This sample chapter explores encapsulation and implementation hiding techniques, which are used to simplify the way that developers interface with classes, making object-oriented program designs easier to understand, maintain, and enhance.

James Wood, Joseph Rupert

Object-Oriented Programming in ABAP Objects

470 Pages, 2016, $69.95/€69.95

www.sap-press.com/3597
Chapter 3

Classes are abstractions that are used to extend the functionality of a programming language by introducing user-defined types. Encapsulation and implementation hiding techniques are used to simplify the way that developers interface with these user-defined types, making object-oriented program designs easier to understand, maintain, and enhance.

3 Encapsulation and Implementation Hiding

One of the most obvious ways to speed up the software development process is to leverage pre-existing code. However, while most projects strive to create reusable source code artifacts, few actually succeed in delivering modules that can be classified as reusable. In most cases, this lack of (re)usability can be traced back to the fact that the module(s) become too tightly coupled with their surrounding environment. With so many “wires” getting in the way, it’s hard to pick up a module and drop it in somewhere else. Therefore, in order to improve reusability, we need to cut the cords and figure out ways of building autonomous components that can think and act on their own.

In this chapter, we’ll learn how to breathe life into objects by exploring the benefits of combining data and behavior together under one roof. Along the way, we’ll explore the use of access control mechanisms and see how they can be used to shape the interfaces of the defining classes to make them easier to modify and reuse in other contexts.

3.1 Lessons Learned from Procedural Programming

Contrary to popular belief, many core object-oriented programming concepts are based on similar principles rooted in the procedural programming paradigm. In both paradigms, the basic goal is to provide developers with the tools they need to translate requirements from the physical world into software-based solutions. However, while both programming models share in this goal, they go about
achieving it in vastly different ways. In this section, we’ll take a closer look at the procedural approach and consider some of the limitations which ultimately caused many language designers to move in the direction of an object-oriented approach.

### 3.1.1 Decomposing the Functional Decomposition Process

Typically, procedural developers formulate their program designs using a process called *functional decomposition*. The term “functional decomposition” is taken from the world of mathematics, where mathematical functions are broken down into a series of smaller discrete functions that are easier to understand on their own. From a development perspective, functional decomposition refers to the process of decomposing a complex program into a series of smaller modules (e.g. procedures or subroutines).

One common approach for discovering these procedures is to scan through the functional requirements and highlight all the verbs used to describe the actions a program must take to meet its objectives. After all of the steps have been identified, they are then composed into a main program that’s responsible for making sure that the procedures are executed in the right sequence. This process of organizing and refining the main program is sometimes called *step-wise refinement*.

For small to medium-sized programs, this strategy works pretty well. However, as programs start to branch out and grow in complexity, the design tends to become unwieldy as the main program becomes saddled with too many responsibilities. Here, besides keeping track of all of the different procedures and making sure that they’re processed in the right sequence, the main program is also normally responsible for managing all of the data used by the various procedures. For this reason, such programs are often referred to as “God programs”.

**Note**

In his book, *Design Patterns Explained: A New Perspective on Object-Oriented Design, 2nd Edition*, Alan Shalloway suggests that the term “God program” stems from the fact that only God can understand these programs.

With functional decomposition, the level of abstraction is the *subroutine*. Within a given subroutine definition, we can implement logic to perform a particular task using data that’s provided from one of two places:

- Parameters that are passed into the subroutine from the calling program
- Global variables which are visible from within the subroutine

Regardless of the approach we use to supply subroutines with data, the reality is that there’s no clean way of doing this without introducing some undesirable dependencies. For example, if we make liberal use of global variables, we open ourselves up to the possibility of data corruption errors. Here, imagine the impacts of switching out the call sequence of a pair of subroutines which make changes to the same global variable(s). If subroutine $b$ depends on subroutine $a$ to initialize the data and the call sequence gets flipped based on a requirements change, it’s very likely that we’ll start seeing strange data-related errors in the processing (see Figure 3.1).

Conversely, replacing global variables by passing around lots of parameters places additional burden on the main program to keep track of the parameters. Plus, we end up cluttering up the subroutine’s parameter interface, which in turn leads to the tight coupling problem we described earlier.

Ideally we’d like for our modules to assume more responsibilities internally so that they are less reliant on controlling programs/modules when carrying out their tasks. Think of it this way, if we were to compare the organization of a software program with organizational (org) structures in an enterprise, which of the
two org structures depicted in Figure 3.2 and Figure 3.3 would we want our programs to look like? In the case of the flat org structure depicted in Figure 3.2, we have one centralized module that’s responsible for (micro)managing lots of sub-modules. On the other hand, the tall org structure shown in Figure 3.3 is much more balanced with higher level modules delegating responsibilities down to specialized submodules.

In programming, just like business, it’s important that we delegate responsibilities so that our programs remain flexible. In order for that to happen, the (sub)modules need to be smart enough to figure certain things out on their own—and that requires data. In the sections to come, we’ll find that combining data and behavior together within a class helps us develop modules that can attain the kind of autonomy we’re looking for.

3.1.2 Case Study: A Procedural Code Library in ABAP
To better illustrate some of the procedural programming challenges noted in Section 3.1.1, let’s consider an example. In this section, we’ll sketch out the development of a date utility library using ABAP function modules.

If you’ve worked with function modules before, then you know that they’re defined within the context of a function group. In some respects, function groups bear some similarities to classes in that you can use them to define data and behaviors together within a self-contained unit (called a function pool). However, this analogy breaks down when you consider the fact that you cannot load multiple instances of a function group inside your program. This limitation makes it difficult for developers to work with the (global) data inside of a function group since additional logic is required to partition the data into separate work areas (or instances).

Because of this shortcoming, most function module developers tend to design their functions as stateless modules which operate on data that’s maintained elsewhere. In this context, the term “stateless” implies that the function modules have no recollection of prior invocations and don’t maintain any sort of internal state. As a result, function module developers need only worry about implementing the procedural logic—keeping track of the data/sessions is someone else’s problem.

Note
Whenever you call a function module from a particular function group inside your program, the global data from the function group is loaded into the memory of the internal session of your program. Any subsequent calls to function modules within that function group will share the same global data allocated whenever the first function module was called.

Blame it on the BAPIs
The stateless approach to function module development increased in popularity quite a bit in the late 1990s/early 2000s whenever SAP started introducing BAPIs (the term “BAPI” stands for Business Application Programming Interface). At that time, SAP rolled out loads of function modules which promoted a stateless architecture. To call these BAPIs, one would generally have to define a slew of (global) variables that would be used to process BAPI calls. This is illustrated with the commonly used BAPI_USER_GET_DETAIL used to read user details. In the function signature shown in Figure 3.4, you can see that there’s quite a bit of data about a user that has to be maintained outside of the function module. It’s also interesting to note that the same variables would be needed to perform other operations on users such as create, change, and so forth.
Encapsulation and Implementation Hiding

For the purposes of our date library example, we'll build our utility functions as stateless function modules. Within these functions, we'll operate on a date value represented by the SCALS_DATE structure shown in Figure 3.5. Here, though we could have just as easily used the internal ABAP date (D) type, we elected to use a structure type so that we could clearly address the individual components of a date (e.g. month, day, or year) without using offset semantics.

