CompSci 101
Introduction to Computer Science

Dec 8, 2016

Prof. Rodger

Announcements

- Last Day of class!
- Assign 8 – With LATE Penalty thru Fri, Dec 9
- Assign 9 by Monday, none accepted after that
- APT 10 due by Monday, no Late APTs

- Form for taking Final exam another time
  - accommodations?
  - Three exams in a 24 hour period?
  - Room for some to take final with the other section
  - Fill out by tomorrow for consideration!!!

More Announcements

- Regrade for Exam 2 – submit by Friday, Dec 9
- Review Session – Tuesday 4pm (LSRC B101)
- Last Consulting Hours tonight
- Prof. Rodger will have office hours
  - Today 3-5pm, Tomorrow 2-5pm, more…
- Concern form – last minute concerns

- Today:
  - Wrapping up, Beyond CompSci 101
  - The Final exam

Final Exam

- Sec 01– Monday, Dec 19, 2pm, **LSRC B101**
- Sec 02 – Thurs, Dec 15, 7pm, **Bio Sci 111**
- Closed Book, Closed Notes, Closed neighbor
- Python Reference Sheet
- Covers all topics through today
- Best way to study is practice writing code!
- See old tests (no old final exams)

Final Exam (cont)

- Test format
  - Multiple choice
  - Writing code – similar to exam 2
- Topics include:
  - if, loops, lists, sets, dictionaries, files, functions, sorting, etc
  - recursion, regular expressions – reading level only

Calculate Your Grade

- From "About" tab on course web page

Labs	10%
Reading Quizzes	5%
Class/Group work	5%
Apts	10%
Programming Assignments	10%
APT Quizzes	5%
Two Midterm Exams	30%
final exam	25%

More on Grades

- Lecture – ignore the first two weeks (drop/add period), plus drop 4 points
- Reading Quizzes – will drop 30 points
  - Lots of problems with Sakai this semester
  - Check your grades to make sure they copied over – fill out duke oit help form if they are wrong
- Lab – drop 6 points (each lab is 4 pts)
  - 44 pts total– 38 pts is 100%

Fill out Duke Course Eval

- Please fill out Duke Course Eval on DukeHub now
  - Only 15% have filled it in as of last night
- If you already have , then go to Sakai and fill out feedback on UTAs

Review - Selection Sort

- Sort a list of numbers.
- Idea:
  - Repeat til sorted
    - Find the smallest element in part of list not sorted
    - Put it where it belongs in sorted order.
      - Swap it with the element where it should be
- Sort example

Sorted, won't move final position	???

Selection Sort – red area sorted

9 5 4 1 3 6 - find smallest, swap

1 | 5 4 9 3 6 - end of 1st pass

1 | 5 4 9 3 6 - find smallest, swap

1 3 | 4 9 5 6 - end of 2nd pass

1 3 | 4 9 5 6 - find smallest, swap

Selection Sort (cont.)

1 3 4 | 9 5 6 - end of 3rd pass

1 3 4 | 9 5 6 - find smallest, swap

1 3 4 5 | 9 6 - end of 4th pass

1 3 4 5 | 9 6 - find smallest, swap

1 3 4 5 6 | 9 - end of 5th pass, done

Bubble Sort

- Sort a list of numbers.
- Idea:
  - Repeat til sorted
    - Compare all adjacent pairs, one at a time. If out of order then swap them
- Sort example

???	*Sorted, won't move final position*

Bubble Sort
bit.ly/101f16-1208-1

- Sort the list of numbers using BubbleSort.
- The body of the loop is one pass.
- Show the elements after each pass.
- [9, 5, 4, 1, 3, 6]

Bubble Sort – red area sorted

9 5 4 1 3 6 - compare, swap
5 9 4 1 3 6 - compare, swap
5 4 9 1 3 6 - compare, swap
5 4 1 9 3 6 - compare, swap
5 4 1 3 9 6 - compare, swap
5 4 1 3 6 9 - end of 1st pass
5 4 1 3 6 | 9

