Towards a Framework for Weaving Social Networks Principles into Web Services Discovery

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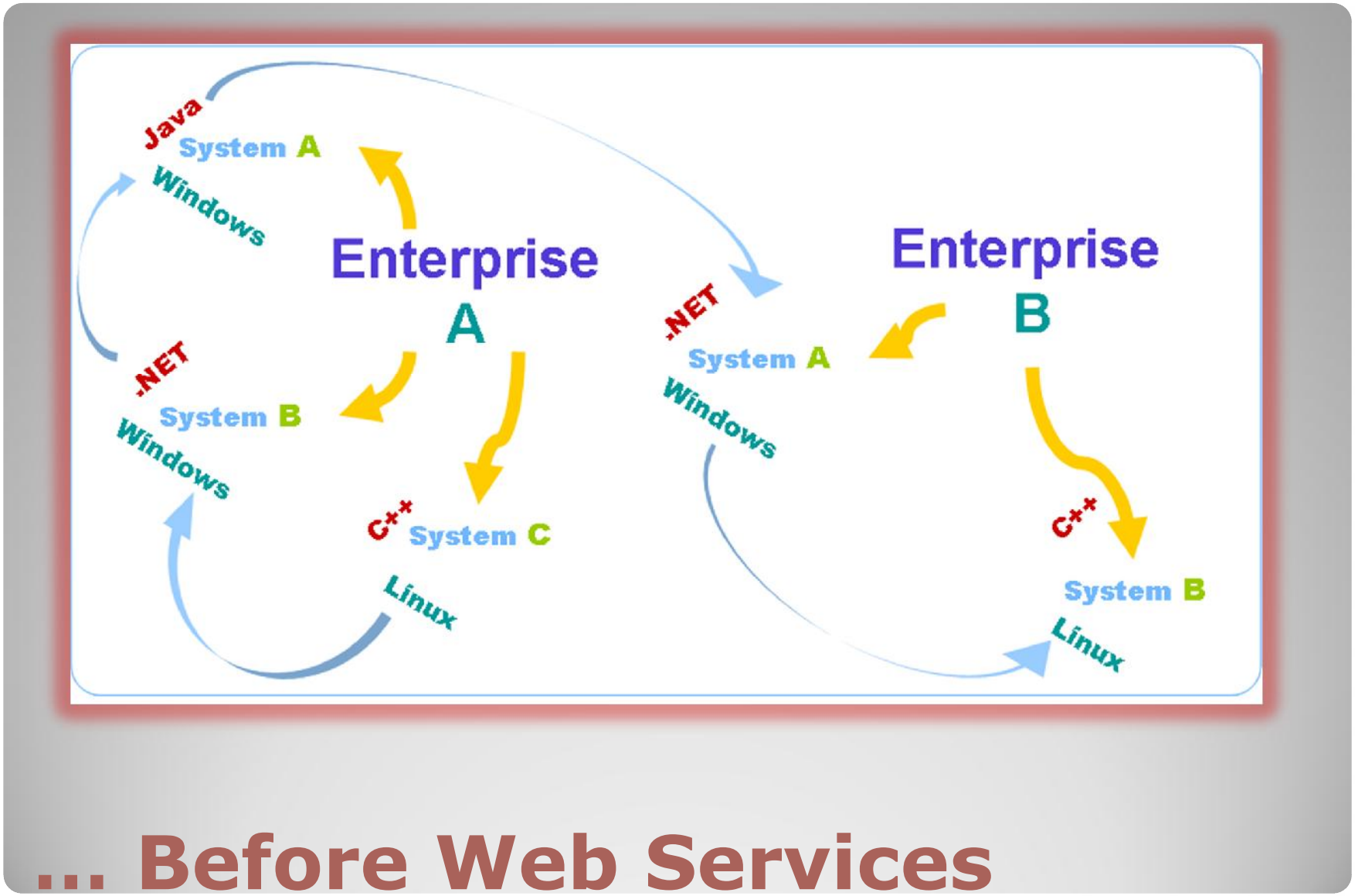
Plan

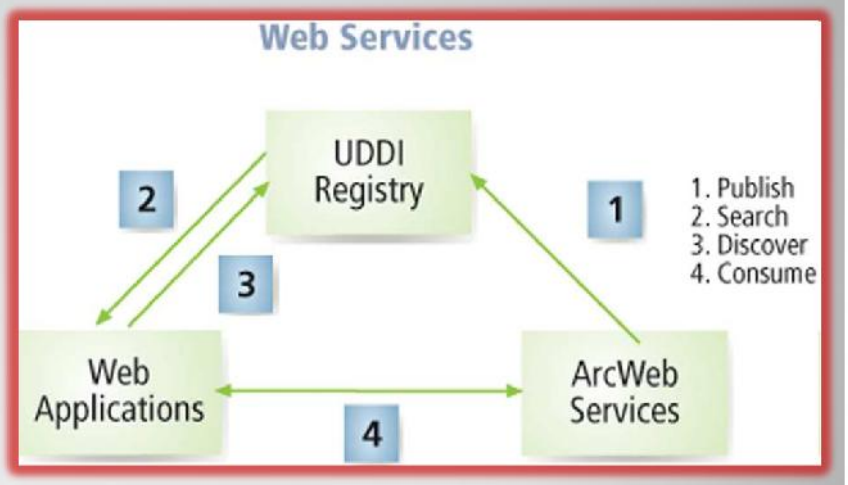
- Drawback of Web Service Discovery
- Social Networks of Web services
- Social Networks Build
- Recommendation (R)
- Similarity (S)
- Collaboration (C)
- Social Networks Use
- Social Networks Building



