ISWC2005
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Searching in the ISWC Semantic Bank:
<negotiation> - One Item Found

A Strategy for Automated Meaning Negotiation in Distributed Information Retrieval

☑ **Vadim Ermolayev** — **Zaporozhye National University, Ukraine**
Natalya Keberle
Vladimir Vladimirov
Wolf-Ekkehard Matzke — **Cadence Design Systems GmbH, Germany**

The Outlook

Shall be as informal as possible

Otherwise we'll perish
in endless deliberation

- Motivation:
  - Google game or
  - Do we always use the PROPER domain theory?
- What happens in Distributed Information Retrieval:
  - Actors, Roles and the need to reach Agreements (on Domain Theories)
- Semantic Context and Negotiation Settings
- Meaning Negotiation Strategy:
  - How to behave smartly to reach agreements
  - Argumentation: Contexts, Propositional Substitutions, Presuppositions, Concession, Reputation … and around
- Conclusions and future work

Do we Use the Proper Domain Theory?

- You work on **agent-based system implementing a tourism-related application**
- **Who is inventing the same square wheel**?
- One **usual** way to find out:
  - To ask a search engine:
    <agent> and <tourism> and <project>
  - E.g., **Google**: http://google.com/search?q=agent+tourism+project
- The results were …

Seems that … we don't – at all!

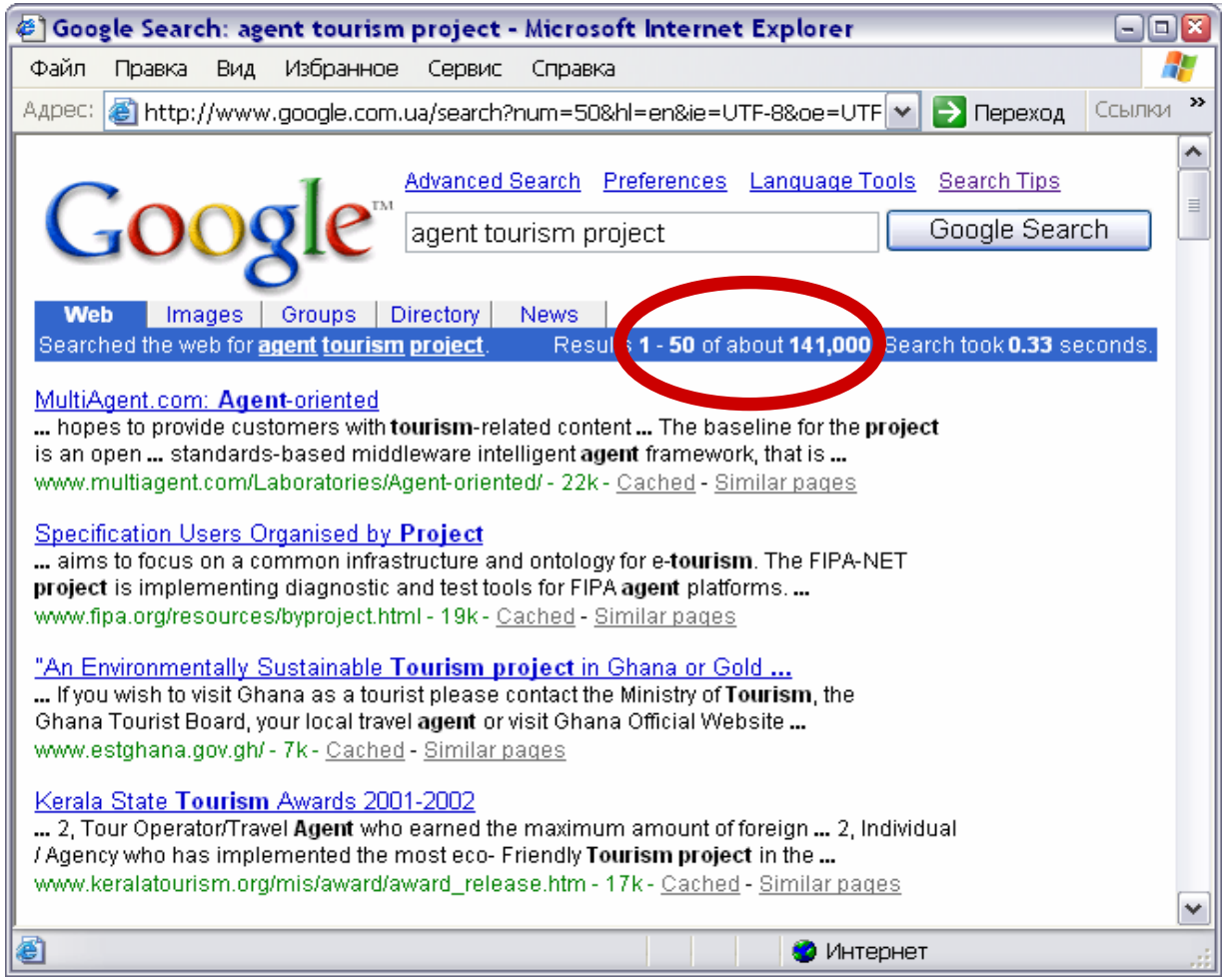
Links Found:
- 141 000

Analyzed:
- 1-50

Among them:

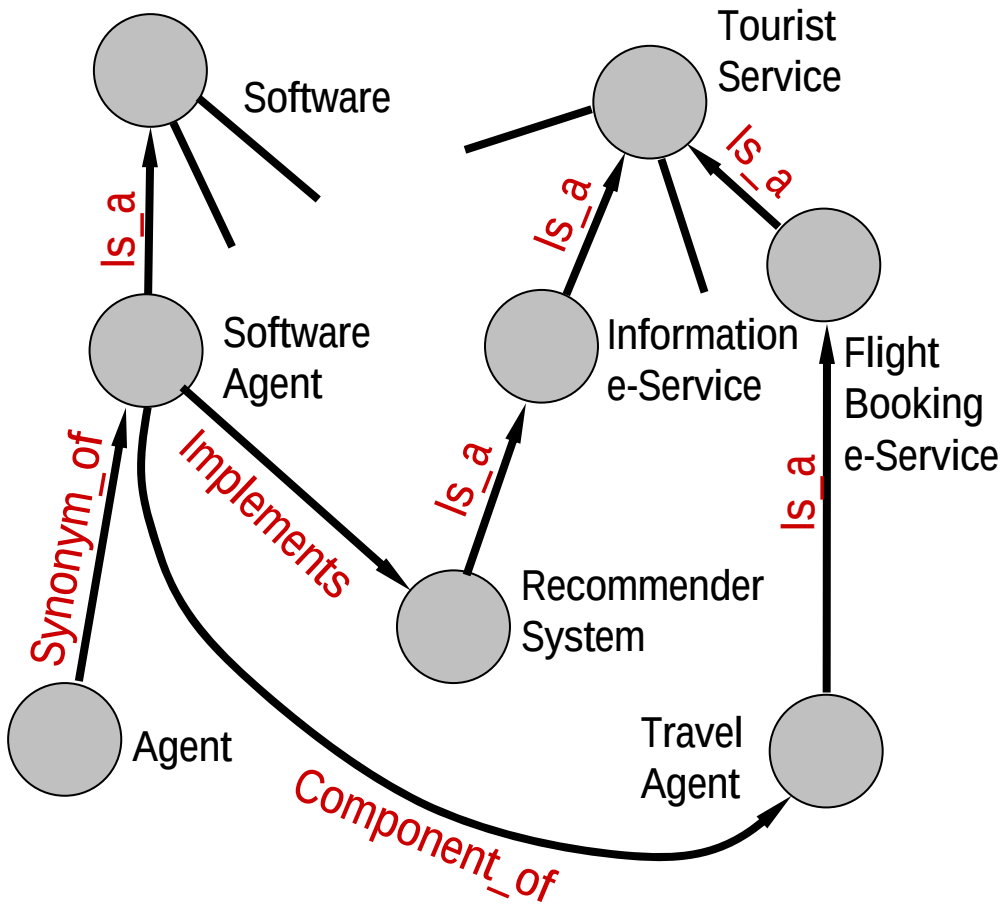
Matches:
- 13(26%)

