Trust-Based Service Discovery in Multi-Relation Social Networks

Joyce El Haddad

PSL, Université Paris-Dauphine, CNRS LAMSADE UMR 7243

Complex Networks Seminar

LIP6, UPMC

April 25, 2013

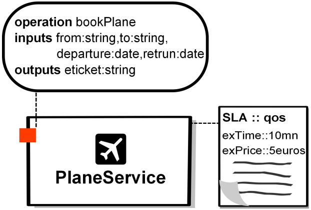
Outline

Outline

Web Service Context

- Service-Oriented Architecture (SOA) and Service Computing (SOC) promote the construction of added-value composite systems out of reusable, loosely coupled, distributed entities called services

- Web services possibly described using three level interfaces:
  1. Signature (operations)
  2. Semantic (capabilities)
  3. Non-fuctional (quality of service)

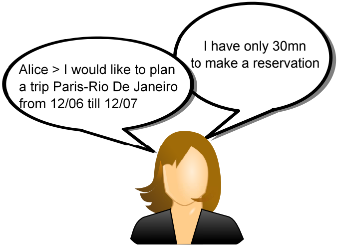


Web Service Composition Goals

- Composing automatically services from requirements:
  - Satisfy non-functional and semantic user requirements
  - Support different service and user need description levels

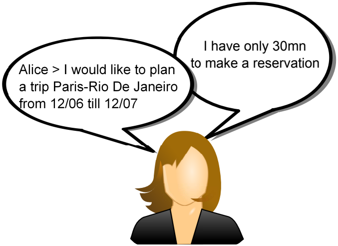
Web Service Composition Goals

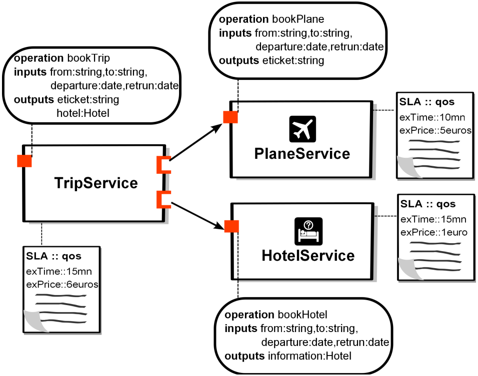
- Composing automatically services from requirements:
  - Satisfy non-functional and semantic user requirements
  - Support different service and user need description levels



Web Service Composition Goals

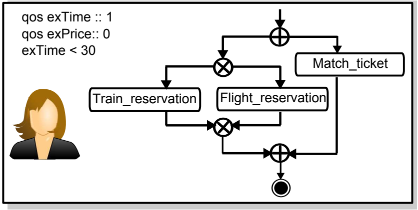
- Composing automatically services from requirements:
  - Satisfy non-functional and semantic user requirements
  - Support different service and user need description levels

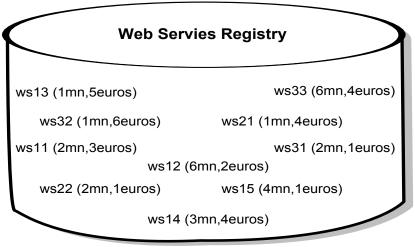




Web Service Composition Process

Requirements





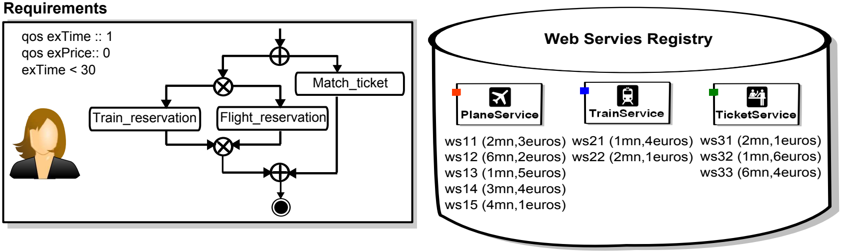
- Discovery: search for sets of semantically similar Web services for tasks of the requirement
  - Why? semantic of services correspond to the tasks of the requirement
  - How? semantically annotated registry

Example

Reservation of a flight ticket for 2014 FIFA World Cup in Brasil, from 12/06 till 12/07:

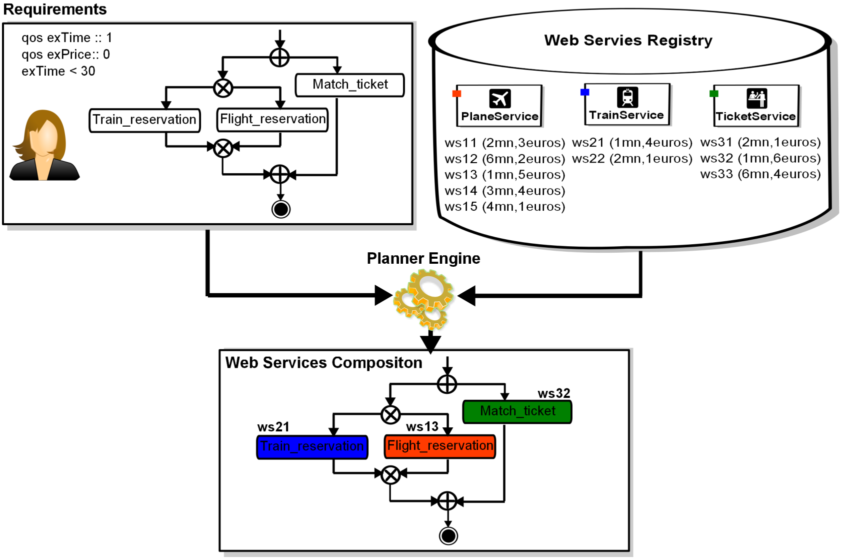
- Task (activity): reservation of a ticket on a flight
- Web services? Air France, TAP Portugal, British Airways, . . .

Web Service Composition Process



- Selection: obtain one candidate for each task of the requirement and under precise constraints
  - Why? Because discovered Web services have the same functionality. In our example, several Web services (companies) do the connection Paris-Rio De Janeiro (Air France, TAP, . . .)
  - How? Non-functional properties such as Quality of Service (execution duration, availability, . . .)

Selection Step



Selection Step

1. User requirements: workflow (abstract) of capacities + weights over QoS criteria
2. Services: functionality (capabilities) + QoS values
3. Instantiation of workflow: selection of the best QoS component Web services that satisfies the user's QoS preferences
   - The set of possible execution plans is combinatorial
   - QoS-aware Web service selection problem for workflow realization is a combinatorial optimization problem (MCKP)
   - Local optimization [El Haddad et al., ICWS 2008, IEEE TSC 2010]
   - Global planning [El Haddad et Spanjaard, ROADEF 2009]
   - ANR JCJC PERSO (2007-2010) (http://pagesperso-systeme.lip6.fr/Pascal.Poizat/ANR_PERSO)

Issues

1. Registry-based SOA deals only with automatic (Web) services
   - What about human services?

Issues

1. Registry-based SOA deals only with automatic (Web) services
   - What about human services?
2. Emergence of Web 2.0 and especially social networks
   - How to take into account the social dimension?

Issues

1. Registry-based SOA deals only with automatic (Web) services
   - What about human services?
2. Emergence of Web 2.0 and especially social networks
   - How to take into account the social dimension?
3. The quality of Web services is known
   - What about quality of providers?

Issues

1. Registry-based SOA deals only with automatic (Web) services
   - What about human services?
2. Emergence of Web 2.0 and especially social networks
   - How to take into account the social dimension?
3. The quality of Web services is known
   - What about quality of providers?
4. Web services ignore past interactions
   - How to keep track of past interactions?

Goal

Melt social aspect into service discovery and selection

PhD of Amine Louati, co-advised with Suzanne Pinson

Outline

Trust-based Service Discovery Problem

- How to determine trustworthy providers before using their services ?
- What information needs to be captured from service requester's multi relation social network ?

[Bansal et al. 2010]

- A trust-based dynamic Web service composition in single-relation social networks
- Trust rating based on centrality measure to select Web services provided by trustworthy providers

☹ Trust representation is limited to one measure

☹ The multi-relation aspect of social networks is ignored

Trust-based Service Discovery Problem

- How to determine trustworthy providers before using their services ?
- What information needs to be captured from service requester's multi relation social network ?