... Before Web Services

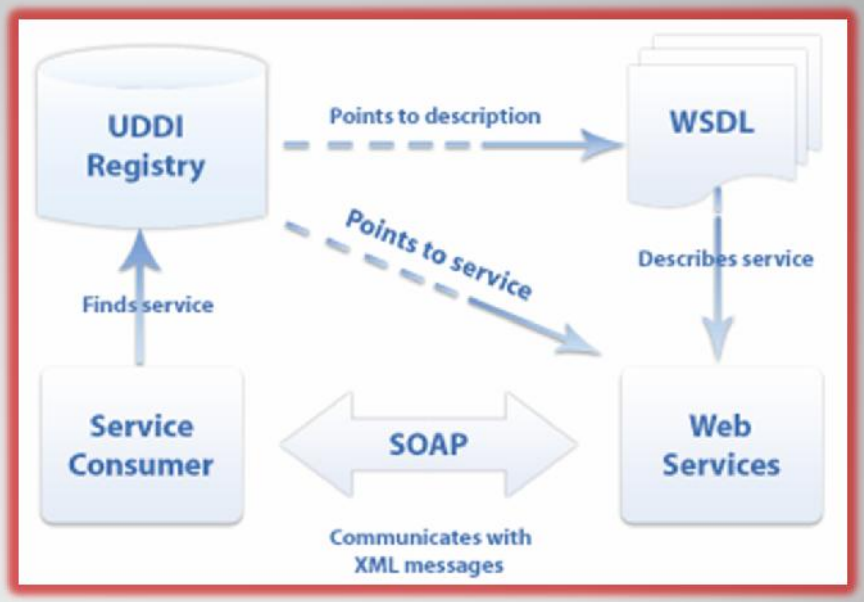
Web Services Architecture

- Web services involve three major roles:
  - Provider, Registry, and Consumer
- Three major operations surround Web services:
  - Publishing, Finding, Binding
- Architectural characteristics:
  - Distributed
  - Loosely coupled
  - Standards based
  - Process-centric



UDDI is used to register and look up services, acting as a central registry that provides a specification for distributed Web service registries through:

- White pages
  - Business name
  - Contact info
- Yellow pages
  - Business categories
  - Industrial classification
  - Geographical taxonomy
- Green pages
  - Business processes
  - Services description
  - Binding information



Making a service available

- Search by category — *ServiceType* **Print** **interface Print** **class PS-Print**
- Attribute-value matching — **format=PS** **location=DC***
- Comparison function — **Paper=(str)"A4"** **x-res=(int)600** **Angle=(float)12.5**
- Compound queries — **(&(q<3)(color in (TrueColor, GreyScale)))**
- Attribute relationship (tree-like query) — **Building=DC** → **Room=3335**
- SQL like query — **For, Let, Where, Order by, Return**

Discovery and Selection of WS

Drawbacks of service selection and discovery:

- Syntactical criteria
- Web services belong to static registries
- No inter-related service selection
- No information about previous compositions

Contribution:

- Enrich the service discovery with relationships between Web services → Social Web Services

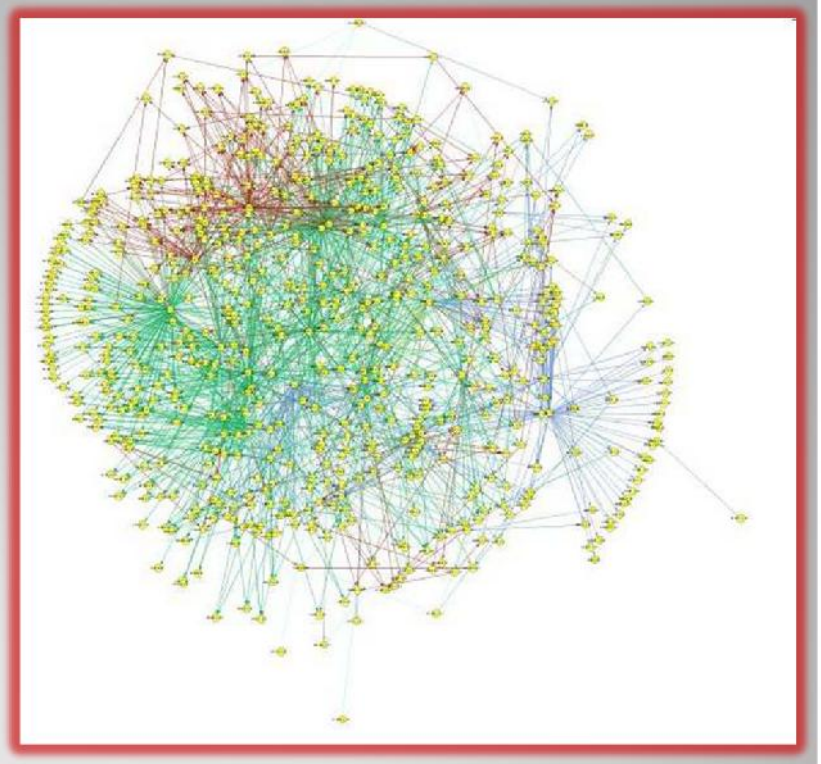
Services Selection & Discovery

Establish networks of peers based on past interactions to:

- Recommend the peers with whom a WS would like to collaborate in the case of composition
- Recommend the peers that can substitute a WS in case of failure; and
- Be aware of the peers that compete against a WS in the case of selection