Mismatches:
- 37(74%)



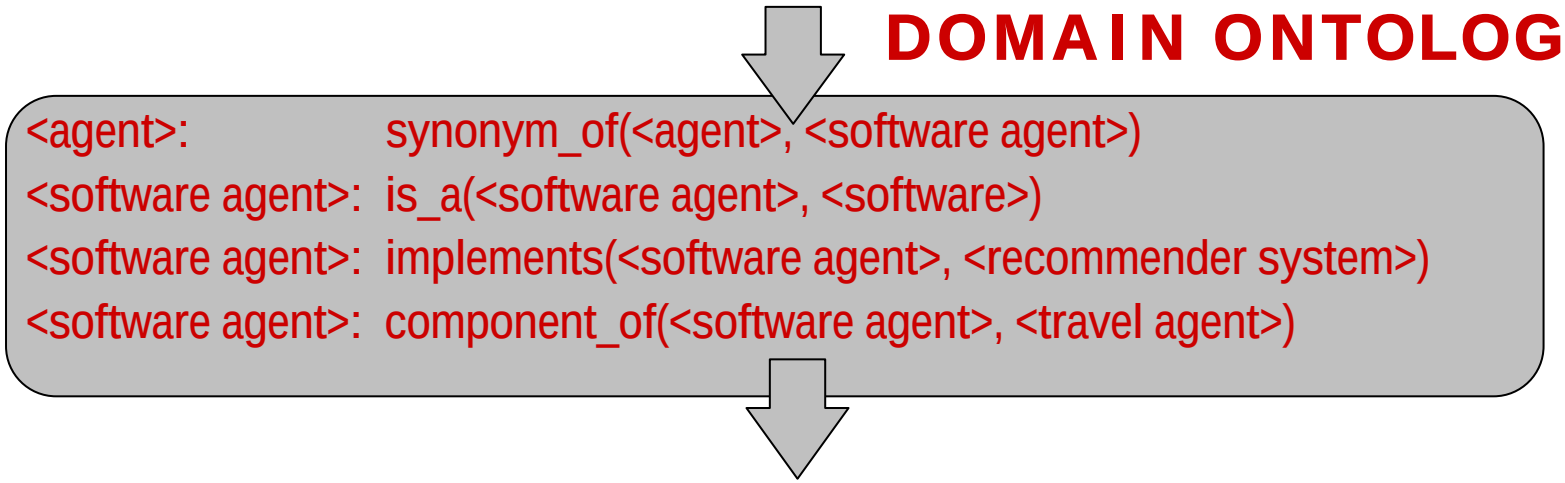
If We've been Smarter

- We should have used a **different** **DOMAIN ONTOLOGY**
- This may have led us to …



… the Transformation Like:

- <agent> AND <tourism> AND <project>



- <tourism> AND <project>
  AND <software agent>
  AND (<recommender system> OR <travel agent>)

- We have tried Google with that …

Is this the Proper Domain Theory?

Resources: **18**

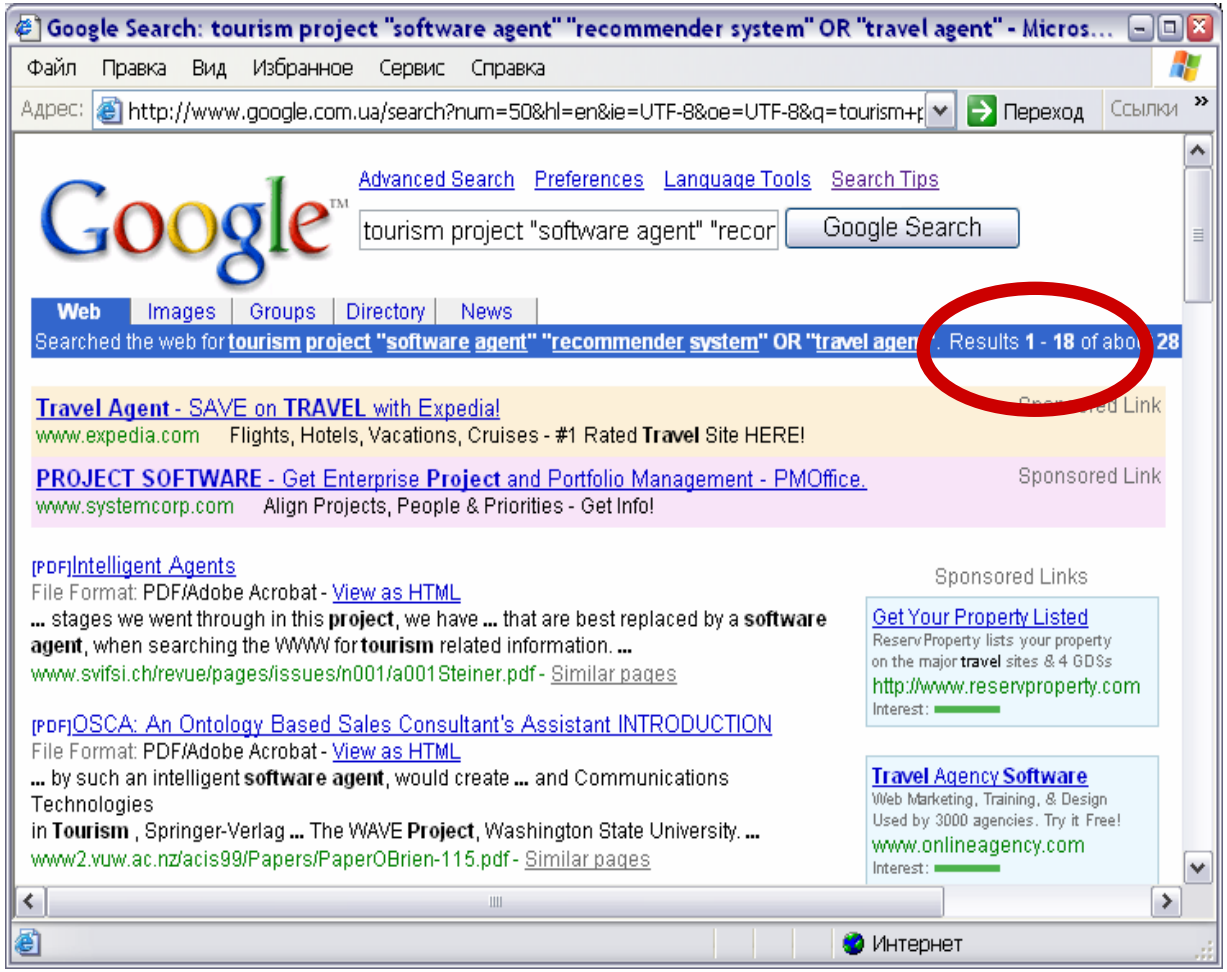
Among them:

Matches: **15 (+2 - 94%)**
vs **26%** before

Mismatches: **3 (6%)**

Interesting to note:
All of them could be found among the results (141 000) of the previous query

