ALIN Results for OAEI 2016

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Abstract. ALIN is an ontology alignment system specialized in the interactive alignment of ontologies. Its main characteristic is the selection of correspondences to be shown to the expert, depending on the previous feedbacks given by the expert. This selection is based on semantic and structural characteristics. ALIN has obtained the alignment with the highest quality in the interactive tracking for Conference data set. This paper describes its configuration for the OAEI 2016 competition and discusses its results.

Keywords: Interactive Ontology Matching; Anti-patterns;

1 Presentation of the system

A large amount of data repositories became available due to the advances in information and communication technologies. Those repositories, however, are highly semantically heterogeneous, which hinders their integration. Ontology alignment has been successfully applied to solve this problem, by discovering correspondences between two distinct ontologies which, in turn, conceptually define the data stored in each repository. Among the various ontology alignment approaches that exist in the literature, interactive ontology alignment includes the participation of experts of the domain to improve the quality of the final alignment. This approach has proven more effective than non-interactive ontology alignment [1]. ALIN is an ontology alignment system specialized in interactive alignment. This is the first version of the system.

1.1 State, purpose, general statement

ALIN is an ontology alignment system, specialized in the ontology interactive alignment, based primarily on linguistic matching techniques, using the Wordnet as external resource. After generating an initial set of correspondences (called set of candidate correspondences, which are the correspondences selected to receive the feedback from the expert), interactions are made with the expert, and to each interaction, the set of candidate correspondences is modified. The modification of the set of candidate correspondences is through the use of the structural analysis of ontologies and use of alignment anti-patterns. The interactions continue until there are no more candidate correspondences left. ALIN was built with a special focus on the interactive matching track of OAEI 2016.

1.2 Specific techniques used

The ALIN workflow is shown in figure 1.

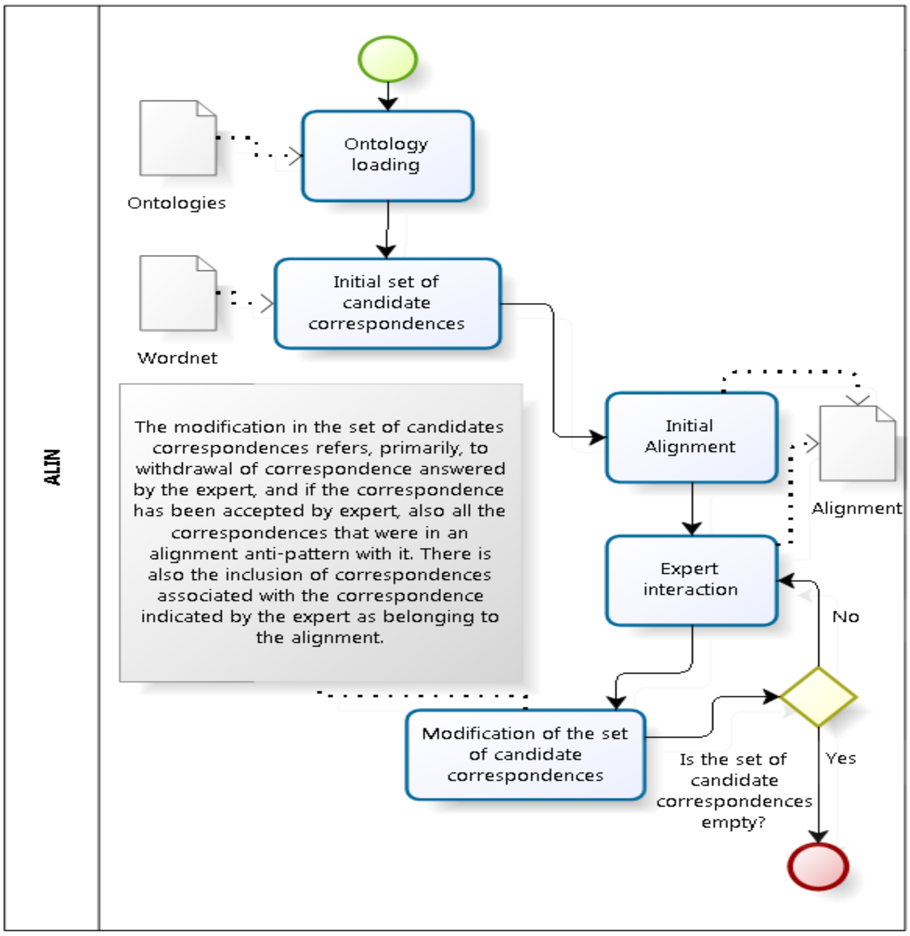

Fig. 1. – Workflow of ALIN

The steps of ALIN workflow are the following:

