

Ranking DBpedia Properties

Experiments details

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The standard approach to this section of our research article is to present and describe the results in a systematic and detailed way. When reporting qualitative results, we will highlight and comment on the themes that emerge from the analysis.

Annex 1: Hallway Testing

Five random people graduated in computer science were chosen in to test our service through a questionnaire.

The questionnaire aims to assess the status of people's choice in absence of the knowledge of DBpedia regarding the implementation of our MLR tool called RankProperties, to identify and assess the ontologies and raw properties are considered most important with a ranking obtained through a weighted average of users's evaluation.

Figure 1. A fragment of the questionnaire sent to random users graduated in computer science

Questionnaire Entity - Properties

Dai un voto di importanza ad ogni proprietà/attributo riferiti all'entità in oggetto.

*Campo obbligatorio

Rose (flower)

familia *

- 1 - Per nulla importante
- 2 - Poco importante
- 3 - Medio importante
- 4 - Molto importante

ordo *

- 1 - Per nulla importante
- 2 - Poco importante
- 3 - Medio importante
- 4 - Molto importante

tribus *

- 1 - Per nulla importante
- 2 - Poco importante

We can see that for the user evaluation we have used a reduced Likert scale where:

- items are the properties
- 4 - strongly significant, 3 - significant, 2- low significant, 1 - in no way significant

Annex 2: List of entities (and their ontologies and raw properties) that are included on the questionnaire

1. Flower - Russelia
2. City - Parma
3. Corporation - Microsoft
4. Animal - Dog
5. Politician - Enrico Berlinguer
6. Actress - Sandra Bullock

Figure 2: The following example cited in the paper*, refers to the Russelia entity (users evaluation)

Property	1 user	2 user	3 user	4 user	5 user
familia	4	4	2	4	4
ordo	3	3	3	3	4
tribus	4	4	3	4	4
genus	3	3	3	4	3
genus authority	1	3	2	4	3
subdivision ranks	4	3	3	4	4
unranked classis	1	1	2	3	1
unranked divisio	3	3	3	3	3
unranked ordo	3	3	3	3	3
regnum	1	3	3	4	4
Name	4	2	2	4	3
subdivision	2	3	3	4	4
image caption	1	3	2	4	1
family	4	4	3	4	4
Subject	1	3	2	4	3
class	1	4	3	4	3
kingdom	1	3	3	4	4
order	1	3	2	4	4
thumbnail	4	1	2	3	2
division	2	1	2	4	2
has abstract	1	2	2	3	4
Wikipedia page ID	1	2	2	1	1
Wikipedia revision ID	1	1	1	2	1
Link from a Wikipedia to an external page	1	1	1	1	2

For each row of table we calculate:

$$M_a = \frac{1}{5} \sum_{i=1}^5 x_i$$

Figure 3: Questionnaire results (Russelia) sorted by average of evaluation

Property	1 user	2 user	3 user	4 user	5 user	AVG
family	4	4	3	4	4	3,8
tribus	4	4	3	4	4	3,8
familia	4	4	2	4	4	3,6
subdivision ranks	4	3	3	4	4	3,6
genus	3	3	3	4	3	3,2
subdivision	2	3	3	4	4	3,2
ordo	3	3	3	3	4	3,2
Name	4	2	2	4	3	3
regnum	1	3	3	4	4	3
class	1	4	3	4	3	3
kingdom	1	3	3	4	4	3
unranked divisio	3	3	3	3	3	3
unranked ordo	3	3	3	3	3	3
order	1	3	2	4	4	2,8
genus authority	1	3	2	4	3	2,6
Subject	1	3	2	4	3	2,6
thumbnail	4	1	2	3	2	2,4
has abstract	1	2	2	3	4	2,4
image caption	1	3	2	4	1	2,2
division	2	1	2	4	2	2,2
unranked classis	1	1	2	3	1	1,6
Wikipedia page ID	1	2	2	1	1	1,4
Wikipedia revision ID	1	1	1	2	1	1,2
Link from a Wikipedia to an external page	1	1	1	1	2	1,2