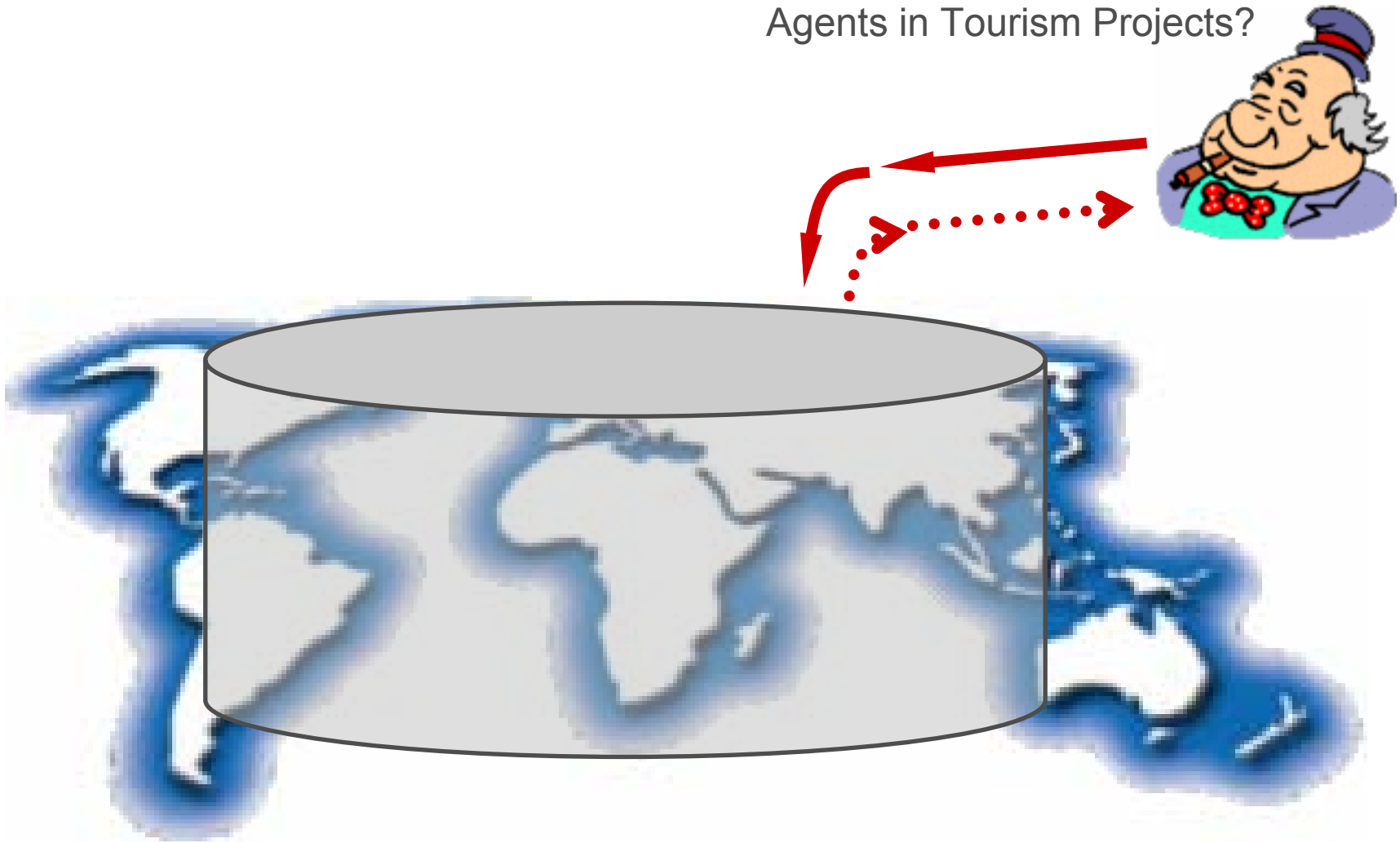
Compare:
recall, precision



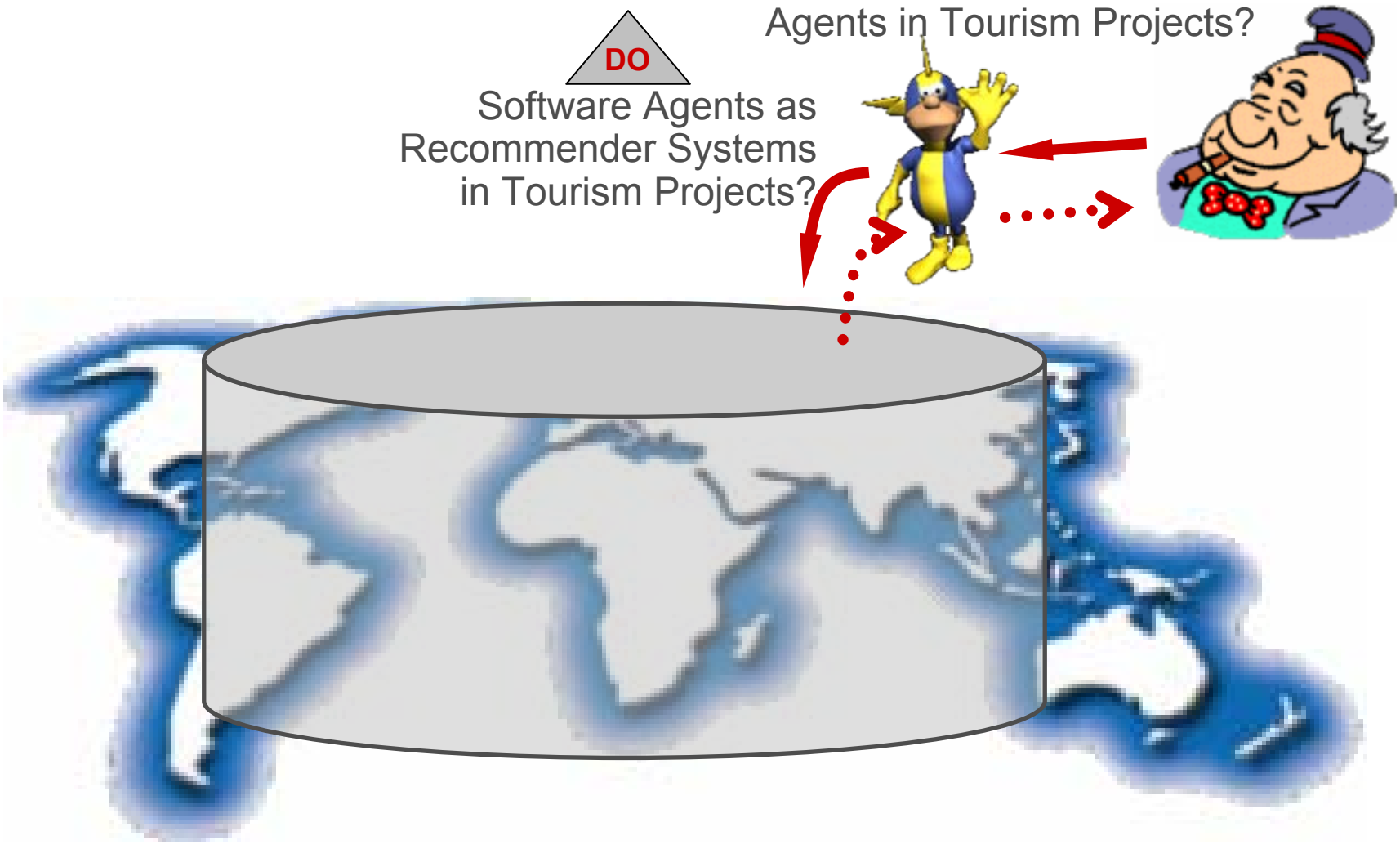
How to Adhere to the **PROPER** Domain Theory?