Figure 3.4 An Example of a Stateless BAPI Function

Figure 3.5 Modeling the Data Used for the Date Library

The code excerpt contained in Listing 3.1 sketches out the date API in a function group called ZDATE_API. Here, we've defined a handful of utility methods that can be used to perform date calculations, format dates according to different locales, and so forth.

FUNCTION-pool zdate_api.
FUNCTION z_add_to_date.
* Local Interface IMPORTING VALUE (iv_days) TYPE i
* CHANGING (cs_date) TYPE scals_date
...
ENDFUNCTION.

FUNCTION z_subtract_from_date.
* Local Interface IMPORTING VALUE (iv_days) TYPE i
* CHANGING (cs_date) TYPE scals_date
...
ENDFUNCTION.

FUNCTION z_get_day_name.
* Local Interface IMPORTING VALUE (is_date) TYPE scals_date
* EXPORTING ev_day TYPE string
...
ENDFUNCTION.

FUNCTION z_get_week_of_year.
* Local Interface IMPORTING VALUE (is_date) TYPE scals_date
* EXPORTING ev_week TYPE i
...
ENDFUNCTION.
FUNCTION z_format_date.
* Local Interface IMPORTING VALUE (is_date) TYPE scal_date
* VALUE (iv_format) TYPE csequence
* EXPORTING ev_formatted TYPE string
ENDFUNCTION.

Listing 3.1 Building a Date Utility Library Using Function Modules

Within an ABAP program, we might use functions in the ZDATE_API function group to operate on date values being evaluated as part of a data processing routine like the contrived reporting example contained in Listing 3.2. With this kind of scenario in mind, in the upcoming sections we’ll think about how our date API might stand up to maintenance requests that might pop up over time. This analysis will set the stage for Section 3.1.3 when we begin thinking about objects.

REPORT zsome_report.
START-OF-SELECTION.
PERFORM get_data.

FORM get_data.
DATA ls_date TYPE scal_date.
DATA lt_itab TYPE STANDARD TABLE OF ...
FIELD-SYMBOLS <ls_wa> LIKE LINE OF lt_itab.
SELECT * INTO TABLE lt_itab ...
LOOP AT lt_itab ASSIGNING <ls_wa>.
  ls_date = ...
  CALL FUNCTION 'Z_ADD_TO_DATE'
    EXPORTING
      iv_days = <ls_wa>-work_days
    CHANGING
      cs_date = ls_date.
  ...
  CALL FUNCTION 'Z_SUBTRACT_FROM_DATE'
    EXPORTING
      iv_days = <ls_wa>-offset
    CHANGING
      cs_date = ls_date.
  ...
  CALL FUNCTION 'Z_FORMAT_DATE'
    EXPORTING
      is_date = ls_date
      iv_format = 'MM/DD/YYYY'
    IMPORTING
      ev_formatted = lv_formatted.
ENDLOOP.
ENDFORM.

Listing 3.2 Incorporating the Date API into an ABAP Report Program

Expanding the Scope of the Date API

For the first scenario, imagine that we discover a need to expand the date API to also keep track of time. While this seems easy enough in principle, this could prove challenging since the structure used to model the date value doesn’t contain components to capture a time stamp.

Looking at the SCALS_DATE structure in the ABAP Dictionary (in Figure 3.6), we discover that this structure cannot be enhanced/appended to. Maybe we could get away with using the unused CONTAINER field, but this wouldn’t be obvious to developers who weren’t intimately familiar with the internal workings of our date API.

To implement this change correctly, we’d probably have to change the signature of our function modules to utilize a new structure. Besides requiring a fair
amount of rework within the functions themselves, this also requires that we make wholesale changes to the programs that call them.

Though you might be saying to yourself that the choice of the SCALS_DATE structure for the date API’s data model was a poor one (and you’re right to say so), that’s really not the issue here. The point of this demonstration is to illustrate the fact that our date API exposes way too much information about its internal representation. Consumers of our date API shouldn’t know (or care) whether we use the native ABAP date type (0), a structure, or something else entirely.

By exposing this kind of information in the function signatures, we’ve effectively coddled ourselves into a corner. For better or worse, we have to stick with the design choices we’ve made and try our best to enhance around them. With stateless modules, this is about the best we can hope for.

Dealing with External Data Corruption

For the next scenario, imagine that you receive a defect report which indicates that the Z_FORMAT_DATE function is producing invalid output. After much investigation, you determine that the invalid output isn’t a function of the logic in Z_FORMAT_DATE, but rather due to fact that an invalid day value has been specified in the SCALS_DATE structure’s DAY field. Here, you discover that the invalid value is set within the calling report program which is accessing the SCALS_DATE structure outside of the ZDATE_API function group.

Though such errors might be easy to fix once you find them, they can be difficult to find. Since the ZDATE_API function group doesn’t technically own the data, there’s nothing stopping other modules from overwriting and/or corrupting the API’s data model. In a perfect world, we’d like all accesses to the date API’s data model to go through functions in the ZDATE_API function group so that we can isolate them and enforce the necessary validation rules (e.g. you can’t have a date value of 20160231). However, this is something the procedural model simply can’t guarantee. To really enforce these rules, we need some support from the underlying language implementation to control access.

3.1.3 Moving Toward Objects

The ZDATE_API function group introduced in Section 3.1.2 is an example of an abstract data type (ADT). As the name suggests, ADTs are data types which provide an abstraction around some entity or concept (e.g. a date). Included in this abstraction is the data itself as well as a set of operations that can be performed on that data.

In order for ADTs to be effective, we must keep the data and operations as close to one another as possible. As we observed in Section 3.1.2, such cohabitation is virtually impossible to achieve with procedural programming techniques. Because of this divide, our date API (though admittedly contrived) was awkward to use and quite error prone. These problems become even more pronounced as the size and complexity of such code libraries expand.

In many ways, all of the problems we’ve considered in this section can be traced back to one central theme: poor support for data. While it would seem obvious that data is the foundation upon which any successful computer program runs, the stark reality is that data takes a back seat to actions in the procedural programming paradigm. As a result, procedural programs tend to decay at a much faster pace than programs built using programming models which place a greater emphasis on the data.

3.2 Data Abstraction with Classes

Recognizing many of the limitations outlined in Section 3.1, software researchers developed the OOP paradigm from the ground up with a strong emphasis on data and behavior. As you’ve already learned, classes are the vehicle that drives this equilibrium, encapsulating data (attributes) and behavior (methods) together inside a self-contained unit.

Encapsulation improves the organization of the code, making object-oriented class libraries much easier to understand and use than their procedural counterparts. To put this into perspective, consider the clumsiness of the function module-based date library we created in Section 3.1.2. Each time we accessed one of the API functions, we had to pass in an externally-managed structure which contained all of the date information needed to handle the request. Plus, if we wanted to work with multiple dates, then we had to define multiple variables and track those variables manually outside of the function group.