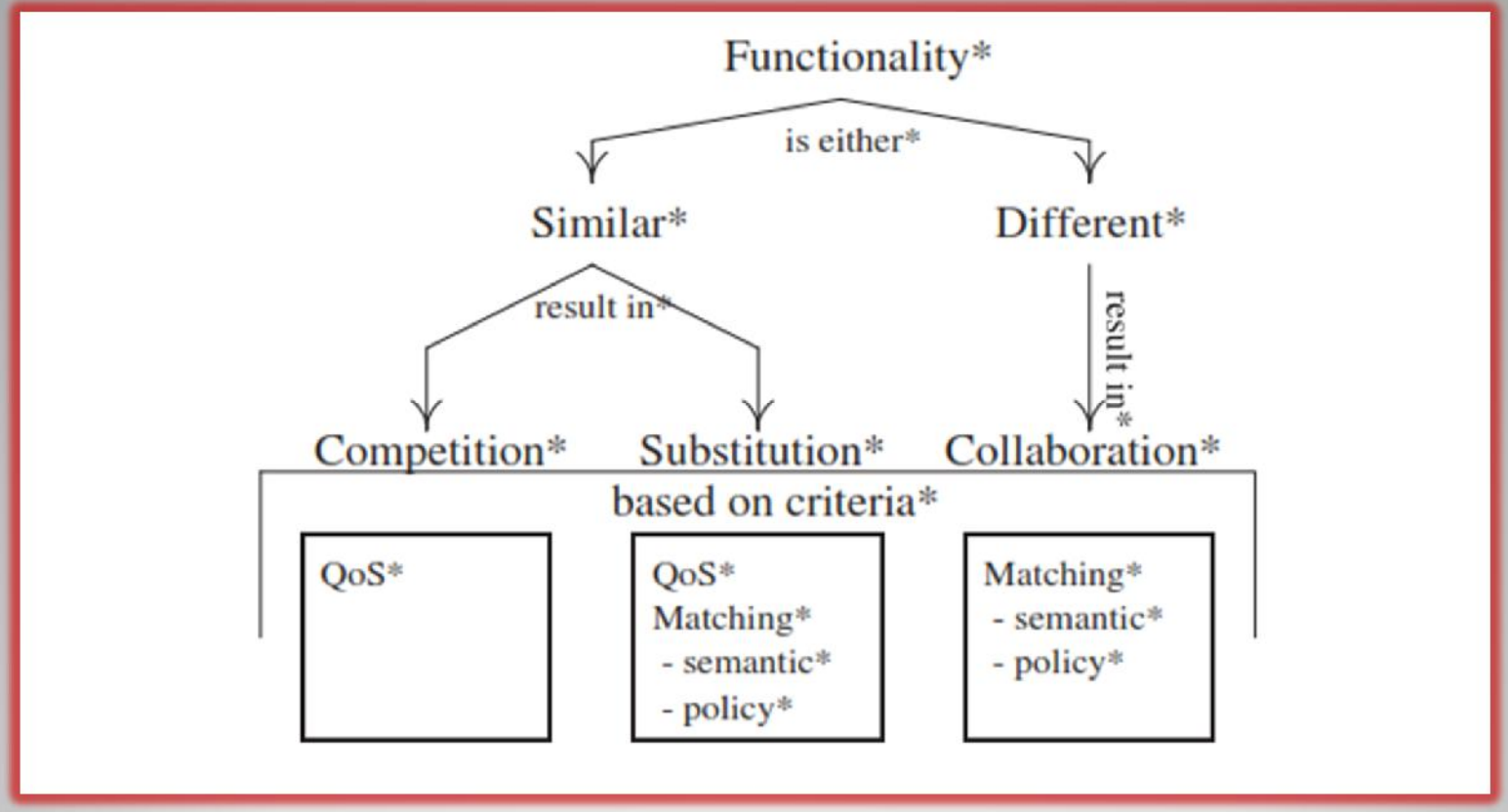
Motivation Behind Social WS

"The Social Network helps us to better understand how and why we interact with each other, as well as how technology can alter this interaction"

