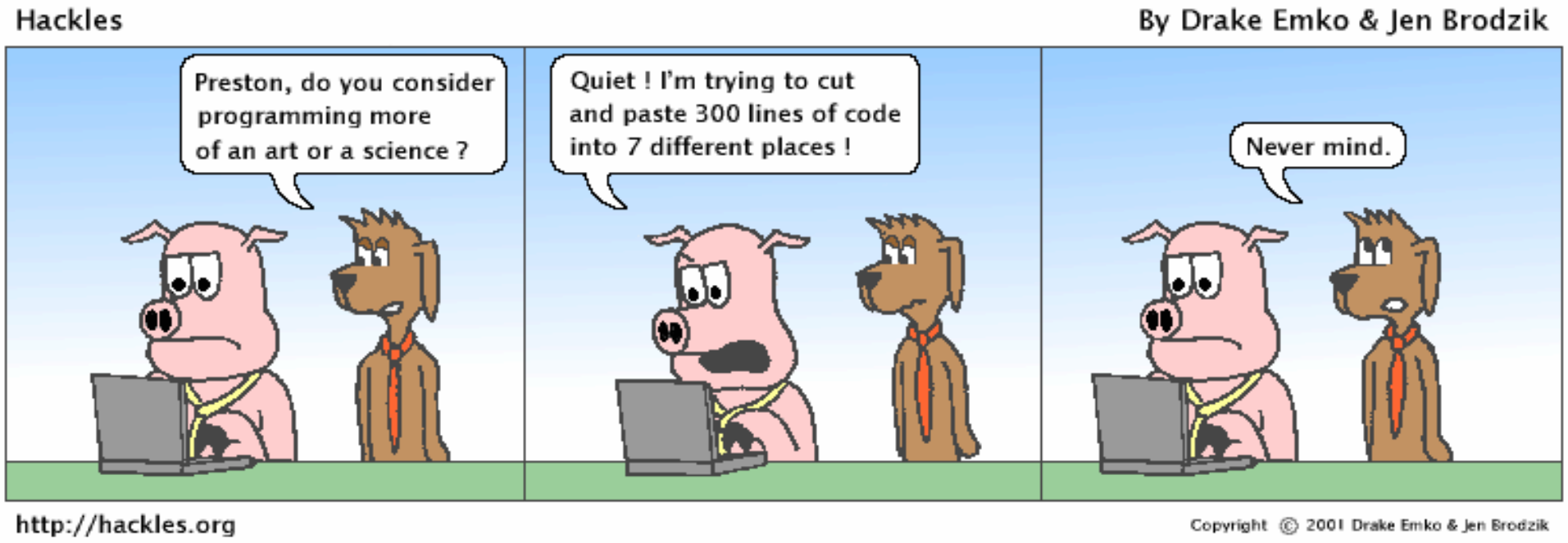
CSc 110, Spring 2017

Lecture 3: Expressions, Variables and Loops

Adapted from slides by Marty Stepp and Stuart Reges



Data and expressions

Data types

- Internally, computers store everything as 1s and 0s

```
104   → 01101000
'h'   → 01101000
'hi'  → 0110100001101001
```

- How are `104` and `h` differentiated?

- **type**: A category of data values.
  - Constrains the operations that can be performed on data

  Examples: integer, real number, string

Some Python number types

Name	Description	Examples

`int`	integers	`42`
		`-3`
		`0`
		`92634`
		`126765060022822940149670320537 6`

`float`	real numbers	`3.1`
		`1.4142135623730951`
		`-0.25`

Expressions

- **expression**: A value, or operation that produces a value.
  - Examples:

```
42
1 + 4 * 5
(7 + 2) * 6 / 3
"Hello, world!"
```

  - The simplest expression is a *literal value*.
  - A complex expression can use operators and parentheses.

As a program runs, its expressions are *evaluated* to produce values.

- What value does `42` produce?
- What value does `1+5` produce?

Arithmetic operators

- **operator**: Combines multiple values or expressions.

