CSC9UT4 (Managing Information):
The use of Files in Java

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Reading and Writing Text Files

- Text Files are very commonly used to store information
  - Both numbers and words can be stored as text
  - They are the most 'portable' types of data files
- The `Scanner` class can be used to read text files
  - We have used it to read from the keyboard
  - Reading from a file requires using the `File` class
- The `PrintWriter` class will be used to write text files
  - Using familiar `print`, `println` and `printf` tools

Text File Input

- Create an object of the `File` class
  - Pass it the name of the file to read in quotes

```
File inputFile = new File("input.txt");
```

- Then create an object of the `Scanner` class
  - Pass the constructor the new `File` object

```
Scanner in = new Scanner(inputFile);
```

- Then use `Scanner` methods such as:
  - `next()`
  - `nextLine()`
  - `hasNextLine()`
  - `hasNext()`
  - `nextDouble()`
  - `nextInt()...`

```
while (in.hasNextLine())
{
  String line = in.nextLine();
  // Process line;
}
```

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Text File Output

- Create an object of the `PrintWriter` class
  - Pass it the name of the file to write in quotes

```
PrintWriter out = new PrintWriter("output.txt");
```

    - If output.txt exists, it will be emptied
    - If output.txt does not exist, it will create an empty file

  `PrintWriter` is an enhanced version of `PrintStream`

  - `System.out` is a `PrintStream` object!

```
System.out.println("Hello World!");
```

- Then use `PrintWriter` methods such as:
  - `print()`
  - `println()`
  - `printf()`

```
out.println("Hello, World!");
out.printf("Total: %8.2f\n", totalPrice);
```

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Closing Files

- You must use the `close` method before file reading and writing is complete
  - Closing a `Scanner`

```
while (in.hasNextLine())
{
  String line = in.nextLine();
  // Process line;
}
in.close();
```

Your text may not be saved to the file until you use the `close` method!

  - Closing a `PrintWriter`

```
out.println("Hello, World!");
out.printf("Total: %8.2f\n", totalPrice);
out.close();
```


Exceptions Preview

- One additional issue that we need to tackle:
  - If the input file for a Scanner doesn't exist, a FileNotFoundException occurs when the Scanner object is constructed.
  - The PrintWriter constructor can generate this exception if it cannot open the file for writing.
    - If the name is illegal or the user does not have the authority to create a file in the given location

Exceptions Preview

- Add two words to any method that uses File I/O

```
public static void main(String[] args) throws
   FileNotFoundException
```

  - Until you learn how to handle exceptions yourself

And an Important `import` or Two..

- Exception classes are part of the `java.io` package
  - Place the `import` directives at the beginning of the source file that will be using File I/O and exceptions

```
import java.io.File;
import java.io.FileNotFoundException;
import java.io.PrintWriter;
import java.util.Scanner;

public class LineNumberer
{
   public void openFile() throws FileNotFoundException
   {
      . . .
   }
}
```

Example: Total.java (1)

```
1  import java.io.File;
2  import java.io.FileNotFoundException;
3  import java.io.PrintWriter;
4  import java.util.Scanner;
5
6  /**
7     This program reads a file with numbers, and writes the numbers to another
8     file, lined up in a column and followed by their total.
9  */
10 public class Total
11 {
12    public static void main(String[] args) throws FileNotFoundException
13    {
14       // Prompt for the input and output file names
15
16       Scanner console = new Scanner(System.in);
17       System.out.print("Input file: ");
18       String inputFileName = console.next();
19       System.out.print("Output file: ");
20       String outputFileName = console.next();
21
22       // Construct the Scanner and PrintWriter objects for reading and writing
23
24       File inputFile = new File(inputFileName);
25       Scanner in = new Scanner(inputFile);
26       PrintWriter out = new PrintWriter(outputFileName);
```

More import statements required! Some examples may use `import java.io.*;`

Note the throws clause

Example: Total.java (2)

```
28       // Read the input and write the output
29
30       double total = 0;
31
32       while (in.hasNextDouble())
33       {
34          double value = in.nextDouble();
35          out.printf("%15.2f\n", value);
36          total = total + value;
37       }
38
39       out.printf("Total: %8.2f\n", total);
40
41       in.close();
42       out.close();
43    }
44 }
```

Don't forget to close the files before your program ends.

