A Graph-Based Approach to Context Matching

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- Approach
- Context-Awareness
- Representation
- Patterns
- Solving Problems

A Graph-Based Approach to Context Matching

overview

Elements of our approach:

· fully distributed system

· use of software agents

· use local information and local communication

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· non-intrusiveness – communicate with other agents, considering privacy, in order to obtain more information on the context.

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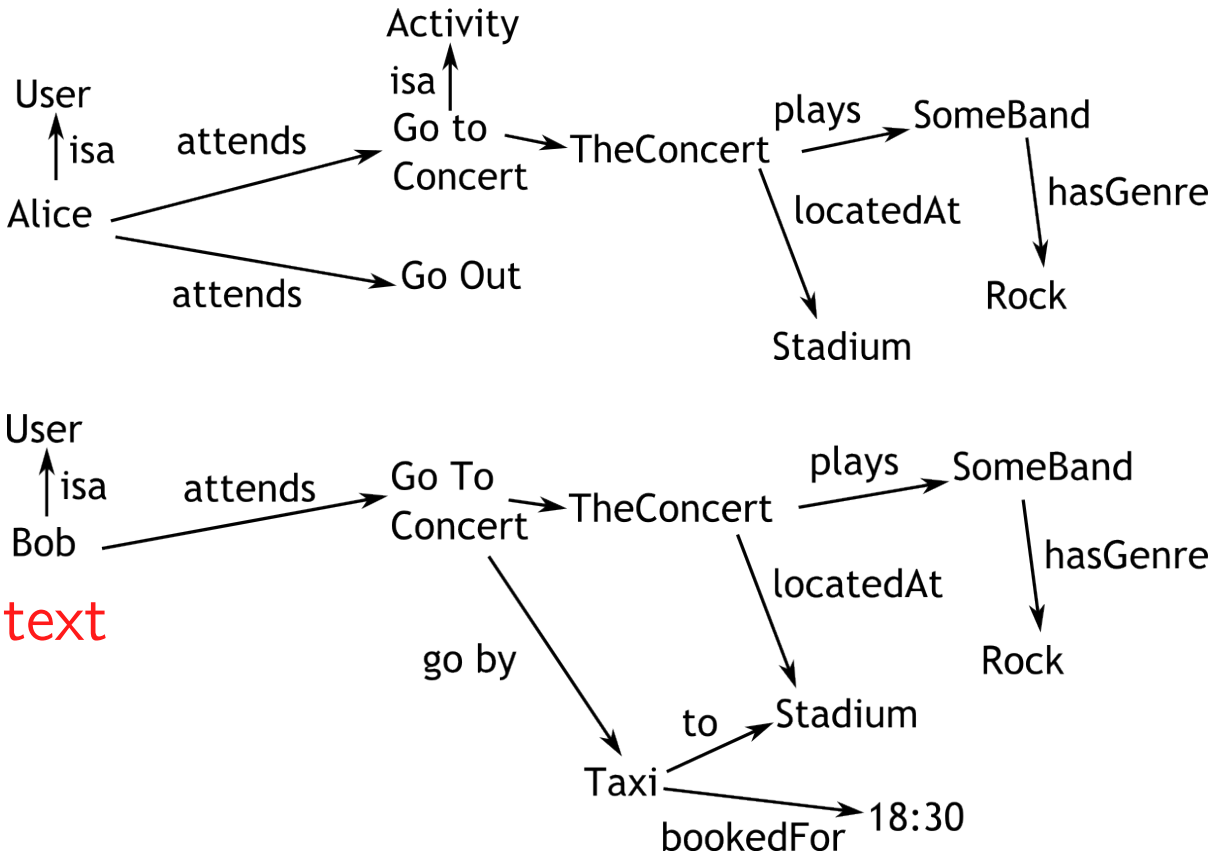
· context-matching ·



