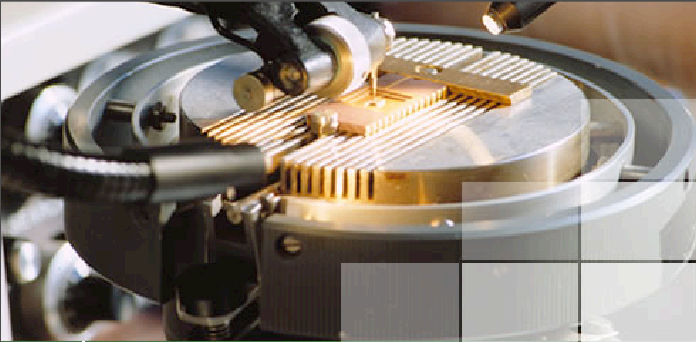

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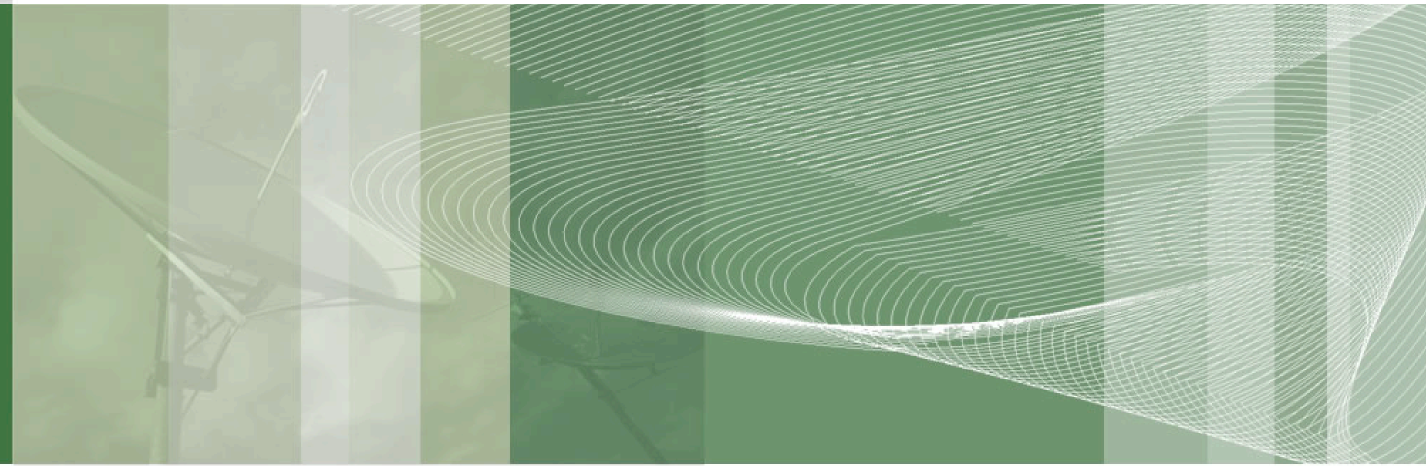


March, 6th, 2009

Lecture on

Web services retrieval

Pierluigi PLEBANI

Dipartimento di Elettronica ed Informazione - Politecnico di Milano
plebani@elet.polimi.it

Who I am

- Assistant Professor at Politecnico di Milano
- I belong to the Information System group at Dipartimento di Elettronica ed Informazione at Politecnico di Milano
- I got both my master degree and my Ph.D. on Information Engineering at Politecnico di Milano in 2000 and 2005, respectively

Research themes in IS group

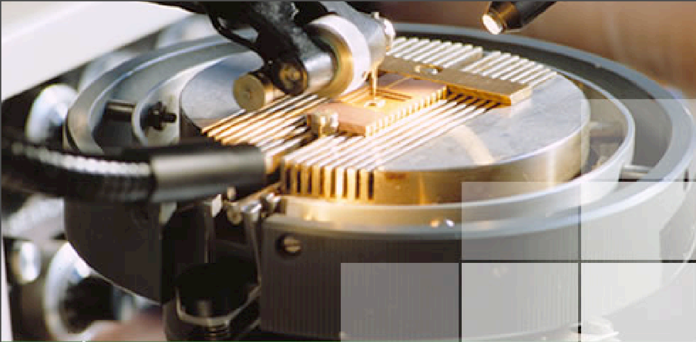
Theme	Research goals	Main achievements
Design if e-services and workflows in cooperative IS	• Design and execution of adaptive process-based information systems	• Service composition algorithms based on QoS • WS Selection criteria • PAWS
Design of multi channel IS	• Requirements posed by micro and mobile environments • Software selection criteria	• MAS and µBPEL • Context management
Cost oriented design of IT infrastructures	• Identification of variables for optimal configuration of distributed systems • Networked systems based on cost optimization	• Architectural design based on cost minimization • Cost and quality based negotiation algorithms
Information quality	• Assessment of time dependent qualities • Information quality improvement methods	• New time-dependent IQ evaluation criteria • Proposal of new cost-based IQ methodology

Before starting ...

- Web service retrieval is only the last problem
- We have had:
  - plumber retrieval
  - data retrieval
  - document retrieval
  - software component retrieval
  - ... and now Web service retrieval
- We consider discovery and retrieval as synonyms

... a look at the real world

- Once upon a time...
  - Friends of mine
  - Friends of friends of mine
  - ... (Friends of $)^n$ mine with $1 \leq n \leq 6$
- Advertising rules!
  - White pages
  - Yellow pages
- e-Advertising rules!
  - http://www.whitepages.com
  - http://www.yellowpages.com



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Who, What, Where, When, Why, and How

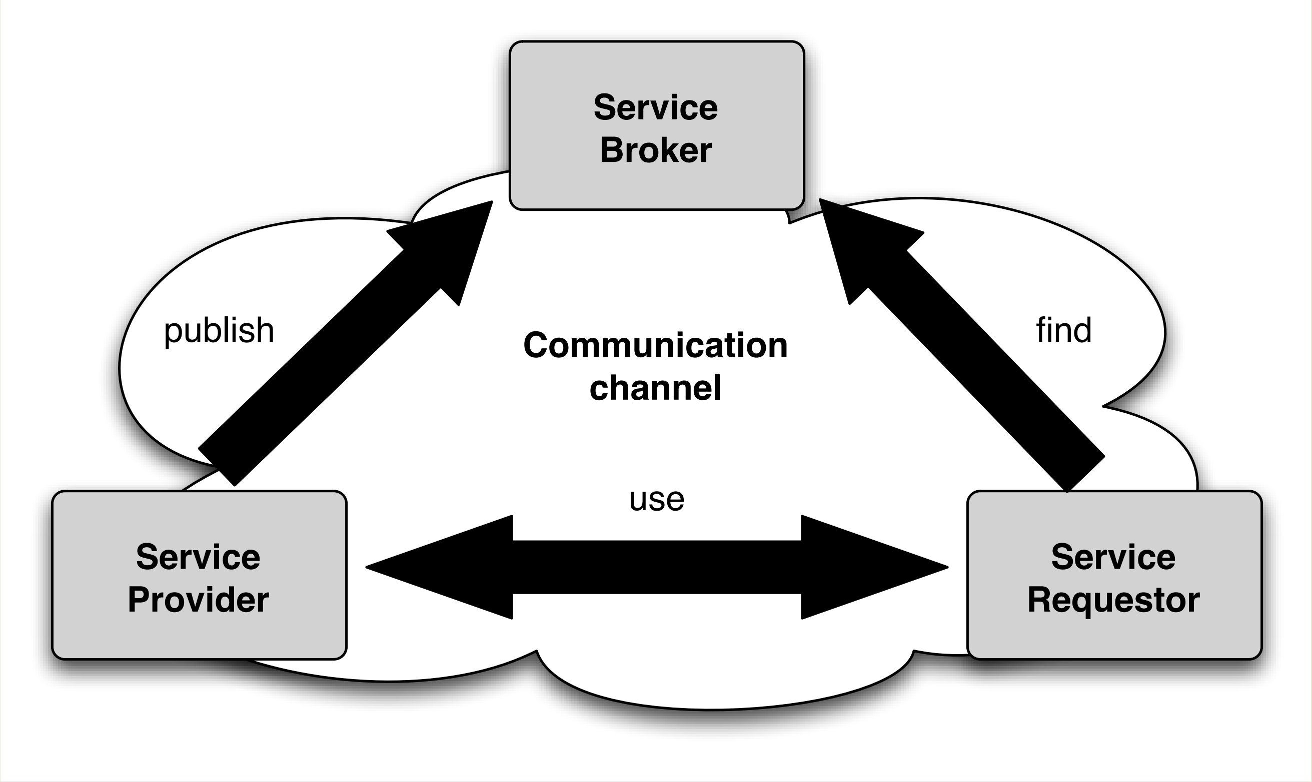
Lecture on "Web services retrieval"

Pierluigi Plebani

March, 6th, 2009

Who does retrieve Web services?

- Web services retrieval is one of the fundamental steps in SOA
- Final users need to retrieve Web services
- We need to consider Web service providers as well



What do we retrieve? 1/2

- We need to find a Web service (obviously)
- But, which one? The one:
  - able to perform what we need
  - accessible in a way we need
  - working in a way we need

What do we retrieve? 2/2

- A shared model for both Web service providers and Web service users is required
- This model must consider:
  - functionalities
  - conversation
  - quality
- Lot of specifications are available today:
  - WSDL
  - WS-CDL
  - WS-BPEL
  - WS-Policy
  - ... and many others

Where do we retrieve Web services?

- All the information should be collected and stored in well known places:
  - centralized solution
  - distributed or peer-to-peer solution
- Who has the ownership on this information?
  - registry
  - repository

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When do we retrieve Web services?

- At design-time
  - we can code the client-side
- At deployment-time
  - we need a declarative model
- At run-time
  - we need... something

Why do we retrieve Web services?

