## 8 References

- AMINI, B., IBRAHIM, R. and OTHMAN, M.S.: Discovering the Impact of Knowledge in Recommender Systems: A Comparative Study. International Journal of Computer Science & Engineering Survey, vol.2, no.3, August 2011.
- [2] ATKINSON, S. and DUKE, R.: Behavioural retrieval from class libraries. Australian Computer Science Communications. pp. 13-20, January 1995.
- [3] AUML, http://www.auml.org/.
- [4] BAEZA-YATES, R. and RIBEIRO-NETO, B.: Modern Information Retrieval. Addison-Wesley, 1999.
- [5] BAÑARES-ALCÁNTARA, R., JIMÉNEZ, L. and ALDEA, A.: Multi-Agent System for Ontology-Based Information Retrieval. European Symposium on Computer Aided Process Engineering, Elsevier Science B.V, 2005.
- [6] BELLIFEMINE, F., CAIRE, G. and GREENWORD, D.: Developing Multi-Agent Systems with JADE. 7<sup>th</sup> International Workshop on Intelligent Agents VII. Agent Theories Architectures and Languages, July 2000, Springer-Verlag 2001.
- [7] BERGENTI, F.: A discussion of two majors benefits of using agent in soft development. 3<sup>rd</sup> International Conference on Engineering Societies in the Agents World III, pp. 1-12, Springer-Verlag 2003.
- [8] BERGENTI, F.: Formalizing the Reusability of Software Agents. vol. 3071, Springer, 2004.
- [9] BERGENTI, F. and HUHNS, M.N.: On the Use of Agents as Components of Software Systems. Available at

http://www.cse.sc.edu/~huhns/chapters/BergentiHuhnsAOSE.pdf.

- [10] BREITMAN, K. K., CASANOVA, M.A. and TRUSZKOWSKI. W.: Semantic Web. Concepts, Technologies and Applications, Springer, 2007.
- [11] CALISTI, M. and RIMASSA, G.: Opportunities to Support the Widespread Adoption of Software Agent Technologies. International Journal of Agent-Oriented Software Engineering archive, vol.3, no.4, pp. 411-415, May 2009.
- [12] CENK, E.R. and DIKENELLI, O.: Agent Oriented Software Reuse. 1<sup>st</sup> International Workshop on Agent-Oriented Software Engineering, Ireland, 2000.
- [13] CHOY, S., NG, S. and TSANG, Y.: Software Agents to Assist in Distance Learning Environments. 2005. Available at http://www.educause.edu/ero/article/software-agents-assist-distance-learningenvironments.
- [14] CLEMENTS, P. and NORTHROP, L.: Software Product Lines: Practices and Patterns. Addison-Wesley, Boston, 2002.
- [15] FAYAD, M. E., SCHMIDT, D. C. and JOHNSON, R. E.: Building Application Frameworks. Wiley, 1999.
- [16] FIPA, http://www.fipa.org/.

