UML-Profile for Metamodel-Driven Design of Database Applications

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Abstract: The article presents a UML profile for a software development environment Sharp Architect RAD Studio. This tool is intended to agile design of object-oriented databases. The main part of the article contains the description of the profile metamodel. There is an example of the profile usage. At the end of the article the authors draw some conclusions and plan future works.

Keywords: UML, UML profile, Databases, Object-oriented design, Metamodeling.

1. INTRODUCTION

Object-oriented technologies such as Java and .NET play an important role in software development. A lot of these applications are designed to process a huge amount of information which is saved in database systems. Some of these database systems are object-oriented database management systems (OODBMS). The problem how to model the whole system in a consistent manner is still a challenge because there are no universal modeling standards. Now database applications are created on the basis of an object-oriented approach. A further step is an object-oriented designing of a database. In this case, a developer works within the unified developmental environment. But, in this case a problem to describe a certain application domain using programming environment tools may arise. The solution of this problem is a special UML Profile for a platform. The profile in UML is a tool for adapting the UML language to a particular application domain.

The article proposes a UML-profile for designing an object-oriented database. The remainder of this paper is organized as follows. In Section 2 we discuss related works including a UML Profile. In Section 3 we define UML-profiles for particular platforms. The examples of the apply approach are given in the end of the article. A further development of the approach is discussed in details in the conclusion.

2. RELATED WORKS

Metamodeling has been widely used in modern software engineering. The consortium OMG recommends to apply the profile in two cases [1, 2]. Firstly, it is an MDA technology for programming platforms and languages. Secondly, it is a profile for particular subject domains, such as business modeling. Many authors develop profiles to support their own software.

In paper [3] the authors propose an approach for conceptual design of relational databases based on construction of usage graphs. In paper [4] the authors suggest the profile for designing software for industrial production control. This software works in real-time mode and makes concurrent computing. The profile allows taking this into account. The solution of the similar problem is considered in paper [5]. Model-driven architecture (MDA) is a software design approach for software systems development. The profile is created to support MDA approach for an own environment of designing software. The environment is created on the base of Eclipse.

The work in [6] shows the definition of the profile for software architectural modeling. The work in [7] presents an approach for designing databases for real-time software and developing the profile for it. The rules of transformation the elements of profile to the user types of data are shown. In [8], the authors present a profile for designing applications which loads data into a data warehouse that is for an ETL-system (Extract / Transform / Load). Finally, in [8] the authors present an example of using the profile.

In paper [9], the profile for patterns of object-relational mapping (ORM) is described. The article has an example of mapping a hierarchy of classes into database tables. The work in [10] represents the profile for designing applications of a geographical information system (GIS). The profile is implemented to the

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Enterprise Architect UML-editor. The paper has an example of the subject domain and an example of using the profile. In article [11] the authors describe the profile for designing Web-applications. The authors have developed a special framework to support this approach. In paper [12] the authors offer a MDA-approach for designing mobile applications. The approach is independent from a subject domain or a platform. To support the approach, they developed a special UML-profile.

As mentioned earlier, a UML-profile is also used for describing a subject domain. An example is the SysML and many profiles of business modeling. The separate case is a profile for an ontology modeling as, for instance, OUP (Ontology UML Profile). One of the authors suggested a profile for an object-oriented simulation [13, 14], which can also be attributed in this direction.

A UML profile is not used for designing an object-oriented database because of the enough UML capability. However, an environment for designing object-oriented databases needs a special UML profile. The survey of literature demonstrates that the problem is still being researched. In next section we describe such profile.

3. THE PROPOSED UML PROFILE

Now usually a software design is a Domain-Driven Design (DDD) [15]. In paper [17] we propose an approach called *metamodel-oriented approach*. The metamodel-oriented approach is a next step of DDD development. The metamodel-oriented approach supposes creation of subject domain classes as samples of metaclasses. The metaclass hierarchy was created for Sharp Architect RAD Studio development environment [16] and was tested on various software [17-20].

A database according to metamodel concepts can be designed using a special UML-profile [23]. The profile is called SAUP (SharpArhitect UML Profile) and fits the SharpArhitect RAD Studio programming environment. In this article the authors suggest a new version of a SAUP profile created on a base of UML 2.5 metamodel [2]. The metamodel of the platform for SAUP is the metamodel described in [16]. A general structure of the profile is depicted in Figure **1**.