- Only for a single invocation
- For building a partnership
- As a part of my application
- As the whole application

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How do we retrieve Web services? 1/2

- (Friends of $)^n$ mine with $1 \leq n \leq 6$
- Browsing the Web (XMethods, SALCentral (?))
- Googling
- White pages
- Yellow pages
- Are we re-inventing the wheel?
  - if you think so, try to describe your plumber with WSDL
  - or to call him by SOAP

How do we retrieve Web services? 2/2

How do we retrieve Web services? 2/2

Available
services

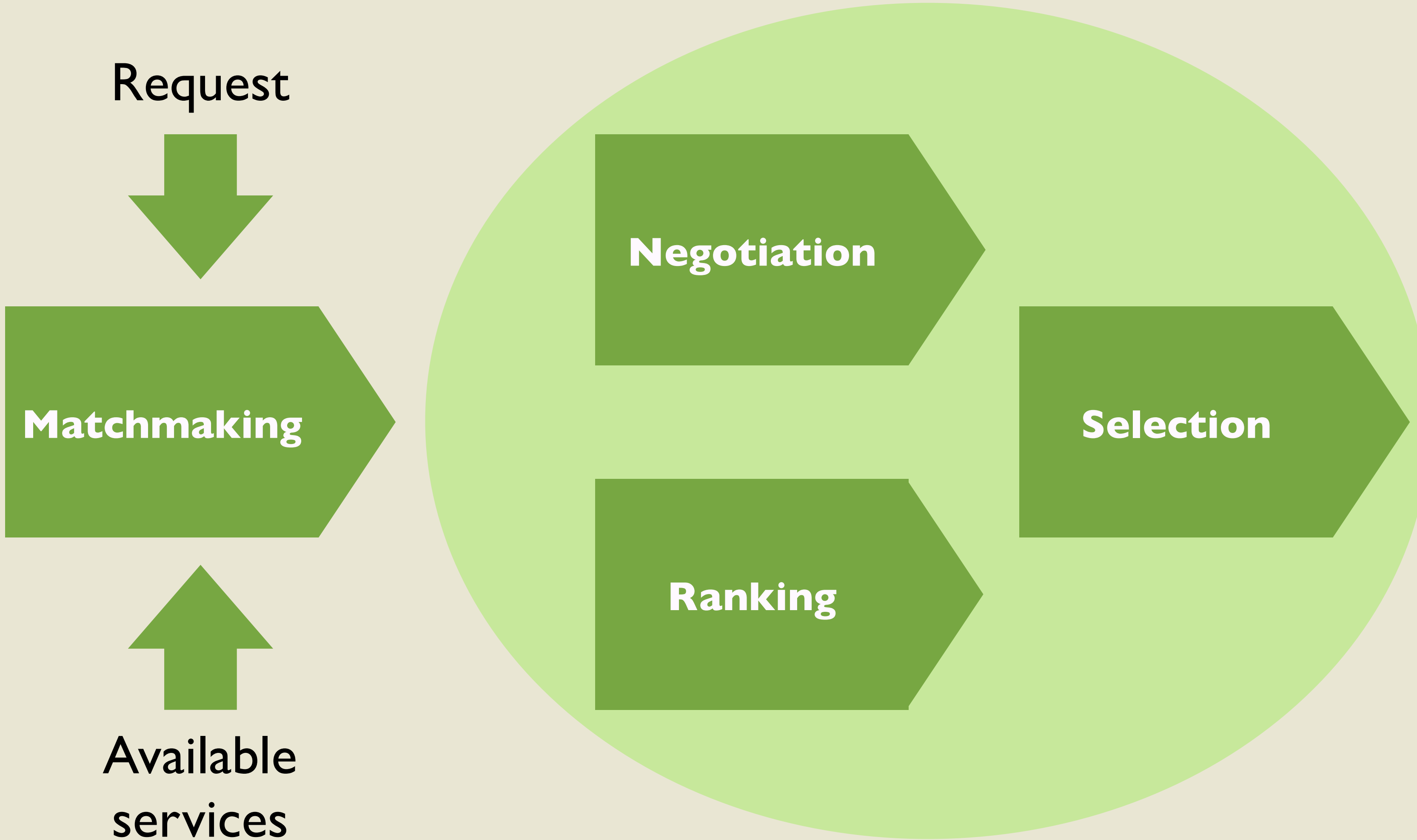
How do we retrieve Web services? 2/2

Request

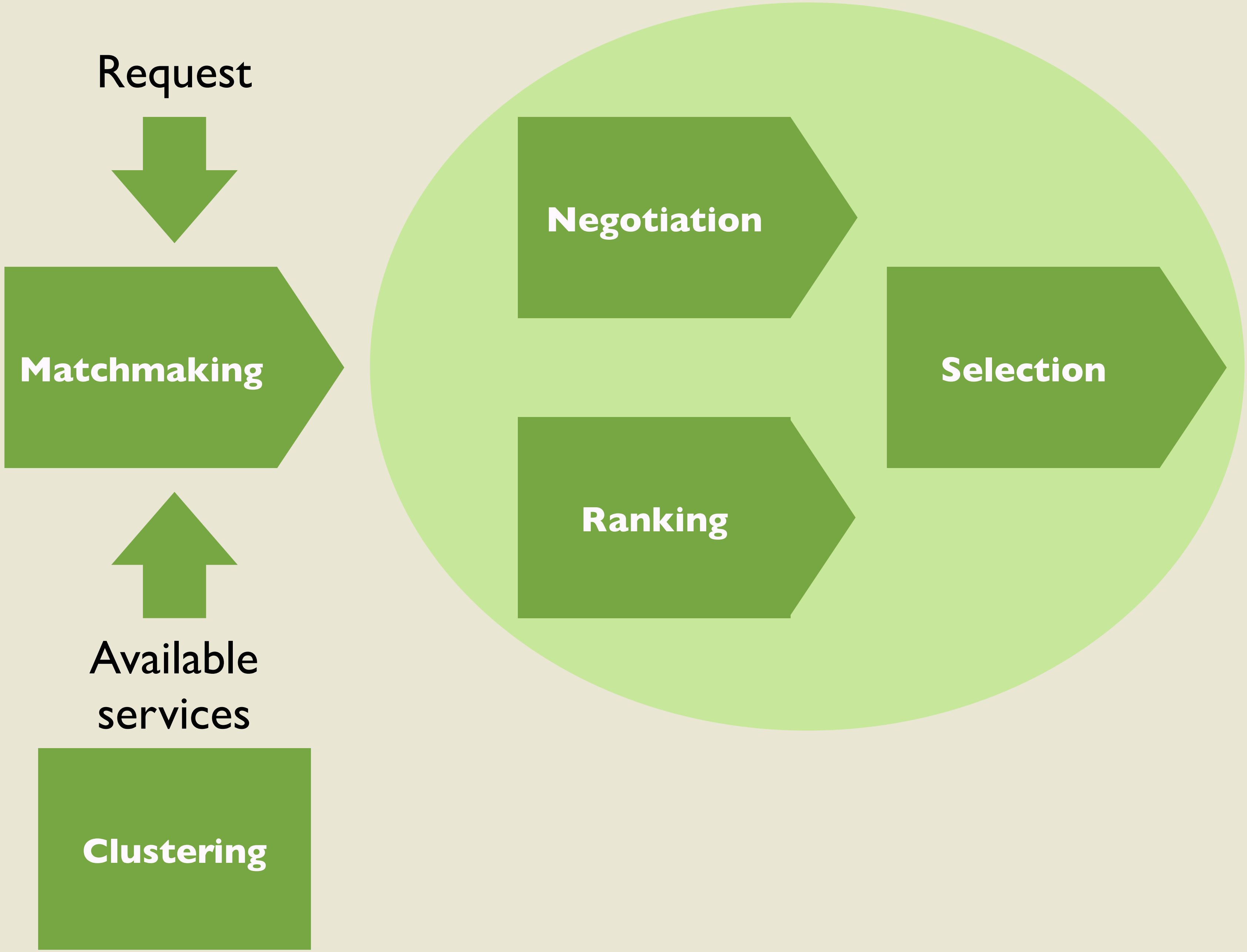
Available services

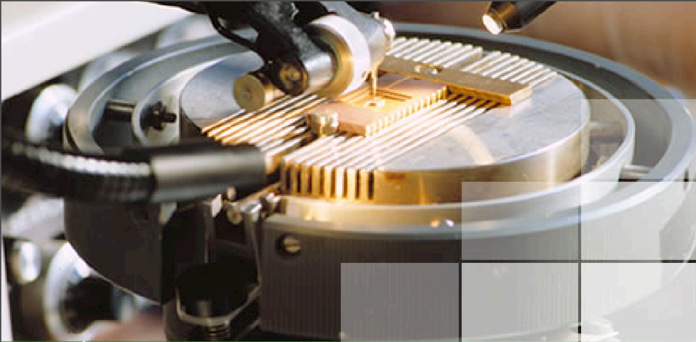
How do we retrieve Web services? 2/2

How do we retrieve Web services? 2/2



How do we retrieve Web services? 2/2





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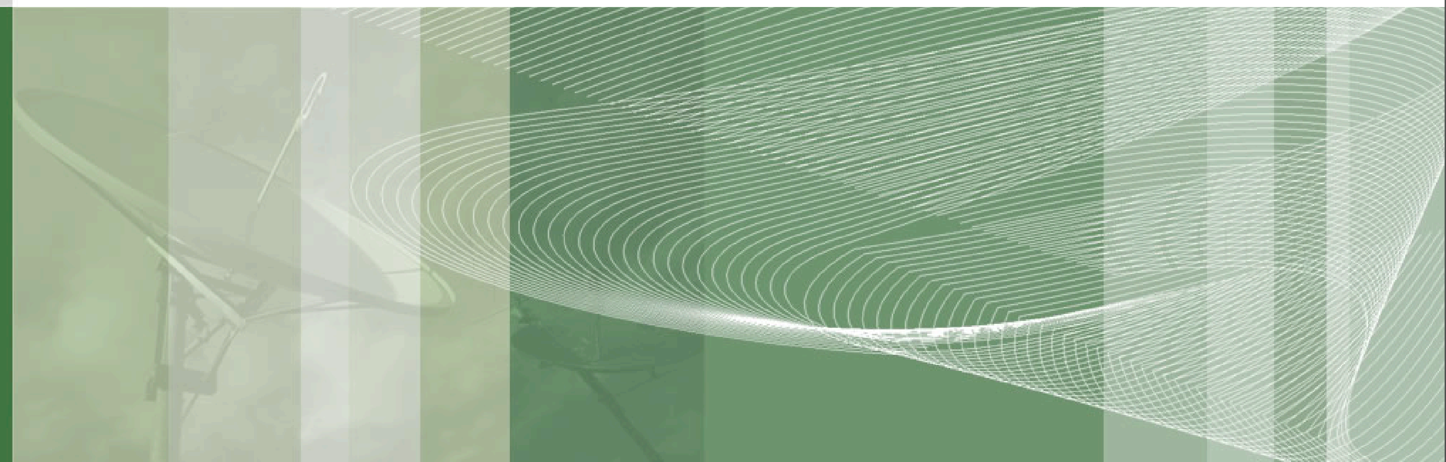


