
RELD

Release 0.1

Manzoor Ali

Feb 06, 2023

CONTENTS

1	Contents	3
1.1	Introduction	3
1.2	Tutorial	3
1.3	Schema	14
1.4	Availablity	25

Note: This project is under active development.

CONTENTS

1.1 Introduction

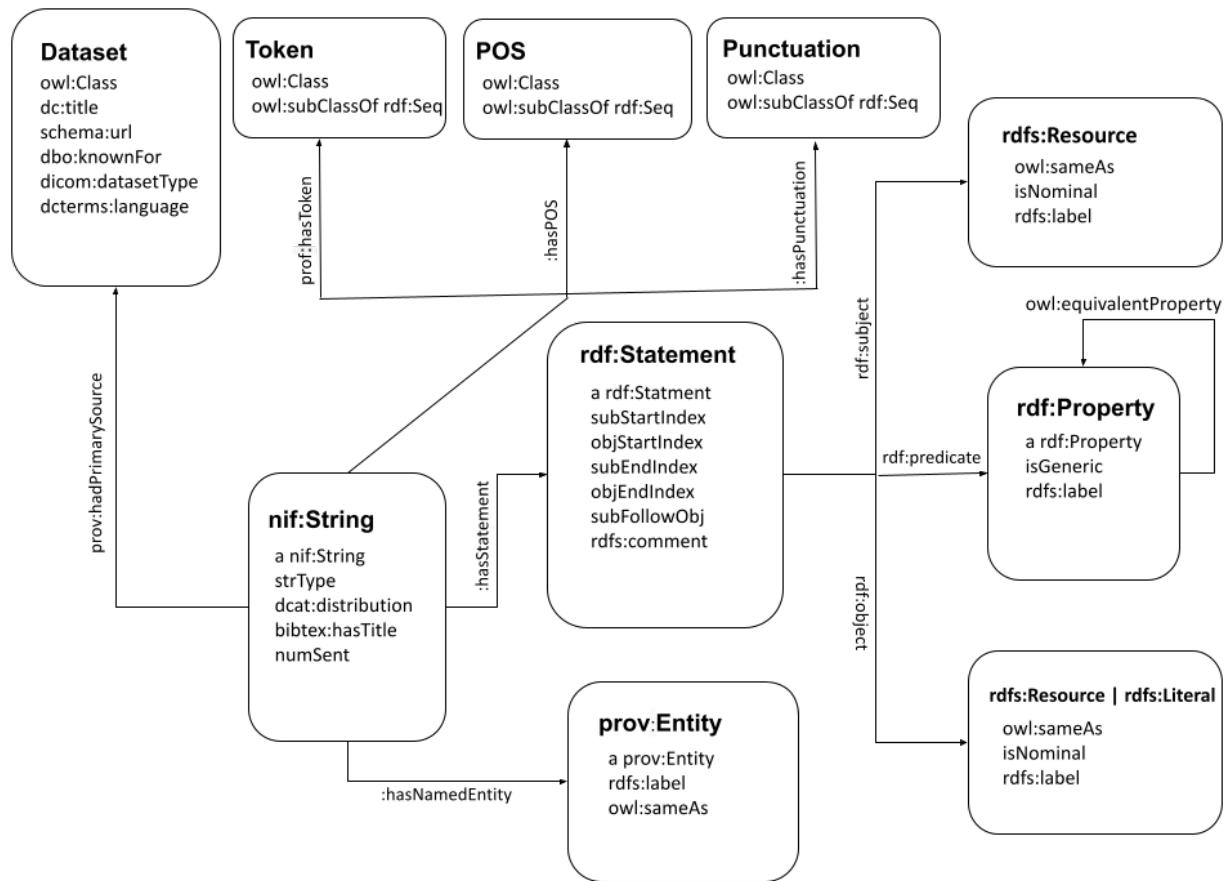
Relation extraction plays an important role in natural language processing. There is a wide range of available datasets that benchmark existing relation extraction approaches. However, most benchmarking datasets are provided in different formats containing specific annotation rules, thus making it difficult to conduct experiments on different types of relation extraction approaches. We present **RELD**, an RDF knowledge graph of eight open-licensed and publicly available relation extraction datasets. We modeled the benchmarking datasets into a single ontology that provides a unified format for data access, along with annotations required for training different types of relation extraction systems. Moreover, **RELD** abides by the Linked Data and FAIR principles. To the best of our knowledge, **RELD** is the largest *RDF knowledge graph* of entities relations from text, containing 1230 million triples describing 1034 relations, 2 million sentences, 3 million abstracts and 4013 documents. **RELD** contributes to a variety of uses in the natural language processing community, and distinctly provides unified and easy modeling of data for benchmarking relation extraction and named entity recognition models.

1.2 Tutorial

On this and next few pages, we will introduce the basics implementation usage and example of **RELD** knowledge Graph.

1.2.1 Framework

The diagram shows the basic **RELD** Framework. This diagram explains the basic schema of the **RELD**. The edges represent the relations between different classes, while the rectangles represent classes in our schema. The complete explanation of vocabularies and ontologies is available in other sections. For the TTL version of schema, click on the [link](#)



1.2.2 Mapping to RELD

The following diagram shows an overview of all the steps required to convert a relation extraction dataset to RDF and integrate it into an RDF-based RELD knowledge graph. The input is a relation extraction dataset available in different formats such as XML, txt, or JSON. Then a python script using [RDFLib](#) and other python libraries converts the dataset to RDF form. Furthermore, we use [sameAs](#) and [DBpedia spotlight](#) to link entities with other large knowledge bases such as [DBpedia](#) and [Wikidata](#). In addition, we use tools like [Spacy](#) and [NLTK](#) to add missing annotations. Finally combines all the previous steps using RELD schema and makes it available publicly using a dereferenceable knowledge graph using [LodView](#).

