



From a Web Services Catalog to a Linked Ecosystem of Services

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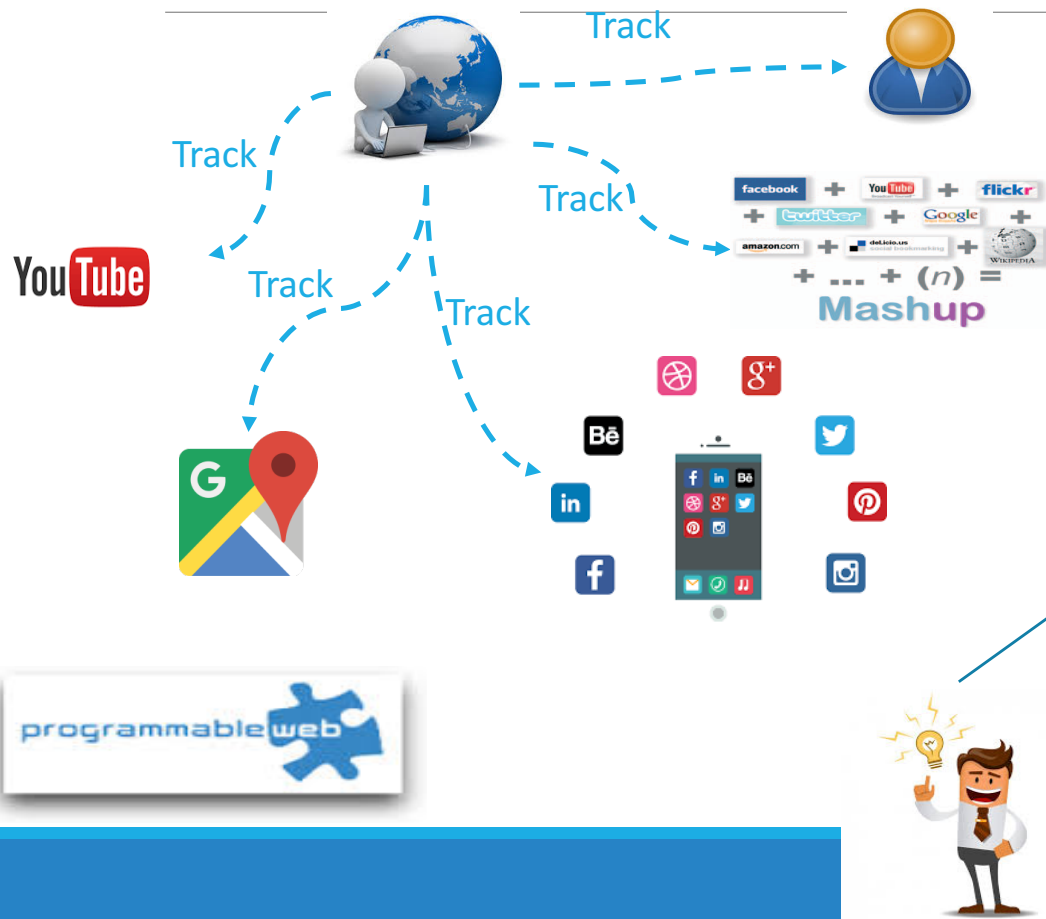
Outline

- Context and motivation
- Related work
- Graph construction
- Recommendation process
- Evaluation
- Conclusion and future work

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Context and Motivation



Increasing number of web services and mashups (> 18 K APIs @Pweb)

☹ Manual search of services and mashups is difficult

☹ Services and mashups are sparse

→ *Tedious process of discovery and recommendation*

link services/ mashups and users
→ discovery and recommendation

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Discovery and recommendation

Approaches	Graphs	Discovery Criteria
Selection and recommendation of APIs [Guo 2015]	Operates on services, mashups, categories and social links between developers	User profiles and preferences
Linked Social Services [Maamar 2011]	Based on Linked Data Principles	Social links
Trust based [Deng 2014] [Deng 2015]	Based on common usage in mashups or by users QoS evaluations	Trust
Linked mashups [Bianchini 2014]	link between mashups of resources which is calculated based on the comparison of their terminological items	Similarity