- Still not ready to answer
- We'll explore what happens in **DIR** first …

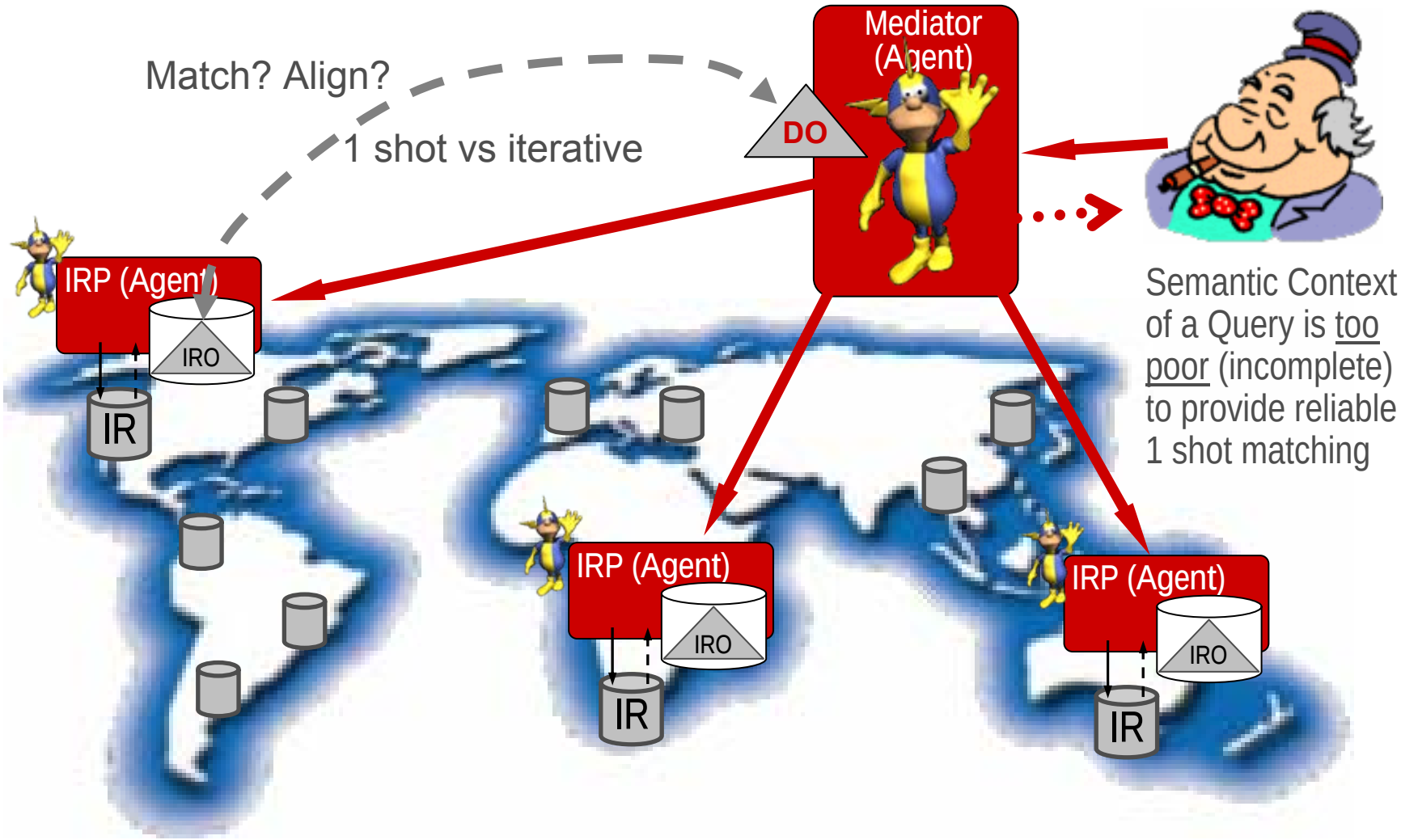
Information Retrieval



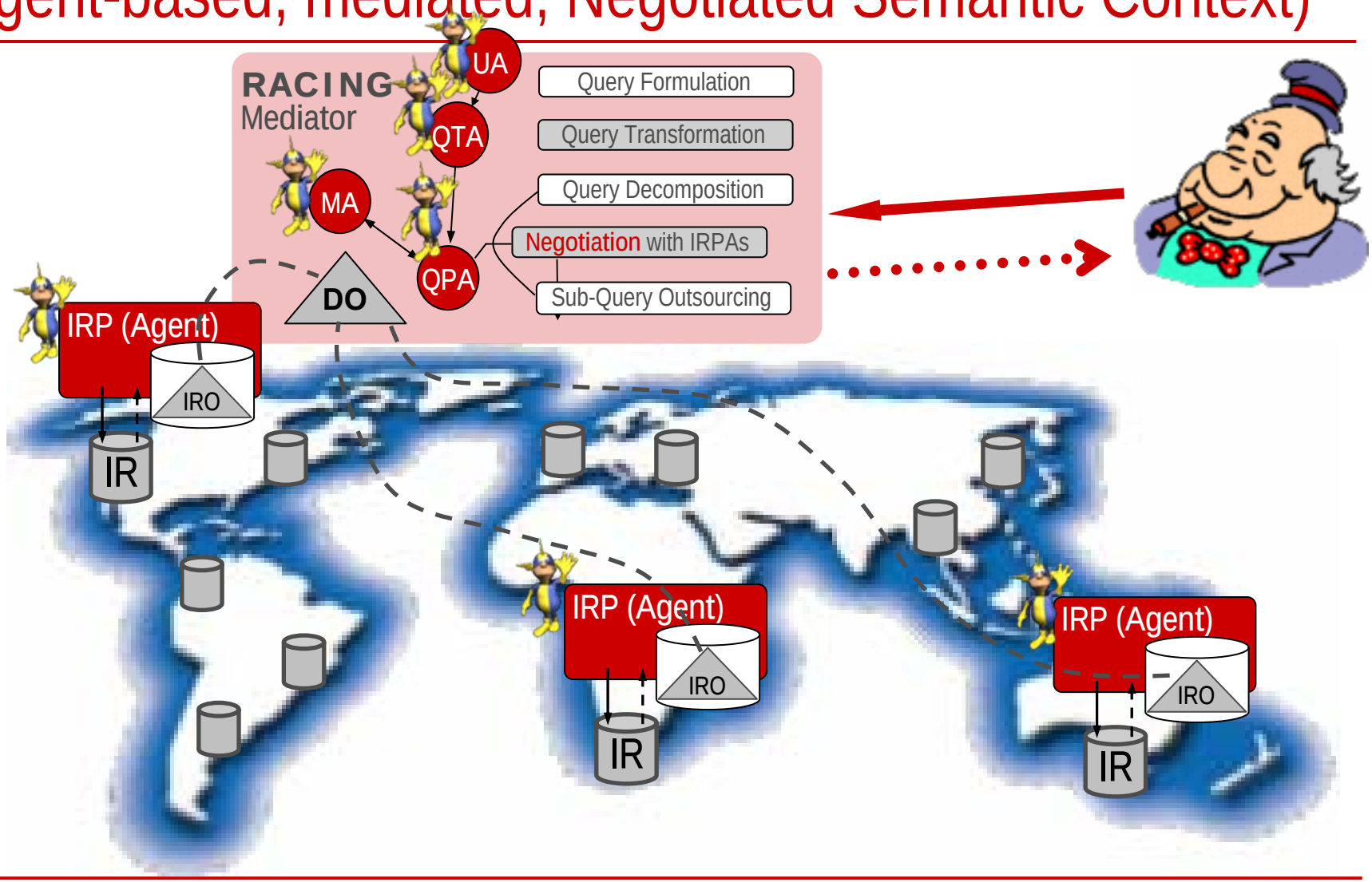
Information Retrieval
(semantically mediated – our Google game)



Distributed Information Retrieval
(agent-based, mediated… Semantic Context?)



Distributed Information Retrieval
(agent-based, mediated, Negotiated Semantic Context)



How to Adhere to the **PROPER** Domain Theory?

