Semantic Repositories for Service Provision: An Approach to Enhance the Business Perspective

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S 1. Introduzione
Motivations and outline

- In service-based interactions and service provision, a major issue consists in enhancing the business perspective:
  - develop strategies and tools to provide support in the choice of services according to the value they have for businesses.

- Our approach: based on semantic repositories of services (not necessarily e-services)
  - Representation of knowledge about services and business processes to enhance service selection from the business perspective.

- Outline
  - We start from our past experience in the Government to Business (G2B) context
  - Semantics behind the repository
  - Semantic enhanced selection – views
  - Example with a specific service selection
Section 2 - The Repository of Service in the context of Service Science
S-2.1

Service vs. W-Service: value based discovery in Service Science
Service vs. W-Service: value based discovery in Service Science

- Service Science... An emerging effort to build service Science start from the consideration that

- Two aspects:
  - Service $\rightarrow$ WS
    - Theory about services are relevant to research in WS discovery, selection and so on, and in particular in D/S with Non functional properties, and in particular QoS
  - WS $\rightarrow$ Service
    - Concepts developed with respect to computational model to handle Web Services may help in providing a formal background for more general problem of service D/S

- In SOC a major issue is in QoS-based D/S of services. When requester of services are businesses and not mere customers, in WS QoS based D/S, as already noticed by Papazoglou, is relevant to consider qualities in order to enhance D/S of service according to the value they actually have for businesses.

- QoS based WS selection & Value based Service (also non web) selection

- In fact, there are still a lot of services, about which web resources provide information that may help in service D/S, that are not provided via web as web services. This is particularly true in the G2B context. These information may help businesses in D/S of services. Problems concerning service D/S in such cases, are related to problems in SOC concerning QoS based D/S of web-services, and in Quality representation. In particular we are interested in such enhancing the business perspective in D/S of services when requester are businesses.
The repository: the registry of services

The repository contains real services offered by Italian Public Administrations (PA) to businesses

- A registry of 450 abstract G2B services classified in terms of about 20 descriptive properties (only partly e-services)
  - service description (short natural language functional description of the service)
  - european cluster (classification of services according to the European guidelines)
  - service's provider(s) (public agencies/private organizations providing the service)
  - type of users (classes of potential users, e.g. farmer)
  - number of potential users, (users interested in requesting the service)
  - service frequency (estimates the number of service requests in a year)
  - level of automation, (measurement of the level of implementation of the service)

- The repository is organized according to a conceptual model enhanced by an ontology built on top of it
**Nuova architettura ICT per interazione G2B**

**a. Technological architecture in the traditional interaction**

**b. Technological architecture in the new interaction**
Usefulness for actors

The repository provides useful knowledge to different types of actors*

- service developers and providers,
- public administrations
  - potential reuse of the services produced
  - business process reengineering opportunities
- businesses
  - to facilitate businesses in the interaction with PAs wrt. administrative services
  - to discover value added services available from PA (often neglected)

→ how to enhance the interaction between services’ providers (PA in this case) and services’ requester (businesses):

Schema Concettuale Servizi/Processi
Schema Concettuale del Repository (Aree di interessi per i vari player G2B)
The Semantic Repository: linking services and processes

- In order to enable a value-driven approach to service selection, services have been associated to business processes
- Value driven approach to service representation, based on Porter’s Value Chain:
  - model based on process hierarchies (mega processes, processes, sub processes), association at the bottom level (activity level)
  - distinction in primary vs. support activities
E.g. Service/Process ontology built on top of the repository
Description of the properties of the Procurement class

<table>
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<tr>
<th>ClassName</th>
<th>Role</th>
<th>Requirements</th>
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<tr>
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<tr>
<td>Resource</td>
<td>AllocationDate</td>
<td>Contents</td>
</tr>
</tbody>
</table>