1.2.3 Used Namespaces

Some of the namespaces we used in **RELD**:

```

@prefix reldr: <http://reld.dice-research.org/resource/>
@prefix reldp: <http://reld.dice-research.org/property/>
@prefix dbo: <http://dbpedia.org/ontology/>
@prefix dc: <http://purl.org/dc/elements/1.1/>
@prefix freebase: <http://rdf.freebase.com/ns>
@prefix owl: <http://www.w3.org/2002/07/owl#>

```

(continues on next page)

(continued from previous page)

```

@prefix ps: <http://www.wikidata.org/prop/statement/>
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@prefix xml: <http://www.w3.org/XML/1998/namespace>
@prefix xsd: <http://www.w3.org/2001/XMLSchema#>
@prefix prov: <http://www.w3.org/ns/prov#>
@prefix schema: <http://schema.org/>
@prefix dicom: <http://purl.org/healthcarevocab/v1>
@prefix dcterms: <http://purl.org/dc/terms/>
@prefix nif: <http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-core#>
@prefix foaf: <http://xmlns.com/foaf/0.1/>
@prefix void: <http://rdfs.org/ns/void#>
@prefix bibtex: <http://purl.org/net/nknouf/ns/bibtex#>
@prefix dcat: <http://www.w3.org/ns/dcat>
@prefix prof: <http://www.w3.org/ns/dx/prof/hasToken>

```

1.2.4 Example Resource

Following is an example resource:

```

@prefix nif: <http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-core#>
@prefix ns1: <http://www.w3.org/ns/dx/prof/>
@prefix ns2: <http://purl.org/net/nknouf/ns/bibtex#>
@prefix ns3: <http://www.w3.org/ns/>
@prefix owl: <http://www.w3.org/2002/07/owl#>
@prefix prov: <http://www.w3.org/ns/prov#>
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@prefix reld: <http://reld.dice-research.org/schema/>
@prefix reldr: <http://reld.dice-research.org/resource/>
@prefix reldp: <http://reld.dice-research.org/property/>
@prefix xsd: <http://www.w3.org/2001/XMLSchema#>

# STRING INSTANCE
reldr:S-1375181 a nif:String ;
  ns2:hasTitle "Sonic Extreme"^^xsd:string ;
  reldr:hasPOS reldr:posSeq1375181 ;
  reldr:hasPunctuation reldr:puncSeq1375181 ;
  reld:hasNamedEntity reldr:sonic,
  reldr:sonic_extreme ;
  reld:hasStatement reldr:Stmt13751810 ;
  reld:numSent "2"^^xsd:int ;
  reld:strType "document"^^xsd:string ;
  ns3:dcatdistribution "train"^^xsd:string ;
  ns1:hasToken reldr:token_1375181 ;
  prov:hadPrimarySource reldr:ds_08 .

# PARTS OF SPEECH POS INSTANCE
reldr:posSeq1375181 a reld:POS ;
  rdf:_0 "JJ"^^xsd:string ;
  rdf:_1 "NNP"^^xsd:string ;

```

(continues on next page)

(continued from previous page)

```

rdf:_10 "NNP"^^xsd:string ;
rdf:_11 "DT"^^xsd:string ;
rdf:_12 "NNP"^^xsd:string ;
rdf:_13 "NN"^^xsd:string ;
rdf:_14 "IN"^^xsd:string ;
rdf:_15 "DT"^^xsd:string ;
rdf:_16 "NNP"^^xsd:string ;
rdf:_17 "."^^xsd:string ;
rdf:_18 "IN"^^xsd:string ;
rdf:_19 "DT"^^xsd:string ;
rdf:_2 "VBZ"^^xsd:string ;
rdf:_20 "NN"^^xsd:string ;
rdf:_21 "VBD"^^xsd:string ;
rdf:_22 "RB"^^xsd:string ;
rdf:_23 "RB"^^xsd:string ;
rdf:_24 "VBN"^^xsd:string ;
rdf:_25 ","^^xsd:string ;
rdf:_26 "NN"^^xsd:string ;
rdf:_27 "IN"^^xsd:string ;
rdf:_28 "DT"^^xsd:string ;
rdf:_29 "NN"^^xsd:string ;
rdf:_3 "DT"^^xsd:string ;
rdf:_30 "VBD"^^xsd:string ;
rdf:_31 "VBN"^^xsd:string ;
rdf:_32 "RB"^^xsd:string ;
rdf:_33 "RB"^^xsd:string ;
rdf:_34 "IN"^^xsd:string ;
rdf:_35 "DT"^^xsd:string ;
rdf:_36 "NN"^^xsd:string ;
rdf:_37 "NN"^^xsd:string ;
rdf:_38 "NN"^^xsd:string ;
rdf:_39 "."^^xsd:string ;
rdf:_4 "JJ"^^xsd:string ;
rdf:_5 "NN"^^xsd:string ;
rdf:_6 "NN"^^xsd:string ;
rdf:_7 "NN"^^xsd:string ;
rdf:_8 "IN"^^xsd:string ;
rdf:_9 "DT"^^xsd:string .

# TOKEN INSTANCE
reldr:token_1375181 a reld:Token ;
  rdf:_0 "Sonic"^^xsd:token ;
  rdf:_1 "Extreme"^^xsd:token ;
  rdf:_10 "Sonic"^^xsd:token ;
  rdf:_11 "the"^^xsd:token ;
  rdf:_12 "Hedgehog"^^xsd:token ;
  rdf:_13 "series"^^xsd:token ;
  rdf:_14 "for"^^xsd:token ;
  rdf:_15 "the"^^xsd:token ;
  rdf:_16 "Xbox"^^xsd:token ;
  rdf:_17 "."^^xsd:token ;
  rdf:_18 "While"^^xsd:token ;

```

(continues on next page)

