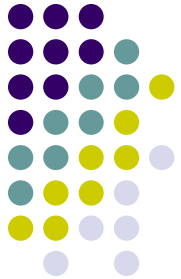
Java 105/200

3 - Advanced object oriented programming



Designing a standard access to multiple classes

INTERFACES

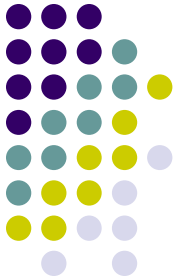
Definition

- An interface is a set of abstract method signatures and constants
- An interface is a data type that acts like a superclass.
- Use an interface when you've already used inheritance.
  - Java does not support multiple inheritance, the ability to inherit from two or more classes.

Internal vs. external

- An internal interface
  - Combines shared behavior into a datatype
  - Is implemented by Java's interface type
- An external interface
  - Are the public methods exposed by a component
  - Are published as the javadocs of the component
  - Is said to be the API of the component

Typical discovery



- Interfaces are found during analysis often when two or more classes exhibit the same behavior
- A common name is defined
  - I<noun> or I<verb>
- The interface is created
- The classes declare the interface
- The interface is used as a reference type

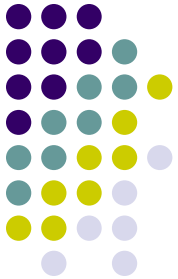
Creating an interface

- The name of the interface describes an ability to do something
  - Clone**able**, Compar**able**, Serializ**able**, Runn**able**
  - IProcess, IMove, IMessage, ISortReverse
- The class-like declaration is
  - public **interface** <name> { }

Interfaces as markers

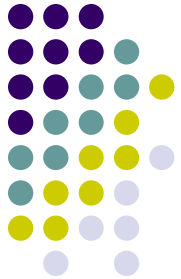
- Approval only, no method implementation required
- Common interfaces
  - Serializable
  - Cloneable
  - EventListener
- Better as an annotation for new markers
  - Needs backwards compatibility for old markers

Writing interface methods



- Interface methods are always by default
  - public abstract
- Interface fields are always by default
  - public static final
- End methods with ; and not a code block.
  - Object clone( );
  - void read( );

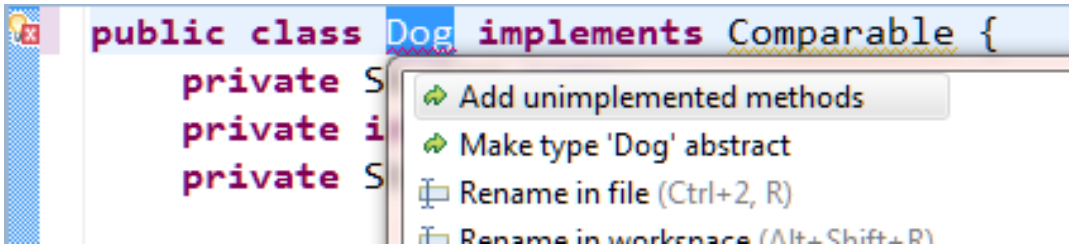
Implementing interfaces



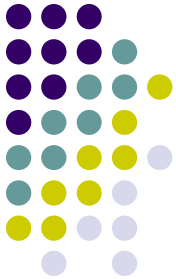
- Interfaces can be used with or without superclasses
- Interfaces use the keyword **implements**
  - public class Bird implements IFly { }
- Classes can implement multiple interfaces
  - public class Bird implements IFly, ICommunicate, INest
    { }

IDEs and interfaces

- Can ask for interfaces on class creation
- Adding an interface after class creation creates a light bulb which will implement methods.

