

Applying Interfaces

- To understand the power of interfaces, let's look at a more practical example. There are many ways to implement a stack. For example, the stack can be of a fixed size or it can be "growable."
- The stack can also be held in an array, a linked list, a binary tree, and so on. No matter how the stack is implemented, the interface to the stack remains the same. That is, the methods **push()** and **pop()** define the interface to the stack independently of the details of the implementation.
- Because the interface to a stack is separate from its implementation, it is easy to define a stack interface, leaving it to each implementation to define the specifics.
- Let's look at two examples.

First, here is the interface that defines an integer stack. Put this in a file called **IntStack.java**. This interface will be used by both stack implementations.

```
// Define an integer stack interface.
interface IntStack {
void push(int item); // store an item
int pop(); // retrieve an item
}
```

- The following program creates a class called **FixedStack** that implements a fixed-length version of an integer stack:

```
// An implementation of IntStack that uses fixed
storage.
class FixedStack implements IntStack {
private int stck[];
private int tos;
// allocate and initialize stack
FixedStack(int size) {
stck = new int[size];
tos = -1;
}
// Push an item onto the stack
public void push(int item) {
```

```

if(tos==stck.length-1) // use length member
System.out.println("Stack is full.");
else
stck[++tos] = item;
}
// Pop an item from the stack
public int pop() {
if(tos < 0) {
System.out.println("Stack underflow.");
return 0;
}
else
return stck[tos--];
}
}
class IFTest {
public static void main(String args[]) {
FixedStack mystack1 = new FixedStack(5);
FixedStack mystack2 = new FixedStack(8);
// push some numbers onto the stack
for(int i=0; i<5; i++) mystack1.push(i);
for(int i=0; i<8; i++) mystack2.push(i);
// pop those numbers off the stack
System.out.println("Stack in mystack1:");
for(int i=0; i<5; i++)
System.out.println(mystack1.pop());
System.out.println("Stack in mystack2:");
for(int i=0; i<8; i++)
System.out.println(mystack2.pop());
}
}

```

- Following is another implementation of **IntStack** that creates a dynamic stack by use of the same **interface** definition. In this implementation, each stack is constructed with an initial length. If this initial length is exceeded, then the stack is increased in size. Each time more room is needed, the size of the stack is doubled.

```

// Implement a "growable" stack.
class DynStack implements IntStack {
private int stck[];
private int tos;
// allocate and initialize stack
DynStack(int size) {

```

```

stck = new int[size];
tos = -1;
}
// Push an item onto the stack
public void push(int item) {
// if stack is full, allocate a larger stack
if(tos==stck.length-1) {
int temp[] = new int[stck.length * 2]; // double
size
for(int i=0; i<stck.length; i++) temp[i] =
stck[i];
stck = temp;
stck[++tos] = item;
}
else
stck[++tos] = item;
}
// Pop an item from the stack
public int pop() {
if(tos < 0) {
System.out.println("Stack underflow.");
return 0;
}
else
return stck[tos--];
}
}
class IFTest2 {
public static void main(String args[]) {
DynStack mystack1 = new DynStack(5);
DynStack mystack2 = new DynStack(8);
// these loops cause each stack to grow
for(int i=0; i<12; i++) mystack1.push(i);
for(int i=0; i<20; i++) mystack2.push(i);
System.out.println("Stack in mystack1:");
for(int i=0; i<12; i++)
System.out.println(mystack1.pop());
System.out.println("Stack in mystack2:");
for(int i=0; i<20; i++)
System.out.println(mystack2.pop());
}
}

```

- The following class uses both the **FixedStack** and **DynStack** implementations. It does so through an interface reference. This means that calls to **push()** and **pop()** are resolved at run time rather than at compile time.

```

/* Create an interface variable and
access stacks through it.*/
class IFTest3 {
public static void main(String args[]) {
IntStack mystack; // create an interface
reference variable
DynStack ds = new DynStack(5);
FixedStack fs = new FixedStack(8);
mystack = ds; // load dynamic stack
// push some numbers onto the stack
for(int i=0; i<12; i++) mystack.push(i);
mystack = fs; // load fixed stack
for(int i=0; i<8; i++) mystack.push(i);
mystack = ds;
System.out.println("Values in dynamic stack:");
for(int i=0; i<12; i++)
System.out.println(mystack.pop());
mystack = fs;
System.out.println("Values in fixed stack:");
for(int i=0; i<8; i++)
System.out.println(mystack.pop());
}
}