[Maaradji et al., 2010]

- Composition based on a recommendation confidence in single-relation social networks
- The recommendation confidence is the combination of 3 ratings: number of times a service is used, social proximity between requester and recommender and, expertise of the recommender

☹ The approach is limited to automatic services

☹ The multi-relation aspect of social networks is ignored

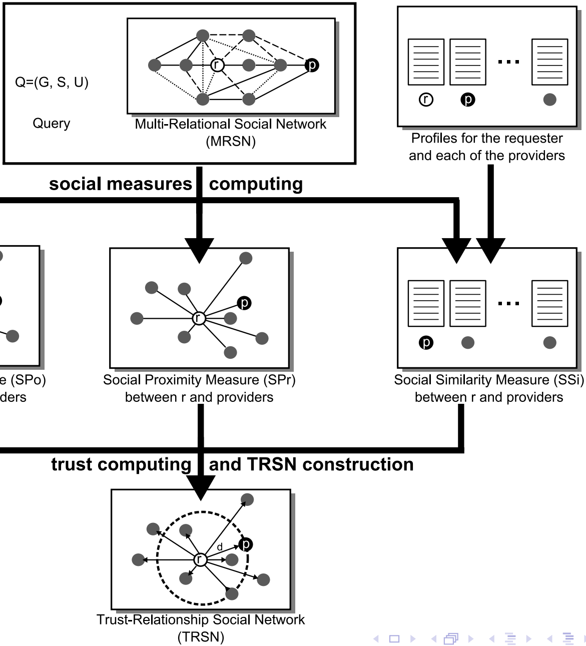
Trust-based Service Discovery Problem

Our contribution

A service provider discovery approach based on social trust measure between service's requester and providers

- Human service as well as automatic service
- Social trust measure computed over the service's requester multi-relation social network
- Social trust measure handles a multi-dimensional rating established from structural as well as semantic information

Our Approach



Our Model

Multi-Relation Social Network (MRSN)

An undirected graph $G = (V, E)$, where V is the set of nodes (users) and $E = \{E_1, \ldots, E_r\}$ is the set of edges where E_i is the set of edges with respect to the ith relationship

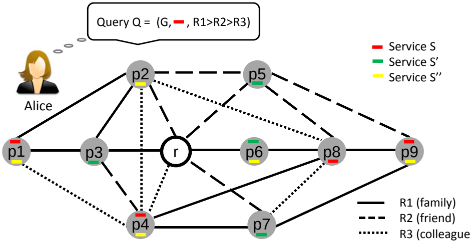
Neighborhood

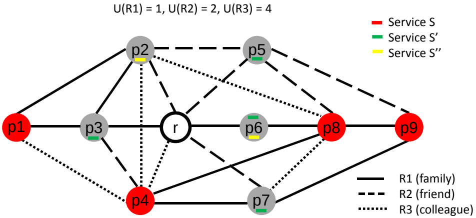
Given a MRSN graph G, the neighborhood of a node u regarding a type of relationship R_i is defined as $N_{R_i}(u) = \{v \in V \mid (u, v) \in E_i\}$

User query

$Q = (G, S, U)$, where G is a MRSN graph, S a requested service, and U a utility function expressing the service requester preferences over types of relationships

Example





$$Q_{Alice} = (G, babysitting, family \succeq friend \succeq colleague)$$

Step1: Social Measures Computing

Three measures are computed:

- Social Position Measure (SPo)
- Social Proximity Measure (SPr)
- Social Similarity Measure (SSi)
  - Profile Similarity (PS)
  - Neighborhood Similarity (DS)

Step1: Social Position Measure (SPo)

Definition

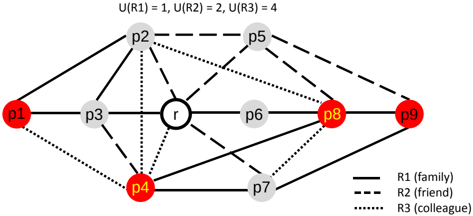
$SPo(p) = \sum_{i=1, \forall p' \in V}^{|R|} w_i \, . \, a^i(p, p')$ where $a^i(p, p') = 1$ iff p and p' are directly connected with an edge of a relation type R_i, 0 otherwise; $w_i = \frac{1}{U(R_i)}$