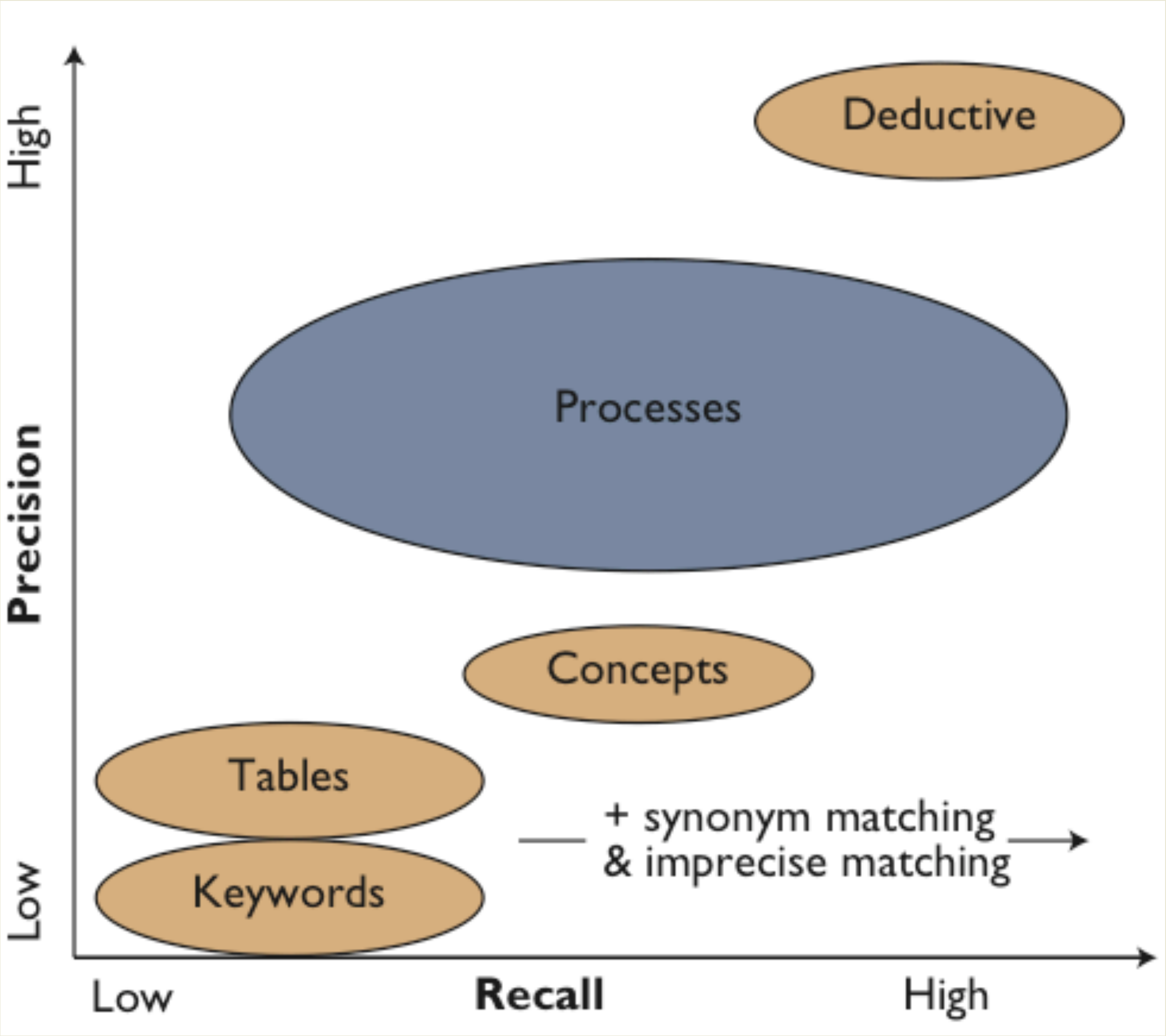
State of the Art

Lecture on “Web services retrieval”

Pierluigi Plebani

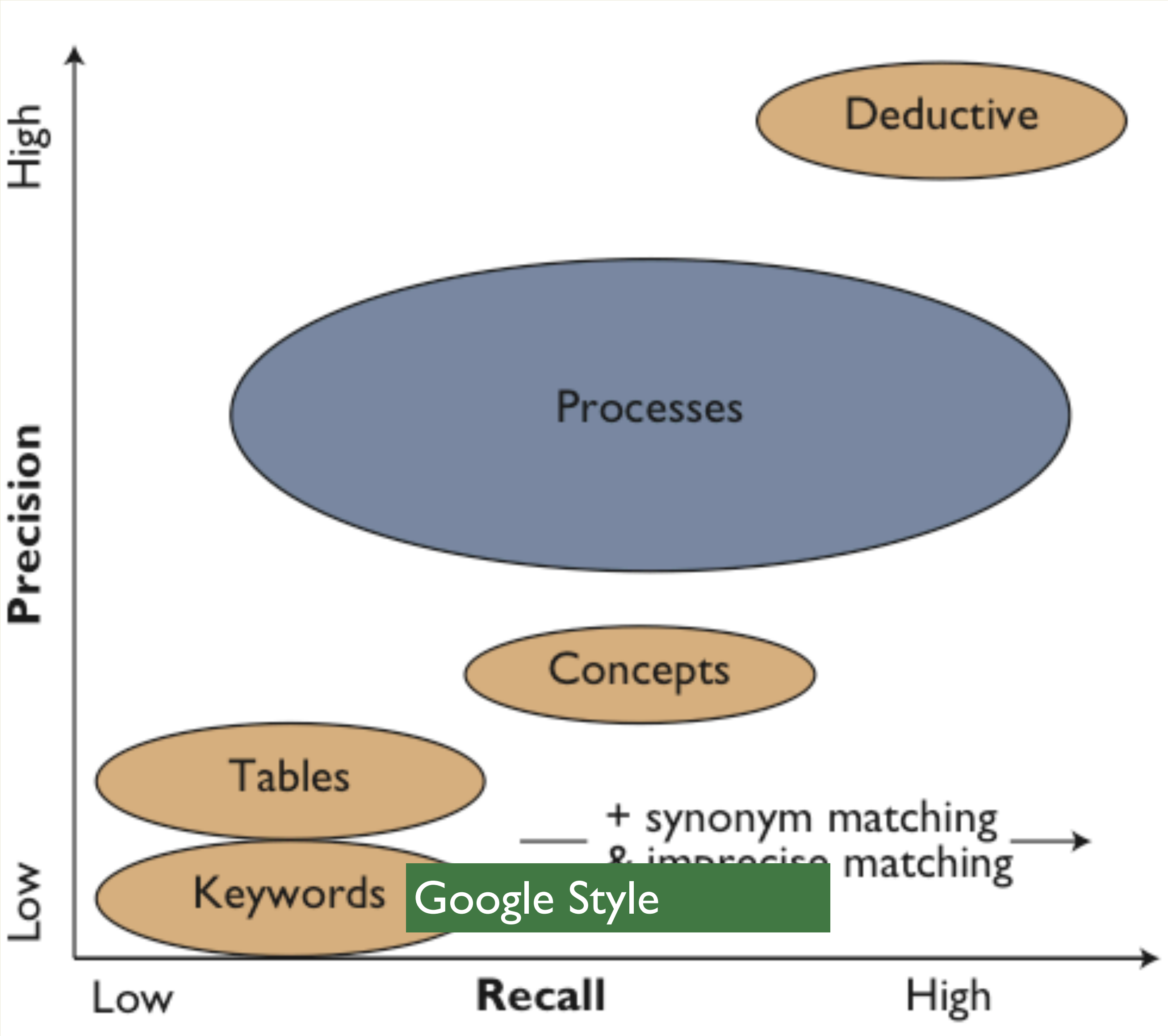
March, 6th, 2009

A possible roadmap



from E. Klein, A. Bernstein, Toward High-Precision Service Retrieval, IEEE Internet Computing, Jan-Feb 2004

A possible roadmap



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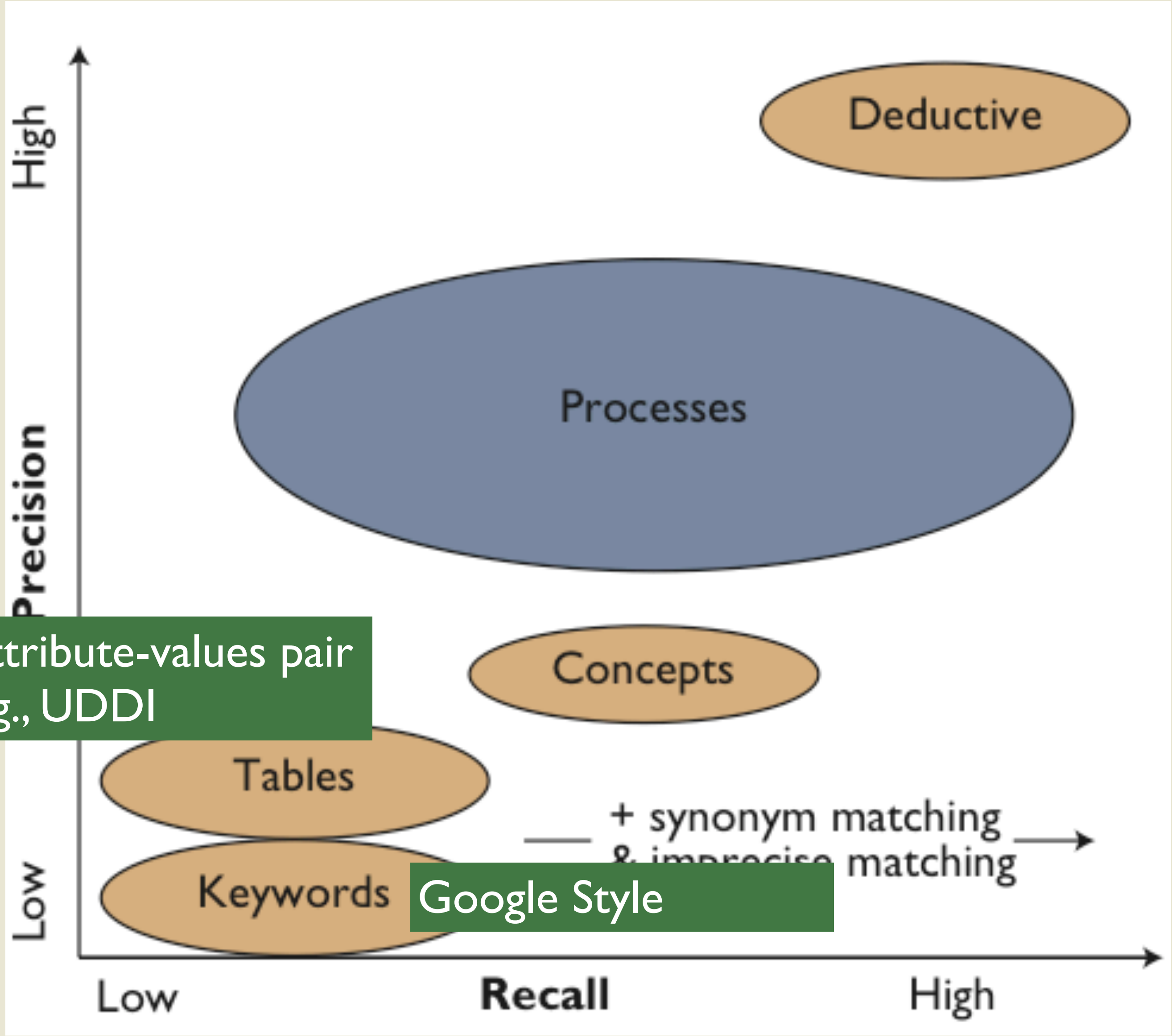
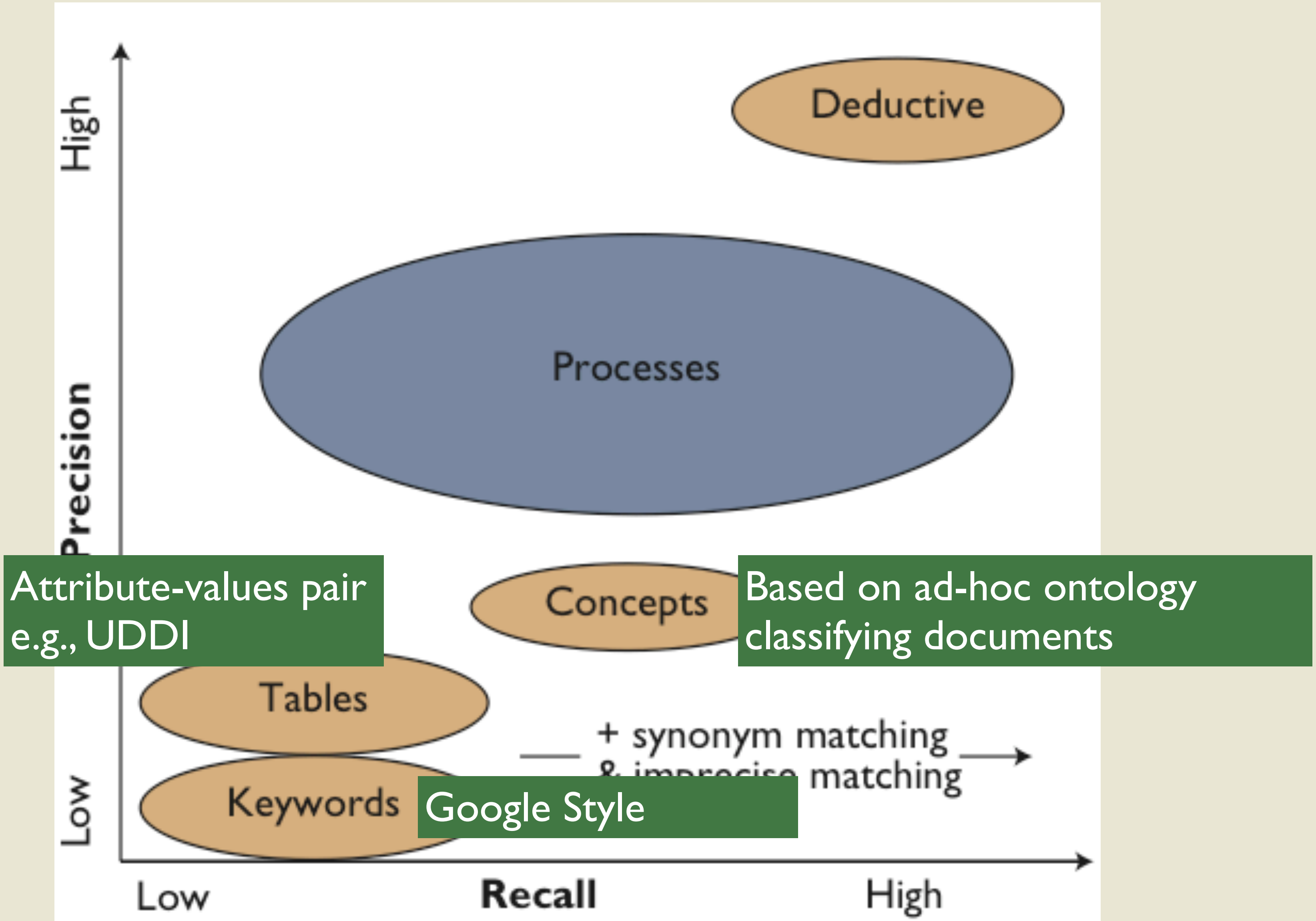


