Compsci 101
More Recursion and Modules

```
d is:
0 -> haiku.txt
1 ->  labtemplate.txt
2 -> lecturetemplate.txt
```

Susan Rodger

April 20, 2023

X is for …

- **XOR**
  - (a or b) and not (a and b), a.k.a. symmetric difference
- **XML**
  - eXtensible Markup Language
- **Xerox Parc**
  - From Mice to Windows

The Power of Collaboration: Ge Wang, Duke Prof. at Stanford

- **Duke 2000: Music and Computer Science**
  - https://www.stanforddaily.com/2016/03/09/qa-with-ge-wang-father-of-stanford-laptop-orchestra/
  - http://www.youtube.com/watch?v=ADEHmkL3HBg
- **About Design in Compsci 308**

Our investment into a huge and meticulous design process was a huge factor in making later progress. 35000+ lines of code / design / documentation gave us a project we were all very happy and proud to be a part of.

Announcements

- **Assign 6 Recommender due TODAY!**
- **APT-7, due Tuesday**
- **Assign 7 due April 26**
  - Can be turned in by April 30 with NO PENALTY
- **APT Quiz 2 posted on APT page – for practice**
- **Lab 11 Friday – due prelab before going**

- **Final Exam – Thurs, May 4, 9am**

Interested in being a UTA?

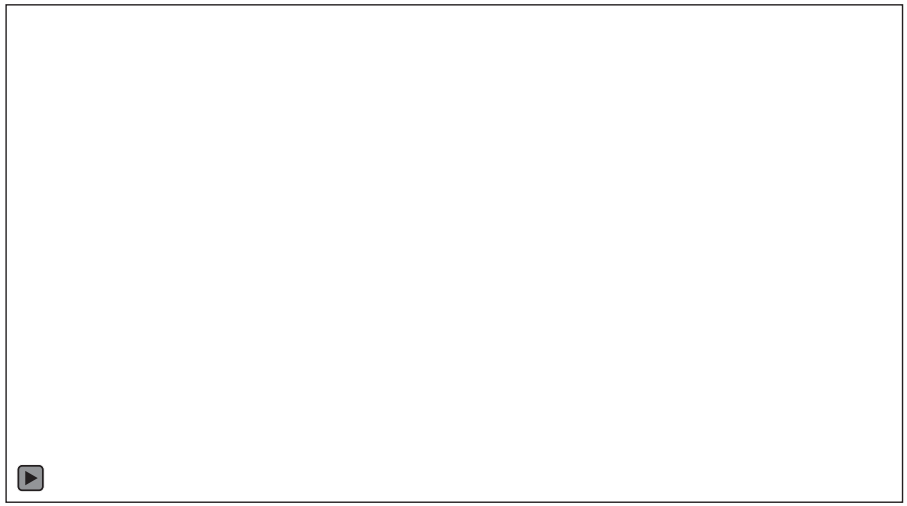
- **Enjoy Compsci101?**
- **Would like to help others learn it?**

- **Consider applying to join the team!**
- **https://www.cs.duke.edu/undergrad/uta**

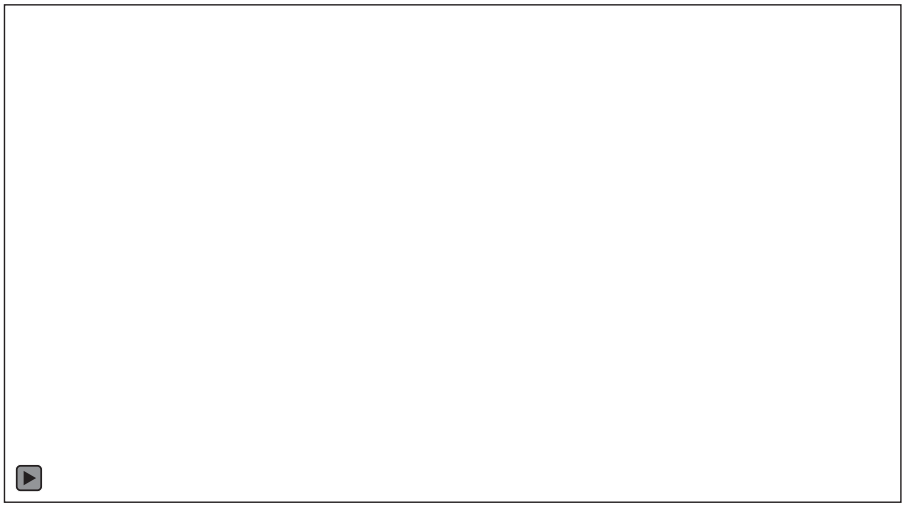
- **Apply soon**

Assignment 7: More samples from previous semesters

A Story – One Eternity Later



APT Due



Haiku – From Previous Semester

Turtles and Pythons

But We Are Not at the Zoo

We Are in CompSci

Haiku – From Previous Semester

Ugh Syntax Error

Did I Forget a Colon?

