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Java Programming

3-5
Input and Output Fundamentals

Objectives

This lesson covers the following topics:

- Use streams to read and write files
- Read and write objects by using serialization

Files Class Checks for File Existence

- The Files class checks to see if files exist, or do not exist.
- By default, symbolic links are not followed.
- If the !exists() method and notExists() method are both false, it means that they cannot determine whether the file exists.

```
public class FilesCheckDemo {
   public static void main(String[] args) {
      Path p1 = Paths.get("C:/BlueJ/NIO2");
      boolean path_exists = Files.exists(p1);
      System.out.println("Exists? " + path_exists);
   }// end of main
}//end of class FilesCheckDemo
```

- This will return a value of false as the path doesn’t exist.

Files Class Checks File Properties

- The Files class checks to see if files are:
  - Readable
  - Writeable
  - Executable
  - Hidden
  - The same

Files Class Checks File Properties

- The Files class provides these static methods for checking file properties and duplication:

```
Files.isReadable(Path p);
Files.isWritable(Path p);
Files.isExecutable(Path p);
Files.isHidden(Path p);
Files.isSameFile(Path p1, Path p2);
```

- Sample output would be:

```
System.out.println(Files.isReadable(woF));        true
System.out.println(Files.isWritable(woF));        true
System.out.println(Files.isExecutable(woF));      true
System.out.println(Files.isHidden(woF));          false
System.out.println(Files.isSameFile(woF, buF));   false
```

Creating Files and Directories

- Create files with one of the following methods:

```
Files.createFile(Path p);
Files.createDirectory(Path p);
```

- Create multiple levels of directories with this method:

```
Files.createDirectories(Path p);
```

Creating Files and Directories Example

```
import java.io.IOException;
import java.nio.file.Files;
import java.nio.file.Path;
import java.nio.file.Paths;

public class FilesDemo {
   public static void main(String[] args) {
      Path p = Paths.get("C:/BlueJ/scores");
      Path p2 = Paths.get("Highscores.txt");
      Path p3 = p.resolve(p2);
      //used to test the value of p3
      System.out.println("The contents of p3 : " + p3.toString());
      try {
          if(Files.notExists(p))
            Files.createDirectories(p);
         //endif
          if(Files.notExists(p3))
            Files.createFile(p3);
         //endif
      } //end try
      catch (IOException x) {
         System.err.println(x);
      } //end catch
   }// end of main
}//end of class FilesDemo
```

Use resolve to add p2 to p as it does not already exist in that path

If the directory does not already exist create it using the Path p

If the file does not already exist create it using the Path p3

Deleting Files and Directories

- Delete files, directories, or links with this method.
- Throws a NoSuchFileException, DirectoryNotEmptyException, or IOException when the file is not found or the directory holds files or directories.

```
Files.delete(Path p);
```

- Delete files, directories, or links without exceptions by using this method.

```
Files.deleteIfExists(Path p);
```

Deleting Files and Directories Example

```java
import java.io.IOException;
import java.nio.file.Files;
import java.nio.file.Path;
import java.nio.file.Paths;

public class FilesDeleteDemo {
   public static void main(String[] args) {
      Path p = Paths.get("C:/BlueJ/scores");
      Path p2 = Paths.get("Highscores.txt");
      Path p3 = p.resolve(p2);
      //The following code will delete the file if it exists.
      try {
          if(Files.exists(p3)){
             Files.deleteIfExists(p3);
             System.out.println(p3.toString()+ " deleted!");
          }
          else
             System.out.println(p3.toString()+ " not found!");
          //endif
      }//end try
      catch (IOException x) {
         System.err.println(x);
     }//end catch
   }// end of main
}//end of class FilesDeleteDemo
```

Copying and Moving Files and Directories

- Import the java.nio.file.StandardCopyOption.* package when you want the ability to copy or move files and directories.
- Copy or move files or directories with these methods:

```
Files.copy(Path p, CopyOption ...);
Files.move(Path p, CopyOption ...);
```

- An example would be:

```
Files.copy(source, target, REPLACE_EXISTING, NOFOLLOW_LINKS);
```

StandardCopyOption and LinkOption Enums

- The StandardCopyOption and LinkOption enums are:
  - REPLACE_EXISTING: Works with existing file or directory.
  - COPY_ATTRIBUTES: Copies related attributes.
  - NOFOLLOW_LINKS: Disables following symbolic links.

