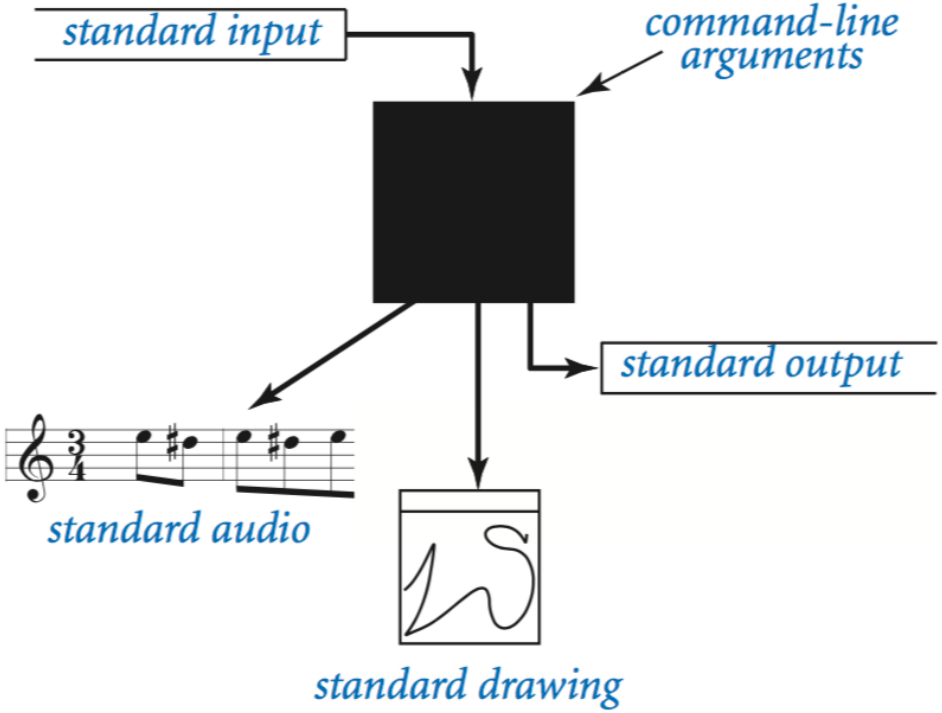
BASIC INPUT/OUTPUT



Outline: Basic Input/Output

- Screen Output
- Keyboard Input

Simple Screen Output

```
System.out.println("The count is " + count);
```

- Outputs the sting literal `"the count is "`
- Followed by the current value of the variable `count`.

- We've seen several examples of screen output already.
  - `System.out` is an object that is part of Java.
  - `println()` is one of the methods available to the `System.out` object.

Screen Output

- The concatenation operator (+) is useful when everything does not fit on one line.

```
System.out.println("Lucky number = " + 13 +
  "Secret number = " + number);
```

- Do not break the line except before or after the concatenation operator (+).

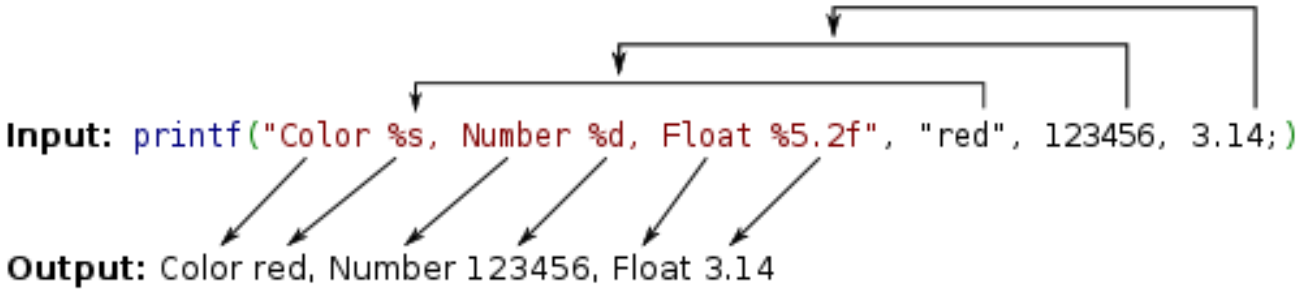
Screen Output

- Alternatively, use `print()`

```
System.out.print("One, two,");
System.out.print(" buckle my shoe.");
System.out.println(" Three, four,");
System.out.println(" shut the door.");
```

ending with a `println()`.