Nope. Parentheses.

PFTD

- **Review Recursion**
- **Modules and exceptions**
- **An APT**

Review: Recursion Summary

- **Make Simpler or smaller calls**
  - Call a clone of itself with different input
- **Must have a base case when no recursive call can be made**
  - Example - The last folder in the folder hierarchy will not have any subfolders. It can only have files. That forms the base case
  - This is the way out of recursion!

Problem: is a number in a list?

- **Is 5 in [7, 5, 6, 8] ?**
- **Is 8 in** [5, [[7,4], 9, [3, 4]], [4, [5, [2, [8, 1], 4,]], 5]] ?

Possible solution

```
18  def isItInList(alist, num):
19      for item in alist:
20          if type(item) == type([]): # is a list
21              return isItInList(item, num)
22          else: # type is number
23              if item == num:
24                  return 'yes'
25      return 'no'
```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- **Doesn't work! Consider 2 and [3, [6,7], 8, [2, 7]]**

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23              if item == num:
24                  return 'yes'
25      return 'no'
```

Line 21 returns "no", doesn't check rest of list

- **Doesn't work! Consider 2 and [3, [6,7], 8, [2, 7]]**

Possible Solution 2

```
8   def isItInList2(alist, num):
9       for item in alist:
10          if type(item) == type([]): # is a list
11              if isItInList2(item, num) == 'yes':
12                  return 'yes'
13          else: # type is number
14              if item == num:
15                  return 'yes'
16      return 'no'
```


Possible Solution 2

```
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16      return 'no'
```

- **Works! Consider 2 and [3, [6,7], 8, [2, 7]]**

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```

Returns 'yes'

- **Works! Consider 2 and [3, [6,7], 8, [2, 7]]**

Problem: is a number in a list?

- **Is 5 in [7, 5, 6, 8] ?**
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Revisit the APT Bagels Recursively

```
filename:  Bagels.py

def bagelCount(orders) :
    """
    return number of bagels needed to fulfill
    the orders in integer list parameter orders
    """
```

1.
```
orders = [1,3,5,7]

Returns:  16
```

No order is for more than a dozen, return the total of all orders.

2.
```
orders = [11,22,33,44,55]

Returns: 175 since 11 + (22+1) +(33+2) + (44+3) + (55+4) = 175
```


APT Bagels Recursively bit.ly/101s23-0420-1

APT Bagels Recursively

A)
```
def bagelCount(orders):
    if len(orders) > 0:
        return orders[0]//12 + orders[0] + bagelCount(orders[1:])
    else:
        return 0
```

B)
```
def bagelCount(orders):
    if len(orders) > 0:
        return orders[-1]//12 + orders[-1] + bagelCount(orders[:-1])
    else:
        return 0
```

C)
```
def bagelCount(orders):
    return orders[0] + orders[0]//12 + bagelCount(orders[1:])
```

D)
```
def bagelCount(orders):
    if len(orders)>1:
        return orders[1] + orders[1]//12 + bagelCount(orders[2:])
    else:
        return bagelCount(orders[0])
```


Why use modules?

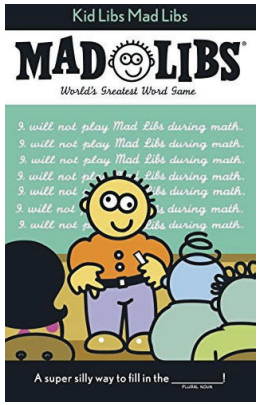
- **Module – Python file (.py file)**
- **Can have several modules work together**

- **Easier to organize code**
- **Easier to reuse code**
- **Easier to change code**
  - As long as the "what" is the same, the "how" can change
    - Ex: sorted(…), one function many sorting algorithms

Modules for Creating

- **“~~MadLibs~~” → Tag-a-Story**
  - User chooses template
  - Computer fills everything in