Attribute-values pair
e.g., UDDI

Google Style

from E. Klein, A. Bernstein, Toward High-Precision Service Retrieval, IEEE Internet Computing, Jan-Feb 2004

A possible roadmap



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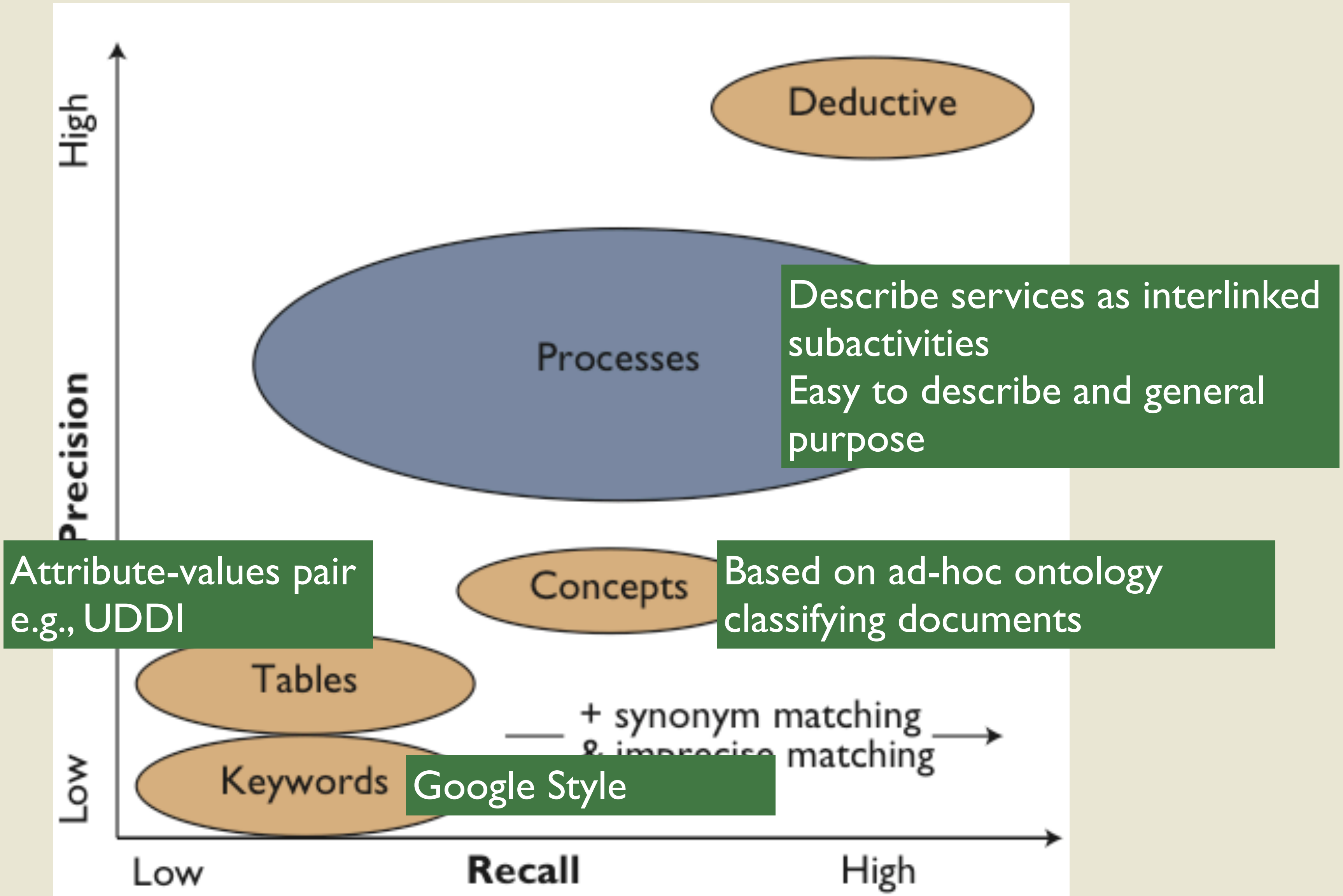

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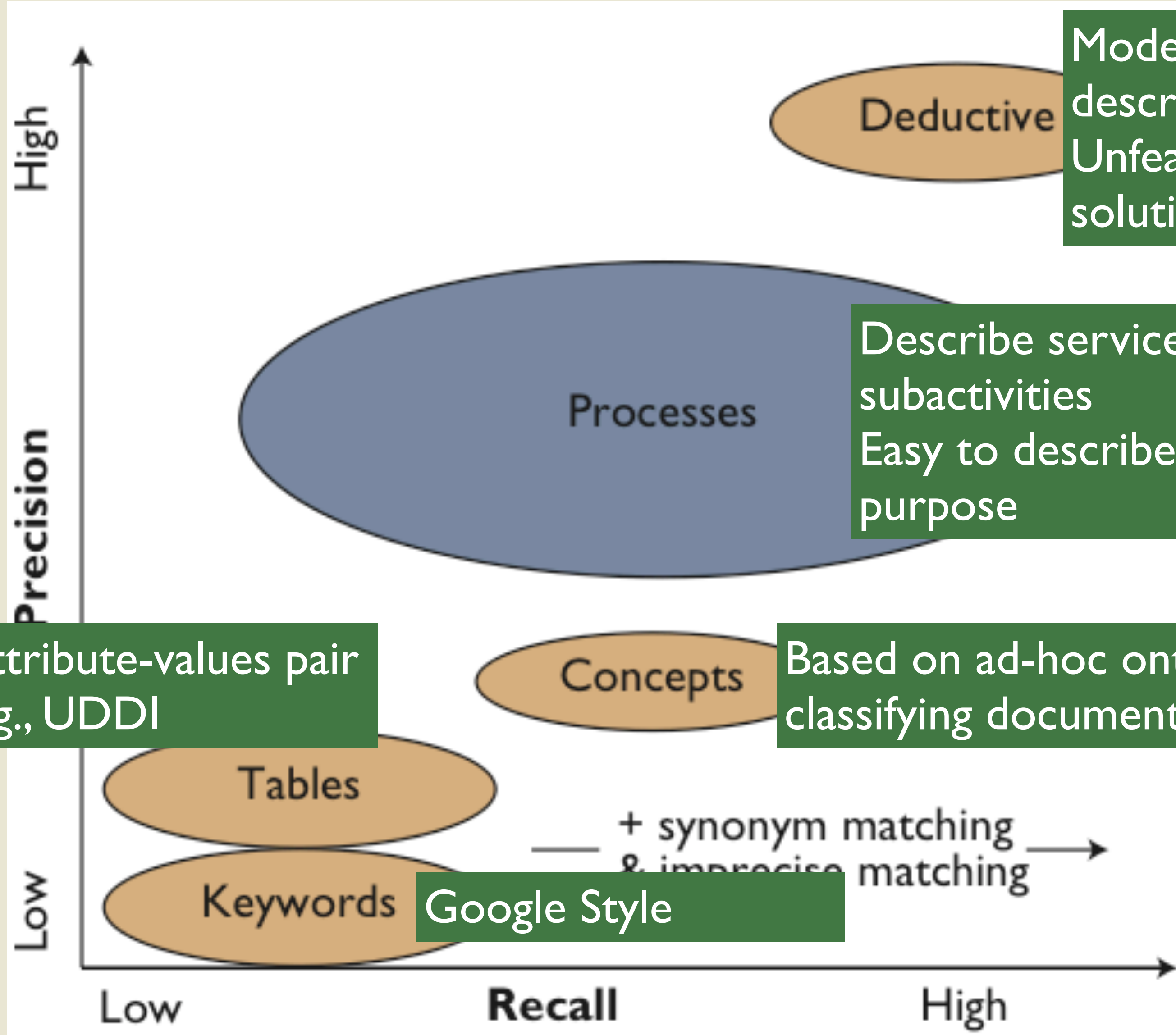


