Conceptualization
A Novel Intensional-based Model

Islam Ali and Hamada Ghenniwa
Department of Electrical and Computer Engineering, Western University, London, Ontario, Canada

Keywords: Conceptualization, Extensional Logic, Intensional Logic, Extensionalization.

Abstract: A formal treatment of conceptualization is essential and a fundamental aspect of knowledge representation, Ontologies and information engineering. Several approaches have been proposed based on extensional logic and extensional reduction model. However, in this paper we highlight several limitations of their applicability for modelling conceptualizations in dynamic and open environments, due to several strong assumptions that are not adequate for dynamic and open environments. To this end we argue that intension based model is a natural and adequate model. We present a model based on the theory of Properties Relations and Propositions. This description takes the concepts and relations as primitives and, as such, irreducible. The proposed description is then extended to describe the world in more details by capturing the properties of the domain concepts.

1 INTRODUCTION

Ontology is a very active topic in the knowledge formalization, information sharing, and artificial intelligence communities. The progress in artificial intelligence, knowledge engineering, the semantic web, information sharing, information integration and P2P systems made the development of ontologies essential for information systems. Especially in dynamic systems and open environment, ontology plays a very important role in facilitating the interaction and collaboration between several agents. Ontology specifies a conceptualization which is essential for the formalization of knowledge (Genesereth and Nilsson, 1987). A conceptualization is defined as “an abstract model that consists of the relevant *concepts* and the *conceptual relations* that exist in a certain domain” (Xue, 2010). This definition emphasizes the intensional nature of a conceptualization.

(Gruber, 1993) defined a conceptualization as "the objects, concepts, and other entities that are presumed to exist in some area of interest and the relations that hold amongst them" (Gruber, 1993). This definition reflects the extensional account of the conceptualization described in (Genesereth and Nilsson, 1987). (Guarino, Oberle and Staab, 2009) argued that a conceptualization is about concepts. And as such, the conceptualization should not change unless the meanings do change (Guarino and Giaretta, 1995). And so, (Guarino and Giaretta, 1995) defined a conceptualization as "an intensional semantic structure that encodes the implicit roles constraining the structure of a piece of reality". This definition also shows that conceptualization is of an intensional nature. As will be shown later, extensional logic cannot describe intensional contexts. And this is why an intensional notation is required for the task of describing a conceptualization.

An extensional reduction notation for describing a conceptualization is proposed (Guarino and Giaretta, 1995), (Guarino, 1998), and (Guarino et al., 2009). This model followed the possible world approach (Anderson, 1984) for intensional logic. The extensional reduction model is more adequate than the extensional model as it deals with conceptual relations as opposed to extensional relations in the extensional model. There are, however, several formal and intuitive concerns about the possible world approach that reduces the intensional entities to extensional ones (Bealer, 1993), (Bealer, 1998a). It is also noticed that extensional reduction model is appropriate for describing systems in which the set of existing entities is not allowed to change while the relations between them may change. However, the

Ali I. and Ghenniwa H..
Conceptualization - A Novel Intensional-based Model.
DOI: 10.5220/0004145202570264
In *Proceedings of the International Conference on Knowledge Engineering and Ontology Development* (KEOD-2012), pages 257-264
ISBN: 978-989-8565-30-3

extensional reduction model does not adequately describe information systems or dynamic systems in which new entities are allowed to enter and/or leave the world. It also describes the domain in terms of extensional entities rather than concepts. The extensional reduction notation also treats the concepts as relations, which is found to be inappropriate and unintuitive. For these reason the need for an intensional-based notation for describing a conceptualization arises.

In this work, two different approaches for describing a conceptualization are discussed and analyzed. These approaches are fundamentally different as they belong to different classes of logic. The PRP theory (Bealer, 1979) for intensional logic is then discussed. An intensional model for the conceptualization, based on the PRP theory, is proposed. This intensional model avoids the limitations of the extensional and the extensional reduction notations. The proposed notation is also extended to support a more fine-grained description of a conceptualization in which the properties of the domain concepts are captured.

