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## A Graph-Based Approach to Context Matching and some more title hello hello

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- Introduction
- Approach
- Context-Awareness
- Background
- Representation
- Patterns
- Matching
- Problems
- Conclusion
- Future Work

A Graph-Based Approach to  
Context Matching and some  
more title hello hello

---

overview



## ■ What is Aml?

Ambient Intelligence – or Aml – is an ubiquitous electronic environment that supports people in their daily tasks, in a proactive, but "invisible" and non-intrusive manner.[?, ?]

■ Approach

■ Context-Awareness

■ Background

■ Representation

■ Patterns

■ Matching

■ Problems

■ Conclusion

■ Future Work



## ■ What is Aml?

■ Approach

■ Context-Awareness

■ Background

■ Representation

■ Patterns

■ Matching

■ Problems

■ Conclusion

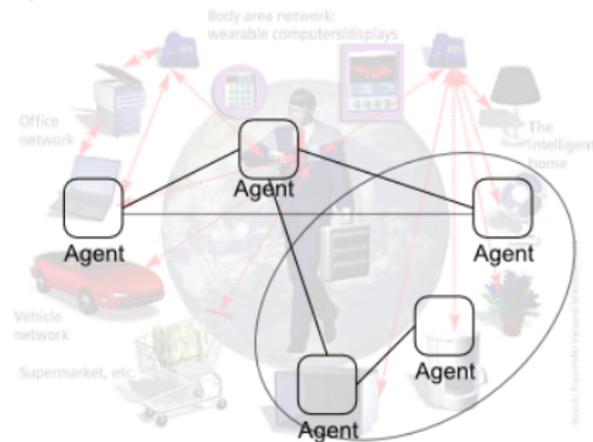
■ Future Work

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Approach

Context-Awareness

Background

Representation

Patterns

Matching

Problems

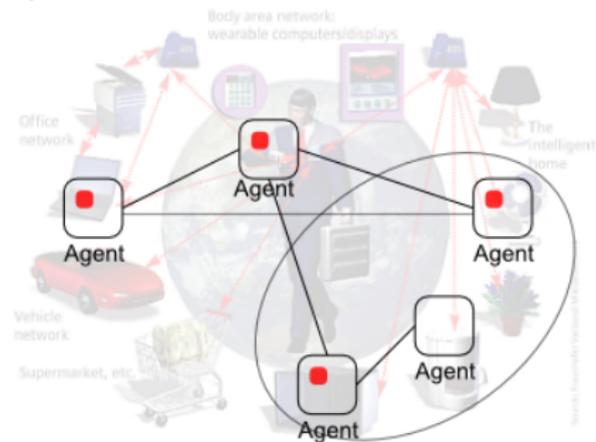
Conclusion

Future Work



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■ Approach

■ Context-Awareness

■ Background

■ Representation

■ Patterns

■ Matching

■ Problems

■ Conclusion

■ Future Work



## ■ What is Aml?

### ■ Approach

### ■ Context-Awareness

### ■ Background

### ■ Representation

### ■ Patterns

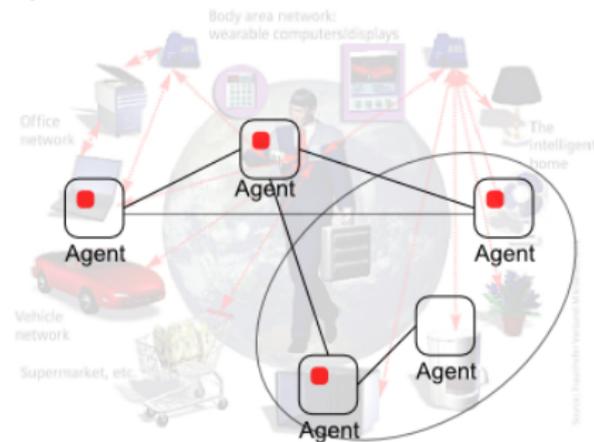
### ■ Matching

### ■ Problems

### ■ Conclusion

### ■ Future Work

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Constraints:

