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REVIEW ARTICLE

APPLICATIVE APPROACH TO PROVIDING A CONCEPTUAL VISUALIZATION

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ABSTRACT

Applicative approach for a getting means for a computer-aided conceptual visualization is presented. We use a term "conceptual visualization" for conceptual information which is intended for a visual graphical representation of data in a form of structured and unstructured descriptions of a domain objects and their relations. An analysis of wide classes of computer-aided tools for such conceptual information processing is given. The constructed model provides extensibility of modeling tools which is reached due to support of computational character of the model. Extensibility provides possibility of an introduction of schemes of typification of objects. They allow getting formalism for a description of data domain. A set of basic combinators representing basis units for creation tools for conceptual data processing may be so offered. An applicative character of the offered computational model allows to have a method of its further implementation by using applicative tools.

INTRODUCTION

A computer-aided conceptual visualization requires determining special kinds of such information and ways to work with them. Let use a term "conceptual visualization" for conceptual information which is intended for a visual graphical representation of data in a form of structured and unstructured descriptions of a domain objects and their relations. Use such information in information systems in practice assumes development of the appropriate means of processing coordinated with the selected conceptual structure. The correct method of achievement of it assumes a creation of a computational model of graphically oriented conceptual data and applicative means of handling them (Wolfengagen, 2014). Such kind of a handling data, in turn, demands to have a specialized language and tools for determination such data. We will mark that actually the range of such means is rather wide: from conceptual systems of interpretation to the appropriate abstract machines (Ismailova and Kosikov, 2010). Essential feature of the considered task is need for supporting an extensibility of modeling tools which is reached first of all due to support of computing character of model. One of most convenient for this purpose formalism is a formalism of applicative computing systems (ACS) (Wolfengagen, 2010, Ismailova, 2014).

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At the level of fixing of objects of a data domain use a lambda calculus (Barendregt, 1992) is justified because it provides the most compact description of abstraction process which is one of the main operations of conceptualization. An important advantage of applicative computing systems using is possibility of a support of flexible schemes of an object typification (Ismailova and Kosikov, 2010). Use of the methods of a typification accepted in the simple type theory is convenient for a description of types of basic graphic objects. Different types of polymorphism determination of generalized (generic) types may be used for defining methods of a processing applicable to some classes of constructions of the description of data domain which are in this or that sense uniform. A computational model of graphically oriented conceptual data presented in the form of the applicative computing system can be provided with means of support of applicative type.

Related work

Approaches to processing of the conceptualized graphic information were researched by many authors under different point of view. So, possibilities of a support of a processing of the conceptualized objects can be collocated both to features of different graphic formats, and to classes of graphic processing supporting tools. It is natural to correlate methods of processing of graphically oriented conceptual data first of all to the existing formats of graphic data representation. It is known that there are two large classes of graphic formats – raster and

vectorial ((Bhattacharya, 2011; Alkoffash *et al.,* 2014). However in the context of this article vectorial formats are of interest first of all. It is connected to that the existing methods of processing of raster formats, as a rule, are oriented on the local information contained in a raster format and, as a result, aren't adjusted for separation conceptualized information. Filters of the Adobe Photoshop program and similar to it can be considered as a common example of use of raster formats. It is necessary to mark that even separation of boundary between two areas which are differently colored in case of such approach is a problem. The analysis existing attempts of conceptualization of raster information (Novak and Canas, 2008) lead to approach based to a separation of an objects (monophonic areas of the image, boundaries of areas, graduated fills, etc.) which are indeed poorly connected to objects of data domain. Besides, establishment of such link usually happens on the basis of the separation of the intermediate level of the abstraction based on a separation of fragments of the image and describing rules of a separation of fragments of the bitmap image, and also their linking with objects of data domain. Such intermediate level can be considered as a peculiar vectorial format and by that joins in a context of this article.