The rest of the paper is organized as follows: section 2 briefly explains the assumptions, applicability, and limitations of the extensional logic and the intensional logic. Section 3 then discusses the extensional model for a conceptualization. Then, Section 4 describes the extensional reduction notation that is based on the possible world approach. The critical points in these two approaches are discussed in section 5 which sheds some light on the PRP theory (Bealer, 1997) and proposes the intensional model for the conceptualization. In the same section, both course-grained and fine-grained intensional-based descriptions for the conceptualization are proposed. Finally, section 6 concludes the work.

2 EXTENSIONAL LOGIC AND INTENSIONAL LOGIC

This section explains briefly the extensional logic and the intensional logic as applied to modelling a conceptualization. We will start by a simple example (Fitting, 2007): If someone tells you that the Morning star is the Evening star, this changes your knowledge. This is because, now you know that the Morning star and the Evening star are equal. However, even though the two signs ("Morning star" and "Evening star") designate the same object, they do not have the same meaning. In this sense, meanings are the intensions, and things they designate are the extensions. A context that cares only about extensions is called an extensional context. On the other hand, if the context cares about the meanings, it is an intensional context (Fitting, 2007).

One of the major differences that help distinguishing between the intensional and extensional contexts is the applicability of substitutivity (Bealer, 1982). In other words, a context in which substitutivity does not apply can be recognized as an intensional context. However, for extensional contexts, the substitutivity of equivalents always holds. The following argument (Bealer 1982) explains the failure of the principle of substitutivity in the intensional contexts.

x believes that everything runs.
Everything runs if and only if everything walks.

.'. x believes that everything walks

It is obvious that the above argument is intuitively invalid. This is because the substitutivity is used in an intensional context in which it does not apply. Sentences like; "It is known that…", "It is believed that …", "It is said that…", "It is necessary that…" are typical intensional contexts (Fitting, 2007). For a computer scientist, expressing the belief of an agent or the knowledge of an information system follows the same role. That is why the belief of an agent and the knowledge of an information system are intensional matters.

Intensional systems are those in which intensional features can be represented (Fitting, 2007). These are the systems that cannot be described in extensional logic. In order to describe such systems, several theories for intensional entities were proposed. Some of these theories included some reduction and some others adopted a non-reductionist view. Those theories, which incorporated reduction, reduce the intensional entities to extensional entities (Bealer, 1998). An example of such category of theories is the possible world approach (Anderson, 1984) and (Lewis, 1986). When used for describing a conceptualization, the reductionist approaches assume that the world has fixed set of entities. As such, these approaches are applicable if one is interested in describing a static system with a fixed set of entities in which the relations between objects are allowed to change. These approaches, however, are not adequate for describing information systems or dynamic systems in which entities or agents can enter and/or leave the system at any time.

The non-reductionist approaches, however, take the intensional entities such as concepts, relations, and properties, at face-values, i.e. as real irreducible entities. An example of theories of this category is the theory of Properties, Relations, and Propositions (Bealer, 1997), (Bealer, 1982), and (Bealer, 1983). Modelling the conceptualization using this class of logic is more adequate for dynamic systems and open environment. It allows for the description of intensional contexts such as belief and knowledge. It also accounts for changes in the world as long the concepts and the meanings do not change.

3 EXTENSIONAL MODEL

The extensional model is based on the extensional logic. And as such it describes the conceptualization in terms of declarative sentences and ordinary relations. According to this model, a conceptualization is formally defined as a triple E_e= (D_e, F_e, R_e) consisting of a universe of discourse, a functional basis set for that universe, a relational basis set (Genesereth and Nilsson, 1987). The universe of discourse D_e is a set of all entities, or what is called extensions, in the domain. A function maps an entity $e_i \in D_e$ to another entity $e_j \in D_e$ based on an interrelation between the two entities. The set of functions that are emphasized in the conceptualization is referred to as the functional basis set F_e. And finally, the relational basis set R_e is the set of all extensional relations that hold between the elements of D_e.

The following example (Genesereth and Nilsson, 1987) explains the extensional model of conceptualization:

Consider the blocks world that has only one concept (block). And consider a specific instance of this world in which there are five blocks arranged as shown in Figure 1.