Let’s compare that experience with a reimagined date API built using an ABAP Objects class. In Listing 3.3, we’ve created a class called LCL_DATE which provides
the same functionality of the ZDATE_API function group. As you look over the class definition, notice the simplification in the signature of the API methods. Instead of passing around an SCALS_DATE structure, the date information is being stored internally in an instance attribute called MS_DATE_INFO. Besides simplifying the interface, this design change also allows us to get out of the business of tracking date information externally. Now, our date API is truly an ADT which provides a complete abstraction around a date value as opposed to a loosely associated set of stateless function modules.

CLASS lcl_date DEFINITION.
  PUBLIC SECTION.
  DATA ms_date_info TYPE scals_date.
  METHODS:
    add IMPORTING iv_days TYPE i
    RETURNING VALUE(ro_date) TYPE REF TO lcl_date,
    subtract IMPORTING iv_days TYPE i
    RETURNING VALUE(ro_date) TYPE REF TO lcl_date,
    get_day_name RETURNING VALUE(rv_day) TYPE string,
    get_week_of_year RETURNING VALUE(rv_week) TYPE i,
    format IMPORTING iv_pattern TYPE csequence
    RETURNING VALUE(rv_date) TYPE string.
  ...
ENDCLASS.

Listing 3.3 Reimagining the Date Utilities API as an ABAP Objects Class

The code excerpt contained in Listing 3.4 demonstrates how we can work with our refactored date library. Once an LCL_DATE instance is created, we no longer have to worry about handling the date value. Instead, we can use methods like add() and subtract() to apply the changes in-place. From a code readability standpoint, this is much easier to follow because the context of an operation like add() is clearly the object referenced by lo_date.

DATA lo_date TYPE REF TO lcl_date.
DATA lv_message TYPE string.

CREATE OBJECT lo_date
  EXPORTING
    lv_date = '20150913'
  lo_date->add( 30 ).
  lv_message = |{ lo_date->subtract( 15 )->format( 'YYYYMMDD' ) }|.

Listing 3.4 Working with an OO-Based API

Ultimately, objects created in reference to encapsulated classes take on their own identity, allowing developers to start thinking about their designs in more conceptual terms (e.g. a date). Consumers of these classes don’t have to worry about low-level implementation details; to the end user the LCL_DATE class is like a black box which performs various date manipulations. We don’t have to supply the LCL_DATE class with lots of data/context/instructions; it intrinsically knows how to do its job.

In the next section, we’ll learn how to round out ADTs like the LCL_DATE class by closing off access to internal components such as the MS_DATE_INFO attribute. This safeguard ensures that all operations on date values are mediated through API methods which rigorously validate incoming requests to ensure that the integrity of date values is maintained. As we’ll see, this approach offers several important benefits.

3.3 Defining Component Visibilities

The term "encapsulation" refers to the idea of enclosing something inside of a capsule. The verbal imagery associated with words like “capsule” implies that we’re setting some kind of boundary between the internal components of a class and the outside world. The purpose of this boundary is to protect (or hide) the inner mechanisms of the object that are sensitive to change. Most of the time, the most vulnerable parts of an object are its attributes since these define the object’s state. However, in this book, we’ll look at ways to hide any design decisions that are subject to change.

In this section, we’ll describe the ABAP Objects language constructs that you can use to establish boundaries within your classes. Then, in the section that follows, we’ll consider how to use these boundaries to build robust classes that can easily be adapted to ever-changing functional requirements.

3.3.1 Working with Visibility Sections

ABAP Objects provides three visibility sections for controlling access to the components defined within a class: the PUBLIC SECTION, the PROTECTED SECTION, and the PRIVATE SECTION. Within a CLASS DEFINITION statement, all component declarations must be defined within one of these three visibility sections. The code
excerpt contained in Listing 3.5 demonstrates the syntax used to define components within these sections.

CLASS lcl_visibility DEFINITION.
  PUBLIC SECTION.
    DATA x TYPE i.
  PROTECTED SECTION.
    DATA y TYPE i.
  PRIVATE SECTION.
    DATA z TYPE i.
ENDCLASS.

Listing 3.5  Working with Visibility Sections

As you might expect, components defined within the PUBLIC SECTION of a class are accessible from any context in which the class itself is visible (i.e., anywhere you can use the class type to declare an object reference variable). These components make up the public interface of the class.

Components defined within the PRIVATE SECTION of a class are only accessible from within the class itself. Note that this is more than just a mere suggestion; this is something that’s strictly enforced by the ABAP compiler/runtime environment. For example, the code excerpt contained in Listing 3.6 would produce a compilation error because the z attribute of the LCL_VISIBILITY class is defined as a private attribute. The only way to get our hands on z is through a method defined in the LCL_VISIBILITY class.

DATA lo_visible TYPE REF TO lcl_visibility.
CREATE OBJECT lo_visible.
IF lo_visible->z GT 0.
  ...
ENDIF.

Listing 3.6  Attempting Access to Private Components of a Class

For now, we’ll defer a discussion on the PROTECTED SECTION until we have a chance to cover inheritance in Chapter 5. For now, simply note that components defined in the PROTECTED SECTION are only accessible within a class and its subclasses.

When working in the form-based view of the Class Builder tool, you can assign components of global classes to visibility sections using the Visibility column highlighted in Figure 3.7.

Designing Across Multiple Dimensions

Choosing the right visibility section for a given component can be tricky, and it requires a fair amount of thought. Here, rather than thinking about the individual components, we need to think in terms of the class’s overall interface. If we want to make our class simple and easy to use, then we’ll need to strip down the public interface to just the essentials. This makes the interface less busy and therefore easier to consume.

In general, clients of a class should be on a “need-to-know” basis. In other words, if a client doesn’t require direct access to a component, then there’s no need for them to even be aware of its existence. Declaring such components within the PRIVATE SECTION of a class makes life easier for everyone: clients get to work with a simplified interface and the owners of the class have the freedom to change/improve the internal implementation of a class without fear of breaking existing client code.

With this concept in mind, we’d suggest that most attributes should be defined within the PRIVATE SECTION of a class. The primary reason for hiding attributes is to ensure that the state of the object cannot be tampered with haphazardly. If a client needs to update the state of an object, then they can do so through a method defined in the PUBLIC SECTION. The advantage of this kind of indirection...
is that we can control the assignment of the attribute using business rules that are defined inside the method. This eliminates a lot of the guesswork in troubleshooting data-related errors since we know that any and all changes to an attribute are brokered through a single method. Methods that update the value of private attributes are sometimes called setter (or mutator) methods. To access these values (or formatted versions of these values), clients can invoke getter (or accessor) methods which broker access in the other direction.

This getter/setter method approach to indirect data access is demonstrated in the LCL_TIME class contained in Listing 3.7. Here, the state of the time object is being represented by three private attributes called mv_hour, mv_minute, and mv_second. Any updates to these attributes are controlled through setter methods such as set_hour() or set_minute(). Within these methods, we’ve included logic to ensure that the attributes remain consistent (e.g. we don’t have an hour value of 113). Clients can obtain copies of these values by calling the corresponding getter methods (e.g. get_hour()).

