

Information Modelling Based on a Meaningful Use of Language

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Abstract. In traditional modelling approaches, such as entity-relationship modelling, the predominant information modelling problem is how to represent external reality in the system in a ‘true’ way. In these approaches semantic aspects of language are in focus. In contrast to this, the main information modelling problem could be to understand how information systems may support a meaningful use of language and information in a social action context. The paper presents an information modelling approach based on speech act theory that takes both semantic and pragmatic aspects into consideration. With such an approach it is possible to reconcile traditional information modelling and the pragmatic aspects of language and information use. Such reconciliation is essential to arrive at information systems that support meaningful communication between different actors within a social action context.

1 Introduction

Information systems are often viewed as more or less accurate images of reality [1]. This view has been characterized as a ‘contents view’ [2], representing a ‘descriptive perspective’ [3, 4]. From such a perspective, correct mappings from one domain (the universe of discourse) to another (the model) are in focus. Although this semantic aspect is important in making sense of the world, it has been suggested that pragmatics [5] is even more fundamental.

The term pragmatics was introduced in [6] to designate the study of the origin, use and effect of signs, and thus the relationship between signs and those who produce and interpret them, while semantics concerns the relationship between signs and the objects they signify. Pragmatics focuses on language in use and on the relationship between utterance, speaker and interpreter, while semantics stresses the referring function of language and the focus is on what could be considered as meaningful sentences and true propositions. This clear-cut division between semantics and pragmatics has shown to be problematic. For example, the difficulties of handling questions, directives and imperatives in formal semantics [7] are now widely recognized. The question is if such aspects of meaning should be disregarded in the study of se-

mantics and only be considered as something that has to do with pragmatics. To solve these problems there has been a suggestion to let semantics be concerned with the analysis of the conventional meaning (or conventional content) of sentences, and pragmatics with the actual meaning that speaker and listener attach when a sentence is used in a communication situation. If one chooses this way of distinguishing the study of semantics from that of pragmatics, the problems with questions and imperatives can be solved. This means letting semantic meaning concern the conventional meaning of sentences, and pragmatic meaning concern how speakers and hearers relate the sentence to the world and its actual conditions when the sentence is used in an act of communication [8]. Nonetheless, there is still no clear-cut distinction between semantics and pragmatics; we still have to understand how the conventional meaning of sentences relates to truth conditions, as this is a fundamental issue in semantic analyses. Arguably, information modelling is concerned with a meaningful use of language and should take both semantics and pragmatics into consideration accordingly [9].

In this paper we show how taking both semantic and pragmatic meaning into consideration gives theoretically justified advice to three problems central to information modelling. First, it can help us to decide what type of identifier to use given a specific entity. We refer to this as the *identifier problem*. Second, it provides a rationale as to why social obligations (such as assignments) sometimes ought to be modelled as objects (classes, entities). We refer to this as the *deontic problem*, since it has to do with whether deontic objects, such as commitments and obligations should be treated as ‘things’ in their own right. Third, it can help us to sort out the relationship between properties and entities, i.e. what thing is a specific property a property of? We refer to this as the *predicate problem*, as it has to do with how we predicate properties to ‘things’ by use of language.

The identifier problem, which emphasizes the importance of designing appropriate identifiers (primary keys), has traditionally been regarded as a database problem [e.g. 10, 11]. Contrary to this misconception, it has been argued that the identifier problem actually has to do with meaning and language use [12]. The problem should therefore be understood as a social one, related to the function that identifiers have in human communication and social interaction, rather than as a technical database problem.

The deontic problem is probably most evident in contemporary work on using Bunge’s ontology [13] as a foundation for information modelling [e.g. 14, 15]. This research leaves out important aspects of language use, such as the idea that social reality is constructed by use of language [16], and that, by implication, we must be able to model also that socially constructed world. Linguistic theories of concept formation have been used as a basis to recognize sound modelling principles that acknowledges the existence of such ‘social things’ [17]. However, this work interprets ‘ontologically sound’ from a strict (and delimited) semantic/cognitive perspective.