Such systems on the basis of an analysis of low level graphic primitives of the given object carry out its interpretation in terms of higher level. It is necessary to mark, however, that the selected images usually are standard (letters and other characters of a font, the conventional signs, etc.). Besides, conceptualization is carried out only in one direction – from the low level to high, the reverse transition usually isn't supported.

An intermediate level is occupied by Computer-Aided Design systems like CAD. In such systems rather high level of conceptualization is combined with developed opportunities of graphic processing. However such systems are, as a rule, oriented on rather specific areas of applications (mechanical engineering, architecture, etc.) that complicate their use in the other domains. An interesting approach is shown by systems of a schematization (scheme diagramming Bounford, Trevor, 2000) like concept maps (Cañas *et al*., 2003; Beel and Langer, 2013). In such systems specialized graphic descriptions may be built by using rich enough graphic means. In particular, a display of different types of conceptual structure, the description of hierarchies, classifications, etc. is possible.

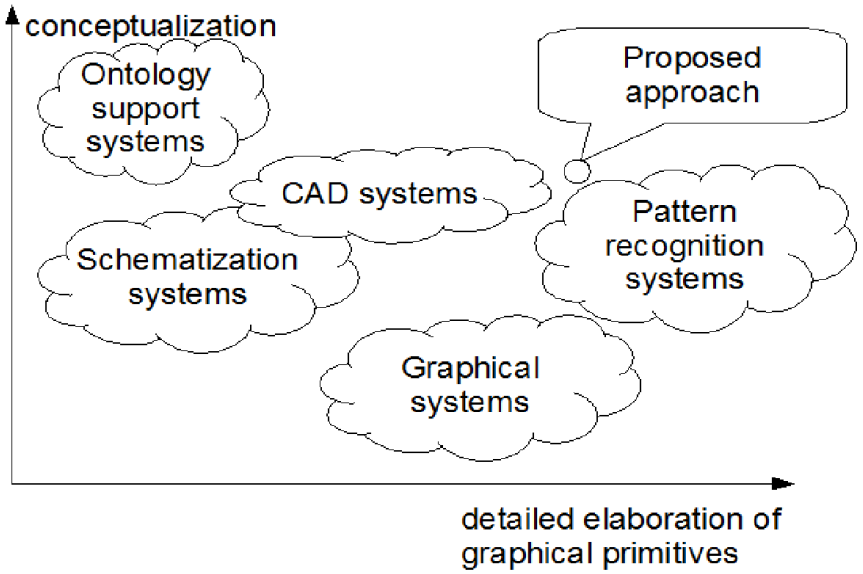

Fig. 1. Approaches to the description of graphically oriented conceptual information

Reviewing of the existing vectorial formats shows that they provide the graphic information or as a set of separate graphic elements (DXF), or as a hierarchical nested structure (SVG). More developed means of operation with vector graphics (PostScript) also use model of graphical representation in the form of a set of graphic elements (Postscript, 1992). The list representation accepted, in particular, in AutoCAD system which potentially is capable to provide the computed variability of graphic representations, and appropriate tools – list processing languages such as Lisp (Ismailova, 2014) appears natural representation of a set of graphic elements. One of the ways of processing of graphic information which may be considered as a conceptualization is used in pattern recognition systems (Alkoffash *et al.,* 2014). Though such systems can be considered as the universal for a determined class of data domains, but usually they badly provide extensibility of the used graphic means (especially methods of composition of means) and methods of their communication with semantic information in need of specification of the description of data domain (Horrocks et al., 2005). The approach offered in this article is oriented on the description of graphically oriented conceptual information at higher level, than it is provided in formats of graphic data or pattern recognition systems. At the same time more detail description of graphic primitives, than is provided in systems of conceptualization of a general purpose. The place of the offered approach among others conditionally illustrated in Fig.1.