Listing 3.7 Working with Getter and Setter Methods

As an alternative to the getter method approach, ABAP also allows us to define read-only attributes within a class definition. This is achieved using the READ-ONLY addition to the DATA keyword. The code excerpt below demonstrates how we might refactor the LCL_TIME class from Listing 3.7 to use this feature.

Listing 3.8 Defining Read-Only Attributes in a Class

While this feature can come in handy for simple classes which are primarily used for transferring data, we’d encourage you to use this option sparingly since it exposes the internal implementation details of your class.

3.3.2 Understanding the Friend Concept

In the previous section, we learned that components defined within the private and protected sections of a class are not visible outside of that class (or subclasses in the case of protected components). However, in some cases, it might be advantageous to be able to grant special access to certain classes of our choosing. Such classes are called friends of the class that grants them access.

Listing 3.9 illustrates the syntax used to create friend relationships between a defining class CL_SOME_CLASS and its friends: C1, C2, and so on. Here, the FRIENDS addition is added to a CLASS DEFINITION statement to declare this relationship up front to the ABAP compiler. As you can see, we can specify multiple friend classes after the FRIENDS addition (not to mention interfaces, which are covered in Chapter 6).

Listing 3.9 Defining Friendship Relationships in Classes
To demonstrate how friendship relationships work between classes, consider the example code contained in Listing 3.10. Here, we have a pair of classes called LCL_PARENT and LCL_CHILD which have entered into a friendship relationship. The LCL_CHILD class is taking advantage of this relationship by accessing the LCL_PARENT class's mv_credit_card_no attribute in a method called buy_toys(). Since mv_credit_card_no is defined as a private attribute, the only way for LCL_CHILD to access this value is through the friendship relationship. Without this addition, the code below would produce a syntax error.

```plaintext
CLASS lcl_child DEFINITION DEFERRED.
CLASS lcl_parent DEFINITION FRIENDS lcl_child.
PRIVATE SECTION.
  DATA mv_credit_card_no TYPE string.
ENDCLASS.
CLASS lcl_child DEFINITION.
  PUBLIC SECTION.
  METHODS buy_toys.
ENDCLASS.
CLASS lcl_child IMPLEMENTATION.
  METHOD buy_toys.
    DATA: lo_parent TYPE REF TO lcl_parent,
         lo_store TYPE REF TO lcl_toy_store.
    lo_parent = ...
    lo_store = ...
    lo_store->checkout( lo_parent->mv_credit_card_no ).
  ENDMETHOD.
ENDCLASS.
Listing 3.10 Bypassing Access Control Using Friends
```

We can achieve the same effect for global classes maintained in the form-based view of the Class Builder tool by plugging the target friend classes on the Friends tab as shown in Figure 3.8.

As you begin working with friendship relationships, there are a couple of important things to consider. First of all, it's important to note the direction and nature of the friendship relationship. In Listing 3.10, class LCL_PARENT explicitly granted friendship access to class LCL_CHILD. This relationship definition is not reflexive. For example, it would not be possible for class LCL_PARENT to access the private components of class LCL_CHILD without the LCL_CHILD class granting friendship access to LCL_PARENT first. Secondly, notice that classes cannot arbitrarily declare themselves friends of another class. For instance, it would not be possible for class LCL_CHILD to surreptitiously declare itself a friend of class LCL_PARENT. If this were the case, access control would be a waste of time since any class could bypass this restriction by simply declaring themselves a friend of whatever class they were trying to access.

The example shown in Listing 3.10 also introduced a new addition to the CLASS DEFINITION statement that we have not seen before: the DEFERRED addition. In a scenario like this, the DEFERRED addition used in the first CLASS DEFINITION statement for LCL_CHILD is needed to instruct the compiler of the existence of the LCL_CHILD class in the CLASS DEFINITION statement for the LCL_PARENT class. Without this clause, the compiler would have complained that class LCL_CHILD was unknown whenever we tried to establish the friendship relationship in the definition of class LCL_PARENT.

Many purists argue that the use of friends should not be allowed in object-oriented languages since they bypass traditional access control mechanisms. Whether you agree with this sentiment or not, we would recommend that you use friendship relationships sparingly in your designs because it truly is rare that you would need to open up access like this.

### 3.4 Designing by Contract

As we've learned, encapsulation and implementation hiding techniques can be used to define very precise public interfaces for a class. These interfaces help to form a contract between the developer of a class and users of that class. The contract metaphor is taken from the business world, where customers enter into contractual agreements with suppliers providing goods or services. In his book, *Object-Oriented Software Construction*, Bertrand Meyer described how this con-
cept could be adapted into object-oriented software designs in order to improve the reliability of software components that are "...implementations meant to satisfy well-understood specifications."

In this context, objects are subject to a series of invariants (or constraints) that specify the valid states for the object. To maintain these invariants, methods are defined using preconditions (what must be true before the method is executed) and postconditions (what must be true after the method is executed). In Chapter 8, we’ll look at ways to deal with exceptions to these rules.

The primary goal when applying the Design by Contract approach in your software designs is to produce components that deliver predictable results. The boundaries set by the visibility sections ensure that loopholes are not introduced into the contract. For instance, the date library that we first introduced in Section 3.1.2 had many loopholes that made it possible to bypass the business rules implemented inside the function module(s). The encapsulation techniques we applied in the class-based reimplementation of this library eliminated these loopholes by encapsulating the date data as a private attribute that’s cut off from external tampering.

Client programmers using classes based on these principles know what to expect from the class based on the provided public interface. Similarly, class developers are free to change the underlying implementation so long as they continue to honor the contract outlined in the public interface. Over time, the dual nature of this relationship helps to increase trust as we accumulate reusable modules that clients know will work.

### 3.5 UML Tutorial: Sequence Diagrams

So far, our study of the UML has been focused on diagrams that are used to describe the static architecture of an object-oriented system. In this chapter, we will introduce the first of several behavioral diagrams that are used to illustrate the behavior of objects at runtime. The sequence diagram depicts a message sequence chart between objects that are interacting inside a software system.

Figure 3.9 shows a simple sequence diagram that is used to illustrate a cash withdrawal transaction in an ATM machine. A sequence diagram is essentially a graph in two dimensions. The various objects involved in the interaction are aligned along the horizontal axis. The vertical axis represents time. Sequence diagrams are initiated by a request message from some kind of external source. In the example in Figure 3.9, the external source is a user interfacing with the ATM machine. This initial message is called a found message. In object-oriented terms, a message is analogous to a method call. Messages are sent to objects (depicted in the familiar object boxes seen on the object diagrams described in Chapter 2). The dashed line protruding from underneath the object box represents the object’s life cycle.

The intersection of a message and an object’s life cycle is depicted with a thin rectangular box called an activation bar. The activation bar shows when an object is active during the interaction. Objects are activated via messages (i.e. method calls). Messages can include parameters that help clarify the operation to be performed by the object. However, it’s not a good idea to try and fully specify the

![Figure 3.9 Sequence Diagram for Withdrawing Cash from an ATM](image-url)
method interface in a sequence diagram—that’s what a class diagram is for. Here, we only use parameters for emphasis or clarity. Synchronous method calls can have a return message that can also have optional parameters.