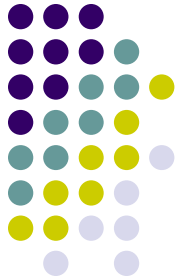


Exercise (200)



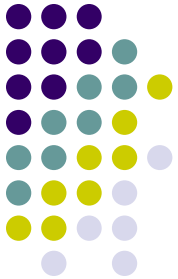
- Write an interface IMotorized with methods
  - startMotor( ), stopMotor( )
- Add classes and implement interfaces
  - GoCart, Canoe, Speedboat, Lawnmower, RidingLawnmower, ReelMower
  - Optionally, other methods like mow( )
- Write other interfaces and apply
  - IControlMotion, IControlDirection, ISubmerge, ITransport
- Use inheritance where useful
- Start motors, move them all, stop moving, stop

Static imports (1.5)



- Static imports make code more readable.
- Constants usually defined in interfaces
- Imports all constants without need to preface with class name

Static imports (1.5)

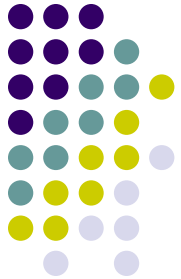


- before
  - import java.awt.Color;
  - class Employee {
  - … **Color**.BLUE … }
- after
  - import **static** java.awt.Color**.***;
  - class Employee {
  - … BLUE … }

Packages, import, CLASSPATH

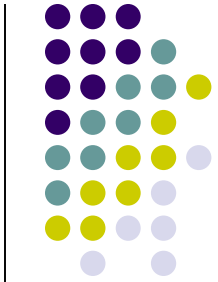
CLASS ORGANIZATION

Packages



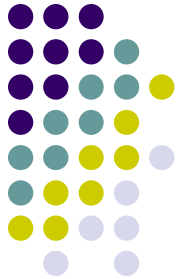
- A package logically organizes classes into groups
  - A Dog class in two different packages will not be confused
    - monday.Dog
    - tuesday.Dog
- A package physically organizes class files into a directory

Declaring a package



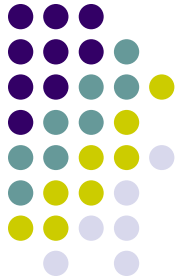
- Putting a class in a package requires one line at the top of the file before the class declaration.
  - **package** monday;
  - public class Dog { }

Nested packages



- Packages can be nested when convenient
  - monday.exercises;
  - java.lang
  - java.util
  - java.util.zip
- javax packages refer to classes from 1.2 on
  - javax.net
  - javax.print
  - javax.sql

Qualified class names



- A class is fully named with its package name
  - monday.Dog
  - java.lang.String
  - java.util.zip.ZipFile

Troubleshooting steps

scope	Limiting factor
Java tool in OS →	PATH
java →	PATH
package.class in OS → package.class in IDE → package.class in java → class	CLASSPATH reference in IDE import (optional) access modifier
method	access modifier

Providing access to package classes

- You must first provide physical access (project reference) to a class you want to use
  - java.lang classes are available by default
- Use the keyword import above the class declaration
  - import java.util.Date;
  - import java.math.BigDecimal;

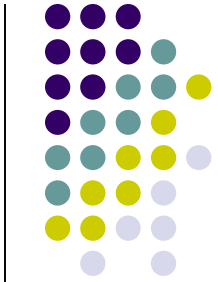
Providing access to package classes

- Provide access to all package classes with *
  - import java.math.*;
  - This is a search help only, it will not physically copy the code so there is no inefficiency.
  - BigDecimal price = new BigDecimal(“39.95”);
- Provide access to a package class without import by using qualified name.
  - java.math.BigDecimal price = new java.math.BigDecimal(“39.95”);

Package access keywords

- <none> - restricts access to package only
- **protected** – same as <none> but allows access by subclasses
  - Used for access into a library only after extending the code
- Access modifiers must be compatible with overriding methods.