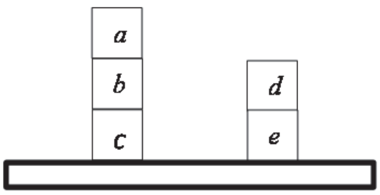

Figure 1: Five blocks on a table example (Genesereth and Nilsson, 1987).

In this example, it is assumed that there is only one function in this domain that is relevant to the conceptualization. This function is called *Hat*, and it maps each item to its hat (the item that lies directly above it). It is also assumed that there are four different relations that are relevant to this conceptualization. These relations are *On*, *Above*, *Clear*, and *Table*. The conceptualization for this world, according to the extensional description, is E_{e1}= (D_{e1}, F_{e1}, R_{e1}) where D_{e1}= {*a*, *b*, *c*, *d*, *e*}, F_{e1}= {hat_1}, and R_{e1}= {on_1, $above_1$, $clear_1$, $table_1$}. The members of both (F_{e1} and R_{e1}) are ordered tuples on the elements of D_{e1}. In that sense, on_1= {(*a*, *b*), (*b*, *c*), (*d*, *e*)}, $above_1$= {(*a*, *b*), (*a*, *c*), (*b*, *c*), (*d*, *e*)}, $clear_1$= {*a*, *d*}, and *table*= {*c*, *e*}.

In the previous example, the extensions, in the snapshot of the blocks world shown in Figure 1, were described using the extensional notation. It should be noticed, however, that the extensional logic cannot describe intensional matters. And this is because extensional logic substitutes equivalent entities based on their extensions. And this does not apply for intensional contexts.

4 EXTENSIONAL REDUCTION MODEL

The fact that "*an agent, or an information system, for simplicity, believes something about the world*" cannot, adequately, be described using extensional logic. This is because it is an intensional context. And as such, describing such contexts using extensional logic might result in unintuitive arguments. (Guarino and Giaretta, 1995) also pointed out that "the extensional notation of conceptualization is only useful if one is interested in an isolated snapshot of the world". For instance, if a different arrangement of blocks is considered, as shown in Figure 2, the corresponding conceptualization, according to the extensional notation, will be different.

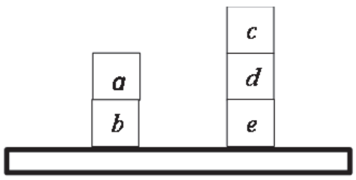

Figure 2: A different configuration for the five blocks (Guarino and Giaretta, 1995).

It is argued (Guarino and Giaretta, 1995), (Guarino, 1998) and (Guarino et al., 2009) that, the conceptualization should focus on the meaning instead of a particular state of the world. And so, the conceptualization should not change when the arrangement of the blocks, in the blocks world, changes. In order to capture such intuition, the possible world theory (Anderson, 1984) is adopted as a basis for describing the conceptualization (Guarino and Giaretta, 1995), (Guarino, 1998), and (Guarino et al., 2009). This theory reduces the intensional entities to extensional entities, i.e. extensional functions or sets (Bealer, 1998).

Using the possible world reduction, (Guarino and Giaretta, 1995) formally described the conceptualization as a triple E_{er}= (D_{er}, W_{er}, R_{er}) (Guarino et al., 2009). In this model, D_{er} is a domain of objects, W_{er} is a set of possible worlds, and R_{er} is a set of conceptual relations. According to this model, a conceptual relation of arity n on D_{er} is a function from the set of possible world W_{er} to the set 2^{Der^n} of all possible n-ary relations on D_{er}. It is also worth mentioning that, in this model the concepts are treated as relations, or functions, from W_{er} to 2^{Der} (Guarino et al., 2009).

Referring to the blocks world example shown in Figure 1, the conceptualization for the blocks world based on the extensional reduction model is E_{er1}= (D_{er1}, W_{er1}, R_{er1}) where: D_{er1}= {a, b, c, d, e}, W_{er1}= {w_{11}, w_{12}, w_{13}, …} the set of possible worlds, i.e., the set of all possible configurations of the members of D_{er}, and R_{er}= {$Block^1$, $Clear^1$, $Table^1$, On^2, $Above^2$} is the set of relations from W_{er} to $\{2^{Der}, 2^{Der}, 2^{Der}, 2^{Der^2}, 2^{Der^2}\}$ respectively.