`+`	addition
–	subtraction (or negation)
`*`	multiplication
`/`	division
`//`	integer division (a.k.a. leave off any remainder)
`%`	modulus (a.k.a. remainder)
`**`	exponent

- An arithemetic operator can be used with mixed number types

```
8 / 5.2      produces 1.5384615384615383
1 + 3.5      produces 4.5
```

Integer division with //

- When we divide integers with //, the quotient is also an integer.
  - `14 // 4` is `3`, not `3.5`

```
   3
4 ) 14
   12
    2
```

```
   4
10 ) 45
   40
    5
```

```
   52
27 ) 1425
   135
    75
    54
    21
```

- More examples:
  - `32 // 5` is `6`
  - `84 // 10` is `8`
  - `156 // 100` is `1`

What happens when you divide by `0`?

Integer remainder with %

- The % operator computes the remainder from integer division.
  - `14 % 4` is `2`
  - `218 % 5` is `3`

```
    3
4 ) 14
    12
    2
```

```
   43
5 ) 218
   20
   18
   15
    3
```

What is the result?

```
45 % 6
2 % 2
8 % 20
11 % 0
```

- Applications of % operator:
  - Obtain last digit of a number: `230857 % 10` is `7`
  - Obtain last 4 digits: `658236489 % 10000` is `6489`
  - See whether a number is odd: `7 % 2` is `1`, `42 % 2` is `0`

Precedence

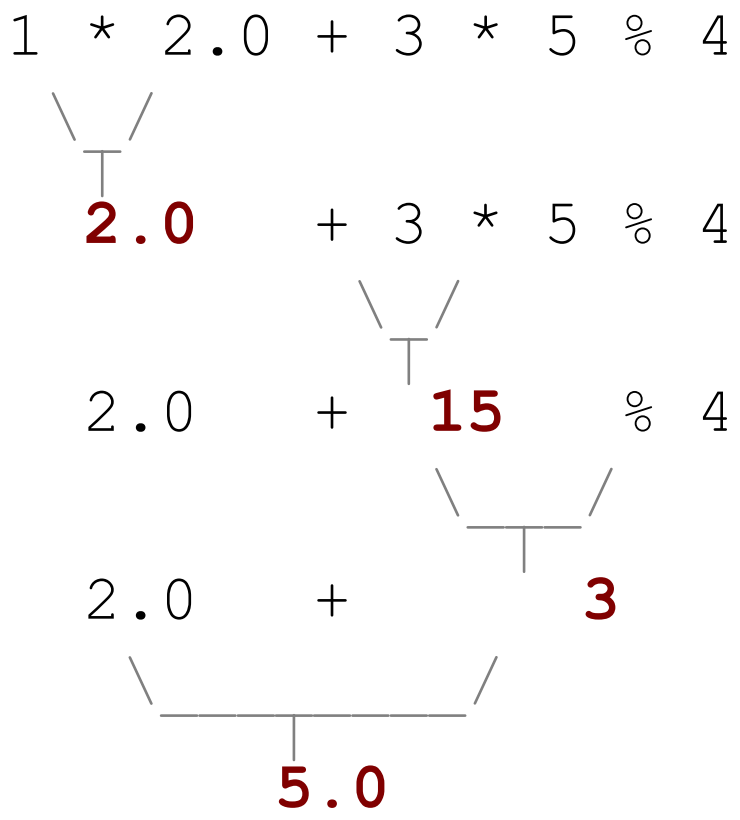
- **precedence**: Order in which operators are evaluated.
  - Generally operators evaluate left-to-right.
    `1 - 2 - 3` is `(1 - 2) - 3` which is `-4`
  - But `* / // %` have a higher level of precedence than `+ -`
    `1 + 3 * 4` is `13`