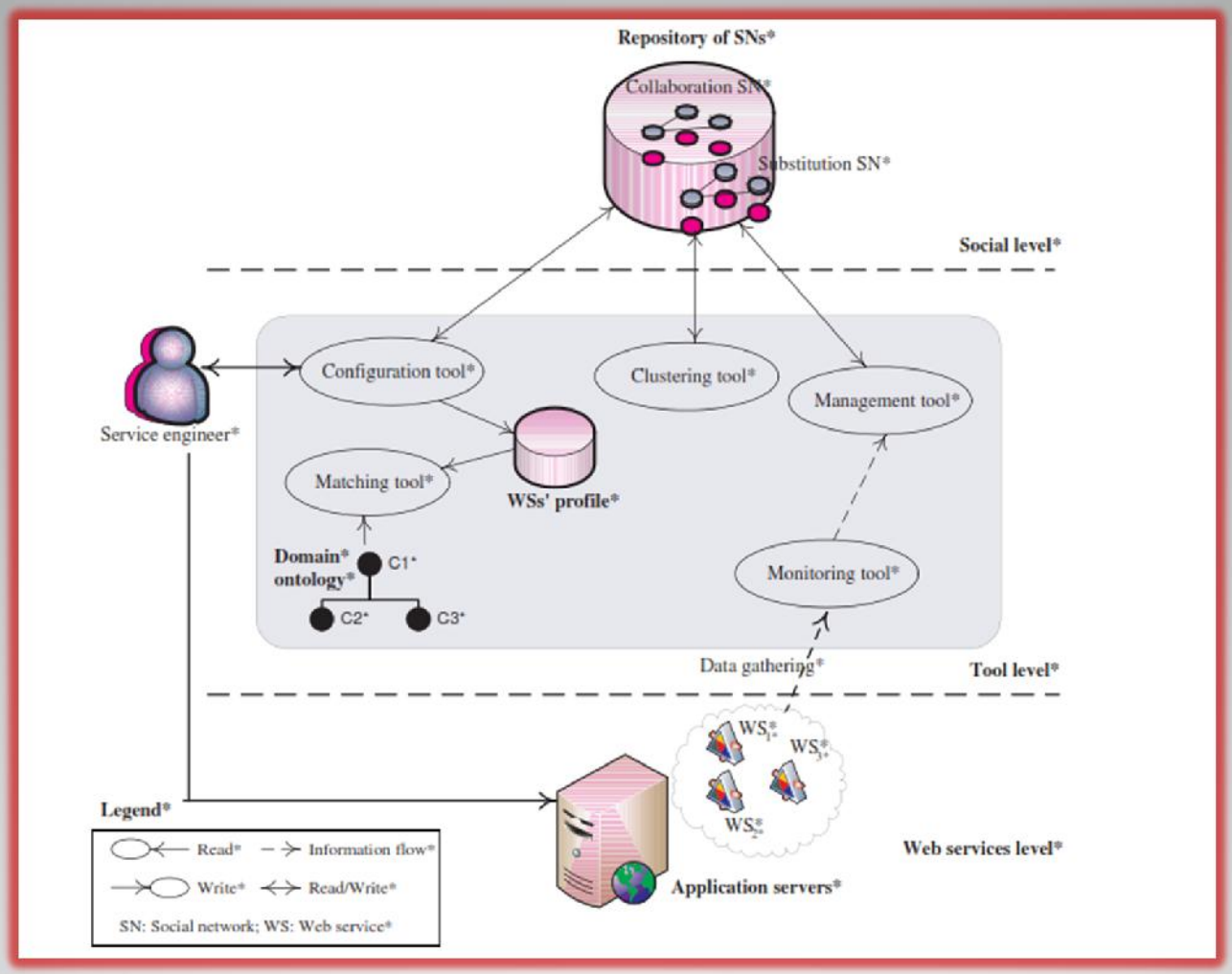


- But how Web services can build their social networks in relation to composition scenarios?