The predicate problem concerns what properties belong to what objects. This has been approached from a semantic point of view in, for example, normalization theory [e.g. 10] and the infological approach [18]. A key question seems to be to understand what can be considered as a thing (i.e. the deontic problem) and how language is used and related to the world when talking about those things.

The aim of this paper is to show how the concepts of semantic and pragmatic meaning can be used to approach the three problems introduced above, and to provide a framework that directs modellers’ attention towards important aspects of informa-

tion modelling not traditionally stressed. This concerns pragmatic aspects, such as actors, responsibilities, actions and commitments, which are not paid sufficient attention to in traditional conceptual modeling. These circumstances have consequences for the information system under development. They may, for example, imply that the system fails to provide relevant information to users and that users cannot trace who is responsible for information, actions and commitments made [4].

Over the years, numerous speech act based approaches have been put forth, including the Action Workflow approach [19] and the DEMO method [20]. Hence, choosing speech act theory as theoretical foundation is not a new idea. However, a problem with these other approaches is that when shifting from a narrow focus on semantics to pragmatic aspects of language they miss an important key notion within the theory. When arguing the importance of taking pragmatic aspects into account, they deemphasize the semantic aspect to the extent that the coupling between semantics and pragmatics, i.e. between what is talked about and what speaking does, has almost vanished [4]. In this paper we focus on pragmatic meaning *together* with semantic meaning to achieve the real value of using speech act theory in information modelling.

The paper proceeds as follows. In section 2 we discuss the nature of information and semantics in relation to information modelling. In section 3 we discuss the concept of pragmatic meaning based on speech act theory and an action perspective of information systems. We then go on to show how the concepts of semantic and pragmatic meaning can be used in practical information modelling in Section 4, using an example derived from a case study [21]. Finally, Section 5 concludes the paper by summarizing the main points.

2 Semantic meaning of information

One early and important contribution to our understanding of the concept of information was the formulation of the infological approach in the late 1960's [18]. In this approach, a central concept for the understanding of information is that of the elementary message (e-message). The e-message is considered to be the smallest structure that carries information: 'while an elementary message has a certain information content, or semantic content, nothing smaller than an elementary message has' [18]. The e-message is often thought of as a triple $\langle o, p, t \rangle$ where o refers to an object, p to a property of that object, and t to the point in time or time interval during which the property holds. A special type of e-message is called a relational message, which is a triple $\langle (o_1, o_2, \dots, o_n), r, t \rangle$ where (o_1, o_2, \dots, o_n) is a list of n objects related by the relationship r during the time or time interval t . E-message properties have both a type part and a value part. This discussion can be exemplified with the business offer in Fig. 1.

Object is 'what is talked about' [18]. For example, in the case of the business offer in Fig. 1, the object is the purchase object (a car). Property is 'something pointed out (a comment)' [18] to the object talked about, such as the model of the car. This implies that the offer described in Fig. 1 consists of a number of e-messages, because

every attribute that is ascribed to the purchase object can be considered as an e-message. Table 1 shows the information content resulting from these e-messages.

To be complete the example should also include a relational e-message referencing all the objects involved in the offer, i.e. the sales person, the customer and the purchase object, as described in Table 2.

Evidently, the concept of the e-message is closely related to that of the ‘tuple’ used to form the basis of the relational model of data [10], the ‘regular entity’ in the entity/relationship approach [11], the ‘entity object’ in object-oriented theory [22], as well as to those of ‘thing’ and ‘property’ in Bunge’s ontology [13]. One difference being that the infological approach stresses the inclusion of the time component, which is left optional in most other approaches.

Business Offer	
Offer no:	970321
Date:	18/12/97
Time:	10.30am
Salesman:	James Howard
Customer:	Jenny Doe
Purchase Object	
Registration no:	DCO 096
Model:	Volvo 850 GLT 2.5L, Front-wheel drive, 4 doors
Engine:	Petrol, Catalytic, 5-cylinder, Transverse, 170hp/125kW, B5254F
Gear Box:	Manual 5-gear, M56
Colour:	Polar white no. 189
Extra equipment:	S-package: Automatic climate control, Cruise control
Amount due:	€ 21,000
Offer valid until	31/12/97.