**Actor**: Owner, Beneficiary, Provider, Applicant, Producer

**Resource**: AdmittanceLevel, Tool, Matter, Reason, OrganizationUpdate, Outcome, AllocationDate, Contents

**Constraints**: RequestDate, ExpiryDate, RequestedSum, Duration, AllocatedSum, BeginningDate

**Process**: SuppliedProcess
Description of the properties of the Procurement class

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<th>Requirements</th>
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<td>Business_Interst_Object</td>
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<td>Constraint</td>
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<tr>
<td>Procurement</td>
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</tbody>
</table>
The *Semantic Repository: deep semantic representation*

- Nowadays it is possible to exploit state of the art semantic representation technologies based on ontologies.
- ...and to integrate them into Semantic SOA (e.g. WSMO).
- OWL-DL representation language:
  - Combined representation of services and processes
  - Associations services-processes and axiomatics
  - E.g.
    \[
    \text{AggregateService} \equiv \text{Service} \sqcap \exists \text{hasAggregate.Service} \\
    \text{UpdateBusinessAddress} \sqsubseteq \text{isAssociatedTo} \sqcap \text{changeBusinessAddress} \\
    \text{aggregates} \equiv \text{providesPartsOf}^{-}
    \]
- A deeper semantic representation enhance:
  - Maintenance (providers)
  - Semantic based navigation
  - Retrieval, Discovery and Selection of services
The Semantic Repository and automated reasoning

- Consistency check
- Inheritance
  - Subclasses of services/processes inherit
    - E.g. Inheritance of process association from `UpdateBusinessAddress` to subclasses
- Inferences based on semantics of relations
  - Exploit transitivity, symmetry, functionality, ...
    - E.g. `providesPartOf` inverse of `aggregates`
- Definitions: automatic classification and type inference
  - Non trivial axiom-based inheritance (through non Is-A relations)
    - E.g. Inherite Porter’s value of processes through subprocesses and service associated (a service is a primary service when associated to primary processes)
  - Infer membership to particularly interesting classes from the value perspective
    - E.g. Infer that a service is an `AggregateService` on the basis of its features
Advantages of an integrated semantic representation of service/processes

from plain association...

- for PAs/providers
  - the association supports predictions in terms of usefulness of a service for a process

- for businesses: process-driven service retrieval
  - the repository provides businesses with knowledge related to administrative services involved in processes (necessary for processes being carried out)
  - helps businesses in the discovery of value added services used in processes, not explicitly related to norms.

...with deep semantic and richer expressiveness

- An advanced navigation of the service repository for discovering and selecting available services for a given selected business process (e.g. Find all services associated to the “Open New Sales Point” process);
Discussion issues

- To support the value-driven selection of services there is still a long way to go...
  - e.g. when Web Services available, automated discovery and selection based on semantic SOA

- Value configuration
  - On the basis of the Porter’s perspective it is possible to:
    - e.g. infer the value of services by inheriting it from the processes to which they are associated;
    - e.g. retrieve all services associated to subprocess of a given macro-process, or all services associated to primary processes.
  - Quite poor as selection criteria... investigate the adoption of different value centred business process models (e.g. see C. B. Stabell and O. D. Fjeldstad [1998]) more informative for service selection

- Interface with platform providing process modelling tools (ERP)
  - Semantic based access to the repository from ERP systems
  - More value-driven business process formal models?
Value-driven semantic based selection of services: the “Updating Business Address” example (I)

- We believe that the semantic approach developed is promising and, combining semantic with quality metrics, it already allows to provide already some support to value based service selection...

- An example: semantic supported selection of the best Address Updating Service

  “...a business moved to other offices (the process change office location is running) and is obliged to update its address...”
Value-driven semantic based selection of services: the “Updating Business Address” example (II)

- Three concrete services in the repository respond to this need:
  - service `UpdateAddressA` (of type `UA-INPS`) and `UpdateAddressB` (UA-UC) update the business address respectively in the Social Security (INPS) and in the Chambers of Commerce (UNIONCAMERE) registries;
  - service `UpdateAddressC` (UA-INPSUC) provides the updating of the business address both in the INPS and the UNIONCAMERE registries.