(continued from previous page)

```

rdf:_19 "the"^^xsd:token ;
rdf:_2 "is"^^xsd:token ;
rdf:_20 "game"^^xsd:token ;
rdf:_21 "was"^^xsd:token ;
rdf:_22 "never"^^xsd:token ;
rdf:_23 "officially"^^xsd:token ;
rdf:_24 "released"^^xsd:token ;
rdf:_25 ","^^xsd:token ;
rdf:_26 "footage"^^xsd:token ;
rdf:_27 "of"^^xsd:token ;
rdf:_28 "the"^^xsd:token ;
rdf:_29 "game"^^xsd:token ;
rdf:_3 "a"^^xsd:token ;
rdf:_30 "was"^^xsd:token ;
rdf:_31 "received"^^xsd:token ;
rdf:_32 "very"^^xsd:token ;
rdf:_33 "poorly"^^xsd:token ;
rdf:_34 "by"^^xsd:token ;
rdf:_35 "the"^^xsd:token ;
rdf:_36 "video"^^xsd:token ;
rdf:_37 "game"^^xsd:token ;
rdf:_38 "press"^^xsd:token ;
rdf:_39 "."^^xsd:token ;
rdf:_4 "cancelled"^^xsd:token ;
rdf:_5 "skateboarding"^^xsd:token ;
rdf:_6 "video"^^xsd:token ;
rdf:_7 "game"^^xsd:token ;
rdf:_8 "in"^^xsd:token ;
rdf:_9 "the"^^xsd:token .

# PUNCTUATION INSTANCE
reldr:puncSeq1375181 a reld:Punctuation ;
  rdf:_0 "."^^xsd:string ;
  rdf:_1 ","^^xsd:string ;
  rdf:_2 "."^^xsd:string .

# STATEMENT INSTANCE
reldr:Stmt13751810 a rdf:Statement ;
  reld:objEndIndex 7 ;
  reld:objStartIndex 6 ;
  reld:subEndIndex 1 ;
  reld:subFollowObj false ;
  reld:subStartIndex 0 ;
  rdf:object reldr:video_game ;
  rdf:predicate reld:p:P31 ;
  rdf:subject reldr:sonic_extreme .

# SUBJECT/ENTITY INSTANCE
reldr:sonic_extreme a rdfs:Resource,
  prov:Entity ;
  rdfs:label "Sonic_Extreme"^^xsd:string,
  "sonic_extreme"^^xsd:string .

```

(continues on next page)

(continued from previous page)

```

# OBJECT INSTANCE
reldr:brave_video_game a rdfs:Resource ;
    rdfs:label "Brave_video_game"^^xsd:string .

# PREDICATE INSTANCE
reldp:P31 a rdf:Property ;
    rdfs:label "P31"^^xsd:string ;
    owl:equivalentProperty reldp:instance_of .

# DATASET INSTANCE
reldr:ds_08 a reld:Dataset ;
    dbo:knownFor "relation_extraction_and_natural_language"^^xsd:string ;
    dc:title "T-REx"^^xsd:string ;
    dcterms:language "en"^^xsd:string ;
    dicom:datasetType "document"^^xsd:string ;
    schema:url <https://hadyelsahar.github.io/t-rex/downloads> .

```

1.2.5 Some useful queries

```

# Get all Relations from NYT-FB dataset.

SELECT DISTINCT ?relation
FROM <http://reld.dice-research.org/Nyt-FB>
WHERE {
    ?s a rdf:Statement;
        rdf:predicate ?relation.
}

```

```

#Get all triples from Wikipedia-Wikidata

SELECT DISTINCT count(*)
FROM <http://reld.dice-research.org/WikiRE>
WHERE {
    ?s ?p ?o .
}

```

```

# Get all distinct String instances which have number of tokens higher than 250

PREFIX reld: <http://reld.dice-research.org/schema/>
PREFIX nif: <http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-core#>
PREFIX prof: <http://www.w3.org/ns/dx/prof/>
SELECT DISTINCT ?sent
WHERE {
    ?sent a nif:String;
        prof:hasToken ?token.

    ?token ?p ?o.
}
GROUP BY ?sent

```

(continues on next page)

(continued from previous page)

```
HAVING (COUNT (?token ) > 250)
```

```
# Select all sentences containing more than 50 named entities
```

```
PREFIX reld: <http://reld.dice-research.org/schema/>
PREFIX nif: <http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-core#>
PREFIX prof: <http://www.w3.org/ns/dx/prof/>
PREFIX prov: <http://www.w3.org/ns/prov#>
SELECT DISTINCT ?sent
WHERE {
  ?sent a nif:String;
        reld:hasNamedEntity ?ent.
}
GROUP BY ?sent
HAVING (COUNT (?ent) > 50)
```

```
# Select all distinct relations with averages of subject and object start indices
```

```
PREFIX reldv: <http://reld.dice-research.org/schema/>
PREFIX nif: <http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-core#>
PREFIX prof: <http://www.w3.org/ns/dx/prof/>
PREFIX prov: <http://www.w3.org/ns/prov#>

SELECT DISTINCT ?r (AVG(?subIndex) as ?avgSubStrtIdx) (AVG(?objIndex) as ?avgObjStrtIdx)
WHERE {
  ?stmt a rdf:Statement;
  rdf:predicate ?r;
  reldv:subStartIndex ?subIndex;
  reldv:objStartIndex ?objIndex.
}
}
```

```
# Generate benchmark of having sentences length less than 50, and other required features
```

```
PREFIX reld:<http://reld.dice-research.org/schema/>
PREFIX nif:<http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-core#>
PREFIX prof:<http://www.w3.org/ns/dx/prof/>
SELECT DISTINCT
?sent ( count(?t ) as ?Tokens) ( count (?e) as ?Entities) ( count(?stmt) as ?Statment)
WHERE
{
  ?sent a nif:String ;
  reld:hasStatement ?stmt ;
  reld:hasNamedEntity ?e ;
  prof:hasToken ?token .
  ?token ?p ?t .
}
GROUP BY ?sent
HAVING ( COUNT(?stmt) > 4 && COUNT (?e) > 10 && COUNT(?t ) < 50)
```

```
# A balance dataset of relations each having 700 sentences
```

```
PREFIX reld:<http://reld.dice-research.org/schema/>
PREFIX nif:<http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-core#>
PREFIX prof:<http://www.w3.org/ns/dx/prof/>
SELECT DISTINCT ?properties COUNT(?sent )
WHERE {
    ?sent a nif:String ;
    reld:hasStatement ?stmt .
    ?stmt rdf:predicate ?properties .
}
GROUP BY ?properties
HAVING ( COUNT(?sent ) = 700)
```

1.2.6 Dereferencing

We also allow dereferencing our dataset URIs using the LodView link. LodView allows RELD users to browse our RDF resource and offers an easy-to-use representation of the RDF data. An example resource from LodView is shown in the following figure. To see it online, click [here](#)

The screenshot shows the LodView interface for the resource `http://reld.dice-research.org/resource/cbs`. The main content area displays the CBS logo and the URI. Below this, a table lists the following properties:

Property	Value
<code>rdf:label</code>	CBS cbs
<code>rdf:type</code>	<code>prov:Entity</code>
<code>rdf:type</code>	<code>rdfs:Resource</code>
<code>owl:sameAs</code>	<code>dbpedia:CBS</code>

Below the table, the 'INVERSE RELATIONS' section shows:

- `is http://reld.dice-research.org/schema:hasNamedEntity` of 1498 resources
- `is rdf:object of` 1156 resources
- `is rdf:subject of` 354 resources