1. Load of the ontologies with load of classes, object properties and data properties through the Align API[1]. For each entity some data are stored such as name and label. In the case of classes, their superclasses and disjunctions are saved. In the case of object properties are saved the properties that are their hypernyms and their associated classes. The classes of property data are saved, too. ALIN does not use instances. After loading, the matching problem is profiled taking into account the size of the ontologies. The ALIN can only work with ontologies whose entity names are in English.
2. As an initial set of candidate correspondences a stable marriage algorithm with incomplete preference lists with maximum size of the list equals to 1, using linguistic metrics to sort the priority list was used [2]. The list is sorted in decreasing order. For this algorithm only the correspondence whose first entity is in the list of second entity and vice-versa is selected. The linguist metrics used are Jaccard, Jaro-Winkler and n-Gram [3] provided by Simmetrics API[2] and Wu-Palmer, Jiang-Conrath and Lin [3] provide by ws4j API[3] that use Wordnet. To use Wordnet the canonical form of the word is needed, therefore Stanford CoreNLP API[4] was considered. The algorithm is run six times, once by each metric, and the result set is the union of results of each metric.
3. The value of the similarity metrics (Wu-Palmer, Jiang-Conrath, Lin, Jaccard, Jaro-Winkler and n-Gram) vary from 0 to 1 (1 is the maximum value). When a correspondence in the set of candidate correspondences has all the six metrics with the maximum value, it is added to the final alignment and removed from the set of candidate correspondences. There are exceptions to this rule, some correspondences that fall into some structural patterns are not put on the final alignment and are not removed from the set of candidate correspondences.
4. The correspondences whose entities are not in the same synset of wordnet are removed from the set of candidate correspondences. These correspondences are put into a backup set, and can return to the set of candidate correspondences using structural analysis.
5. At this point the interactions with the expert begin. The correspondences in the set of candidate correspondences are sorted by the sum of similarity metric values, with the greatest sum first. The options are showed one by one to the expert. The first correspondence is showed and it is removed from the list after the answer of the expert. The set of candidate correspondences has, at first, only correspondences of classes. When the expert answer one question, the set of candidate correspondences is changed. Correspondences (besides the

1 "Alignment API". Available at http://alignapi.gforge.inria.fr/ Last accessed on Apr, 11, 2016.

2 "String Similarity Metrics for Information Integration". Available on http://www.coli.uni-saarland.de/courses/LT1/2011/slides/stringmetrics.pdf. Last accessed on Apr, 19, 2016.

3 "WS4J". Available at https://code.google.com/archive/p/ws4j/ Last accessed on Apr, 11, 2016.

4 "Stanford CoreNLP". Available at http://stanfordnlp.github.io/CoreNLP/ Last accessd on Sept, 15, 2016.

correspondence answered by expert) can be removed and included, depending on the answer of the expert. If the expert does not accept the correspondence it is removed from the set of candidate correspondences. But if the expert accepts the correspondence it is removed from the set of candidate correspondences and put in the final alignment.

At each interaction with the specialist we also:

- We remove from the set of candidate correspondences and disregard all the correspondences that are in anti-pattern of alignment [4]with the correspondence accepted by the expert;
- We insert into the set of candidate correspondences, correspondences of data properties and correspondences of object properties related to the correspondence of classes accepted by the expert.
- We insert into the set of candidate correspondences, correspondences of the backup set (step 4) whose both entities are subclasses of the classes of a correspondence accepted by expert.

This step continues until the set of candidate correspondences is empty.

1.3 Link to the system and parameters file

ALIN is available through Mediafire (https://www.mediafire.com/folder/726zo-hj792kod/ALIN) as a package for running through the SEALS client.