Discovery and recommendation

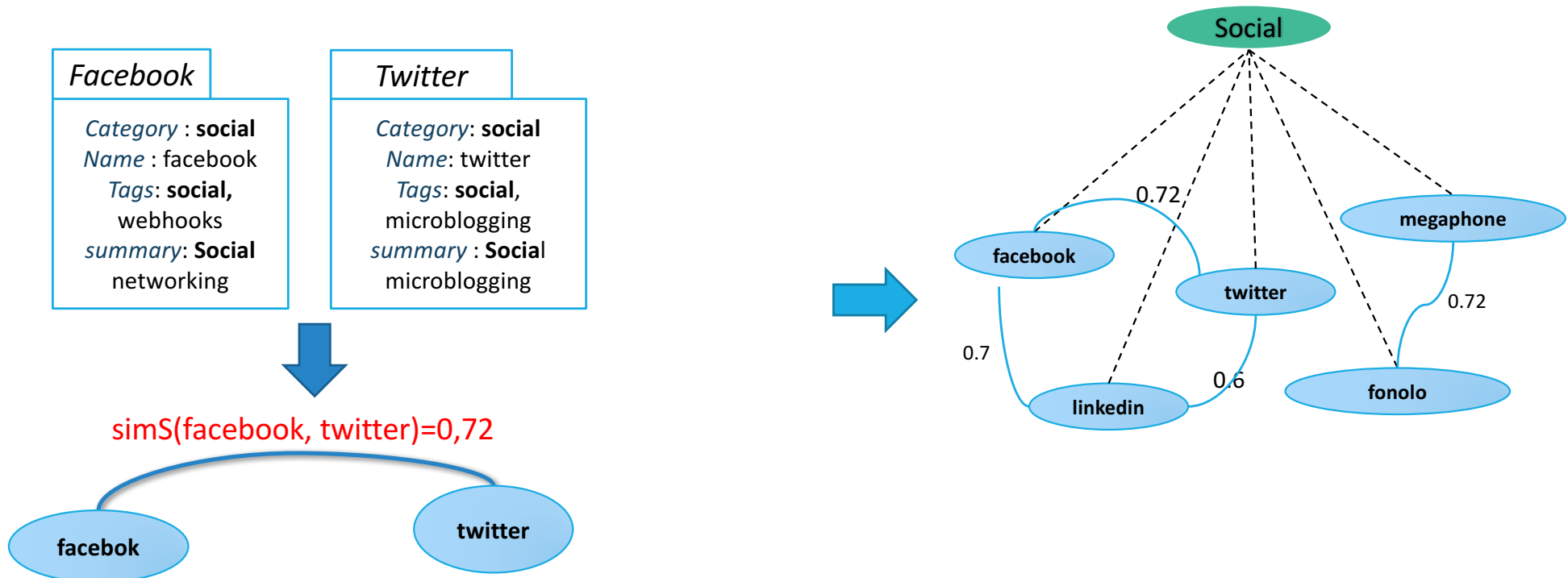
- Most recommendations are based on common usages of services/mashups or result in "same" QoS properties
- ☹ **Ignore** services' properties and mashups (documentation, functional and non functional)
- ☹ **Ignore** services and mashups' similarities
- ☹ QoS are not always available

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Services relationships

Similarities between categories, names, description and tags





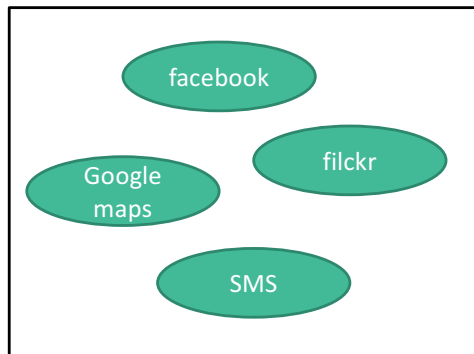
Mashups relationships

How to create links between mashups?