```
In lecture I saw a <color> <noun>
For lunch I had a <adjective> <food>
The day ended with seeing a <animal>
<verb> in <place>
```



From <noun> to story

```
In lecture I saw a <color> <noun>
For lunch I had a <adjective> <food>
The day ended with seeing a <animal>
<verb> in <place>
```

```
In lecture I saw a magenta house
For lunch I had a luminous hummus
The day ended with seeing a cow sleep in Mombasa
```

Demo

- Run storyline.py
- Show Lecture template
- Show Haiku’s
- Make modifications

Let's create/modify a story

- **Choose a template or make a new one**
  - We'll choose lecturetemplate.txt first
- **Add a new category/replacement**
  - We'll choose number and list some choices
- **Run the program and test our modifications**
  - Randomized, hard to test, but doable

Main Parts (3 modules) for tag-a-story

- **Put everything together, the template and words**
  - Storyline.py
- **Loading and handling user choosing templates**
  - TemplateChooser.py
- **Loading and picking the word for a given tag**
  - Replacements.py

Main Parts (3 modules) for tag-a-story

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Creating a story

- **Main steps in Storyline.py**
  - Get template – use module TemplateChooser
  - Go through template
    - Get words for a tag – use module Replacements
    - Replace tag with word
- **Using modules**
  - Assume they work
  - Only care ***what*** they do, not ***how*** (abstraction!)

Modules in Action: makeStory() is in Storyline.py

- **How can we access TemplateChooser functions?**
  - import and access as shown

```
41  def makeStory():
42      """
43      let user make a choice of
44      available templates and print
45      the story from the chosen template
46      """
47      lines = TemplateChooser.getTemplateLines("templates")
48      st = linesToStory(lines)
49      print(st)
```

Modules in Action: makeStory() is in Storyline.py

- **How can we access TemplateChooser functions?**
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Another module (file)

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Modules in Action: makeStory() is in Storyline.py

- **How can we access TemplateChooser functions?**
  - import and access as shown

A function in the file: TemplateChooser.py

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41  def makeStory():
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```


Modules in Action: linesToStory() is in Storyline.py

- **We call doWord() – does replacements for words**

```
27  def linesToStory(lines):
28      """
29      lines is a list of strings,
30      each a line from a template file
31      Return a string based on substituting
32      for each <tag> in each line
33      """
34      story = ""
35      for line in lines:
36          st = ""
37          for word in line.split():
38              st += doWord(word) + " "
39          story += st.strip() + "\n"
40      return story
```


Modules in Action: linesToStory() is in Storyline.py

- **We call doWord() – does replacements for words**

A function in this file: doWord no dot before it

```
27  def linesToStory(lines):
28      """
29      lines is a list of strings,
30      each a line from a template file
31      Return a string based on substituting
32      for each <tag> in each line
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34      story = ""
35      for line in lines:
36          st = ""
37          for word in line.split():
38              st += doWord(word) + " "
39          story += st.strip() + "\n"
40      return story
```

Understanding Code/Module

doWord is in Storyline.py

- **What does getReplacement do?**
  - How does getReplacement do it?

```
10  def doWord(word):
11      """
12      word is a string
13      if word is <tag>, find replacement
14      and return it. Else return word
15      """
16      start = word.find("<")
17      if start != -1:
18          end = word.find(">")
19          tag = word[start+1:end]
20
21          rep = Replacements.getReplacement(tag)
22          return rep
23      return word
```


Understanding Code/Module

doWord is in Storyline.py

- **What does getReplacement do?**
  - How does getReplacement do it?

```
10  def doWord(word):
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Another module (file)

Understanding Code/Module

doWord is in Storyline.py

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18          end = word.find(">")
19          tag = word[start+1:end]
20
21          rep = Replacements.getReplacement(tag)
22          return rep
23      return word
```

A function in the file: Replacements.py

Main Parts for tag-a-story

- Put everything together, the template and words
  - Storyline.py
- **Loading and handling user choosing templates**
  - TemplateChooser.py
- Loading and picking the word for a given tag
  - Replacements.py

Another module TemplateChooser.py

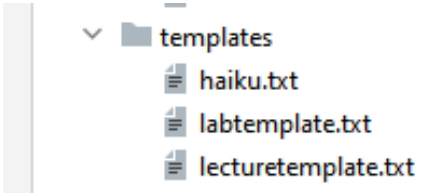
- **Get template**
  - `TemplateChooser.getTemplateLines(DIR)`
  - What:
    - From the templates in the directory DIR (type: str)
    - Return a list of strings, where each element is a line from one of the templates in DIR
- **Word for a tag**
  - `Replacements.getReplacement(TAG)`
  - What:
    - Return a random word that matches TAG (type: str)

Where is it called from?

- **In module Storyline.py, function makestory**