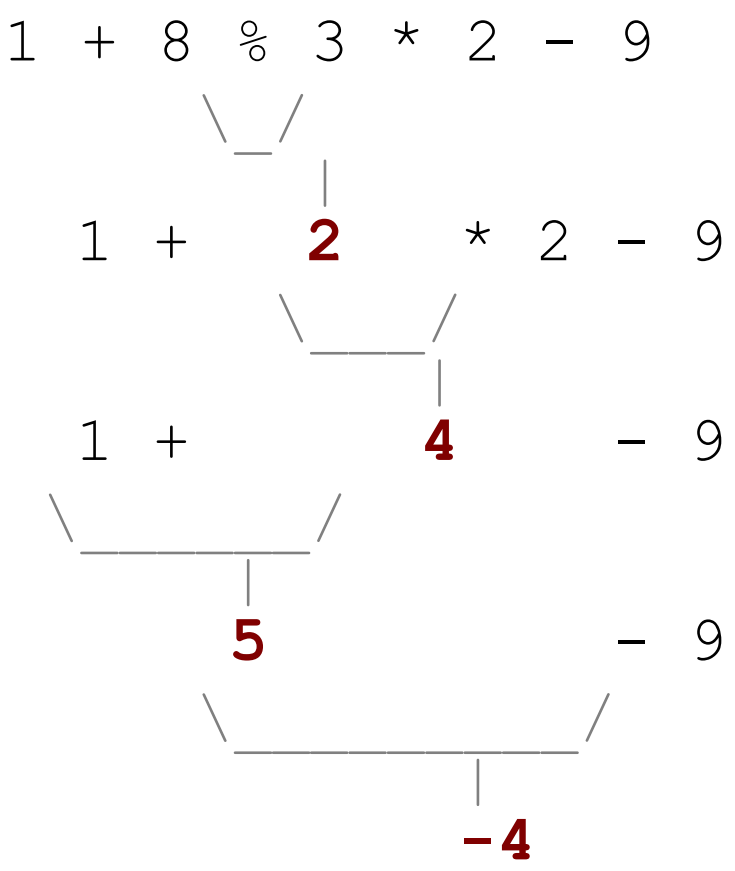
    `6 + 8 // 2 * 3`
    `6 + 4 * 3`
    `6 + 12` is `18`
  - Parentheses can force a certain order of evaluation:
    `(1 + 3) * 4` is `16`
  - Spacing does not affect order of evaluation
    `1+3 * 4-2` is `11`

Operator precedence

```
**
+pos -neg
/ % // *
+ -
```

Precedence examples





Precedence questions

- What values result from the following expressions?
  - `9 // 5`
  - `695 % 20`
  - `7 + 6 * 5`
  - `7 * 6 + 5`
  - `248 % 100 / 5`
  - `6 * 3 - 9 // 4`
  - `(5 - 7) * 2 ** 2`
  - `6 + (18 % (17 - 12))`

Operation on strings

- **String concatenation**: + operator

```
"Hello," + " world!"        is "Hello, world!"
```

- Example using print statement

```
print("Hello," + " world!")
```

Variables

Receipt example

```
# Calculate total owed, assuming 8% tax / 15% tip
print("Subtotal:")
print(38 + 40 + 30)
print("Tax:")
print((38 + 40 + 30) * .08)
print("Tip:")
print((38 + 40 + 30) * .15)
print("Total:")
print(38 + 40 + 30 + (38 + 40 + 30) * .15 + (38 + 40 + 30) * .08)
```

- The subtotal expression `(38 + 40 + 30)` is repeated
- So many `print` statements

Variables

Variable : A named location in the computer's memory that holds a value.

- Variables must be initialized before they can be used.
- The value can be an expression; the variable stores its result.

- Syntax for variable assignment:

  name = **expression**

- The rules for **name** are the same as for function names:

  Consist of upper and lower case letters, "_", and digits 0 through 9

- Examples:
  - `zipcode = 90210`
  - `total = 1.0 + 2.25`

zipcode	90210

total	3.25

Using variables

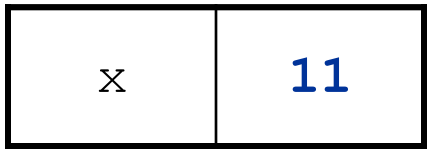
- Once given a value, a variable can be used in expressions:

```
x = 3                    # x is 3
y = 5 * x                # now y is 15
```

- You can assign a value more than once:

```
x = 3                    # 3 here

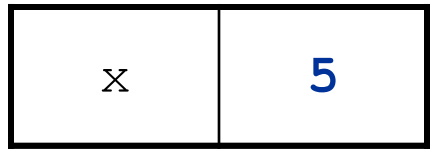
x = 4 + 7                # now x is 11
```



Assignment and algebra

- Assignment uses = , but it is not an algebraic equation.
  - = means, *"store the value at right in variable at left"*
    - The right side expression is evaluated first, and then its result is stored in the variable at left.
- What happens here?

```
x = 3
x = x + 2    # ???
```



Printing a variable's value

- Use `+ str(`**`value`**`)` to print a string and a variable's value on one line.
  - ```
    grade = (95.1 + 71.9 + 82.6) / 3.0
    print("Your grade was " + str(grade))

    students = 11 + 17 + 4 + 19 + 14
    print("There are " + str(students) +
          " students in the course.")
    ```
  - Output:

    ```
    Your grade was 83.2
    There are 65 students in the course.
    ```
    ```

Receipt question

Improve the receipt program using variables.