In some cases, a method might need to call other local helper methods to complete its task. In this case, a self call can be illustrated by drawing a circuitous arrow to another activation bar that is stacked on top of the current activation bar. For example, in Figure 3.9, messages dispenseCash and printReceipt are both represented as self calls on the atm object inside method withdraw.

Sequence diagrams are very useful for explaining complex interactions where the order of operations is difficult to follow. One of the reasons that sequence diagrams are so popular is that the notation is very intuitive and easy to read. To maintain this readability, it’s important to avoid cluttering a sequence diagram with too many interactions. In the coming chapters, we’ll look at other types of interaction diagrams that can be used to illustrate fine-grained behavior within an object or more involved interactions that span multiple use cases.

3.6 Summary

In this chapter, you learned about the many advantages of applying encapsulation and implementation hiding techniques to your class designs. Encapsulating data and behavior in classes simplifies the way that users/clients work with classes. Hiding the implementation details of these classes strengthens the design even further, making classes much more resistant to change and/or data corruption. The combination of these two design techniques helps you to design intelligent classes that are highly self-sufficient. Such classes are easy to reuse in other contexts since they are loosely coupled to the outside world.

In the next chapter, we’ll examine the basic lifecycle of an object. We’ll also learn about special methods called constructors that can be used to ensure that object instances are always created in a valid state.
# Contents

Introduction ........................................................................................................ 15

## PART I Introduction

1. Introduction to Object-Oriented Programming ........................................... 23
   1.1 The Need for a Better Abstraction .................................................. 23
       1.1.1 The Evolution of Programming Languages .......................... 24
       1.1.2 Moving Towards Objects ............................................... 25
   1.2 Classes and Objects ................................................................. 26
       1.2.1 What Are Objects? ....................................................... 26
       1.2.2 Introducing Classes ..................................................... 27
   1.3 Establishing Boundaries ............................................................ 30
       1.3.1 An Introduction to Encapsulation and Implementation Hiding .......... 31
       1.3.2 Understanding Visibility Sections ...................................... 33
   1.4 Reuse .................................................................................... 34
       1.4.1 Composition ................................................................ 34
       1.4.2 Inheritance ................................................................. 34
       1.4.3 Polymorphism ............................................................... 36
   1.5 Object Management .................................................................... 38
   1.6 UML Tutorial: Class Diagram Basics ............................................. 38
       1.6.1 What are Class Diagrams? ............................................... 39
       1.6.2 Classes ..................................................................... 41
       1.6.3 Attributes .................................................................. 41
       1.6.4 Operations ................................................................. 42
       1.6.5 Associations ............................................................... 43
       1.6.6 Notes ...................................................................... 44
   1.7 Summary .................................................................................. 45

## PART II Getting Started with Objects

2. Getting Started with Objects ................................................................. 47
   2.1 Defining Classes ......................................................................... 47
       2.1.1 Creating a Class .......................................................... 48
       2.1.2 Component Declarations .............................................. 49
       2.1.3 Implementing Methods ................................................ 57
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2 Working with Objects</td>
<td>59</td>
</tr>
<tr>
<td>2.2.1 Object References</td>
<td>59</td>
</tr>
<tr>
<td>2.2.2 Creating Objects</td>
<td>60</td>
</tr>
<tr>
<td>2.2.3 Object Reference Assignments</td>
<td>64</td>
</tr>
<tr>
<td>2.2.4 Accessing Instance Components</td>
<td>67</td>
</tr>
<tr>
<td>2.2.5 Accessing Class Components</td>
<td>68</td>
</tr>
<tr>
<td>2.2.6 Working with Events</td>
<td>73</td>
</tr>
<tr>
<td>2.2.7 Working with Functional Methods</td>
<td>76</td>
</tr>
<tr>
<td>2.2.8 Chaining Method Calls Together</td>
<td>78</td>
</tr>
<tr>
<td>2.3 Building your First Object-Oriented Program</td>
<td>82</td>
</tr>
<tr>
<td>2.3.1 Creating the Report Program</td>
<td>85</td>
</tr>
<tr>
<td>2.3.2 Adding in the Local Class Definition</td>
<td>86</td>
</tr>
<tr>
<td>2.4 Working with Global Classes</td>
<td>88</td>
</tr>
<tr>
<td>2.4.1 Understanding the Class Pool Concept</td>
<td>97</td>
</tr>
<tr>
<td>2.4.2 Getting Started with the Class Builder Tool</td>
<td>98</td>
</tr>
<tr>
<td>2.4.3 Creating Global Classes</td>
<td>104</td>
</tr>
<tr>
<td>2.4.4 Using the Form-Based Editor</td>
<td>107</td>
</tr>
<tr>
<td>2.4.5 Using the Source Code Editor</td>
<td>113</td>
</tr>
<tr>
<td>2.5 Developing Classes Using the ABAP Development Tools in Eclipse</td>
<td>114</td>
</tr>
<tr>
<td>2.5.1 What is Eclipse?</td>
<td>117</td>
</tr>
<tr>
<td>2.5.2 Setting Up the AIE Environment</td>
<td>117</td>
</tr>
<tr>
<td>2.5.3 Working with the AIE Class Editor Tools</td>
<td>120</td>
</tr>
<tr>
<td>2.5.4 Where to Go to Find More Information about AIE</td>
<td>123</td>
</tr>
<tr>
<td>2.6 New Syntax Features in Release 7.40</td>
<td>125</td>
</tr>
<tr>
<td>2.7 UML Tutorial: Object Diagrams</td>
<td>128</td>
</tr>
<tr>
<td>2.8 Summary</td>
<td>131</td>
</tr>
</tbody>
</table>

| 3 Encapsulation and Implementation Hiding | 121 |
| 3.1 Lessons Learned from Procedural Programming | 121 |
| 3.1.1 Decomposing the Functional Decomposition Process | 122 |
| 3.1.2 Case Study: A Procedural Code Library in ABAP | 125 |
| 3.1.3 Moving Toward Objects | 130 |
| 3.2 Data Abstraction with Classes | 131 |
| 3.3 Defining Component Visibility | 133 |
| 3.3.1 Working with Visibility Sections | 133 |
| 3.3.2 Understanding the Friend Concept | 137 |
| 3.4 Designing by Contract | 139 |
| 3.5 UML Tutorial: Sequence Diagrams | 140 |
| 3.6 Summary | 142 |

| 4 Object Initialization and Cleanup | 143 |
| 4.1 Understanding the Object Creation Process | 143 |
| 4.2 Working with Constructors | 148 |
| 4.2.1 Defining Constructors | 148 |
| 4.2.2 Understanding How Constructors Work | 149 |
| 4.2.3 Class Constructors | 151 |
| 4.3 Object-Creational Patterns | 152 |
| 4.3.1 Controlling the Instantiation Context | 152 |
| 4.3.2 Implementing the Singleton Pattern | 154 |
| 4.3.3 Working with Factory Methods | 156 |
| 4.4 Garbage Collection | 157 |
| 4.5 Tuning Performance | 159 |
| 4.5.1 Design Considerations | 159 |
| 4.5.2 Lazy Initialization | 159 |
| 4.5.3 Reusing Objects | 161 |
| 4.5.4 Making Use of Class Attributes | 161 |
| 4.6 UML Tutorial: State Machine Diagrams | 164 |
| 4.7 Summary | 163 |