- limited storage
- limited performance
- large numbers
- much information



## ■ What is Aml?

■ Approach

■ Context-Awareness

■ Background

■ Representation

■ Patterns

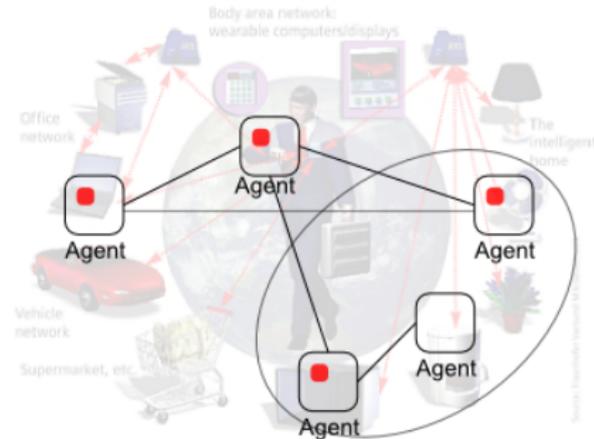
■ Matching

■ Problems

■ Conclusion

■ Future Work

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- much information
- **context-awareness**



## ■ Introduction

## ■ Approach

Elements of our approach:

## ■ Context-Awareness

- fully distributed system

## ■ Background

- use of software agents

## ■ Representation

- use local information and local communication

## ■ Patterns

## ■ Matching

## ■ Problems

## ■ Conclusion

## ■ Future Work



Any information that can be used to characterize the situation of entities (i.e. whether a person, place or object) that are considered relevant to the interaction between a user and an application, including the user and the application themselves. [?]

■ A Graph-Based Approach to  
■ Context Matching and some  
■ more title hello hello

■ Introduction

■ Approach

■ **Context-Awareness**

■ Background

■ Representation

■ Patterns

■ Matching

■ Problems

■ Conclusion

■ Future Work



■ Introduction

■ Approach

■ Context-Awareness

■ Background

■ Representation

■ Patterns

■ Matching

■ Problems

■ Conclusion

■ Future Work

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Context-awareness enables:

- **pro-activity** – anticipate problems, detect compatible or incompatible contexts.
- non-intrusiveness – communicate with other agents, considering privacy, in order to obtain more information on the context.



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A Graph-Based Approach to  
Context Matching and some  
more title hello hello

■ Introduction

■ Approach

■ **Context-Awareness**

■ Background

■ Representation

■ Patterns

■ Matching

■ Problems

■ Conclusion

■ Future Work



■ Introduction

■ Approach

■ Context-Awareness

■ Background

■ Representation

■ Patterns

■ Matching

■ Problems

■ Conclusion

■ Future Work

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**Our goal:** A simple, generic formalism that allows agents in a multi-agent system, that have only local knowledge, to share and process context-related information and to solve problems.



■ Introduction

■ Approach

■ **Context-Awareness**

■ Background

■ Representation

■ Patterns

■ Matching

■ Problems

■ Conclusion

■ Future Work

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- **context-matching** ·



## ■ Introduction

## ■ Approach

## ■ Context-Awareness

## ■ Background

## ■ Representation

## ■ Patterns

## ■ Matching

## ■ Problems

## ■ Conclusion

## ■ Future Work

- infrastructures for the processing of context information have been proposed [?, ?, ?, ?, ?, ?].

- context as associations [?, ?].

- semantic networks, concept maps [?] and conceptual graphs [?].

- graph matching (e.g. for image processing [?])

- we are not discussing ontology alignment [?].