Bubble Sort – red area sorted

5 4 1 3 6 | 9 - compare, swap
4 5 1 3 6 | 9 - compare, swap
4 1 5 3 6 | 9 - compare, swap
4 1 3 5 6 | 9 - compare, no swap
4 1 3 5 6 | 9 - end of 2cd pass
4 1 3 5 | 6 9

Bubble Sort – red area sorted

4 1 3 5 | 6 9 - compare, swap
1 4 3 5 | 6 9 - compare, swap
1 3 4 5 | 6 9 - compare, no swap
1 3 4 5 | 6 9 - end of 3rd pass
1 3 4 | 5 6 9

Two more passes would guarantee sorted.

Or Check if sorted and skip last two passes

Code for Bubblesort

```
def bubblesort(data):
    for j in range(len(data)-1,0,-1):
        print data
        for k in range(0,j):
            if data[k] > data[k+1]:
                data[k],data[k+1] = data[k+1], data[k]
    return data
```


Insertion Sort

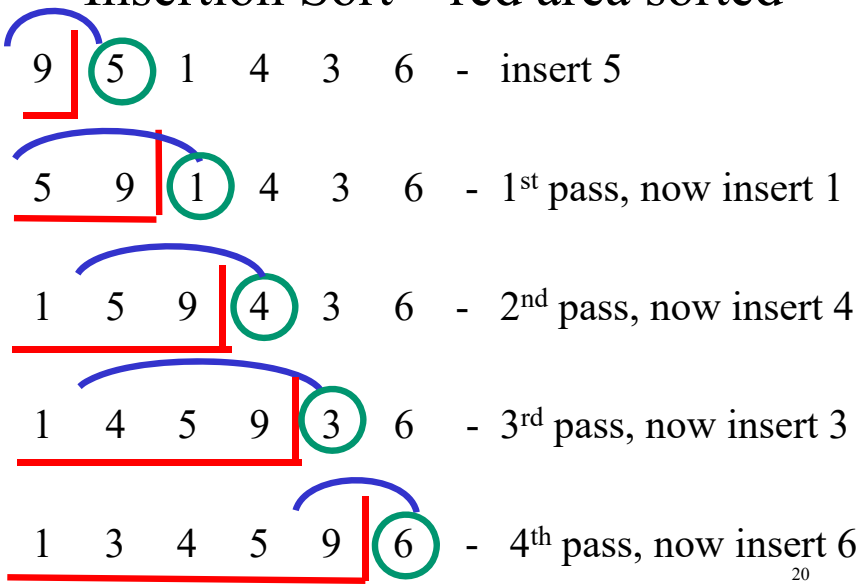
- Sort a list of numbers.
- Idea:
  - Sort by repeated inserting another element
    - Leftmost element is sorted part of list
    - Insert another element in that sublist keeping it sorted
    - Insert another element in that sublist keeping it sorted
    - Etc.
- Sort example

Sorted relative to each other	???

Insertion Sort
bit.ly/101f16-1208-2

- Sort the list of numbers using InsertionSort.
- The body of the loop is one pass.
- Show the elements after each pass.
- [9, 5, 1, 4, 3, 6]

Insertion Sort – red area sorted



Insertion Sort – red area sorted

9 3 4 5 6 9 - 5th pass

Merge Sort

- Idea: Divide and Conquer
- Divide list into two halves
- Sort both halves (smaller problem)
- Merge the two sorted halves

9 5 1 4 3 6 2 7

Merge Sort

- Idea: Divide and Conquer
- Divide list into two halves
- Sort both halves (smaller problem)
- Merge the two sorted halves

9 5 1 4 3 6 2 7

9 5 1 4 3 6 2 7

9 5 1 4 3 6 2 7 divide list into 2 halves

Merge Sort

- Idea: Divide and Conquer
- Divide list into two halves
- Sort both halves (smaller problem)
- Merge the two sorted halves