- Just observe **what people do**:
  - Be **smart**
  - Don't be **stubborn**
  - Be ready to **concede**
    - As much as your reputation allows
  - Be **pro-active**
    - Try to reach the agreement on the Semantic Context of the Query

Mind that you are **software** and **software**

- **Negotiation** -incorporating all of the **above**
  - Use **Argumentation** to negotiate
  - In a way to **Concede monotonically** to the **Deal**

Negotiation Settings:
One-to-One, Non-Symmetric, Multi-Issue, on Semantic Context

- The **Goal**
  - The **Deal** stricken over the **Negotiation Set**
- The Interaction **Protocol**
  - Symmetric vs **Non-Symmetric**
  - **One-to-One**, One-to-Many, Many-to-Many
- The **Negotiation Set**
  - Single-Issue vs **Multi-Issue**
  - **Semantic Context** (the part of the Domain Theory communicated to the negotiation party)
- The **Strategy** (of a party)
  - The set of internal Rules an Agent uses to pursue the Goal (of striking the Deal)

The FOCUS of the paper

Semantic Context
after (Beun, van Eijk, and Prüst, 2004)

- **Definition 1** (Semantic Context): The context $\mathbf{C}_c$ of a concept $c \in \mathbf{\Gamma}^*$ is the union of the set $\mathbf{\Gamma}_i$ of TT** statements $\gamma_i \in \mathbf{\Gamma}$ which are the assumptions over c and the set $\mathbf{\Gamma}_j$ of TT statements $\gamma_j \in \mathbf{\Gamma}$ which may be explicitly inferred from $\{\mathbf{\Gamma} \vdash c{:}\bigstar_s{}^{***}\} \cup \mathbf{\Gamma}_i$ using the rules of the type system:

$$\mathbf{C}_c = \mathbf{\Gamma}\big|_c = \mathbf{\Gamma}_i \bigcup \mathbf{\Gamma}_j$$

* $\mathbf{\Gamma}$ stands for Domain Theory

** TT stands for **Type Theory**
See, e.g.: Luo, Z.: Computation and Reasoning: A Type Theory for Computer Science. Int. Series of Monographs on Computer Science. Clarendon Press, Oxford (1994)

*** $\mathbf{\Gamma} \vdash c{:}\bigstar_s$ reflects that 1) c is the concept (has the special type "sort") and 2) this fact (1) may be inferred from the Domain Theory

Negotiation Strategy:
the Questions to be Answered (by providing the Rules)

- Let **Q** has Γ_Q and **M** has Γ_M:
  - Which of the parties starts first? – Straightforward! **Q** of course
- The others are **more difficult**:
  - How to generate argumentation on the semantic discrepancies between Γ_Q and Γ_M?
  - How to ensure that these discrepancies are eliminated monotonically in negotiation rounds?
  - How to assess if the current level of these semantic discrepancies is sufficient to strike the deal?
  - How to find out that the movement to the perfect match (no discrepancies) is no longer possible?

Argumentation on Semantic Discrepancies

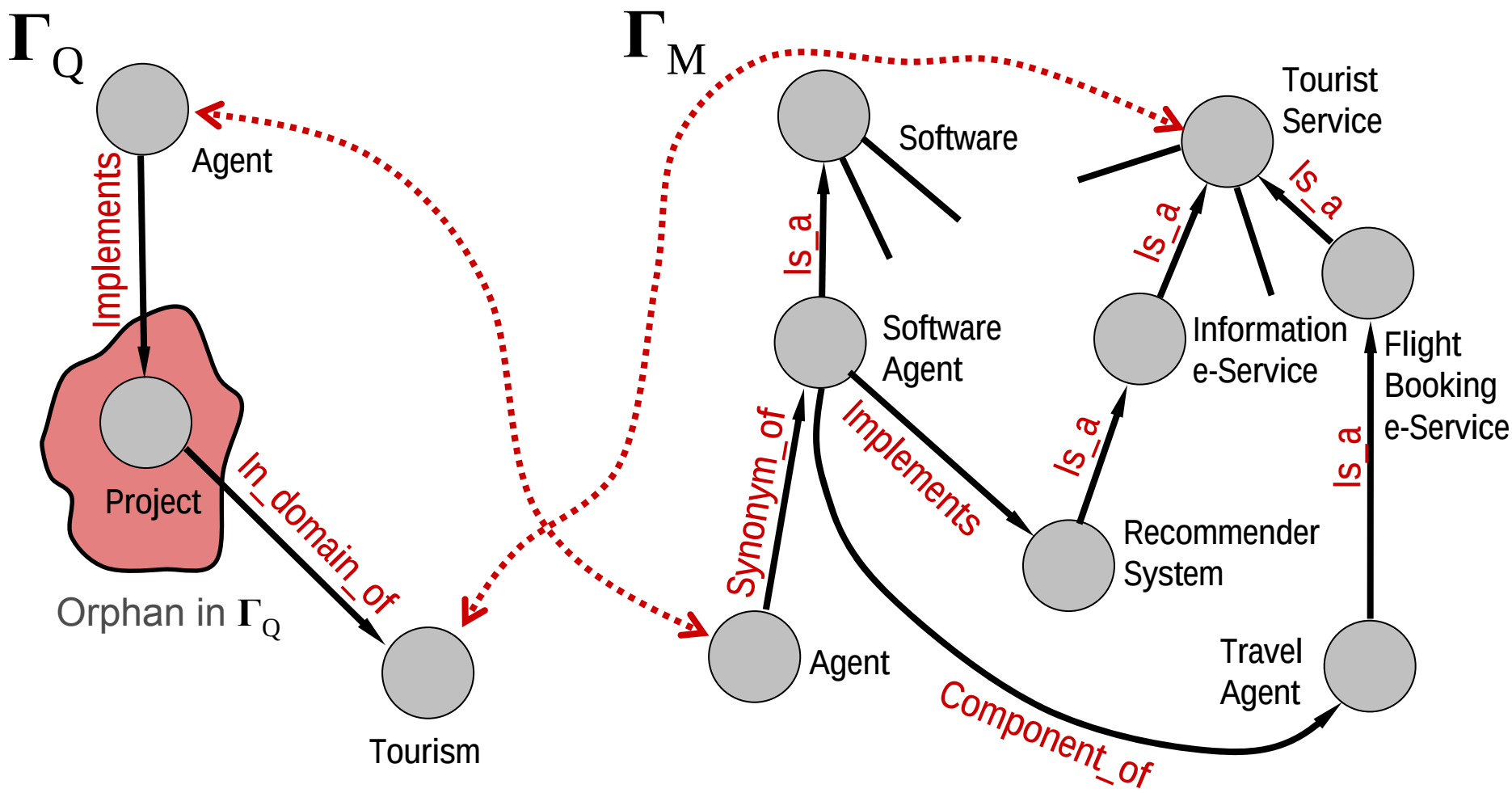
- Define **S**emantic **D**istance as $\mathbf{SD}: \mathbf{\Gamma}_Q \times \mathbf{\Gamma}_M \rightarrow \mathbf{R}$
- Efficient argumentation should lower the $\mathbf{SD}$ (monotonically)
- Biggest contribution to $\mathbf{SD}$ is provided by the "**orphans**" of $\mathbf{\Gamma}_Q$ wrt $\mathbf{\Gamma}_M$ (or $\mathbf{\Gamma}_M$ wrt $\mathbf{\Gamma}_Q$)
  - **Orphans**: concepts, concept properties, or propositions expressing relationships of $\mathbf{\Gamma}_Q$ having no analogy in $\mathbf{\Gamma}_M$ (or of $\mathbf{\Gamma}_M$ in $\mathbf{\Gamma}_Q$)
- So – find a kind of an extra context $\mathbf{\Delta}_o$ for each encountered orphan, say, o
- A party concedes on o if $\mathbf{C}_o \cap \mathbf{\Delta}_o \neq \varnothing$

Hints on how to measure the $\mathbf{SD}$ are in the paper

Euzenat, J. et al.: State of the Art on Ontology Alignment. **KnowledgeWeb** project deliverable D2.2.3, v.1.2. August 2, 2004. URL: http://knowledgeweb.semanticweb.org/

