Core Java

Packages & Exception Handling

Objective

At the end of this session, you will be able to:

- Package classes
- Catch & throw exceptions
- Understand Exception Propagation
- Create User defined exceptions

Agenda

- Packages
  - Introduction
  - Predefined packages
  - User defined package
- Exception Handling
  - Introduction
  - Checked & Unchecked Exceptions
  - Using try, catch, finally, throw, throws
  - Exception Propagation
  - Predefined exceptions
  - User defined exceptions

Introduction to Packages

- Why Packages
  - To avoid naming conflicts
  - To control access
  - To achieve Reusability

- What is Package

  A *package* is a group of related types (classes, interfaces etc.) providing access and namespace management

Predefined Packages

- Already defined in the Java API library & can be *imported* into user programs

- Examples of predefined packages:

Core packages

`java.lang.*;`	`Frequently required Operations (By default, it is imported)`
`java.util.*;`	`Utility Operations`
`java.sql.*;`	`Database operations`
`java.net.*;`	`Networking operations`
`java.io.*;`	`File related operations`
`java.awt.*;`	`GUI operations`

Extended Packages

`javax.sql.*;`	`Database`
`javax.servlets.*;`	`Servlets`

Creating Packages

- A *package* allows logical grouping of classes

```
package myPackage;
public class MyClass {
    MyClass()
    {
    }
}
```

- Strict file & directory naming conventions and organization
- All classes put into a package must reside in a directory with that package name
- Package name is strictly specified at the beginning of the java code

Class Member Access

Access Rights for different Elements

Class \ Has access to	Private Elements	Default Elements (*no modifier*)	Protected Elements	Public Elements
own class (**Base**)	yes	yes	yes	yes
subclass - same package (**SubA**)	no	yes	yes	yes
class - same package (**AnotherA**)	no	yes	no	yes
subclass - another package (**SubB**)	no	no	yes	yes
class - another package (**AnotherB**)	no	no	no	yes

Working with CLASSPATH

- An environment variable which tells the JVM and java compiler where to look for class files
- Class files are searched in the directories specified in the class path in the order specified
- `set CLASSPATH=%CLASSPATH%;.; source location from root folder;`

Example:

`set CLASSPATH=%classpath%;…`

The symbol . (dot) means Current Directory

Adds the current classpath

PackageDemo.txt

Give this a Try…

1. What is the missing code in this class?

```
Class MyClass
{
Public static void main(String args[])
{
Date d=new Date();
System.out.println(“Date = “+d);
}
}
```

Core Java

Exception Handling

Exception Handling

- A built in mechanism for trapping & handling errors
- Usually deals with abnormal events or code execution which prevents the program from continuing, like:
  - Array out of bounds accesses
  - Divide by Zero
  - Null pointers & so on…
- Exception Handling handles these errors whenever they happen

What is Exception?

- An Exception is a Java class
- A variety of subclasses allows handling different kinds of errors & abnormal events
- Basic concept:

  Whenever an abnormal event occurs, Java *throws* an Exception

  It means Java instantiates a subclass of the Exception class

  Whenever an Exception could possibly be thrown, we must provide a mechanism for *catching* it in our code

Throwing Exceptions

- If the programmer does not catch the exception, it is thrown automatically to the caller function

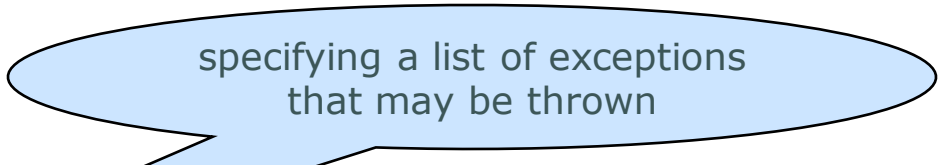
- If an exception is thrown from the *main* function, the program is terminated abnormally

ExceptionDemo.java

Throwing Exceptions (Contd…)

- Exceptions may be thrown explicitly by using the *throws* keyword

- Throwing exceptions in Java terminates method execution




```
public class String
{
    public char charAt(int index)
        throws IndexOutOfBoundsException
    {
        . . .
        throw new IndexOutOfBoundsException();
        . . .
        return c;
    }
}
```

Catching Exceptions

- A *try* statement executes a block and oversees the execution of enclosed statements for exceptions
- try also defines the scope for exception handlers (defined in catch clause)
- A try block must be accompanied by at least one *catch* block or one *finally* block
- Any method declared as being able to throw an Exception, can have a try / catch block to handle the exception