Step1: Social Position Measure (SPo)

Definition

$SPo(p) = \sum_{i=1,\forall p' \in V}^{|R|} w_i \; . \; a^i(p,p')$ where $a^i(p,p') = 1$ iff p and p' are directly connected with an edge of a relation type R_i, 0 otherwise; $w_i = \frac{1}{U(R_i)}$

Example



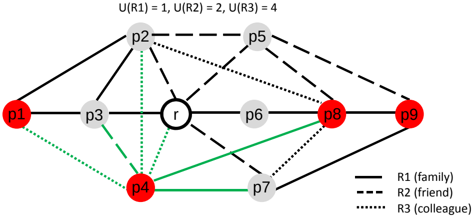
Step1: Social Position Measure (SPo)

Definition

$SPo(p) = \sum_{i=1,\forall p' \in V}^{|R|} w_i \, . \, a^i(p,p')$ where $a^i(p,p') = 1$ iff p and p' are directly connected with an edge of a relation type R_i, 0 otherwise; $w_i = \frac{1}{U(R_i)}$

Example

- $SPo(p_4) = 1 \times 2 + \frac{1}{2} \times 1 + \frac{1}{4} \times 3 = 3.25$



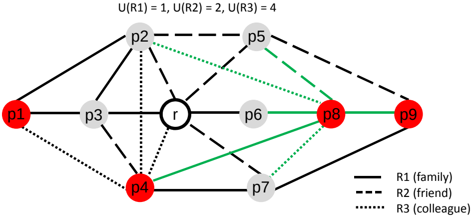
Step1: Social Position Measure (SPo)

Definition

$SPo(p) = \sum_{i=1, \forall p' \in V}^{|R|} w_i \ . \ a^i(p, p')$ where $a^i(p, p') = 1$ iff p and p' are directly connected with an edge of a relation type R_i, 0 otherwise; $w_i = \frac{1}{U(R_i)}$

Example

- $SPo(p_4) = 1 \times 2 + \frac{1}{2} \times 1 + \frac{1}{4} \times 3 = 3.25$
- $SPo(p_8) = 1 \times 3 + \frac{1}{2} \times 1 + \frac{1}{4} \times 2 = 4$



Step1: Social Proximity Measure (SPr)

Definition

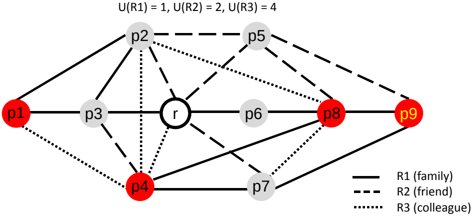
$$SPr(r, p) = \frac{\sum_{i=1}^{k} U((x_i, x_{i+1}))}{k-1}$$

Step1: Social Proximity Measure (SPr)

Definition

$$SPr(r,p) = \frac{\sum_{i=1}^{k} U((x_i, x_{i+1}))}{k-1}$$

Example



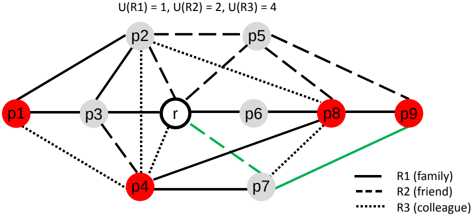
Step1: Social Proximity Measure (SPr)

Definition

$$SPr(r,p) = \frac{\sum_{i=1}^{k} U((x_i, x_{i+1}))}{k-1}$$

Example

- $path_1 = (r, p_7, p_9)$ and cost$=\frac{3}{2} = 1.5$



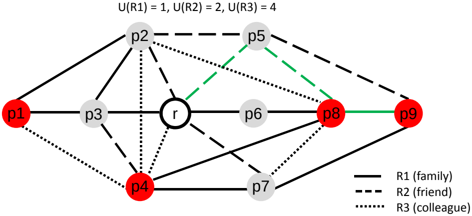
Step1: Social Proximity Measure (SPr)