```

- In this program, **mystack** is a reference to the **IntStack** interface. Thus, when it refers to **ds**, it uses the versions of **push()** and **pop()** defined by the **DynStack** implementation. When it refers to **fs**, it uses the versions of **push()** and **pop()** defined by **FixedStack**.
- As explained, these determinations are made at run time. Accessing multiple implementations of an interface through an interface reference variable is the most powerful way that Java achieves run-time polymorphism.

Variables in Interfaces

- Interfaces can be used to import shared constants into multiple classes by simply declaring an interface that contains variables that are initialized to the desired values. When you include that interface in a class (that is, when you “implement” the interface), all of those variable names will be in scope as constants (This is similar to using a header file in C/C++ to create a large number of **#defined** constants or **const** declarations.).
- If an interface contains no methods, then any class that includes such an interface doesn’t actually implement anything. It is as if that class were importing the constant fields into the class name space as **final** variables. The next example uses this technique to implement an automated “decision maker”:

```
import java.util.Random;
interface SharedConstants {
    int NO = 0;
    int YES = 1;
    int MAYBE = 2;
    int LATER = 3;
    int SOON = 4;
    int NEVER = 5;
}
class Question implements SharedConstants {
    Random rand = new Random();
    int ask() {
        int prob = (int) (100 * rand.nextDouble());
        if (prob < 30)
            return NO; // 30%
        else if (prob < 60)
            return YES; // 30%
        else if (prob < 75)
            return LATER; // 15%
        else if (prob < 98)
            return SOON; // 13%
        else
            return NEVER; // 2%
    }
}
```

```

class AskMe implements SharedConstants {
static void answer(int result) {
switch(result) {
case NO:
System.out.println("No");
break;
case YES:
System.out.println("Yes");
break;
case MAYBE:
System.out.println("Maybe");
break;
case LATER:
System.out.println("Later");
break;
case SOON:
System.out.println("Soon");
break;
case NEVER:
System.out.println("Never");
break;
}
}

public static void main(String args[]) {
Question q = new Question();
answer(q.ask());
answer(q.ask());
answer(q.ask());
answer(q.ask());
}
}

```

- Notice that this program makes use of one of Java's standard classes: **Random**. This class provides pseudorandom numbers. It contains several methods that allow you to obtain random numbers in the form required by your program.
- In this example, the method **nextDouble()** is used. It returns random numbers in the range 0.0 to 1.0. In this sample program, the two classes, **Question** and **AskMe**, both implement the **SharedConstants** interface where **NO**, **YES**, **MAYBE**, **SOON**, **LATER**, and **NEVER** are defined.

- Inside each class, the code refers to these constants as if each class had defined or inherited them directly. Here is the output of a sample run of this program. Note that the results are different each time it is run.

```
Later  
Soon  
No  
Yes
```

Interfaces Can Be Extended

- One interface can inherit another by use of the keyword **extends**. The syntax is the same as for inheriting classes. When a class implements an interface that inherits another interface, it must provide implementations for all methods defined within the interface inheritance chain.

- Following is an example:

```
// One interface can extend another.  
interface A {  
    void meth1();  
    void meth2();  
}  
// B now includes meth1() and meth2() -- it adds  
meth3().  
interface B extends A {  
    void meth3();  
}  
// This class must implement all of A and B  
class MyClass implements B {  
    public void meth1() {  
        System.out.println("Implement meth1().");  
    }  
    public void meth2() {  
        System.out.println("Implement meth2().");  
    }  
    public void meth3() {  
        System.out.println("Implement meth3().");  
    }  
}  
class IFExtend {
```

```
public static void main(String arg[]) {  
    MyClass ob = new MyClass();  
    ob.meth1();  
    ob.meth2();  
    ob.meth3();  
}  
}
```

- As an experiment, you might want to try removing the implementation for **meth1()** in **MyClass**. This will cause a compile-time error. As stated earlier, any class that implements an interface must implement all methods defined by that interface, including any that are inherited from other interfaces.