

Part III

Chapter 10

Binding

10.1 Introduction

This chapter deals with the idea of bindings between objects. Bindings and the binder that provides them are clearly associated with the structure of a system of objects. When describing systems of interconnected objects, it is possible to separate the objects from the structure that interconnects them. There then results a description of the collection of objects and a description of the interconnections between the objects. The latter can be interpreted to provide bindings and in some cases connections between objects.

The description of the structure of a system of objects requires the expression of three kinds of concerns:

- ▶ a belief that two objects may interact, which is modelled by an **association**.
- ▶ a knowledge that two objects can interact, which is modelled by a **binding**.
- ▶ a knowledge that two objects will interact, which is modelled by a connection.

One way to provide the structure of a system is to introduce a **representation of structure**. The representation of structure is an object that is a replica of the configuration of some real or imagined system of connected objects. The representation of structure is a **specialized representation** (as introduced in chapter 9) and consists of a structure interpreter that interprets a structure denotation.

A structure interpreter is a special purpose interpreter that can interpret a structure denotation. A structure interpreter, together with a structure denotation behaves as a configuration, as described in Chapter 7.

The structure denotation imposes a constraint on the structure interpreter, so that it provides the configuration of a prototype. A structure denotation of a system of objects is a denotation of the configuration of that system. The configuration is the prototype. Because the denotation can exist without being interpreted in connection with the objects it assumes are in the

configuration, the denotation identifies a belief that the objects are connected. It is not until an appropriate structure interpreter and collection of objects are provided, that this belief may be turned into an actual configuration.

A structure denotation that is restricted to pairwise connections between objects, is a collection of associations. Each association identifies a belief that two objects may interact and is a denotation of a connection.

Not all the structure of a system need be identified in the structure denotation. Any structure that is not in the denotation must be made explicit. The part of the configuration that is identified by the structure denotation is called the interpreted configuration.

The combination of a structure interpreter and a collection of associations is called a **binder**. A binder can provide a binding between one object and one of a collection of other objects. This is similar to the mathematical notion of binding. In some special circumstances, a binding may be replaced by a connection, for the purpose of analysis of a model. Sometimes no connection seems possible; for instance when a variable is bound to a value. A value in an abstraction and interactions with a value are clearly impossible. In a model, a connection with an empty alphabet may be specified.

A binder that can be controlled from a controller, such that different bindings are possible, is described as a dynamic binder.

10.2 Reference section

The manual pages that follow contain the description of the concepts of

Representation of structure

Structure interpreter

Association

Collection of associations

Interpreted configuration

Binder

Dynamic binder

Binding

NAME

Representation of structure

PURPOSE

To provide a replica of the configuration of a system of objects.

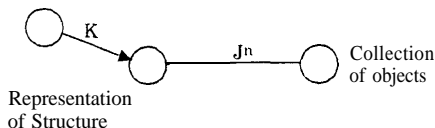
SYNOPSIS

A representation of structure is a replica that is constructed from two objects: one is a structure interpreter, the other a structure denotation. The representation of structure replicates a structure of some system of objects.

CANONICAL FORM

A representation of structure is represented by an hierarchical arrangement of two objects. as illustrated in Figure 10.1, where a representation of structure is connected to the rest of the system, in the form of a collection of objects.

Figure 10.1 The representation of the structure consists of two objects



SPECIFICATION

REALIZABILITY ISSUES

SEE ALSO

REPRESENTATION
STRUCTURE INTERPRETER
STRUCTURE DRNOTATION
COLLECTION

FUTURE DIRECTIONS

Provision of the specification.

NAME

Structure Interpreter

PURPOSE

To interpret the structure denotation.

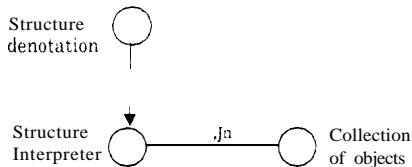
SYNOPSIS

The structure interpreter is a special purpose interpreter, that can interpret structure denotations. When connected to such denotation, the structure interpreter acts as the configuration defined by the denotation.