The 'DATA FROM THE LINKED DATA CLOUD' section displays a grid of related resources, including:

- Resource connected to:** Resource not online 100 Resource loaded 16
- CBS** (http://dbpedia.org/resource/CBS): CBS Broadcasting Inc. an abbreviation of its former legal name Columbia Broadcasting System and commonly known as CBS, is an American commercial broadcast television and radio network. It is the
- CBS** (http://www.wikidata.org/entity/Q4330): CBS (미국인 방송사) (미국어, 방송사)
- Columbia Broadcasting System** (http://en.wikipedia.org/wiki/CBS): SCPT tag for 'CBS' is undetermined. Name is Columbia Broadcasting System, Inc.
- CBS (미국인 방송사)** (http://ko.wikipedia.org/resource/CBS): CBS(영어: CBS Broadcasting Inc. AME 방송 네트워크)는 미국에서 방송하는 텔레비전, 라디오, 인터넷 방송사이다. 미국에서 방송하는 텔레비전 방송사 중 가장 오래된 방송사 중 하나이다. 1928년 설립된 CBS는 1941년 11월 30일 CBS 라디오 네트워크를 통해 텔레비전 방송을 시작하였다. CBS는 현재 미국에서 가장 오래된 텔레비전 네트워크 중 하나이다. CBS는 현재 미국에서 가장 오래된 텔레비전 네트워크 중 하나이다.
- Columbia Broadcasting System, Inc.** (http://www.wikidata.org/entity/Q4330): CBS (미국인 방송사) (미국어, 방송사)
- CBS** (http://ko.wikipedia.org/resource/CBS): CBS(영어: CBS Broadcasting Inc. AME 방송 네트워크)는 미국에서 방송하는 텔레비전, 라디오, 인터넷 방송사이다. 미국에서 방송하는 텔레비전 방송사 중 가장 오래된 방송사 중 하나이다. 1928년 설립된 CBS는 1941년 11월 30일 CBS 라디오 네트워크를 통해 텔레비전 방송을 시작하였다. CBS는 현재 미국에서 가장 오래된 텔레비전 네트워크 중 하나이다. CBS는 현재 미국에서 가장 오래된 텔레비전 네트워크 중 하나이다.
- CBS** (http://fr.dbpedia.org/resource/CBS): CBS (San incisione del antiguo nombre de la red, la Columbia Broadcasting System) es una cadena de televisión abierta estadounidense, que tiene sus raíces como una cadena de radio propiedad de la división CBS Entertainment Group de ViacomCBS. Es la tercera cadena de televisión más grande en el mundo, detrás de la American Broadcasting Company.
- CBS** (http://yago-knowledge.org/resource/CBS): American broadcast television network (en)

1.2.7 Usage

Named Graphs

To use the data of a single relation extraction dataset **RELD** uses a named graph. Named graphs in **RELD** are kept using the `http://reld.dice-research.org/dataset_name`. `dataset_name` in URI represents the name of each dataset. For simplicity, we use the names of the datasets as shown in the following *Table*. Few datasets names are shorten for simplicity.

Table 1: Named Graphs with their used URIs in RELD

Dataset	Named Graphs
SemEval 2010 Task 8	http://reld.dice-research.org/SemEval
NYT-FB	http://reld.dice-research.org/Nyt-FB
FewREL	http://reld.dice-research.org/FewRel
Google-RE	http://reld.dice-research.org/Google-RE
WebNLG	http://reld.dice-research.org/WebNLG
Wikipedia-Wikidata	http://reld.dice-research.org/WikiRE
DocRED	http://reld.dice-research.org/DocRed
T-REx	http://reld.dice-research.org/T-Rex

nif:String

Sentences/Documents are represented in the String IRI format as http://reld.dice-research.org/resource`S_ID`. ID in *S_ID* is the unique value for each string or document. All the properties of the sentences/documents are attached to the sentences. The detail of each property is available in our schema.

rdf:Statement

Each string has a corresponding single or multiple annotated statements. This RDF statement also has a unique IRI like the *nif:String*. Each statement has an attached Subject and the object also has an attached predicate which represents the corresponding relation.

Relation

Relations are attached with statements as *rdf:predicate*. The IRI is different than other resources to uniquely differentiate predicate from other resources. Instead of resource we use *property* for relations http://reld.dice-research.org/property/property_name.

RELD Preferred Namespaces

We use three different namespaces for RELD.

- reld: for schema of reld such as classes and properties
- reldr: for resources such as instances
- reldp: for properties/predicates

Table 2: Namespaces with IRIs

Namespaces	IRI
reld	http://reld.dice-research.org/schema/
reldr	http://reld.dice-research.org/resource/
reldp	http://reld.dice-research.org/property/

1.2.8 RELD Metadata in Void

We represents metadata of **RELD** in void representation.

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
@prefix dcterms: <http://purl.org/dc/terms/> .
@prefix void: <http://rdfs.org/ns/void#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix relldr: <https://reld.dice-research.org/resource/> .
@prefix : <#> .

:RELD
  rdf:type void:Dataset ;
  foaf:homepage <https://reld-tutorial.readthedocs.io/en/latest/intro.html> ;
  dcterms:title "Knowledge Graph of Relation Extraction" ;
  void:sparqlEndpoint <http://reld.cs.upb.de:8890/sparql>;
  dcterms:contributor <https://dice-research.org> ;
  dcterms:source <https://github.com/dice-group/RELD> ;
  dcterms:modified "2022-11-03"^^xsd:date ;
  dcterms:publisher :Manzoor_Ali ;
  dcterms:publisher :Muhammad_Saleem ;
  dcterms:publisher :Diego_Moussallem ;
  dcterms:publisher :Mohamed_Ahmed_Sherif ;
  dcterms:publisher :Axel-Cyrille_Ngonga_Ngomo ;
  dcterms:license <https://creativecommons.org/licenses/by-nc/3.0/> ;
  void:feature <https://www.w3.org/ns/formats/data/Turtle> ;
  void:feature <https://www.w3.org/ns/formats/data/JSON-LD>;
  void:triples 55305748 ;
  void:vocabulary <http://reld.dice-research.org/resource/> ;
  void:vocabulary <http://reld.dice-research.org/schema/> ;
  void:vocabulary <http://purl.org/ontology/bibo/> ;
  void:vocabulary <http://purl.org/net/nknouf/ns/bibtex#> ;
  void:vocabulary <http://purl.org/dc/terms/> ;
  void:vocabulary <http://xmlns.com/foaf/0.1/> ;
  void:vocabulary <http://www.w3.org/2005/11/its/rdf#> ;
  void:vocabulary <http://www.w3.org/ns/prov#> ;
  void:vocabulary <http://www.w3.org/1999/02/22-rdf-syntax-ns#> ;
  void:vocabulary <http://www.w3.org/2000/01/rdf-schema#> ;
  void:vocabulary <http://schema.org/> ;
  void:vocabulary <http://www.w3.org/2006/vcard/ns#> ;
  void:vocabulary <http://www.w3.org/XML/1998/namespace> ;
  void:vocabulary <http://www.w3.org/2001/XMLSchema#> ;
  void:vocabulary <https://data.linkeddatafragments.org/> ;
  void:linkPredicate rdfs:seeAlso ;
  void:linkPredicate rdfs:label ;
  void:linkPredicate rdf:type ;
  void:linkPredicate owl:equivalentProperty ;
  void:linkPredicate owl:sameAs .