In order to show that the extensional reduction model has an advantage over the extensional model, the configuration in Figure 2 will be described according to the two models. The conceptualization for the world shown in Figure 2, according to the extensional model, is E_{e2}= (D_{e2}, F_{e2}, R_{e2}) where D_{e2}= {a, b, c, d, e}, F_2= {hat_2}, and R_2= {on_2, $above_2$, $clear_2$, $table_2$}. The members of the two sets, F and R, are ordered tuples on the elements of D. In that sense, on_2= {(a, b), (c, d), (d, e)}, $above_2$= {(a, b), (c, d), (c, e), (d, e)}, $clear_2$= {a, c}, and $table_2$= {b, e}. Here it is noticed that D_{e1}=D_{e2}, however, R_{e1}≠R_{e2}, and in turn E_{e1}≠E_{e2}. On the other hand, the configuration in Figure 2, described using the extensional reduction model, is E_{er2}= (D_{er2}, W_{er2}, R_{er2}). And based on the possible world reduction, it can be shown that D_{er1}=D_{er2}. This is obvious since the entities in the world have not changed, i.e. the five blocks in both Figure 1 and Figure 2. Since W_{er} is the set of all possible configurations of the elements of D_{er}, and since D_{er1}=D_{er2}, it can also be shown that W_{er1}= W_{er2}. And finally since R_{er} is a set of relations from W_{er} to 2^{Der^n}. It is also obvious that, R_{er1} and R_{er2} are equivalent. And in turns, E_{er1} = E_{er2} as one would expect.

5 INTENSIONAL MODEL

It is clear that the extensional reduction, or the possible world approach, is more expressive as compared to the extensional model. As discussed in the previous section, different arrangements of the same entities will not result in different conceptualization. This is because the meanings of the relations between them do not change. However, for several reasons, this model needs to be further revisited, especially in the context of knowledge formalization, information systems, information integration, and open environments.

There are several formal and intuitive concerns about the possible world reduction (Bealer, 1993), (Bealer, 1998a). First and foremost is that, it is a reduction that reduces the intensional entities to extensional entities. Further discussions about the possible world reduction can also be found in (Adams, 1974) and (Jubien, 1988) (as cited in Bealer, 1993). Bealer proposed a non-reductionist formulation for intensional logic that is compatible with actualism as opposed to possibilism. The theory of Properties Relations and Propositions (Bealer, 1997) and (Bealer, 1982), and (Bealer, 1993) takes properties, relations and propositions as real irreducible intensional entities.

Before the formal description is proposed, some important definitions will be discussed first. We will start with the definition of a *concept*. "Cognitive scientists generally agree that a concept is a mental representation that picks out a set of entities, or a category. That is, concepts *refer*, and what they refer to are *categories*" (Medin and Rips, 2005). In other words, the term *concept* denotes a general, abstract, idea of a category. A *particular*, is a concrete entity that exists in space and time as opposed to a *concept*. This does not mean that every *instance* of a *category* is exactly the same. But, only that from some perspective they are treated equivalently based on something they have in common. The relation between a *concept* and *particular* will be referred to as *abstraction*. So a concept is created by keeping the characteristics that are common between several particulars while *abstracting* away the characteristics that are uncommon.

A *conceptualization* is also defined as an abstract model that consists of the relevant *concepts* and the *conceptual relations* that exist in a certain domain (Xue, 2010). Again this definition emphasizes the fact that the conceptualization is about concepts and meanings. And so, the *conceptualization* should remain the same even when the state of the world is changed or a *particular* is introduced to the world.

This assumes that the new *particular* that is introduced to the system is an extension of a *concept* that is already captured in the *conceptualization*. It is only the introduction of a new *concept* or *conceptual relation* that should result in different *conceptualization*.