- [17] FONSECA, B., DE BARROS, E. and BITTENCOURT, I.: Um Modelo para Especificação de Agentes, Brazil, 2008.
- [18] FONSECA, P. S.: An internal Agent Architecture for Dynamic Composition of Reusable Agent Subsystems Part I: Problem Analysis and Decomposition Framework. HP Labs, United States of America, 2002. Available at http://www.hpl.hp.com/techreports/2002/HPL-2002-193.pdf.
- [19] FRANKLIN, S. and GRAESSER, A.: Is it an Agent, or Just a Program?: A Taxonomy for Autonomous Agents. Third International Workshop on Agent Theories, Architectures, and Languages, 1996, Springer-Verlag, 1997.
- [20] GUARINO, N.: Formal Ontology and Information Systems. 1<sup>st</sup> International Conference, June 1998, Italy.
- [21] HANSEN, D. L., KHOPLAR, H. and ZHANG, J.: Recommender Systems and Expert Locators. Understanding Information Retrieval Systems: Management, Types, and Standards, pp. 435-447, 2011.
- [22] HARA, H., FUJITA, S. and SUGAWARA, K.: Reusable Software Components based on an Agent Model. IEEE Parallel and Distributed Systems: Workshops, Seventh International Conference, pp. 447 – 452, Japan, July 7, 2000.
- [23] HARTMANN, J., PALMA R. and GÓMEZ-PÉREZ A.: Ontology Repositories, 2009. Available at http://oa.upm.es/6430/2/OntologyRepositories.pdf.
- [24] HUANG, R. and SHI, Z.: Multi-Agent Based Web Search with Heterogeneous Semantics. Agent Computing and Multi-Agent Systems, pp. 158 - 170. Springer-Verlag 2009.
- [25] Jadex, http://jadex-agents.informatik.unihamburg.de/xwiki/bin/view/About/Overview.
- [26] Jason, http://jason.sourceforge.net/wp/.
- [27] Jena, http://jena.apache.org/.
- [28] JENNINGS, N. R.: Agent-based Computing. Available at http://users.ecs.soton.ac.uk/nrj/download-files/ifip-02.pdf.
- [29] JENNINGS, N. R.: An Agent-based Approach for Building Complex Software Systems. Communications of the ACM, vol. 44, no. 4, April 2001.
- [30] JENNINGS, N. R.: On Agent-based Software Engineering. Artificial Intelligence, pp. 277-296, 2000.
- [31] JIAC Framework, http://www.jiac.de/agent\_frameworks/.
- [32] JSON, http://json.org/.
- [33] HESSLER, A., HIRSCH, B., KÜSTER, T. and ALBAYRAK, S.: Agent Store – A Pragmatic Approach to Agent Reuse. AOSE 2011 Workshop at AAMAS 2011, Taiwan.
- [34] GAUCH, S., CHAFFEE, J. and PRETSCHNER, A.: Ontology-Based Personalized Search and Browsing. UMUAI, Web Intelligence and Agent Systems, p. 219–234, 2004.
- [35] GIRARDI, M. R.: Reuse in Agent-based Application Development, 2002. Available at http://maae.deinf.ufma.br/Ensino/ES/CGCC/Reuse%20in%20Agentbased%20Application%20Development.pdf.
- [36] GIRARDI, M. R. and IBRAHIM, B.: A Similarity Measure for Retrieving Software Artifacts. 1994. Available at http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.50.9503.

- [37] GORODETSKY, V., KARSAEV, O., KUPIN, V. and SAMOILOV, V.: Agent-Based Air Traffic Control in Airport Airspace. IAT '07 Proceedings of the 2007 IEEE/WIC/ACM International Conference on Intelligent Agent Technology, pp. 81-84.
- [38] GREENWALD, A., JENNINGS, N. R. and STONE, P.: Agents and Markets. Intelligent Systems Journals & Magazines, vol.18, no.6, pp.12-14, December 2003.
- [39] GRISS, M. L.: Software Agents as Next Generation Software Components. Component-based Software Engineering, pp. 641- 657, Addison-Wesley, 2001.
- [40] GRISS, M. L.: Software Engineering with Java Agent Components. November 2003. Available at

http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.85.1125.

- [41] GRISS, M. L. and KESSLER, R.R.: Achieving the Promise of Reuse with Agent Components. First International Workshop on Software Engineering for Large-Scale Multi- Agent Systems, May 2002, Spring-Verlag 2003.
- [42] GRISS, M. L. and POUR, G.: Accelerating Development with Agent Components. Computer Journals & Magazines, vol.34, no.5, pp.37-43, May 2001.
- [43] KAUSHIK, S. and KOLLIPALLI, D.: Multi-Agent based Architecture for Querying Disjoint Data Repositories. International Conference on Machine and Web Intelligence (ICMWI), October 2010.
- [44] KELLAR, M., WATTERS, C. and SHEPHERD: M.: The impact of task on the usage of web browser navigation mechanisms. GI '06 Proceedings of Graphics Interface, pp. 235-242. 2006.
- [45] KRUEGER, C. W.: Software Reuse. Journal of ACM Computing Surveys, United States of America, June 1992.
- [46] KUMAR, C. A. and SRINIVAS, S.: On Adopting Software Agents for Distributed Digital Libraries. DESIDOC Bulletin of Information Technology, vol. 24, no.3, pp. 3-8, May 2004.
- [47] LINDOSO, A. N. and GIRARDI, R.: The SRAMO Technique for Analysis and Reuse of Requirements in Multi-agent Application Engineering. IX Workshop on Requirements Engineering, Cadernos do IME, UERJ Press, vol. 20, pp. 41-50, Brazil, 2006.
- [48] LUCENE, http://lucene.apache.org/.
- [49] MACREDIE, R.D. and KEEBLE, R.J.: Software Agents and Agency: A Personal Information Management Perspective. Personal Technologies, p.88-100, Springer-Verlag, 1997.
- [50] MANNING, C.D., RAGHAVAN, P. and SCHÜTZE, H.: An Introduction to Information Retrieval. Cambridge University Press, April 2009.
- [51] MATSUMOTO, Y.: A software factory: An overall approach to software production. IEEE Computer Society, pp.155-178, March 1987.
- [52] MCCANDLESS, M., HATCHER, E. and GOSPODNETIĆ, O.: Lucene In Action, Second Edition. Manning, 2010.
- [53] MELO, F., CHOREN, R., CERQUEIRA, R., LUCENA, C.J.P. and BLOIS, M.: An Agent Deployment Model Based on Components, PUC-RioInf.MCC 37/03, Brazil, 2003.
- [54] MIRANDA, S., MARIANO, H., KULESZA, U. and BATISTA, T.: Automating Software Product Line Development: A Repository-Based