CatchExceptionDemo.java

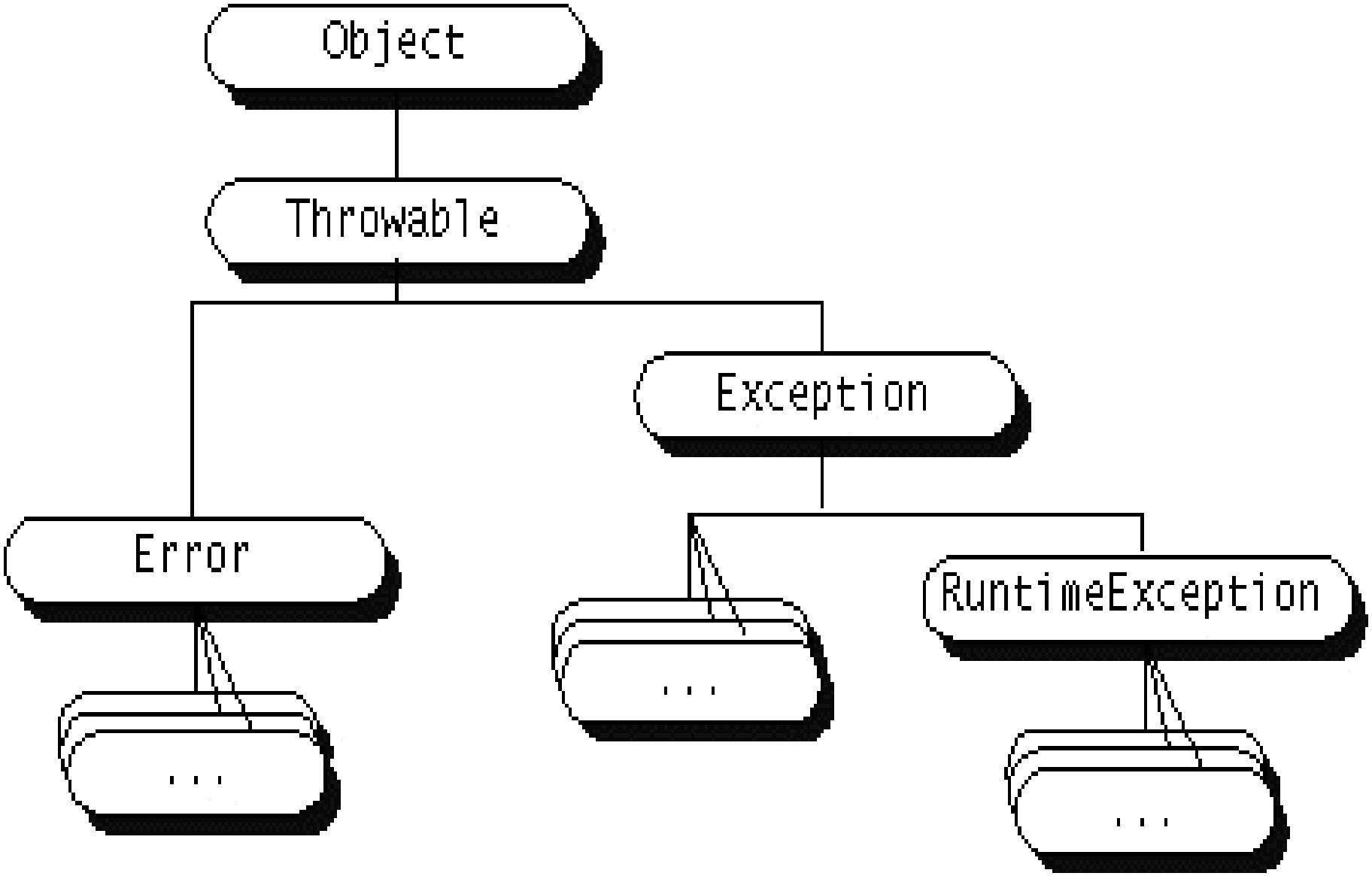
Catching Exceptions (Contd…)

```
try {
    String text = "text";
    System.out.println(text.charAt(10));
} catch(IndexOutOfBoundsException e) {
    System.err.println("Index out of bounds");
    e.printStackTrace();
}
```