2 Results

The system ALIN has been developed with its focus on interactive ontology alignment. The approach performs better when the number of data and object properties is proportionately large. ALIN considers properties associated to correspondent classes when selecting entities for user feedback, thus allowing for increased recall. When the number of properties in the ontologies is small, the system still generates a very precise alignment, but its recall tends to decrease.

Another characteristic of ALIN is its reliance on an interactive phase. The non-interactive phase of the system is quite simple, mainly based on maximum string similarity, specializing in maintaining a high precision without worrying about recall, generating initially a low f-measure. The recall increases in the interactive phase. Finally, ALIN is also not robust to users errors. The system uses a number of techniques that take advantage of the expert response to reach other conclusions when the expert gives a wrong answer it is propagated generating other errors, thereby diminishing the f-measure.

2.1 Comments on the participation of the ALIN in non-interactive tracks

As expected the participation of ALIN in non-interactive alignment processes showed the following results: high precision and not so high recall, as can be seen in Table 1, where recall+ field refers to non-trivial correspondences found and Coherent field filled by + indicates that the generated alignment is consistent.

Matcher	Runtime	Size	Precision	F-Measure	Recall	Recall+	Coherent
Alin	306	510	0.996	0.501	0.335	0.0	+

Table 1. - Participation of ALIN in Anatomy track

Matcher	Threshold	Precision	F.5-measure	F1-measure	F2-measure	Recall
Alin	0	0.89	0.65	0.46	0.36	0.31

Table 2. - Participation of ALIN in Conference track taking into account only the classes (m1) , and the reference alignment publicly available (r1).

Matcher	Threshold	Precision	F.5-measure	F1-measure	F2-measure	Recall
Alin	0	0	0	0	0	0

Table 3. - Participation of ALIN in Conference track taking into account only the properties (m2) and the reference alignment publicly available (r1)

Matcher	Threshold	Precision	F.5-measure	F1-measure	F2-measure	Recall
Alin	0	0.89	0.6	0.4	0.3	0.26

Table 4. - Participation of ALIN in Conference track taking into account the classes and properties (m3), and the reference alignment publicly available (r1).

Regarding the Conference track, as ALIN evaluates only the properties associated with classes already evaluated as belonging to the alignment, the alignment of the M2 type (which take into account only the properties of ontologies) were with the f-measure = 0, as can be seen in Table 3. As properties are evaluated only in the interactive phase in the ALIN, alignments of type M1 (only classes) remained with a higher recall than M3 (classes and properties), as can be seen in Tables 2 and 4, because the reference alignments of type M3 contain properties besides classes.

2.2 Comments on the participation of ALIN in interactive tracks

Anatomy track.

In this track the program ALIN showed the highest precision among the four evaluated tools when the error rate is zero. When the error rate increases both the precision as the recall falls, reducing the f-measure. This is expected and explained earlier.

Error Rate 0.0

Tool	Run Time (sec)	Size	Precision	Recall	F-measure	Recall+	Precision Non Inter	Recall Non Inter	F-measure Non Inter	Recall+ Non Inter	Precision Oracle	Recall Oracle	F-measure Oracle	Total Requests	Distinct Mappings	True Positives	True Negatives	False Positives	False Negative	Precision	Negative Precision
⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩
Alin	505	1142.8	0.993	0.749	0.854	0.35	0.984	0.335	0.5	0	0.993	0.749	0.854	803	1221	626	594	0	0	1	1
AML	48	1484	0.968	0.948	0.958	0.862	0.95	0.936	0.943	0.832	0.968	0.948	0.958	241	240	51	189	0	0	1	1
LogMap	27	1306	0.982	0.846	0.909	0.595	0.911	0.846	0.877	0.593	0.982	0.846	0.909	590	590	287	303	0	0	1	1
XMap	49	1416	0.929	0.867	0.897	0.653	0.928	0.865	0.895	0.647	0.929	0.867	0.897	35	35	5	30	0	0	1	1