Definition

$$SPr(r,p) = \frac{\sum_{i=1}^{k} U((x_i,x_{i+1}))}{k-1}$$

Example

- $path_1 = (r, p_7, p_9)$ and cost$=\frac{3}{2} = 1.5$
- $path_2 = (r, p_5, p_8, p_9)$ and cost$=\frac{5}{3} = 1.66$



Step1: Social Proximity Measure (SPr)

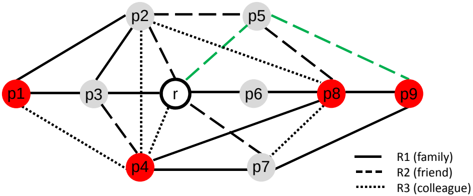
Definition

$$SPr(r,p) = \frac{\sum_{i=1}^{k} U((x_i, x_{i+1}))}{k-1}$$

Example

- $path_1 = (r, p_7, p_9)$ and cost$=\frac{3}{2} = 1.5$
- $path_2 = (r, p_5, p_8, p_9)$ and cost$=\frac{5}{3} = 1.66$
- $path_3 = (r, p_5, p_9)$ and cost$=\frac{4}{2} = 2$

U(R1) = 1, U(R2) = 2, U(R3) = 4



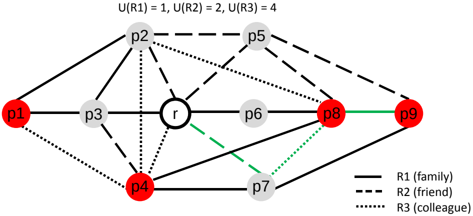
Step1: Social Proximity Measure (SPr)

Definition

$$SPr(r, p) = \frac{\sum_{i=1}^{k} U((x_i, x_{i+1}))}{k-1}$$

Example

- $path_1 = (r, p_7, p_9)$ and cost$=\frac{3}{2} = 1.5$
- $path_2 = (r, p_5, p_8, p_9)$ and cost$=\frac{5}{3} = 1.66$
- $path_3 = (r, p_5, p_9)$ and cost$=\frac{4}{2} = 2$
- $path_4 = (r, p_7, p_8, p_9)$ and cost$=\frac{7}{3} = 2.33$



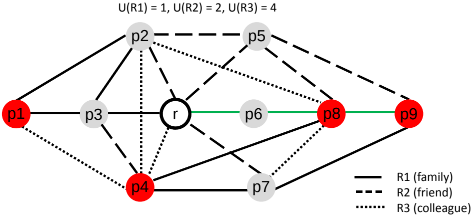
Step1: Social Proximity Measure (SPr)

Definition

$$SPr(r,p) = \frac{\sum_{i=1}^{k} U((x_i, x_{i+1}))}{k-1}$$

Example

- $path_1 = (r, p_7, p_9)$ and cost$=\frac{3}{2} = 1.5$
- $path_2 = (r, p_5, p_8, p_9)$ and cost$=\frac{5}{3} = 1.66$
- $path_3 = (r, p_5, p_9)$ and cost$=\frac{4}{2} = 2$
- $path_4 = (r, p_7, p_8, p_9)$ and cost$=\frac{7}{3} = 2.33$
- $path_5 = (r, p_6, p_8, p_9)$ and cost$=\frac{3}{3} = 1$



Step1: Social Similarity Measure (SSi)

Definition

$SSi = DS \times PS$

Step1: Social Similarity Measure (SSi)

Definition

$SSi = DS \times PS$

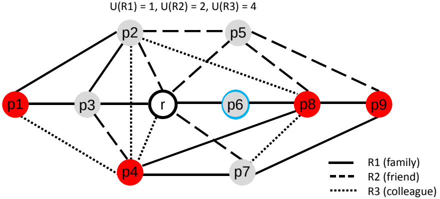
Degree Similarity (DS)

$DS(r,p) = \sum_{i=1}^{|R|} w_i \,.\, \delta^i(r,p)$ *with* $\delta^i(r,p) = \frac{1}{1+dist^i}$, $w_i = \frac{1}{U(R_i)}$; and

$dist^i = \frac{b_i+c_i}{a_i+b_i+c_i}$ is the Jaccard distance between r and p according to the relationship R_i