```
lines = TemplateChooser.getTemplateLines("templates")
```

- **Where templates is a folder with three templates:**



TemplateChooser.py Steps

- **List all templates in the folder**
- **Get user input that chooses one**
- **Load that template**
- **Return as list of strings**

TemplateChooser.py Steps

- **List all templates in the folder**
  - pathlib Library
- **Get user input that chooses one**
  - Handle bad input → try…except
- **Load that template**
  - Open file, .readlines()
- **Return as list of strings**

These Steps in Code getTemplateLines in TemplateChooser.py

- **Read directory of templates, convert to dictionary**
  - Let user choose one, open and return it

```
59  def getTemplateLines(dirname):
60      """
61      dirname is a string that's the name of a folder
62      Prompt user for files in folder, allow user
63      to choose, and return the lines read from file
64      """
65      d = dirToDictionary(dirname)
66      lines = chooseOne(d)
67      return lines
```


Creating User Menu dirToDictionary in TemplateChooser.py

- **What does this function return? What type?**

```
11  def dirToDictionary(dirname):
12      """..."""
18      d = {}
19      index = 0
20      for one in pathlib.Path(dirname).iterdir():
21          d[index] = one
22          # print(type(one))
23          index += 1
24      return d
```


Creating User Menu dirToDictionary in TemplateChooser.py

- **What does this function return? What type?**

```
11  def dirToDictionary(dirname):
12      """..."""
18      d = {}
19      index = 0
20      for one in pathlib.Path(dirname).iterdir():
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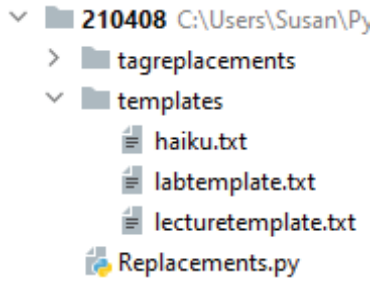
```

d is:
0 -> haiku.txt
1 -> labtemplate.txt
2 -> lecturetemplate.txt

Folder in Pycharm



Output:

```
C:\Users\Susan\AppData\Lo
0   haiku.txt
1   labtemplate.txt
2   lecturetemplate.txt
------
choose one> 0
the slimy bathtub
reminded them of Africa
chartreuse squeaky brown
```

pathlib Library

- **Path: “rodger/Pycharm/cps101/lab11/temp/haiku.txt”**
- **The pathlib library is more recent/Python3**
  - Simpler, easier to use than functions from **os**
- **Handles domain specifics!**
  - Doesn’t matter if on Windows, Mac, etc.
  - We worry about the ***what***, it handles the ***how***

pathlib Library cont.

- **Path: “rodger/Pycharm/cps101/lab11/temp/haiku.txt”**
- **`pathlib.Path(DIR).iterdir()`**
  - Returns iterable of Path objects representing each “thing” in the directory DIR
- **Path object’s .parts – tuple of strings, each element is a piece of a filename’s path**
  - `(‘rodger’, ‘Pycharm’, ‘cps101’,’lab11’, ‘temp’, ‘haiku.txt’)`

Understanding the Unknown chooseOne in TemplateChooser.py

- **We will return to this, but analyze parts now**
  - What's familiar? What's not familiar …

```
39  def chooseOne(d):
40      """..."""
46      while True:
47          for key in sorted(d.keys()):
48              print("%d\t%s" % (key, d[key].parts[-1]))
49          print("------")
50          st = input("choose one> ")
51          try:
52              val = int(st)
53              if 0 <= val and val < len(d):
54                  return reader(d[val])
55          except ValueError:
56              print("please enter a number")
```


Python exceptions

- **What should you do if you prompt user for a number and they enter "one"**
  - Test to see if it has digits?
- **Use exceptions with `try:` and `except:`**
  - See code in function **`chooseOne`** from ***TemplateChooser.py***

Handling Exceptions

- **What happens: `x = int("123abc")`**