StandardCopyOption and LinkOption Enums Format

- The options must be prefaced with StandardCopyOption or LinkOption.
- Examples:
  - StandardCopyOption.REPLACE_EXISTING
  - StandardCopyOption.COPY_ATTRIBUTES
  - StandardCopyOption.NOFOLLOW_LINKS
  - LinkOption.REPLACE_EXISTING
  - LinkOption.COPY_ATTRIBUTES
  - LinkOption.NOFOLLOW_LINKS

File example

```
import java.io.IOException;
import java.nio.file.Files;
import java.nio.file.Path;
import java.nio.file.Paths;
import java.nio.file.StandardCopyOption;

public class FilesDemo {
   public static void main(String[] args) {
      //create path variables
      Path p = Paths.get("C:/BlueJ");
      Path p1 = Paths.get("scores");
      Path p2 = Paths.get("backup");
      Path p3 = Paths.get("Highscores.txt");
      //create path for the working directory
      Path woD = p.resolve(p1);
      //create path for the working file
      Path woF = p.resolve(p1.resolve(p3));
      //create path for the backup directory
      Path buD = p.resolve(p2);
      //create path for the backup file
      Path buF = p.resolve(p2.resolve(p3));
```

Creates paths for the working directory/file

Creates paths for the backup directory/file

Code continues on next slide…

File example

… code continued from previous slide

```
      try {
       if(Files.exists(woF)){
          if(Files.notExists(buD)){
             Files.createDirectories(buD);
          }//endif
          Files.copy(woF, buF, StandardCopyOption.REPLACE_EXISTING,
StandardCopyOption.COPY_ATTRIBUTES);
          } //endif
          if(Files.notExists(woD))
             Files.createDirectories(woD);
          //endif
          if(Files.notExists(woF))
            Files.createFile(woF);
          //endif
       } //end try
       catch (IOException x) {
          System.err.println(x);
       } //end catch
   }// end of main
}//end of class FilesDemo
```

Existing file is copied to the backup directory

If the required directory/file does not exist then they are created.

File Permissions

- The relativize() method constructs a path from one location to another when:
  - It requires relative paths.
  - It only works when working between nodes of the same file directory tree (hierarchy).
  - It raises an IllegalArgumentException when given a call parameter in another directory tree.

File Permissions

```
Path p1 = Paths.get("NIO2");
Path p2 = Paths.get("Projects");

// Output value of join between two paths.cd
System.out.println("p1.realativize(p1)  [" +
                            p1.relativize(p2).toString() + "]");
```

The relativize() method only works with two relative paths.