Error Rate 0.1

Tool	Run Time (sec)	Size	Precision	Recall	F-measure	Recall+	Precision Non Inter	Recall Non Inter	F-measure Non Inter	Recall+ Non Inter	Precision Oracle	Recall Oracle	F-measure Oracle	Total Requests	Distinct Mappings	True Positives	True Negatives	False Positives	False Negative	Precision	Negative Precision
⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩
Alin	489	1121.1	0.947	0.701	0.805	0.307	0.984	0.335	0.5	0	0.993	0.742	0.85	769	1123	554	451	51	67	0.916	0.87
AML	50	1503.7	0.953	0.945	0.949	0.856	0.95	0.936	0.943	0.832	0.969	0.95	0.959	273	272	47	194	23	6	0.67	0.967
LogMap	24	1312	0.961	0.832	0.892	0.565	0.911	0.846	0.877	0.593	0.964	0.831	0.893	612	612	258	290	35	28	0.881	0.912
XMap	46	1416.1	0.929	0.867	0.897	0.653	0.928	0.865	0.895	0.647	0.929	0.866	0.896	35	35	4.2	27.5	2.7	0.8	0.609	0.972

Error Rate 0.2

Tool	Run Time (sec)	Size	Precision	Recall	F-measure	Recall+	Precision Non Inter	Recall Non Inter	F-measure Non Inter	Recall+ Non Inter	Precision Oracle	Recall Oracle	F-measure Oracle	Total Requests	Distinct Mappings	True Positives	True Negatives	False Positives	False Negative	Precision	Negative Precision
⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩
Alin	481	1103.7	0.907	0.661	0.765	0.266	0.984	0.335	0.5	0	0.993	0.736	0.845	750	1077	493	368	94	121	0.84	0.753
AML	48	1521.9	0.939	0.943	0.941	0.85	0.95	0.936	0.943	0.832	0.969	0.952	0.96	300	299	46	193	46	13	0.503	0.936
LogMap	24	1314.2	0.944	0.819	0.877	0.543	0.911	0.846	0.877	0.593	0.944	0.814	0.874	645	645	225	287	70	61	0.761	0.823
XMap	47	1416.1	0.929	0.867	0.897	0.653	0.928	0.865	0.895	0.647	0.929	0.865	0.896	35	35	4.3	25.1	5.4	0.7	0.448	0.974

Error Rate 0.3

Tool	Run Time (sec)	Size	Precision	Recall	F-measure	Recall+	Precision Non Inter	Recall Non Inter	F-measure Non Inter	Recall+ Non Inter	Precision Oracle	Recall Oracle	F-measure Oracle	Total Requests	Distinct Mappings	True Positives	True Negatives	False Positives	False Negative	Precision	Negative Precision
⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩	⇧⇩
Alin	472	1080.1	0.869	0.619	0.723	0.231	0.984	0.335	0.5	0	0.993	0.73	0.841	740	1058	430	311	134	182	0.763	0.631
AML	47	1540.1	0.925	0.94	0.932	0.843	0.95	0.936	0.943	0.832	0.969	0.952	0.96	308	307	40	177	71	18	0.363	0.905
LogMap	24	1327.2	0.932	0.817	0.871	0.541	0.911	0.846	0.877	0.593	0.926	0.8	0.858	650	650	202	256	106	84	0.655	0.752
XMap	47	1416.4	0.929	0.867	0.897	0.653	0.928	0.865	0.895	0.647	0.929	0.864	0.895	35	35	3.1	21.8	8.9	1.9	0.265	0.92

Table 5. - Participation of ALIN in interactive alignment - Anatomy track.

Tool	Run Time (sec)	Precision	Recall	F-measure	Precision Non Inter	Recall Non Inter	F-measure Non Inter	Precision Oracle	Recall Oracle	F-measure Oracle	Total Requests	Distinct Mappings	True Positives	True Negatives	False Positives	False Negative	Precision	Negative Precision
⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩
Alin	101	0.957	0.735	0.831	0.888	0.259	0.401	0.957	0.735	0.831	326	574	144	429	0	0	1	1
AML	29	0.912	0.711	0.799	0.841	0.659	0.739	0.912	0.711	0.799	271	270	47	223	0	0	1	1
LogMap	26	0.886	0.61	0.723	0.818	0.59	0.686	0.886	0.61	0.723	142	142	49	93	0	0	1	1
XMap	21	0.837	0.574	0.681	0.837	0.574	0.681	0.837	0.574	0.681	4	4	0	4	0	0	0	1