Orphans: an Example

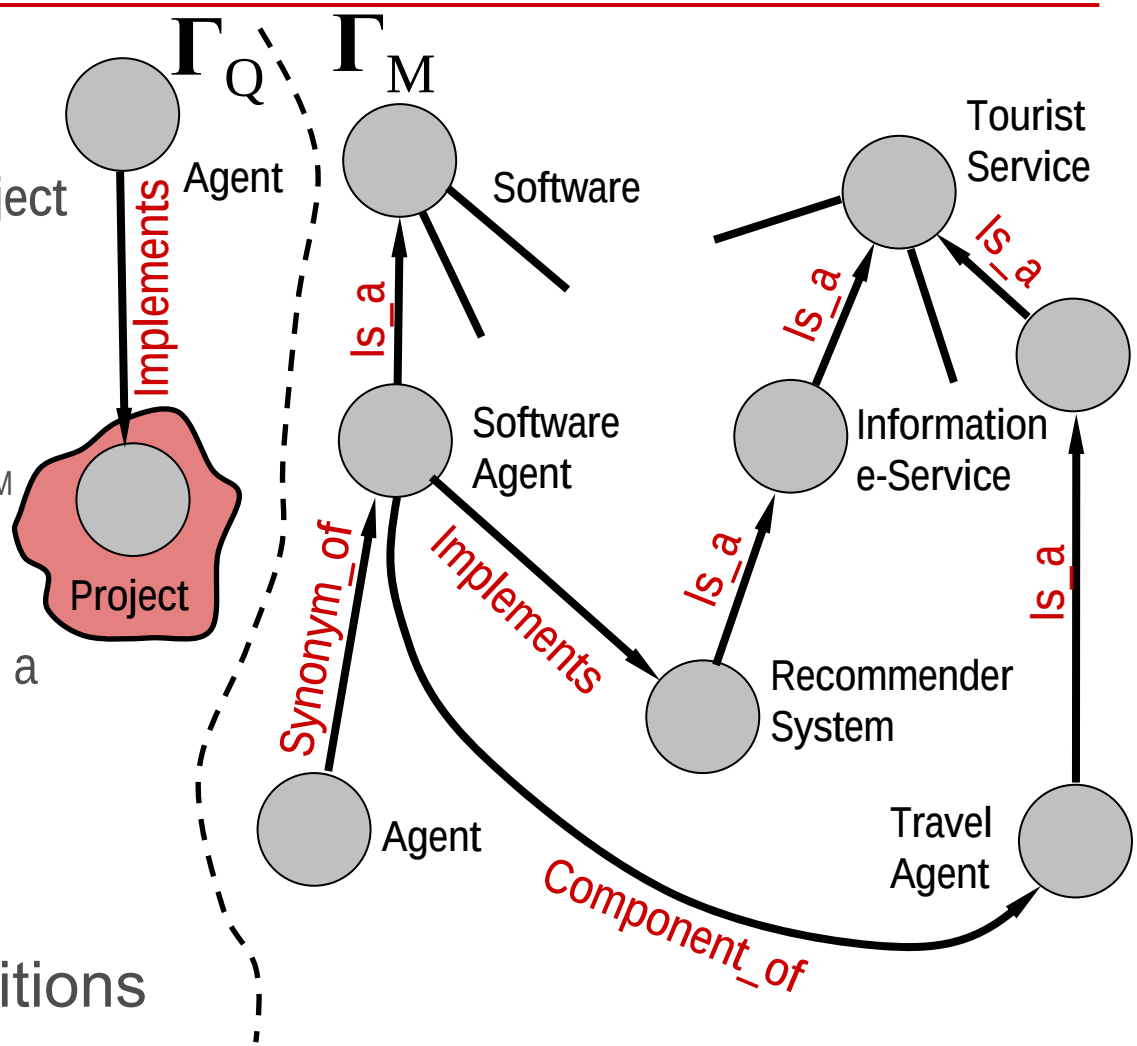
The Google Game



One can find a different (more detailed) example in the paper

Contexts & Propositional Substitutions

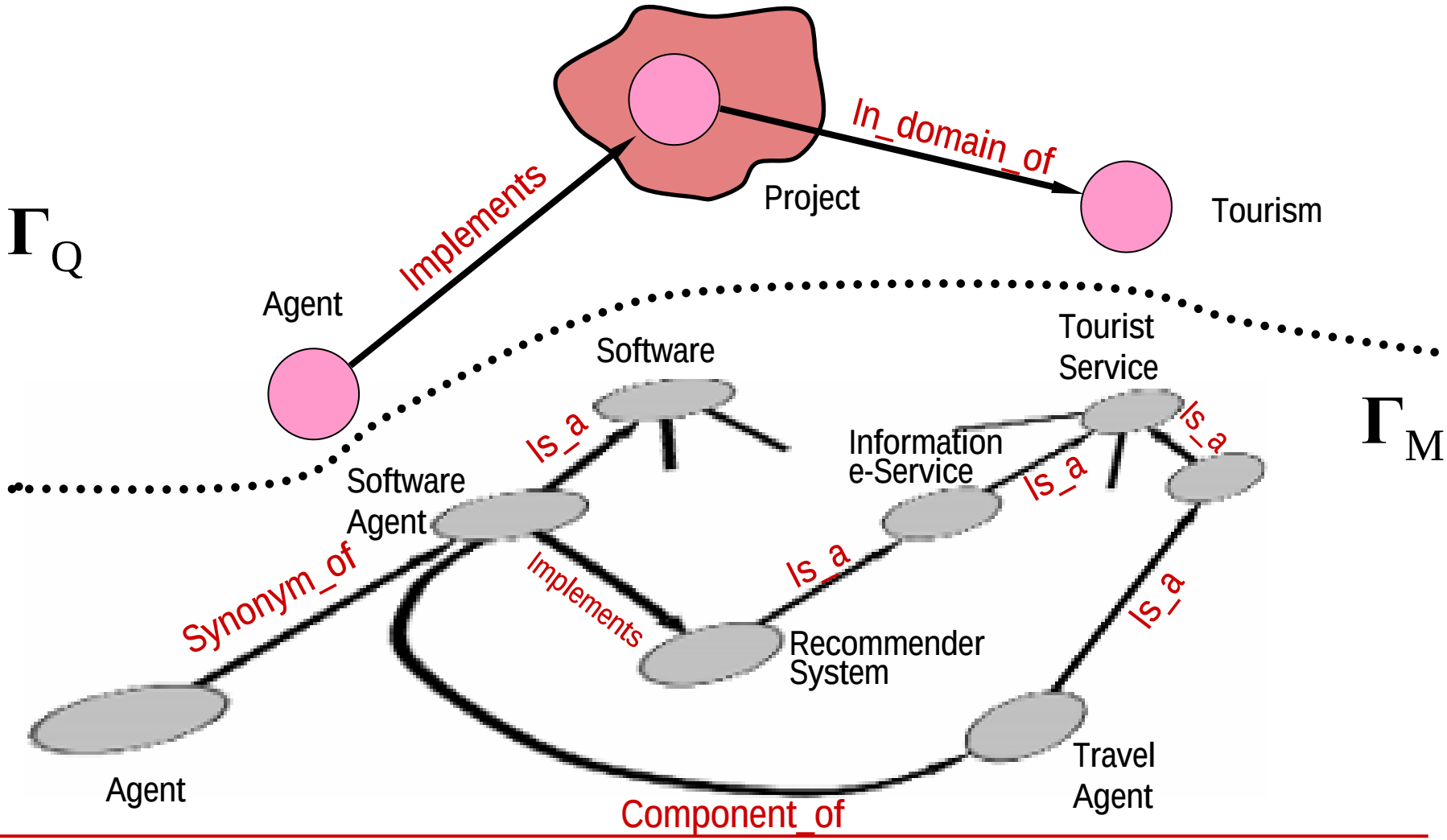
- **Q** -> the **Context** of a **Project**:
  - An Agent implements a Project
- **M** -> **Equivalence hypotheses**:
  - $Agent_Q \leftrightarrow Agent_M$
  - $Agent_Q \leftrightarrow$ Software $Agent_M$
- **M** -> **Propositional substitution**:
  - Software Agent implements a Recommender System
- Communicated to **Q** as the Argumentation (**Context**)
- By making Presuppositions



