Applying Multi-Level Typing to Model Knowledge-Intensive Processes

Previsão de defesa em Abril/2019

Tatiana Barboza[1], Fernanda Araújo Baião[2], Flávia Maria Santoro[1]

[1]Department of Applied Informatics, Federal University of the State of Rio de Janeiro (UNIRIO), Janeiro, Brazil
Av. Pasteur 458, Urca, PA 22290-240, Rio de Janeiro, RJ, Brasil.

{tatiana.barboza, fernanda.baiao, flavia.santoro}@uniriotec.br

Abstract. *Modeling Knowledge-Intensive Processes (KIP) is very important for understanding critical scenarios in current organizations. KIPO (Knowledge-Intensive Process Ontology) is an ontology well-founded, semantically rich conceptualization of KIP. However, it is difficult to distinguish instances and models in KIP. Our goal is to propose an application with the notion of multi-level conceptual modeling for representing elements with multiple classification level.*

1. Introduction

The importance of knowledge as resource in organizations is always in growing. It is a big challenge to model Knowledge-Intensive Process (KIP), because it involves decision making, innovative solutions and collaborative work. This kind of process accesses a great amount of relevant unstructured data such as exchange among participants, business rule, belief, intentions and others. In fact, KIP shares many common characteristics with Case Management approaches, in which each process instance can be performed in a completely ad-hoc manner [Maldonado 2008].

[Franca et al. 2014] proposed a well-founded, semantically rich conceptualization of KIP in the form of an ontology called KIPO (Knowledge Intensive Process Ontology). KIPO comprises concepts from perspectives that are crucial for a complete understanding and representation of a KIP, namely Business Process, Business Rules, Decision-Making Rationale and Collaboration perspectives. This ontology is well-founded on UFO (Unified Foundational Ontology) [Guizzardi 2005], a foundational ontology based on philosophic and cognitive theories.

However, [Franca et al. 2014] observed the difficulty of distinguishing instances and models in KIP. There are many problems in modeling Knowledge-Intensive Process, mainly because it is very common to misunderstand instances and models when thinking about the characterization of each element as part of a KIP definition.

When this situation is solved, the alignment of the Knowledge Management strategy to the Business Process Management strategy of an organization will facilitate the identification of faults, the correction of errors and adaptation to changes. The more information the managers of organizations obtain, the better decisions will be made.

For address this problem, we propose to apply the notion of multi-level conceptual modeling [Carvalho et al. 2017] for representing elements with multiple classification levels, such as MLT (Multi-Level Theory), which is a theory of multi-level modeling for capturing and analysing a number of nuances related to modeling [Carvalho and Almeida 2016]. Moreover, we will also use the powertype pattern for representing KIP characterizations.

2. Related Work

There are many kinds of multi-level modeling which the main goal is to identify concrete and abstract elements . One of those elements is the Materialization [Goldstein and Storey 1994], which means the relationship between two entity types, one that represents a conceptual object, for example, a TV Model, and the other that represents its corresponding concrete object, in this case, actual Tv Sets. This strategy helped us to determine which elements are concrete existents in KIPO. Another multi-level modeling approach is Powertype [Odell 1994], which defines its concept informally using regular associations between the powertype and a base type. Based on this concept, it is possible to build constructs to denote cross-level relations between types defined in MLT. This concept is used in our research for supporting i such characterizations in models.

There are other kinds of multi-level modeling with the focus on reducing accidental complexity in models, for instance: Deep Instantiation [Atkinson and Künner 2008] , Dual Deep Instantiation [Neumayr and Schrefl 2014], Melanee [Atkinson 2012], among others. All of them are also very useful to address the shortcomings of the UML-based model. However, they are not proper for the instantiation of Knowledge-Intensive Process. These techniques are not usually applied in unstructured processes.

[Carvalho et al. 2017] presented a theory for multi-level modeling called MLT, which distinguished between types (that have other types as instances) and individuals (cannot be instantiated anymore). The notion of type order is used in MLT. Carvalho also combined UFO (Unified Foundational Ontology) [Guizzardi 2005] with MLT (Multi-Level Theory) [Carvalho et al. 2017] for establishing a hierarchy of conceptual models, where the concepts of UFO instantiate and specialize elements of MLT, thereby respecting MLT's axiom and leveraging the use of structural relations and MLT pattern in UFO. Many rules applied in this combination were also adapted to be used in our research, because KIPO is well-founded in UFO.