| 5 Inheritance and Composition | 165 |
| 5.1 Generalization and Specialization | 166 |
| 5.1.1 Inheritance Defined | 166 |
| 5.1.2 Defining Inheritance Relationships in ABAP Objects | 167 |
| 5.1.3 Working with Subclasses | 173 |
| 5.1.4 Inheritance as a Living Relationship | 173 |
| 5.2 Inheriting Components | 175 |
| 5.2.1 Designing the Inheritance Interface | 176 |
| 5.2.2 Visibility of Instance Components in Subclasses | 178 |
| 5.2.3 Visibility of Class Components in Subclasses | 179 |
| 5.2.4 Redefining Methods | 182 |
| 5.2.5 Instance Constructors | 183 |
| 5.2.6 Class Constructors | 183 |
| 5.3 The Abstract and Final Keywords | 183 |
| 5.3.1 Abstract Classes and Methods | 183 |
| 5.3.2 Final Classes | 188 |
| 5.3.3 Final Methods | 189 |
| 5.4 Inheritance vs. Composition | 191 |
| 5.5 Working with ABAP Refactoring Tools | 194 |
5.6 UML Tutorial: Advanced Class Diagrams ........................................ 198
5.6.1 Generalizations ................................................................. 198
5.6.2 Dependencies and Composition ........................................... 198
5.6.3 Abstract Classes and Methods ........................................... 199
5.7 Summary .................................................................................. 201

6 Polymorphism .............................................................................. 203
6.1 Object Reference Assignments Revisited ................................... 204
6.1.1 Static and Dynamic Types .................................................. 205
6.1.2 Casting .............................................................................. 207
6.2 Dynamic Method Call Binding .................................................. 210
6.3 Interfaces .................................................................................. 212
6.3.1 Interface Inheritance vs. Implementation Inheritance ........... 213
6.3.2 Defining Interfaces ............................................................ 214
6.3.3 Implementing Interfaces ...................................................... 218
6.3.4 Working with Interfaces ...................................................... 221
6.3.5 Nesting Interfaces .............................................................. 224
6.3.6 When to Use Interfaces ....................................................... 227
6.4 UML Tutorial: Advanced Class Diagrams Part II ....................... 229
6.4.1 Interfaces .......................................................................... 229
6.4.2 Providing and Required Relationships with Interfaces ........... 230
6.4.3 Static Attributes and Methods ............................................ 231
6.5 Summary .................................................................................. 232

7 Component-Based Design Concepts ........................................... 233
7.1 Understanding the SAP Component Model ................................. 233
7.2 The Package Concept ............................................................. 236
7.2.1 Why Do We Need Packages? ............................................. 237
7.2.2 Introducing Packages ......................................................... 238
7.2.3 Creating Packages Using the Package Builder ................... 240
7.2.4 Embedding Packages ....................................................... 248
7.2.5 Defining Package Interfaces ............................................. 250
7.2.6 Creating Use Accesses ...................................................... 253
7.2.7 Performing Package Checks ............................................ 254
7.2.8 Restriction of Client Packages ......................................... 256
7.3 Package Design Concepts ........................................................ 258
7.4 UML Tutorial: Package Diagrams ............................................ 260
7.5 Summary .................................................................................. 262

8 Error Handling with Exception Classes .................................... 263
8.1 Lessons Learned from Prior Approaches .................................. 263
8.1.1 Lesson 1: Exception Handling Logic Gets in the Way ............ 264
8.1.2 Lesson 2: Exception Handling Requires Varying Amounts of Data .................................................... 265
8.1.3 Lesson 3: The Need for Transparency ............................... 265
8.2 The Class-Based Exception Handling Concept ......................... 266
8.3 Creating Exception Classes ...................................................... 268
8.3.1 Understanding Exception Class Types ................................ 268
8.3.2 Local Exception Classes .................................................... 270
8.3.3 Global Exception Classes .................................................. 270
8.3.4 Defining Exception Texts ................................................... 273
8.3.5 Mapping Exception Texts to Message Classes .................... 274
8.4 Dealing with Exceptions .......................................................... 275
8.4.1 Handling Exceptions .......................................................... 275
8.4.2 Cleaning Up the Mess ....................................................... 280
8.5 Raising and Forwarding Exceptions ........................................ 281
8.5.1 System-Driven Exceptions ............................................... 282
8.5.2 Raising Exceptions Programmatically ............................... 282
8.5.3 Propagating Exceptions ..................................................... 287
8.5.4 Resumable Exceptions ...................................................... 290
8.6 UML Tutorial: Activity Diagrams ........................................... 294
8.7 Summary .................................................................................. 297

9 Unit Tests with ABAP Unit ......................................................... 299
9.1 ABAP Unit Overview .............................................................. 300
9.1.1 Unit Testing Terminology .................................................. 300
9.1.2 Understanding How ABAP Unit Works ............................... 301
9.1.3 ABAP Unit and Production Code ....................................... 301
9.2 Creating Unit Test Classes ...................................................... 301
9.2.1 Unit Test Naming Conventions ......................................... 302
9.2.2 Test Attributes ................................................................. 303
9.2.3 Test Methods ................................................................. 304
9.2.4 Managing Fixtures ......................................................... 305
9.2.5 Test Class Generation Wizard ......................................... 306
9.2.6 Global Test Classes .......................................................... 307
9.3 Assertions in ABAP Unit ........................................................... 307
9.3.1 Creating and Evaluating Custom Constraints .................... 308
9.3.2 Applying Multiple Constraints ......................................... 309
Index

A

ABAP development tools, 98
installation, 98
ABAP development tools for Eclipse refactoring tools, 196
ABAP development tools in Eclipse → AIE
ABAP list viewer → ALV
ABAP object services, 331
introduction, 331
persistence service, 333
query service, 334
services overview, 333
transaction service, 335
ABAP refactoring tools, 194
ABAP runtime type services RTTS, 398
ABAP unit
ABAP unit browser, 316–317
ABAP unit results display, 301, 308, 319
applying multiple constraints, 309
assertion, 300, 308
CL_ABAP_UNIT_ASSERT, 305, 307–310, 316, 319
CL_AUNIT_CONSTRAINT, 310
code coverage, 320
code inspector, 318
creating favorites (unit test groups), 317
duration, 304
evaluating unit test results, 319
executing unit tests, 316
FOR TESTING, 302–304, 307, 312, 315
global test classes, 307
IF_CONSTRAINT, 308–310
local test classes, 306
risk level, 303
test class generation wizard, 302, 306
unit test attributes, 303
unit test fixtures, 301, 305
unit test methods, 304
unit test naming conventions, 302
Abstract
keyword, 183
methods, 183