CANONICAL FORM

In Figure 10.2 a representation of structure is decomposed into structure interpreter and a structure denotation. The structure interpreter is connected to the rest of the system, in the form of collection of objects.

Figure 10.2 A structure interpreter

**SPECIFICATION****REALIZABILITY ISSUES**

The interpreter must be able to decode the structure denotation.

There can be different kinds of structure interpreters, for different styles of interactions between objects. A structure interpreter that can deal with a call and return style of interaction for instance is called a node in the Computing projection.

SEE ALSO

REPRESENTATION OF STRUCTURE
STRUCTURE DENOTATION

Binding

ANSA Reference Manual

STRUCTURE
INTERPRETER

INTERPRETER
DENOTATION
REPRESENTATION

FUTURE DIRECTIONS

Provide specification. Possibly identify different kinds of structure interpreters, for the various interaction styles.

NAME

Structure denotation

PURPOSE

To impose a constraint on the structure interpreter, so that it provides the configuration of a prototype.

SYNOPSIS

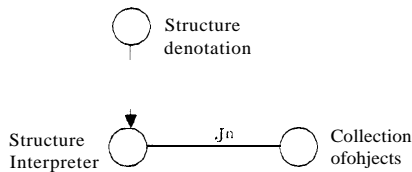
A structure denotation of a system of objects is a denotation of the configuration of that system. The configuration is the prototype. The prototype does not have to physically exist. It may be an idea in which case we must believe that the denotation is a denotation of the abstract prototype.

The denotation may exist in isolation, that is, it may exist and be interacted with directly and not through the structure interpreter. In such a case, the structure denoted by the structure denotation identifies a belief about how objects in a collection of objects may be connected. Without an interpreter and the objects in question interactions may never take place.

CANONICAL FORM

A structure denotation is represented by an object in object diagrams. Since it concerns a denotation, it must be interpreted, if it is to have any effect in a system. In Figure 10.3 a structure denotation is interpreted by a structure interpreter, that is connected to the rest of the system, in the form of a collection of objects.

Figure 10.3 The structure denotation in a system



SPECIFICATION

REALIZABILITY ISSUES

An interpreter, that can interpret the structure denotation, is required.

SEE ALSO

REPRESENTATION OF STRUCTURE
STRUCTURE INTERPRETER
COLLECTION

FUTURE DIRECTIONS

Provision of the specification.

NAME

Association

PURPOSE

To represent a denotation of a connection between two objects.

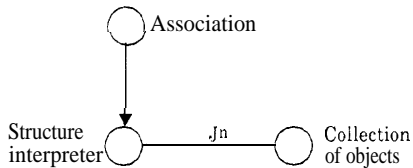
SYNOPSIS

An association associates two objects. An association is a denotation of a connection between two objects; it denotes a part of a system structure. An association identifies a belief that two objects may interact, rather than a fact about the existence of a connection. Associations can be part of a more elaborate structure denotation.

CANONICAL FORM

An association is represented by an object in object diagrams. Since an association is a denotation, it must be interpreted, if it is to have any effect in a system. In Figure 10.4 an association is interpreted by a structure interpreter, that is connected to the rest of the system, in the form of a collection of objects.

Figure 10.4 An association as an object



SPECIFICATION

REALIZABILITY ISSUES

An interpreter that can interpret the association as a denotation required to turn the belief of possible interaction into actual possible interaction.

Binding

ANSA *Reference Manual*

ASSOCIATION

SEE ALSO

REPRESENTATION OF STRUCTURE
STRUCTURE INTERPRETER
DENOTATION

FUTURE DIRECTIONS

Provision of specification.

NAME

Collection of associations

PURPOSE

To represent a denotation of a collection of pairwise connections between objects.

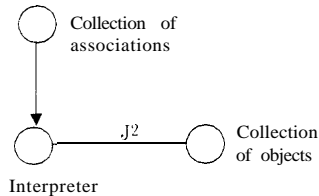
SYNOPSIS

A collection of associations is a specialization of the general notion of a structure denotation. A collection of associations denotes a structure of objects in which the objects are associated in a pairwise manner, because an association is a denotation of a connection between two objects. A collection of associations identifies a belief that objects may interact in a pairwise manner. It does not present any facts about the actual existence of any connection.