Fig. 1. A business offer.

Table 1. An information content structure consisting of several e-messages that together describe the purchase object.

	Type part	Value part
Object	Purchase Object (Car)	DCO 096
Property	Model	Volvo 850 GLT 2.5L, Front-wheel drive, 4 doors
Property	Engine	Petrol, Catalytic, 5-cylinder, Transverse, 170hp/125kW, B5254F
Property	Gear Box	Manual 5-gear, M56
Property	Colour	Polar white no. 189
Property	Extra equipment	S-package: Automatic climate control, Cruise control
Property	Price	€ 21,000
Time	Offer issued	18/12/97

Clearly the infological approach represents a descriptive perspective of information and information systems, depicted in Fig. 2. With such a perspective an important goal for information modelling is to achieve a correspondence between the representations (the e-messages, the entities) in the information system and the corresponding ‘elementary facts’ in the world that they describe.

Table 2. A relational e-message describing the ternary relationship between Purchase object, Sales person, and Customer, together forming an offer with number 970321.

	Type part	Value part
Object	Purchase object (Car)	DCO 096
Object	Salesman	James Howard
Object	Customer	Jenny Doe
Relation	Offer	970321
Time	Valid until	31-12-97

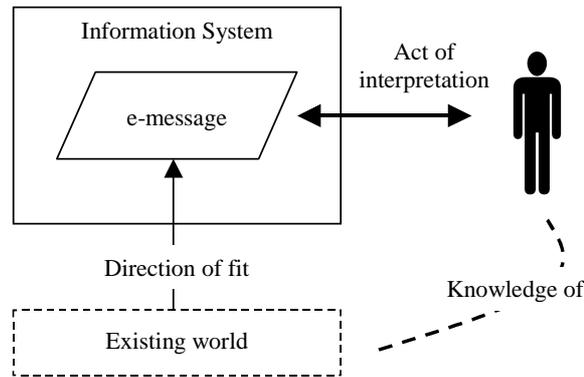


Fig. 2. Traditional view of an information system as an image of reality.

Many problems addressed in information modelling can be explained by a semantic focus. Semantics concerns the analysis of the conventional meaning of propositions (an e-message can be considered as a proposition) and their truth conditions which means that analyses focus on how language is used for representing facts about objects. There is, however, no consensus on how to represent the ternary relationships described by relational e-messages. According to the descriptive view, such a relationship could be considered as a weak entity, an aggregate object or as a relationship [14]. This ambiguity arises because the meaning of a relational message is unclear if we only analyse it from a semantic point-of-view [14]. In contrast to this view, we must see that there are always pragmatic aspects evident in language use [5, 23]. As a consequence we have to analyse also the pragmatic meaning of information, not only the semantic, when doing information analyses. This affects how we perform information modelling, and also our understanding of a meaningful use of information. This will be elaborated further in Sections 3 and 4.

3 Semantic and pragmatic meaning

According to speech act theory [7, 24] we cannot understand what is to be meant by a meaningful use of language if we assume that the only function of language is to produce true or false statements about the world. Besides description of reality we also use language to *promise, offer, order, warn, request, etc.* These are speech acts that cannot be evaluated as either true or false. Therefore, the success of a speech act has to be evaluated using both the true/false criteria and the happy/unhappy [7]. To account for this use of language, a speech act is understood to consist of two components: an information content component (propositional component) and an illocutionary component (an action component). This can be illustrated by the following two speech acts:

1. I *assert* to you that the price of the car is € 21,000.
2. I *offer* you the car at a price of € 21,000.

In the two utterances above the action component is constituted by the illocutionary verbs *assert* and *offer*, and the information content is constituted by the *proposition about the car*. The two components of the speech-act show the double structure of language and that the meaning of a speech act must be determined at two levels:

1. Semantic meaning: The function of the information content is to assign attributes to identifiable objects, e.g. the attribute price to the object car in the example above. (This is covered by approaches based on the descriptive perspective.)
2. Pragmatic meaning: The function of the illocutionary component is to decide the communication modus (or action type), i.e. how the information content should be used. For example whether the speech act should be used cognitively (*assert*) or interpersonally (*offer*). (This is not covered by approaches based on the descriptive perspective.)