Figure 4: Final compare between Questionnaire results and RankProperties results

	From Questionnaire	From RankProperties*
1	family	dbpprop: familia
2	tribus	dbpprop: ordo
3	familia	dbpprop: tribus
4	subdivision ranks	dbpprop: genus
5	genus	dbpprop: genusAuthority
6	subdivision	dbpprop: subdivisionRanks
7	ordo	dbpprop: unrankedClassis
8	Name	dbpprop: unrankedDivisio
9	regnum	dbpprop: unrankedOrdo
10	class	dbpprop: regnum
11	kingdom	dbpprop: name
12	unranked divisio	dbpprop: subdivision
13	unranked ordo	dbpprop: imageCaption
14	order	dbpedia-owl: family
15	genus authority	http://purl.org/dc/terms/subject
16	Subject	dbpedia-owl: class
17	thumbnail	dbpedia-owl: kingdom
18	has abstract	dbpedia-owl: order
19	image caption	dbpedia-owl: thumbnail
20	division	dbpedia-owl: division
21	unranked classis	dbpedia-owl: abstract
22	Wikipage page ID	dbpedia-owl: wikiPageID
23	Wikipage revision ID	dbpedia-owl: wikiPageRevisionID
24	Link from a Wikipage to an external page	dbpedia-owl: wikiPageExternalLink

***Random Forests**

Figure 5: Spearman's Rank Correlation (Russelia)

From RankProperties*	From Questionnaire	Ranking RankProperties	Ranking Questionnaire	d	d ²
dbpprop: familia	familia	1	3	2	4
dbpprop: ordo	ordo	2	7	5	25
dbpprop: tribus	tribus	3	2	1	1
dbpprop: genus	genus	4	5	1	1
dbpprop: genusAuthority	genus authority	5	15	10	100
dbpprop: subdivisionRanks	subdivision ranks	6	4	2	4
dbpprop: unrankedClassis	unranked classis	7	21	14	196
dbpprop: unrankedDivisio	unranked divisio	8	12	4	16
dbpprop: unrankedOrdo	unranked ordo	9	13	4	16
dbpprop: regnum	regnum	10	9	1	1
dbpprop: name	name	11	8	3	9
dbpprop: subdivision	subdivision	12	6	6	36
dbpprop: imageCaption	image caption	13	19	6	36
dbpedia-owl: family	family	14	1	13	169
http://purl.org/dc/terms/subject	Subject	15	16	1	1
dbpedia-owl: class	class	16	10	6	36
dbpedia-owl: kingdom	kingdom	17	11	6	36
dbpedia-owl: order	order	18	14	4	16
dbpedia-owl: thumbnail	thumbnail	19	17	2	4
dbpedia-owl: division	division	20	20	0	0
dbpedia-owl: abstract	has abstract	21	18	3	9
dbpedia-owl: wikiPageID	Wikipage page ID	22	22	0	0
dbpedia-owl: wikiPageRevisionID	Wikipage revision ID	23	23	0	0
dbpedia-owl: wikiPageExternalLink	Link from a Wikipage to an external page	24	24	0	0
				94	716

We calculate:

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}$$

- n = 24

$$p = 1 - [(6 * 716) / 24 (24^2 - 1)] = 0,688695652173913 \text{ [Close to 1 - Positive correlation]}$$

Other algorithms and their evaluations with Spearman's coefficient:

0: MART (gradient boosted regression tree)

1: RankNet

2: RankBoost

3: AdaRank

4: Coordinate Ascent

6: LambdaMART

7: ListNet

Ranknet

From RankProperties 1	Ranking RankProperties	Ranking Questionnaire	d	d ²
regnum	1	10	9	36
familia	2	1	1	1
ordo	3	2	1	1
tribus	4	3	1	1
Name	5	11	6	36
Wikipedia page ID	6	22	16	196
Wikipedia Revision ID	7	23	16	196
genus	8	4	4	16
Subject	9	15	6	36
thumbnail	10	19	9	81
order	11	18	7	49
kingdom	12	17	5	25
class	13	16	3	9
division	14	20	6	36
unranked classis	15	7	8	64
unranked divisio	16	8	8	64
unranked ordo	17	9	8	64
has abstract	18	21	3	9
subdivision rank	19	6	13	169
wikiPage External Link	20	24	4	16
image caption	21	13	8	64
genus authority	22	5	17	289
subdivisio	23	12	11	121
family	24	14	10	100
			180	1679