Conceptual operations

Let consider some set of operations. We will suppose that this set has an enough general form for building practically useful systems of describing graphically oriented conceptual information and ways for a manipulation with it. It seems that such set has to involve: search operations, operations for DB modification and specialized conceptual operations. It is supposed that in a case of execution of specialized operations as an extensional of argument of operation the full set of conceptual constructions (Coquand, Huet, 1988) received at a certain stage of the domain description (Strachey, 2000) is used. Computation of an extensional of such operations happens according to the uniform scheme provided below.

A. Search operation may be viewed differently. Searching may be done as for the purpose of selection of the data meeting peep conditions as well as for check of, whether the data meeting a condition are available. We have to note that to different operations in the conceptual model correspond, generally speaking, different quantifiers though interpretation of operations isn't reduced to interpretation of quantifiers.
The most typical operation of search is considered as having the following type: CBag → CBag where the argument of an operation represents a DB status, and result of it is interpreted as a set of the selected conceptual constructions.
It is set by the function:

fs: CGIType → B (function of a search criterion)

where B = {true, false } – the semantic domain of truth values. Computation of an extensional of operation is made as follows

F ({}) = { }

F (c + b) = if Fs (c) then c + F (b) else F(b)

where function of selection of conceptual constructions Fs: GCIBag → B is defined as follows:

Fs ({}) = false

Fs ((t, v) + b) = if fs (t) = true, then true, else Fs (b).

It is possible to carry out synthesis of determination for involving in to reviewing more difficult search criterions.

B. Operation of modification is considered as having a type: CBag → CBag,

where an argument of an operation of modification is an initial state of database and a result is interpreted as modified state of the data base. This operation is defined by the couple of function.

f_s : CGIType → B (function of type selection)

f_v : CGIVal → CGIVal (modification value function)

A computing of an extensional of an operation may be done by the function F : CBag → CValBag. It is defined as follows:

F ({}) = {}

F (c + b) = Fv (c) + F (b),

where function of modification of a conceptual construction Fv : GCIBag → CGIBag is defined as follows:

Fv ({}) = {}

Fv ((t, v) + b) = if f_s (t) = true, then (t, f_v (v)) + Fv (b), else Fv (b).

C. Specialized conceptual operation is considered as having a type CBag → CValBag. It defined by the couple of functions

f_s : CGIType → B (type checking function)

f_v : CGIVal → CGIVal (function of value).

Computation of an extensional of the conceptual construction may be done on the base of these couple of functions and by the function F : CBag → CValBag, defined as follows

Fv ({}) = {}

Fv ((t, v) + b) = if f_s (t) = true, then f_v (v) + Fv (b), else Fv (b).

It may be possible to get different kind of specialized conceptual construction by defining differently type checking functions. Let consider basic practically useful kinds of conceptual operations. 1. Selection

In this case function of value computation is a identity mapping

$f_v = \lambda x.x$

Selection combined with a projection

$f_v = \lambda x.Pr(x)$

Pr {} = {}

Pr (x + y) = p (x) + Pr (y)

and, thus

Fv ({}) = {}

Fv ((t, v) + b) = if f_s (t) = true, then Pr (v) + Fv (b), else Fv (b).

Aggregate function

$f_v = \lambda x.\lambda y.x + y,$

where operation "+" is understood as a specialized aggregating function.

Conclusion

An approach to creation of the conceptualized means of graphical representation of objects of data domain and their processing on the basis of a computational model of an

applicative type is offered. The applicative computational model on a lambda calculus basis is constructed and means of its support in a form of a set of the specialized combinators providing representation and processing of graphically oriented conceptual data may be offered. The constructed model provides extensibility of modeling tools which is reached due to support of computing character of the model. Extensibility provides possibility of introduction of schemes of a typification of objects. They are adequate to formalism of the description of data domain. Standard tasks of processing and the appropriate conceptual constructions are considered. Applicative character of the offered computational model allows offering a method of its further implementation with use of tools of applicative type.

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