9 5 1 4 3 6 2 7

9 5 1 4 3 6 2 7 divide list into 2 halves

1 4 5 9 2 3 6 7 recursively sort each half

Merge Sort

- Idea: Divide and Conquer
- Divide list into two halves
- Sort both halves (smaller problem)
- Merge the two sorted halves

9 5 1 4 3 6 2 7		
9 5 1 4	3 6 2 7	divide list into 2 halves
1 4 5 9	2 3 6 7	recursively sort each half
1 2 3 4 5 6 7 9		merge the two sorted list

What does recursively sort mean? Merge Sort

- Use the same Merge Sort algorithm
  - Divide list into two halves
  - Sort both halves (smaller problem)
  - Merge the two sorted halves

9 5 1 4		
9 5	1 4	divide list into 2 halves
5 9	1 4	recursively sort each half
1 4 5 9		merge the two sorted list

MergeSort idea for code

```
def mergesort(data)
    n = len(data)
    if  n == 1:
        return data
    else:
        d1 = mergesort(data[:n/2])
        d2 = mergesort(data[n/2:])
        return merge(d1, d2)
```


bit.ly/101f16-1208-3

Question 1

Which sort is this?

4 10 5 3 8 2
4 10 5 3 8 2
4 5 10 3 8 2
3 4 5 10 8 2
3 4 5 8 10 2
2 3 4 5 8 10

Question 2

Which sort is this?

4 10 5 3 8 2
4 2 5 3 8 10
4 2 5 3 8 10
4 2 3 5 8 10
3 2 4 5 8 10
2 3 4 5 8 10

Wrap up Sorting

- Some Ways to Compare sorts.
  - How many total swaps?
  - Is one faster for certain types of input?
  - Does the input matter
- Different ways to sort?
  - Over 50 sorting algorithms
- Does President Obama know his sorts?
- Sorting animations

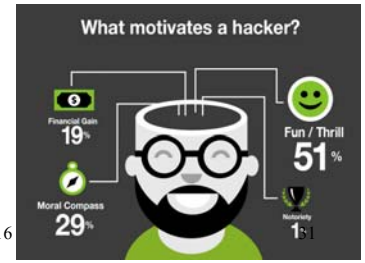
  http://www.sorting-algorithms.com/

More on Sorting in CompSci 201

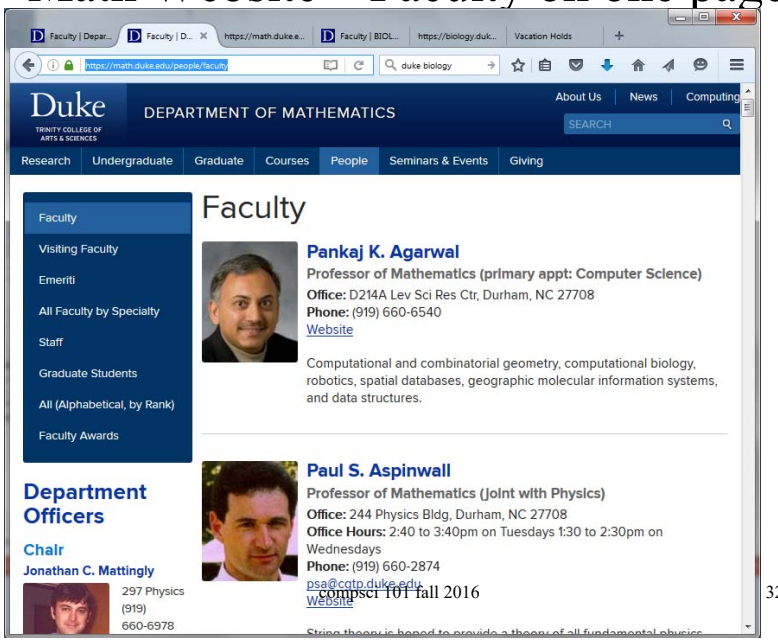
- Learn about this and other sorts in CompSci 201, also how to analyze them to determine which one works best.
- Python: Timsort
  - combines mergesort and insertion sort
- Shellsort
  - uses insertion sort on parts of the list repeatedly - those parts getting larger each time