$$p = 1 - [(6 * 1679) / 24 (24^2 - 1)] = 0,27$$

RankBoost

From RankProperties 2	Ranking RankProperties	Ranking Questionnaire	d	d²
Subject	1	10	9	81
has abstract	2	13	11	121
class	3	16	13	169
family	4	14	11	121
kingdom	5	17	12	144
order	6	28	12	144
division	7	20	13	169
thumbnail	8	19	11	121
familia	9	1	8	64
genus	10	4	6	36
genus author	11	5	6	36
image caption	12	13	1	1
Name	13	11	2	4
ordo	14	2	12	144
regnum	15	10	5	25
subdivision	16	12	4	16
subdivision ranks	17	13	4	16
tribus	18	12	6	36
unranked classis	19	7	12	144
unranked divisio	20	8	12	144
unranked ordo	21	9	12	144
Wikipedia page ID	22	22	0	0
Wikipedia Revision ID	23	23	0	0
wikiPage External Link	24	24	0	0
			182	1880

$$p = 1 - [(6 * 1880) / 24 (24^2 - 1)] = 0,1826086956521739$$

AdaRank

From RankProperties 3	Ranking RankProperties	Ranking Questionnaire	d	d²
Subject	1	15	14	196
class	2	16	14	196
family	3	14	11	121
kingdom	4	17	13	169
order	5	18	13	169
division	6	20	14	196
thumbnail	7	19	12	144
wikiPage External Link	8	24	16	256
familia	9	1	8	64
genus author	10	5	5	25
ordo	11	2	9	81
subdivision ranks	12	6	6	36
tribus	13	3	10	100
unranked classis	14	7	7	49
unranked divisio	15	8	7	49
unranked ordo	16	9	8	64
has abstract	17	21	4	16
Wikipedia page ID	18	22	4	16
Wikipedia Revision ID	19	23	4	16
genus	20	4	4	16
image caption	21	13	8	64
Name	22	11	11	121
regnum	23	10	13	169
subdivision	24	12	12	144
			227	2477

$$p = 1 - [(6 * 2477) / 24 (24^2 - 1)] = -0,0769$$

Coordinate Ascent

From RankProperties 4	Ranking RankProper ties	Ranking Question narie	d	d²
tribus	1	3	2	4
ordo	2	2	0	0
familia	3	1	2	4
regnum	4	10	6	36
wikiPage External Link	5	24	19	361
Subject	6	15	9	81
subdivision	7	12	5	25
unranked ordo	8	9	1	1
unranked divisio	9	8	1	1
unranked classis	10	7	3	9
subdivision ranks	11	6	5	25
genus author	12	5	7	49
Name	13	11	2	4
image caption	14	13	1	1
family	15	14	1	1
division	16	20	4	16
class	17	16	1	1
kingdom	18	17	1	1
order	19	18	1	1
thumbnail	20	19	1	1
genus	21	4	17	289
has abstract	22	21	1	1
Wikipage page ID	23	22	1	1
Wikipage Revision ID	24	23	1	1
			92	914

$$p = 1 - [(6 * 914) / 24 (24^2 - 1)] = 0,6026086956521739$$

LambdaMART

From RankProperties 6	Ranking RankProper ties	Ranking Question narie	d	d²
Name	1	11	9	81
genus	2	4	2	4
family	3	14	11	121
regnum	4	10	6	36
subdivision	5	12	7	49
has abstract	6	21	15	225
Wikipedia page ID	7	22	15	225
Wikipedia Revision ID	8	23	15	225
thumbnail	9	19	10	100
familia	10	1	9	81
ordo	11	2	9	81
tribus	12	3	9	81
order	13	18	5	25
kingdom	14	17	3	9
class	15	16	1	1
division	16	20	4	16
image caption	17	13	4	16
Subject	18	15	3	9
unranked classis	19	7	12	144
unranked divisio	20	8	12	144
unranked ordo	21	9	12	144
genus author	22	5	17	289
subdivision ranks	23	6	17	289
wikiPage External Link	24	24	0	0
			207	2395

