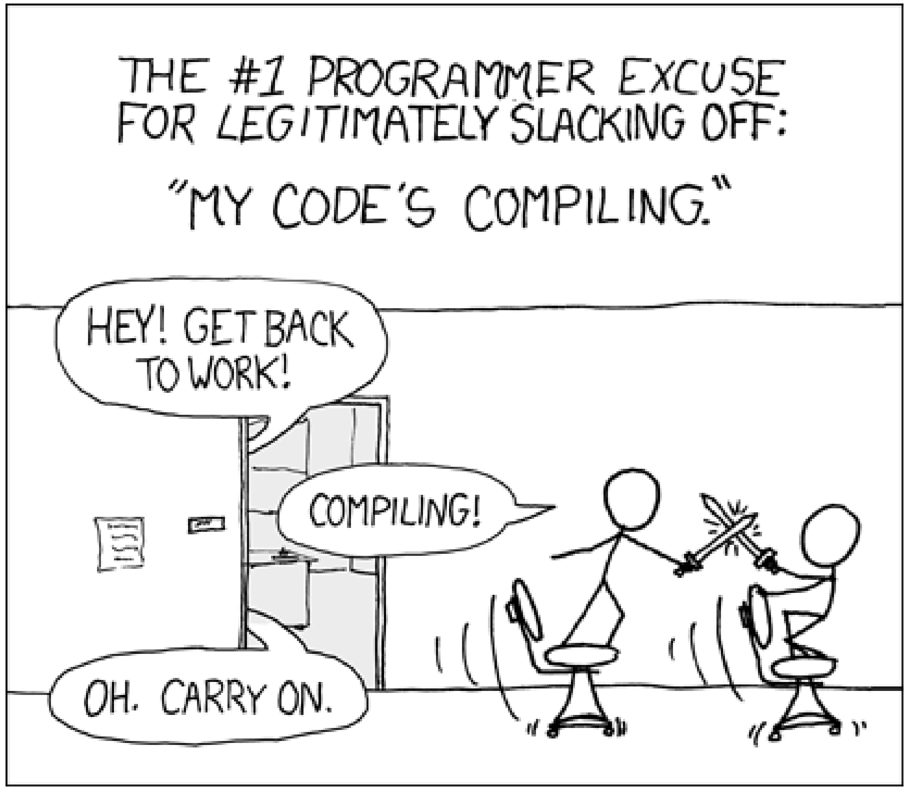
CSc 110, Spring 2018

Lecture 24: Lists for Tallying; Text Processing

Adapted from slides by Marty Stepp and Stuart Reges



List return question

- Write a function `merge` that accepts two lists of integers and returns a new list containing all elements of the first list followed by all elements of the second.

```
a1 = [12, 34, 56]
a2 = [7, 8, 9, 10]

a3 = merge(a1, a2)
print(a3)
# [12, 34, 56, 7, 8, 9, 10]
```

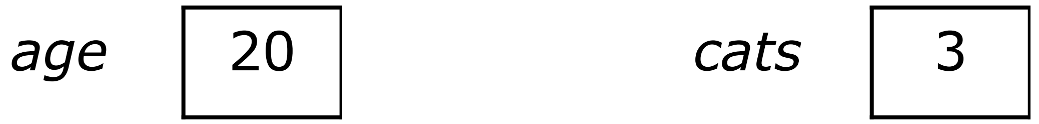
- Write a function `merge3` that merges 3 lists similarly.

```
a1 = {12, 34, 56]
a2 = {7, 8, 9, 10]
a3 = {444, 222, -1]

a4 = merge3(a1, a2, a3)
print(a4)
# [12, 34, 56, 7, 8, 9, 10, 444, 222, -1]
```

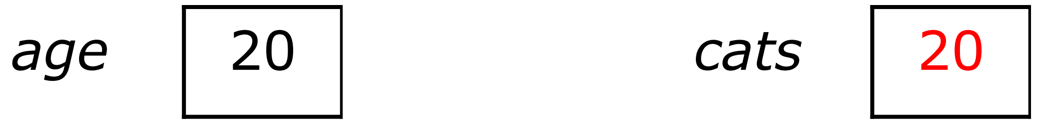
Value/Reference Semantics

- Variables of type int, float, boolean, store values directly:

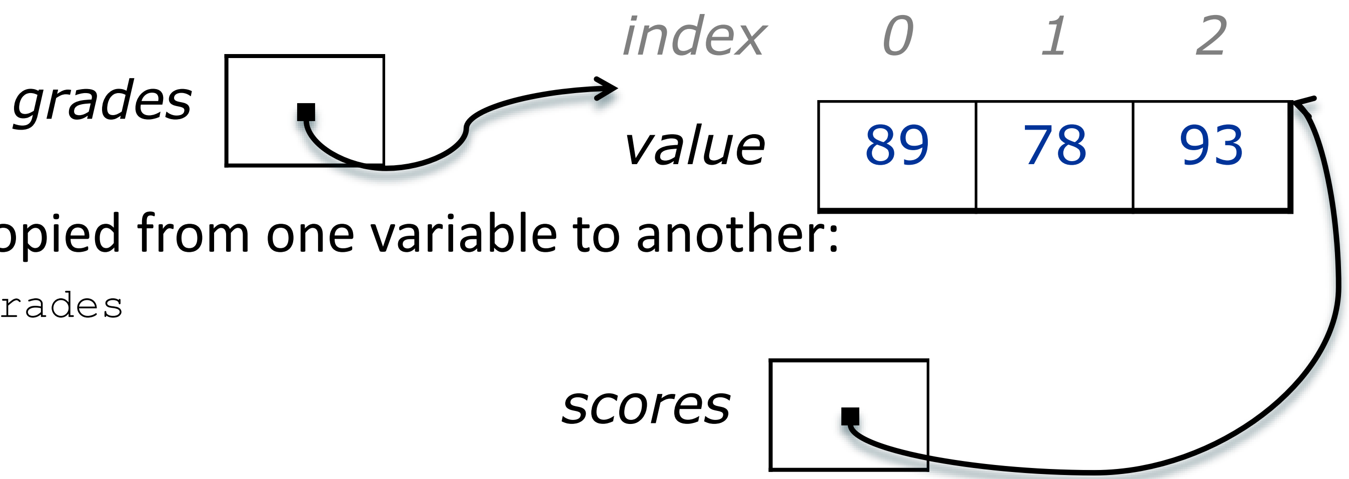


- Values are copied from one variable to another:

```
cats = age
```



- Variables of object types store references to memory:



- References are copied from one variable to another:

```
scores = grades
```

A multi-counter problem

- Problem: Write a function `most_frequent_digit` that returns the digit value that occurs most frequently in a number.
    - Example: The number 669260267 contains:
      one 0, two 2s, four 6es, one 7, and one 9.
      `most_frequent_digit(669260267)` returns 6.
    - If there is a tie, return the digit with the lower value.
      `most_frequent_digit(57135203)` returns 3.

A multi-counter problem

- We could declare 10 counter variables ...

```
counter0, counter1, counter2, counter3, counter4,
counter5, counter6, counter7, counter8, counter9
```

- But a better solution is to use a list of size 10.
  - The element at index *i* will store the counter for digit value *i*.
  - Example for 669260267:

index	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
value	1	0	2	0	0	0	4	1	0	0

  - How do we build such an list? And how does it help?

Creating a list of tallies

```
# assume n = 669260267
counts = [0] * 10
while n > 0:
    # pluck off a digit and add to proper counter
    digit = n % 10
    counts[digit] += 1
    n = n // 10
```

index	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
value	1	0	2	0	0	0	4	1	0	0

Tally solution

```
# Returns the digit value that occurs most frequently in n.
# Breaks ties by choosing the smaller value.
def most_frequent_digit(n):
    counts = [0] * 10
    while n > 0:
        digit = n % 10     # pluck off a digit and tally it
        counts[digit] += 1
        n = n // 10

    # find the most frequently occurring digit
    best_index = 0
    for i in range(1, len(counts)):
        if counts[i] > counts[best_index]:
            best_index = i
    return best_index
```