Error Rate 0.1

Tool	Run Time (sec)	Precision	Recall	F-measure	Precision Non Inter	Recall Non Inter	F-measure Non Inter	Precision Oracle	Recall Oracle	F-measure Oracle	Total Requests	Distinct Mappings	True Positives	True Negatives	False Positives	False Negative	Precision	Negative Precision
⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩
Alin	101	0.794	0.67	0.727	0.888	0.259	0.401	0.961	0.743	0.838	315	557	124	375	42	15	0.747	0.962
AML	30	0.847	0.703	0.768	0.841	0.659	0.739	0.921	0.732	0.816	285	279	51	204	18	5	0.74	0.977
LogMap	26	0.847	0.6	0.702	0.818	0.59	0.686	0.855	0.593	0.701	140	140	45	81	10	3	0.819	0.965
XMap	22	0.837	0.574	0.681	0.837	0.574	0.681	0.837	0.573	0.68	4	4	0	3.6	0.4	0	0	1

Error Rate 0.2

Tool	Run Time (sec)	Precision	Recall	F-measure	Precision Non Inter	Recall Non Inter	F-measure Non Inter	Precision Oracle	Recall Oracle	F-measure Oracle	Total Requests	Distinct Mappings	True Positives	True Negatives	False Positives	False Negative	Precision	Negative Precision
⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩
Alin	100	0.672	0.615	0.642	0.888	0.259	0.401	0.964	0.748	0.843	303	538	108	321	81	27	0.572	0.923
AML	33	0.767	0.681	0.721	0.841	0.659	0.739	0.925	0.745	0.825	290	277	53	170	42	11	0.558	0.94
LogMap	26	0.822	0.588	0.686	0.818	0.59	0.686	0.831	0.579	0.682	143	143	38	75	18	10	0.679	0.883
XMap	21	0.837	0.574	0.681	0.837	0.574	0.681	0.837	0.572	0.68	4	4	0	3.2	0.8	0	0	1

Error Rate 0.3

Tool	Run Time (sec)	Precision	Recall	F-measure	Precision Non Inter	Recall Non Inter	F-measure Non Inter	Precision Oracle	Recall Oracle	F-measure Oracle	Total Requests	Distinct Mappings	True Positives	True Negatives	False Positives	False Negative	Precision	Negative Precision
⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩	⇧ ⇩
Alin	99	0.57	0.568	0.569	0.888	0.259	0.401	0.967	0.767	0.855	303	535	93	279	120	42	0.437	0.87
AML	30	0.718	0.651	0.683	0.841	0.659	0.739	0.929	0.75	0.83	284	269	47	143	58	20	0.448	0.878
LogMap	26	0.803	0.585	0.677	0.818	0.59	0.686	0.804	0.563	0.662	144	144	33	67	28	15	0.541	0.818
XMap	22	0.837	0.574	0.681	0.837	0.574	0.681	0.837	0.572	0.68	4	4	0	2.9	1.1	0	0	1

Table 6. - Participation of ALIN in interactive alignment - Conference track.

As ontologies of the Anatomy Track contains almost no properties, techniques used in ALIN can not be utilized, the selection of properties associated with classes assessed as belonging to the alignment, this has limited the increase in recall, which influenced the f-measure, as can be seen in Table 5.

Conference Track.
In this track ALIN stood out, showing the greatest f-measure among the four tools when the error rate is zero, as with a loss of f-measure when the error rate increases, as can be seen in Table 6.

3 General Comments

Evaluating the results it can be seen that the system can be improved towards:
(a) handling user error rate;
(b) generating a higher quality (especially w.r.t. recall) initial alignment in its non-interactive phase;
(c) reducing the number of interactions with the expert; and
(d) optimize the process to reduce its execution time.

4 Conclusions

Within certain characteristics, the ALIN system stands out in ontology alignment process in interactive application scenarios, especially when the amount of data and object properties are also subject to the alignment and when the expert does not make mistakes. With these features there is an alignment generated with relatively high precision and recall.

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