g. Semantics of constraints needs more than plain OWL reasoning.
 - negotiation, etc. (not necessarily in scope of ODRL?)

Just a starting point...

- Formalizing ODRL 2.1:
- Conceptual model:

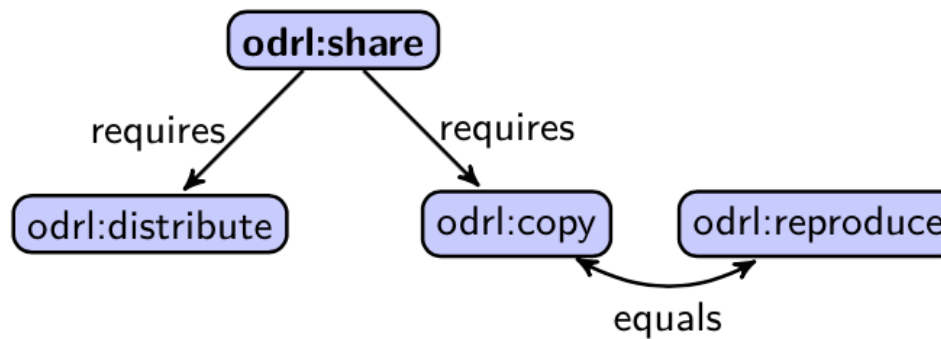
	ODRL Policy Components	
Policy	\mathcal{P}	$::= \mathcal{P}_{id} = [\langle (PRR_{id} PER_{id})^+ \rangle, \mathcal{ALG}]$
ProhibitionRule	PRR	$::= PRR_{id} = [\mathcal{RM}, \mathcal{A}, \mathcal{CONS}]$
PermissionRule	PER	$::= PER_{id} = [\mathcal{RM}, \mathcal{A}, \langle DUR_{id}^* \rangle, \mathcal{CONS}]$
DutyRule	DUR	$::= DUR_{id} = [\mathcal{RM}, \mathcal{A}, \mathcal{CONS}]$
ConstraintSet	\mathcal{CONS}	$::= \mathcal{CONS}_{id} = \langle \mathcal{CON}_{id}^* \rangle$
Constraint	\mathcal{CON}	$::= \mathcal{CON}_{id} = f^{bool}(status(a), operator(o), bound(a))$
RuleMatch	\mathcal{RM}	$::= \mathcal{RM}_{id} = \langle \mathcal{M}^+ \rangle$
Match	\mathcal{M}	$::= \mathcal{M}_{id} = \phi(a)$
Action	\mathcal{A}	$::= \mathcal{A}_{id} = action(a)$
		$\phi(a) ::= party(a) \mid asset(a)$
		$a ::= value$
		$o ::= eq \mid neq \mid lt \mid lteq \mid gt \mid gteq$
ConflictRes.Strat.	\mathcal{ALG}	$::= perm \mid prohibit \mid invalid$
	Query & Proof	
QueryRequest	\mathcal{Q}	$::= \langle party(a)?, action(a), asset(a) \rangle$
DutyTarget	\mathcal{DT}	$::= \mathcal{DT}_{id} = \langle party(a)?, action(a), asset(a)? \rangle$
DutyProof	\mathcal{DPF}	$::= \mathcal{DPF}_{id} = [\mathcal{DT}, \mathcal{CON}_{id}, status(a)]$
Proof	\mathcal{PF}	$::= \mathcal{PF}_{id} = [\mathcal{CON}_{id}, status(a)]$
ProofSet	\mathcal{PFS}	$::= \langle (\mathcal{DPF}_{id} \mathcal{PF}_{id})^* \rangle$

Table 1. Abstract Syntax of ODRL

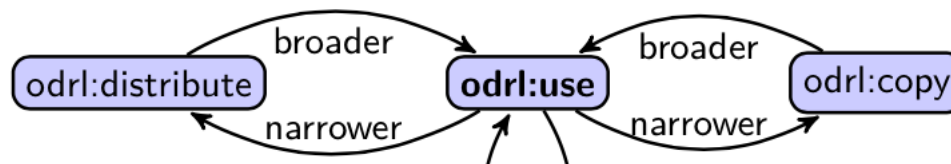
Just a starting point...

Implicit Dependencies among ODRL Actions

odrl:share: The act of the non-commercial reproduction and distribution of the asset to third-parties.



Other dependencies expressed using SKOS (in the ODRL ontology):



Our current work:

- 1) express these dependencies in terms of rules
- 2) express **conflict resolution strategies** in rules
 - perm: the Permissions will always takes precedence
 - prohibit: the Prohibitions will always takes precedence
 - invalid: the policy is not valid

Remarks:

- Some Duties/Prohibitions may be enforceable, others not. E.g.
 - "**Limiting number of allowed requests**" can be enforced by the server (block user)...
 - But how about controlling **distribution of items to which are readable only**?
 - read implies the **ability** "can copy/distribute,
 - → may make sense to distinguish between "enforcable" and non-enforcable" policies, between ability and enforcability?
 - Cf. existing work on policiy negotiation?

Summary: Representing & Reasoning about Linked Data policies with ODRL

(1) only a starting point

- **Many more things to do:
reasoning, enforcement of fulfillment,...**

(2) popular & emerging research topic

- **Rodríguez, Villata, Rotolo, Governatori...**

Other topics related to Normative MAS, I'd love to discuss, except enabling Data Markets (but no time ☹) ... :

- Policies and regulations in safety-critical engineering projects (national project SHAPE)
- Belief revision and SPARQL Update with RDFS/OWL entailment (national project SEE)
- How to enable Semantic Search in legal texts / laws? (project with the Federal Chancellery of Austria: RISearch)
- Details: <http://www.polleres.net/>

... Hopefully time to discuss these offline with you! 😊

This work is being supported by the FFG project 845638 (SHAPE) and by the WWTF project ICT12-015 (SEE)