FORMATTED PRINTING



Pretty Text Formatting

- printf-style formatting
  - Common way to nicely format output
  - Present in many programming languages
    - Java, C++, Perl, PHP, ...
  - Use a special format language:
    - Format string with special codes
    - One or more variables get filled in
- In Java, used via:
  - `System.out.printf()` – output to standard out
  - `String.format()` – returns a formatted String

Floating-Point Formatting

```
double d = 0.123456789;
float  f = 0.123456789f;

// %f code is used with double or float variables
// %f defaults to rounding to 6 decimal places
System.out.printf("d is about %f\n", d);
System.out.printf("f is about %f\n", f);
```

```
d is about 0.123457
f is about 0.123457
```

\n means line feed

```
// Number of decimal places specified by .X
// Output is rounded to that number of places
System.out.printf("PI is about %.1f\n", Math.PI);
System.out.printf("PI is about %.2f\n", Math.PI);
System.out.printf("PI is about %.3f\n", Math.PI);
System.out.printf("PI is about %.4f\n", Math.PI);
```

```
PI is about 3.1
PI is about 3.14
PI is about 3.142
PI is about 3.1416
```

```
// %e code outputs in scientific notation
// .X specifies number of significant figures
final double C = 299792458.0;
System.out.printf("speed of light = %e\n", C);
System.out.printf("speed of light = %.3e\n", C);
```

```
C = 2.99792e+08
C = 2.998e+08
```

Integer Formatting

```
// %d code is for integer values, int or long
// Multiple % codes can be used in a single printf()
long power = 1;
for (int i = 0; i < 8; i++)
{
   System.out.printf("%d = 2^%d\n", power, i);
   power = power * 2;
}
```

You can have multiple % codes that are filled in by a list of parameters to printf()

```
1 = 2^0
2 = 2^1
4 = 2^2
8 = 2^3
16 = 2^4
32 = 2^5
64 = 2^6
128 = 2^7
```

```
// A number after the % indicates the minimum width
// Good for making a nice looking tables of values
power = 1;
for (int i = 0; i < 8; i++)
{
   System.out.printf("%5d = 2^%d\n", power, i);
   power = power * 2;
}
```

Minimum width of this field in the output. Java will pad with whitespace to reach this width (but can exceed this width if necessary).

```
    1 = 2^0
    2 = 2^1
    4 = 2^2
    8 = 2^3
   16 = 2^4
   32 = 2^5
   64 = 2^6
  128 = 2^7
```

Flags

```
// Same table, but left justify the first field
power = 1;
for (int i = 0; i < 8; i++)
{
   System.out.printf("%-5d = 2^%d\n", power, i);
   power = power * 2;
}
```

- flag causes this field to be left justified

```
1     = 2^0
2     = 2^1
4     = 2^2
8     = 2^3
16    = 2^4
32    = 2^5
64    = 2^6
128   = 2^7
```

```
// Use commas when displaying numbers
power = 1;
for (int i = 0; i < 17; i++)
{
   System.out.printf("%,5d = 2^%d\n", power, i);
   power = power * 2;
}
```

, flag causes commas between groups of 3 digits

```
    1 = 2^0
    2 = 2^1
    4 = 2^2
    8 = 2^3
   16 = 2^4
   32 = 2^5
   64 = 2^6
  128 = 2^7
  256 = 2^8
  512 = 2^9
1,024 = 2^10
2,048 = 2^11
4,096 = 2^12
8,192 = 2^13
16,384 = 2^14
32,768 = 2^15
65,536 = 2^16
```

Text Formatting

```
// Characters can be output with %c, strings using %s
String name = "Bill";
char grade = 'B';
System.out.printf("%s got a %c in the class.\n", name, grade);
```

```
Bill got a B in the class.
```

```
// This prints the same thing without using printf
System.out.println(name + " got a " + grade + " in the class.");
```

An equivalent way to print the same thing out using good old println().