- Three classes of services... *Which is the most valuable concrete service from the business perspective?*
Value-Driven semantic based selection of services: the “Updating Business Address” example (III)
Combining Quality Metrics and Semantics

- Two aspects need to be considered:
  - QUALITY METRICS (QoS - Nfp)
    - Metrics to compute the service value according to suitable quality parameters are needed
      - Time spent by the business for requesting the service ($c^{RT}$),
      - Time spent by the provider to deliver the service ($c^{DT}$),
      - Price of the service ($c^p$)
  - SEMANTIC
    - In the comparison of different values, it is necessary to take into account the fact that the class $\text{UA-INPS}$ aggregates $\text{UA-UC}$ and $\text{UA-INPSUC}$
**Metrics for total cost computation**

- **Time vs Price**: normalization of different parameters
  - Normalization reference values (e.g. defined in the ontology for classes of services)

- **Assuming therefore** $c^{RT}$, $c^{DT}$ and $c^{P}$ as the three normalized costs (percentages), the total cost $c^s$ for a service $s$ can be then computed by the following weighted average:

  $$
  c^s = \sum_{i=1}^{n} w_i c_i, \text{ where } \sum_{i=1}^{n} w_i = 1
  $$
Service comparison: an example

- Suppose $c^{RT}$, $c^{DT}$, $c^P$ being as in the table and $c^s$ determined assuming $w_0 = 20\%$, $w_1 = 20\%$, $w_2 = 60\%$

<table>
<thead>
<tr>
<th>Service</th>
<th>$c^{RT}$</th>
<th>$c^{DT}$</th>
<th>$c^P$</th>
<th>$c^s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>UpdateAddressA</td>
<td>60</td>
<td>10</td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>UpdateAddressB</td>
<td>30</td>
<td>10</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>UpdateAddressC</td>
<td>50</td>
<td>15</td>
<td>35</td>
<td>34</td>
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</table>

Service **UpdateAddressC** is by far the most expensive wrt
- price ($c^P = 35$)
- total cost

- Nevertheless since it is defined in the ontology as aggregating **UpdateAddressA** and **UpdateAddressB**, its cost should be compared with the sum of the two.

- We defined an algorithm that, combining semantics and metrics, provides an informative comparison table for Aggregate Services and suggest which is the best according to the given criteria ($c^P$ here)
The algorithm pseudo-code

This pseudocode implements a function that given as argument a function search and a OWL-DL concept C, support the choice among an aggregate service and the services it aggregates providing: a comparison table and a suggestion for the choice.

```pseudo
Object: findAndCompareAggregate (search, C):
begin
    for all x ∈ (C ∩ AggregateService) do
        L = ∅;
        sum = 0;
        for all y ∈ (C ∩ providesPartOf ∋ x) do
            L = L ∪ {y};
            sum = sum + cost(y)
        end for
        write x "aggregate" L;
        show comparisonTable(x, L);
        if cost(x) < cost(sum)
            then
                suggest(x)
            else
                suggest(L)
        end if
    end for
end
```
Selection, comparison and weights

- Although price has been heavily weighted and the aggregate service UpdateAddressC's price is higher than the sum of the other two ones, this service is to prefer to the composition of UpdateAddressA and UpdateAddressB.
  - This is sound wrt the consideration that aggregation of services has an added value based on saving time, up to a certain balance in the weight association.

- Selection of weight is crucial: it is easy to check that if saving money is the main concern (e.g. assuming weights such as $w^0 = 5\%$, $w^1 = 5\%$ and $w^0 = 90\%$) the choice of composing the two services can be preferred to the aggregation of the two.