■ Introduction

■ Approach

■ Context-Awareness

■ Background

■ Representation of Context

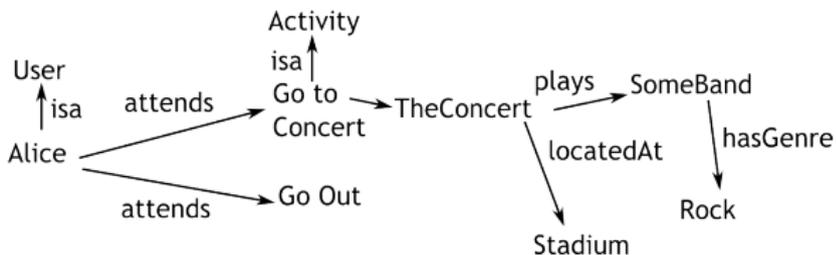
■ Patterns

■ Matching

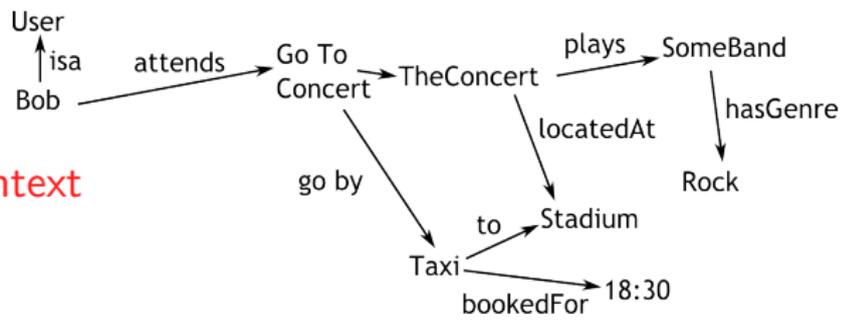
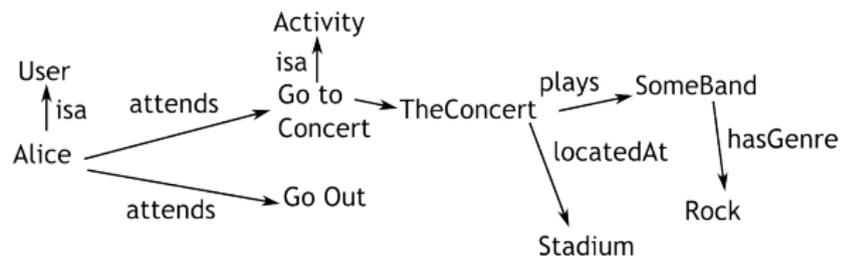
■ Problems

■ Conclusion

■ Future Work



- Introduction
- Approach
- Context-Awareness
- Background
- **Representation of Context**
- Patterns
- Matching
- Problems
- Conclusion
- Future Work



■ Introduction

■ Approach

■ Context-Awareness

■ Background

■ Representation of Context

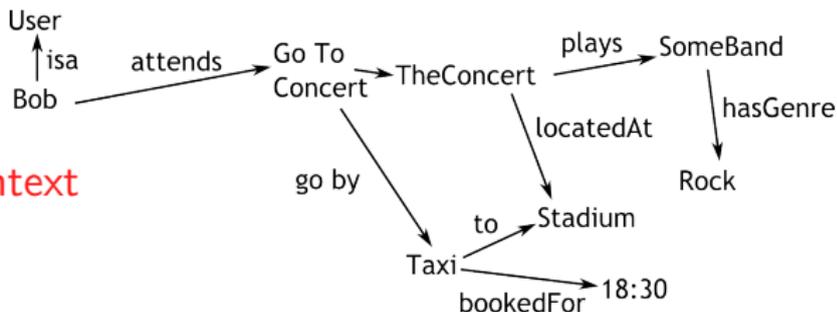
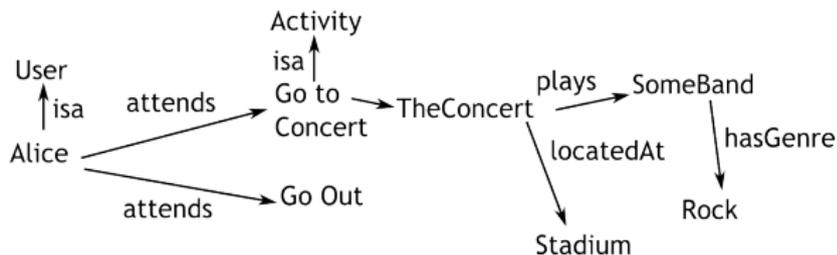
■ Patterns

■ Matching

■ Problems

■ Conclusion

■ Future Work



The agent of a user holds a context graph  $G$ :

$$G = (V, E)$$

$$V = \{v_i\}, E = \{e_k\}, e_k = (v_i, v_j, value)$$

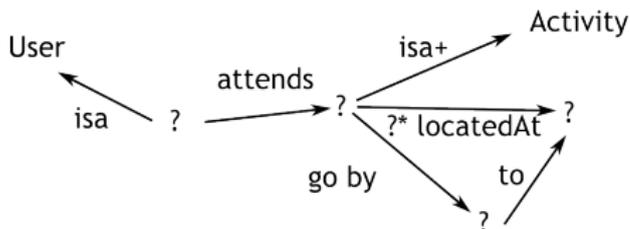
where  $v_i, v_j \in V, i, j = \overline{1, n}, k = \overline{1, m}$

values are strings or URI identifiers.



