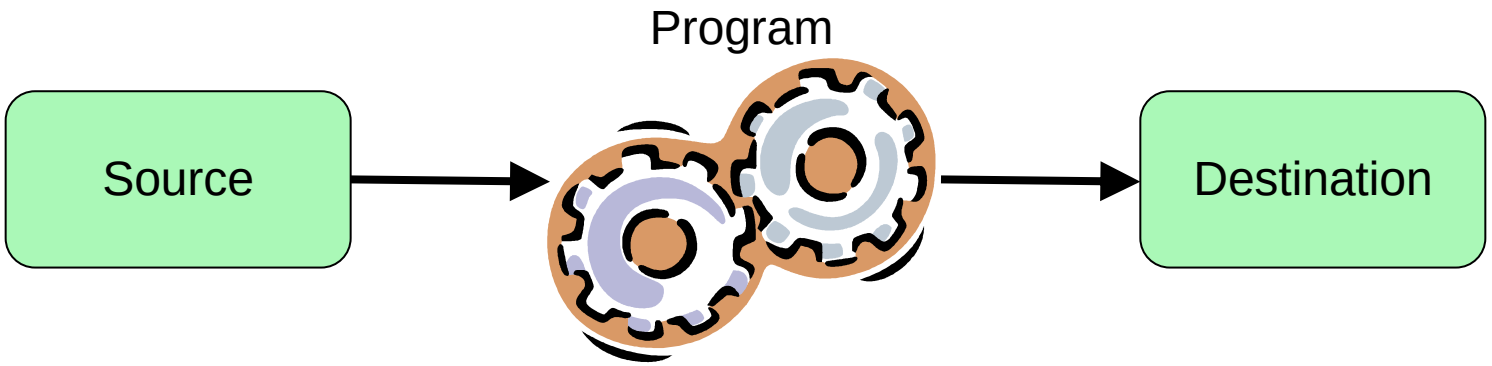
תוכנה 1

תרגול 8 – קלט/פלט

רובי בוים ומתי שמרת

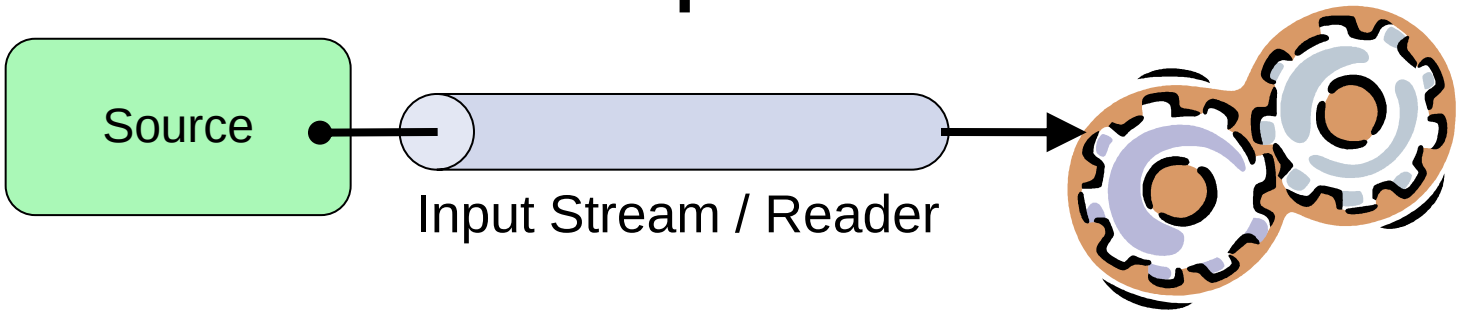
A Typical Program

- Most applications need to process some input and produce some output based on that input
- The Java IO package (**`java.io`**) is to make that possible in Java

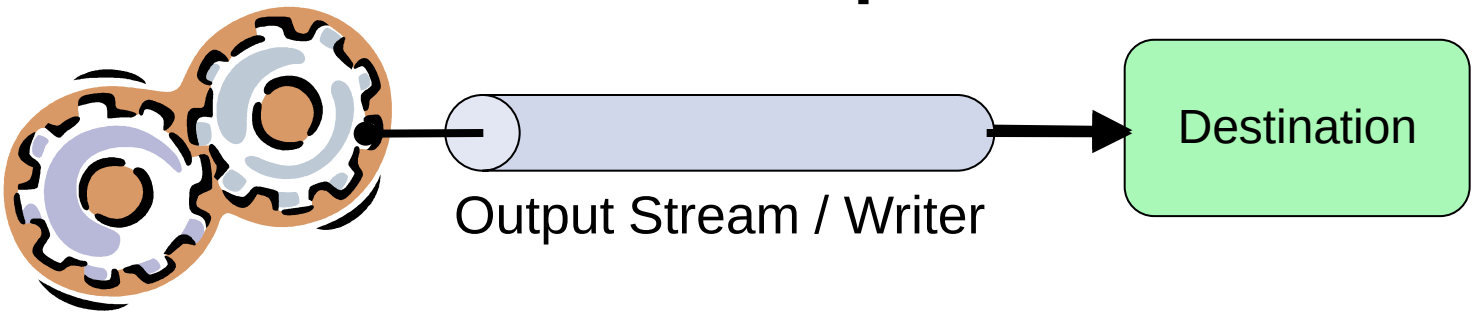


Streams

- A program that needs to read data from a source needs an **input stream** or **reader**



