Object-oriented tools for advanced applications
(an extended abstract)

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Abstract

This paper contains a brief discussion of the Application Development Environment (ADE) that is used to build database applications involving the graphical user interface (GUI). ADE computing separates the database access and the user interface. The variety of applications may be generated that communicate with different and distinct desktop databases. The advanced techniques allow to involve remote or stored procedures retrieval and call.

Introduction

Recent research activity generated not only the valuable advance in understanding the nature of object but stimulated the experimental efforts in development of the object-oriented tools.

Here is briefly discussed the Application Development Environment (ADE) that is used to build database applications involving the graphical user interface (GUI). ADE computing separates the database access and the user interface. The variety of applications may be generated that communicate with different and distinct desktop databases. The advanced techniques allow to involve remote or stored procedures retrieval and call.

According to an object-oriented tradition [Gro91], ADE include some basic features of inheritance, encapsulation, and polymorphism. They are used to derive an actual object to cover the needed information resources.

The potential object (PO) is composed with the menu (M), data access (DA), and modular counterparts (MC). The Ancestor Potential Objects (APO) contain the menus, events, event evolver, attributes and functions (that are encapsulated). The Descendant Potential Objects (DPO) are inherited from APO.

The aim of the current contribution is to give a brief profile of the ADE project without any detailed mathematical or implementational consideration. Nevertheless, some mathematical background corresponds to the references [Gro91, He95]. Other less traditional for the database area ideas are due to Wol96 to conform the object computation strategies. The main ADE building blocks have the relative uniformity to resolve the modular linkages. ADE enables the host computational environment to extend the properties of the distinct MC.

1 Event driven objects

The MC is a holder of all the controls to communicate with the user. The event is assigned by the user call (for instance, clicking) or selection. Thus, when the activity is initiated, the following main events may be triggered: respond to a request from the user application, database retrieval or updating. The possible order of the events is prescribed by evolver and is determined by the scripts. A fragment of the event driven procedure is shown in Fig. 1.

1.1 Menu

Menu gives more flexibility to the attribute selection. Usually the lists of possible attributes are supported to give the developer or user more freedom. Menus are established to be encapsulated in APO and are inherited in DPO.
1.2 Particular application

The particular application is derived from Potential Object Library (POL) giving rise to Actual Object Libraries (AOL).

2 Computational and relative backgrounds

ADE concepts are based on a variant of computation theory for information systems. The object-oriented programming, data base and knowledge base engineering are included. Some vital concepts have clear mathematical representations: data object that represents the computer stored data; metadata object that represents the conceptual information; assignment that captures more dynamics and intrinsic states; expandible database that represent the individualized self contained object couples. The main feature of the general approach is in embedding the typed entities (also the variable concepts) into the typeless system that is based on the a theory of the variable concepts. The last one is fitted to capture the dynamics of different objects and switching the states in the information systems. The prescribed modes in the information systems as a rule are corresponded to the known classic cases: the relational database theory, frame theory and logical reasoning in knowledge systems, theory of programming. The implementation results in a non-Coddian notion of (relational) database management system. Coddian type of database is equipped with the first order relational logic but the current data objects' base needs a higher order logic with the descriptions. To extract its possible advantages the unified architecture based on extensible data objects' model is proposed. It supports the main object-oriented mechanisms of encapsulation, polymorphism and inheritance and contains five major components. They are Conceptual Shell (CS), Application Development Environment (ADE), Basic Relational Tool System (BRTS), and MetaRelational Tool System (MRTS). Some general counterparts neatly corresponding to ADE are reflected in Fig. 1. These subsystems are relatively self-contained, and incorporated into the ToolKit. BRTS supports relational interfaces (extensional level), MRTS adds the intentional level, and the pair <BRTS, MRTS> gives the enhanced relational features. ADE contains the extensible data objects' model and manipulates the switching or variable concepts (references may be found in [Volb96a]). Both BRTS and MRTS are embedded into ADE. CS adds an external interactive mode to maintain and generate applications.

3 The relative approaches

The ADE notion is based on the theory of variable concepts in the form of variable sets originate from F.Lawvere investigations carried out in 1970's. These constructions were used in elementary category theory, in particular in representation of predicate logic. Until present time these results were of interest only for theoreticians. In computer science variable sets are used in the form of variable domains' theories in denotational semantics of programming languages (pioneer investigations by C.Starchey & C.Wadsworth [1974]).