The *Elements* package comprises stereotypes that reflect entities of the domain. The *TypedAttributes* package defines a set of stereotypes for attributes of classes. The *Data Types* package is a library of types; it is imported from SharpArhitect RAD Studio. There is constraint on *Typed Attributes* stereotypes usage: a stereotype must fit the type of the attribute. The Additional Elements package defines auxiliary stereotypes. The *SAUP Models* package defines a model for the SAUP.

The structure of the *Elements* package is depicted in Figure **2**.

Every stereotype supplies data for the platform metaclass. The *DomainClass* stereotype defines a set of tagged values, which provide a data for the *DomainClass* class (see [16]). The *DomainAssociation* stereotype delivers data for the *Association* and *AssociationEnd* classes. The *EnumClass* stereotype is used for "class" metaclass. The *TypedAttribute*

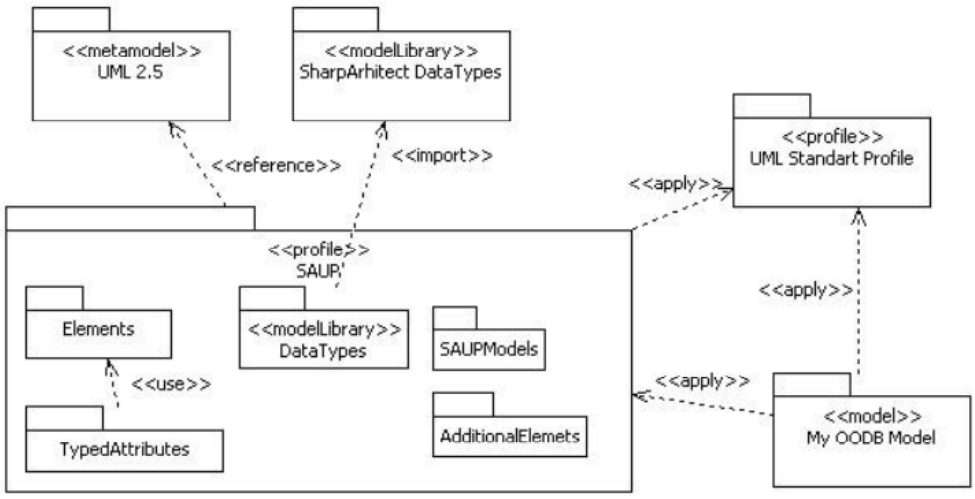

Figure 1: A general structure of the SAUP profile.

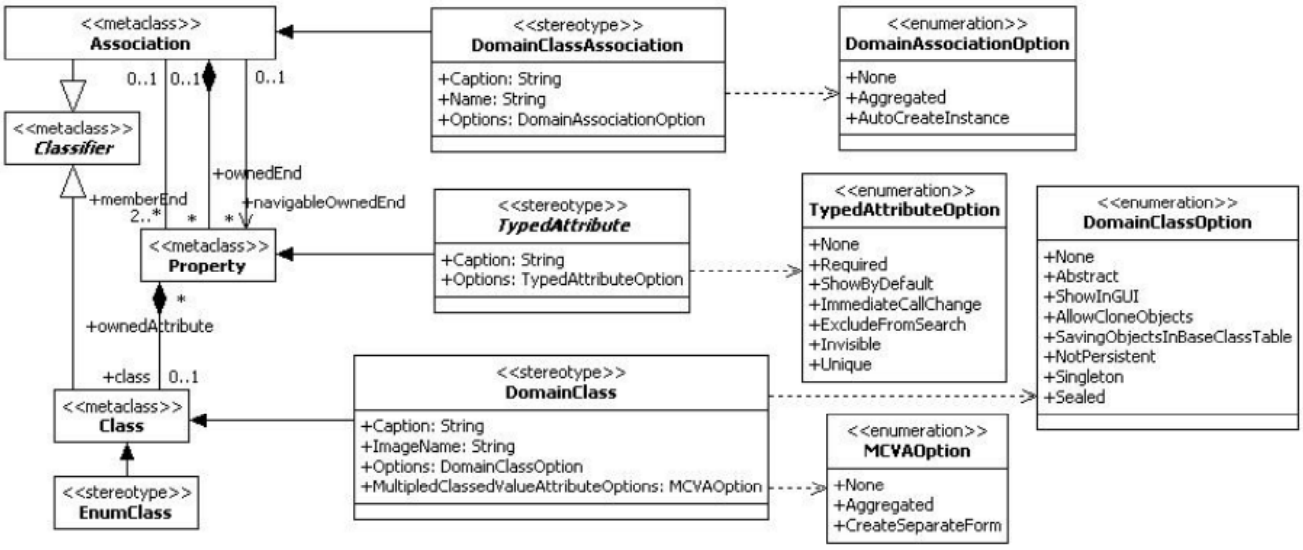

Figure 2: The structure of the Elements package.

stereotype is an abstract stereotype and it is a parent of all stereotypes of data types.