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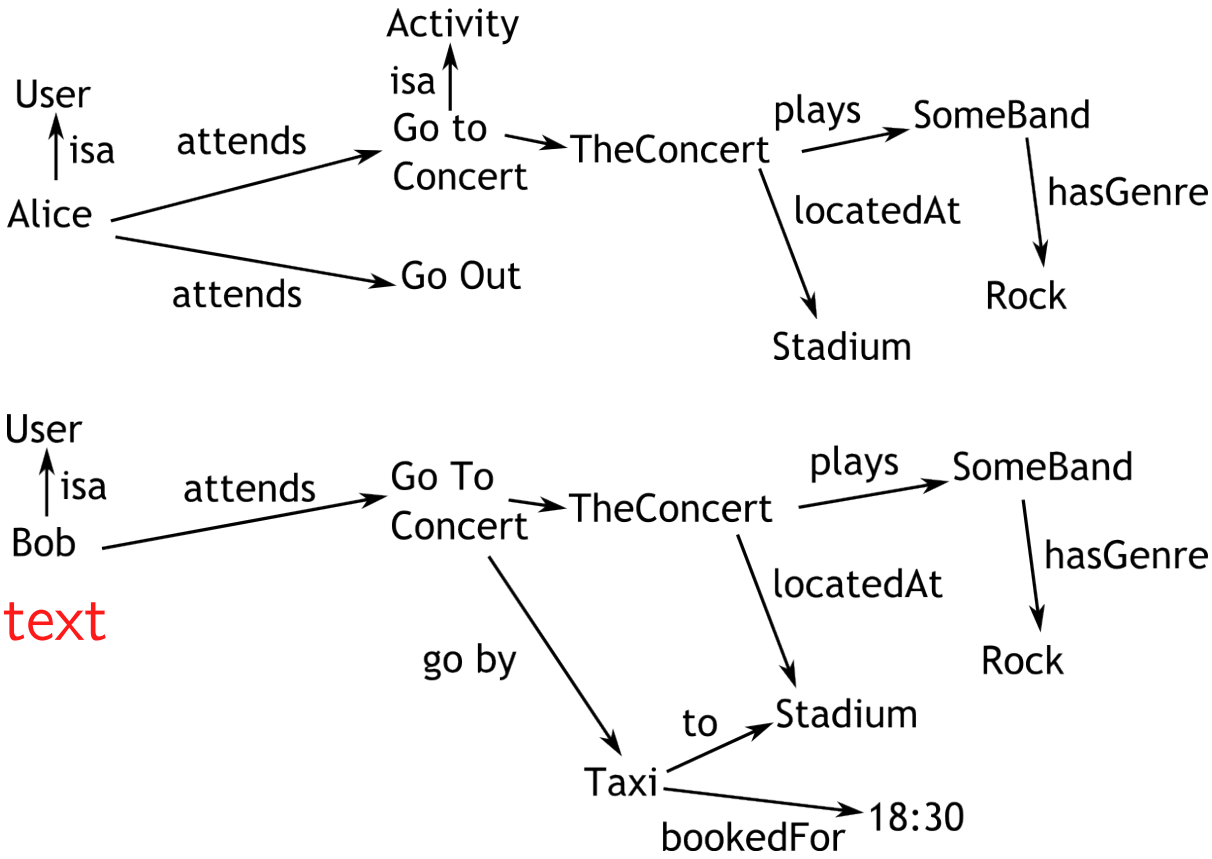

