

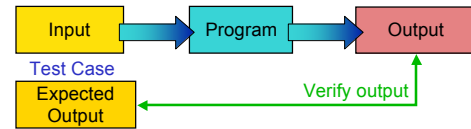
## Objectives

- Wrap up arithmetic
- A few programming tricks
- String operations
- Formatting output

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## Review: Testing Process



- Test case: **input** used to test the program, **expected output** given that input
- Verify if **output** is what you expected
- Need good test cases
  - For now, good that you know the "problematic" test cases, even if we don't know how to address them yet

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## Review: Arithmetic Operations

Symbol	Meaning	Associativity
+	Addition	Left
-	Subtraction	Left
*	Multiplication	Left
/	Division	Left
%	Remainder ("mod")	Left
**	Exponentiation (power)	Right

Precedence rules: P E - DM% AS  
 negation  
 Associativity matters when you have the same operation multiple times

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## Review: Two Types of Division

- Float Division: Result is a **float**
  - 3.0/6.0 --> 0.5
  - 6.0/3.0 --> 2.0
  - **At least** one of numerator and denominator must have a decimal, i.e., have type **float**
- Integer Division: Result is an **int**
  - 3/6 --> 0
  - 6/3 --> 2
  - x/y, if both x and y are **ints**
  - If both numerator and denominator are **ints**, result is **int**

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## Modulo Operator: %

- Modular Arithmetic: Remainder from division
  - $x \% y$  is the remainder of  $x/y$
  - Read as "x mod y"
- Works only with integers
  - Typically just positive numbers
- Example:  $6 \% 4$ 
  - Read as "six mod four"
  - 6/4 is 1 with a remainder of 2, so  $6\%4$  evaluates to 2

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## Brainstorm

- What useful thing does  $\% 10$  do?
  - $3 \% 10 =$
  - $51 \% 10 =$
  - $40 \% 10 =$
  - $678 \% 10 =$
  - $12543 \% 10 =$
- What useful thing does  $/10$  do (integer division)?
  - $3/10 =$
  - $51/10 =$
  - $40/10 =$
  - $678/10 =$
  - $12543 / 10 =$
- What useful thing does  $\% 2$  do?

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## Trick #1: Type Conversion

- You can convert a variable's type
  - Use the type's **constructor**

Conversion Function/Constructor	Example	Value Returned
int(<number or string>)	int(3.77) int("33")	3 33
long(<number or string>)	long(12)	12L
float(<number or string>)	float(22)	22.0
str(<any value>)	str(99)	"99"

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## Trick #2: Arithmetic Shorthands

- Called **extended assignment operators**
- Increment Operator
  - $x = x + 1$  can be written as  $x += 1$
- Decrement Operator
  - $x = x - 1$  can be written as  $x -= 1$
- Shorthands are similar for  $-$ ,  $*$ ,  $/$  :
  - $x /= 2$
  - amount  $*= 1.05$

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## Programming, Testing Practice

- Average three numbers
  - What are good test cases?

average3.py

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## Programming, Testing Practice

- Average three numbers
  - What are good test cases?
  - How can we make sure we get a floating point number?
    - Two alternatives

average3.py

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## String Operations

Operand	Syntax	Meaning
+	str1 + str2	Concatenate two strings into one string
*	str * num	Concatenate string <b>num</b> times

- Examples:
  - $str = "I feel " + "sleepy"$
  - $str = "Oops! " * 3$

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## Practice

- Given the following code

```
SCALE_MIN = "1"
SCALE_MAX="10"

scale = input( prompt )
```
- Create the string variable **prompt** for the **input** statement so that it prompts the user:

On a scale of 1 to 10, how much do you like Matt Damon?

scale.py

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## Strings: `str`

- Used for text
- Indicated by double quotes `""` or single quotes `' '`
  - In general, I'll use double quotes
  - Empty string: `""` or `' '`
- Use triple quotes `"""` for strings that go across multiple lines

```
"""This string
is long.
Like, really long """
```

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## Printing Output

- **print**
  - Simple statement
  - Displays the result of expression(s) to the terminal
- `print "Hello, class"`
  - ← `print` automatically adds a `'\n'` (carriage return) after it's printed
  - string literal
- `print "Your answer is", answer`
  - Use commas to print multiple "things" in one line
  - Unless ends with ,

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demo\_str.py

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## Escape Sequences

- Escape Sequences
  - newline character (carriage return) -> `\n`
  - tab -> `\t`
  - quote -> `\'`
  - backslash -> `\\`
- Example:
  - `print "To print a \\, you must use \\\\\""`
    - What does this display?