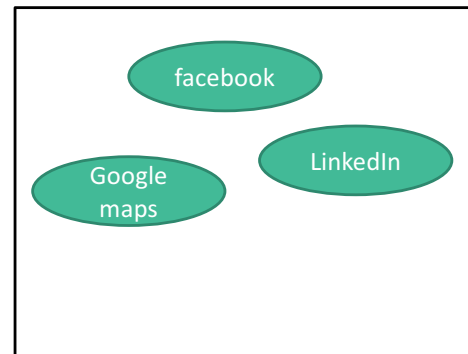
→ common services in mashups

$$Sim_{Mashups}(M1, M2) = \frac{|SM1 \cap SM2|}{|SM1 \cup SM2|}$$

M1



M2

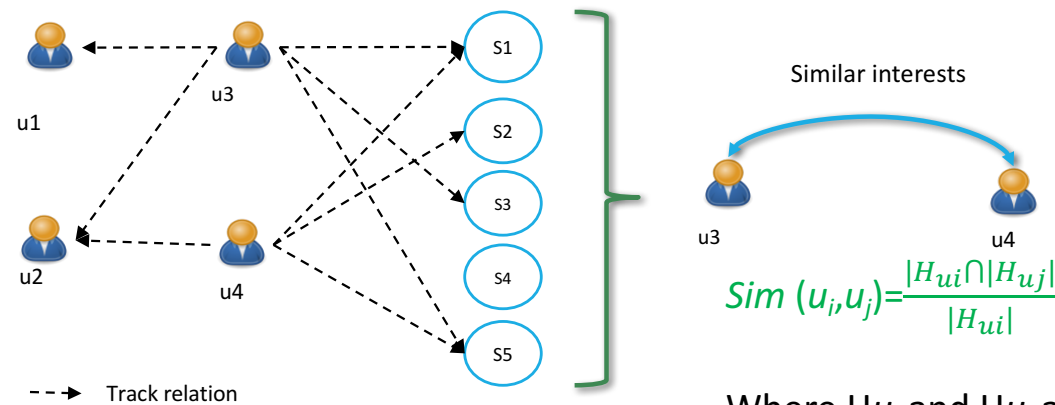


$$Sim_{Mashups}(M1, M2) = \frac{2}{5} = 0,4$$

Users relationships

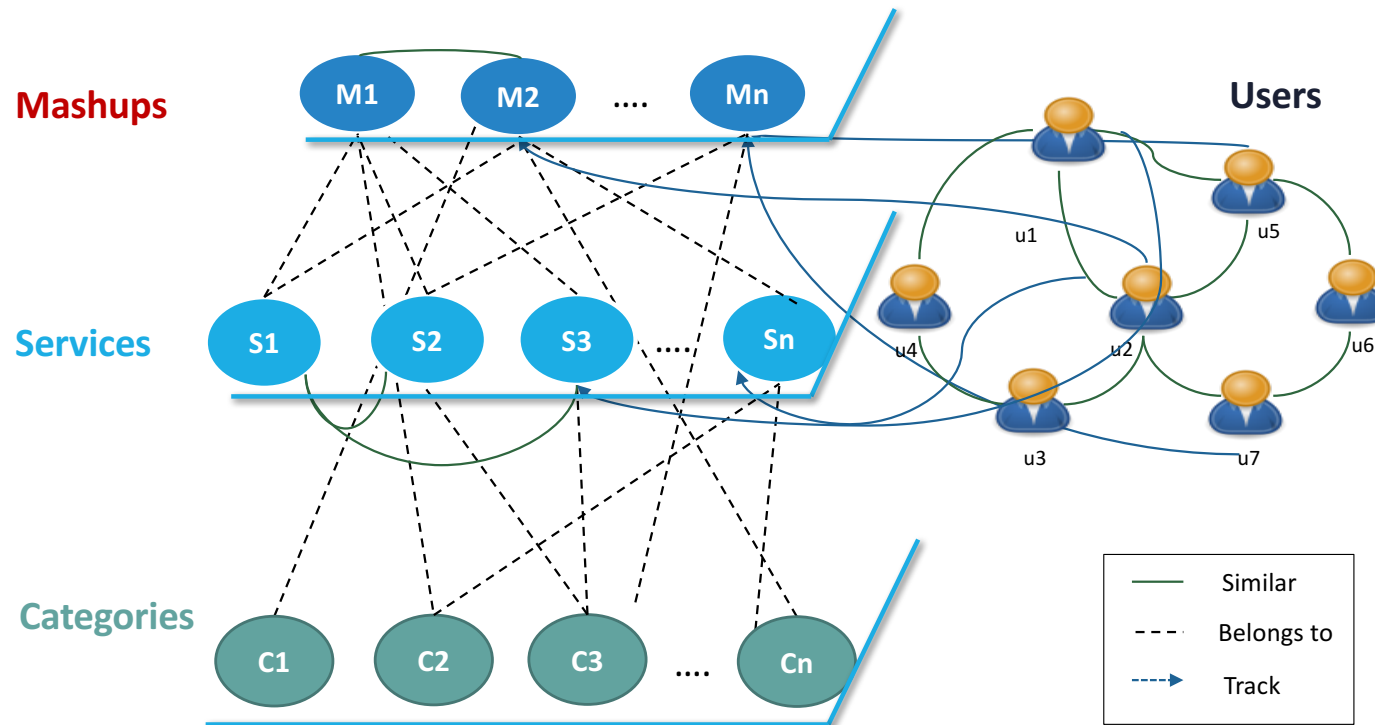
How to create links between users?