Modeling query and description with logics. Unfeasible as a general purpose solution

Describe services as interlinked subactivities
Easy to describe and general purpose

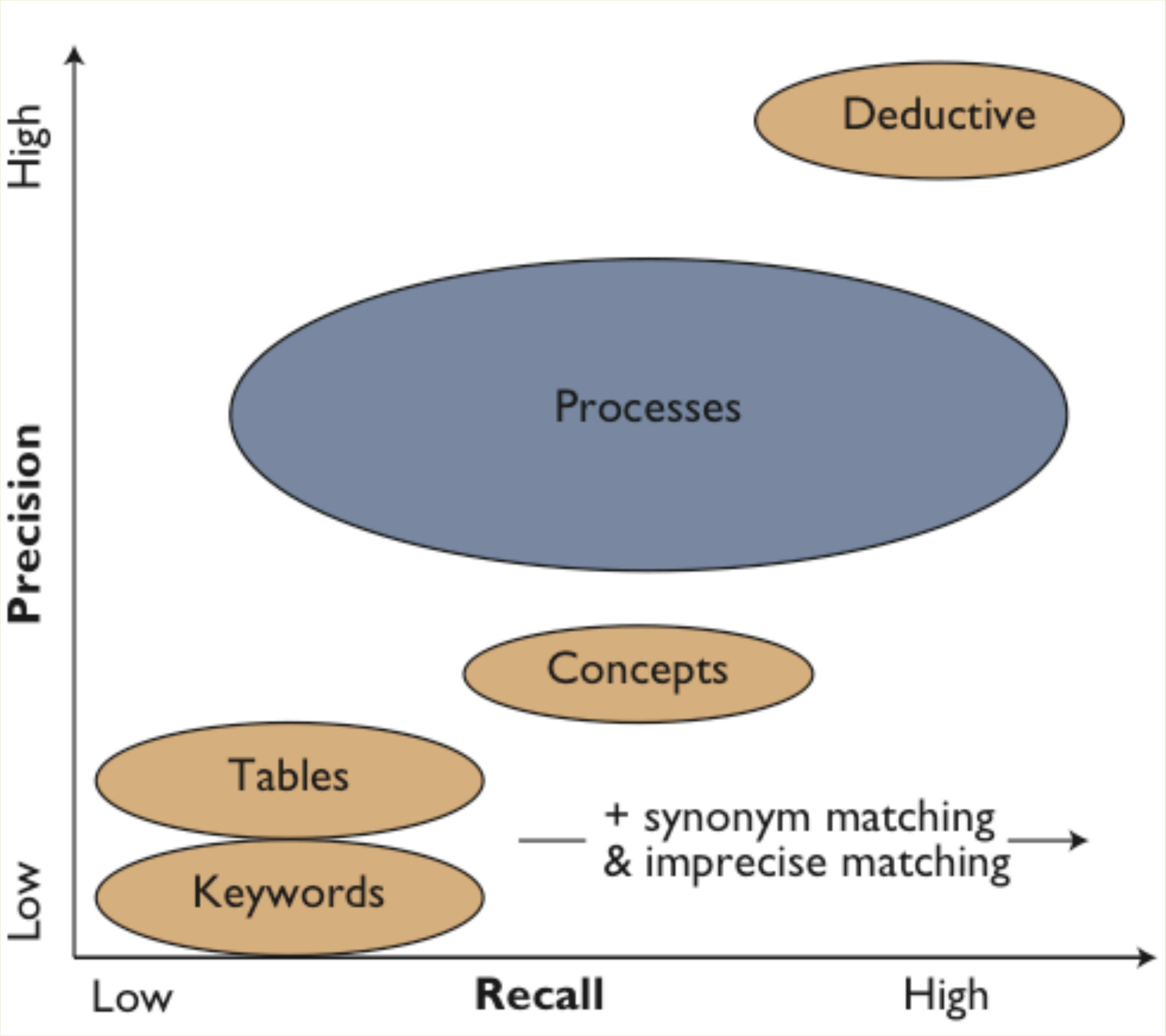
Attribute-values pair e.g., UDDI

Based on ad-hoc ontology classifying documents

Google Style

from E. Klein, A. Bernstein, Toward High-Precision Service Retrieval, IEEE Internet Computing, Jan-Feb 2004

A possible roadmap



from E. Klein, A. Bernstein, Toward High-Precision Service Retrieval,
IEEE Internet Computing, Jan-Feb 2004

Web service description

- Some current useful specifications
  - WSDL
  - SAWSDL (formerly WSDL-S)
  - OWL-S (formerly DAML-S)
  - WSMO
  - WS-Policy
  - WSOL
  - WS-CDL
  - WS-BPEL
  - ...
- How much Web service description costs?

Some of the current approaches

- Interface matching
  - Stroulia and Yang, Woogle (WSDL)
- Semantic matching
  - OWL-S MM, WSMO MM
- Hybrid matching
  - Lumina (SAWSDL)
- Quality driven matching
  - WSOI (WSOL), UDDIe (Proprietary Language)
- Hybrid+Quality matching
  - URBE (WSDL, SAWSDL, WS-Policy)
- What about behavior?

Interface matching: Zaremski & Wing 1/2

- Proposed for reusable components
- Introduces concepts useful and used in Web service retrieval
- Two kinds of similarity evaluations:
  - signature matching
  - specification matching
- Various degrees of similarity
  - exact-match
  - several relaxed matches

Interface matching: Zaremski & Wing 2/2

- Signature matching: based on data type analysis
  - Exact match
  - Partial match (generalized match, specialized match)
  - Relax match (generalized relax match, specialized relax match)
- Specification matching: based on pre- and post-condition analysis
  - Exact match
  - Plug-in match
  - Plug-in post match
  - Guarded post match

Interface matching: Stroulia and Yang

- Two main aspects
  - structural similarity based only on data type analysis (casting)
  - semantic similarity based on operations and parameters names
- This approach also considers the documentation field
  - relies on IR approach (tf/idf)
- Term similarity evaluation is based on Wordnet

Interface matching: Woogle

- Proposed by Dong et al. at VLDB 2004
  - now it seems to be abandoned
- Operation-based query
- Based on parameter names clustering
  - parameters tend to express the same concept if they occur together often
- Operation matching is based on the defined clusters
- Tool available on line http://data.cs.washington.edu/webService/

OWL-S and WSMO Matchmaking

- Web services are semantically described using OWL-S or WSMO
- Matchmakers take advantage of these semantic descriptions
- Matchmaking relates to reasoning on ontology
  - concepts composing web services are related
  - the more strict is the relationship the more similar are the service
- Classes of similarities:
  - exact
  - plug-in
  - subsumes
  - fail

Hybrid approaches

- Considers both interfaces and semantics
- Usually based on annotations
- SAWSDL extends WSDL with annotations offering semantic description about operations, messages, parameters
- Good balance between:
  - expressiveness
  - feasibility
- What about the matchmaker?

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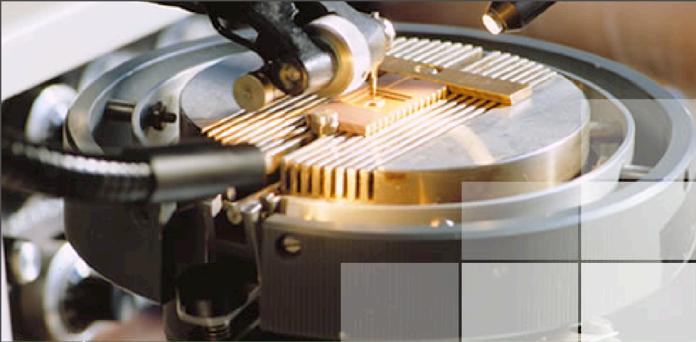

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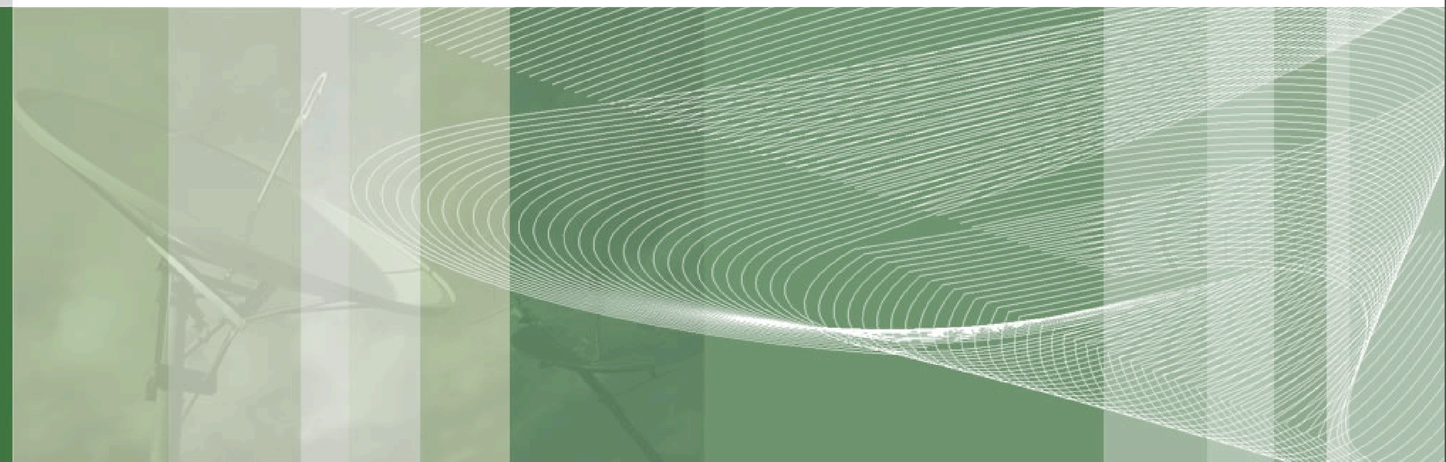


URBE (Uddi Registry By Example)

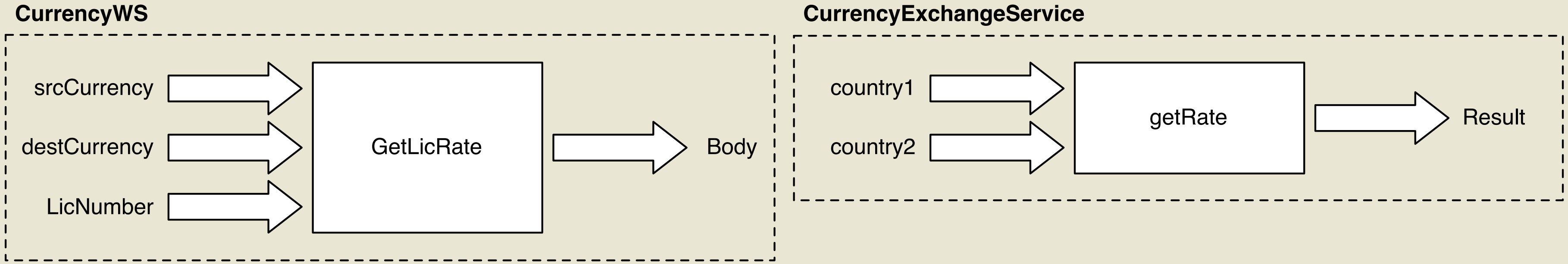
Seminar on “Web services retrieval”