Example

	family		friend		colleague	
(r,p8)	a=1					



Step1: Social Similarity Measure (SSi)

Definition

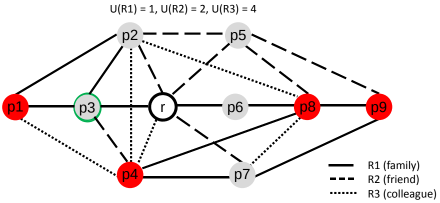
$SSi = DS \times PS$

Degree Similarity (DS)

$DS(r,p) = \sum_{i=1}^{|R|} w_i \, . \, \delta^i(r,p)$ *with* $\delta^i(r,p) = \frac{1}{1+dist^i}$, $w_i = \frac{1}{U(R_i)}$; and
$dist^i = \frac{b_i+c_i}{a_i+b_i+c_i}$ is the Jaccard distance between r and p according to the relationship R_i

Example

	family		friend		colleague	
(r,p8)	a=1	b=1				



Step1: Social Similarity Measure (SSi)

Definition

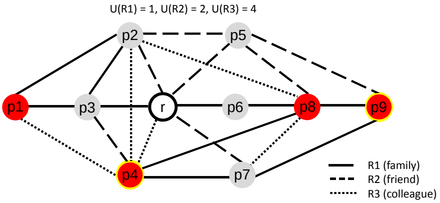
$SSi = DS \times PS$

Degree Similarity (DS)

$DS(r,p) = \sum_{i=1}^{|R|} w_i \,.\, \delta^i(r,p)$ *with* $\delta^i(r,p) = \frac{1}{1+dist^i}$, $w_i = \frac{1}{U(R_i)}$; and $dist^i = \frac{b_i+c_i}{a_i+b_i+c_i}$ is the Jaccard distance between r and p according to the relationship R_i

Example

	family		friend		colleague	
(r,p8)	a=1 c=2	b=1				



Step1: Social Similarity Measure (SSi)

Definition

$SSi = DS \times PS$

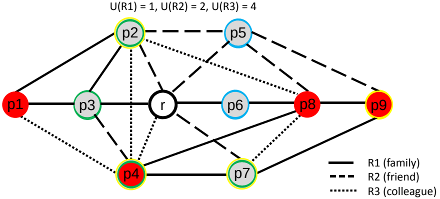
Degree Similarity (DS)

$DS(r,p) = \sum_{i=1}^{|R|} w_i \, . \, \delta^i(r,p)$ with $\delta^i(r,p) = \frac{1}{1+dist^i}$, $w_i = \frac{1}{U(R_i)}$; and $dist^i = \frac{b_i+c_i}{a_i+b_i+c_i}$ is the Jaccard distance between r and p according to the relationship R_i

Example

	family		friend		colleague	
(r,p8)	a=1 c=2	b=1	1 0	2	0 2	1

$DS(r,p_8) = 1 \times \frac{1}{1+\frac{3}{4}} + \frac{1}{2} \times \frac{1}{1+\frac{2}{3}} + \frac{1}{4} \times \frac{1}{1+\frac{3}{3}} = 0.9$



Step1: Social Similarity Measure (SSi)

Definition

$SSi = DS \times PS$

Degree Similarity (DS)

$DS(r,p) = \sum_{i=1}^{|R|} w_i \; . \; \delta^i(r,p)$ *with* $\delta^i(r,p) = \frac{1}{1+dist^i}$, $w_i = \frac{1}{U(R_i)}$; and

$dist^i = \frac{b_i+c_i}{a_i+b_i+c_i}$ is the Jaccard distance between r and p according to the relationship R_i

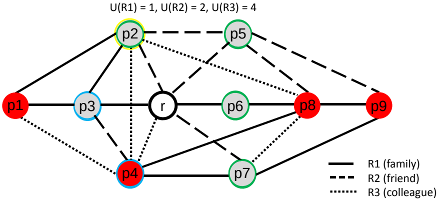
Example

	family		friend		colleague	
(r,p8)	a=1 c=2	b=1	1 0	2	0 2	1

$DS(r,p_8) = 1 \times \frac{1}{1+\frac{3}{4}} + \frac{1}{2} \times \frac{1}{1+\frac{2}{3}} + \frac{1}{4} \times \frac{1}{1+\frac{3}{3}} = 0.9$

	family		friend		colleague	
(r,p1)	1 1	1	0 0	3	1 0	0

$DS(r,p_1) = 1 \times \frac{1}{1+\frac{2}{3}} + \frac{1}{2} \times \frac{1}{1+\frac{3}{3}} + \frac{1}{4} \times \frac{1}{1+\frac{0}{1}} = 1.1$



