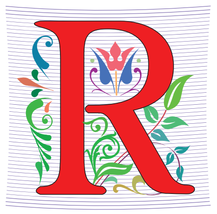
Compsci 101 Stable Sorting, Lambda, Clever Hangman Part 1 of 3

Susan Rodger

October 20, 2020

```
>>> inc = lambda x : x + 1
>>> p = [1, 3, 5, 7]
>>> [inc(num) for num in p]
[2, 4, 6, 8]
```

R is for …



- **Random**
  - **.choice**, **.shuffle**, **.seed**, **.randint**
- **R**
  - Programming language of choice in stats
- **Refactoring**
  - Better, but not different

PFTD

- Sorting in Python and sorting in general
  - How to use .sort and sorted, differences
  - Key function – change how sorting works
  - Lambda – create anonymous functions
- Stable sorting
  - How to leverage when solving problems
  - Why Timsort is the sort-of-choice (! quicksort)
- Clever Hangman –
  - How does it work?

Go over Last WOTO from last time

WOTO last time – 1st question

Showing the list and the list sorted

```
In[14]: a = ['red', 'orange', 'yellow', 'green', 'blue', 'indigo', 'violet']
In[15]: sorted(a)
Out[15]: ['blue', 'green', 'indigo', 'orange', 'red', 'violet', 'yellow']
```

What's the list returned by sorted(a, reverse=True)? *

- ◯ ['yellow','violet', 'red', 'orange', 'indigo', 'green', 'blue']
- ◯ ['violet', 'indigo', 'blue', 'green', 'yellow', 'orange', 'red']

WOTO last time – 1st question

Showing the list and the list sorted

```
In[14]: a = ['red', 'orange', 'yellow', 'green', 'blue', 'indigo', 'violet']
In[15]: sorted(a)
Out[15]: ['blue', 'green', 'indigo', 'orange', 'red', 'violet', 'yellow']
```

What's the list returned by sorted(a, reverse=True)? *

- [✓ ['yellow','violet', 'red', 'orange', 'indigo', 'green', 'blue']]
- ◯ ['violet', 'indigo', 'blue', 'green', 'yellow', 'orange', 'red']

WOTO last time – 2cd question

Showing the list and the list sorted

```
In[14]: a = ['red', 'orange', 'yellow', 'green', 'blue', 'indigo', 'violet']
In[15]: sorted(a)
Out[15]: ['blue', 'green', 'indigo', 'orange', 'red', 'violet', 'yellow']
```

What's the list returned by sorted(a, key=len)? *

- ◯ ['red', 'blue', 'green', 'orange', 'yellow', 'indigo', 'violet']
- ◯ ['red', 'blue', 'orange', 'green', 'yellow', 'indigo', 'violet']

WOTO last time – 2cd question

Showing the list and the list sorted

```
In[14]: a = ['red', 'orange', 'yellow', 'green', 'blue', 'indigo', 'violet']
In[15]: sorted(a)
Out[15]: ['blue', 'green', 'indigo', 'orange', 'red', 'violet', 'yellow']
```

What's the list returned by sorted(a, key=len)? *

- [✓ ['red', 'blue', 'green', 'orange', 'yellow', 'indigo', 'violet']]
- ◯ ['red', 'blue', 'orange', 'green', 'yellow', 'indigo', 'violet']

WOTO last time – 3rd question

Showing the list and the list sorted

```
In[14]: a = ['red', 'orange', 'yellow', 'green', 'blue', 'indigo', 'violet']
In[15]: sorted(a)
Out[15]: ['blue', 'green', 'indigo', 'orange', 'red', 'violet', 'yellow']
```

The function max applied to a string returns the alphabetically greatest character in the string, so max('indigo') == 'o' and max('yellow') == 'y'. What's the list returned by sorted(a, key=max)? *

- ◯ ['indigo', 'orange', 'green', 'red', 'blue', 'violet', 'yellow']
- ◯ ['indigo', 'red', 'orange', 'green', 'blue', 'violet', 'yellow']

WOTO last time – 3rd question

Showing the list and the list sorted

```
         2        2         5         2        3         1          4
         r        r         y         r        u         o          v
In[14]: a = ['red', 'orange', 'yellow', 'green', 'blue', 'indigo', 'violet']
In[15]: sorted(a)
Out[15]: ['blue', 'green', 'indigo', 'orange', 'red', 'violet', 'yellow']
```

The function max applied to a string returns the alphabetically greatest character in the string, so max('indigo') == 'o' and max('yellow') == 'y'. What's the list returned by sorted(a, key=max)? *

- ◯ ['indigo', 'orange', 'green', 'red', 'blue', 'violet', 'yellow']
- ◯ ['indigo', 'red', 'orange', 'green', 'blue', 'violet', 'yellow'] ←

Turing Award 2019
Pat Hanrahan, Ed Catmull

- Pixar, RenderMan, Computer Generated Imagery

Catmull: You are not your idea, and if you identify too closely with your ideas, you will take offense when they are challenged.