Pierluigi Plebani

April, 11th, 2007

Main features of URBE

- Interface matching
- Semantic matching
- Quality driven matching
- So far:
  - we have studied the first and second points
  - we are going to validate the third point
- The main goal is: *retrieval for substitutability*



- Details in: P. Plebani and B. Pernici, URBE: Web service Retrieval based on Similarity Evaluation. IEEE Transaction on Knowledge and Data Engineering, ISSN: 1041-4347, to appear (now available on line)

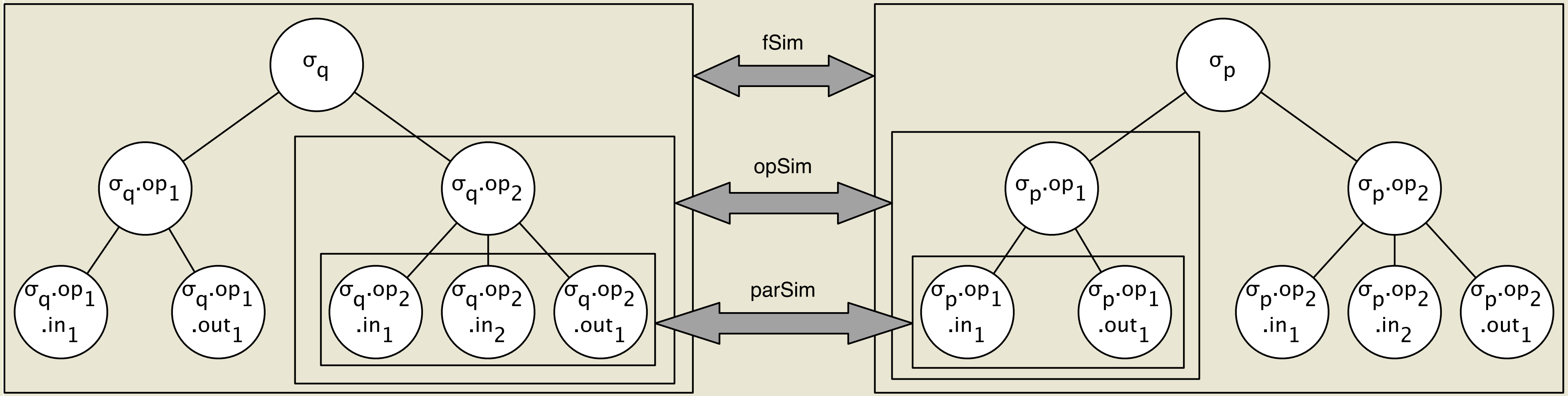
URBE in details

- Uddi Registry By Example
  - is compliant with UDDI (publishing, searching, data models)
  - performs content based query based
    - user submits a WSDL expressing the requirements
    - URBE returns a list of Web services close to the request
- Similarity function fSim is the core of URBE
  - semantic analysis
  - structural analysis

fSim properties

- Given:
  - σ_q as a query
  - σ_p as an available service
- fSim: $(\sigma_q, \sigma_p) \rightarrow [0..1]$
  - fSim$(\sigma_q, \sigma_q) = 1$
  - fSim is not symmetric
  - fSim relies on a linear programming model
- The value returned by fSim is used to rank services

fSim components



- fSim compares the overall services description by using:
  - opSim that compares the operations description by using:
    - parSim that compares the parameters description

Adopted linear problem

- Assignment in bipartite graphs which compares:
  - terms, operation, services

Q	P
Q.1	P.1
Q.2	P.2
Q.3	P.3

$$maxSim(f, Q, P) =$$

$$\frac{1}{|Q|} \cdot max \sum_{i \in I}^{j \in J} f(q_i, p_j) \cdot x_{i,j}$$

$$\sum_{j \in J} x_{i,j} \leq 1 \quad \forall i \in I$$

$$\sum_{i \in I} x_{i,j} \leq 1 \quad \forall j \in J$$

$$I = [1..|Q|], \quad J = [1..|P|]$$

Adopted linear problem

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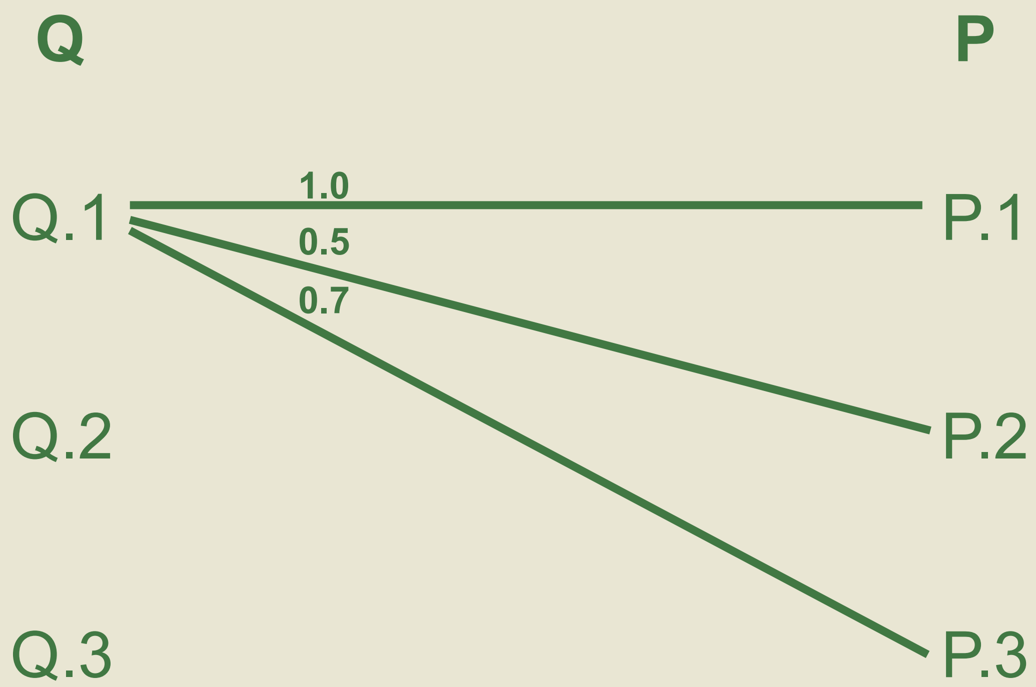

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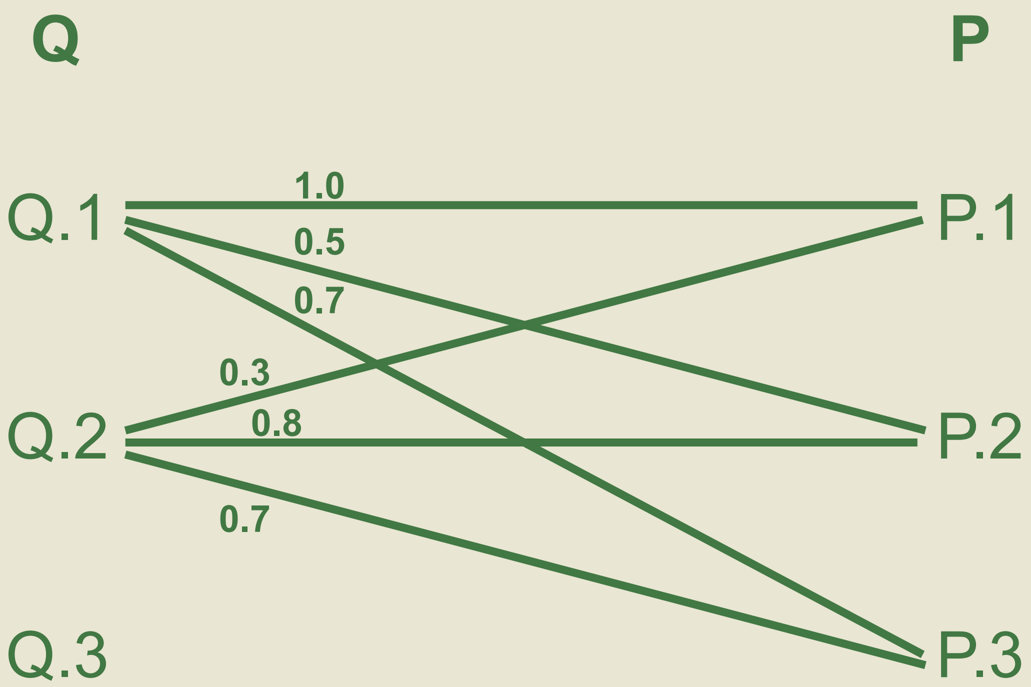

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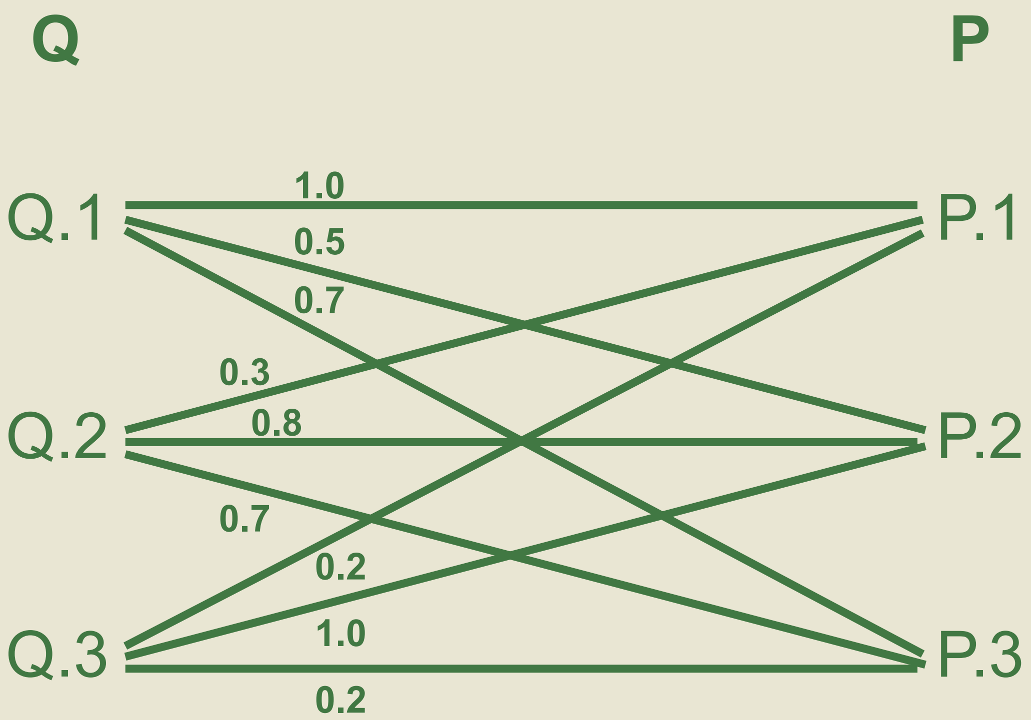