Approach. 36<sup>th</sup> EUROMICRO Conference on Software Engineering and Advanced Applications, France, 2010.

- [55] NWANA, H.S.: Software Agents: An Overview. Knowledge Engineering Review, Vol. 11, No 3, pp. 205-244, October - November 1996.
- [56] NUNES, I., CIRILO, E. and LUCENA, C.J.P.: Developing a Family of Software Agent with Fine-grained Variability: an Exploratory Study. V Workshop on Software Engineering for Agent-oriented Systems, Brazil, 2009.
- [57] NUNES, I., COWAN, D., CIRILO, E. and LUCENA, C.J.P.: A Case for New Directions in Agent-Oriented Software Engineering. Agent-Oriented Software Engineering XI, p. 37-61, Springer, 2011.
- [58] OOWL, http://www.w3.org/TR/owl-features/.
- [59] PAGE, R. D. M.: Taxonomic Names, Metadata, And The Semantic, https://journals.ku.edu/index.php/jbi/article/viewFile/25/12.
- [60] Play! Framework, http://www.playframework.org/.
- [61] PODGURSKI A. and PIERCE, L.: Behaviour sampling: A technique for automated retrieval of reusable components. 14<sup>th</sup> International Conference on Software Engineering, pp 349-360, 1992.
- [62] POHL, K., BÖCKLE, G. and VAN DER Linden, F. J: Software Product Line Engineering: Foundations, Principles and Techniques. Springer-Verlag, 2005.
- [63] PRIETO-DIAZ, R. and FREEMAN, P.: Classifying Software for Reusability. IEEE Software, vol. 4, no. 1, pp. 6-16, January, 1987.
- [64] Protégé, http://protege.stanford.edu/.
- [65] RAO, A. S. and GEORGEFF, M.P.: BDI Agents: From Theory to Practice. First International Conference on Multi-Agent Systems, June 1995.
- [66] RAO, V. S.: Multi Agent-Based Distributed Data Mining: An Overview. International Journal of Reviews in Computing, 2009.
- [67] RDF, http://www.w3.org/RDF/.
- [68] ROSHCHIN, M., GRAUBMANN, P. and KAMAEV, V.: Semantic Modeling For Product Line Engineering. International Journal Information Theories and Applications, 2008.
- [69] SAMETINGER, J.: Software Engineering with Reusable Components. Springer-Verlag, March 1997.
- [70] Scala, http://www.scala-lang.org/.
- [71] SILVA, V.T. and LUCENA, C.J.P.: Modeling multi-agent systems. Magazine Communications of the ACM- ACM at sixty: a look back in time, United States, May 2007.
- [72] SILVERMAN, B. G., BEDEWI, N. and MORALES, A.: Intelligent Agents in Software Reuse Repositories. Available at http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.23.621.
- [73] SIMES, M. S., MOURA E SILVA, L., SIMÕES, P. and GABRIEL E SILVA, J.: Using Mobile Agents for the Management of Telecommunication Networks. Available at

http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.39.5648.

- [74] SPACEK, P., DONY, C., TIBERMACINE, C. and FABRESSE, L: An Inheritance System for Structural & Behavioral Reuse in Component-based Software Programming. 11<sup>th</sup> International Conference on Generative Programming and Component Engineering, 2012.
- [75] SPARQL, http://sparql.org/.