Variable collections (sets) are more widely used in computer science in the form of approximation lattices (works by D.S. Scott commenced in 1969, [Scott7]) with employing infinite domain. An attempt to formalize an idea of 'information system' with infinite domain is known as continuity principle and called Scott-Base's thesis. In the early 1980's D.S. Scott resumed his analysis of the idea of variable domains because of the nature of lambda-calculus models and related formal systems (like combinatory logic) having been elucidated. Logician H.Curry and his school independently investigated the concepts of the 'object' and the 'substitution' in order to render theoretical computer science with the trustworthy representations from the early 1960's (in fact, even earlier). The results obtained by H.Curry-D.S. Scott became the mathematical foundations of modern computer science and inspired many subsequent works, e.g. D.Turner ([1979] applicative programming), T.Hughes ([1982] supercombinators in programming), P.-L. Curien et.al. ([1985] categorical combinatory logic in programming), P. Frade et.al. ([1990-91] functional programming languages reducible to collections (systems) of combinators). All these investigations as well as adjoining contemporary works employ the idea of 'object' borrowed from the combinatory logic (in the sense of Curry-Scott). The analysis of problems arose and, in particular, representation of transition processes in information systems (dependency of program code on the basis of combinators, transition from some basis to another etc.) reflects the principle effect of varying the primary established objects. The attempts of partial solutions do not result in an adequate mathematical apparatus. Some advance was done within the applicative computational framework (see references in [Wol96a]).

4 Applied research

The starting point for ADE project originates from the various object notions.

Known results in the field of relational data bases (originated from works by E. Codd and his school [1972 and later]), in the field of conceptual modelling (M.Brodie [1984 and later]), in the field of knowledge based systems (including inference and transformation mechanisms) chiefly deal with established modes of information systems. Establishing the representation of a concept as invariant on variations, creating the tools of 'evolving the concept' as a mathematical process overtake these essential difficulties and are put into fundamentals of analysis an information system dynamics (also the transition or switching processes). Developing the theory of variable concepts naturally arises from the very process of creating theoretical foundations of computer science. Information systems contain besides database (DB) also the metadata base (MDB) that does include different facts concerning database. In applications metadata bases are used as the components of knowledge system with knowledge bases. Both parts, DB and MDB communicate each other and the host computational environment of information system. The relative ideas were understood from 1987 in the nine known research projects of extensible database systems. De Witt ([1988] and later) gave a brief comparison and further directions of the possible research. The main ideas were concentrated on a model of data. Even the project without any pre-defined data model was proclaimed, but the desirable degree of flexibility was not achieved. The most prominent experiments with experimental (object-oriented) extensible system have used the molecular chaining of objects to avoid the known difficulties in designing and development. But the completed solution was not obtained neither in a theory nor in practice. The design of the systems which accumulate and process both information and metadata does influence the effectiveness of information system, the efforts of its designing, maintenance, modifications and extensions. This results in the problem of designing the Application Development Environment (ADE) which communicates with the varying DB...
5 Objectives of the proposed ADE conception

ADE is both the research project and tool kit aimed at development of the mathematical apparatus, models and methods which being considered together comprise a variant of theory of computations for object-oriented programming technology, database management systems and knowledge based systems. The research aims were establishing and experimental issues of some generic concepts in computer science: data object to represent the storable data; metadata object to represent the conceptual information; assignment to represent internal states and dynamics; extensible database to represent relatively self-contained couples of objects and some additional derived concepts. All of these notions are important to succeed in ADE development. At the present time in computer science there are proper means and methods to handle static application domains. And there is an appropriate mathematical apparatus as well. But the work with dynamic application domain is still a problem unsolved also in mathematical aspect. Other aspect of the proposed research is to verify the feasibility of previously aimed generic concepts. Thus the implementation of a prototype information system will assist in understanding the dynamics of data objects both within tool and applied (programming of information) system.

6 ADE contribution to the research activity

ADE has under research the idea of a concept as the variable entity to possess the creation of the variable concepts and associated transition effects. In their turn the variable concepts lead to parameterized type system. The approach developed in ADE is based on the reasons stated. The usage of the method of embedding typed system (including the apparatus of variable concepts) into untyped system based on the apparatus of Applicative Computational Systems (ACS) is the distinctive feature of the approach being developed. Combining the ideas of variable concepts will make possible development of a wide range of applied information systems, particularly in the field of data base management systems, knowledge based systems and programming systems.

7 General features

ADE is viewed to be a comprehensive research as follows:

- establishing the primitive frame to represent and analyze a ‘variable concept’;
- setting up the approach to integrate the far distant concepts, means and models from computer science branches;
- developing methods to adopt some intentional concepts of computer science that naturally result from the idea of ‘variable concepts’ and their potential applications;
- creating the tool kit to explicate and apply the advantages of variable concepts;
- augmenting the possibilities of host programming system;
- specifying the enhanced data models;
- fixing the possible ranges of design and development those systems that involve the idea of data/metadata object;
- creating the generalized tool kit on the basis of the mathematical concepts in the current contribution.

The target prototype system Application Development Environment (ADE) is mainly based on the idea of variable, or switching concept and covers the vital mechanisms of encapsulation, inheritance and polymorphism. Variable concepts naturally generate families of similar types that are derived from the generic types. Concepts in ADE are equipped with the evolvents that manage the transitions, or switching between the types. In particular, the identity evolvent supports the constant concepts and types (statical concepts). To achieve the needed flexibility a general ADE layout consists of the uniform modular units, as shown in Fig.