Abstract classes, 183
as a template, 187
Abstract data type
ADT, 130
AIE, 97
class editor tools, 104
reference materials, 113
release compatibility, 98
ALV
report example, 416
reuse function library, 417
ALV Object Model
ALV, 415
overview, 418
Attributes, 26, 50
class attributes, 50
constants, 51
instance attributes, 50
naming convention, 51

B

Behavior-driven development, 322
BOPF
action example, 406
actions, 387
associations, 392
BO organization, 382
bootstrapping the client API, 401
business object concept, 379
client API, 397
configuration service, 398
constants interface concept, 399
creating BO instances, 401
determinations, 389
introduction, 379
persistence layer, 381
queries, 396
query example, 404
related resources, 410
service manager interface, 397
transaction manager interface, 398
transaction manager usage, 407
BOPF (Cont.)
- updating BO instances, 405
- validations, 391
BOPF business object
- nodes, 383
Business application programming interface
- RAP, 125
Business object layer
- BOL, 382
Business object processing framework
- BOPF, 379
Business server pages
- BSP, 422

C
- CALL METHOD statement, 64
- CAST operator, 209
- Casting, 207
  - casting operator (\%), 209
  - dynamic types, 206
  - narrowing cast, 207
  - narrowing cast example, 207
  - widening cast, 208
- CATCH statement, 266
  - best practices for using, 278
Class Builder
- defining inheritance relationships, 170
  - exception builder view, 270
- form-based editor, 88
  - local definitions / implementations, 95
  - mapping assistant tool, 340
  - source code editor, 96
  - transaction SE24, 85
Class components
- accessing, 67
  - CLASS DEFINITION statement
    - DEFERRED addition, 139
Class diagram
- example, 39
Class elements
- attributes, 26
- methods, 26
Class interface, 29
Class pools, 85
CLASS statement
- INHERITING FROM addition, 169

Class-based exception handling concept, 263
- exception classes, 264
- prior approaches, 263
- resumable exceptions, 290
- the TRY control structure, 266
Classes, 26
- attributes, 50
- class attributes, 50
- class components, 49
- comparison with type declarations, 27
  - component declarations, 49
  - constants, 51
- declaration section, 47
  - declaring types, 56
  - defining a local class, 82
  - defining in ABAP, 47–48
- encapsulation, 131
- events, 56
- global classes, 84
  - implementation section, 47
  - instance attributes, 50
  - instance components, 49
  - introduction, 27
  - methods, 52
  - naming conventions, 48
  - template analogy, 26
  - visibility sections, 33
Classes and objects
- relationship, 28
Classic debugger tool, 447
CLEANUP statement, 266
- usage example, 281
Common closure principle, 258
Common reuse principle, 258
Composition, 34, 165
- defined, 593
  - the ‘has-a’ relationship, 192
COND statement, 285
Constructor expressions, 115
- conditional operators, 115
- conversion/casting operators, 115
- instance operator, 115
- reference operator, 115
- value operator, 115
Constructors, 38
- class constructor syntax, 151
- defining class constructors in global classes, 151

Constructors (Cont.)
- defining class constructors in local classes, 151
- defining instance constructors in global classes, 149
- defining instance constructors in local classes, 148
  - guaranteed initialization, 148
  - instance constructor behavior example, 149
  - CREATE OBJECT statement, 60

D
Data objects
- dynamic data objects, 147
- dynamic type, 206
Data transfer object
- DTO, 156
Debugging objects
- always create exception object option, 452
- Dependency injection, 311, 313
  - partially implemented interfaces, 312
  - private dependency injection, 311
Design patterns, 434
- reference materials, 434
- Design-by-contract, 139
  - invariants, 140
  - postconditions, 140
Development classes, 236
Development packages, 239
Dynamic method call binding, 210
Dynamic object allocation
- performance costs, 143

E
Eclipse, 97
- history, 97
  - templates, 107
- Encapsulation, 31, 121
  - purpose, 133
  - the ‘least privilege’ concept, 177
Events, 56
- declaration syntax, 56
  - event handler methods, 69
  - example, 71

Events (Cont.)
- registering event handler methods, 70
  - relevant ABAP syntax, 69
  - usage scenario, 68
Exception classes, 263
- constructor method, 272
  - CX_DYNAMIC_CHECK, 269
  - CX_NO_CHECK, 269
  - CX_STATIC_CHECK, 269
  - defining exception texts, 273
  - global exception class example, 271
  - global exception classes, 270
  - mapping exception texts to message classes, 274
  - types, 268
Exception handling
- message table parameters, 265
Exception texts, 273
  - as constants, 273
  - text parameters, 274
Exceptions
- exception classes with message classes, 271
  - non-class-based exceptions, 265
  - the exception builder tool, 270
  - the RAISE EXCEPTION statement, 283
  - Extended program check
    - transaction SLIN, 256

Factory pattern
- defined, 156
Final classes, 188
Final keyword, 183
Final methods, 189
Floorplan manager
- FPM, 423
- FPM-BOPF integration
  - FPI, 381
  - Friend concept, 137
  - Function group, 125
  - Function modules, 125
  - Functional decomposition, 122
  - Functional methods
    - changes in release 7.40, 76
    - usage example, 73
    - usage in ABAP expressions, 75
Garbage collection, 157
behavior of the CLEAR statement, 159
Garbage collector, 62
Gateway-BOPF integration
GBI, 381
Generic ABAP types, 56
Generic interaction layer
genIL, 382
Generic OBJECT type, 167
Global classes, 84
creating in the class builder tool, 86

Implementation hiding, 31, 121
hiding data, 135
setter methods, 136
Inheritance, 34, 165
‘isa’ vs. ‘has-a’ relationship, 192
ABAP syntax, 167
as a relationship, 35
class component scope, 179
class constructor behavior example, 183
component namespace, 178
defined, 166
element, 167
generalization and specialization, 166
instance constructors, 182
interface, 176
multiple inheritance, 213
multiple inheritance ‘diamond problem’, 213
redefining methods, 179
relationship behavior, 173
rules, 175
single inheritance, 213
superclass vs. subclass, 166
the super pseudoreference, 178
vs. ‘copy-and-paste’ approach, 173
vs. composition, 191
Instance components
accessing, 64
Instantiation context
defining, 152

Interaction frame, 412
common operators, 412
example, 412
guards, 412
notation, 412
operator, 412
Interface, 212
DEFAULT addition, 220
defining a local interface, 214
defining components, 215
generic definition, 212
implementing an interface in a local class, 218
inheritance, 203
INTERFACES keyword, 218
public visibility section, 214
reference variables, 223
scope, 214
type, 214
vs. abstract classes, 227

Lazy initialization, 159
Local exception classes, 270

Main packages, 239
Message classes, 274
Methods, 26, 52
chained method calls, 76
defining parameters, 53
definition syntax, 52
EXCEPTIONS addition, 265
functional methods, 73
implementing, 57
method call syntax, 64
overloading, 156
parameter types, 53
pass-by-value vs. pass-by-reference, 54
signature, 55
Syntax Restrictions, 58
variable scoping rules, 58
Model-view-controller → MVC
MVC
Overview, 421