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Adopted linear problem

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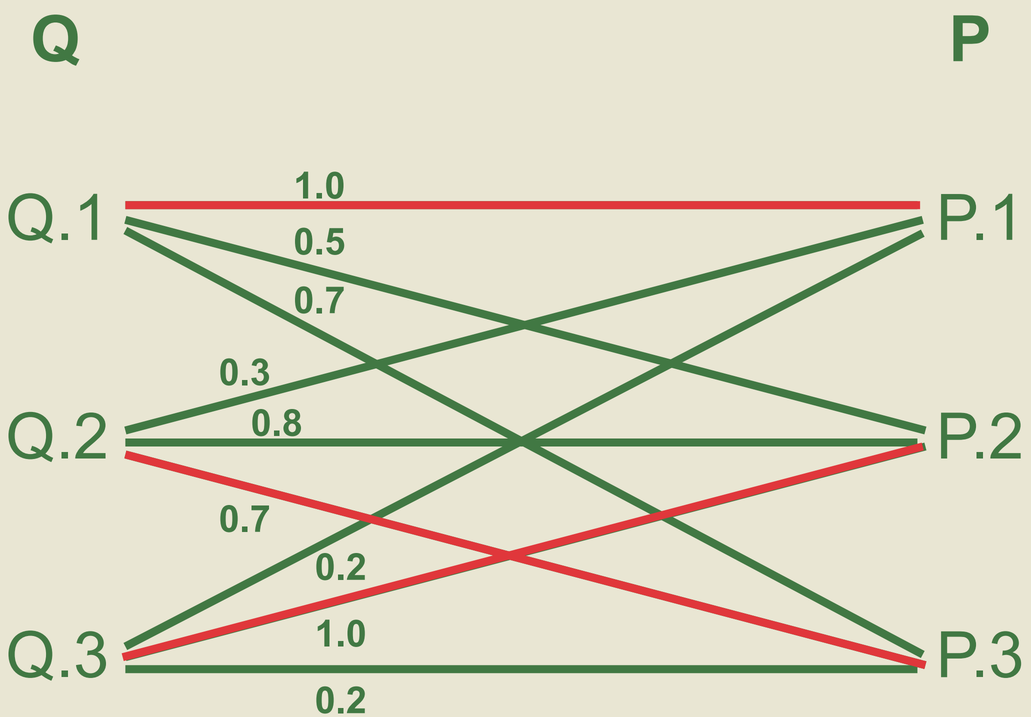

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$$\sum_{i \in I} x_{i,j} \leq 1 \quad \forall j \in J$$

$$I = [1..|Q|], \quad J = [1..|P|]$$

opt(sim(Q, P)) = (1.0 + 0.7+ 1.0) / 3 = 2.7 / 3 = 0.9

Names similarity

- We assume that the WSDL is automatically generated
- Names reflect coding conventions
- Stemming and tokenization are required before comparing names
  - getData, currencyExchange

Rule	**Original term**	**Tokenized version**
Case change	currencyExchange	currency, exchange
Case change	SendSMSTo	send, sms, to
Suffix numbers elimination	currency1	currency
Underscore separator	currency_exchange	currency, exchange

- Some terms have less meaning
  - body, result, parameters

DataType similarity 1/2

- Data types are grouped into categories [Stroulia and Yang]

Group	**Simple and derived XSD Data Types**
Integer group	integer, byte, short, long
Real group	float, double, decimal
String group	string, normalizedString
Date group	date, dateTime, duration, gDay, gMonth, gMonthDay, gYear, gYearMonth, time
Boolean group	boolean

- dataTypeSim is inversely proportional to the information loss if we cast from dt_q to dt_p

		dt_q				
	dataTypeSim	**Integer**	**Real**	**String**	**Date**	**Boolean**
dt_p	**Integer**	1.0	0.5	0.3	0.1	0.1
	Real	1.0	1.0	0.1	0.0	0.1
	String	0.7	0.7	1.0	0.8	0.3
	Date	0.1	0.0	0.1	1.0	0.0
	Boolean	0.1	0.0	0.1	0.0	1.0

DataType similarity 2/2

- Information loss is quantified according to the following reference scale

Information loss	Value
data types are totally incompatible	1.0
in some rare case casting does not produce information loss	0.7
information loss happens by casting	0.5
often casting does not produce information loss	0.3
data types are the same	0.0

Semantic extension

- Recall can be improved if SAWSDL description is available
- In this case name similarity is based on the annotations
  - Annotation refers to concept in the domain-specific ontology
  - Similarity evaluation depends on the nature of the annotation (it could be either class or property)
- Annotations similarity results
  - more precise than names similarity
  - faster to calculate

pathSim

- both a_q and a_p are classes, or
- both a_q and a_p are properties

$$pathSim(a_q, a_p) = \begin{cases} 0 & \text{if no subsumption path exists} \\ \dfrac{1}{(pathlength(a_q, a_p) + 1)} & \text{otherwise} \end{cases}$$

classPropSim and propClassSim

- a_q is a class
- a_p is a property

$$classPropSim(a_q, a_p) = \begin{cases} \dfrac{1}{\#\text{properties of } a_q} & \text{if } a_q \equiv \text{domain}(a_p) \\ 0 & \text{otherwise} \end{cases}$$

- a_q is a property
- a_p is a class

$$propClassSim(a_q, a_p) = \begin{cases} 1 & \text{if } a_q \equiv \text{domain}(a_p) \\ 0 & \text{otherwise} \end{cases}$$

Benchmark

- Benchmark has been obtained from the OWL-S service retrieval test collection (OWL-S TC)
  - 570 Web services
  - 32 test queries
  - http://projects.semwebcentral.org/projects/owls-tc/
- Machine
  - IBM xSeries, 2 CPU Intel XEON 3GHz, 2 GByte RAM

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Evaluation parameters

- Precision = #relevant returned / #returned
- Recall = #relevant returned / #relevant in the corpus
- Top-5 = precision when 5 items are returned
- Top-10 = precision when 10 items are returned
- R-Precision = precision when the number of items returned corresponds to the number of relevant items
- Average Precision (AP) = precision calculated after a relevant item is returned

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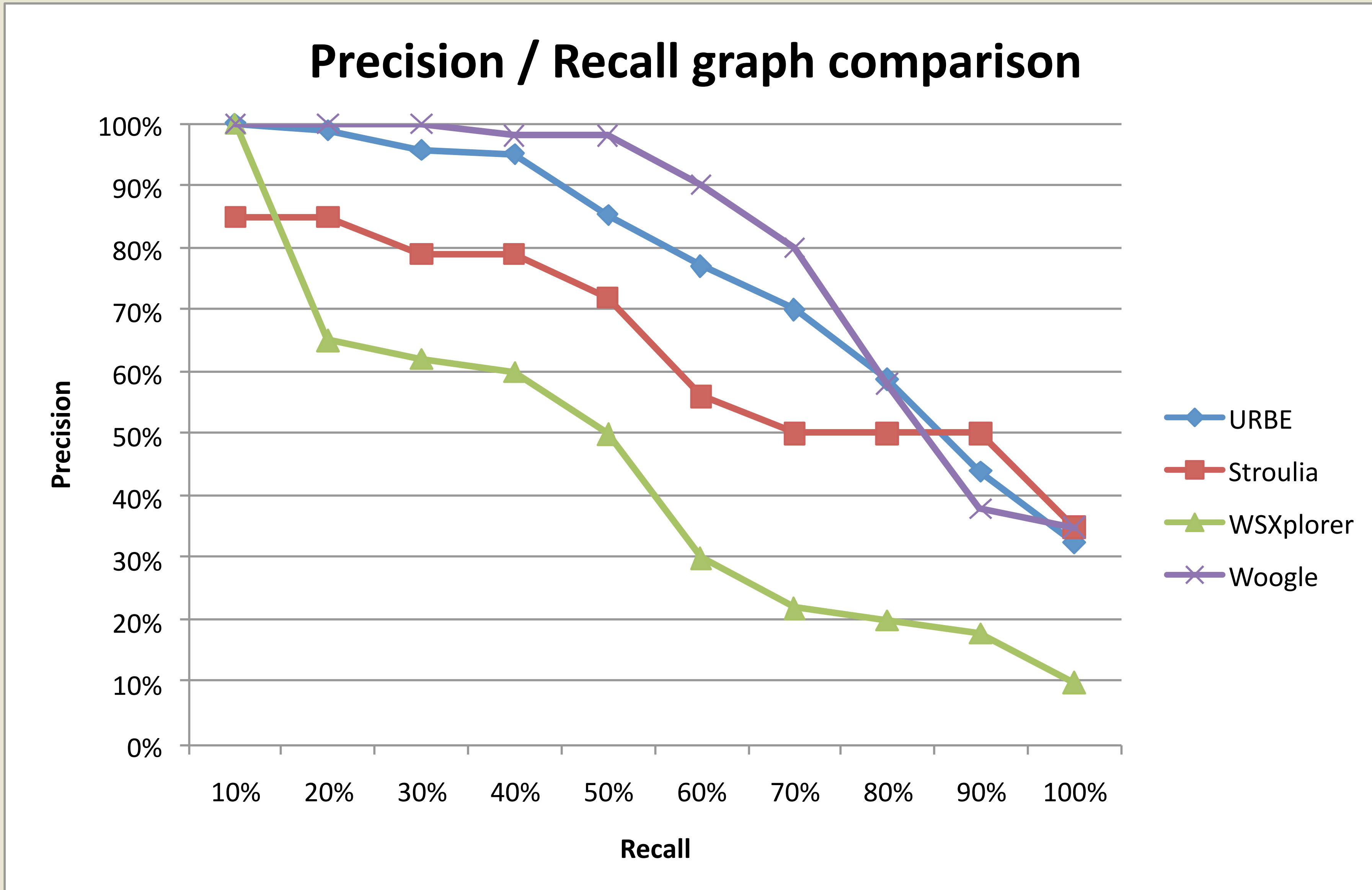
Results: precision/recall graph