Social Networks

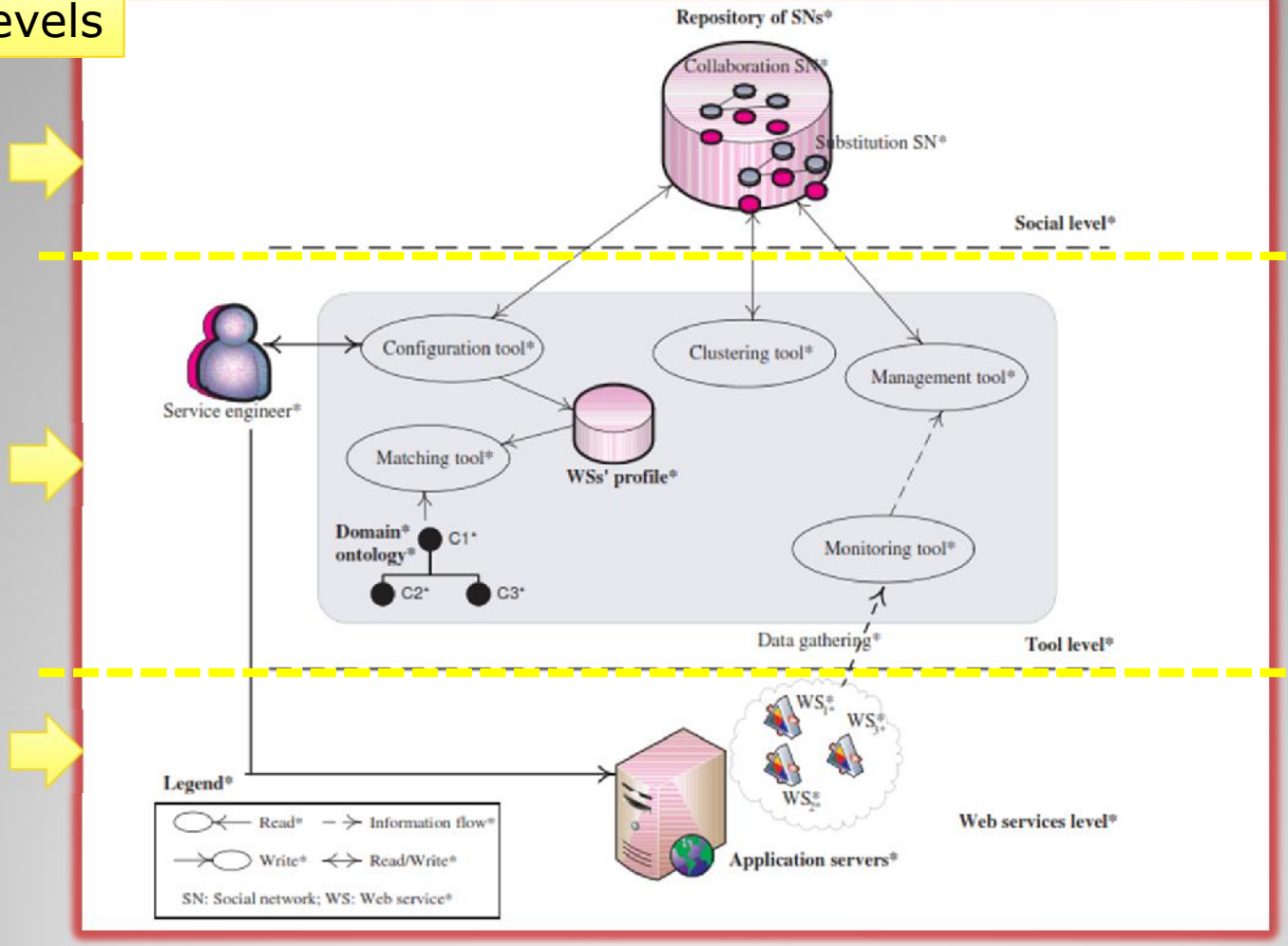


Criteria for SWS network building

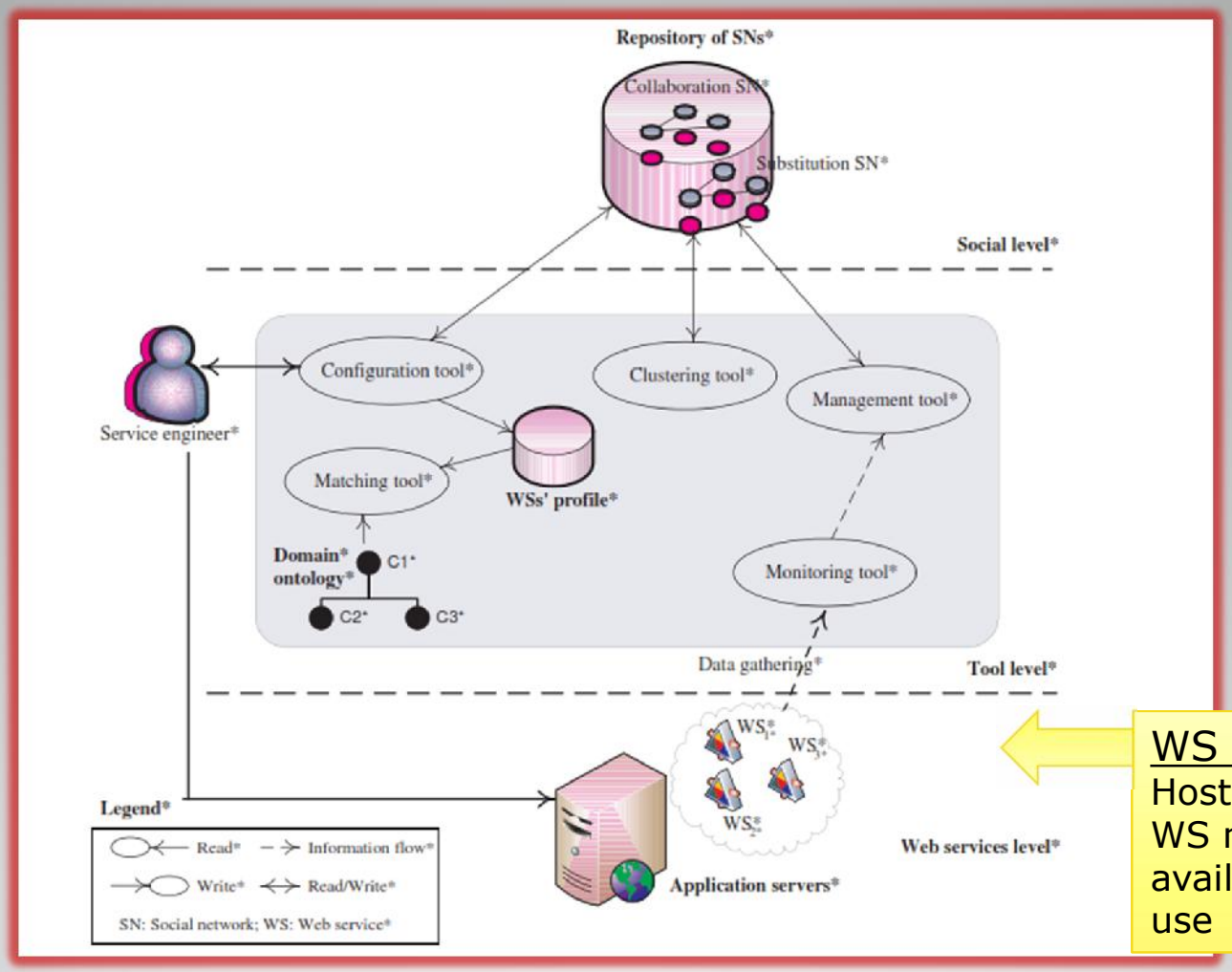


Framework general representation

3 levels

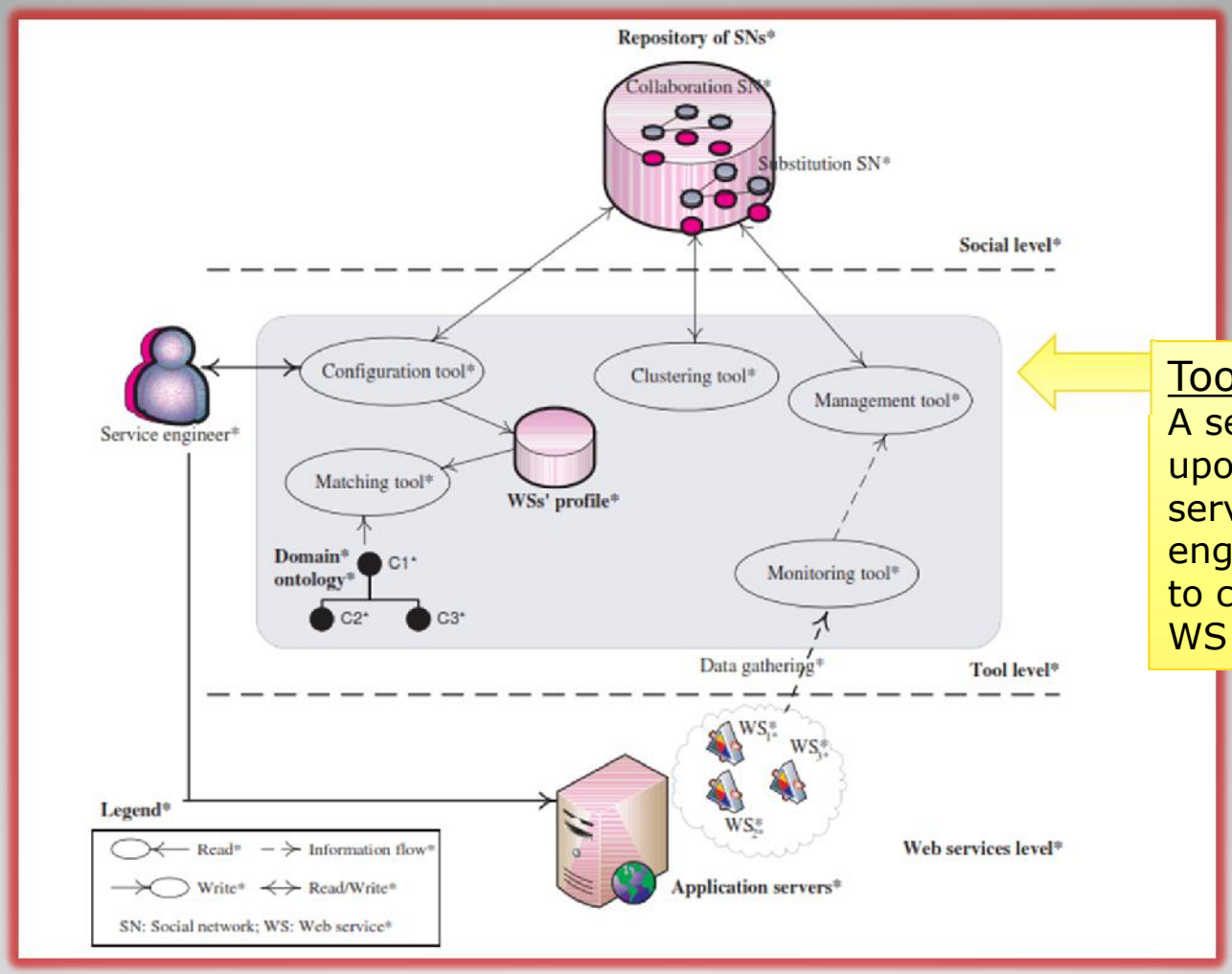


Framework general representation



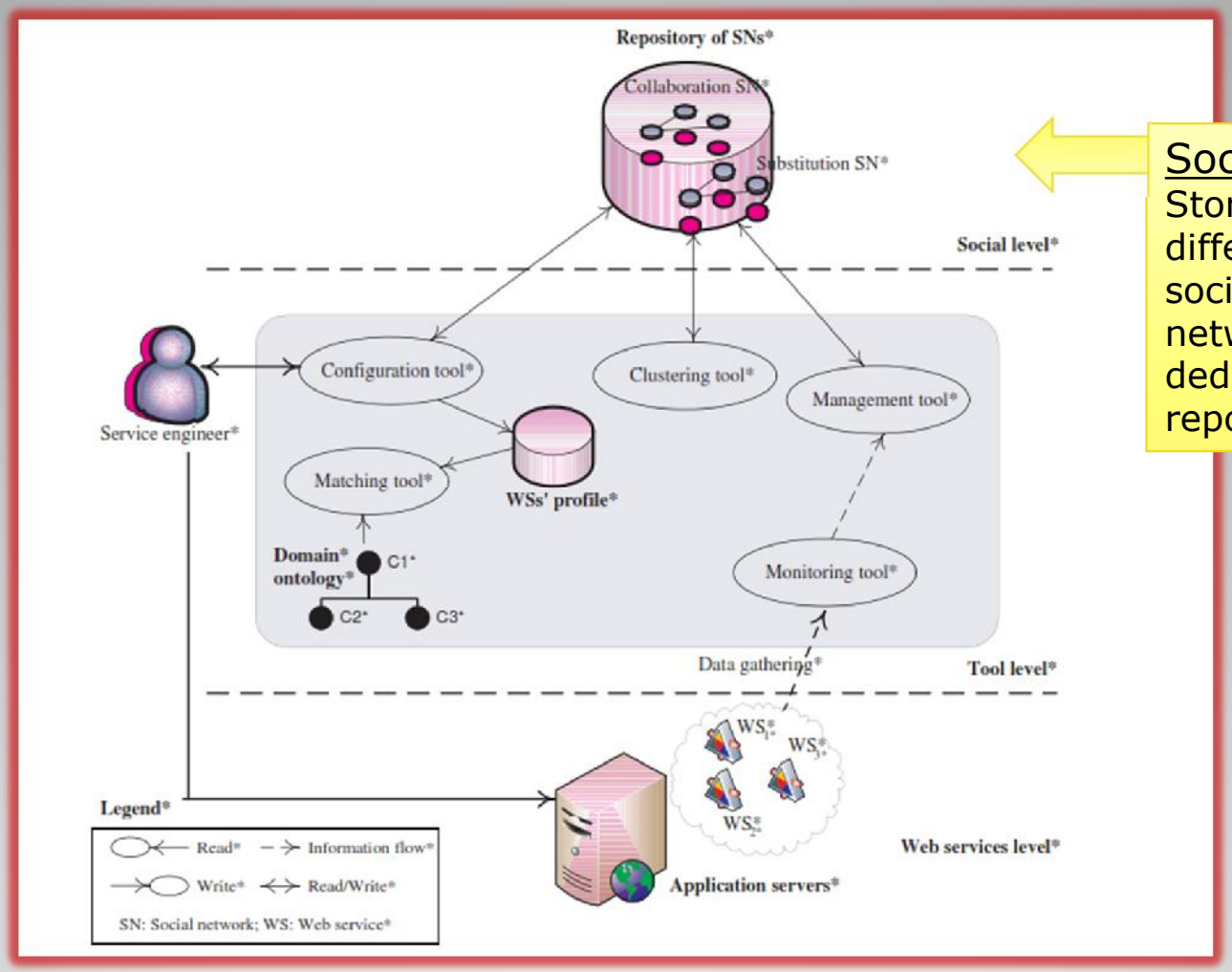
WS level
Hosts different WS made available for use

Framework general representation