```
46          st = input("choose one> ")
47          try:
48              val = int(st)
49              if 0 <= val and val < len(d):
50                  return reader(d[val])
51          except ValueError:
52              print("please enter a number")
```


WOTO-1 Modules
http://bit.ly/101s23-0420-2

APT WordPlay

APT: WordPlay

Problem Statement

Given a phrase of words, your task is to return a string of the unique words from the phrase, with the words sorted using the following rules.

1. First the unique words should be sorted in reverse order based on their length (number of characters in the word)
2. For words the same length, they should be sorted in alphabetical order based on only the first letter of each such word
3. If there are ties after 1) and 2) criteria, then sort those words in reverse alphabetical order based on the last letter of each such word
4. If there are ties after 1), 2) and 3) criteria, then sort those words in alphabetical order based on the sub-word between the first and last letter of each such word.

APT WordPlay example

"mouse elephant moth zebra mole tiger moose moth mule"

Returns:

"elephant moose mouse tiger zebra moth mole mule"

APT WordPlay example

"mouse elephant moth zebra mole tiger moose moth mule"

Returns:

"elephant moose mouse tiger zebra moth mole mule"

- No duplicates

APT WordPlay example

"mouse elephant moth zebra mole tiger moose moth mule"

Returns:

8 5 5 5 5 4 4 4

"elephant moose mouse tiger zebra moth mole mule"

- No duplicates
- Reverse order by length

APT WordPlay example

"mouse elephant moth zebra mole tiger moose moth mule"

Returns:

"elephant moose mouse tiger zebra moth mole mule"

- No duplicates
- Reverse order by length
- Ties: alphabetical by first letter

APT WordPlay example

"mouse elephant moth zebra mole tiger moose moth mule"

Returns:

"elephant moose mouse tiger zebra moth mole mule"

- No duplicates
- Reverse order by length
- Ties: alphabetical by first letter
- 2nd Ties: reverse alphabetical by last letter

APT WordPlay example

"mouse elephant moth zebra mole tiger moose moth mule"

Returns:

"elephant moose mouse tiger zebra moth mole mule"

- No duplicates
- Reverse order by length
- Ties: alphabetical by first letter
- 2nd Ties: reverse alphabetical by last letter
- 3rd Ties: alphabetical sub-word between first and last letter

APT WordPlay

APT: WordPlay

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WOTO-3 APT WordPlay
http://bit.ly/101s23-0420-3

APT: WordPlay

Problem Statement

Given a phrase of words, your task is to return a string of the unique words from the phrase, with the words sorted using the following rules.

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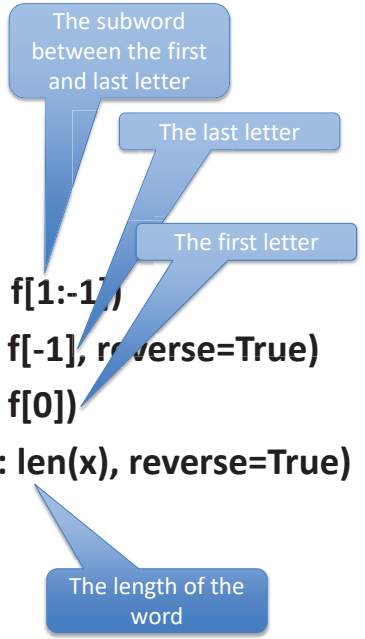
2. For words the same length, they should be sorted in alphabetical order based on only the first letter of each such word
3. If there are ties after 1) and 2) criteria, then sort those words in reverse alphabetical order based on the last letter of each such word
4. If there are ties after 1), 2) and 3) criteria, then sort those words in alphabetical order based on the sub-word between the first and last letter of each such word.

WOTO-3 APT WordPlay
http://bit.ly/101s23-0420-3

WordPlay

```
def sortinorder(phrase):
    alist = list(set(phrase.split()))
    blist = sorted(alist, key=lambda f: f[1:-1])
    clist = sorted(blist, key=lambda f: f[-1], reverse=True)
    dlist = sorted(clist, key=lambda f: f[0])
    elist = sorted(dlist, key=lambda x: len(x), reverse=True)
    return " ".join([x for x in elist])
```


WordPlay

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    clist = sorted(blist, key=lambda f: f[-1], reverse=True)
    dlist = sorted(clist, key=lambda f: f[0])
    elist = sorted(dlist, key=lambda x: len(x), reverse=True)
    return " ".join([x for x in elist])
```