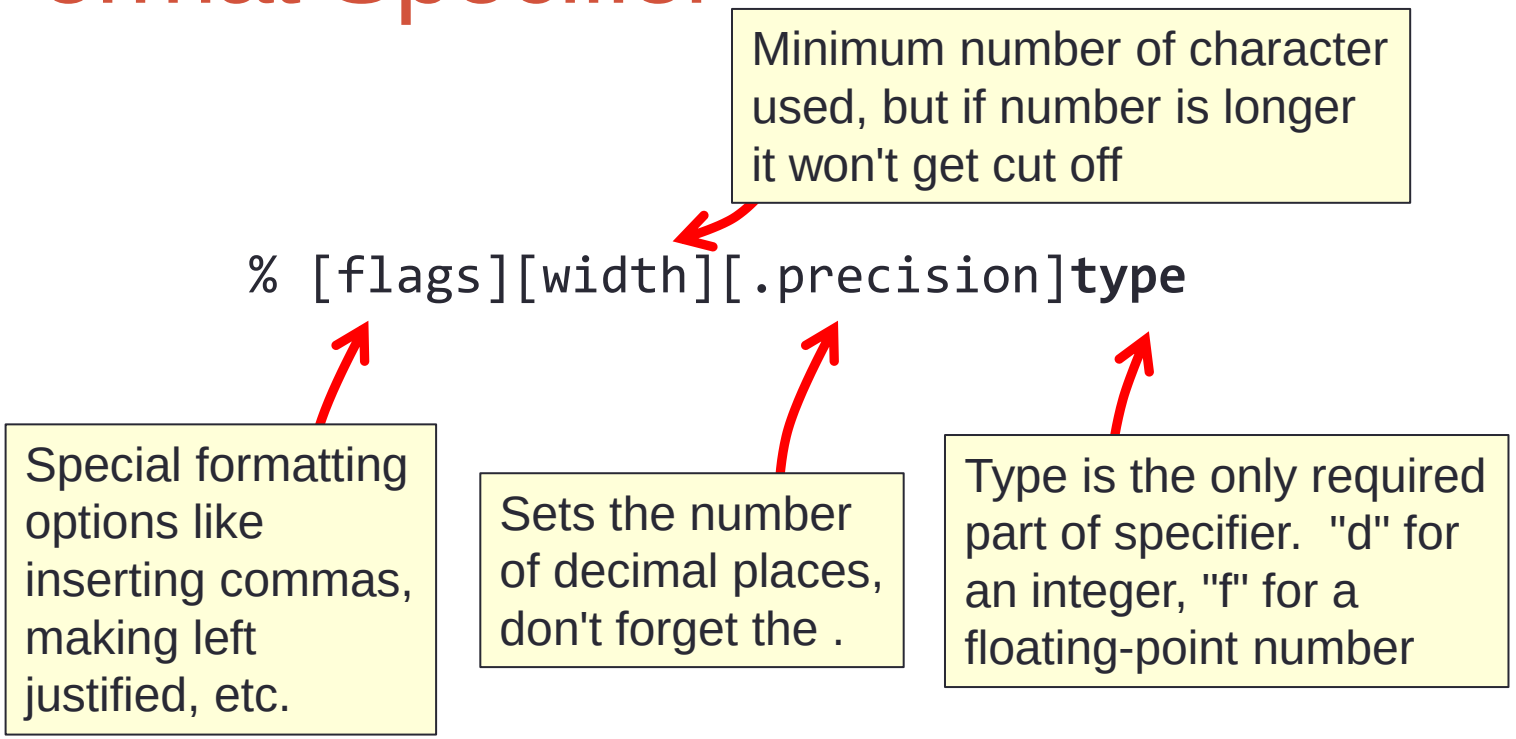
Creating Formatted Strings

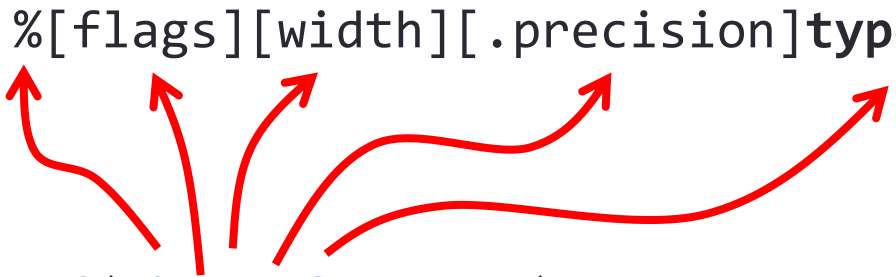
- Formatted `String` creation
  - You don't always want to immediately print formatted text to standard output
  - Save in a String variable for later use

```
// Formatted Strings can be created using format()
String lines = "";
for (int i = 0; i < 4; i++)
   lines += String.format("Random number %d = %.2f\n", i, Math.random());
System.out.print(lines);
```

```
Random number 0 = 0.54
Random number 1 = 0.50
Random number 2 = 0.39
Random number 3 = 0.64
```

The Format Specifier





printf Gone Bad

- Format string specifies:
  - Number of variables to fill in
  - Type of those variables
- With great power comes great responsibility
  - Format must agree with #/types of arguments
  - Runtime error otherwise
  - Compiler / Eclipse won't protect you

```
// Runtime error %f expects a floating-point argument
System.out.printf("crash %f\n", 1);

// Runtime error, %d expects an integer argument
System.out.printf("crash %d\n", 1.23);

// Runtime error, not enough arguments
System.out.printf("crash %d %d\n", 2);
```

printf Puzzler

Code	Letter
`System.out.printf("%f", 4242.00);`	E
`System.out.printf("%d", 4242);`	A
`System.out.printf("%.2f", 4242.0);`	B
`System.out.printf("%.3e", (double) 4242);`	C
`System.out.printf("%,d", 4242);`	D