All stereotypes of the *TypedAttributes* package inherit tagged values of the *TypedAttribute* stereotype but nine stereotypes (DecimalAttribute, EnumAttribute, FileDataAttribute, HelperClassAttribute, IntAttribute, MetaModelClassAttribute, TextAttribute, TypeAttribute, StringAttribute) have additional tagged values. The *AdditionalElements* package defines a set of stereotypes that supply additional data for the platform. The *SAUPModels* package defines only one stereotype “SAUPModel” on the base of the *Model* metaclass (from the *Models* package). Thus, from definition implies that SAUP-model is a package.

Let’s consider the profile application example. First of all, the profile was tested on the UMT (unified model of test for a tool) [23, 24]. Another example is shown in a fragment of the class diagram depicted in Figure **3** [26].

The diagram Figure **3** shows classes with DomainClass stereotype. This class is an entity of a subject domain. The classes for standard constructions of objects are called "system class". The BaseRunTimeTreeNodeDomainClass system class enables making an object tree and is marked as the “SystemClass”. The class comprises a *NewAttribute*, this is the way to add a new attribute into a system class. The *InputPaymentParameter* class is a class-parameter and depends on the *Order* class and must

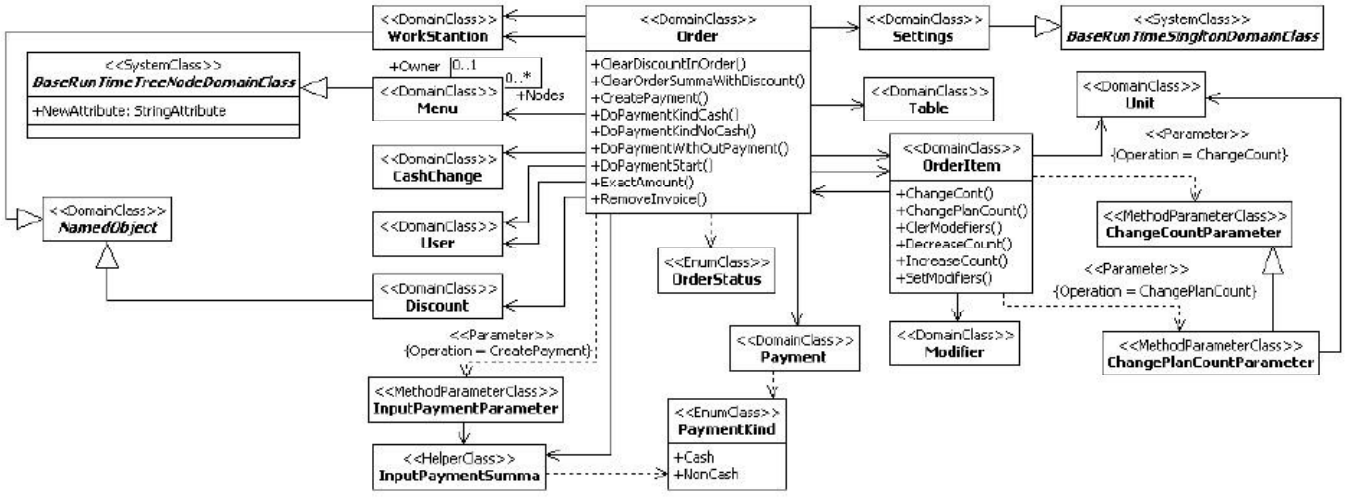

Figure 3: The fragment of the class diagram of the information system for fast food restaurants.

be marked as the “MethodParameterClass”. The dependency relationship is marked as the «Parameter» which has an *Operation* by tagged value. Its value defines a class operation.

4. CONCLUSION

The software engineers are widely using UML profile for designing applications at present times. In this paper we have discussed a metamodel-oriented approach for designing databases. Moreover, the authors have developed the UML-profile for it. The profile greatly facilitates a database designing in the development environment.

In future, we plan to extend the profile for describing the rules of visualization, validation and class methods.

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