A speech act, $F(p)$, consists of a propositional content p associated with an illocutionary force F . These are the propositional and illocutionary components of a speech act. In speech act theory it is noticed that the same propositional content could be used with a number of different illocutionary forces, which implies that F and p can be analysed separately. However, in order to understand the meaning of a speech act both these components have to be considered together. The main focus in speech act theory is on analysing different illocutionary functions of language, and when speech act theory has been used a basis for systems development it is this aspect that has been stressed. However, if we want to use speech act theory for improving information modelling, the propositional component is of course essential [4].

Speech act theory makes clear that the propositional content of a speech act fulfils two important functions: the referring function and the predicating function [24]. Referring means identifying a phenomenon, and predicating means characterizing or describing a phenomenon. This is in line with the semantic descriptive view of information. The difference is that speech act theory stresses the speaker's act of producing information, while the infological approach stresses the interpreter's act of interpreting the message and being informed. Arguably, it is important to consider both the sender's creation of information (and thus the knowledge expressed) and the receiver's interpretation [23]. The reason is that there has to be some sort of mutual

understanding of the world, and of the relationships between senders and interpreters, in order communication to succeed. From the business offer (in Fig. 1) we can see that the term registration number (the identifier) is used for referring and naming a specific car 'DCO 096', and other terms (attributes), such as model, body and length, are used for characterising and describing it.

Furthermore, all speech acts must be understood within the social context in which they are uttered [23] and actors must understand this context to participate successfully in communication. The context of a speech act can be thought of as a combination of *speaker*, *hearer*, *time*, *place* and *possible world* [25]. The first two concepts refer to the actors who are performing and interpreting the speech act. Time and place represent the temporal and spatial aspects of the act. Possible world refers to the residual features of the context that make a particular speech act possible and meaningful. Typically, these features include shared norms, values and beliefs and the existence of certain social and material (brute) facts [16]. When doing business, the social context of the communication can be referred to as a *business context*; a norm-based institutionalized context [23]. Referring to a possible world rather than the actual world is what makes it possible to talk about the future and what ought to be [25], as required by the second speech act in the list above – the offer.

The business offer, detailed in Fig. 1, can be understood as a speech act, which consists of a propositional content and an illocutionary component. In the message, the propositional content identifies and describes the attributes of the purchase object, which is a car. The illocutionary component shows how the propositional content is intended to be used, i.e. its pragmatic meaning. In this case it should be understood and used as a business offer. The business context of the speech act consists of: time (18/12/97, 10.30 am), place (car dealer's office), communicator (car dealer in interaction with the system), interpreter (customer), and possible world (the purchase object, i.e. the car and the price at which it is being offered), as described by the propositional content; and business rules, social expectations and beliefs that govern the actors' behaviour).

When the speech act is performed, it changes the state of the business context to a state in which a car has been offered. This transition implies that (a) a *proposition* has been made, manifested in the propositional content, (b) the car dealer has expressed an *intention and will* to sell the car and (c) a *commitment* has been made on the part of the car dealer to sell the car under the conditions detailed in the offer.

In order to stress the pragmatic function and meaning of language, the idea of the e-message has been expanded into a concept of an action-elementary message (ae-message) [2, 26]. An ae-message can be seen as a collection of e-messages, corresponding to a propositional content, complemented with an action type and the actors participating in the communication, i.e. the communicator and the intended interpreter. An ae-message is thus elementary with respect to a communicator who says (and thus does) something to an interpreter about something in a certain mode [26].

Table 3 shows an example of two ae-message structures, including the offer communicated from a salesperson to a customer, and an additional report communicated to the sales manager. The notion of an ae-message communicated by use of an information system is illustrated in Fig. 3. In the figure we can notice two arrows showing two possible directions of fit between the ae-message and the world. The illocutionary

component's function is to show how the propositional content should be used and related to the world [24].