Shell demonstration

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## Practice

- Display To print a tab, you must use `'\t'`.
- Display I said, "How are you?"

escape\_practice.py

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## Problem with `print`

- By default, `print` puts spaces around numbers when they get printed out
  - Example:

```
x = 13.54
print "You owe $", x, "."
```

Displays:  
You owe \$ 13.54 .  
Extra spaces

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## Solution: using `str()`

- Recall: `str()` is constructor/converter function to convert other data types to strings
  - Example: `str(33) → '33'`
- Use constructor with the `+` (i.e., concatenation) operator when printing output
  - `print "You owe $" + str(x) + "."`

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## Another problem with print

```
SALES_TAX=.05 # the sales tax in VA

value = input("How much does your item cost? ")

tax = value * (1+SALES_TAX)

print "Your item that cost ($", value, ")",
print "costs $", tax, "with tax"
```

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sales\_tax.py

## Solution: Format Operator & Specifiers

- Format operator: %
- Format specifiers give control over how output is displayed to user
  - Right, left justification
  - Number of decimals to display

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## Formatting Strings

- Syntax is
  - <templatestring> % (<value1>, <value2>, ..., <valueN>)
- Semantics: creates a formatted string
  - Means "format the templatestring, using the format(s) specified by **format specifiers** on the corresponding replacement values"
- Typically used with print statements

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## Formatting Strings

- **templatestring** is a template for the resulting string with format specifiers instead of the values
  - For each format specifier in templatestring, should have a **replacement value**
  - Throws **TypeError** if not enough replacements for specifiers in templatestring
  - If only one replacement value, don't need ()
- Example:
  - "%0.2f" % 3.14159 result is "3.14"

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## Format Specifiers

- General format: %**[flags][width][.precision]****code**
- The **[]** mean "optional"
- **flags:**
    - 0: zero fills
    - +: adds a + sign before positive values
    - -: left-justification (default is right-justification)
  - **width:**
    - *Minimum* number of character spaces reserved to display the entire value
    - Includes decimal point, digits before and after the decimal point and the sign

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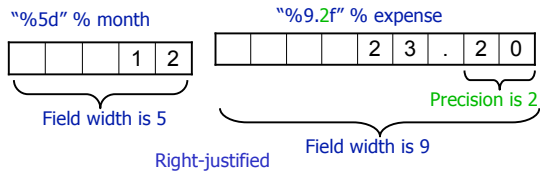
## Format Specifiers

- General format: %**[flags][width][.precision]****code**
- **precision:**
  - Number of digits after the decimal point for **real** values
- **code:**
  - Indicates the value's **type**/way to format
    - s - string
    - d (or i) - integer
    - f - floating point
    - e - floating point with exponent

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## Example Format Specifiers

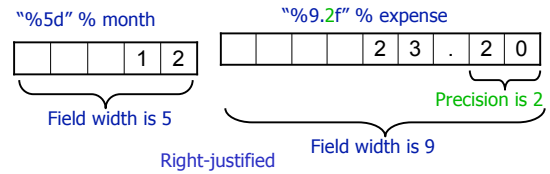


- What if precision is bigger than the decimal places?
- What if field width is smaller than the length of the value?

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## Example Format Specifiers



- What if precision is bigger than the decimal places?  
 > Fills decimal with 0s
- What if field width is smaller than the length of the value?  
 > String contains entire value

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## Example using Format Operator

```
print "Your item that cost (%.2f)" % value,
print "costs $%.2f with tax" % tax
```

Format specifier

Formatting operator

Replacement values

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## Formatting Practice

- x=10
- y = 3.5
- z = "apple"
- "%6.2d" % x
- "%6.2f" % x
- "%06.2f" % y
- "%+6.2f" % y
- "%-10s" % z
- "%5d %-7.3f" % (x,y)

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