- A program that needs to write data to a destination needs an **output stream** or **writer**

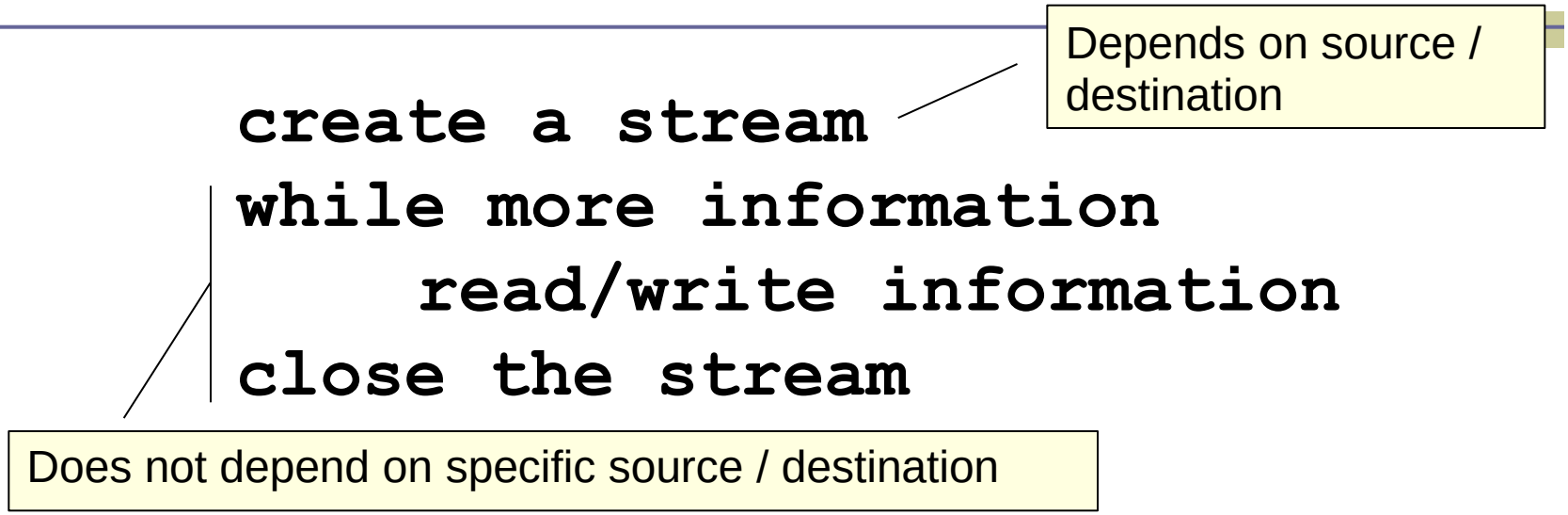


Sources and Destinations

- Typical sources and destinations are:
  - Files
  - Pipes (inter-process communication)
  - Network connections
  - In-memory buffers (e.g arrays)
  - Console (system.in, System.out, System.err)

- The Java IO package provides classes to handle all types of sources and destinations

Using Streams



- This is the general flow no matter what the source / destination is
- All streams are automatically opened when created

Types of Streams

- Character based streams
  - Used for working with textual data
- Byte based streams
  - Used for other types of data (binary)
- Class Name suffix:

	Byte	Character
Input	InputStream	Reader
Output	OutputStream	Writer

Java IO Class Overview (Character based)

Source / Destination	Input	Output
Basic	Reader	Writer
Arrays	CharArrayReader	CharArrayWriter
Files	FileReader	FileWriter
Buffering	BufferedReader	BufferedWriter
String	StringReader	StringWriter

- For now, think of Reader/Writer as an interface defining the fundamental read/write functionality

Java IO Class Overview (Byte based)

Source / Destination	Input	Output
Basic	InputStream	OutputStream
Arrays	ByteArrayInputStream	ByteArrayOutputStream
Files	FileInputStream	FileOutputStream
Data	DataInputStream	DataOutputStream
Buffering	BufferedInputStream	BufferedOutputStream
Objects	ObjectInputStream	ObjectOutputStream

- **InputStreamReader** and **OutputStreamWriter** are bridge classes converting byte based stream to a character based one

IO Errors

- When using IO operations we may encounter problems
  - Attempt to open a file that doesn't exists
  - Corrupted data
  - …
- An exception is thrown to indicate an error
  - We will learn a great deal more about exceptions later on
- For now, we just need to know how to handle exceptions

Handling Exceptions

1. Catch the exception and handle it
   - try-catch block
2. Ignore the exception, but indicate that you are throwing one now
   - add a throws clause at the end of your method signature