relldr:Google_RE a void:Dataset;
```

(continues on next page)

(continued from previous page)

```

void:target <https://reld.dice-research.org/>;
void:target <https://github.com/google-research-datasets/>;
void:linkPredicate owl:sameAs;
void:triples 685633 .

reldr:NYT-FB a void:Dataset;
  void:target <https://reld.dice-research.org/>;
  void:target <http://iesl.cs.umass.edu/riedel/ecml/>;
  void:linkPredicate owl:sameAs;
  void:triples 3119910 .
reldr:FewRel a void:Dataset;
  void:target <https://reld.dice-research.org/>;
  void:target <https://www.zhuhao.me/fewrel/>;
  void:linkPredicate owl:sameAs;
  void:triples 1288803 .
reldr:SemEval a void:Dataset;
  void:target <https://reld.dice-research.org/>;
  void:target <http://www.kozareva.com/>;
  void:linkPredicate owl:sameAs;
  void:triples 188991 .

reldr:WebNLG a void:Dataset;
  void:target <https://reld.dice-research.org/>;
  void:target <https://webnlg-challenge.loria.fr/>;
  void:linkPredicate owl:sameAs;
  void:triples 1863267 .

reldr:Wiki-RE a void:Dataset;
  void:target <https://reld.dice-research.org/>;
  void:target <https://www.informatik.tu-darmstadt.de/ukp/research_ukp/ukp_research_
↳data_and_software/>;
  void:linkPredicate owl:sameAs;
  void:triples 41156660 .

reldr:docRed a void:Dataset;
  void:target <https://reld.dice-research.org/>;
  void:target <https://github.com/thunlp/DocRED>;
  void:linkPredicate owl:sameAs;
  void:triples 2487493 .
reldr:t-rex a void:Dataset;
  void:target <https://reld.dice-research.org/>;
  void:target <https://hadyelsahar.github.io/t-rex/downloads/>;
  void:linkPredicate owl:sameAs.

:Manzoor_Ali a
  foaf:Person ;
  rdfs:label "Manzoor Ali" ;
  foaf:homepage <https://dice-research.org/ManzoorAli>;
  foaf:mbox <mailto:manzoor@mail.uni-paderborn.de> .

:Mohammad_Saleem a

```

(continues on next page)

(continued from previous page)

```

foaf:Person ;
rdfs:label "Muhammad Saleem" ;
foaf:homepage <https://dice-research.org/MuhammadSaleem>;
foaf:mbox <mailto:saleem@informatik.uni-leipzig.de> .

:Diego_Moussallem a
foaf:Person ;
rdfs:label "Diego Moussallem" ;
foaf:homepage <https://dice-research.org/DiegoMoussallem>;
foaf:mbox <mailto:diego.moussallem@uni-paderborn.de> .

:Mohamed_Ahmed_Sherif a
foaf:Person ;
rdfs:label "Mohamed Ahmed Sherif" ;
foaf:homepage <https://dice-research.org/MohamedAhmedSherif>;
foaf:mbox <mailto:mohamed.sherif@upb.de> .

:Axel-Cyrille_Ngonga_Ngomo a
foaf:Person ;
rdfs:label "Axel-Cyrille Ngonga Ngomo" ;
foaf:homepage <https://dice-research.org/AxelCyrilleNgongaNgomo>;
foaf:mbox <mailto:axel.ngonga@upb.de> .

```

1.3 Schema

Following is a view of reld schema

```

@prefix : <http://reld.dice-research.org/schema/> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix xml: <http://www.w3.org/XML/1998/namespace> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base <http://reld.dice-research.org/schema/> .

<http://reld.dice-research.org/schema/> rdf:type owl:Ontology ;
                                         owl:versionIRI <http://reld.dice-research.org/
↳ schema#/0.0.2> ;
                                         <http://purl.org/dc/elements/1.1/contributor>
↳ "Axel-Cyrille Ngonga Ngomo" ,
                                         <http://purl.org/dc/elements/1.1/creator>
↳ "Muhammad Saleem" ;
                                         <http://purl.org/dc/elements/1.1/description> ""
↳ "The RELD Core Schema (http://reld.dice-research.org/schema#) provides classes and
↳ properties to describe the NLP sub task Relation Extraction. The schema models the

```

(continues on next page)

(continued from previous page)

→relations, sentences, entities and related concepts. The schema represents the
 →relation extraction in a standard manner where other relation extraction related
 →datasets can easily mapped to this schema. The schema is available on our webpage and
 →we recommend the audience to visit our web page and explore our pre-print paper to
 →further explore the schema.

The main class in this ontology is `reld:Relation`, which is the class of all relations
 →available in different RE based datasets.

The data built using RELD schema its diagram all are available online. Apart from
 →relation class RELD also maps sentences, subjects, objects, named entities and related
 →properties.

Feedback

If you'd like to leave feedback, please open an issue on GitHub (<https://github.com/dice-group/RELD>) and read the README or write an email to the mailing list: given on the
 →Github page.

Versioning process is explained here: <https://reld-tutorial.readthedocs.io/en/latest/availability.html#version>

Licence information is available here: <https://reld-tutorial.readthedocs.io/en/latest/availability.html#license> @en ;