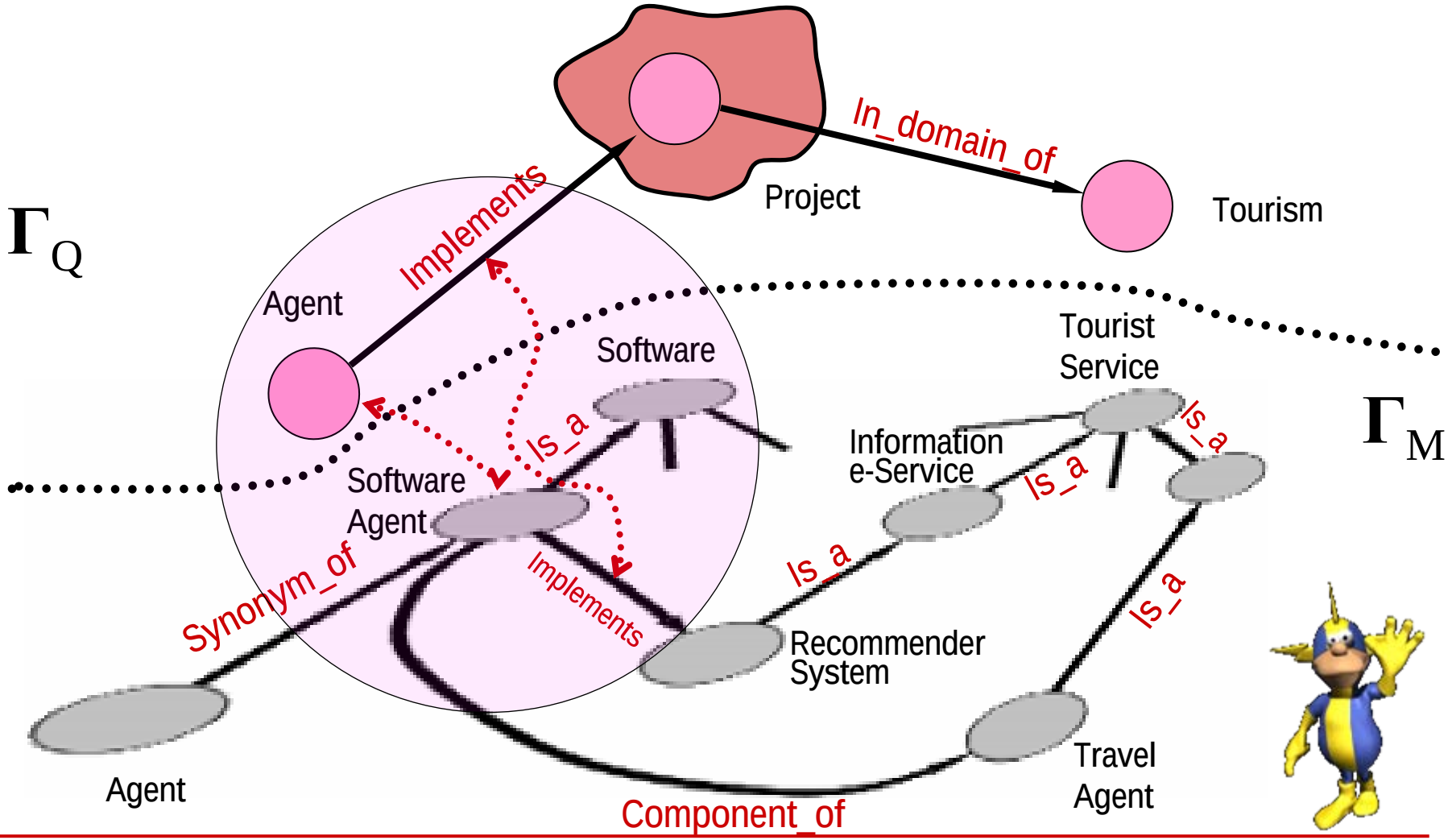
Presuppositions

- Based on the computed **Sim** values
- **M** - Presupposition: $\text{Project}_Q \leftrightarrow \text{Recommender System}_M$
- **M**: What if **Q** submitted
  - An Agent implements a Recommender System
- But NOT
  - An Agent implements a Project
- The Sim value of $\text{Agent}_Q \leftrightarrow \text{Software Agent}_M$ will GROW
- **Formally: Presupposition Set** $\mathbf{PR} = \bigcup_{i=1}^{n} PR_i$ is formed wrt the communicated context **C**