Exercise - protected

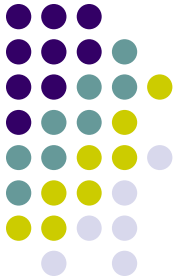


- Change a get method in Person from public to
  - Package access
  - Private
  - Protected
- And see if you can access it from your package

Exercise – using external jars

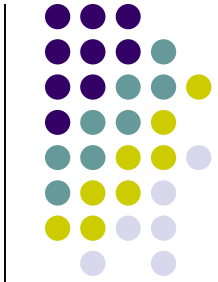
- Go to apache.org and get a jar file from the Commons library
  - Projects > Language > Java
  - Choose a project like
    - Apache Commons Lang
    - Apache Commons Math
    - Apache Commons Net
  - Choose download site (and mirror)
  - Download binaries and source (and docs if separate).

Eclipse external jars



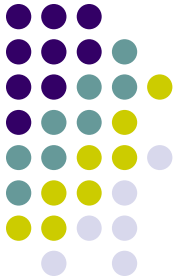
- Project Properties > Java Build Path > Libraries > Add External JARs…
  - Choose location of JAR
- Add source code
  - Select JAR file > click outline arrow on left
  - Select Source attachment > Edit…
  - Choose External File.. Location
- Add Javadocs if available.

Eclipse external jars

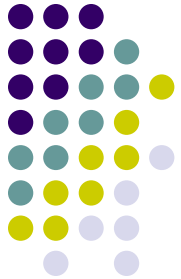


- Confirm under project > Referenced Libraries
- Easy method:
  - Drag and drop file from Explorer window to project folder.

Exercise – external jars



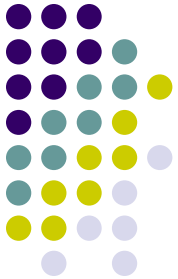
- Import package
- Use classes



Try-catch, throw, throws, finally

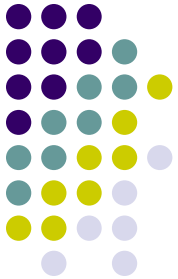
EXCEPTION HANDLING

Old school



- try some code
- if (rule is broken) {
  - if(first type of error) handle this error
  - else if (second type of error) handle it
  - …
  - else do the default error handling thing
- }
- try some more code
- if (…

OO school

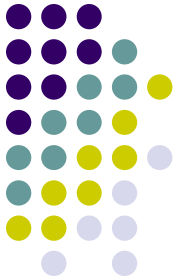


- write error handling code **FIRST**
- try {
  - code
  - code
  - code
- }
- the JVM routes you to a kind of case structure you write

OO error handling

- Benefits
  - reusable error handling
  - customized error types
  - simple structure creates easy to read code
- Not benefits
  - writing the same amount of code
  - nesting structures creates hard to read code

try and catch



- try {
  - code that can fail
- }
- catch (ExceptionDatatype objectCaught) {
  - do something about it
- }

Catching what?

- Exception type objects are managed by JVM
- Objects are created by JVM when
  - code fails to pass explicit tests
  - code fails for other reasons
- Objects are routed to the catch block by the JVM
- Code is run by matching object to catch parameter type just like a method

Two exception types

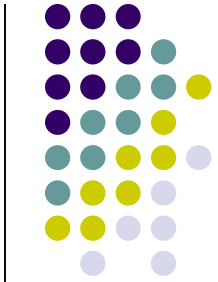
- Compile time (checked)
  - Running code that can create an exception **must** be in a try block
  - Code will not compile otherwise
- Runtime (unchecked)
  - Exceptions can be caught and handled if wanted
  - Exceptions not caught cause program failure.

Unchecked exceptions - IDEs

- You can always wrap code in a try/catch
- Surround with try-catch

```
byte[] emptyArray = new byte[0];
System.out.println(emptyArray[0]);
```

Unchecked exceptions

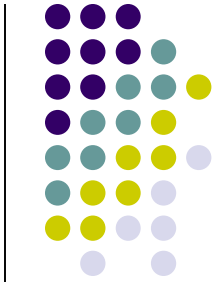


- Remove comment, print the message

```
byte[] emptyArray = new byte[0];
try {
    System.out.println(emptyArray[0]);
} catch (Exception e) {
    System.out.println(e);
}
```

- Always initialize variables outside of try/catch so they are in scope in or out of those blocks.