```

    <http://purl.org/dc/elements/1.1/publisher>
    "DICE, University Paderborn" ;
    <http://purl.org/dc/elements/1.1/rights> "The
    schema is licensed under GNU General Public License v3.0 (https://www.gnu.org/licenses/
    gpl-3.0.en.html)" ;
    <http://purl.org/dc/elements/1.1/title>
    "Relation Extraction Linked Data"@en ;
    <http://purl.org/dc/terms/license> "https://www.
    gnu.org/licenses/gpl-3.0.en.html" ;
    :preferredNamespacePrefix "http:reld.dice-
    research.org/schema#" ,
    "reld" ;
    <http://reld.dice-research.org/schema/ww.w3.org/
    2000/01/rdf-schema#isDefinedBy> "https://github.com/dice-group/RELD/blob/main/ontology.
    ttl" ;
    <http://reld.dice-research.org/schema/ww.w3.org/
    2002/07/owl#versionInfo> "0.0.2" .
  
```

```
#####
```

```
# Annotation properties
```

```
#####
```

```
### http://purl.org/dc/elements/1.1/contributor
```

```
<http://purl.org/dc/elements/1.1/contributor> rdf:type owl:AnnotationProperty .
```

```
### http://purl.org/dc/elements/1.1/creator
```

```
<http://purl.org/dc/elements/1.1/creator> rdf:type owl:AnnotationProperty .
```

```
### http://purl.org/dc/elements/1.1/description
```

```
<http://purl.org/dc/elements/1.1/description> rdf:type owl:AnnotationProperty .
```

(continues on next page)

(continued from previous page)

```

### http://purl.org/dc/elements/1.1/publisher
<http://purl.org/dc/elements/1.1/publisher> rdf:type owl:AnnotationProperty .

### http://purl.org/dc/elements/1.1/rights
<http://purl.org/dc/elements/1.1/rights> rdf:type owl:AnnotationProperty .

### http://purl.org/dc/elements/1.1/title
<http://purl.org/dc/elements/1.1/title> rdf:type owl:AnnotationProperty .

### http://purl.org/dc/terms/license
<http://purl.org/dc/terms/license> rdf:type owl:AnnotationProperty .

### http://reld.dice-research.org/schema/preferredNamespacePrefix
:preferredNamespacePrefix rdf:type owl:AnnotationProperty .

### http://reld.dice-research.org/schema/preferredNamespaceUri
:preferredNamespaceUri rdf:type owl:AnnotationProperty .

### http://reld.dice-research.org/schema/ww.w3.org/2000/01/rdf-schema#isDefinedBy
<http://reld.dice-research.org/schema/ww.w3.org/2000/01/rdf-schema#isDefinedBy> rdf:type_
↪ owl:AnnotationProperty .

### http://reld.dice-research.org/schema/ww.w3.org/2002/07/owl#versionInfo
<http://reld.dice-research.org/schema/ww.w3.org/2002/07/owl#versionInfo> rdf:type_
↪ owl:AnnotationProperty .

### http://www.w3.org/2002/07/owl#samAs
owl:samAs rdf:type owl:AnnotationProperty .

#####
# Object Properties
#####

### http://reld.dice-research.org/schema/hasNamedEntity
:hasNamedEntity rdf:type owl:ObjectProperty ;
                rdfs:domain <http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-
↪ core#String> ;
                rdfs:range <http://www.w3.org/ns/prov#Entity> .

### http://reld.dice-research.org/schema/hasPOS
:hasPOS rdf:type owl:ObjectProperty ,

```

(continues on next page)

(continued from previous page)

```

        owl:FunctionalProperty ;
        rdfs:domain <http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-core
↵#String> ;
        rdfs:range :POS ;
        rdfs:comment "Each String has a corresponding POS instance connected with this_
↵property."^^xsd:string .

### http://reld.dice-research.org/schema/hasPunctuation
:hasPunctuation rdf:type owl:ObjectProperty ,
                  owl:FunctionalProperty ;
                  rdfs:domain <http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-
↵core#String> ;
                  rdfs:range :Punctuation ;
                  rdfs:comment "Connects String with punctuation"^^xsd:string .

### http://reld.dice-research.org/schema/hasStatement
:hasStatement rdf:type owl:ObjectProperty ;
               rdfs:domain <http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-core
↵#String> ;
               rdfs:range rdf:Statement ;
               rdfs:comment "Connect String with its annotated statements"^^xsd:string .

### http://schema.org/url
<http://schema.org/url> rdf:type owl:ObjectProperty ,
                           owl:FunctionalProperty ;
                           rdfs:domain :Dataset ;
                           rdfs:comment "This property connect the original uri of the dataset
↵"^^xsd:string .

### http://www.w3.org/1999/02/22-rdf-syntax-ns#object
rdf:object rdf:type owl:ObjectProperty ;
            owl:inverseOf rdf:subject ;
            rdf:type owl:FunctionalProperty ;
            rdfs:domain rdf:Statement ;
            rdfs:range rdfs:Literal ,
                      rdfs:Resource ;
            rdfs:comment "Each statement has an object it may be a resource or a literal."^^
↵xsd:string .

### http://www.w3.org/1999/02/22-rdf-syntax-ns#predicate
rdf:predicate rdf:type owl:ObjectProperty ,
                   owl:FunctionalProperty ;
                   rdfs:domain rdf:Statement ;
                   rdfs:range rdf:Property ;
                   rdfs:comment "Each statement is connected to a property which represents a_
↵relation using this property."^^xsd:string .

```

(continues on next page)

(continued from previous page)

```

### http://www.w3.org/1999/02/22-rdf-syntax-ns#subject
rdf:subject rdf:type owl:ObjectProperty ,
              owl:FunctionalProperty ;
rdfs:domain rdf:Statement ;
rdfs:range rdfs:Resource ;
rdfs:comment "Each statment has a resource subject."^^xsd:string .

### http://www.w3.org/2002/07/owl#equivalentProperty
owl:equivalentProperty rdf:type owl:ObjectProperty ,
                          owl:SymmetricProperty ;
rdfs:domain rdf:Property ;
rdfs:range rdf:Property ;
rdfs:comment "It connect similar properties."^^xsd:string .

### http://www.w3.org/2002/07/owl#sameAs
owl:sameAs rdf:type owl:ObjectProperty ;
rdfs:domain rdfs:Resource ,
            <http://www.w3.org/ns/prov#Entity> ;
rdfs:range rdfs:Resource .