- If an Exception is thrown inside of a try block, the returned exception is forwarded as an argument to the catch block where the Exception can be handled

CatchExceptionDemo.java

Exception Hierarchy



Categories of Exceptions

- Java exceptions fall in two categories:

1. Unchecked
   - Not checked by the compiler at compile time
   - Does not force the client program / method to declare each exception thrown by a method, or even handle it
   - All exceptions are derived from *RuntimeException* class

2. Checked
   - Checked by the compiler to see if these exceptions are properly caught or specified, & if not, the code fails to compile
   - Forces client program to deal with the scenario in which an exception may be thrown
   - All exceptions which are not derived from RuntimeException class

Dealing with Exceptions

1. By using a try / catch block as seen

2. By indicating that the *calling method* throws the same Exception, essentially forwarding the responsibility of catching the exception to the code that calls your method

```
public void myMethod() throws IOException
{
    //calls a method that throws an IOException
}
```

Multiple Catch Blocks

- A method can throw more than one possible Exceptions, or the try block could call two different methods that throw two different Exceptions

```
try {
   String text = "text";
   System.out.println(text.charAt(10));
   int n = Integer.parseInt("abc");
} catch(IndexOutOfBoundsException e) {
   System.err.println("Index out of bounds");
   e.printStackTrace();
} catch(NumberFormatException e) {
   System.err.println("bad number");
   e.printStackTrace();
}
```

Multiple Catch Blocks (Contd…)

- Since all Exceptions are subclasses of the Exception class, we can generalize catch blocks to accept multiple different types of Exceptions by using a super class

```
try {
    String text = "text";
    System.out.println(text.charAt(10));
    int n = Integer.parseInt("abc");
} catch(Exception e) {
    System.err.println("Something bad happened");
    e.printStackTrace();
}
```

The *finally* Block

- Sometimes, while in a try / catch block, an Exception could be thrown before some important code at the end of the try block
- The *finally* block can be used to run this code
- Code in *finally* always executes (even in case of unhandled exceptions)

```
try {
   String text = "text";
   System.out.println(text.charAt(10));
} catch(IndexOutOfBoundsException e) {
   System.err.println("Index out of
bounds");
   e.printStackTrace();
} finally {
   //important code
}
```

FinallyDemo.java

Rethrowing Exceptions

- We can *rethrow* an exception after catching it & processing it

```
try {
    String text = "text";
    System.out.println(text.charAt(10));
} catch(IndexOutOfBoundsException e) {
    System.err.println("Index out of bounds");
    e.printStackTrace();
    throw e;
}
```

- If we *rethrow* an Exception, we must specify that the calling method throws the Exception

Rethrowing.java

Exception Methods

- What type of information do we get from the Exception objects:
  - getCause()
  - getMessage()
  - printStackTrace()

- Subclasses of Exception can be much more elaborate and contain more information if desired

ExceptionMethods.java

Exception Propagation

- Exceptions are always propagated from the *called* method to the *caller* method, if thrown from the *called* method
- If an Exception is thrown from the *main()* method, it will be propagated to the Java Runtime
- In exception propagation, all statement executions are ignored until finding the exception handler

Exception Propagation (Contd…)

```
public class Propagate {
    void calculate() {
        int m = 25, i = 0;
        i = m / i;
    }
public static void main(String[] args) {
        Propagate p = new Propagate();
        p.calculate();
    }
}
```

ArithmeticExceptio n Occurred

Exception propagated from calculate() to main() method

Exception propagated from main( ) function to java

```
Exception in thread "main" java.lang.ArithmeticException: / by zero
        at Propagate.calculate(Propagate.java:4)
        at Propagate.main(Propagate.java:8)
```

User Defined Exceptions

- A User Defined Exception must be a subclass of Exception or one of its subclasses

```
class AgeException extends Exception
{
 public AgeException(String message)
 {
  super(message);
 }
}
```

```
class Employee
{
 public void setAge(int age) throws AgeException
 {
  if(age<18)
   throw new AgeException("Age must be > 10");
 }
}
```

Give this a Try…

1. In a program, can we have a try block without catch?

2. In a program, can a try block have multiple catch blocks?

3. Can a program have more than one *finally* blocks?

Summary

In this session, we have covered:

- Packages
  - Introduction
  - Predefined packages
  - User defined package
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  - Checked & Unchecked Exceptions
  - Using *try, catch, finally, throw, throws*
  - Exception Propagation
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Thank You