- For now we will choose option 2

Console I/O

- The System class provides references to the standard input, output and error streams:

```
System.in   - InputStream
System.out  - PrintStream
System.err  - PrintStream
```

Copy input to output

```
public static void copy() throws IOException {
                                    amReader(System.in);
                                    reamWriter(System.out);

    int c;
    while ((c = in.read()) != -1) {
        out.write(c);
        out.flush();
    }
    in.close();
    out.close();
}
```

Read a single character from the source

-1 indicates the end of the input

Write a single character to the destination

Copy input to output

Don't handle the exception, but indicate that we might be throwing one as well (the one being thrown from the method we use)

```
public static void copy() throws IOException {
    Reader in = new InputStreamReader(System.in);
    Writer out = new OutputStreamWriter(System.out);

    int c;
    while ((c = in.read()) != -1) {
        out.write(c);
        out.flush();
    }
    in.close();
    out.close();
}
```

might throw an exception

Copy input to output

```
public static void copy() throws IOException {
    Reader in = new InputStreamReader(System.in);
    Writer out = new OutputStreamWriter(System.out);

    int c;

    }
    in.close();
    out.close();
}
```

Convert the input stream attached to the keyboards into a Reader

Copy input to output

```
public static void copy() throws IOException {
    Reader in = new InputStreamReader(System.in);
    Writer out = new OutputStreamWriter(System.out);

    int c;
    }
    in.close();
    out.close();
}
```

Convert the PrintStream (byte based) attached to the console into a Writer

Copy input to output

```
public static void copy() throws IOException {
    Reader in = new InputStreamReader(System.in);
    Writer out = new OutputStreamWriter(System.out);

    int c;
    while ((c = in.read()) != -1) {
        out.write(c);
        out.flush();
    }
    in.close();
    out.close();
}
```

Close the streams once we're done

Java Files

- To read from a file use FileInputStream or FileReader
- To write to a file use FileOutputStream or FileWriter
- To access information about a file (length, exist?, directory?) use the **`File`** class

Copy one file to another

The path to the file we're reading from
e.g. `C:\Software1\example.txt`

The path to the file we're writing to

```
public static void copy(String src, String dst)
   throws IOException {
     Reader in = new FileReader(src);
     Writer out = new FileWriter(dst);

     int c;
     while ((c = in.read()) != -1) {
         out.write(c);
         out.flush();
     }
     in.close();
     out.close();
}
```

Create a FileReader

Create a FileWriter

Exactly as before

The File Class

- Represents pathname (file or directory)
- Retrieve meta data about a file
  - isFile / isDirectory
  - length
  - exists
  - …
- Performs basic file-system operations:
  - removes a file: delete()
  - creates a new directory: mkdir()
  - checks if the file is writable: canWrite()
  - …

Directory Listing

```
public class DirectoryListing {
    public static void main(String[] args) throws IOException {
        File file = new File(args[0]);
        System.out.println("Path = " + file.getCanonicalPath());

        if (file.isDirectory()) {
            for (File f : file.listFiles()) {
                System.out.printf("%c\t%-10s\t%d\n",
                                  f.isDirectory() ? 'd' : 'f',
                                  f.getName(),
                                  f.length());
            }
        }
    }
}
```

Parsing

- Breaking text into a series of tokens
- The **Scanner** class is a simple text scanner which can parse primitive types and strings using regular expressions
- The source can be a stream or a string

The Scanner Class

- Breaks its input into tokens using a delimiter pattern (default: whitespace)
- The resulting tokens may then be converted into values

```
Scanner s = new Scanner(System.in);
int anInt = s.nextInt();
float aFloat = s.nextFloat();
String aString = s.next();
String aLine = s.nextLine();
```

How can we be sure that the user will type-in the correct input?

Example - Scanner

```
String input = "1 fish 2 fish red fish blue fish";
Scanner s =
    new Scanner(input).useDelimiter(" *fish *");
while (s.hasNext())
        System.out.println(s.next());
s.close();
```

Reverse Polish Notation

- **Reverse Polish notation** (**RPN**) is a mathematical notation wherein every operator follows all of its operands
  - 3 4 + = 7
  - 3 2 * = 6
- 5 + ((1 + 2) * 4) − 3 is 5 1 2 + 4 * + 3 − in RPN

Evaluating RPN Expressions

- While there are input tokens left
  - Read the next token from input
  - If the token is a value
    - Push it onto the stack
  - Otherwise, the token is an operator
    - Pop the top values from the stack
    - Evaluate the operator, with the values
    - Push the returned results, back onto the stack
- If there is only one value in the stack
  - That value is the result of the calculation

Simple RPN Calculator

```
public class RPNCalculator {

   public double evaluate(String expr) {
        return evaluate(new Scanner(expr));
   }

   private double evaluate(Scanner s) {
        ...
   }
   ...
}
```

- See supplement code

Online Resources

- JAVA API Specification:

  http://java.sun.com/j2se/1.6.0/docs/api/index.html

- The Java Tutorial (Sun)

  http://java.sun.com/docs/books/tutorial/essential/io/