### http://www.w3.org/ns/dx/prof/hasToken
<http://www.w3.org/ns/dx/prof/hasToken> rdf:type owl:ObjectProperty ,
                                          owl:FunctionalProperty ;
rdfs:domain <http://persistence.uni-leipzig.org/
↳nlp2rdf/ontologies/nif-core#String> ;
rdfs:range :Token ;
rdfs:comment "Connects String with Token"^^
↳xsd:string .

### http://www.w3.org/ns/prov#hadPrimarySource
<http://www.w3.org/ns/prov#hadPrimarySource> rdf:type owl:ObjectProperty ,
                                                  owl:FunctionalProperty ;
rdfs:domain <http://persistence.uni-leipzig.
↳org/nlp2rdf/ontologies/nif-core#String> ;
rdfs:range :Dataset ;
rdfs:comment "connect each instance of
↳String to each orignal source dataset"^^xsd:string .

#####
# Data properties
#####

### http://dbpedia.org/ontology/knownFor
<http://dbpedia.org/ontology/knownFor> rdf:type owl:DatatypeProperty ;
rdfs:domain :Dataset ;
rdfs:range xsd:string ;

```

(continues on next page)

(continued from previous page)

```

                                rdfs:comment "Shows the popularity of a dataset"^^
↪xsd:string .

### http://purl.org/dc/elements/1.1/title
<http://purl.org/dc/elements/1.1/title> rdf:type owl:DatatypeProperty ,
                                owl:FunctionalProperty ;
                                rdfs:domain :Dataset ;
                                rdfs:range xsd:string ;
                                owl:propertyDisjointWith <http://purl.org/net/
↪nknouf/ns/bibtex#hasTitle> .

### http://purl.org/dc/terms/language
<http://purl.org/dc/terms/language> rdf:type owl:DatatypeProperty ;
                                rdfs:domain :Dataset ;
                                rdfs:range xsd:string ;
                                rdfs:comment "It shows the language of the dataset"^^
↪xsd:string .

### http://purl.org/healthcarevocab/v1/datasetType
<http://purl.org/healthcarevocab/v1/datasetType> rdf:type owl:DatatypeProperty ;
                                rdfs:domain :Dataset ;
                                rdfs:range xsd:string ;
                                owl:propertyDisjointWith :strType ;
                                rdfs:comment "It could be sentence type, ↪
↪multi-lingual document etc."^^xsd:string .

### http://purl.org/net/nknouf/ns/bibtex#hasTitle
<http://purl.org/net/nknouf/ns/bibtex#hasTitle> rdf:type owl:DatatypeProperty ,
                                owl:FunctionalProperty ;
                                rdfs:domain <http://persistence.uni-
↪leipzig.org/nlp2rdf/ontologies/nif-core#String> ;
                                rdfs:range xsd:string ;
                                rdfs:comment "this property shwos a ↪
↪title for a document if any"^^xsd:string .

### http://reld.dice-research.org/schema/isGeneric
:isGeneric rdf:type owl:DatatypeProperty ,
                                owl:FunctionalProperty ;
                                rdfs:domain rdf:Property ;
                                rdfs:range xsd:boolean .

### http://reld.dice-research.org/schema/isNominal
:isNominal rdf:type owl:DatatypeProperty ,
                                owl:FunctionalProperty ;
                                rdfs:domain rdfs:Literal ,
                                rdfs:Resource ;

```

(continues on next page)

(continued from previous page)

```

    rdfs:range xsd:boolean ;
    rdfs:comment "shows tha a resource is nominal"^^xsd:string .

### http://reld.dice-research.org/schema/numSent
:numSent rdf:type owl:DatatypeProperty ,
          owl:FunctionalProperty ;
    rdfs:domain <http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-core
↳#String> ;
    rdfs:range xsd:integer ;
    rdfs:comment "shows number of sentences in a document"^^xsd:string .

### http://reld.dice-research.org/schema/objEndIndex
:objEndIndex rdf:type owl:DatatypeProperty ,
                owl:FunctionalProperty ;
    rdfs:domain rdf:Statement ;
    rdfs:range xsd:integer .

### http://reld.dice-research.org/schema/objStartIndex
:objStartIndex rdf:type owl:DatatypeProperty ,
                  owl:FunctionalProperty ;
    rdfs:domain rdf:Statement ;
    rdfs:range xsd:integer .

### http://reld.dice-research.org/schema/strType
:strType rdf:type owl:DatatypeProperty ;
    rdfs:domain <http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-core
↳#String> ;
    rdfs:range xsd:string ;
    rdfs:comment "it shows that wether a String is a sentence or documnet"^^
↳xsd:string .

### http://reld.dice-research.org/schema/subEndIndex
:subEndIndex rdf:type owl:DatatypeProperty ,
                owl:FunctionalProperty ;
    rdfs:domain rdf:Statement ;
    rdfs:range xsd:integer ;
    rdfs:comment "shows the end index of subject"^^xsd:string .

### http://reld.dice-research.org/schema/subFollowObj
:subFollowObj rdf:type owl:DatatypeProperty ,
                  owl:FunctionalProperty ;
    rdfs:domain rdf:Statement ;
    rdfs:range xsd:boolean ;
    rdfs:comment "shows that an object apears before than subject"^^xsd:string .

```

(continues on next page)

(continued from previous page)

```

### http://reld.dice-research.org/schema/subStartIndex
:subStartIndex rdf:type owl:DatatypeProperty ,
                  owl:FunctionalProperty ;
    rdfs:domain rdf:Statement ;
    rdfs:range xsd:integer ;
    rdfs:comment "shows the subject start index in the tokens"^^xsd:string .

### http://www.w3.org/2000/01/rdf-schema#comment
rdfs:comment rdf:type owl:DatatypeProperty ;
    rdfs:domain rdf:Statement ;
    rdfs:range xsd:string .

### http://www.w3.org/ns/dcat#distribution
<http://www.w3.org/ns/dcat#distribution> rdf:type owl:DatatypeProperty ,
                                              owl:FunctionalProperty ;
    rdfs:domain <http://persistence.uni-leipzig.org/
↳nlp2rdf/ontologies/nif-core#String> ;
    rdfs:range xsd:string ;
    rdfs:comment "shows the String distribution in
↳the original dataset"^^xsd:string .