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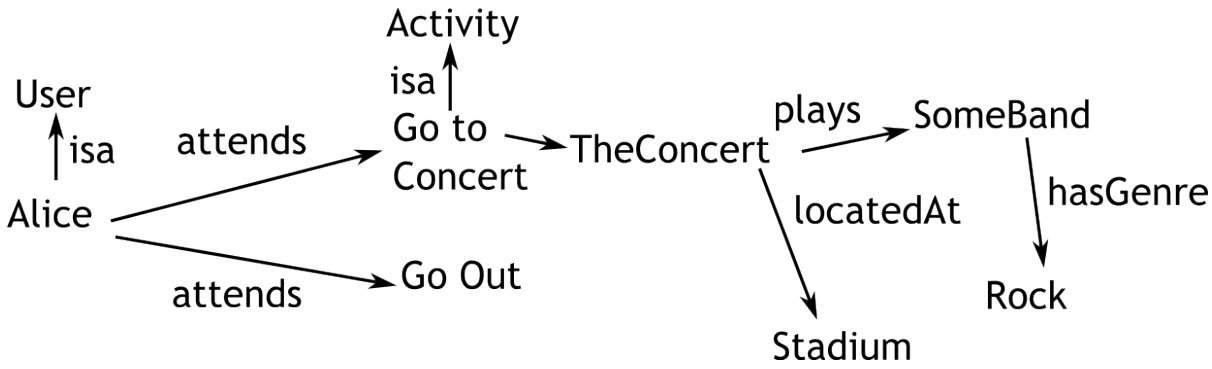
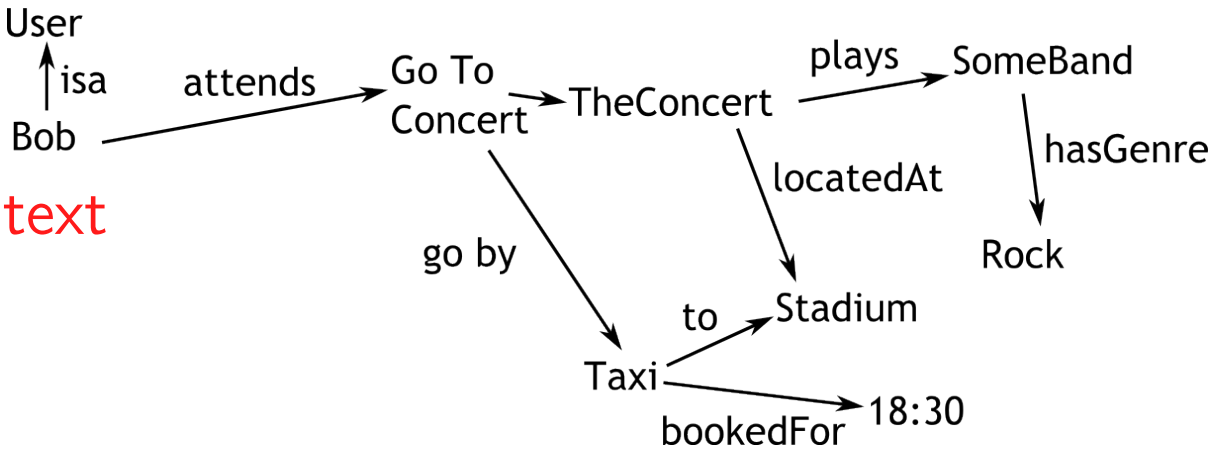




The agent of a user holds a context graph G:

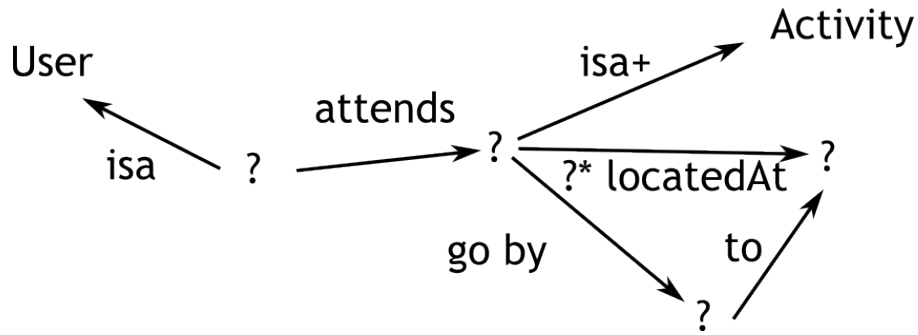
$G = (V, E)$

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

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

values are strings or URI identifiers.