Scraping email address from websites

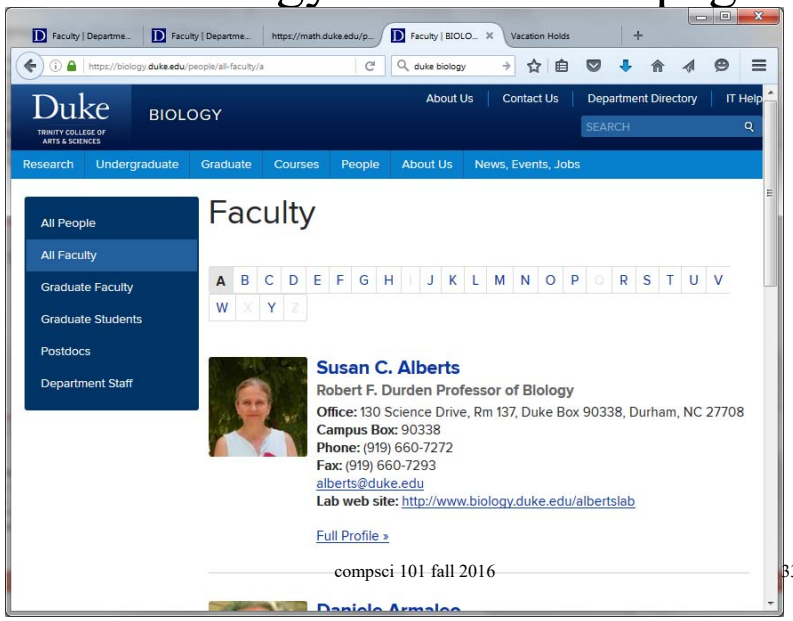
- Suppose we want to send email to all Duke Faculty to let them know …
  - Visit Departmental website, people, faculty
  - View (HTML) Source
  - Develop regex to access email – if possible!
- RegexScraper.py
  - Python makes this simple
  - Ethical hacking?