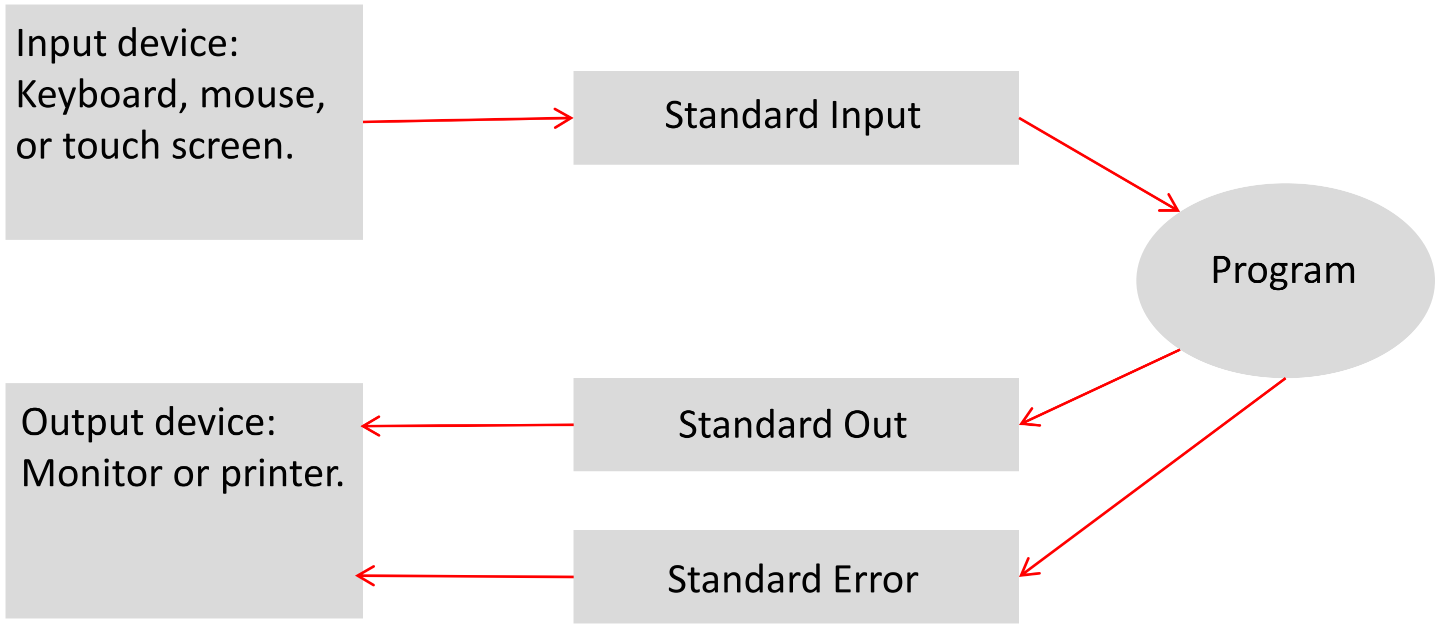
File Permissions and Operating Systems

- The file permissions differ from operating system to operating system.
- Linux Permissions
  - read/write/execute
- Windows Permissions
  - Full control/Modify/Read and execute/Read/Write

Input and Output Stream Basics

- Standard programming has three basic streams:
  - Standard in (stdin), input to programs
  - Standard out (stdout), output from programs
  - Standard error (stderr), error messages from programs
- Java has three basic streams:
  - System.in an InputStream (like standard in)
  - System.out a PrintStream (like standard out)
  - System.err a PrintStream (like standard error)

Input and Output Stream Diagram



Java Stream Basics

- Java provides specialized stream classes:
  - Input Streams
  - Output Streams
- Java stream libraries:
  - Simplify deployment
  - Handle most types of input and output

Reading an Input Stream by Character

- Java reads an input stream:
  - Character-by-character - Line-by-line

```
    private static String readEntry() {
       try {
      int c;
      StringBuffer buffer = new StringBuffer();
      c = System.in.read();
      while (c != '\n' && c != -1) {
         buffer.append((char)c);
         c = System.in.read();
      }//endwhile
      return buffer.toString().trim();
   }//end try

   catch (IOException e) {
      return null;
   }//endcatch
}//end method readEntry
```

This reads the input stream character-by-character.

Reading an Input Stream by Line

- Line-by-line reads require a BufferedReader, which is a specialization of an IO Reader class.
- System.in provides a static method to create an instance of an InputStream class.

```
private static String readLine() {
   String line = "";
   InputStreamReader isr = new InputStreamReader(System.in);
   BufferedReader in = new BufferedReader(isr);
   try {
      line = in.readLine();
   }//end try
   catch (IOException e) {}//end catch

   return line;
}//end method readLine
```

This is a static call to construct an input stream from the command-line.

Create a BufferedReader stream that provides the readLine() method.

This reads the input stream line-by-line.

Reading an Input from file

- Reading from a file since the introduction of Java 7 is a relatively straightforward process.
- The try with resources method includes an auto close that closes the file when the operation is complete.

```
private static String ReadFile() {
   try(BufferedReader br = new BufferedReader(new FileReader("file.txt"))){
      StringBuilder fileContents = new StringBuilder();
      String line = br.readLine();

      while (line != null) {
         fileContents.append(line);
         fileContents.append(System.lineSeparator());
         line = br.readLine();
       }//end while

       String fileComplete = fileContents.toString();
       System.out.println(fileComplete);
   }//end try
}//end ReadFile
```

Create a BufferedReader stream that provides the readLine() method.

This reads the input stream line-by-line and appends it to the String. Uses the line separator that corresponds to the current operating system.

Writing an Output Stream

- Output to the console is typically managed by calling the static System.out, which is a PrintStream.
- Other alternatives require combining streams.

```java
public static void main(String[] args) {
   StringBuffer sb = new StringBuffer();
   char[] input;
   System.out.print("Enter a string: ");
   input = readEntry();
   for (int i = 0; i < input.length; i++)
   {
      if (input[i] != '\n' && input[i] != '\0')
         sb.append(input[i]);
      //endif
   }//end for
   System.out.println(sb);
}//end method main
```

Uses a modified readEntry() method that returns an array of char, which are then appended to a StringBuffer until the end of the output is found.

System.out is PrintStream that can be accessed by a static call.

Writing Output to File

- Output to a file is managed through the PrintWriter and FileWriter.
- A println statement is used to write the contents to the file.
- If you have created a toString() method to override the default output you can control the format of the text in the file.

```
public void WriteFile(ClassName objName) throws IOException{
   PrintWriter writer = new PrintWriter(new BufferedWriter(new
                                    FileWriter(filepath)));
   writer.println(objName);
   writer.close();
}
```

Writing Output to File

- If you want to append to the file instead of overwriting add the optional true parameter to the FileWriter call.

```
public void WriteFile(EmployeeInfo objName) throws IOException{
    PrintWriter writer = new PrintWriter(new BufferedWriter(new
                                  FileWriter(filepath, true)));
    writer.println(objName);
    writer.close();
}
```

- You can also write individual pieces of information by calling the get methods of the class.

```
public void WriteFile() throws IOException{
    PrintWriter writer = new PrintWriter(new BufferedWriter(new
                                  FileWriter(filepath, true)));
    writer.println(classname.methodname);
    writer.close();
}
```

Object Serialization

- Object serialization is the process of encoding objects as a byte stream, transmitting them, and reconstructing objects by decoding their byte stream.
- Encoding an object into a stream is serialization.
- Decoding a stream into an object is deserialization.
- Serialization is the standard method for Java beans.
- Serialized classes implement the Serializable interface.