3. Metodology

To achieve the goal of this research, it is necessary the following phases:

1. **Review literature:** Study instantiations strategies, popular graphical notations and modeling tools which can be applied in Knowledge Intensive Processes;
2. **Combine MLT theory with KIPO:** In this phase, all elements KIPO will be reviewed under MLT Theory. Based on the combination created in [Carvalho and Almeida 2016], the concepts of KIPO will instantiate and specialize elements of MLT. These concepts in KIPO's taxonomy of individuals will be instances of "1stOT" specializing "Individual". The concepts in the taxonomy of "type" are instances of "2ndOT" specializing "1stOT". We will use UML to provide a graphical representation, because it is a well-known pattern by modelers. To exemplify this combination, Figure 1 shows one of the main KIPO elements (*KIPCO::Agent* with their specializations *KIPCO::Innovation Agent* and *KIPCO::Impact Agent)* combined with MLT (Theory Multi-Level), using Powertype concepts [Odell]. Each element has a meaning, for instance: *KIPCO::Agent* is a participant of process which has his/her actions motivated by his/her intentions, *KIPCO::Innovation Agent* is responsible for incorporating innovations in an knowledge-intensive activity and *KIPCO::Impact Agent* is responsible for executing a KIP and identifying questions during execution of KIP. KIPCO::Agent Type *is instance of* "2ndOT" (second order), *specializes* "1stOT" (first order) and *characterizes* KIPCO::Agent, which *is instance of* "1stOT" and *specializes* "Individual". According [Odell] the specializations of KIPCO::Agent (KIPCO::Innovation Agent and KIPCO::Impact Agent) *are instances* of KIPCO::Agent Type.

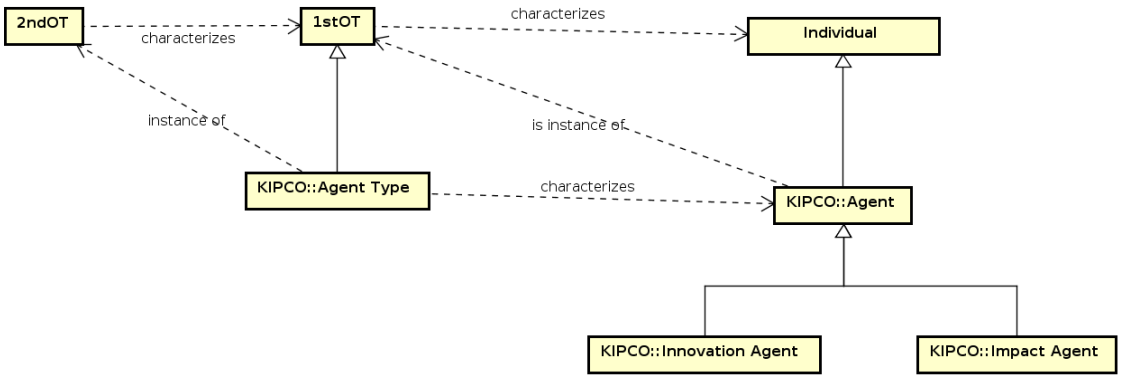

Figure 1. Applying MLT to KIPO taxonomies of KIPCO::Agent element.

The Figure 2 exemplifies the application of MLT with KIPO (cited above) using a scenario of the participants of a dissertation assessment. We used stereotype [Sellers and Perez 2005] for identifying each element in diagram that is referencing the application MLT to KIPO.

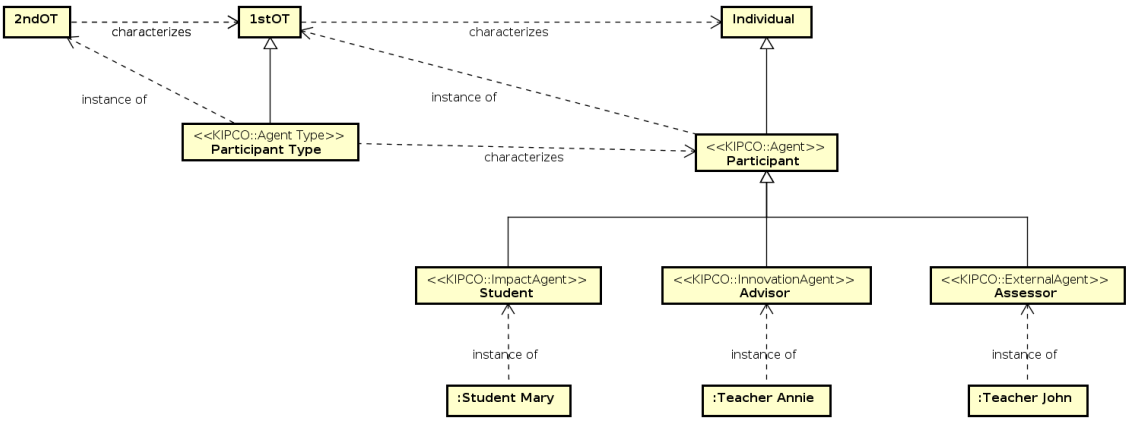

Figure 2. Illustrating the use of MLT combining KIPO, using powertype.