Naming conventions
class naming example, 49
Narrowing casts
implicit casts for importing parameters, 212
Nested interface
comaent interface, 224
defining component interfaces in local interfaces, 224
INTERFACES statement, 224
New debugger tool, 447
displaying inheritance hierarchy, 457
layout, 455
release, 447

Object component selector operator, 64
Object management, 38
Object reference assignments, 204
compatible types, 204
remote control analogy, 206
Object reference variable, 59
assignments, 60
static vs. dynamic types, 205
the super pseudoreference variable, 178
Object-creational patterns, 152
Object-oriented analysis and design → OOAD
Object-oriented programming → OOP
Object-relational mapping
illustration, 333
ORM, 332
Objects, 26, 59
creating instances with CREATE OBJECT, 60
defined, 26
dynamic allocation, 143
header data, 147
identity, 133
initialization and cleanup, 143
object lifecycle, 143
OOAD
delelating Responsibilities to objects, 143
domain modeling, 166
reference materials, 433

POWL, 423

Package builder, 240
Package concept, 236
package checks, 254
package design concepts, 258
restriction of client packages, 256
use access, 253
Package interfaces, 240
creating, 250
Package types
development packages, 238
main packages, 238
structure packages, 238
Packages
attributes, 243
benefits, 237
creating new packages, 240
embedding subpackages, 248
introduction, 238
package interfaces, 250
Performance tuning, 159
Persistence service, 335
accessing class agents, 352
persistent classes, 335
Personal classes
advanced modeling concepts, 362
class agent, 338
defining one-to-one mappings, 344
how to create, 335
mapping concepts, 340
mapping types, 341
modeling entity relationships, 349
modeling n-to-m relationships, 346
modeling reverse lookups, 362
Persistent objects, 352
creating a new instance, 353
deleting, 357
reading an instance by key, 355
updating, 356
Personal object worklist
POWL, 423
Polymorphism, 36, 203
example, 37
extensibility, 212
flexibility, 212
Procedural programming
case study, 125
lessons learned, 121
Programming languages
assembly language, 24
c, 24
evolution, 24
SAP support portal, 245
SAP Web AS
ABAP runtime environment, 143
performance optimizations of the ABAP runtime environment, 147
Semantic dissonance, 25
Singleton pattern
defined, 154
Software components, 233
SOLID design principals, 313
Standard classes
/BOBF/CL_FRW_FACTORY, 399
/BOBF/CL_TRA_SERV_MGR_FACTORY, 399
CL_GUI_ALV_GRID, 417
CL_OS_SYSTEM, 358
CL_SALV_HIERSEQ_TABLE, 419
CL_SALV_TABLE, 419
Standard interfaces
/BOBF/IF_FRW_ACTION, 388
/BOBF/IF_FRW_ASSOCIATION, 394
/BOBF/IF_FRW_CONFIGURATION, 398
/BOBF/IF_FRW_DETERMINATION, 389
/BOBF/IF_FRW_QUERY, 396
/BOBF/IF_FRW_VALIDATION, 392
/BOBF/IF_TRA_SERVICE_MANAGER, 397
/BOBF/IF_TRA_TRANSACTION_MGR, 398
IF_MESSAGE, 278
IF_OS_CA_INSTANCE, 340
IF_OS_CA_PERSISTENCY, 340
IF_OS_CHECK, 374
IF_OS_FACTORY, 340
IF_OS_QUERY, 358
IF_OS_QUERY_MANAGER, 358
IF_OS_STATE, 336
IF_OS_TRANSACTION, 369
Static dependencies principle, 259
Step-wise refinement, 122
Structure packages, 238
Subclasses, 173
SWITCH statement, 285
Transaction service (Cont.)
overview, 369
usage example, 370
TRY Statement
Generic CATCH blocks, 279
TRY statement, 276
CATCH block, 266, 276
CLEANUP block, 266
defined, 266
syntax, 266
Types, 56
using in classes, 56
UML activity diagram, 294, 430
advanced class diagrams, 198
advanced sequence diagrams, 411
Class Diagram, 38
communication diagrams, 375
object diagrams, 117
package diagrams, 260
sequence diagrams, 140
state machine diagrams, 161
UML activity diagram
action, 295
activity final node, 295
decision node guards, 432
decision nodes, 432
defined, 294
decision region, 295
delivered blocks, 295
initial node, 294
jumps, 431
merge node, 295
notification, 294
partitions, 430
protected nodes, 295
signals, 430
sub-activities, 430
time signal, 430
UML class diagram
abstract class example, 199
composition example, 199
composition notation, 199
UML class diagram (Cont.)
defining nested and component interfaces, 229
generalization notation for interfaces, 229
non-normative notation for abstract classes, 200
UML communication diagram
interaction diagrams, 375
notation, 375
numbering scheme, 376
relationship to collaboration diagrams, 375
relationship to object diagram, 376
UML diagrams
behavioral diagrams, 140
interaction diagrams, 142
UML package diagram
defining visibility of components, 261
dependency notation, 261
dependency example, 261
notation, 261
packages, 260
released notation, 261
UML sequence diagram
"new" message, 412
deleting an object lifeline, 412
found message, 141
messages, 141
notation, 140
object activation bar, 141
object lifelines, 141
self call, 142
UML state machine diagram
final state, 163
initial pseudostate, 161
notation, 161
states, 162
transitions, 162
UML use case diagram
defined, 326
use cases, 326
Unified Modeling Language, 23
unit test, 299
Use cases, 323–324
actor, 323–324
extension scenarios, 324
extensions, 323
Use cases (Cont.)
guarantees, 324
main success scenario, 323–324
preconditions, 324
primary actor, 324
scope, 324

V
Visibility sections, 33, 133
private section, 133
protected section, 176
public section, 133

W
Web Dynpro ABAP, 422
Widening casts
compiler checks, 208

X
xUnit, 300

Z
ZIF_COMPARABLE interface, 215
First-hand knowledge.

James Wood is the founder and principal consultant of Bowdark Consulting, Inc., a consulting firm specializing in technology and custom development in the SAP landscape. Before starting Bowdark in 2006, James was an SAP NetWeaver consultant for SAP America, Inc. and IBM Corporation, where he was involved in many large-scale SAP implementations. James is also an SAP Mentor and author of several best-selling SAP titles. To learn more about James and this book, please check out his website at www.bowdark.com.

Joseph Rupert is a senior technical consultant at Bowdark Consulting, Inc. Before joining Bowdark, Joe worked for several health care technology companies building complex search engines for querying biomedical research, patient lab and clinical data.

We hope you have enjoyed this reading sample. You may recommend or pass it on to others, but only in its entirety, including all pages. This reading sample and all its parts are protected by copyright law. All usage and exploitation rights are reserved by the author and the publisher.

© 2016 by Rheinwerk Publishing, Inc. This reading sample may be distributed free of charge. In no way must the file be altered, or individual pages be removed. The use for any commercial purpose other than promoting the book is strictly prohibited.