Common Error (1)

- Backslashes in File Names
  - When using a String literal for a file name with path information, you need to supply each backslash twice:

```
File inputFile = new File("c:\\homework\\input.dat");
```

  - A single backslash inside a quoted string is the *escape character*, which means the next character is interpreted differently (for example, '\n' for a newline character)
  - When a user supplies a filename into a program, the user should not type the backslash twice

Common Error (2)

- Constructing a `Scanner` with a `String`
  - When you construct a PrintWriter with a String, it writes to a file:

```
PrintWriter out = new PrintWriter("output.txt");
```

  - This does *not* work for a `Scanner` object

```
Scanner in = new Scanner("input.txt"); // Error?
```

  - It does *not* open a file. Instead, it simply reads through the String that you passed ("`input.txt`")
  - To read from a file, pass `Scanner` a `File` object:

```
Scanner in = new Scanner(new File("input.txt"));
```

  - or

```
File myFile = new File("input.txt");
Scanner in = new Scanner(myFile);
```

Processing Text Input

- There are times when you want to read input by:
  - Each Word
  - Each Line
  - One Number
  - One Character

Processing input is required for almost all types of programs that interact with the user.

- Java provides methods of the `Scanner` and `String` classes to handle each situation
  - It does take some practice to mix them though!

Reading Words

- In the examples so far, we have read text one line at a time
- To read each word one at a time in a loop, use:
  - The `Scanner` object's `hasNext()` method to test if there is another word
  - The `Scanner` object's `next()` method to read one word

```
while (in.hasNext())
{
  String input = in.next();
  System.out.println(input);
}
```

  - Input:

Mary had a little lamb

Output:

Mary
had
a
little
lamb

White Space

- The `Scanner`'s `next()` method has to decide where a word starts and ends.
- It uses simple rules:
  - It consumes all white space before the first character
  - It then reads characters until the first white space character is found or the end of the input is reached

White Space

- What is whitespace?
  - Characters used to separate:
    - Words
    - Lines

Common White Space

' '	Space
\n	NewLine
\r	Carriage Return
\t	Tab
\f	Form Feed

"Mary had a little lamb,\n
her fleece was white as\tsnow"

The `useDelimiter` Method

- The `Scanner` class has a method to change the default set of delimiters used to separate words.
  - The `useDelimiter` method takes a String that lists all of the characters you want to use as delimiters:

```
Scanner in = new Scanner(. . .);
in.useDelimiter("[^A-Za-z]+");
```


The `useDelimiter` Method


```
Scanner in = new Scanner(. . .);
in.useDelimiter("[^A-Za-z]+");
```


- You can also pass a String in *regular expression* format inside the String parameter as in the example above.
- `[^A-Za-z]+` says that all characters that `^`not either `A-Z` uppercase letters A through Z or `a-z` lowercase a through z are delimiters.
- Search the Internet to learn more about regular expressions.

Reading Characters

- There are no `hasNextChar()` or `nextChar()` methods of the `Scanner` class
  - Instead, you can set the `Scanner` to use an 'empty' delimiter (`""`)

```
Scanner in = new Scanner(. . .);
in.useDelimiter("");

while (in.hasNext())
{
  char ch = in.next().charAt(0);
  // Process each character
}
```

  - `next` returns a one character `String`
  - Use `charAt(0)` to extract the character from the `String` at index 0 to a `char` variable

Classifying Characters

- The Character class provides several useful methods to classify a character:
  - Pass them a char and they return a boolean

```
if ( Character.isDigit(ch) ) …
```

Table 1 Character Testing Methods

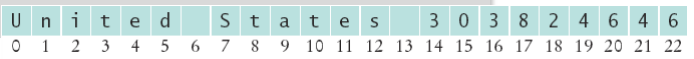
Method	Examples of Accepted Characters
`isDigit`	0, 1, 2
`isLetter`	A, B, C, a, b, c
`isUpperCase`	A, B, C
`isLowerCase`	a, b, c
`isWhiteSpace`	space, newline, tab

Reading Lines

- Some text files are used as simple databases
  - Each line has a set of related pieces of information
  - This example is complicated by:
    - Some countries use two words
      - "United States"
  - It would be better to read the entire line and process it using powerful `String` class methods

China 1330044605
India 1147995898
United States 303824646

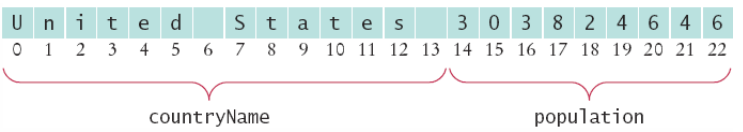
```
while (in.hasNextLine())
{
  String line = in.nextLine();
  // Process each line
}
```



- `nextLine()` reads one line and consumes the ending '\n'

Breaking Up Each Line

- Now we need to break up the line into two parts
  - Everything before the first digit is part of the country



  - Get the index of the first digit with `Character.isdigit`

```
int i = 0;
while (!Character.isDigit(line.charAt(i))) { i++; }
```

Breaking Up Each Line

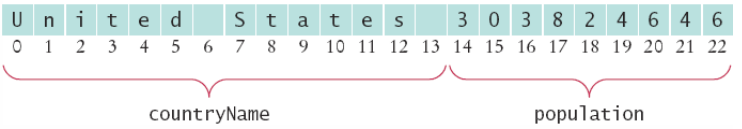
- Use `String` methods to extract the two parts

```
String countryName = line.substring(0, i);
String population = line.substring(i);
// remove the trailing space in countryName
countryName = countryName.trim();
```

United States

303824646

`trim` removes white space at the beginning and the end.