Links may have different semantics: follows, similarity



Where H_{u_i} and H_{u_j} are the recent histories of users u_i and u_j respectively

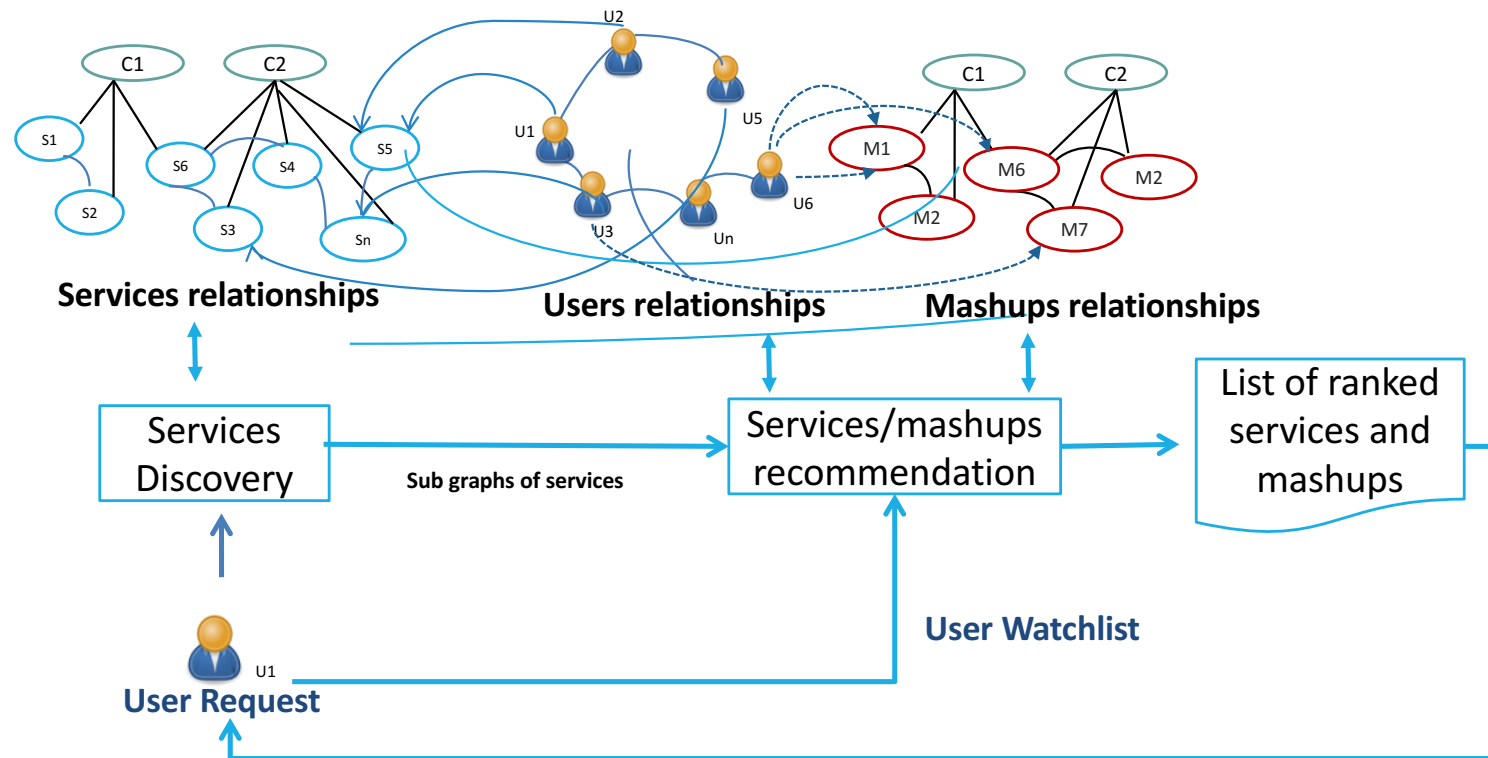
Global graph



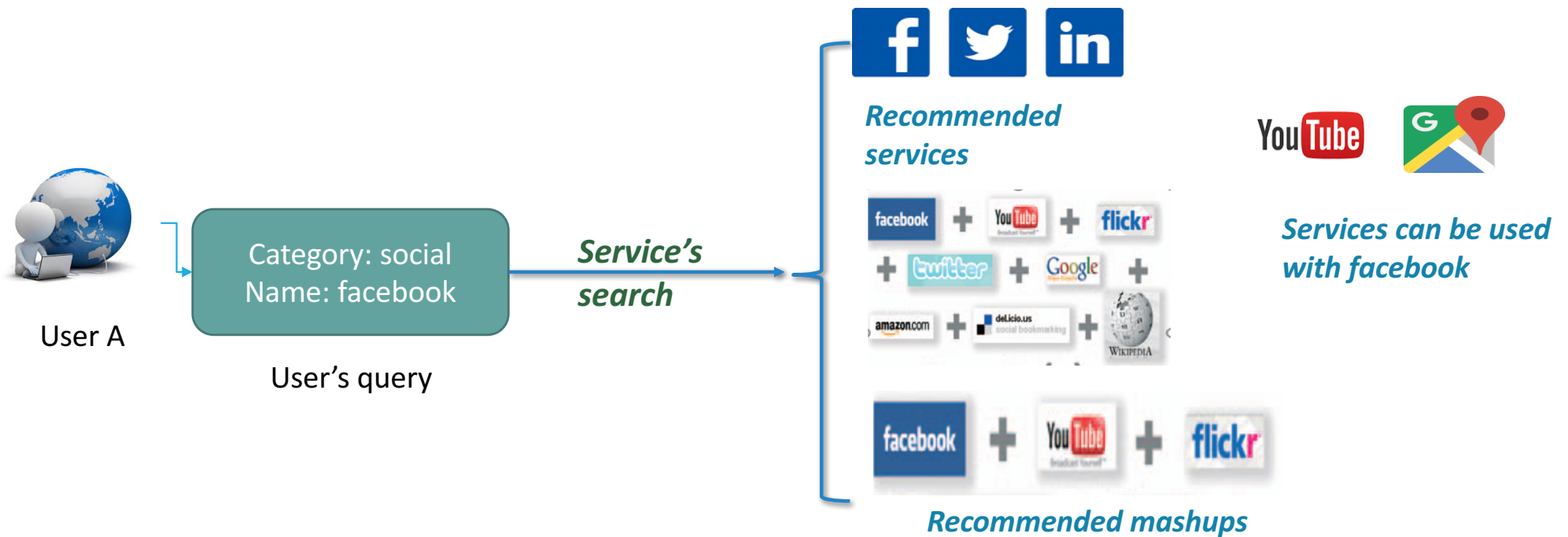
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Recommendation process