- Introduction
- Approach
- Context-Awareness
- Background
- Representation
- **Patterns**
- Matching
- Problems
- Conclusion
- Future Work

**Problem:** Alice should also think about some means of transportation to the concert.



· patterns are also graphs. The graph for pattern  $s$ :

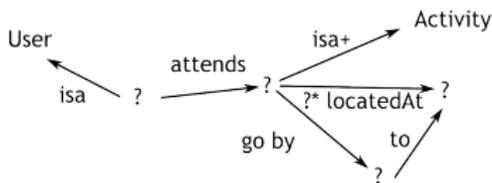
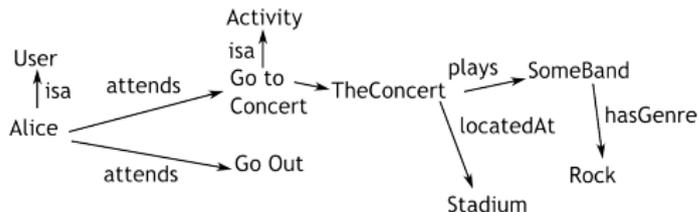
$$G_s^P = (V_s^P, E_s^P)$$

$$V_s^P = \{v_i\}, v_i = \text{string} \mid \text{URI} \mid ?, i = \overline{1, n}$$

$$E_s^P = \{e_k\}, e_k = (v_i, v_j, E\_RegExp), v_i, v_j \in V_s^P, k = \overline{1, m}$$

where  $E\_RegExp$  is a regular expression formed of strings or URIs.





The pattern *matches* subgraph  $G'$  of the context graph  $G$  if every non-? vertex from the pattern must match a different vertex from  $G'$ ; every non-regular-expression edge from the pattern must match an edge from  $G'$ ; and every regular expression edge from the pattern must match a series (possibly void, if the expression allows it) of edges from  $G'$ .

A pattern  $G_s^P$  *k-matches* a subgraph  $G'$  of  $G$ , if the condition for edges above is fulfilled for  $m - k$  edges in  $E_s^P$ ,  $k \in [1, m - 1]$ ,  $m = ||E_s^P||$  and  $G'$  remains connected.

## Introduction

## Approach

## Context-Awareness

## Background

## Representation

## Patterns

## Pattern Matching

## Problems

## Conclusion

## Future Work

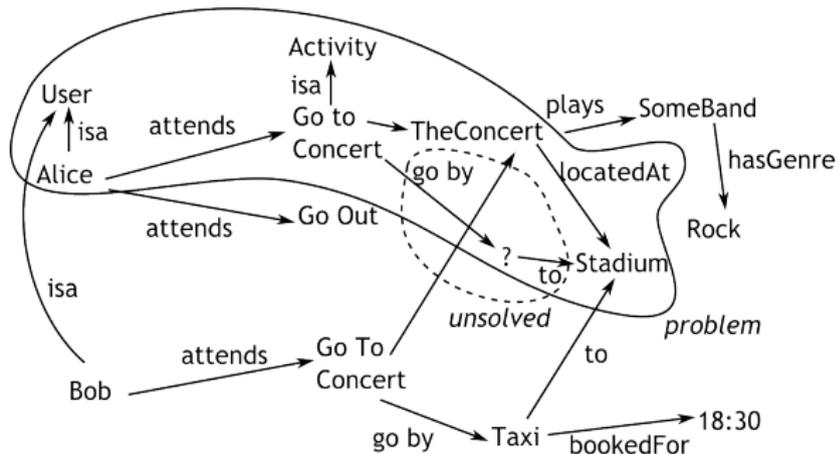


- Introduction
- Approach
- Context-Awareness
- Background
- Representation
- Patterns
- Matching
- Solving Problems
- Conclusion
- Future Work

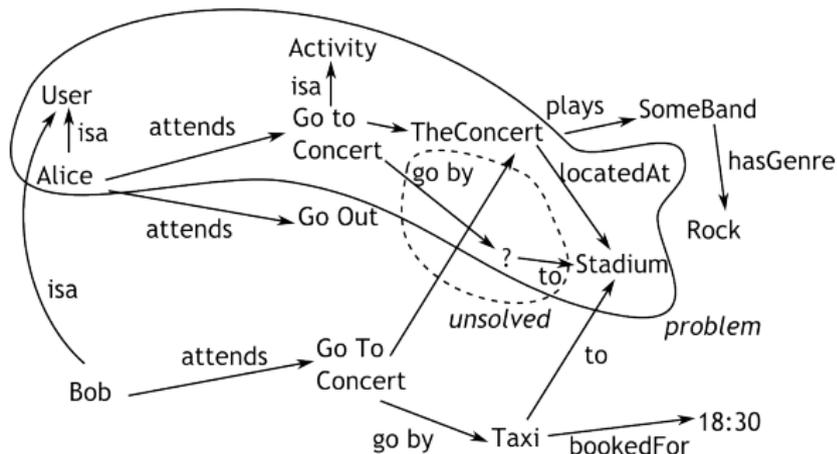
- agents can communicate and share information.
- information sharing is done by starting from shared context and try to extend the common context.