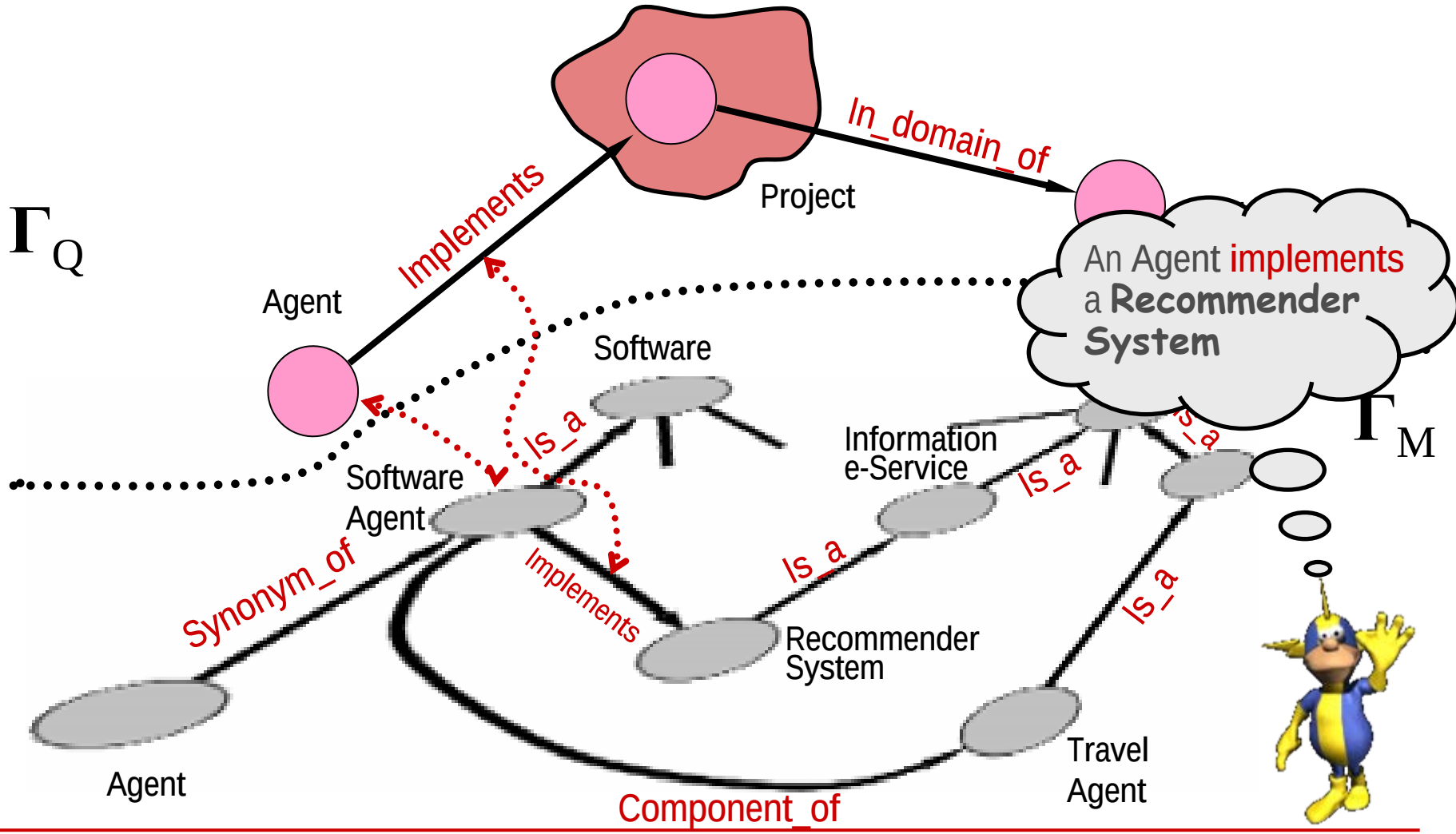
Presuppositions Make Contexts *Closer*



Presuppositions Make Contexts *Closer*



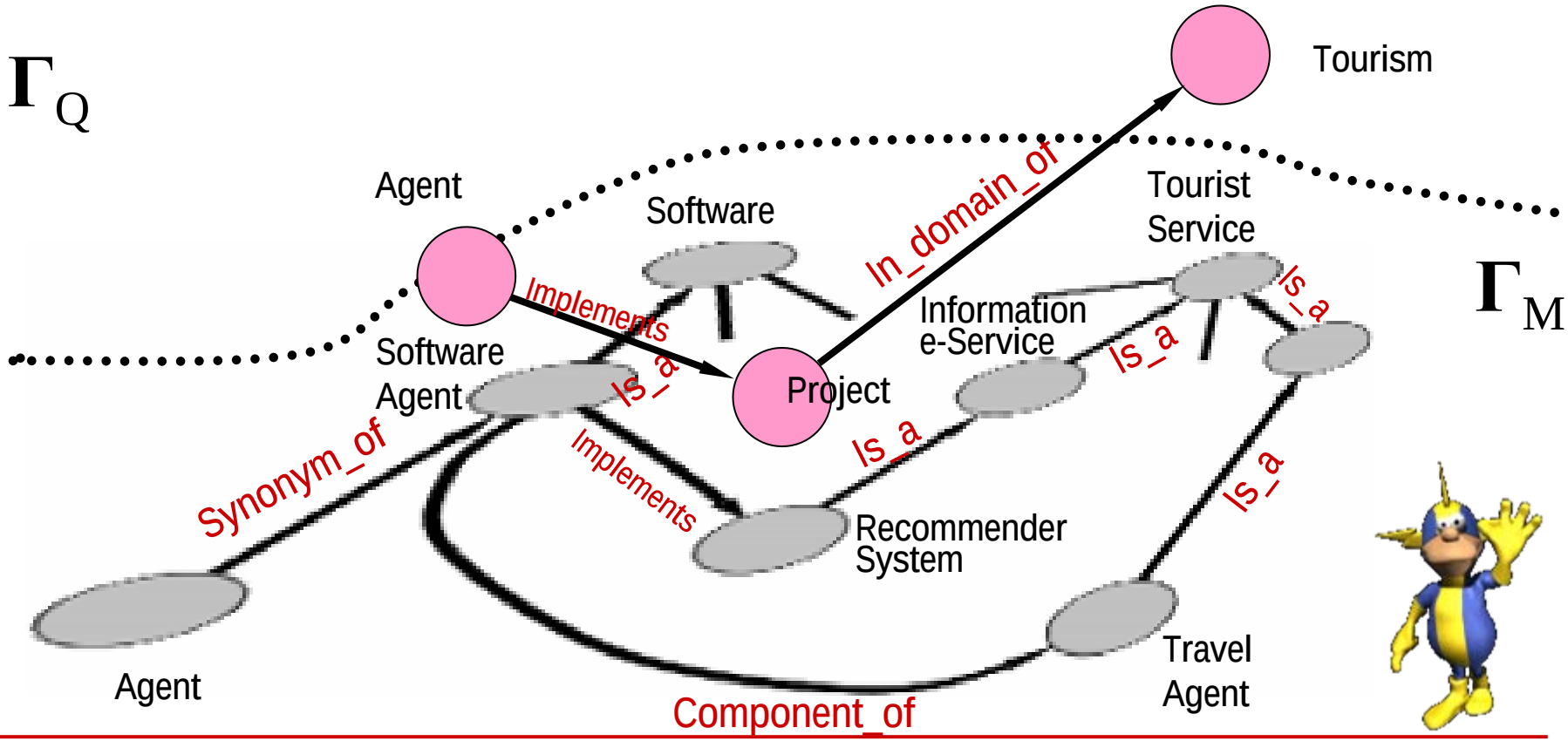
Presuppositions Make Contexts *Closer*



Presuppositions Make Contexts *Closer*

A Presupposition becomes the Propositional Substitution

h: Project_Q equals to $\text{Recommender System}_M$



The Use of Presuppositions

- (1) Set up the similarity threshold $minSim$ for accepting a hypothesis as the presupposition
- (2) For each H_i:
  - Choose the hypothesis h with the highest Sim_h value and add it to PR_i as pr iff its Sim_h value is over $minSim$
  - Revise the propositional substitutions for $\mathbf{H}$ wrt pr and re-assess Sim_h values
- (3) Repeat (2) until at least one pr is added to $\mathbf{H}$
- (4) For PR_i drop all pr except the one with the highest Sim_h value
- After $\mathbf{PR}$ is formed we may also drop all the hypotheses in each H_i except the one with the highest Sim_h value
- The difference in $\mathbf{SD}_b$ before and $\mathbf{SD}_a$ after the formation of $\mathbf{PR}$ shows the efficiency of the formed $\mathbf{PR}$:

$$E_{\mathbf{PR}} = (\mathbf{SD}_b - \mathbf{SD}_a)/\mathbf{SD}_b$$

When to Stop?

- A **deal may be stricken** if:
  - No **orphans** are left in Γ_Q wrt Γ_M (or Γ_M wrt Γ_Q)
  - Some **orphans** are still present, but **SD** is less than the commonly agreed threshold
- Further **negotiation is useless** (the parties have exhausted their argumentation and end up without the deal):
  - The (substantial) **orphans** are still present
  - There were no **concessions** in the two subsequent rounds
  - **Q** needs to reformulate the query it in the terms more coherent to Γ_M or to give up

More Semantic Commitments – Less Freedom to Concede

- The encounter is **non-symmetric**
- **M** normally has lots of **Semantic Commitments** to keep (agreements on similarities or even equivalence)
- **Q** may offer a good reason to drop some of them
  - If **M** **adopts** – than needs to re-negotiate with all the others (lots of risk that some peers abstain)
  - If **M** **abstains** – no concession – risk to end up with no deal (locally)
- So **M** will better **abstain**
- The **Readiness to Concede** should be **weighted by** the degree of the **Semantic Commitment** of the party:
  - **Q** should be ready to **concede more** (to receive the service)
  - **M**'s **reputation** makes it **more stubborn**

Conclusions and Future Work

- We are at an **early stage**
- The formal framework has been developed in **RACING***
- Partly adopted by **PSI*** Negotiation Framework
- Ontology debate framework (1 PhD student working)
- Research Prototype implementation anticipated
- Evaluation experiments
  - E.g., like the extended Google game …
  - As one of the reviewers wrote – a challenging task itself …
- Looking forward to receiving **advice**
- Ready for **cooperation**

* Please ask for back-up slides

"I find it critical to remember that every ontology is a treaty – a social agreement – among **people** ??? with some common motive in sharing."

- Tom Gruber (recently)

Propositional Substitution: **People** <- **Agents**

question marks and coloring are ours

Questions please ...

BACK-UP SLIDES

RACING (2002-2004)

- **Title: Rational Agent Coalitions for INtelliGent Mediation of Information Retrieval on the Net**
- **Objective:**
  - Investigate and evaluate the applicability of agent-based approach covering rationality, agency, coalition formation, collaboration to market oriented sectors of Distributed Information Retrieval
- **Focus:**
  - Mediation of infromation search and retrieval from structured or weakly structured information resources of:
    - Full-text online collections of Scientific Publications
    - Online Teaching Materials
- **Performed by:**
  - Dept of IT, Zaporozhye National University
- **Funded by:**
  - Ukrainian National Ministry of Education and Science
- **URL:**
  - http://www.zsu.zp.ua/racing/

Productivity Simulation Initiative

Project Lines and Partners