Table 3. Two ae-message structures.

Sender	Propositional content	Time	Action type	Receiver
Salesperson	See Table 1	Offer issued	Offer	Customer
Salesperson	An existing Offer	Report issued	Report	Sales Manager

This direction-of-fit, i.e. how the speech act can be related to the world, can be considered in two directions. In certain types of speech acts, the intention is that actions should be performed so that the world is adjusted to the propositional content of the speech act, such as in the Offer ae-message in Table 3. In this case, the propositional content in the offer must be considered as an expression of the car dealer's will to sell the purchase object specified in the propositional content of the offer. The customer, then, has to perform a subsequent purchase act. In other types of speech acts, the intention is to map the propositional content to the world like in the Report ae-message in Table 3.

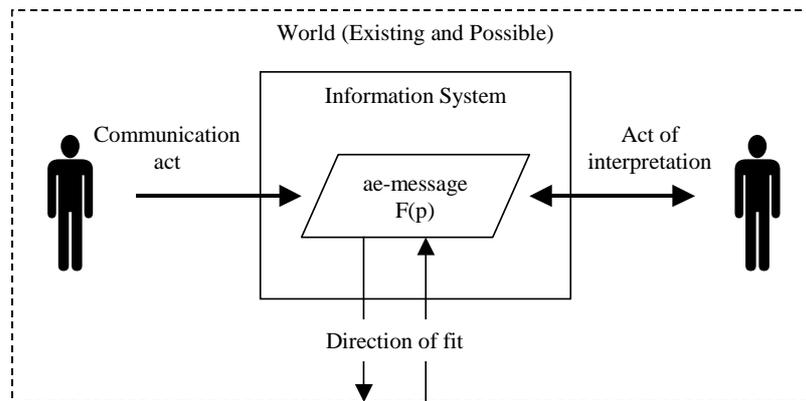


Fig. 3. An information system as a social tool equipped with a pragmatic language functionality used for human communication in a social context.

The offer is considered as an object in its own right in ae-messages of type AE_2 because the car dealer, in this case, reports to the sales manager the existing fact that he has made an offer to a customer, by implicitly referring to the offer as a (deontic) object. Thus, the offer is a significant business action, which is important to be able talk about and to keep track of. We will return to this issue in the next section when showing how the concepts introduced can be used in information modelling.

4 Semantic and pragmatic meaning in Information modelling

To base information modelling on speech act theory means that the propositional content, and thus the semantic meaning, is essential, just as in traditional approaches, since it is used for referring to important objects. For example, the propositional content of the business offer refers to something that is called a purchase object, which refers to a car that the car dealer wants to sell. However it is important to analyse the propositional content together with the illocutionary component. The pragmatic (illocutionary) meaning of an offer is not that it is true that the car referred to exists, which would be the case if the illocutionary component were used for stating a fact. The pragmatic meaning of the offer should be understood as an undertaking of an *obligation* to sell the purchase object referred to, whether it exists or not at the time the offer is issued. This condition has consequences for the information model.

First of all, it implies that the existing car object and the purchase object offered are not really the same object. In this action context, the car company can sell cars that physically exist at the time when the car is offered but can also offer cars that will be built after the customer has purchased the car (i.e. on customer order). It is also obvious that the purchase object and existing car object are not the same since we must allow for existing cars that have not yet been offered. As a consequence we cannot always use the licence number or the vehicle's chassis number as the identifier to refer to the purchase object because these are identifiers used for cars that physically exist. This means that we have to have an identifier that can be used for identifying the purchase object. In the example we have chosen a number to identify the purchase object. The choice and design of identifiers is an important design issue in information modelling [12], and this example shows that taking pragmatic meaning into consideration can help us solve this problem.