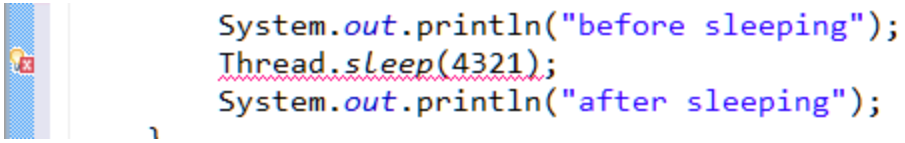
Exercise



- Create an array and access an element that is not in range. Add a println statement before and after access.
- Wrap the access statement in a try/catch and run again.
- Try dividing by zero.
- Wrap in a try/catch and print out the exception object.

Checked exceptions - IDEs

- Checked exceptions will show a light bulb error.



- Click on light bulb to show options

  - Add throws declaration (defer error handling)
  - Surround with try/catch (handle error now - **BEST**)

Checked exceptions

- Output can be better.

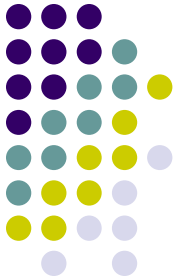
```
try {
    Thread.sleep(4321);
} catch (InterruptedException e) {
    // TODO Auto-generated catch block
    e.printStackTrace();
}
```

- Trim comment, show just message.

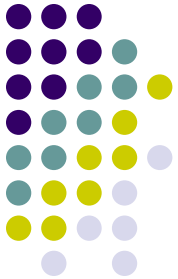
```
try {
    Thread.sleep(4321);
} catch (InterruptedException e) {
    System.out.println(e);
}
```

Exercise

- Do the Thread.sleep(#####) example



Multiple catch blocks



- try {…}
- catch (MinorExceptionType e) { … }
- catch (AnotherMinorType e) { … }
- catch (MajorExceptionType e) { … }
- catch (Exception e) { … }
  - will catch anything else

Defining your own error states

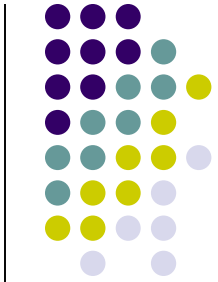
- Reusing Java's exception classes
  - if (you don't like something) {
    - throw new Exception("I didn't like it");
  - }

  - if (it's a new kind of Arithmetic problem) {
    - throw new ArithmeticException("My arithmetic error #3543");
  - }

Defining your own error states

- Creating your own class of error types
  - class MySpecialException extends Exception { }
  - void myLogic( ) throws MySpecialException {
    - if (it's a special case) {
      - throw new MySpecialException("I especially didn't like it");
    - }

Rethrowing



- Not common
  - try { … }
  - catch (Exception e) {
    - System.out.println(“Exception was caught.”);
    - **throw** e;
  - }
- Method that calls this code **must** be in a try block.

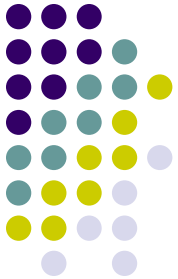
finally

- Code block to execute when try **OR** catch has executed.
- Must be after catch blocks
- Used for
  - cleaning up resources
    - close database connections
    - close file handles
  - finalizing processes

Defer error handling

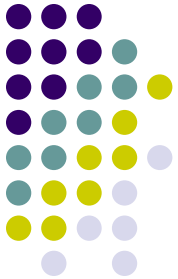
```
try { Aclass.doA( ); } catch (AnException a) {…}


class Aclass {
        static void doA ( ) throws AnException {
                BClass.doB( ); }  }
class Bclass {
        static void doB() throws AnException {
                        throw AnException( ); }  }
```

Throwable



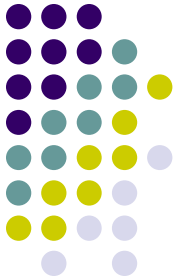
- Exception extends Throwable
- Methods to use in **catch** block on object caught
  - e.getMessage( );
  - e.toString( );
  - e.printStackTrace( );

