Semantic Relations for Content-based Recommendations

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1. INTRODUCTION

The main objective of the CHIP (Cultural Heritage Information Personalization) project is to demonstrate how Semantic Web and personalization technologies can be deployed to enhance access to digital museum collections. In collaboration with the Rijksmuseum Amsterdam[1], we have developed the Art Recommender[2]: a content-based recommender system that recommend art concepts based on user ratings of artworks. For example, if a user gives "Night watch" a high ratings, she will get its *creator* "Rembrandt" recommended. The demonstrator works with the Rijksmuseum ARIA[3] database, containing images and metadata descriptions of artworks. The mappings of metedata from ARIA to Iconclass[4] and the three Getty vocabularies[5] (AAT, TGN and ULAN) [1] allows for recommending a wide range of concepts via various semantic relations, within one (e.g. *broader/narrower*) or across two different vocabularies (e.g. *hasStyle*). Fig. 1 presents a top-level overview of the RDF Schema used in CHIP.

However, for recommender systems, not all related items are useful or interesting for users. Our main challenge is to find which semantic relations are generally useful for content-based recommendations of art concepts.

2. SEMANTIC RELATIONS

The metadata vocabularies bring in total 11 semantic relations (Nr. 5-15) as well as 4 basic artwork features (Nr. 1-4), see Table 1. Nr. 1-4 refer to artwork fea-
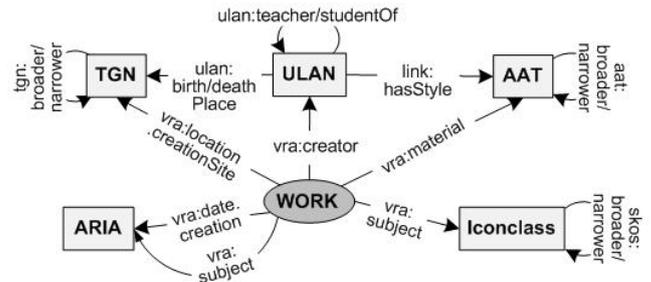
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[1]http://www.rijksmuseum.nl
[2]http://www.chip-project.org/demo/
[3]http://www.rijksmuseum.nl/collectie/ontdekdecollectie
[4]http://www.iconclass.nl/libertas/ic?style=index.xsl
[5]http://www.getty.edu/research/conductingresearch/

Figure 1: CHIP metadata vocabularies

tures, which are used for recommending art concepts based on the rated artwork. For example, if a user likes the artwork "Night watch", it would recommend the *creator* "Rembrandt" from ULAN, and the *creation site* "Amsterdam" from TGN. Nr. 5-15 are semantic relations linking concepts within one or across two different vocabularies, which are used for recommending concepts based on the rated concept. For example, if a user likes the painter "Rembrandt" from ULAN, it would recommend his *teacher* "Pieter Lastman" from ULAN, his art *style* "Baroque" from AAT, and his *death place* "Amsterdam" from TGN. Nr. 10-15 are the general *broader/narrower* relations linking concepts within AAT (concepts about art styles), Iconclass (concepts about general subjects) and TGN vocabularies (concepts about geographic locations).

3. EXPERIMENT

In a period of three weeks, 48 users participated in the experiment[6]. Using the Art Recommender (see Fig. 2), they were asked to rate artworks and related concepts by giving 1-5 stars (*precision*). Based on positive ratings of artworks or concepts with 4 or 5 stars, the system recommends related concepts via both artwork features and semantic relations. In addition, the "why recommended" option (see Fig. 2) gives an explanation about which feature/relation is used for each recommended concept. The user is also asked about whether he/she finds the concept recommended via this feature/relation interesting (*interestingness*) on a scale of 1-5 stars.

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[6]http://www.chip-project.org/demoUserStudy3/

Figure 2: Interface of the Art Recommender in the experiment

Table 1: Results of the experiment

Nr.	Relation type	Total Rec.	Precision	Interestingness
1	vra:creator	332	0.67	0.82
2	vra:location.creationSite	182	0.40	0.56
3	vra:material	159	0.43	0.45
4	vra:subject	3245	0.50	0.59
1-4	all artwork features	3918	0.50	0.60
5	link:hasStyle	82	0.63	0.73
6	ulan:teacherOf	291	0.43	0.71
7	ulan:studentOf	92	0.44	0.68
8	ulan:birthPlace	184	0.32	0.43
9	ulan:deathPlace	130	0.26	0.25
10	aat:broader	69	0.53	0.60
11	aat:narrower	125	0.55	0.62
12	skos:broader	404	0.50	0.51
13	skos:narrower	1198	0.52	0.50
14	tgn:broader	82	0.22	0.15
15	tgn:narrower	1204	0.16	0.13
5-15	all semantic relations	3861	0.45	0.53

4. RESULTS AND DISCUSSION

Table 1 gives an overview for both artwork features and semantic relations. As a baseline, artwork features provide in total 3918 recommended concepts and reach an average precision of 0.50 for precision and 0.60 for interestingness. In comparison, semantic relations bring 3861 new recommended concepts and reach an average precision of 0.46 for precision and 0.53 for interestingness, which are only slightly lower than artwork features. In more details, we found out: (i) artwork feature *vra:creator* and semantic relations *link:hasStyle* and *aat:broader/narrower* produce the most accurate recommendations and they are also the most interesting relations; (ii) semantic relations *ulan:birth/deathPlace* and *tgn: broader/narrower* that recommend geographic

locations perform very badly. This suggests that, for art recommendations, relations about geographic locations might not be interesting for users because they are not intrinsically related to artworks but to locations or artists; (iii) artwork feature *vra:subject* and semantic relations about subjects *skos:broader/narrower* produce the largest number of recommended concepts. For precision and interestingness, they score on the average. We may conclude that the use of semantic relations can enhance the content-based recommendations by retrieving more related items and some specific relations significantly increase the precision and interestingness.

Generalizing, we found that vocabularies which are relatively close to the domain are usually more useful for content-based recommendations than vocabularies, which are more general. In particular, in the case of CHIP, ULAN and AAT vocabularies which contain concepts about artists and art styles proved to be more useful for art recommendations than the TGN vocabulary which contains concepts about geographic locations.

5. ACKNOWLEDGMENTS

6. REFERENCES
[1] Y. Wang, N. Stash, L. Aroyo, P. Gorgels, L. Rutledge, and G. Schreiber. Recommendations based on semantically-enriched museum collections. *Journal of Web Semantics*, 2008.

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[7]http://www.nwo.nl/catch