Furthermore, information modelling from a pragmatic perspective implies that essential messages and actions must be considered as entities [4]. In the example, the business offer is considered as a thing in the world. It is not just a weak entity or a relationship between purchase objects, salespersons and customers. This is because the offer is as real as anything else for the people involved in the car deal; they need to keep track of it, and to be able to talk about in subsequent acts. These types of deontic objects can be thought of as belonging to the social world [27], because they express social commitments and obligations which are of great importance to the people participating in the social interaction. This implies that we have to describe the offer as an object in its own right and decide how we want to refer to individual offers, e.g. by introducing specific offer numbers (as in Fig. 1). An example of a Class Diagram and the ae-messages that could be produced based on this discussion are depicted in Fig. 4, Table 4 and Table 5.

Table 4. Two ae-messages as results of two distinct business offers.

Offer number	ae-message type	Salesperson	Propositional content	Offer issued	Customer
970322	AE ₁	Eva Eriksson	0100	03/12/97:2.15pm	Sven Larsson
970321	AE ₁	James Howard	0101	18/12/97:10.30am	Jenny Doe

If making a more thorough analysis of the attributes used in the propositional content of the business offer we see that some attributes are related to the speech act as a whole, and some attributes are related to the purchase object (i.e. to the propositional content). Notably, 'price' is attributed to the offer (the speech act) and not to the car (the purchase object). This can be explained from a pragmatic point-of-view. The attribute price has to be understood in the context where the car dealer is saying something about the car in the mode of an offer. The pragmatic meaning is that he is trying to commit himself to sell the car to the customer at the price specified in the offer while at the same time trying to make the customer buy the car. This implies that the price attribute and the value presented in the propositional content of the business offer must be understood in that context. The price cannot be understood only as an objective fact based on a semantic analysis. In car retailing there are a number of different prices, having different pragmatic meaning. For example, there are list prices communicated between wholesalers and retailers. The list price needs to be understood in the context of a wholesaler saying something about the cars in the mode of recommending. The pragmatic meaning is that the wholesaler is trying to make retailers standardize prices. This implies that we have to understand how language is used in order to understand how to ascribe the attribute price to the right object

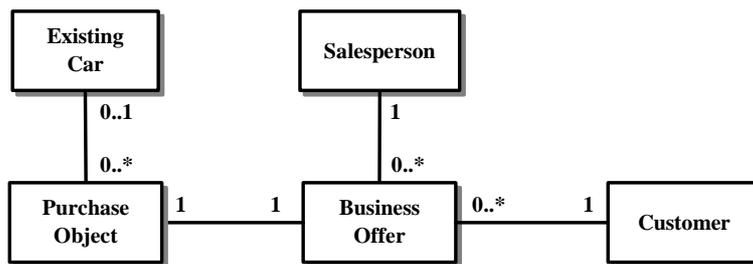


Fig. 4. UML Class Diagram showing how a business offer is related to the actors involved and to (part of) its propositional content.

Table 5. Propositional content describing what is talked about when making an offer.

PC _i #	Type part	Value part
0101	Purchase Object (Car)	1000000
	License number	DCO 096
	Engine	Petrol, Catalytic, 5-cylinder, Transverse, 170hp/125kW, B5254F
	Gear Box	Manual 5-gearred, M56
	Colour	Polar white no. 189
	Extra equipment	S-package: Automatic climate control, Cruise control
	Price	€ 21,000
	Valid until	31/12/97

Another example which shows that the price should be attributed to the speech act is the subsequent purchase order. From a semantic perspective, the price is considered as a mutual attribute dependent on the customer, sales person and the purchase object [14]. However, when the same customer communicates the purchase order concerning the same car to the same salesperson, the price does not necessarily be the one offered. In our example, this is shown by the fact that the price in Table 6 (the purchase order) differs from that in Table 5 (the offer).

Table 6. A propositional content used in offers and purchase orders.

PC _i #	Type part	Value part
0102	Purchase Object (Car)	1000000
	License number	DCO 096
	Engine	Petrol, Catalytic, 5-cylinder, Transverse, 170hp/125kW, B5254F
	Gear Box	Manual 5-gear, M56
	Colour	Polar white no. 189
	Extra equipment	S-package: Automatic climate control, Cruise control
	Additional equipment	-
	Price	€ 20,000
	Valid until	The deal has been made

If we complement the Class Diagram in Fig. 4 with other important speech acts in this business context (the customer purchase order and the business contract), we may arrive at the Class diagram depicted in Fig. 5.