$$p = 1 - [(6 * 2395) / 24 (24^2 - 1)] = -0,041304347826087$$

ListNet

From RankProperties 7	Ranking RankProper ties	Ranking Question narie	d	d²
regnum	1	10	9	81
tribus	2	3	1	1
ordo	3	2	1	1
familia	4	1	3	9
subdivision	5	12	7	49
image caption	6	13	7	49
unranked ordo	7	9	2	4
unranked divisio	8	8	0	0
unranked classis	9	7	2	4
subdivision ranks	10	6	4	16
genus author	11	5	6	36
division	12	20	8	64
class	13	16	3	9
kingdom	14	17	3	9
order	15	18	3	9
thumbnail	16	19	3	9
wikiPage External Link	17	24	7	49
has abstract	18	21	3	9
Wikipedia page ID	19	16	3	9
Wikipedia Revision ID	20	23	3	9
Subject	21	15	6	36
genus	22	4	18	324
Name	23	11	12	144
family	24	14	10	100
			124	1030

$$p = 1 - [(6 * 1030) / 24 (24^2 - 1)] = 0,5521739130434783$$

The results of the experiments and their theoretical foundations are evaluated in terms of the impact they might have on future utilization of machine learning algorithm for our systems.

The idea is to compare the opinions of the users with the results of the algorithms. Watching the opinion of users, who comes closest ranking algorithm is the Random Forests.

This is because, as shown in Figure 5, we using Spearman’s Rank Correlation, the result suggests a largest Positive Correlation.

An interesting result of the first experiment was that people rated the dbpedia properties very similarly than the RankProperties tool. Further research is interesting to understand why there are very few differences that were found between the average of users evaluation and the features chosen for the Random Forests Ranking algorithm.

Appendix A. - Procedure to use our framework

1. Choose an entity **e**
2. Get **e:<?s,?p,?o>** from an endpoint of DBpedia
3. Assign value from 1 to 4 to each property based on the importance that we think would have that property.
4. Create a file with a following format <http://sourceforge.net/p/lemur/wiki/RankLib%20File%20Format/> through the library in this sites:

<http://lemurproject.org/ranklib.php>

<http://sourceforge.net/p/lemur/wiki/RankLib/>

<http://people.cs.umass.edu/~vdang/ranklib.html>

where each column will be one of 8 features described on the paper.

5. Create training, test and validate set for “train” the ranking algorithms
6. Execute this command line:

<http://sourceforge.net/p/lemur/wiki/RankLib%20How%20to%20use/>

(2.1) training phase and (2.5) ranking & scoring phase

Appendix B. - Time of Execution (Seconds) for each A-G ranking Feature

property	entity	A	A var	B	C	D	E	F	G
dbp:genusAuthority	Russelia (flower)	0.067	0.001	<0.001	<0.001	0.094	<0.001	0.402	0.480
dbo:populatedPlace/AreaTotal	Parma (city)	0.027	0.001	<0.001	<0.001	0.259	<0.001	0.560	0.743
dbo:birthPlace	Sandra Bullock	0.015	0.001	<0.001	<0.001	0.089	<0.001	0.269	0.586
dbo:NationalCollegiateAthletic AssociationAthlete (class)	Bobby Plumb (basketball team)	0.001	0.002	<0.001	<0.001	0.101	<0.001	0.179	0.437
dbp:2ndName	Boon Lay Secondary School	0.001	0.001	<0.001	<0.001	0.090	<0.001	0.178	0.614

Appendix C. - Results for obtain models for RankLib

Entities:

1. **M**:Rho
2. **M**:Russelia
3. **M**:Ritmo
4. **M**:Red
5. **T**:Radiohead

M: for model (training set, test set, evaluate test)