#####
#    Classes
#####

### http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-core#String
<http://persistence.uni-leipzig.org/nlp2rdf/ontologies/nif-core#String> rdf:type
↳owl:Class ;
                                              rdfs:comment
↳"This class exists in nif. It will maps all the sentences or documents of our project
↳and will assign a unique identifier to each string."@en ;
                                              rdfs:label
↳"String"@en .

### http://reld.dice-research.org/schema/Dataset
:Dataset rdf:type owl:Class .

### http://reld.dice-research.org/schema/POS
:POS rdf:type owl:Class ;
    rdfs:subClassOf rdf:Seq ;
    owl:disjointWith :Token ;
    rdfs:comment "The class represens all the parts of speach of each token."@en ;
    rdfs:label "Parts of speach"@en .

### http://reld.dice-research.org/schema/Punctuation
:Punctuation rdf:type owl:Class ;

```

(continues on next page)

(continued from previous page)

```

    rdfs:subClassOf rdf:Seq ;
    rdfs:comment "Will contains punctuations in a String."@en ;
    rdfs:label "Punctuation"@en .

### http://reld.dice-research.org/schema/Token
:Token rdf:type owl:Class ;
    rdfs:subClassOf rdf:Seq .

### http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
rdf:Property rdf:type owl:Class .

### http://www.w3.org/1999/02/22-rdf-syntax-ns#Seq
rdf:Seq rdf:type owl:Class .

### http://www.w3.org/1999/02/22-rdf-syntax-ns#Statement
rdf:Statement rdf:type owl:Class .

### http://www.w3.org/2000/01/rdf-schema#Literal
rdfs:Literal rdf:type owl:Class .

### http://www.w3.org/2000/01/rdf-schema#Resource
rdfs:Resource rdf:type owl:Class .

### http://www.w3.org/ns/prov#Entity
<http://www.w3.org/ns/prov#Entity> rdf:type owl:Class ;
    rdfs:comment "this class is als present in the
↳provanance. It will maps all the entities presetn in a String."@en ;
    rdfs:label "Entity"@en .

#####
#    Individuals
#####

### http://reld.dice-research.org/schema/Dataset
:Dataset rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/NamedEntity
:NamedEntity rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/Relation
:Relation rdf:type owl:NamedIndividual .

```

(continues on next page)

(continued from previous page)

```
### http://reld.dice-research.org/schema/Token
:Token rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/distribution
:distribution rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/dsType
:dsType rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/hasNamedEntity
:hasNamedEntity rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/hasObject
:hasObject rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/hasOrigin
:hasOrigin rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/hasString
:hasString rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/hasSubject
:hasSubject rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/hasToken
:hasToken rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/isGeneric
:isGeneric rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/language
:language rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/match
:match rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/name
:name rdf:type owl:NamedIndividual .
```

(continues on next page)

(continued from previous page)

```

### http://reld.dice-research.org/schema/naturalLanguageRepresentation
:naturalLanguageRepresentation rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/numToken
:numToken rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/objPosition
:objPosition rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/relationType
:relationType rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/subPosition
:subPosition rdf:type owl:NamedIndividual .

### http://reld.dice-research.org/schema/http://reld.dice-research.org/schema/
↳primaryTask
<http://reld.dice-research.org/schema/http://reld.dice-research.org/schema/primaryTask>↳
↳rdf:type owl:NamedIndividual .

#####
# Annotations
#####

<http://purl.org/dc/elements/1.1/title> rdfs:comment "shows the title of the dataset"^^
↳xsd:string .

:Dataset rdfs:comment "This class maps RE datasets. It indicates the origin of a
↳relation or sentences, It helps in backtracing a sentence or relation to original
↳source dataset."@en .

:Token rdfs:comment "Representa each token including punctuations."@en ;
rdfs:label "Token"@en .

:hasNamedEntity rdfs:comment "This property connect entites with String"^^xsd:string .

:isGeneric rdfs:comment "shows that a property is generic"^^xsd:string .

rdfs:comment rdfs:comment "It shows extra information of the statment e.g. the meta data
↳of the statement."^^xsd:string .

```

(continues on next page)

(continued from previous page)

```
### Generated by the OWL API (version 4.5.9.2019-02-01T07:24:44Z) https://github.com/  
↪owlcs/owlapi
```

1.4 Availability

1.4.1 Source Code

Source code for converting RE datasets to RDF is available on our [Github repository](#) . The requirements for running the code, and the basic command to run the code are given on the README file.

1.4.2 Live Endpoint

The [live endpoint](#) of **RELD** is available for querying anywhere on the internet. We have made it available on the Virtuoso open-source server. The endpoint might result in slow query execution. In the meanwhile, you can also [download](#) and run a local instance of the endpoint. The prepared endpoint is available here in zip format. To run the local instance you just need to run simple commands, and your local endpoint in Virtuoso is running.

```
wget https://hobbitdata.informatik.uni-leipzig.de/RELD/endpoint/reld.virtuoso-7.2.5-  
↪linux-v2.zip  
unzip reld.virtuoso-7.2.5-linux-v2.zip  
cd reld.virtuoso-7.2.5-linux-v2/bin  
sh start_virtuoso.sh
```

1.4.3 Static Dumps

The different versions of the dumps is available for [downloads](#). The dumps are in .ttl and JSON-LD formats. The ttl files names are self-descriptive. Each file represents an individual dataset converted to RDF. Same file names can be used during querying on our live endpoint.

1.4.4 Public Availability

The resource is publicly available on the community registry with a unique DOI:

on Zenodo [here](#).

1.4.5 Sustainability

The resource is publicly available from the homepage, which contains the complete source code, data, and documentation. The homepage also links to the corresponding RELD ontology. The same homepage will be used for sustainability and adding future datasets into the RELD. Paderborn Center for Parallel Computing PC2 will sustain the RELD resources. PC2 provides computing resources and consultation regarding their usage; to research projects at Paderborn University and external research groups. The Information and Media Technologies Center (IMT) at Paderborn University also provides a permanent IT infrastructure to host the RELD project. The open-source code available on GitHub is easily extendable to convert other datasets in the future. The RELD dataset is publicly available from the SPARQL endpoint, where the user can execute a SPARQL query for desired output.

1.4.6 Version

Currently it is the second version of **RELD**. We will keep updating this version info as the new changes occur. The schema is of version 0.2.

1.4.7 License

RELD is under the licence GNU General Public License v3.0. The [licence](#) is hosted on our Github repository.

RELD is now hosted on [Read the docs](#)