3. **Adapt modeling tool with combination:** It is necessary to automate the process of instantiation. In this phase it will be implemented the combination in a modeling tool, which will have to read a knowledge base (owl, xml, etc.) and will represent, through of UML diagrams, instances and models found in these bases.
4. **Execute Case Study and Experiment:** Apply the tool (already adapted) in knowledge base with different contexts (tickets of call center, governamental wiki and others) . The diagrams will be evaluated by specialists in data modeling experts in multi-level theory, besides users of the knowledge bases.

4. Expected Outcomes and Results

The main outcome is KIPO reviewed, according to the MLT theory. Another contribution is the deepening of the discussion about instances and models in the domain of KIP.

The expected results with the new version of KIPO is the possibility of distinguishing instances and models. A practical example is, considering the domain of elaboration dissertation, universities need to manager the types of “Knowledge Intensive Activity” (KIA) (“Select Advisor”, “Define Problem”) that are executed. They may need to classify those KIA types giving rises to types of KIA types. In this case, “Select Advisor” could be considered as examples “Dissertation Enrollment Process Type” and “Define Problem” which is an example of “Define Problem Type” . Finally, they need to track the specific activity of problem definition of a student’s dissertation (e.g. “Define Problem of Mary”). So, for representing this case, we need to use differents classification levels, such as individual KIA (“Define Problem of Mary”) , KIA type (“Define Problem”) , and types of KIA Type (“Define Problem Type”).

5. Final Considerations

In this paper, we argued about the importance of Knowledge-Intensive Process and how it is a valuable resource into organizations. We also discussed that it is difficult to

manage a KIP and how the ontology KIPO helps to understand it. However, the problem identified r was the difficulty in distinguishing instances and models in KIP, which KIPO does not address in its current form. Therefore, a solution was proposed based on the application of combination MLT and KIPO, using concepts of powertype, defined by Odell.

The results expected are to represent, through of UML diagrams, instances and models, from reading a knowledge base, using the strategy defined. These representations will be generated by an implemented tool.

References

[Goldstein and Storey 1994] Goldstein, R.C. and Storey,V. C. (1994): Materialization. In: IEEE Transactions on Knowledge and Data Engineering (Volume: 6, Issue: 5, Oct 1994).

[Odell 1994] Odell, J.(1994): Power types. In: Journal of Object-Oriented Programing, 7(2), pp. 8-12.

[Guizzard 2005] Guizzard, G.(2005): Ontological Foundations for Structural Conceptual Model. In: Enschede, The Netherlands. Telematica Institut Fundamental Research Series, No. 015 (TI/FRS/015). Netherlands

[Sellers and Perez 2005] Sellers, B.H. and Perez, C.G.(2005): Connecting Powertypes and Stereotypes. In: J OURNAL OF O BJECT T ECHNOLOGY.Online at http://www.jot.fm. Published by ETH Zurich, Chair of Software Engineering ©JOT, 2005. Vol. 4, No. 7, September - October 2005. Zurich

[Atkinson and Künner 2008] Atkinson, C. and Künner, T. (2008): Reducing accidental complexity in domain models. In: Software & Systems Modeling .July 2008, Volume 7, Issue 3, pp 345–359.

[Maldonado 2008] Maldonado, M. (2008): Impact analysis of knowledge intensive process creation and transfer policy: a system dynamic model. M.Sc. dissertation. Programa de Pós-Graduação em Engenharia e Gestão do Conhecimento, UFSC, Brazil (in Portuguese)

[Atkinson 2012] Atkinson, C. (2012): Melanie – Multi-level Modeling and Ontology Engineering Environment. In: Proceeding MW '12 Proceedings of the 2nd International Master Class on Model-Driven Engineering: Modeling Wizards. Article No. 7 . Austria

[França et al. 2014] França, J.B.S., Netto, J.M.S., Carvalho, J.E.S., Santoro, F.M., Baião, F.A., Pimentel, M.(2014): "KIPO: the knowledge-intensive process ontology". In: Software & System Modeling. Springer.

[Neumayr and Schrefl 2014] Neumayr, B. and Schrefl, M. (2014): Abstract vs Concrete Clabjects in Dual Deep Instantiation. In: Proc MULT 14 Workshop, pages 3-12.

[Carvalho and Almeida 2016] Carvalho, V. A. and Almeida, J. P. A.(2016): Toward a well-founded theory for multi-level conceptual modeling. . Software & Systems Modeling, Springer Berlin Heidelberg

[Carvalho et al. 2017] Carvalho, V.A., Almeida, J.P.A., Fonseca, C.M., Guizzard, G. (2017) : Multi-Level Ontology-based Conceptual Modeling