Inheritance structure



- java.lang.Throwable
  - **Error** – serious problems, don't try to **catch**.
    - IOError, ThreadDeath, VirtualMachineError…
    - doesn't require **throws**
  - Exception
    - AclNotFoundException, ActivationException, AlreadyBoundException, ApplicationException, AWTException, BackingStoreException, BadAttributeValueExpException,BadBinaryOpValueExpException, BadLocationException, BadStringOperationException, BrokenBarrierException, CertificateException, ClassNotFoundException, CloneNotSupportedException,DataFormatException, DatatypeConfigurationException, DestroyFailedException, ExecutionException, ExpandVetoException, FontFormatException, GeneralSecurityException, GSSException,IllegalAccessException, IllegalClassFormatException, InstantiationException, InterruptedException, IntrospectionException, InvalidApplicationException, InvalidMidiDataException,InvalidPreferencesFormatException, InvalidTargetObjectTypeException, InvocationTargetException, IOException, JAXBException, JMException, KeySelectorException, LastOwnerException,LineUnavailableException, MarshalException, MidiUnavailableException, MimeTypeParseException, MimeTypeParseException, NamingException, NoninvertibleTransformException,NoSuchFieldException, NoSuchMethodException, NotBoundException, NotOwnerException, ParseException, ParserConfigurationException, PrinterException, PrintException,PrivilegedActionException, PropertyVetoException, RefreshFailedException, RemarshalException, RuntimeException, SAXException, ScriptException, ServerNotActiveException, SOAPException,SQLException, TimeoutException, TooManyListenersException, TransformerException, TransformException, UnmodifiableClassException, UnsupportedAudioFileException,UnsupportedCallbackException, UnsupportedFlavorException, UnsupportedLookAndFeelException, URIReferenceException, URISyntaxException, UserException, XAException,XMLParseException, XMLSignatureException, XMLStreamException, XPathException

Try-with-resources – JDK 7



- Use with resources implementing AutoCloseable
- Used in i/o
- Will close opened resources
- try (**managed resource**) {
  - …
- } // managed resource is closed

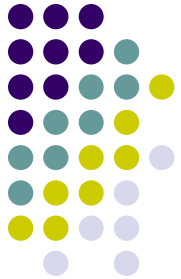
Multi-catch – JDK 7

- separate exception types with | (OR operator)
- catch(ArithmeticException | ArrayIndexOutOfBoundsException) {
  - …
- }

Exercise – custom exceptions

- CreditCardProcessor
  - setNumber
  - main( ) – call process
- CreditCardException
  - String creditCard
  - All constructors from superclass
- on process error
    - create object, set creditCard, throw object

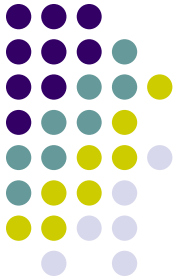
javadoc tags



- @throws, @param, @return
- @author, @see, @since, @version
- {@code}, {@docroot}, {@inheritDoc}, {@link}, {@linkplain}, {@literal}, {@value}
- @deprecated

javadoc - Eclipse

- Project > Generate javadoc
  - Generate javadoc command
    - Point to a JDK bin directory location of the javadoc utility program
  - Select packages
  - Select visibility
  - Select doclet (formatter: standard = html)

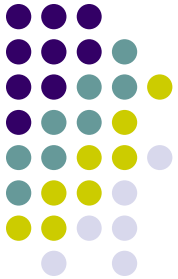


END TASKS

105 End tasks

- Zip files and save/mail
- Certificate
- Evaluation

.jar files



- File > Export…
- Java > JAR file > Next
  - JAR file is self-executing if you choose
  - Runnable JAR file - for self-executing jars with GUIs using a launch configuration
- Select the project (src only)
- Check: Export Java source files and resources
- Select export destination: name of .jar file
- Options: compress