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



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

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

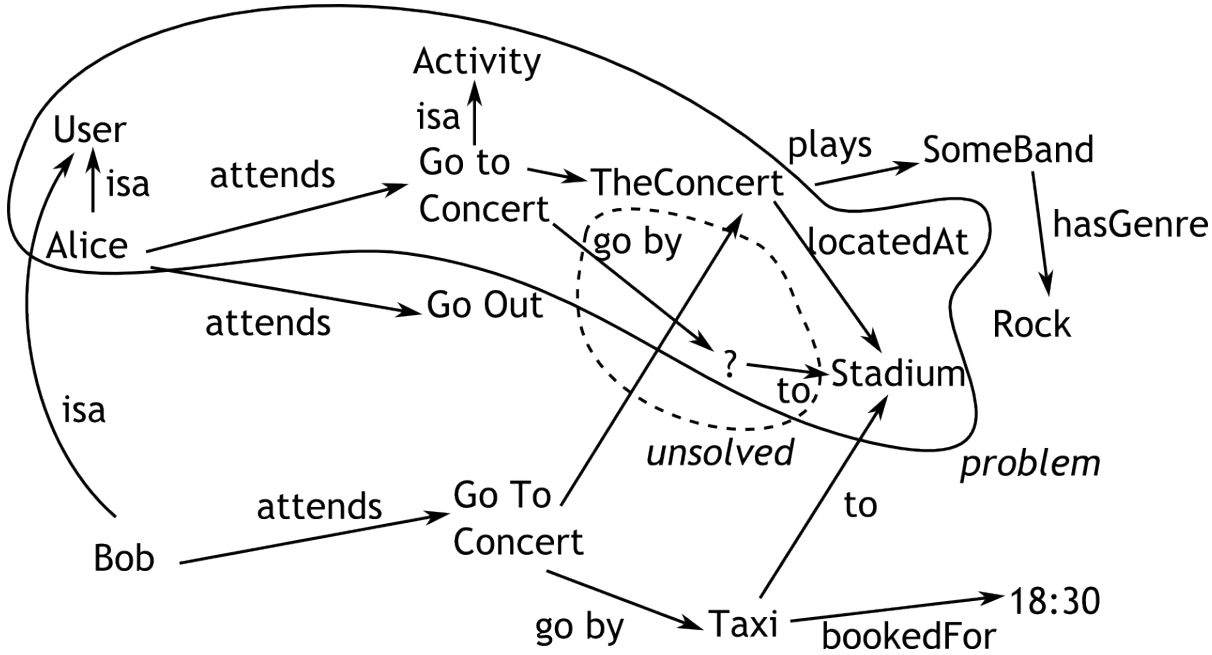
$$V_s^P = \{v_i\}, v_i = string \mid URI \mid ?, i = \overline{1, n}$$

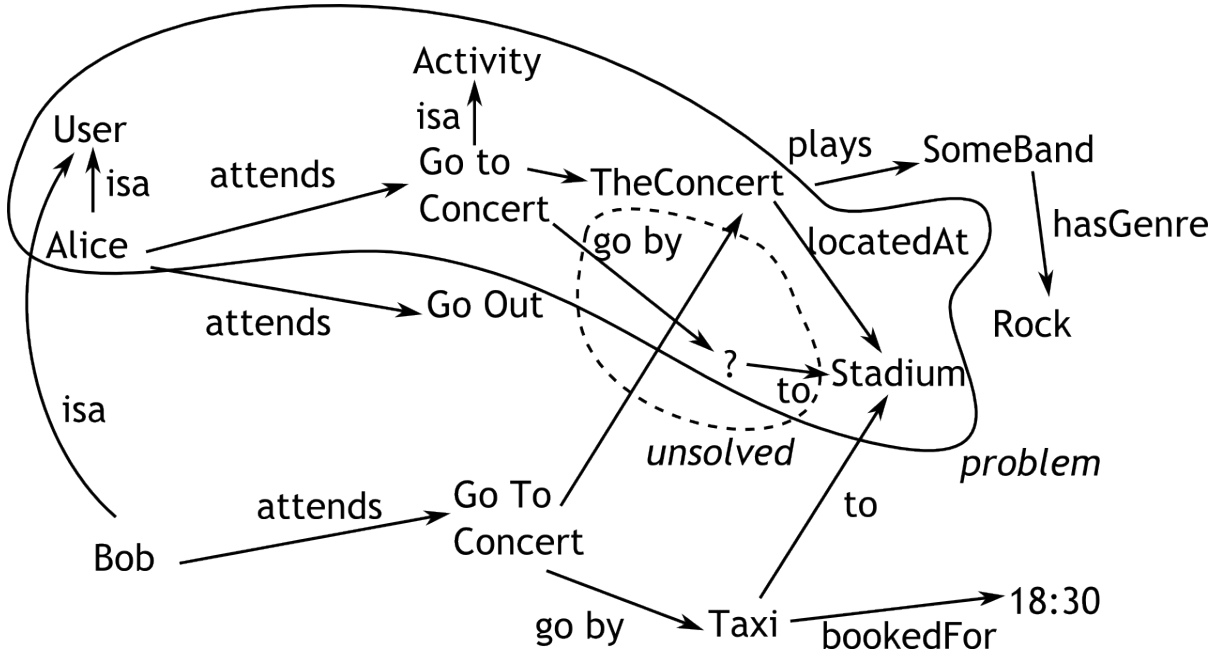
$$E_s^P = \{e_k\}, e_k = (v_i, v_j, E\_RegExp), v_i, v_j \in V_s^P, k = \overline{1, m}$$

where E_RegExp is a regular expression formed of strings or URIs.

· agents can communicate and share information.

· information sharing is done by starting from shared context and try to extend the common context.