T: for target

1. Rho

Output of RankProperties:

```
{'frequencyEntity': '0.248563', 'isEnglish': '1.000000', 'numberOfWords': '1.000000', 'answersLink': '1.000000', 'suggestChars': '0.000000', 'frequencyTriples': '1.000000', 'property': u'http://purl.org/dc/terms/subject', 'ontOrProp': '0.500000', 'containsNumber': '0.000000', 'label': u'subject'}, {'frequencyEntity': '0.245153', 'isEnglish': '1.000000', 'numberOfWords': '0.500000', 'answersLink': '0.000000', 'suggestChars': '0.333333', 'frequencyTriples': '0.604169', 'property': u'http://dbpedia.org/ontology/abstract', 'ontOrProp': '1.000000', 'containsNumber': '0.000000', 'label': u'has abstract'}, {'frequencyEntity': '0.750733', 'isEnglish': '0.666667', 'numberOfWords': '0.333333', 'answersLink': '0.000000', 'suggestChars': '0.000000', 'frequencyTriples': '0.750743', 'property': u'http://dbpedia.org/ontology/wikiPageID', 'ontOrProp': '1.000000', 'containsNumber': '0.000000', 'label': u'Wikipedia page ID'}, {'frequencyEntity': '0.750733', 'isEnglish': '0.666667', 'numberOfWords': '0.333333', 'answersLink': '0.000000', 'suggestChars': '0.000000', 'frequencyTriples': '0.750743', 'property': u'http://dbpedia.org/ontology/wikiPageRevisionID', 'ontOrProp': '1.000000', 'containsNumber': '0.000000', 'label': u'Wikipedia revision ID'}, {'frequencyEntity': '0.096459', 'isEnglish': '1.000000', 'numberOfWords': '1.000000', 'answersLink': '1.000000', 'suggestChars': '0.000000', 'frequencyTriples': '0.096459', 'property': u'http://dbpedia.org/ontology/thumbnail', 'ontOrProp': '1.000000', 'containsNumber': '0.000000', 'label': u'thumbnail'}, {'frequencyEntity': '0.002498', 'isEnglish': '1.000000', 'numberOfWords': '1.000000', 'answersLink': '0.000000', 'suggestChars': '0.500000', 'frequencyTriples': '0.002820', 'property': u'http://dbpedia.org/property/map', 'ontOrProp': '0.800000', 'containsNumber': '0.000000', 'label': u'map'}, {'frequencyEntity': '0.133243', 'isEnglish': '1.000000', 'numberOfWords': '1.000000', 'answersLink': '0.000000', 'suggestChars': '0.500000', 'frequencyTriples': '0.205432', 'property': u'http://dbpedia.org/property/name', 'ontOrProp': '0.800000', 'containsNumber': '0.000000', 'label': u'Name'}, {'frequencyEntity': '0.000001', 'isEnglish': '0.000000', 'numberOfWords': '1.000000', 'answersLink': '0.000000', 'suggestChars': '0.000000', 'frequencyTriples': '0.000002', 'property': u'http://dbpedia.org/property/ref1char', 'ontOrProp': '0.800000', 'containsNumber': '1.000000', 'label': u'ref1char'}, {'frequencyEntity': '0.000004', 'isEnglish': '0.000000', 'numberOfWords': '1.000000', 'answersLink': '0.000000', 'suggestChars': '0.000000', 'frequencyTriples': '0.000007', 'property': u'http://dbpedia.org/property/map3char', 'ontOrProp': '0.800000', 'containsNumber': '1.000000', 'label': u'map3char'}, {'frequencyEntity': '0.000004', 'isEnglish': '0.000000', 'numberOfWords': '1.000000', 'answersLink': '0.000000', 'suggestChars': '0.000000', 'frequencyTriples': '0.000007', 'property': u'http://dbpedia.org/property/map3char', 'ontOrProp': '0.800000', 'containsNumber': '1.000000', 'label': u'map3char'}
```

'1.000000', 'answlsLink': '0.000000', 'suggestChars': '0.000000', 'frequencyTriples': '0.000008', 'property': u'http://dbpedia.org/property/map4char', 'ontOrProp': '0.800000', 'containsNumber': '1.000000', 'label': u'map4char'}, {'frequencyEntity': '0.000001', 'isEnglish': '0.000000', 'numberOfWords': '1.000000', 'answlsLink': '1.000000', 'suggestChars': '0.000000', 'frequencyTriples': '0.000001', 'property': u'http://dbpedia.org/property/namedref', 'ontOrProp': '0.800000', 'containsNumber': '0.000000', 'label': u'namedref'}, {'frequencyEntity': '0.000006', 'isEnglish': '0.000000', 'numberOfWords': '1.000000', 'answlsLink': '0.000000', 'suggestChars': '0.000000', 'frequencyTriples': '0.000012', 'property': u'http://dbpedia.org/property/map2char', 'ontOrProp': '0.800000', 'containsNumber': '1.000000', 'label': u'map2char']}]

2. Russelia

Output of RankProperties:

```
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3. Red

Output of RankProperties:

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4. Ritmo

Output of RankProperties:

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5. Radiohead

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