Catmull: If you aren't experiencing failure, then you are making a far worse mistake: You are being driven by the desire to avoid it.

Compsci 101
Stable Sorting, Lambda, Clever Hangman
Part 2 of 3

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```
>>> inc = lambda x : x + 1
>>> p = [1, 3, 5, 7]
>>> [inc(num) for num in p]
[2, 4, 6, 8]
```

Review: CSV and Sort for top artists

- Using two-sorts to get top artists

```
    print('\nTop 5 artists:')
    sortbycount = sorted([(a[1], a[0]) for a in counts.items()])
    sortedArtists = [(a[1], a[0]) for a in sortbycount]
    for artist in sortedArtists[-5:]:
        print(artist)
```

- Reverse tuples to sort
- Reverse tuples to print

```
Top 5 artists:
('John, Elton', 21)
('Who', 24)
('Rolling Stones', 36)
('Led Zeppelin', 38)
('Beatles', 51)
```

Top 5 Artists

- Instead of intermediary list, use **`lambda`**
- Instead of **`[-5:]`**, use **`reverse=True`**

```
print('\nTop 5 artists:')
sortbycount = sorted([(a[1], a[0]) for a in counts.items()])
sortedArtists = [(a[1], a[0]) for a in sortbycount]
for artist in sortedArtists[-5:]:
    print(artist)

print("repeat it")
sortedArtists = sorted(counts.items(), key=lambda item: item[1], reverse=True)
for tup in sortedArtists[:5]:
    print(tup)
```

Output slightly different. Why?

```
repeat it
('Beatles', 51)
('Led Zeppelin', 38)
('Rolling Stones', 36)
('Who', 24)
('Eagles', 21)
```

The power of lambda

- We want to create a function "on-the-fly"
  - aka anonymous function
  - aka "throw-away" function

```
In[7]: a
Out[7]: ['red', 'orange', 'green', 'blue', 'indigo', 'violet']
In[8]: sorted(a,key=lambda x : x.count("e"))
Out[8]: ['indigo', 'red', 'orange', 'blue', 'violet', 'green']
```

- Why 'indigo' first and 'green' last?
  - What about order of ties? Later today! Stable

Sorting Examples

- Use key=function argument and reverse=True
  - What if we want to write our own function?

```
In[2]: a = ["red", "orange", "green", "blue", "indigo", "violet"]
In[3]: sorted(a)
Out[3]: ['blue', 'green', 'indigo', 'orange', 'red', 'violet']
In[4]: sorted(a,key=len)
Out[4]: ['red', 'blue', 'green', 'orange', 'indigo', 'violet']
In[5]: sorted(a,key=len,reverse=True)
Out[5]: ['orange', 'indigo', 'violet', 'green', 'blue', 'red']
```

Anonymous Functions

- Useful when want “throw-away” function
  - Our case mainly sort
- Syntax: `lambda PARAMETERS: EXPRESSION`
  - `PARAMETERS` – 0 or more comma separated
  - `EXPRESSION` – evaluates to something

Why is lambda used?

- It doesn't matter at all could use zeta? iota? …
  - https://en.wikipedia.org/wiki/Alonzo_Church
  - Lisp and Scheme have lambda expressions
  - Guido van Rossom, learned to live with lambda

λ

What is a lambda expression?

- It's a function object, treat like expression/variable
  - Like list comprehensions, access variables

```
>>> inc = lambda x : x + 1
>>> p = [1, 3, 5, 7]
>>> [inc(num) for num in p]
[2, 4, 6, 8]
```

Syntactic sugar (makes the medicine go down)

- Syntactic sugar for a normal function definition

```
def f(x):
    return x[1]
sorted(lst, key=f)
```

```
f = lambda x : x[1]
sorted(lst, key=f)
```

```
sorted(lst, key=lambda x : x[1])
```

```
>>> d.items()
dict_items([('a', [1, 2, 3]), ('b', [4, 7]), ('c', [1, 1, 5, 8])])
>>> sorted(d.items(), key=lambda x : len(x[1]))
[('b', [4, 7]), ('a', [1, 2, 3]), ('c', [1, 1, 5, 8])]
>>> sorted(d.items(), key=lambda sparky : len(sparky[1]))
[('b', [4, 7]), ('a', [1, 2, 3]), ('c', [1, 1, 5, 8])]
```

Parameter name does not matter

Syntax and Semantics of Lambda

- Major use: single variable function as key