Tool level
A set of tools upon which service engineers rely to carry out WS weaving

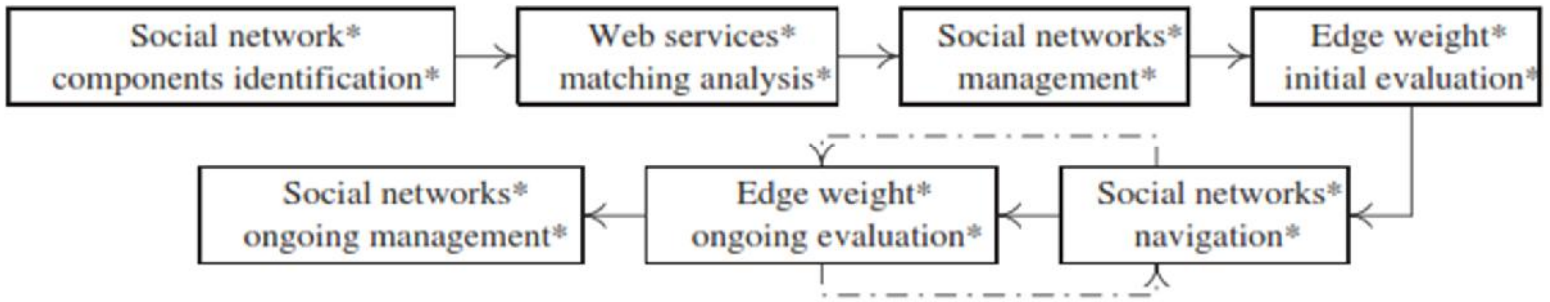
Framework general representation



Social level
Stores the different WS social networks in a dedicated repository

Framework general representation

Steps to perform the Weaving of social networks' principles into WS discovery:



Weaving of social networks

Building SWS Network

- The social network of a WS consist on the services that are similar to or that have already interacted with it by the means of:
  - Collaboration
  - Substitution
  - Competition
- To built the network, we:
  - Use the knowledge of a service Engineer
  - Analyze WS's similarity (matching score)
- In fact, we have one network for each meaning (collaboration, substitution or competition)

Matching analysis of Web services

- Similarity is established by a matching algorithm that compares the following elements of WS's profiles:
  - Preconditions (P)
  - Inputs (I) and Outputs (O)
  - Effects (E)
  - QoS
- From many approaches to match WS, we have chosen the one of Min et al. (2009), and WS descriptors are semantically enriched (OWL-S)
- In our experiments, just Input, Output and QoS (i.e., *load*) were used

Similarity between ws_i and ws_j is then calculated by the following equation:

$$DS(ws_i, ws_j) = \frac{\sum_k w_k \times MS(C_{ws_{i_k}}, C_{ws_{j_k}})}{\sum_k w_k}$$

- Each element (category) of the profile is compared by this equation, giving an degree of similarity (DS)
- *C_{ws} is the concept used in the profile to describe the corresponding element, and MS is the matching score between two concepts*
- *Concepts are described by an Ontology*

Degree of similarity

Score between Cs_i and Cs_j is calculated by the following equation, which is based on Li et al. (2003):

$$MS(Cs_i, Cs_j) = f1 \times f2 \times f3$$

- It takes into account:
  - f1: the number of edges one needs to follow to connect Cs_i and Cs_j (l)
  - f2: as the depth of each concept in the ontology (h)
  - f3: the semantic density of each concept*
  - Alpha, beta, and gamma as smoothing factors

* Not used in our experiment (dependent of a corpus)

$$f_1 = e^{\alpha l}$$

$$f_2 = \frac{e^{\beta h} - e^{-\beta h}}{e^{\beta h} + e^{-\beta h}}$$

$$f_3 = \frac{e^{\lambda l} - e^{-\lambda l}}{e^{\lambda l} + e^{-\lambda l}}$$

Matching Score

- Service12:

  Translates words from one language to another

  - Input: Word, Language
  - Output: Word
- Service51:

  Translates English words into Pig Latin

  - Input: Word
  - Output: Word

Example

- Input category (pair of concepts):

  `{(Word, Word), (Word, Language)}`

- Output category (pair of concepts):

  `{(Word, Word)}`

- Matching scores: $MS(Word,Word) = e^{0} \times \left(\frac{e^{2} - e^{-2}}{e^{2} + e^{-2}} \right) = 0.964$

$$MS(Word,Language) = e^{-1} \times \left(\frac{e^{2} - e^{-2}}{e^{2} + e^{-2}} \right) = 0.355$$

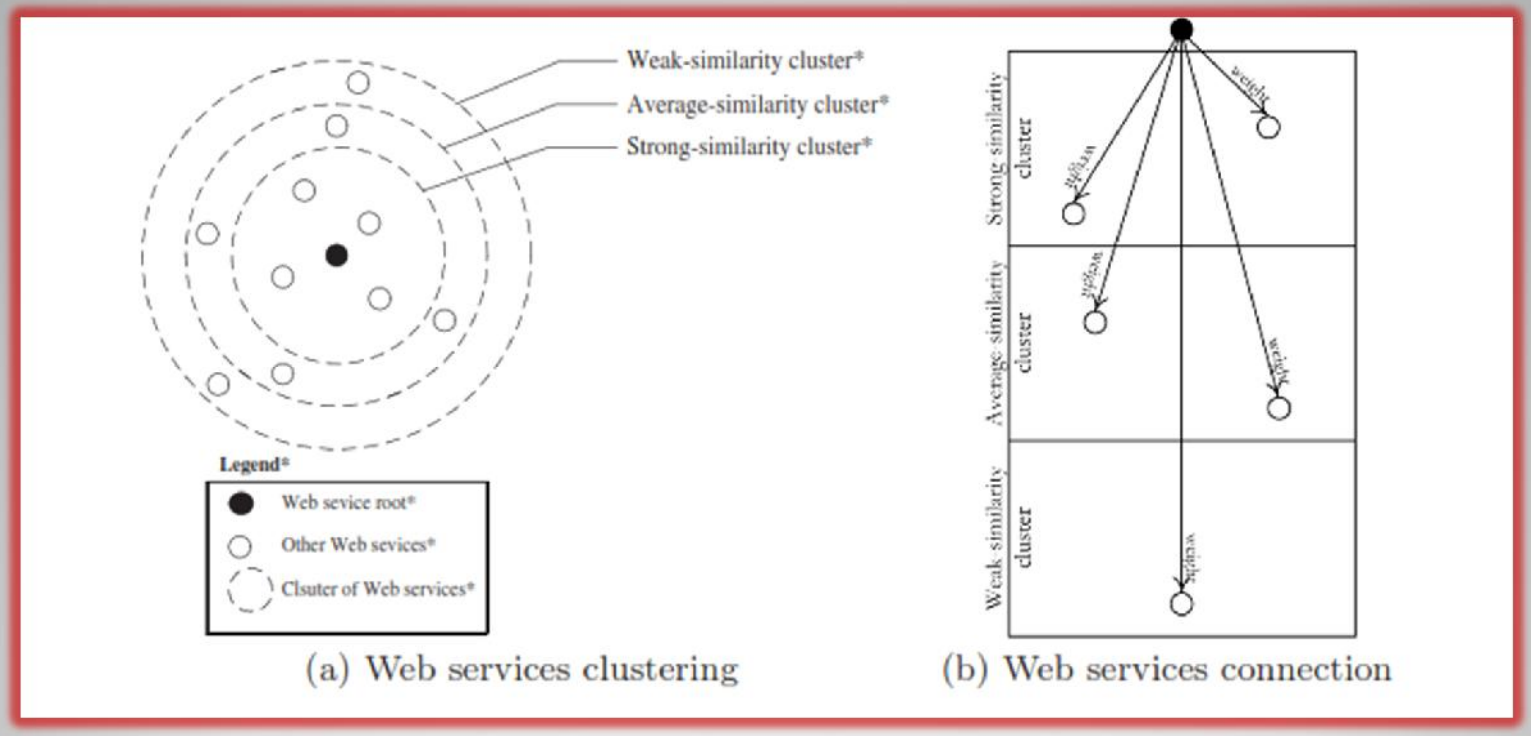
- Similarity degree:

$$DS(WS_{51}, WS_{12}) = \frac{MS(Word,Word) + MS(Word,Word) + MS(Word,Language)}{3}$$

$$DS(WS_{51}, WS_{12}) = \frac{0.964 + 0.964 + 0.355}{3} = 0.761$$

Example: WS_{51} versus WS_{12}

WS are grouped according to the following clusters, which different priorities:



Social networks management/use

- The discovery of a Web service is now based on:
  - its social network
  - on the type of relationship we need: substitution, collaboration or competition
- For instance, to find a substitute for WS_{12} we look into its substitution SN (WS_{12} will be the root and the candidates are all the nodes connected to it)

Social networks management/use

- The selection of a substitute node is based on:
  - Pc: its priority (which varies according the cluster it is)
  - Co: its cost (proportional to cluster priority and inversely to the weight of the edge that connects it to the edge)
  - E: its satisfaction level (based on previous experiences)
  - L: its current loading level

$$Selection_{ws_j} = \alpha_1 \times Co_{ws_j} + \alpha_2 \times E_{ws_j} + \alpha_3 \times (1 - L_{ws_j})$$

$$Co_{ws_j} = \frac{P_c}{1 + (P_c \times WE_{t_n}(ws_i, ws_j))}$$

Selection equation

- Reinforcement happens each time a service is substituted (or collaborate or compete with other services)
- The following equation is used to update the edges involved on substitution:

$$WE_{t+\delta t}(ws_i, ws_j) = WE_t(ws_i, ws_j) + \alpha \times \left(\frac{|\, selection_{ws_j} \,|}{|\, failure_{ws_j} \,|} - WE_t(ws_i, ws_j) \right)$$

Network edges' update

Experiments

- Used some services from the collection http://andreas-hess.info/projects/annotator/index.html
- Calculated the matching degree among all services and used it to build the substitution network of Service12
- Simulated the substitution of Service12, considering different scenarios (different levels of service loading)

Network weights for Service12

List of available Web services	Interation 0							Interation 1						
	W	Cluster	Co	E	L	S	Subs	W	Cluster	Co	E	L	S	Subs
1 service2	0,13	Weak	0,19	1,00	0,00	2,19	0	0,13	Weak	0,19	1,00	0,00	2,19	0
2 service6	0,13	Weak	0,19	1,00	0,00	2,19	0	0,13	Weak	0,19	1,00	0,00	2,19	0
3 service12	0,13	Weak	0,19	1,00	0,00	2,19	0	0,13	Weak				2,19	0
4 service17	0,13	Weak	0,19	1,00	0,00	2,19	0	0,13	Weak				2,19	0
5 service20	0,13	Weak	0,19	1,00	0,00	2,19	0	0,13	Weak				2,19	0
6 service22	0,13	Weak	0,19	1,00	0,00	2,19	0	0,13	Weak				2,19	0
7 service30	0,13	Weak	0,19	1,00	0,00	2,19	0	0,13	Weak				2,19	0
8 service38	0,56	Average	0,39	1,00	0,00	2,39	0	0,56	Average	0,39	1,00	0,00	2,39	0
9 service51	0,76	Strong	0,50	1,00	0,00	2,50	1	0,77	Strong	0,49	1,00	1,00	1,49	1
10 service52	0,96	Strong	0,45	1,00	0,00	2,45		0,96	Strong	0,45	1,00	0,00	2,45	1
11 service53	0,36	Average	0,42	1,00				0,36	Average	0,42	1,00	0,00	2,42	
12 service60	0,66	Average	0,38	1,00				0,66	Average	0,38	1,0			
13 service76	0,13	Weak	0,19	1,00				0,13	Weak	0,19	1,0			
14 service85	0,13	Weak	0,19	1,00	0,00	2,19	0	0,13	Weak	0,19	1,0			
15 service91	0,13	Weak	0,19	1,00	0,00	2,19	0	0,13	Weak	0,19	1,0			
16 service95	0,96	Strong	0,45	1,00	0,00	2,45	0	0,96	Strong	0,45	1,00	0,00	2,45	0

Changed its loading level

Service51 is selected

Service52 is then selected

Experiments

- Different steps along with different tools were identified:
  - identification of the components of a social network,
  - matching analysis of Web services,
  - management of the social networks,
  - initial evaluation of the weights of edges of these social networks,
  - navigation through these social networks,
  - evaluation of the weights of these edges,
  - management of these social networks.

Conclusions

Conclusions and future work

- Weaving social elements into Web service operation means Social Web Services that:
  - will establish and maintain networks of contacts enabling additional functionalities through collaboration and annotation, and count on their contacts when needed
  - form strong and long lasting collaborative groups with other peers
  - know with whom to partner
- Our future work consists of fine tuning the implementation and comparing for example discovery time using our social networks and other registry-based means

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Thanks for your attention!

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