Use Serialization Wisely

- Use serialization wisely because serialized classes:
  - Are less flexible to change.
  - May have more likelihood of bugs and security vulnerabilities.
  - Are more complex to test.

Serializing and Deserializing

- This serializes a file into an object.

```
public static void serialize( String outFile, Object serializableObject)
throws IOException {
   FileOutputStream fos = new FileOutputStream(outFile);
   ObjectOutputStream oos = new ObjectOutputStream(fos);
   oos.writeObject(serializableObject);
}//end  method serialize
```

- This deserializes an object.

```
public static Object deSerialize(String serializedObject) throws
                   FileNotFoundException,
                   IOException,
                   ClassNotFoundException {
   FileInputStream fis = new FileInputStream(serializedObject);
   ObjectInputStream ois = new ObjectInputStream(fis);
   return ois.readObject();
}//end method deSerialize
```

Testing Serializing and Deserializing

- The main() method tests serialization by:
  - Serializing an object.
  - Deserializing an object.
  - Printing the transferred contents of the first object.
- The code for testing serialization in this way begins on the next slide.

Testing Serializing and Deserializing Example

- Create the following Course class in a project named serialDeserial:

```
public class Course implements java.io.Serializable {
   public String name;
   public String type;
   public String courseCode;
   public int passingScore;
}//end class Course
```

- This will be used to create the object that you will serialize and deserialize.
- For a class to be serialized successfully it must implement the java.io.Serializable interface.

Testing Serializing and Deserializing

- Create the following DemoSerialization class in your serialDeserial project:

```
import java.io.FileInputStream;
import java.io.FileOutputStream;
import java.io.IOException;
import java.io.ObjectInputStream;
import java.io.ObjectOutputStream;

public class DemoSerialization {
   public static void main(String [] args)
   {
      Course c = new Course();//create a new object(c)
      serializeData(c);//pass the object to serializeData
      c = deSerializeData(c);//pass the object to deSerializeData
      if(c!=null)
         displayData(c);
      //endif
   }//end method main
```

Code continues on next slide…

Testing Serializing and Deserializing

… code continued from previous slide

```
public static void serializeData(Course c){
  //assign values to the Course class attributes
  c.name = "Java Programming";
  c.type = "Programming";
  c.courseCode = "JPL2";
  c.passingScore = 60;
  try
  {//try writing to the file
     FileOutputStream fileOut = new FileOutputStream("C:/BlueJ/details.ser");
     ObjectOutputStream out = new ObjectOutputStream(fileOut);
     out.writeObject(c);
     out.close();
     fileOut.close();
     System.out.printf("Serialized data is saved in C:/BlueJ/details.ser");
  }//end try
  catch(IOException i)
  {
     i.printStackTrace();
  }//end catch
}//end method serializeData
```

Code continues on next slide…

Testing Serializing and Deserializing

… code continued from previous slide

```
public static Course deSerializeData(Course c){
   try
   {//try reading the file
      FileInputStream fileIn = new FileInputStream("C:/BlueJ/details.ser");
      ObjectInputStream in = new ObjectInputStream(fileIn);
      c = (Course) in.readObject();
      in.close();
      fileIn.close();
      return c;
   }//end try
   catch(IOException i)
   {//catch any IO exception error that is thrown
      i.printStackTrace();
      return null;
   }//end catch
   catch(ClassNotFoundException e)
   {//catch any error where the class is not found
      System.out.println("Course class not found");
      return null;
   }//end catch
}//end method deSerializeData
```

Code continues on next slide…

Testing Serializing and Deserializing

… code continued from previous slide

```
   public static void displayData(Course c){
     //display the contents of the class to screen
     System.out.println("Deserialized Course Details...");
     System.out.println("Name: " + c.name);
     System.out.println("Type: " + c.type);
     System.out.println("Code: " + c.courseCode);
     System.out.println("Pass Score: " + c.passingScore);
   }//end method displayData

}//end class DemoSerialization
```

End of code.

Terminology

Key terms used in this lesson included:

- Deserialization
- File Name
- Tree
- Resolve path
- Output Streams
- Standard input
- Standard output
- Standard error

Summary

In this lesson, you should have learned how to:

- Use streams to read and write files
- Read and write objects by using serialization

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