Step1: Social Similarity Measure (SSi)

Profile Structure (P)

- $P = Item^{+}$
- $Item = Field^{+}$
- $Field = value^{*}$

Profile Similarity (PS)

$PS(r,p) = \frac{1}{|I|} \times \sum_{i \in I} \beta_i \,.\, S_i(r,p)$ where I is the set of items, $S_i(r,p)$ is the similarity between the ith items of r and p; and β_i is a weight attributed to the item i

Item Similarity (IS)

$$S_i(r,p) = \frac{1}{|Fd|} \times \sum_{k=1}^{|Fd|} \frac{1}{|\mathcal{V}(Fd_k^r)|} \sum_{l=1}^{|MaxB_k|} bur_l$$

where FD is the set of fields, $\mathcal{V}(Fd_k)$ is the set of values taken by a multi-valued field Fd_k, $MaxB_k$ is the set of the $|\mathcal{V}(Fd_k^r)|$ biggest similarity values computed between all possible pairs of $\mathcal{V}(Fd_k^r)$ and $\mathcal{V}(Fd_k^v)$ and, bur is the Burnaby similarity

Step1: Social Similarity Measure (SSi)

Single-valued Field Similarity

$$Burnaby(X_k, Y_k) = \begin{cases} 1 & \text{if } X_k = Y_k \\ \dfrac{\sum_{q \in \mathcal{A}_k} 2\log(1-\hat{p}_k(q))}{\log \frac{\hat{p}_k(X_k)\hat{p}_k(Y_k)}{(1-\hat{p}_k(X_k))(1-\hat{p}_k(Y_k))} + \sum_{q \in \mathcal{A}_k} 2\log(1-\hat{p}_k(q))} & \text{otherwise} \end{cases}$$

Example

$|Fd| = 3$, $|\mathcal{V}(Fd_k^r)| = 1$ and $|MaxB_k| = 1$ (for all k)

work	Alice	Bob
employer	society1 (s1)	society1 (s1)
type	consulting (c)	development (d)
post	manager (m)	engineer (en)

$$\Rightarrow S_{work}(Alice, Bob) = \frac{1}{3} \times [\frac{1}{1} \times Burnaby(s1, s1) + \frac{1}{1} \times Burnaby(d, c) + \frac{1}{1} \times Burnaby(en, m)]$$

Step1: Social Similarity Measure (SSi)

work	10 profiles		
employer	society1 (s1) 5	society2 (s2) 3	society3 (s3) 2
type	development (d) 3	consulting (c) 4	audit (a) 3
post	engineer (en) 3	manager (m) 5	expert (ex) 2

- $Burnaby(s1, s1) = 1$
- $Burnaby(d, c) = \frac{2(\log(1-\frac{3}{10})+\log(1-\frac{4}{10})+\log(1-\frac{3}{10}))}{\log(\frac{\frac{3}{10}*\frac{4}{10}}{(1-\frac{3}{10})(1-\frac{4}{10})})+2(\log(1-\frac{3}{10})+\log(1-\frac{4}{10})+\log(1-\frac{3}{10}))} = 0.66$
- $Burnaby(en, m) = \frac{2(\log(1-\frac{3}{10})+\log(1-\frac{5}{10})+\log(1-\frac{2}{10}))}{\log(\frac{\frac{3}{10}*\frac{5}{10}}{(1-\frac{3}{10})(1-\frac{5}{10})})+2(\log(1-\frac{3}{10})+\log(1-\frac{5}{10})+\log(1-\frac{2}{10}))} = 0.75$

Thus, $S_{work}(Alice, Bob) = \frac{1}{3} \times [\frac{1}{1} \times 1 + \frac{1}{1} \times 0,66 + \frac{1}{1} \times 0,75] = 0.8$