- Introduction
- Approach
- Context-Awareness
- Background
- Representation
- Patterns
- Matching
- Solving Problems
- Conclusion
- Future Work



- Introduction
- Approach
- Context-Awareness
- Background
- Representation
- Patterns
- Matching
- Solving Problems
- Conclusion
- Future Work



If a pattern  $G_s^P = (V_s^P, E_s^P)$   $k$ -matches the subgraph  $G' = (V', E')$  of  $G$ , we can define a problem  $p$  as a tuple  $(G_s^P, G_p^P)$ , where  $G_p^P$  is the problem's graph:

$$G_p^P = G' \cup G_x^P$$

$$G_x^P = (V_x^P, E_x^P)$$

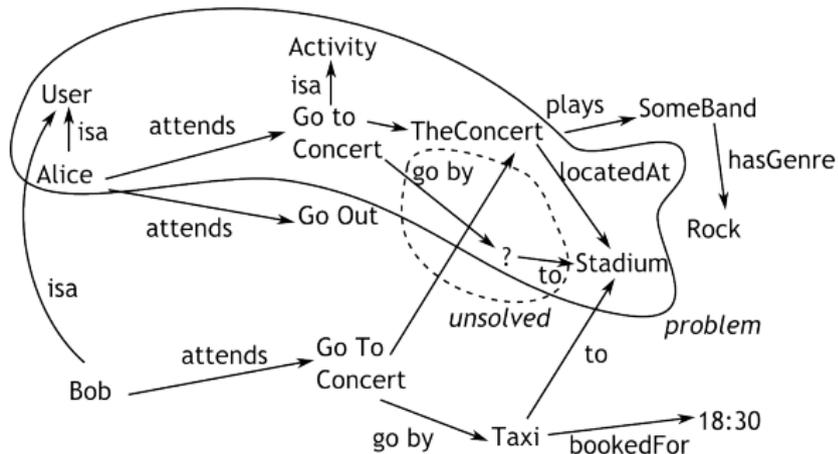
$$V_x^P = \{v \in V_s^P, v \notin \text{dom}(f)\}$$

$$E_x^P = \{e \in E_s^P \text{ for which condition (2) is not fulfilled}\}$$

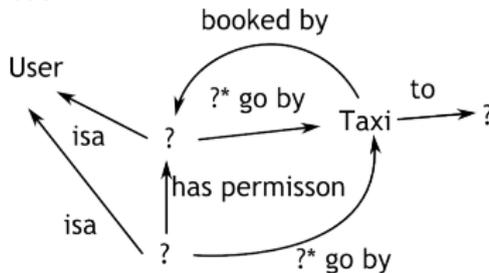
Note that  $G_x^P$  (the unsolved part of the problem) is a subgraph of  $G_s^P$ .



- Introduction
- Approach
- Context-Awareness
- Background
- Representation
- Patterns
- Matching
- Solving Problems
- Conclusion
- Future Work



One more pattern:



## Why?

- need to have decentralized, local, not pre-defined context-awareness.

- need a mechanism that is simple and generic.

What we presented:

- a generic representation for context, based on graphs.

- the notion of context matching for the detection of compatible contexts, and a possible generic mechanism for solving problems.

■ Introduction

■ Approach

■ Context-Awareness

■ Background

■ Representation

■ Patterns

■ Matching

■ Problems

■ Conclusion

■ Future Work



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■ Introduction

■ Approach

■ Context-Awareness

■ Background

■ Representation

■ Patterns

■ Matching

■ Problems

■ Conclusion

■ Future Work



- Introduction
- Approach
- Context-Awareness
- Background
- Representation
- Patterns
- Matching
- Problems
- Conclusion

## ■ Future Work

### Future work:

- ▶ devise an efficient algorithm for context matching.
- ▶ large context graphs, many matching (contradictory?) context patterns.
- ▶ work on the idea of incompatible contexts.
- ▶ uncertainty of information.
- ▶ temporality, history of context.