CANONICAL FORM

A collection of associations is represented by an object in object diagrams. Since a collection of associations is a structure denotation, it must be interpreted, if it is to have any effect in a system. In Figure 10.5 a collection of associations is interpreted by a structure interpreter, that is connected to the rest of the system, in the form of a collection of objects.

Figure 10.5 A collection of associations as an object



SPECIFICATION

Binding

ANSA *Reference Manual*

COLLECTION
OF
ASSOCIATIONS

REALIZABILITY ISSUES

An interpreter, that can interpret the collection of associations as a denotation, is required to turn the belief about possible interactions into actual interactions.

SEE ALSO

ASSOCIATION
REPRESENTATION OF STRUCTURE
STRUCTURE DENOTATION
STRUCTURE INTERPRETER

FUTURE DIRECTIONS

Provision of specification.

NAME

Interpreted configuration

PURPOSE

To describe that part of the structure of a system of objects that is governed by a structure denotation.

SYNOPSIS

Only part of the structure of a system of objects may be implemented by a representation of structure. Another part of the system configuration may be made explicit in object diagrams. The full system configuration consists of the interpreted configuration together with any other connections between the objects in the system.

CANONICAL FORM

Figure 10.6 illustrates the canonical form. A representation of structure forms part of the structure of the system under consideration. This representation consists of the structure denotation and a structure interpreter. A collection of objects has been decomposed into two such collections. The representation of structure forms some of the connections between objects in both collections. There also exist other connections, that are not governed by the representation. These have been made explicit, by a separate connection between the two collections.

Figure 10.6 The interpreted configuration as part of the system structure

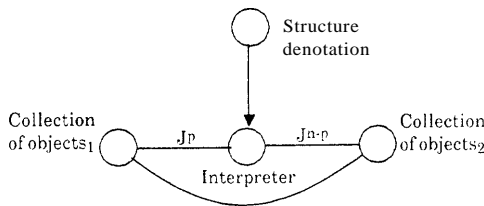
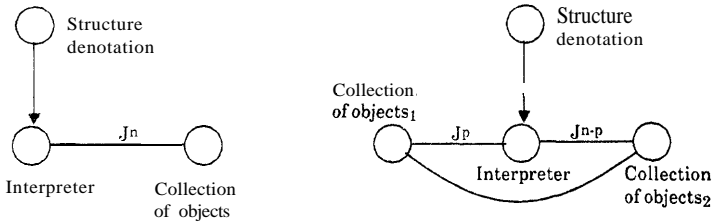
**SPECIFICATION**

Figure 10.6 has been derived from the canonical form for Representation of structure, as shown in Figure 10.7. The collection

of objects has been decomposed in two collections that are not independent. This lack of independence is expressed by the connection between the two collections. The composite alphabet J^n has been decomposed into two parts, J_p and J^{n-p} . These parts may themselves be composite alphabets.

Figure 10.7 Decomposition of the collection of objects results in the canonical form



REALIZABILITY ISSUES

The interpreter needs to be able to read the denotation. The interpreter and the denotation provide a collection of potential connections. The connection, shown separately, guarantees that interactions between the two collections will take place.

SEE ALSO

ASSOCIATION
REPRESENTATION OF STRUCTURE

FUTURE DIRECTIONS

Extension of the specification.

NAME

Binder

PURPOSE

To allow objects to become bound to one another in a pairwise fashion

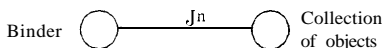
SYNOPSIS

A binder is a representation of structure. A binder is made up of a combination of a structure interpreter and a structure denotative that has been limited to a collection of associations. The interpreter and the collection of associations together form the binder, the binder provides a collection of binary bindings between objects in a collection of objects.

CANONICAL FORM

The canonical form for a binder is illustrated in Figure 10.8, where the binder is connected to a collection of objects.