Step1: Social Similarity Measure (SSi)

work	10 profiles		
employer	society1 (s1) 5	society2 (s2) 3	society3 (s3) 2
type	development (d) 3	consulting (c) 4	audit (a) 3
post	engineer (en) 3	manager (m) 5	expert (ex) 2

- $Burnaby(s1, s1) = 1$
- $Burnaby(d, c) = \frac{2(\log(1-\frac{3}{10})+\log(1-\frac{4}{10})+\log(1-\frac{3}{10}))}{\log(\frac{\frac{3}{10}*\frac{4}{10}}{(1-\frac{3}{10})(1-\frac{4}{10})})+2(\log(1-\frac{3}{10})+\log(1-\frac{4}{10})+\log(1-\frac{3}{10}))} = 0.66$
- $Burnaby(en, m) = \frac{2(\log(1-\frac{3}{10})+\log(1-\frac{5}{10})+\log(1-\frac{2}{10}))}{\log(\frac{\frac{3}{10}*\frac{5}{10}}{(1-\frac{3}{10})(1-\frac{5}{10})})+2(\log(1-\frac{3}{10})+\log(1-\frac{5}{10})+\log(1-\frac{2}{10}))} = 0.75$

Thus, $S_{work}(Alice, Bob) = \frac{1}{3} \times [\frac{1}{1} \times 1 + \frac{1}{1} \times 0,66 + \frac{1}{1} \times 0,75] = 0.8$

Using the same method:

- $S_{gi}(Alice, Bob) = 0.81$
- $S_{interest}(Alice, Bob) = 0.17$

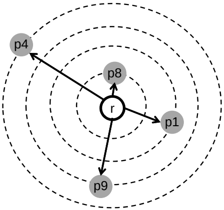
$\Rightarrow PS(Alice, Bob) = \frac{S_{work}(Alice,Bob)+S_{gi}(Alice,Bob)+S_{interest}(Alice,Bob)}{3} = 0.59$

Step2: Trust Computing and TRSN Construction

Social Trust (ST)

$ST(r,p) = \sum_{j=1}^{3} \lambda_j \, . \, M_{pj}(r,p)$ where $M_p = (SPo(p), SPr(r,p), SSi(r,p))$ and $\lambda_j \in [0,1]$ and $\sum_{j=1}^{3} \lambda_j = 1$.

id	SPo	SPr	PS	DS	SSi	**ST**
1	0.125	1	0.59	1.1	0.651	**0.637**
4	0.625	0.5	0.417	0.875	0.335	**0.486**
8	1	1	0.74	0.966	0.764	**0.921**
9	0.25	1	0.512	0.925	0.513	**0.587**



Trust-Relationship Social Network (TRSN)

The outcome of the proposed approach is a weighted directed graph modeling a new social network that is service requester centered and based on a single relation, the social trust relation

Outline

Summing up

Conclusion

- A service provider discovery approach based on social trust measure
- Social trust measure is the aggregation of three measures: social position, social proximity, and social similarity
- Social trust measure take into account both semantic and structural knowledge extracted from the multi-relation social network

Perspectives

- Scalability in big graphs and pertinence on real data sets
- Exploiting feedback and history of service requester's experiences
- Extension of our trust model to perform a trustworthy composition

References

Louati, El Haddad, Pinson
Trust-Based Service Discovery in Multi-relation Social Networks
Int. Conf. on Service oriented Computing, 664-671, 2012

Bansal *et al.*
Trust-based dynamic web service composition using social network analysis
IEEE Int. Workshop on Business Applications of Social Network Analysis, 1-8, 2010

Maaradji *et al.*
Towards a social network based approach for services composition
IEEE Int. Conference on Communications, 1-5, 2010

Golbeck
Generating predictive movie recommendations from trust in social networks
Proceedings of the 4th Int. Conf. on Trust Management, 93-104, 2006

Ziegler, Golbeck
Investigating correlations of trust and interest similarity-do birds of a feather really flock together?
Decision Support Systems, 43:460-475, 2007

Ziegler, Lausen
Analyzing correlation between trust and user similarity in online communities
Proceedings of Second International Conference on Trust Management, 251-265, 2004