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:

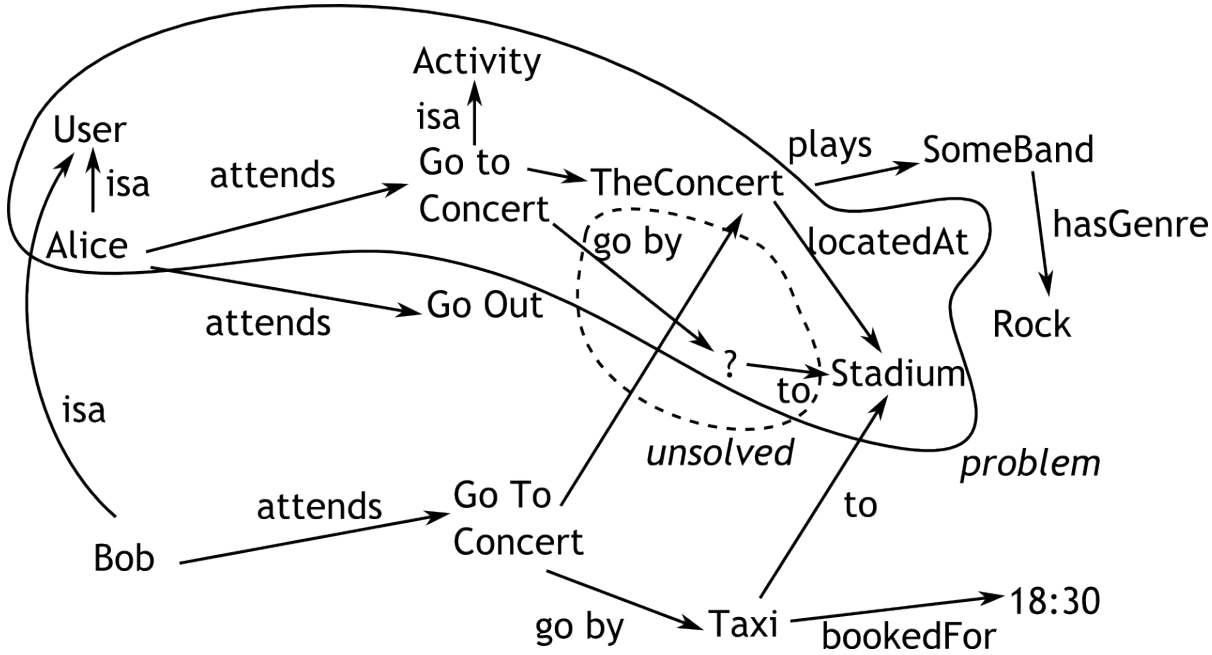
$G_p^P = G' \cup G_x^P$

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

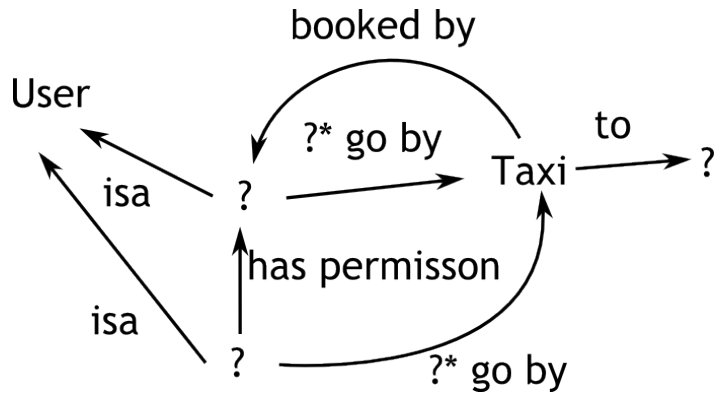
$V_x^P = \{v \in V_s^P, v \notin dom(f)\}$

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

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



One more pattern:



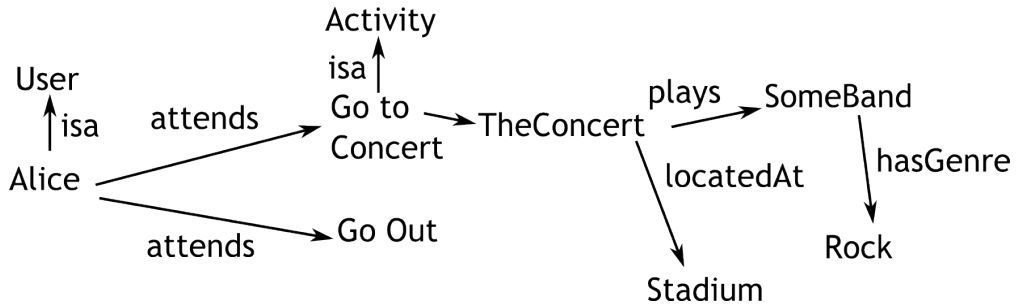
· infrastructures for the processing of context information have been proposed [Hong and Landay, 2001, Harter et al., 2002, Lech and Wienhofen, 2005, Henricksen and Indulska, 2006, Baldauf et al., 2007, Feng et al., 2004].

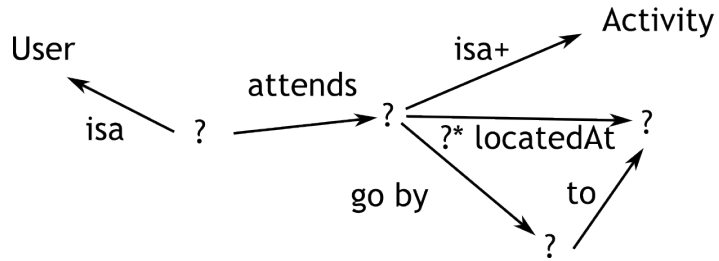
· context as associations [Henricksen and Indulska, 2006, Bettini et al., 2010].

· semantic networks, concept maps [Novak and Cañas, 2006] and conceptual graphs [Sowa, 2000].

· graph matching (e.g. for image processing [Bengoetxea et al., 2002])

· we are not discussing ontology alignement [Viterbo et al., 2008].





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.

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Baldauf, M., Dustdar, S., and Rosenberg, F. (2007).
A survey on context-aware systems.
International Journal of Ad Hoc and Ubiquitous Computing, 2(4):263–277.

Bengoetxea, E., Larrañaga, P., Bloch, I., Perchant, A., and Boeres, C. (2002).
Inexact graph matching by means of estimation of distribution algorithms.
Pattern Recognition, 35(12):2867–2880.

Bettini, C., Brdiczka, O., Henricksen, K., Indulska, J., Nicklas, D., Ranganathan, A., and Riboni, D. (2010).
A survey of context modelling and reasoning techniques.
Pervasive and Mobile Computing, 6(2):161–180.

Dey, A. (2001).
Understanding and using context.
Personal and ubiquitous computing, 5(1):4–7.

Feng, L., Apers, P. M. G., and Jonker, W. (2004).
Towards context-aware data management for ambient intelligence.
In Galindo, F., Takizawa, M., and Traunmüller, R., editors, *Proceedings of DEXA 2004, 15th International Conference on Database and Expert Systems Applications, Zaragoza, Spain, August 30 - September 3*, volume 3180 of *Lecture Notes in Computer Science*, pages 422–431. Springer.

Harter, A., Hopper, A., Steggles, P., Ward, A., and Webster, P. (2002).
The anatomy of a context-aware application.
Wireless Networks, 8(2):187–197.

Henricksen, K. and Indulska, J. (2006).
Developing context-aware pervasive computing applications: Models and approach.
Pervasive and Mobile Computing, 2(1):37–64.

Hong, J. and Landay, J. (2001).
An infrastructure approach to context-aware computing.
Human-Computer Interaction, 16(2):287–303.

Lech, T. C. and Wienhofen, L. W. M. (2005).

AmbieAgents: a scalable infrastructure for mobile and context-aware information services.
Proceedings of the 4th International Joint Conference on Autonomous Agents and Multiagent Systems (AAMAS 2005), July 25-29, 2005, Utrecht, The Netherlands, pages 625–631.

Novak, J. D. and Cañas, A. J. (2006).

The origins of the concept mapping tool and the continuing evolution of the tool.
Information Visualization, 5(3):175–184.

Sowa, J. (2000).

Knowledge representation: logical, philosophical, and computational foundations.
MIT Press.

Viterbo, J., Mazuel, L., Charif, Y., Endler, M., Sabouret, N., Breitman, K., El Fallah Seghrouchni, A., and Briot, J. (2008).

Ambient intelligence: Management of distributed and heterogeneous context knowledge.
CRC Studies in Informatics Series. Chapman & Hall, pages 1–44.

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Thank You!

Any Questions?