- Open issue: weight attribution
  - association of weights to class of services within the ontology
  - human dynamic association through interaction
  - exploitation of history of choices and user profiling
Future Works

- Integrating this approach in semantic SOA
  - Web-Service discovery and selection (e.g. WSMO)
    - NfP based-discovery (NeP4B Project)
      - ...taking into account quality aspects for discovery and selection of services
    - Include business perspective on quality parameters of services

- Integration of ERP process modeling and service population, enhancing discovery, selection and provision according to specific business processes tracked into ERP
  - applications proactively suggesting the value added services for the running business processes?
Thank you very much for your attention...

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In service-based interactions and service provision, a major issue consists in enhancing the business perspective developing strategies and tools to provide support in the choice of services according to the value they have for businesses.

This paper presents an approach based on semantic repositories of services, where knowledge about services and business processes is exploited to support service retrieval, selection processes whose address consists in providing strategies and tools to provide support in the choice of services according to the value they have for businesses.

This means to provide

1) a way to determine the value of services according to specific business criteria;
2) technologies that support the sharing of such kind of knowledge involved in service provision.

We start from our past experience in the Government to Business context (G2B in the following) where a conceptual model was provided and implemented in a repository for the Italian Public Administration (namely a meta DB),
In the repository we also provide a representation of business processes based on the Porter value chain.

Porter addresses the interplay of cost and differentiation, as two major types of competitive advantage, with the scope of businesses’s activities.

A relevant issue in Porter’s model is related to the relationships or linkages between cost and performances of the different value activities.

On that basis, Porter introduces the value chain as a tool for diagnosing and enhancing the competitive advantage of a business by its disaggregation into its most relevant activities.

Value activities at an high level are classified in two types,

- the primary activities, that are involved in production, sales and assistance
- support activities, that support the former.
Usefulness of the repository for businesses (value added services)

- Usually public administrations in their e-Government projects tend to develop administrative services, strictly related to their administrative procedures and laws to be enforced, disregarding the importance of value added services, that provide added value to business processes.

- An example of administrative service is the provision of a certification, while an example of value added service is a statistics or else territorial information that may be useful for marketing processes.

- In the repository both types of services are included and related to business processes using them.

- Point: how to enhance the interaction between services' providers (PA in this case) and services' requester
Advantages of an integrated semantic representation of service/processes

- The joint Service/Processes ontology:
  - Enhance the semantic expressivity of the repository;
  - Allows for the exploitation of inferences for service retrieval, discovery and selection on the basis of the value the services have for businesses with respect to their business process value;
  - Provides a representation of the service/process associations based on value models, which integrates:
    - Businesses’ perspective focused on business processes;
    - Providers’ perspective based on service classification (in this case Public Administrations).

- This integration may lead to (e.g. in a unified portal for businesses)
  - An easier navigation of the service repository for retrieving, discovering and selecting available services for a given selected business process (e.g. Find all services associated to the “Open New Sales Point” process);
  - The future development of applications proactively suggesting the value added services for the running business processes. This type of application require an integration among ERP applications and service provision technologies (e.g. built on SOAs).

- With respect to SOA based on Semantic Web Services:
  - A better and more powerful selection mechanism on the basis of the value of services for business processes.
Advantages of an integrated semantic representation of service/processes

- The joint Service/Processes ontology:
  - Enhance the semantic expressivity of the repository;
  - Allows for consent to draw inferences for the identification of services based on their value for the company in relation to their own processes;
  - Offers a representation of the services/processes association based on value models, which integrates
    - the business-oriented perspective of the company;
    - the perspective on services at the base of the repository typical of providers (e.g., public administrations).

- This integration can lead, for example, in the case of a portal for companies to
  - Improved navigation of services available for a selected business process;
  - The development of applications that, in a proactive manner, provide recommendations on the service of greater value added for the business process in which a company is currently engaged. This type of applications requires an integration, for example, between ERP systems and service enabling technologies.