- [76] SUGUMARAN, V. and STOREY, V.: A semantic-Based Approach to Component Retrieval. The Data Base for advances in Information Systems, vol. 34, no. 3, 2003.
- [77] UCHYIGIT, G.: Semantically Enhanced Web Personalization. Web Mining Appl. in E-Commerce & E-Services, SCI 172, pp. 25-43, Springer-Verlag, 2009.
- [78] VANDERLEI, T. A., DURÃO, F. A., MARTINS, A. C., GARCIA, V.C., ALMEIDA, E. S. and MEIRA, S.R. de L.: A Cooperative Classification Mechanism for Search and Retrieval Software Components. SAC '07 ACM symposium on Applied computing, pp. 886-871, 2007.
- [79] WOOLDRIDGE, M.: Agent-oriented Software Engineering: The State of the Art. Agent-Oriented Software Engineering, Lecture Notes in AI Volume 1957, Springer-Verlag, 2000.
- [80] WOOLDRIDGE, M.: An Introduction to Multi Agent Systems. Wiley. 2002.
- [81] WOOLDRIDGE, M. and JENNINGS, N. R.: Intelligent Agents: Theory and Practice. Knowledge Engineering Review, Vol. 10, No 2, 1995, pp. 115-152.
- [82] WordNet, http://wordnet.princeton.edu/.
- [83] XML Schema, http://www.w3.org/XML/Schema.
- [84] YEN, I-L., KHAN, L. and LINN, J.: An On-line Repository for Embedded Software.13<sup>th</sup> IEEE International Conference on Tools with Artificial Intelligence (ICTAI), pp. 314, 2001.
- [85] ZAREMSKI, A. M. and WING J. M.: Signature matching: A key to reuse. 1<sup>st</sup> ACM SIGSOFT symposium on Foundations of software engineering, pp. 182 – 190, 1993. ACM SIGSOFT Software Engineering Notes, vol.18, no.5, pp. 182 – 190, December 1993.
- [86] ZHANG, Z., SVENSSON, L., SNIS, U., SRENSEN, C., FGERLIND, H., LINDROTH, T., MAGNUSSON M. and STLUND, C. Enhancing Component Reuse Using Search Techniques. IRIS 23, Laboratorium for Interaction Technology, University of Trollhttan Uddevalla, 2000.

## A Ontology

This appendix completes the formal specification of an agent component. The definition of each class of the attributes of an agent component is included in the ontology that models agents, how is depicted in Figure 23 and Figure 23. We represent only the mandatory feature, as a constant to represent a *Variability\_Type*, to help with the visualization of the figure, but the other features (or, alternative and options) are represented analogously to the mandatory one.



Figure 22. Definition of Classes (i).



Figure 23: Definition of Classes (ii).

Figure 24 shows some individuals we make reference for representing the attributes of the *Book Buyer Agent*, like behaviors, programming language, tags and platform.



Figure 24: Individuals of the Attributes of an Agent.

## B Questionnaire

Aiming to achieve one of the steps of this thesis, we conducted a survey that related software agents treated as software components. The main idea was to populate the repository of agents as software components and to initialize the taxonomies and individuals of the ontology, according to the survey' results. The questionnaire that is part of the survey consisting of:

1. Briefly describe the agent.

Example: The agent searches every two days among several airline companies for the cheapest flight from a particular city to other preselected destinations made by the user. It then sends an email or text message to the user with the suggested flight.

2. Name of the agent. Ex: FlightPromotionAgent

3. From what software context is the agent? Ex. Buy and Sell Tickets, Aeronautics, Travel

4. What is the role of the agent in the system?

Ex: Search for cheap flights B. Send a message or email to the user

5. What programming language was used to implement the agent? Ex: Java

6- What platform was the multi-agent developed with? Ex: Jason

7- Which are the behaviors of the agent? Ex: Autonomy, Mobile

8- What tags are associated with the agent?

Ex: Flight searcher, flight promotion searcher

9- What version is the agent? Ex: 2.9

10- When was the agent created? Ex: August 3, 2011

11- What are the attributes of the agent's interface?
Ex:
Receiver Message Interface
Type of message = "Inform"
Context of the message = "negotiation"
Content of the message = "new price of the flight it is looking for"
Agent participant = SellerFlightAgent

12- Upload each agent in one of the following formats: .jar, .war, .rar, .zip and send the file to the researcher's email.

If you are able to contribute more than one agent you have developed, please fill out a form for each agent sent with the corresponding documentation.