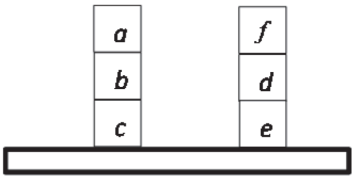

Figure 3: The blocks world with 6 entities instead of 5.

In order for this point to be clear, Figure 3 shows another example of the blocks world in which another block *f* is introduced to the world. Let us assume that the conceptualization for the configuration shown in Figure 3, based on the extensional model, is E_{e3}. As discussed before, it is quite evident that E_{e1}, E_{e2}, and E_{e3} are different. This is partially taken care of in the extensional reduction model that is based on the possible world approach. The conceptualization for the configuration in Figure 3, based on the extensional reduction model, will be referred to as E_{er3}= (D_{er3}, W_{er3}, R_{er3}). As mentioned earlier, E_{er1} and E_{er2} are equivalent. However, D_{er3}= {a, *b*, *c*, *d*, *e*, *f*}, and that means $D_{er1}=D_{er2}\neq D_{er3}$. Since W_{er} is defined as all possible configurations of elements of the domain D_{er}, then $W_{er1}=W_{er2}\neq W_{er3}$. Because R_{er} is a set of relations from W_{er} to $2^{D_{er}^{n}}$, it is easy to show that $R_{er1}=R_{er3}\neq R_{er3}$ and in turn $E_{er1}=E_{er2}\neq E_{er3}$.

Since the extensional reduction model is based on the possible world reduction, the so called conceptual relations are, in fact, extensional relations between the set of possible worlds and the set of extensions in the domain. It is also clear that, the introduction of a new extension to the world changes the conceptualization. According to the intensional model, introducing a new particular, which corresponds to a concept that is already captured in the system, should not change the conceptualization.

Based on the above discussion, an intensional model that accounts for the instantiation, or extensionalization, is required. Being an intensional model, it should take the relations as intensional entities rather than reducing them to extensional functions. The intensional model should also capture the concepts (based on the observation of the particulars) instead of capturing the particulars themselves. Especially in the context of information systems, inserting a record in the database, for instance, can be considered as sort of instantiation. And this should not affect the conceptualization.

It is also worth mentioning that, the extensional reduction model treats the concepts as relations and mixes them with the set of relations. We find this inappropriate and unintuitive for the purpose of this work. This is because, the concepts are abstractions of entities that exist in certain time and space while the relations are abstractions of the interrelations between these entities. Even though both concepts and relations are intensional entities, they are different in nature.

Another observation is that, the relations in the possible world approach are separated from the domain. And even though this is not wrong for describing the conceptualization, we adopt the view that the relations are intensional entities and should be taken as primitive, irreducible, entities (Bealer, 1997) and (Bealer, 1982). And as such, it is more adequate to treat the intensional relations as part of the domain. In that sense, both the set of concepts and the set of conceptual relations will be members of the domain.

Finally, it is also important that the model can be expanded in order to describe the world in more details. An example of this would be a model that describes the properties of the concepts as will be shown later.

Motivated by the above observations, a new intensional model for describing the conceptualization is proposed. This model is based on Bealer's intensional logic (Bealer, 1997) (Bealer, 1983). The following section will shed some light on Bealer's intensional logic. Then the proposed model will be explained. The proposed model will then be extended to describe the properties assigned to the concepts.

5.1 Intensional Algebra

This section briefly explains the Intensional Algebraic structure according to the theory of Properties Relations and Propositions for intensional logic (Bealer, 1979). For more details about the theory of PRP, we refer the reader to (Bealer, 1979) (Bealer, 1982), (Bealer, 1983). The theory of PRP is a non-reductionist intensional formalization for intensional logic. This formalization takes the properties, the relations, and the propositions as real irreducible entities instead of reducing them to extensional entities. According to the theory of PRP, an intensional algebra is a structure (D, J, K) consisting of a domain D, a set of logical operations

J, and a set of possible extensionalization functions *K* (Bealer, 1979) and (Bealer, 1998b). The domain *D* divides into subdomains that include the intensional entities of the domain. The set of logical operations includes, but not limited to, conjunction, negation, singular predication, existential generalization, and so on. And the possible extensionalization functions assign extensions to relevant items in the domain. Extensionalization can be defined as the process of keeping the abstraction distinct and maintaining the relationship between the abstractions and observed facts (Aparaso, 2010). In other words, extensionalization is the connection between reality and the conception of the observer.