```
>>> fruits = ["banana", "apple", "lemon", "kiwi", "pineapple"]
>>> sorted(fruits)
['apple', 'banana', 'kiwi', 'lemon', 'pineapple']
>>> min(fruits)
'apple'
>>> max(fruits)
'pineapple'
>>> min(fruits, key=lambda f: len(f))
'kiwi'
>>> max(fruits, key=lambda z: z.count("e"))
'pineapple'
>>> sorted(fruits, key=lambda z: z.count("e"))
['banana', 'kiwi', 'apple', 'lemon', 'pineapple']
```

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```
>>> inc = lambda x : x + 1
>>> p = [1, 3, 5, 7]
>>> [inc(num) for num in p]
[2, 4, 6, 8]
```

How is the sorting happening?

```
>>> d
{'a': [1, 2, 3], 'b': [4, 7], 'c': [1, 1, 5, 8]}
>>> sorted(d.items())
[('a', [1, 2, 3]), ('b', [4, 7]), ('c', [1, 1, 5, 8])]
>>> sorted(d.items(), key=lambda x: x[1])
[('c', [1, 1, 5, 8]), ('a', [1, 2, 3]), ('b', [4, 7])]
>>> sorted(d.items(), key=lambda x: x[1][-1])
[('a', [1, 2, 3]), ('b', [4, 7]), ('c', [1, 1, 5, 8])]
```

How to do some “fancy” sorting

- lambda PARAMETER : EXPRESSION
- Given data: list of tuples: (first name, last name, age)

```
[(‘Percival’, ‘Avram’,  51),
 (‘Melete’,   ‘Sandip’, 24), …]
```

- Think: What is the lambda key to sort the following?

```
sorted(data, key=lambda z : (z[0],z[1],z[2]))
```

  - Sort by last name, break ties with first name
  - Sort by last name, break ties with age
  - Alphabetical by last name, then first name, then reverse age order

Creating Tuples with lambda

- Sort by last name, break ties with first name
  - key = lambda x: (x[1], x[0])
- Sort by last name, break ties with age
  - key = lambda x: (x[1], x[2])
- Alphabetical by last name, then first name, then reverse age order
  - key = lambda x: (x[1], x[0], -x[2])

- What if wanted something really different?
  - Sort alphabetical by last name, break ties by reverse alphabetical using first name

Leveraging the Algorithm

- Can't sort by creating a tuple with lambda, use:
  - Pattern: Multiple-pass *stable* sort – first sort with last tie breaker, then next to last tie breaker, etc. until at main criteria

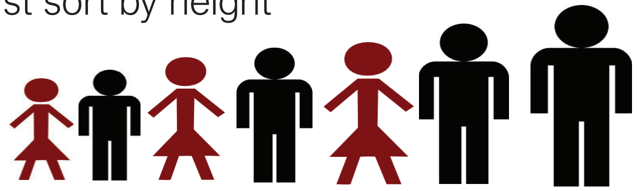
- Sort by index 0, break tie in reverse order with index 1

```
[('b', 'z'), ('c', 'x'), ('b', 'x'), ('a', 'z')]
[('b', 'z'), ('a', 'z'), ('c', 'x'), ('b', 'x')]
[('a', 'z'), ('b', 'z'), ('b', 'x'), ('c', 'x')]
```

- *Stable* sort respects original order of "equal" keys

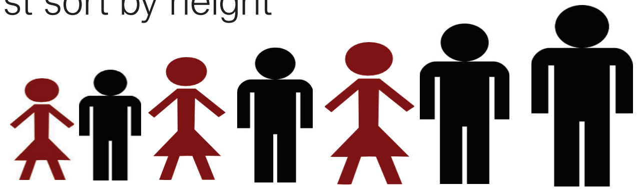
Stable sorting: respect "equal" items

- Female before male, each group height-sorted
  - First sort by height

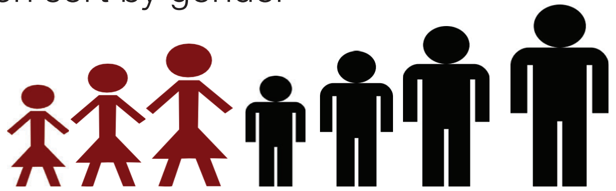


Stable sorting: respect "equal" items

- Female before male, each group height-sorted
  - First sort by height



  - Then sort by gender



Understanding Multiple-Pass Sorting

```
> a0 = sorted(data, key = lambda x: x[0])
> a1 = sorted(a0, key = lambda x: x[2])
> a2 = sorted(a1, key = lambda x: x[1])
> a0
[('a', 2, 0), ('b', 3, 0), ('c', 2, 5),
 ('d', 2, 4), ('e', 1, 4), ('f', 2, 0)]
> a1
[('a', 2, 0), ('b', 3, 0), ('f', 2, 0),
 ('d', 2, 4), ('e', 1, 4), ('c', 2, 5)]
> a2
[('e', 1, 4), ('a', 2, 0), ('f', 2, 0),
 ('d', 2, 4), ('c', 2, 5), ('b', 3, 0)]
```