- In the case of SOA technologies based on Web Services a
  - an improvement of the process of selection of services based on the value of the business processes.
Usefulness of the repository for public administrations

- In the context of public administration, building a repository of services aims at creating value for public administration in terms of:
  - potential reuse of the services produced
  - business process reengineering opportunities.
Usefulness of the repository for providers

- Service providers are a first type of player that may take profit of the knowledge represented in the repository G4B.
- Providers may decide to operate in two major business areas:
  - development of services,
  - development of frameworks for integration of services provided by third parties, namely agencies or other providers.
Usefulness of the repository for businesses (value added services)

- Usually public administrations in their e-Government projects tend to develop **administrative services**, strictly related to their administrative procedures and laws to be enforced, disregarding the importance of **value added services**, that provide added value to business processes.

- An example of administrative service is the provision of a certification, while an example of value added service is a statistics or else territorial information that may be useful for marketing processes.

- In the repository both types of services are included and related to business processes using them.
Cambiata la sede, occorre aggiornare l’indirizzo...

INPS

UnionCamere

Comunica il cambio di indirizzo a INPS e UnioCamere!
Le alternative

- Three concrete services respond to this need:
  - services A and B update the business address respectively in the Social Security (INPS) and in the Chambers of Commerce (UNIONCAMERE) registries;
  - service C provides the updating of the business address both in the INPS and the UNIONCAMERE (UC) registries.

- Il primo è servizio concreto di un servizio astratto SA, il secondo di un servizio SB e il terzo di SC tale che SC è' aggregazione di SA e SB nella ontologia.
Quali alternative?

- INPS
- UnionCamere
- INPS + UNIONCAMERE
Scelta del servizio supportata dal repository

Semantic Repository

<table>
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<tr>
<th>Service</th>
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<th>$c^D$</th>
<th>$c^P$</th>
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INPS  UnionCamere  INPS+UNIONCAMERE
Esempio servizio di aggiornamento indirizzo per l'impresa (2)

- A ciascuno di A B e C sono associati tre parametri di qualità:
  - tempo che perde l'impresa nel richiedere il servizio (c^{RT})
  - tempo che perde nell'ottenerlo (c^{DT})
  - Costo del servizio (c^{P})

- Questi valori andranno opportunamente pesati.

- Si puo' calcolare tra i tre servizi quello che da piu' valore, che in questo caso e' il minor costo complessivo (il tempo perso e' costo).
Flow of the Government to Businesses interaction
Example

- An example of **administrative service** is the provision of a certification, while an example of **value added service** is a statistics or else territorial information that may be useful for marketing processes.
Vantaggi di una rappresentazione integrata servizi/processi

- L'ontologia Servizi/Processi
  - aumenta l'espressività semantica del repository;
  - consente di sviluppare inferenze per l'individuazione dei servizi in base al proprio valore per le imprese in relazione al valore per i propri processi di business;
  - offre una rappresentazione dell'associazione servizi/processi basata su modelli del valore, che integra
    - la prospettiva delle imprese orientata da processi di business;
    - la prospettiva sui servizi alla base del repository tipica dei provider (ad esempio, pubbliche amministrazioni).

- Questa integrazione può portare, nel caso, ad esempio, di un portale per le imprese a
  - Una navigazione migliorata dei servizi disponibili per un processo di impresa selezionato;
  - Lo sviluppo di applicazioni che, in maniera proattiva, forniscano suggerimenti sul servizio a maggior valore aggiunto per il processo di business in cui sia impegnata attualmente una data impresa. Questo tipo di applicazioni richiede un'integrazione, ad esempio, tra sistemi ERP e le tecnologie erogatrici di servizi.

- Nel caso di tecnologie SOA basate su Web Services a
  - un miglioramento del processo di selezione dei servizi in base al valore per i processi di business.
Classificazione dei servizi nel repository
La semantica alla base del repository permette di inferire in maniera automatica se un servizio si caratterizza come semplice o aggregato.
La semantica alla base del repository permette di inferire in maniera automatica che tutti i servizi della classe “Aggiornamento indirizzo dell’azienda” sono associati al processo “Cambio di indirizzo dell’azienda”
Scenario*: Semantica e tecniche di inferenza a supporto della scelta di un servizio di aggiornamento indirizzo