In ADE Data Object Definition Language (DODL) contains the construction of data objects’ base scheme as a relation between concepts. Concepts are included into the type system with the interpretation over the variable domains. A coherent set of variable domains generates the data objects’ base. Basis to maintain the data objects in use and their bases is generated by computational models with applicative structures. The developer obtains the set of the means that establish, support and modify the linkage between the data objects’ base schemes, data objects’ base and computational models. DODL declares: type system as a set of metadata objects; em linkages between the types; system of domains; linkages between the domains; extensions of domains and types; computational tools of applicable pre-structures and structures.

The third part of the implementation supports two level of interfaces. The first is the Intentional Management System (IMS) to support concepts (metadata objects) of different kinds, and the second is associated Extensional Management System (EMS) to support the appropriated extensions (data objects) generated by the intentions.

EMS is embedded into the unified computational model. It is object-oriented extensible programming system Basic Relational Tool System (BRTS). BRTS has the fixed architecture with the one level comprehension, separate self-contained components, interfaces and languages. It is the First Order Tool (FOT) and generates ‘fast prototypes’. D(M)DL and D(M)OML of BRTS contain the SQL-based relational complete languages that cooperate with ADE. BRTS mainly supports relatively large number of low cardinality relations (extensions) and supports Data (Metadata) Object Model D(M)OM with retrieval, modifications and definitions of a storable information.

IMS is also embedded into the computational model and supports a numerous metadata objects. Their amount is almost the same as for data objects. IMS is based on D(M)OM with a simple comprehension to manage metadata base and is supported by MetaRelational Tool System (MRTS). MRTS manipulates with the metatables (concepts) and metarelations (frames) and is embedded into ADE.

8 New supporting technologies

A main result is the experimental verification of variable concepts approach. This would be applied to develop the variety of applied information systems.

Computations with variable concepts and appropriated programming system allows to built a system especially to manipulate the objects. All of this results in an apparatus for analysis the branches of object-oriented approach:

- programming in terms of concepts. This generalizes the programming in terms of superobjects;
Figure 2: Application Development Environment: ADE. Abbreviations: GUI - Graphical User Interface; POL - Potential Object Library; PO - Potential Object; AOL - Actual Object Library; AO - Actual Object; DPO - Descendent Potential Object; R-level - Representation level; S-level - Storage level
object oriented database (management) systems. The database extensibility, development of databases with varying data models, dynamical databases, analyzers of 'data object' dynamics, the 'bases of invariants' etc. would be achieved;

knowledge base systems grounded on the concepts which are metadata objects. Maintenance of the systems of 'variable concepts' and their interrelations, management of switching the systems of concepts, management of database modification etc.

9 Usage of intentions and extensions

ADE gives a smart framework for intentions and extensions and intentional tool/applied system. It enables the possibility to develop the conceptual support that encircles the adjunct ideas:

establishing the logical apparatus (on the basis of higher order theory) to study the hierarchies of variable concepts;

development of specialized 'tool theories' to estimate a selective power of newly designed programming systems, database systems and models for systems with databases and knowledge bases;

support and development of specialized semantical theories and models for systems with databases and knowledge bases.

Possible applications of this framework: 'rapid prototypes' of newly developed computer information systems, estimation of their ranges, adaptation to variations in problem domains, demands, programming systems, experts. The specific feature of architecture: two levelled design - intentional and extensional levels.

10 Improvements in design, engineering and management processes

At present it is difficult to estimate real benefits of using the apparatus of variable concepts in particular applied information systems because of the newness and the originality of mathematical apparatus being developed and the approach on the whole. The possible gains and prospects that may be yielded by the ADE approach are set forth below:

high degree of generalization; taking into account the intentional features ('subjects', 'dynamical scripts', etc.); relative simplicity of interfaces; possibility to aggregate/disaggregate the representations; clarity, referential transparency and fully explicit constructions; possibilities to handle collections of objects or concepts; the modular implementation to cover the higher order logic.

11 Experimental techniques, Software, and Tools

The feature of current research is in primary creation of the needed tool system to be adequate to the newly generated mathematical apparatus. The experimental research and verification of the obtained model is based on prototypes - CS, ADE, BRTS, BMRS. The difficulties to implement full scale prototype are resolved by the high level object-oriented programming language. Some candidate programming systems are tested to enable the needed computational properties. After that the main programming tool kit is selected. Preliminary candidate tools were C++ or Modula-2. An intention is paid to select an appropriate database management system. If needed the original DBMS is attached. At the preliminary tests the attention was paid to OLE-2 techniques.

Some ready made original systems were tested and expanded to achieve the prototype system with the properties mentioned (by E.Codd, by N.Roussoupolos).

Conclusions: interpretation of the results

The resulting two level comprehension model and computational environment verify the feasibility of the approach. The adequate, neutral and semantical representation of data is the target in the sphere of extensible systems and their moderations and modifications. The relational solutions are the criteria in database technology. Therefore, the variable concepts generate the power and sound representation of data objects, have the boundary conditions as the known results in information systems (both in a theory and applications) and capture the additional effects of dynamics to simulate, in particular, the encapsulation, polymorphism and inheritance. The last gives the contribution in development of object-oriented systems.

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