Figure 10.8 A binder may bind objects in a collection of objects to one another



SPECIFICATION

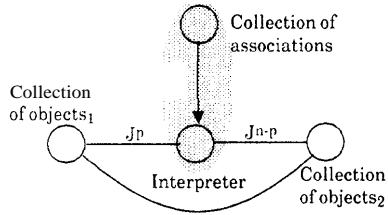
A binder is a specialization of the representation of structure.

It consists of a combination of denotation and interpreter described in interpreted configuration. The structure denotation is restricted to a collection of associations, between pairs of objects. The object pairs must furthermore interact using the same alphabet, if bindings are to be made.

The way in which the canonical form for the binder has been derived from that of the interpreted configuration has been illustrated in Figure 10.9, where, the two objects that form the binder have been shaded.

From the point of view of a particular object in the collection of objects, the binder allows it to become bound to another object taken from the collection of objects. Note that this is identical to the

Figure 10.8 The interpreted configuration as part of the system structure



mathematical notion of binding, where a variable can be bound to one of a set of values.

REALIZABILITY ISSUES

SEE ALSO

ASSOCIATION
COLLECTION
CONTROLLED CONFIGURATION

FUTURE DIRECTIONS

The specification needs to be extended.

NAME

Dynamic binder

PURPOSE

To allow the binder to change the bindings between objects in a collection of objects.

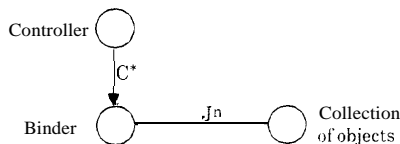
SYNOPSIS

The binder, as the combination of a structure interpreter and a collection of associations, will only allow the bindings that are described in the collection of associations. Dynamic binding can be achieved by introducing an object that may change the structure denotation. This object is called a controller, and a binder that allows changes to the collection of associations it contains is referred to as a dynamic binder.

CANONICAL FORM

The canonical form for a binder is illustrated in Figure 10.10, where the binder is connected to a collection of objects and can be controlled by a controller. The interaction between Controller and Binder is by indefinite interaction, to illustrate the possibility of continual change.

Figure 10.10 A dynamic binder is controlled by a controller



SPECIFICATION

REALIZABILITY ISSUES

The controller must instruct the binder, such that the collection of associations can be updated.

SEE ALSO

BINDER
BINDING
CONTROLLED CONFIGURATION
INDEFINITE INTERACTION

FUTURE DIRECTIONS

Provision of the specification for the general purpose dynamic binder.

NAME

Binding

PURPOSE

To provide for a possible connection that is realized by a binder.

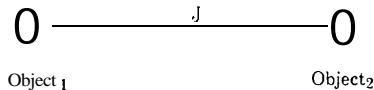
SYNOPSIS

A binding can be seen as a connection between objects. Objects can be bound and unbound. Bindings take place between an object and one of a collection of objects. Because binding implies connecting objects that can become bound must use the same alphabet on their interfaces that are to be connected.

CANONICAL FORM

The canonical form for a binding is the same as the canonical form for the connection, and is shown in Figure 10.11. It simply consists of a connection between the bound objects, Object₁ and Object₂.

Figure 10.11 A binding is a connection

**SPECIFICATION**

When a binder establishes a binding between two objects, the binder maintains the identity relation between its interfaces with the two objects. This relation can be replaced by a connection in object diagrams. For the duration of the binding the binder and the controller can be ignored in the analysis of the system.

A binding can only exist when both objects that are to be bound interact using the same alphabet.

REALIZABILITY ISSUES

The existence of a binding implies the existence of the binder and its controller. A binder may be present in one epoch and can be

removed in the next epoch when the binding it has established persists throughout that epoch.

The presence of a binding does not always imply that a connection is in place over which interactions can take place. If a variable is bound to a value, for instance, then there is no scope for interaction between the variable and the value, since the value is abstract and does not exist in the physical world. The connection can still be used to model this situation, if the alphabet of the connection is the empty set.

In a particular epoch, a binding is thus a connection for which there is no absolute requirement of a physical mechanism that enforces the influence of objects on one another.

SEE ALSO

BINDER
CONNECTION
EPOCH

FUTURE DIRECTIONS

10.3 Examples

Editorial examples are to be provided.