```
def main():
    # Calculate total owed, assuming 8% tax / 15% tip
    print("Subtotal:")
    print(38 + 40 + 30)

    print("Tax:")
    print((38 + 40 + 30) * .08)

    print("Tip:")
    print((38 + 40 + 30) * .15)

    print("Total:")
    print(38 + 40 + 30 + (38 + 40 + 30) * .15 + (38 + 40 + 30) * .08)
```

Receipt answer

```
def main():
    # Calculate total owed, assuming 8% tax / 15% tip
    subtotal = 38 + 40 + 30          # int
    tax = subtotal * .08             # float
    tip = subtotal * .15             # float
    total = subtotal + tax + tip     # float

    print("Subtotal: " + str(subtotal))
    print("Tax: " + str(tax))
    print("Tip: " + str(tip))
    print("Total: " + str(total))
```

Repetition with `for` loops

- So far, repeating an action results in redundant code:

```
makeBatter()
bakeCookies()
bakeCookies()
bakeCookies()
bakeCookies()
bakeCookies()
frostCookies()
```

- Python's **`for` loop** statement performs a task many times.

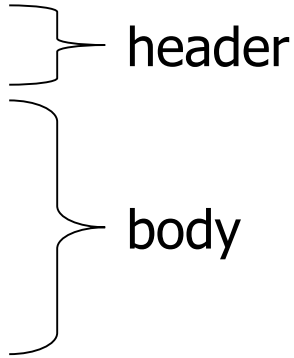
```
mixBatter()
for i in range(1, 6):     # repeat 5 times
    bakeCookies()
frostCookies()
```

Control structures

- **Control structure**: a programming construct that affects the flow of a program's execution
- Controlled code may include one or more statements
- The for loop is an example of a looping control structure

`for` loop syntax

```
for variable in range (start, stop):
    statement
    statement
    ...
    statement
```



- Set the variable equal to the start value
- Repeat the following:
  - Check if the **variable** is less than the stop. If not, stop.
  - Execute the **statement**s.
  - Increase the variable's value by 1.

Indentation

- Python uses indentation to show that lines of code are inside control structures
- Always use only spaces **or** only tabs, otherwise you will get very confusing errors!

Repetition over a range

```
print("1 squared = " + str(1 * 1))
print("2 squared = " + str(2 * 2))
print("3 squared = " + str(3 * 3))
print("4 squared = " + str(4 * 4))
print("5 squared = " + str(5 * 5))
print("6 squared = " + str(6 * 6))
```

- Intuition: "I want to print a line for each number from 1 to 6"

- The `for` loop does exactly that!

```
for i in range(1, 7):
    print(str(i) + " squared = " + str(i * i));
```

- "For each integer **i** from 1 through 6, print ..."

Loop walkthrough

```
for i in range(1, 5):
    print(str(i) + " squared = " + str(i * i))

print("Whoo!")
```

Output:

```
1 squared = 1
2 squared = 4
3 squared = 9
4 squared = 16
Whoo!
```

Multi-statement loop body

```
print("+----+")
for i in range(1, 4):
    print("\\    /")
    print("/    \\")
print("+----+")
```

- Output:

```
+----+
\    /
/    \
\    /
/    \
\    /
/    \
+----+
```

Expressions for counter

```
high_temp = 5
for i in range(-3, high_temp // 2 + 1):
    print(i * 1.8 + 32)
```

- Output:

```
26.6
28.4
30.2
32.0
33.8
35.6
```

`print('', end='')`

- Adding `, end=''` allows you to print without moving to the next line
  - allows you to print partial messages on the same line

```
highTemp = 5
for i in range(-3, int(highTemp / 2 + 1)):
    print(i * 1.8 + 32, end=' ')
```

  - Output:

```
26.6  28.4  30.2  32.0  33.8  35.6
```

    - Either concatenate `'  '` to separate the numbers or set `end='  '`