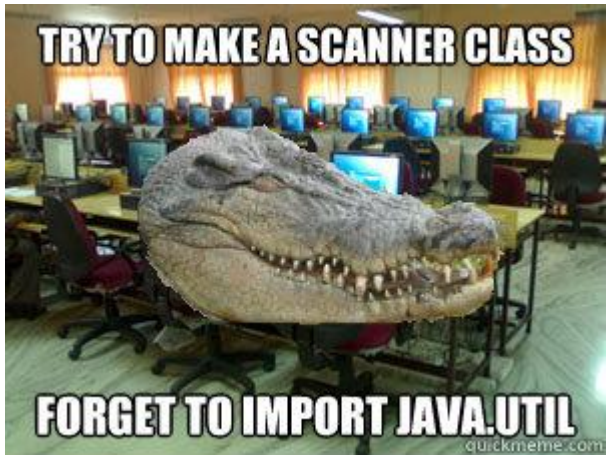
Letter	Output
A	4242
B	4242.00
C	4.242e+03
D	4,242
E	4242.000000

Code	#
`System.out.printf("%d%d", 42, 42);`	2
`System.out.printf("%d+%d", 42, 42);`	1
`System.out.printf("%d %d", 42);`	5
`System.out.printf("%8d", 42);`	3
`System.out.printf("%-8d", 42);`	4
`System.out.printf("%d", 42.0);`	5

#	Output
1	42+42
2	4242
3	42
4	42
5	runtime error

Keyboard Input

- Java has reasonable facilities for handling keyboard input.
- These facilities are provided by the `Scanner` class in the `java.util` package.
  - A *package* is a library of classes.



Simple Input

- Sometimes the data needed for a computation are obtained from the user at run time.
- Keyboard input requires

```
import java.util.Scanner
```

at the beginning of the file.

Simple Input

- Data can be entered from the keyboard using

```
Scanner keyboard =
        new Scanner(System.in);
```

  followed, for example, by

```
eggsPerBasket = keyboard.nextInt();
```

  which reads one `int` value from the keyboard and assigns it to `eggsPerBasket`.

Using the Scanner Class

- Near the beginning of your program, insert

```
import java.util.Scanner;
```

- Create an object of the `Scanner` class

```
Scanner keyboard =
    new Scanner (System.in)
```

- Read data (an `int` or a `double`, for example)

```
int n1 = keyboard.nextInt();
double d1 = keyboard,nextDouble();
```

- Close the Scanner

```
keyboard.close();
```

Some `Scanner` Class Methods

Scannner_Object_Name`.next()`
Returns the `String` value consisting of the next keyboard characters up to, but not including, the first delimiter character. The default delimiters are whitespace characters.

Scannner_Object_Name`.nextLine()`
Reads the rest of the current keyboard input line and returns the characters read as a value of type `String`. Note that the line terminator `'\n'` is read and discarded; it is not included in the string returned.

Scannner_Object_Name`.nextInt()`
Returns the next keyboard input as a value of type `int`.

Scannner_Object_Name`.nextDouble()`
Returns the next keyboard input as a value of type `double`.

Scannner_Object_Name`.nextFloat()`
Returns the next keyboard input as a value of type `float`.

Some `Scanner` Class Methods

- Figure 2.7b

Scannner_Object_Name`.nextLong()`
Returns the next keyboard input as a value of type `long`.

Scannner_Object_Name`.nextByte()`
Returns the next keyboard input as a value of type `byte`.

Scannner_Object_Name`.nextShort()`
Returns the next keyboard input as a value of type `short`.

Scannner_Object_Name`.nextBoolean()`
Returns the next keyboard input as a value of type `boolean`. The values of `true` and `false` are entered as the words *true* and *false*. Any combination of uppercase and lowercase letters is allowed in spelling *true* and *false*.

Scannner_Object_Name`.useDelimiter(`*Delimiter_Word*`);`
Makes the string *Delimiter_Word* the only delimiter used to separate input. Only the exact word will be a delimiter. In particular, blanks, line breaks, and other whitespace will no longer be delimiters unless they are a part of *Delimiter_Word*.

This is a simple case of the use of the `useDelimiter` method. There are many ways to set the delimiters to various combinations of characters and words, but we will not go into them in this book.

`nextLine()` Method Caution

- The `nextLine()` method reads
  - The remainder of the current line,
  - Even if it is empty.

- Example – given following declaration.

```
 int n;
String s1, s2;
n = keyboard.nextInt();
s1 = keyboard.nextLine();
s2 = keyboard.nextLine();
```

- Assume input shown

```
42
and don't you
forget it.
```

`n` is set to `42`

but `s1` is set to the empty string.

Outline: Basic Input/Output

- Screen Output
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