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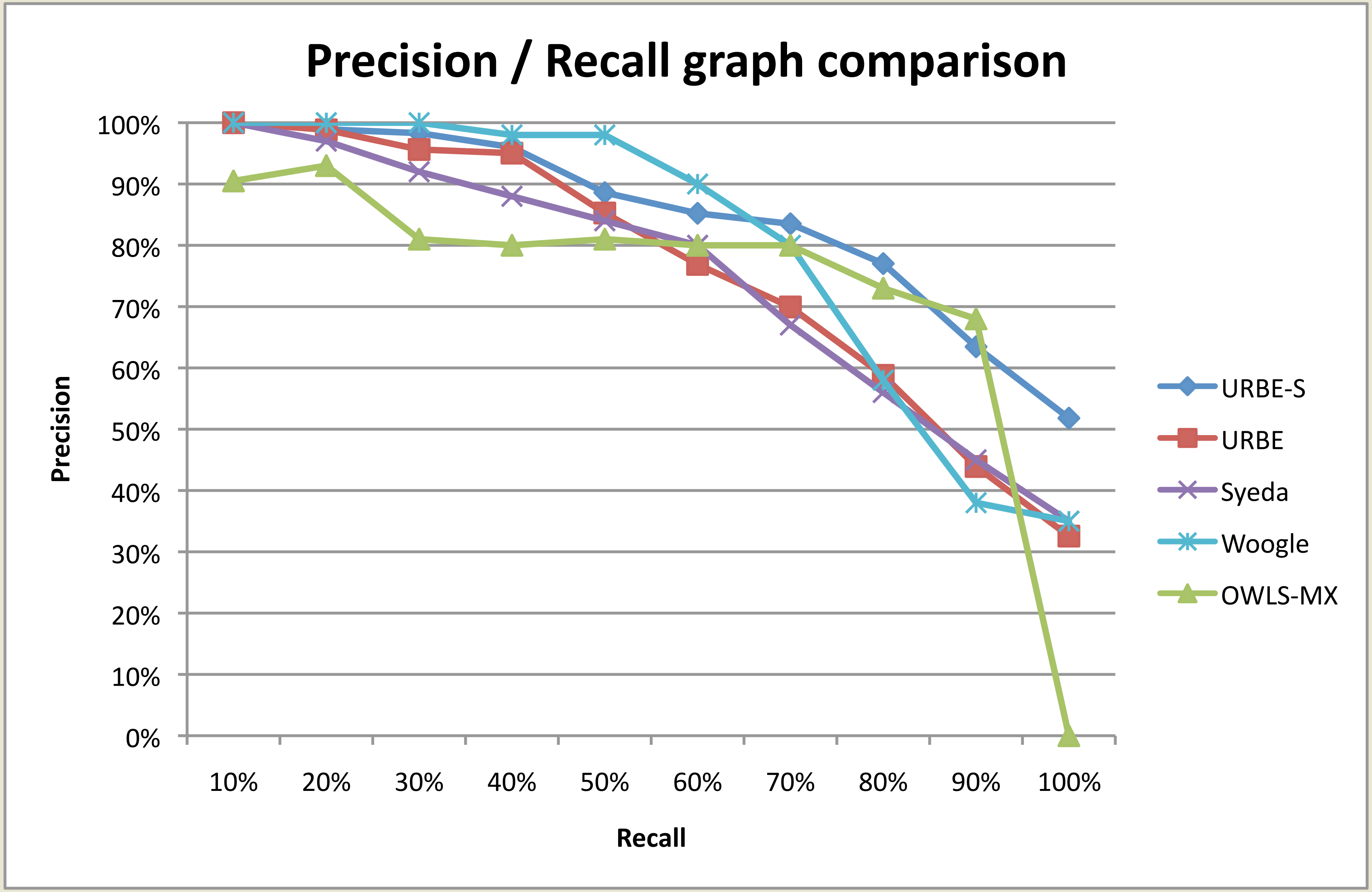
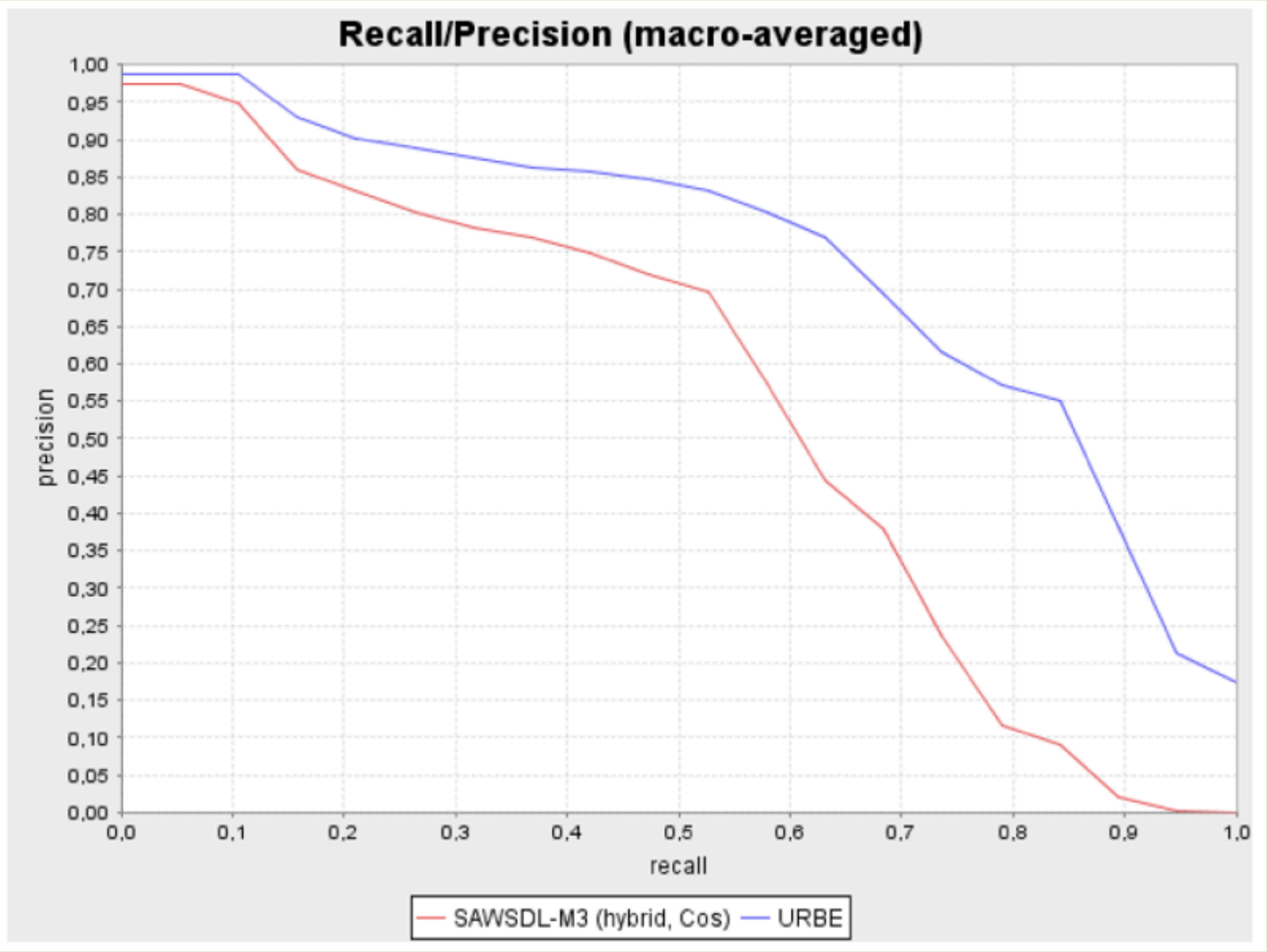


Semantic Service Selection Contest



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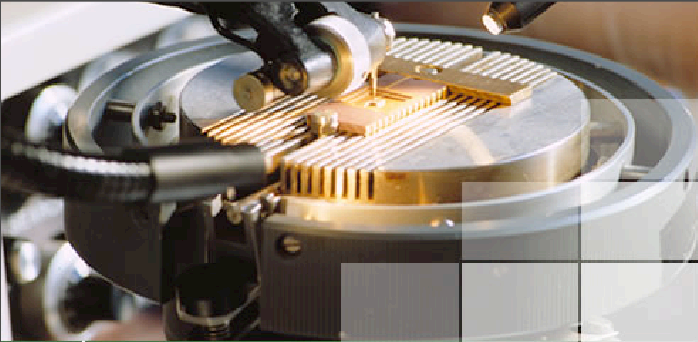

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Concluding remarks

Lecture on "Web services retrieval"

Pierluigi Plebani

March, 6th, 2009

My standpoint

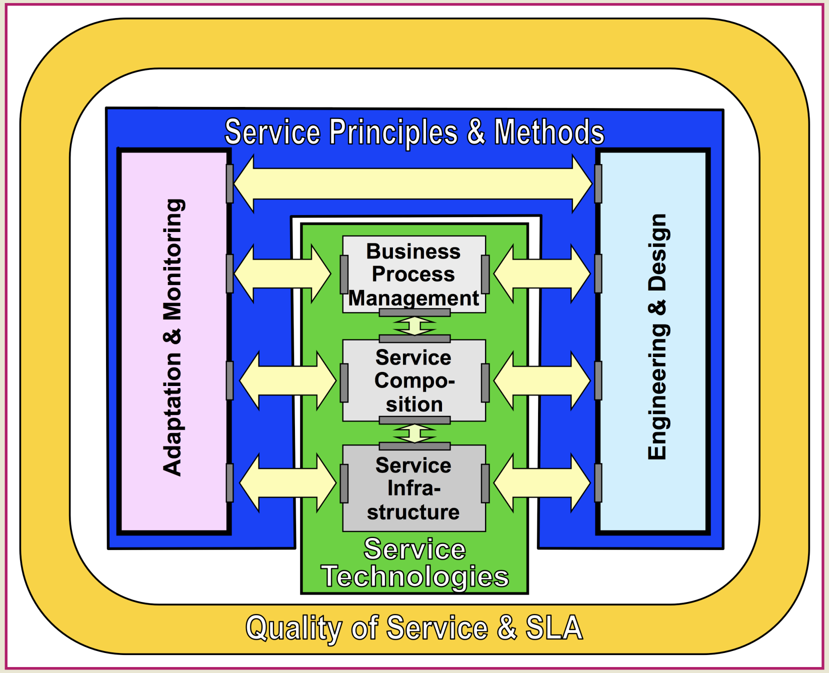
- Quality and negotiation matchmaking represent, at this stage, the biggest open issues
- About the functional matchmaking is matter of computation time
- Web service registry managing should be deeply investigated as well
- Semantic based approaches suffer of the need of services semantically described
- Web services retrieval must be, first of all, *usable*!
  - Holy grail: “I would like a service able to...”

Acknoledgments

S-CUBE

The Software Services and Systems Network

Information Society Technologies



S-CUBE service vision

S-CUBE focuses on the new-generation of services mainly on:

- Adaptive and Flexible execution
- Human Computing Interaction
- Context awareness
- Quality and SLA definition

These aspects will be investigated from BPM down to the infrastructural perspective.

Service engineering and governance hold a key role in the S-CUBE vision.

http://www.s-cube-network.eu/

SEVENTH FRAMEWORK PROGRAMME

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Contacts

Pierluigi PLEBANI

Dipartimento di Elettronica ed Informazione

Politecnico di Milano

Via Ponzio 34/5

20133 Milano - Italy

plebani@elet.polimi.it

http://home.dei.polimi.it/plebani