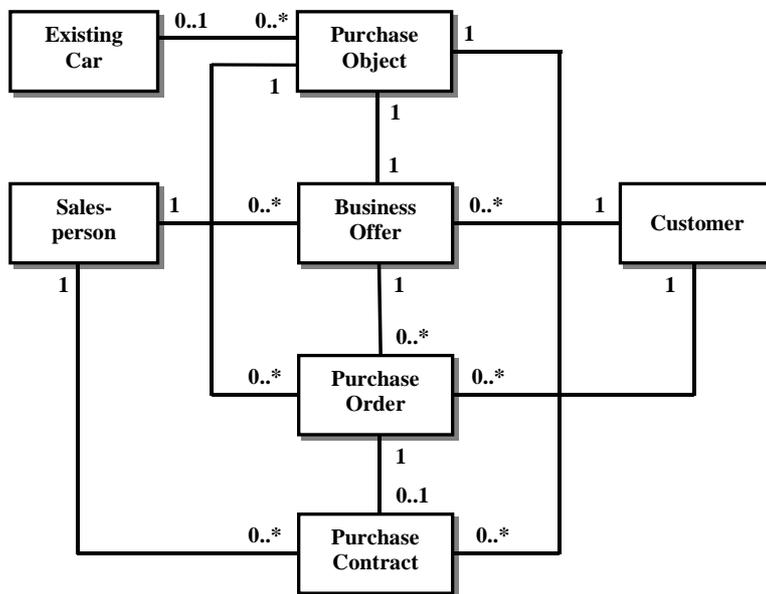


Fig. 5. A ‘complete’ Class Diagram.

5 Conclusion

In this paper we have discussed three central problems in information modelling: the identifier problem, the deontic problem and the predicate problem, and how these problems can be approached if taking both semantic and pragmatic aspects of language into consideration.

First, we have shown how a problem associated with the choice of identifiers (the identifier problem) can be approached by using the concept of pragmatic meaning. In order to choose appropriate identifiers, it is important to understand how these identifiers can be used; such as if they refer to things that exist or things that ought to be. This relates to the way language is used and related to the world – one of the major issues in the philosophy of language. We have shown that it is important to consider the direction-of-fit between language and world in information modelling.

Second, the current trend of founding information modelling on the ontology of Bunge [13] brings some consequences that may be hard to intuitively accept [17]. An important example is that an assignment cannot be a class since there are no ‘things’ in it [14]; i.e. ‘thing’ as in ‘an object that has a separate entity in the real world’ [28]. Based on a study of information modellers, the authors of [17] argue that an assignment can indeed be perceived as a specific object, as a thing. It is as real as anything else for the person who uses it to make sense of the world, although not ontologically sound following [14] (the deontic problem). We have argued that this important insight can be brought further by using the concepts of semantic and pragmatic meaning. Our analyses show that objects such as assignments and offers have to be considered as objects in their own right (as deontic objects). The reason being that these objects are referred to and talked about in the propositional content of speech acts, and that we have to keep track of these objects in the world – i.e. in the social world [27]. Admitting the existence of such objects creates new possible ways of structuring information, which are indeed ontologically sound.

Third, an ontology allowing for deontic objects makes it possible to ascribe properties (the predicate problem) to these objects based on a meaningful use of language. We have shown that ascribing properties can be approached from a pragmatically oriented point-of-view. Using an example we have shown that the price of a car have to be understood in different relationships, where the price attribute is used in the communication between different actors, and that the price have different pragmatic meaning depending on which relationship we are analysing.

Using these concepts in information systems design would ensure that relevant information about important business actions is recorded and accessible and that users can trace who is responsible for information, actions and commitments made through the system. It would also mean that proper identifiers are more likely to be identified, which could affect system performance and ease system maintenance and evolution.

The next step in this research is to conduct further empirical studies in order to, more thoroughly, establish the validity of the suggested approach.

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