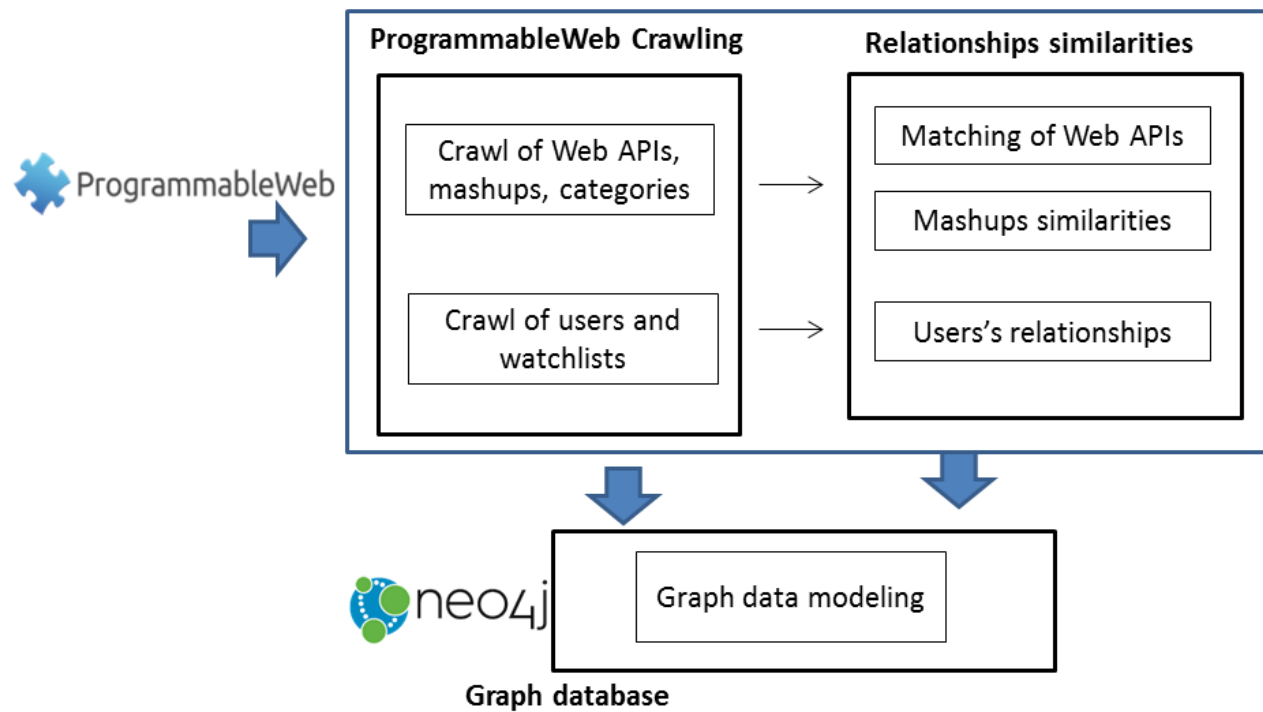
Recommendation process



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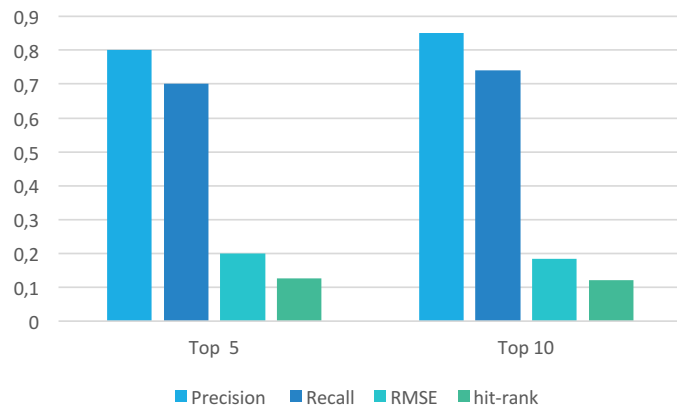
System architecture



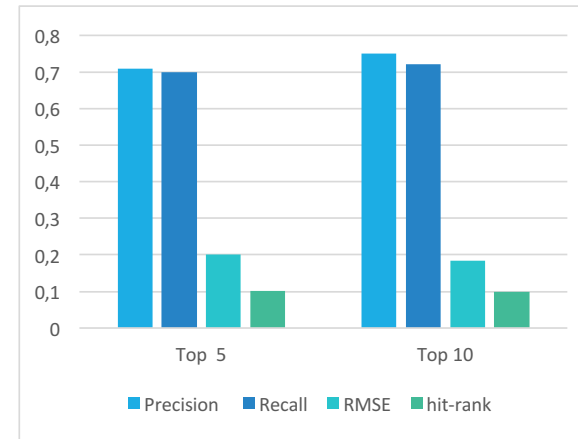
Data set

Number of categories	116
Number of mashups	300
Number of services	700
Number of users (with wtachlists)	344

Evaluation numbers



Recall, Precision, RMSE and Hit-rank numbers (w.r.t the number of recommended services)



Recall, Precision, RMSE and Hit-rank numbers (w.r.t the number of recommended mashups)

→ it is relatively easier to recommend a subset of relevant services.

Evaluations numbers

- **TrsutSVD**: Trust based recommendation
- **Popular**: Recommendation of popular services (ProgrammableWeb)

Approaches	Precision @5	Precision @10	Recall @5	Recall @10	RMSE @5	RMSE @10
TrustSVD	0.73	0.75	0.61	0.63	0.211	0.2
WReG	0.80	0.85	0.70	0.74	0.2	0.185
Popular	0.41	0.39	0.34	0.61	0.31	0.3

Evaluation numbers

- **WReG** is based on users-services and users-mashups relationships
 - recommendations are more precise.
- **TrustSVD** considers trust relations between users and services
 - gives good precision values
 - Not able to recommend services in absence of rating values
- *Popular*
 - lowest results compared to TrustSVD and WReG
 - does not take into account users' interests (results are not personalized).

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- Evaluations results
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Conclusion

- A new web services ecosystem catalog
 - Multigraph
 - service → service relations
 - user → user relations
 - user → service relations
 - Neo4J prototype
- Recommendation process
 - Search
 - Recommendation

Future work

- Exploit the graph and links between services and mashups to assist the mashups **construction** process
- Extend this work to service management for IoT in order to perform IoT services discovery.

References

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