5.2 Intensional Description of Conceptualization

As mentioned earlier, the conceptualization is defined as abstract model that consists of the relevant concepts and relations that exist in certain domain (Xue, 2010). This definition will be revised as "an abstraction that consists of the relevant concepts and relations that exist in certain domain". We purposely take off the word model from the definition because it might imply the use of formal language, or the lead to the illusion of being something physical. In order to intensionally describe conceptualization, an intensional structure, based on the theory of PRP, is used. This structure is formally explained below and various advantages of the new model are discussed.

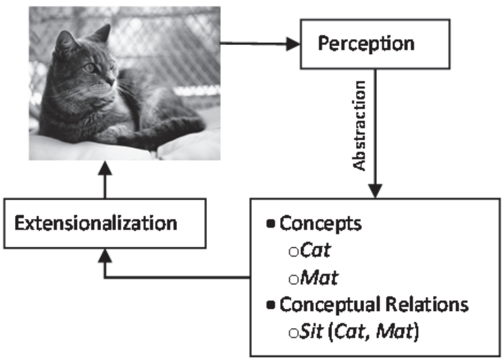

Figure 4: The relation between the conceptualization and the reality.

According to the intensional notation, a conceptualization, is described as a tuple E_i= (*D*, *K*) in which *D* is a domain and *K* is a set of extensionalization functions. The domain *D*, in turns, consists of the set of concepts *C* and the set of conceptual relations *R,* written as *D*= (*C*, *R*). The set of concepts *C* captures abstracts to all relevant entities in the world. And the set of relations *R* can be further decomposed into binary relations R_2, ternary relations R_3, and so on. The members of the set of extensionalization functions *K* assign entities of the reality to the corresponding concepts and conceptual relations in the conceptualization. Figure 4 explains how an extensionalization function relates elements of the reality to both concepts and intensional relations in the conceptualization.

Figure 4 shows how the particulars are related to the conceptualization through the extensionalization function. Note that, the predicate *Sit* (*Cat*, *Mat*) does not describe certain instances of the concepts *Cat* or *Mat*. Rather it intensionally means that entities corresponding to the concept *Cat* can be described as *Sit*ting on any entity that can be referred to as a *Mat*. And as such the conceptualization corresponding to the world in Figure 4 can be described as E_{i4}= (D_4, K_4). In that case, D_{i4}= ({*Cat*, *Mat*}, {*Sit* (*Cat, Mat*)}).

Figure 5: Two cats sitting on a mat.

The question now is, what changes to reality should affect the conceptualization? Or in other words, when should the conceptualization change? In order to answer this question Figure 5 and Figure 6 are closely examined. In Figure 5, one can see two cats sitting on a mat. Is the conceptualization that describes the world in Figure 5 different from the one that describes the world in Figure 4? In order to answer this question we need to answer the following questions first:

Did the world change? If yes then:

a. Were extensions of new concepts introduced to the world? If yes, then:
   i. Are these concepts relevant to our conceptualization?

b. Were extensions of new relations introduced to the world? If yes, then:
   i. Are these intensional relations relevant to our conceptualization?

By looking at Figure 5; the answer to the first question is YES. This is because another cat is now sitting on the mat. However, since the concept that is already captured in E_{i4}, this should not change the conceptualization. This is because the introduction of a new cat does not change the meaning of the concept cat. Now let us examine the relations between relevant concepts in Figure 5. There seem to be a relation between the two cats, as one of them is beside the other. Now, if this relation is relevant to our conceptualization, this will be perceived as a binary relation on the concept *Cat*, i.e. *SidebySide*(*Cat*, *Cat*). However, if this relation is irrelevant to our conceptualization, it will be abstracted out and the conceptualization *Ei4* will be able to describe the *Cat*/*Mat* world in Figure 5. And as such, our conceptualization captures the facts that, there can be cats, and there can be mats, and cats can sit on mats. No matter how many cats, how many mats, and how many cats are sitting on mats, this should not affect the conceptualization.