Or Use Scanner Methods

- Instead of `String` methods, you can sometimes use `Scanner` methods to do the same tasks
  - Read the line into a `String` variable
    - Pass the `String` variable to a new `Scanner` object
  - Use `Scanner hasNextInt` to find the numbers
    - If not numbers, use `next` and concatenate words

United States 303824646

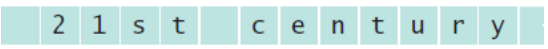
```
Scanner lineScanner = new Scanner(line);

String countryName = lineScanner.next();
while (!lineScanner.hasNextInt())
{
  countryName = countryName + " " + lineScanner.next();
}
```

Remember the `next` method consumes white space.

Safely Reading Numbers

- `Scanner` `nextInt` and `nextDouble` can get confused



  - If the number is not properly formatted, an "Input Mismatch Exception" occurs
  - Use the `hasNextInt` and `hasNextDouble` methods to test your input first

```
if (in.hasNextInt())
{
  int value = in.nextInt();  // safe
}
```

- They will return `true` if digits are present
  - If true, `nextInt` and `nextDouble` will return a value
  - If not true, they would 'throw' an 'input mismatch exception'

Reading Other Number Types

- The `Scanner` class has methods to test and read almost all of the primitive types

Data Type	Test Method	Read Method
byte	hasNextByte	nextByte
short	hasNextShort	nextShort
int	hasNextInt	nextInt
long	hasNextLong	nextLong
float	hasNextFloat	nextFloat
double	hasNextDouble	nextDouble
boolean	hasNextBoolean	nextBoolean

- What is missing?
  - Right, no `char` methods!

Mixing Number, Word and Line Input

- `nextDouble` (and `nextInt`…) do not consume white space following a number
  - This can be an issue when calling `nextLine` after reading a number
  - There is a 'newline' at the end of each line
  - After reading 1330044605 with `nextInt`
    - `nextLine` will read until the '\n' (an empty String)

China
1330044605
India

```
while (in.hasNextInt())
{
  String countryName = in.nextLine();
  int population = in.nextInt();
  in.nextLine();   // Consume the newline
}
```

C	h	i	n	a	\n	1	3	3	0	0	4	4	6	0	5	\n	I	n	d	i	a	\n

Command Line Arguments

- Text based programs can be 'parameterized' by using command line arguments
  - Filename and options are often typed after the program name at a command prompt:

```
>java ProgramClass -v input.dat
```

```
public static void main(String[] args)
```

  - Java provides access to them as an array of `Strings` parameter to the main method named `args`

```
args[0]: "-v"
args[1]: "input.dat"
```

  - The `args.length` variable holds the number of args
  - Options (switches) traditionally begin with a dash '-'

Command Line Arguments: Example 1

- We receive one argument and print it
- To run this program, you must pass at least one argument from the command prompt

```
class CommandLineExample {
    public static void main(String args[]) {
    System.out.println("Your first argument is: "+args[0]);
    }
}
```

- Compile and Run

```
> javac CommandLineExample.java
> java CommandLineExample sonoo
```

- Output

```
Your first argument is: sonoo
```

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Command Line Arguments: Example 2

- We print all the arguments passed from the command line
- We traverse the array using for loop

```
class A {
    public static void main(String args[]) {
    for(int i=0;i<args.length;i++)
    System.out.println(args[i]);
    }
}
```

- Compile and Run

```
> javac A.java
> java A sonoo jaiswal 1 3 abc
```

- Output

```
Sonoo
Jaiswal
1
3
abc
```

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Steps to Processing Text Files

1) Understand the Processing Task
   -- Process 'on the go' or store data and then process?
2) Determine input and output files
3) Choose how you will get file names
4) Choose line, word or character based input processing
   -- If all data is on one line, normally use line input
5) With line-oriented input, extract required data
   -- Examine the line and plan for whitespace, delimiters…

Summary: Input/Output

- Use the `Scanner` class for reading text files.
- When writing text files, use the `PrintWriter` class and the `print/println/printf` methods.
- Close all files when you are done processing them.

Summary: Processing Text Files

- The `next` method reads a string that is delimited by white space.
- The `Character` class has methods for classifying characters.
- The `nextLine` method reads an entire line.
- If a string contains the digits of a number, you use the `Integer.parseInt` or `Double.parseDouble` method to obtain the number value.
- Programs that start from the command line receive the command line arguments in the `main` method.