Section attendance question

- Read a file of section attendance (*see next slide*):

```
yynyyynayayynyyyayanyyyaynayyayyanayyyanyayna
ayyanyyyyayanaayyanayyyanayayaynyayayynynya
yyayaynyyayyanynnyyyayyanayaynannnyyayyayayny
```

- And produce the following output:

```
Section 1
Student points: [20, 16, 17, 14, 11]
Student grades: [100.0, 80.0, 85.0, 70.0, 55.0]

Section 2
Student points: [16, 19, 14, 14, 8]
Student grades: [80.0, 95.0, 70.0, 70.0, 40.0]

Section 3
Student points: [16, 15, 16, 18, 14]
Student grades: [80.0, 75.0, 80.0, 90.0, 70.0]
```

  - Students earn 3 points for each section attended up to 20.

Section input file

```
student     123451234512345123451234512345123451234512345
week          1    2    3    4    5    6    7    8    9
section  1  yynyyynayayynyyyayanyyyaynayyayyanayyyanyayna
section  2  ayyanyyyyayanaayyanayyyananayayaynyayayynynya
section  3  yyayaynyyayyanynnyyyayyanayaynannnyyayyayayny
```

- Each line represents a section.
- A line consists of 9 weeks' worth of data.
  - Each week has 5 characters because there are 5 students.
- Within each week, each character represents one student.
  - `a` means the student was absent (+0 points)
  - `n` means they attended but didn't do the problems (+1 points)
  - `y` means they attended and did the problems (+3 points)

Section attendance answer

```
def main():
    file = open("sections.txt")
    lines = file.readlines()
    section = 1
    for line in lines:
        points = [0] * 5
        for i in range(0, len(line)):
            student = i % 5
            earned = 0
            if (line[i] == 'y'):      # c == 'y' or 'n' or 'a'
                 earned = 3
            elif (line[i] == 'n'):
                earned = 1
            points[student] = min(20, points[student] + earned)
        grades = [0] * 5
        for i in range(0, len(points)):
            grades[i] = 100.0 * points[i] / 20
        print("Section " + str(section))
        print("Student points: " + str(points))
        print("Student grades: " + str(grades))
        print()
        section += 1
```

Data transformations

- In many problems we transform data between forms.
  - Example: digits $\rightarrow$ count of each digit $\rightarrow$ most frequent digit
  - Often each transformation is computed/stored as an list.
  - For structure, a transformation is often put in its own function.

- Sometimes we map between data and list indexes.

• by position	(store the *i* th value we read at index *i*)
• tally	(if input value is *i*, store it at array index *i*)
• explicit mapping	(count `'J'` at index 0, count `'X'` at index 1)

- *Exercise:* Modify our Sections program to use functions that use lists as parameters and returns.

List param/return answer

```
# This program reads a file representing which students attended
# which discussion sections and produces output of the students'
# section attendance and scores.

def main():
    file = open("sections.txt")
    lines = file.readlines()
    section = 1
    for line in lines:
        # process one section
        points = count_points(line)
        grades = compute_grades(points)
        results(section, points, grades)
        section += 1

# Produces all output about a particular section.
def results(section, points, grades):
    print("Section " + str(section))
    print("Student scores: " + str(points))
    print("Student grades: " + str(grades))
    print()

    ...
```

List param/return answer

```
    ...
# Computes the points earned for each student for a particular section.
def count_points(line):
    points = [0] * 5
    for i in range(0, len(line)):
        student = i % 5
        earned = 0
        if line[i] == 'y':     # c == 'y'  or  c == 'n'
            earned = 3
        elif line[i] == 'n':
            earned = 2
        points[student] = min(20, points[student] + earned)
    return points

# Computes the percentage for each student for a particular section.
def compute_grades(points):
    grades = [0] * 5
    for i in range(0, len(points)):
        grades[i] = 100.0 * points[i] / 20
    return grades
```