Figure 6: The relation between the conceptualization and the reality.

By examining Figure 6 and trying to answer the same questions above, one can observe that the world has changed. This change adds both an extension of a new concept, *Dog*, and extensions of new conceptual relations, i.e. *SidebySide* (*Dog, Cat*) and *Sit* (*Dog*, *Mat*). The next question would be, is the concept *Dog* relevant to our conceptualization? If the answer is No, then the concept *Dog* will be abstracted out and the conceptualization won't be affected. However, if the concept *Dog* is relevant to our conceptualization then the conceptualization should change in order to account for that new *concept*. In a similar way, we will need to answer the question about the conceptual relations and whether or not they are relevant to our conceptualization.

5.3 Advantages of the Intensional Model

As discussed earlier, the extensional reduction model is more appropriate for describing the conceptualization as compared to the extensional model. The extensional reduction model, however, is suitable for describing static systems in which the configuration of the system may change, without introducing new entities. For the sake of describing information systems, or dynamic system that exist in open environment, the extensional reduction model may not be a good candidate. For this reason and for several reasons, mentioned above, the need for an intensional-based model is quite evident.

The intensional model has further improved the description of conceptualization so that it describes the relations as real irreducible entities instead of reducing them to extensional functions. It also deals with concepts rather than extensional entities or objects. Moreover, the intensional relation separates the concepts from the relations as they are different in nature. This is different from the extensional reduction model which treats the concepts as relations. Furthermore, since the intensional model treats the intensional relations as primitive entities, they are considered to be part of the domain. It is also worth mentioning that the use of the singular term in the intensional logic (Bealer, 1987) avoids higher order syntax for intensional logic (Majkic, 2009). And finally, the proposed intensional description of conceptualization is easy to expand so that it describes more details about the world. In the next section, it will be shown how the intensional model will be expanded to describe the properties of the domain concepts.

5.4 Fine Grained Description

Recall in section 5.2, the intensional model of conceptualization describes the conceptualization as a tuple (D_i, K_i). In this description, D is composed of subdomains containing both the concepts C, and the conceptual relations R. This model can further be extended to describe not only the relations between concepts, but also the properties of the concepts. A particular instance of a property is referred to as an abstract particular or a trope (Bacon, 2008). Following the PRP theory (Bealer, 1997) and (Bealer, 1998), the *properties* are taken as primitive entities and considered as part of the domain. The values assigned to the properties can be thought of as concepts. However these concepts are not of direct relevance to the conceptualization. And as such, these concepts are going to be called extrinsic concepts Ce. On the other hands, the concepts that are of direct relevance to the domain will be referred to as intrinsic concepts C_i.

The expanded model of the conceptualization is defined as a tuple E_i= (D_i, K_i). In this model, the domain consists of four members D_i= (C_i, C_e, R, P). These four members represent intrinsic concepts, extrinsic concepts, relations, and properties. An example of a property in Figure 4 would be the color of the cat. Assuming that a *Cat* can have one of several colors (*Black*, *White*, *Grey*, or *Brown*), these colors are considered extrinsic concepts in our conceptualization. The fact that cats can have the grey color will be described by the property *Color* (*Cat*, *Grey*). This should not be confused with asserting certain fact about a certain entity in the world. However, this should be understood as an intensional property that can be read as "extensions of the concept *Cat* can be attributed as having a *Grey Color*".

As shown in this section, the intensional deception of conceptualization can be expanded. This allows scalability and gives more control on the description of a system. The ability to expand the intensional description is used here to describe the properties of the domain concepts. However, we expect this property to offer flexibility in describing even more details about the system.

6 CONCLUSIONS

In this work, extensional and extensional reduction models for describing a conceptualization are critically discussed and analysed. It was shown that, while the extensional description is suitable for describing a certain state of the world, the extensional reduction description is appropriate for describing a static world. For information systems, multi-agent systems, and in general, any dynamic system in which entities can enter and leave the system, it is shown that there is a need for an intensional description of the conceptualization. An intensional model for describing a conceptualization is proposed. This model is based on the PRP theory for intensional logic. The advantages of the intensional description are discussed. And, both course-grained and fine-grained descriptions for the conceptualization are provided.

REFERENCES

Adams, R. M. (1974). Theories of Actuality, *Nous*, 8, 211-231.

Anderson, C. A. (1984). General Intensional Logic. In Gabbay, D. and Guenthner, F. (Eds.), *Handbook of Philosophical Logic* (Vol. 2, pp 355-385). Dordrecht: D. Reidel.

Aparaso, R. (2010). *Research Methods for Pharmaceutical Practice and Policy* (1st ed.). London and Chicago: Pharmaceutical Press.

Bealer, G. (1979). Theories of Properties Relations and Propositions, *Journal of Philosophy*, 76, 634-648.

Bealer, G. (1982). Quality and Concept (1st ed.). USA: Oxford University Press.

Bealer, G. (1983). Completeness in the Theory of Properties, Relations, and Propositions. *The Journal of Symbolic Logic*, 48(2), 415-426.

Bealer, G. (1993). A Solution to Frege's Puzzle. *Philosophical Perspectives*, 7, 17-16.

Bealer, G. (1998a). Propositions, *Mind*, 107, 1-32.

Bealer, G. (1998b). Intensional Entities. In Edward, C. (Ed.), *Routledge encyclopaedia of philosophy* (Vol. 4, pp 803-807), London: Routledge.

Beacon, J. (2008). Tropes. In Zalta, E. N. (Ed.), *Stanford encyclopaedia of philosophy*. Retrieved April 1, 2012, from http://plato.stanford.edu/entries/tropes/

Fitting, M. (2007). Intensional Logic. In Zalta, E. N. (Ed.), *Stanford Encyclopedia of Philosophy*. Retrieved April 1, 2012, from http://plato.stanford.edu/entries/logic-intensional/.

Guarino, N. and Giaretta P. (1995). Ontologies and knowledge bases: towards a terminological clarification. In Mars, N. J. I. (Eds.), *Towards Very Large Knowledge Bases, Knowledge Building & knowledge sharing* (pp 25-32), IOS Pr Inc.

Guarino, N. (1998). Formal Ontology and Information Systems. In *FOIS'98, 1st International Conference on Formal Ontology in Information Systems*, 3-15.

Guarino, N., Oberle, D. and Staab, S. (2009). What is an Ontology? In Stasb, S. and Studer, R., *Handbook on Ontology (International Handbooks on Information Systems)* (2nd ed.) (pp. 1-17). Springer.

Genesereth, M. R. and Nilsson, N. J. (1987). Logical Foundation of Artificial Intelligence (1st ed.). Los Altos, California: Morgan Kaufmann.

Gruber, T. R. (1993). A Translation Approach to Portable Ontologies, *Knowledge Acquisition*, 5(2), 199-220.

Gruber, T. R. (1995). Towards Principles for the Design of Ontologies Used for Knowledge Sharing. *International Journal of Human Computer Studies,* 43(5-6), 907-928.

Jubien, M. (1988). Problems with Possible Worlds. In Austin, D. F. (Ed.), *Philosophical Analysis* (pp. 299-322). Dordrecht: Kluwer.

Lewis, D. (1986). *On the Plurality of Worlds*. Oxford: Blackwell.

Majkic, Z. (2009). Intensional First-Order Logic for P2P Database Systems, In *JoDS XII*, *Journal of Data Semantics* (*Lecture Notes in Computer Science*), 5480, 131-152.

Medin, D. L., and Rips, L. J. (2005). Concepts and categories: Meaning, memory, and metaphysics. In K. J. Holyoak and R. G. Morrison (Eds.), *Cambridge handbook of thinking and reasoning* (pp. 37–72). Cambridge, UK: Cambridge University Press.

Xue, Y. (2010). Ontological View-driven Semantic Integration in Open Environment, PH.D Thesis, *the University of Western Ontario*. London, Ontario, Canada.