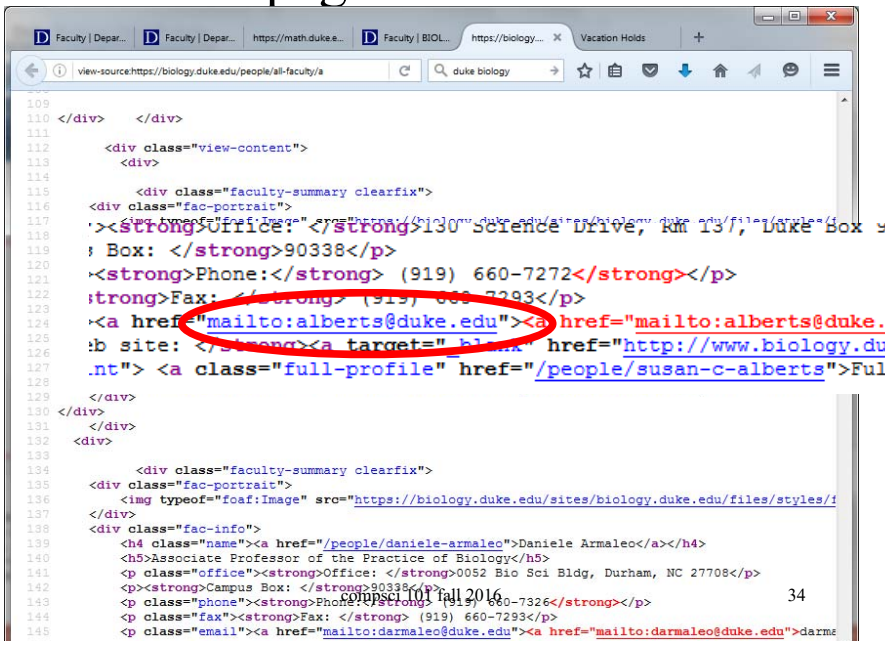
Math Website – Faculty on one page



Duke Biology Website A-Z pages



View page source of html

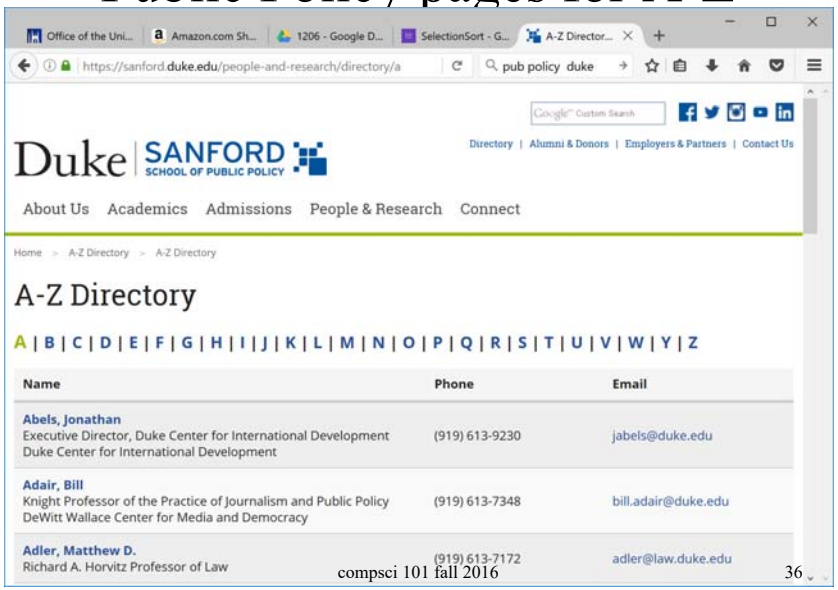


Scraping Biology faculty

- Pattern:
  - `r'mailto:(\w+[.\w]*)@(\w+[.\w+]*)'`
- URL
  - `https://biology.duke.edu/people/all-faculty/a`
- Matches (call 26 times with different URL)

…
('emily.bernhardt', 'duke.edu')
('emily.bernhardt', 'duke.edu')
('bhandawat', 'gmail.com')
('bhandawat', 'gmail.com')
('jboynton66', 'gmail.com')
('jboynton66', 'gmail.com')

Public Policy pages for A-Z



Scraping Sanford/PubPol faculty

- Pattern:
  - `r'(\w+[.\w]*)@(\w+[.\w+]*)'`
- URL
  - https://sanford.duke.edu/people…/
- Matches (call 26 times with different URL)

…
('schanzer', 'duke.edu')
('steveschewel', 'gmail.com')
('michael.schoenfeld', 'duke.edu')
('schroeder', 'law.duke.edu')

What is Computing? Informatics?

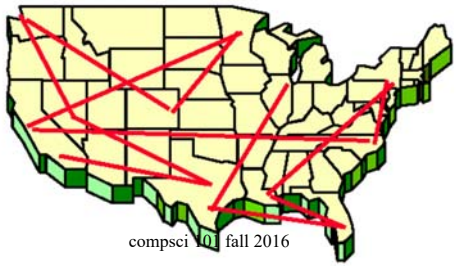
- What is computer science, what is its potential?
  - What can we do with computers in our lives?
  - What can we do with computing for society?
  - Will networks transform thinking/knowing/doing?
  - Society affecting and affected by computing?
  - Changes in science: biology, physics, chemistry, …
  - Changes in humanity: access, revolution (?), …
- Privileges and opportunities available if you know code
  - Writing and reading code, understanding algorithms
  - Majestic, magical, mathematical, mysterious, …

Computing - solve all problems?

- Some problems can be solved 'efficiently'
  - Run large versions fast on modern computers
  - What is 'efficient'? It depends
- Some cannot be solved by computer.
  - Provable! We can't wait for smarter algorithms
- Some problems have no efficient solution
  - Provably exponential 2^n so for "small" n …
- Some have no known efficient solution, but
  - If one does they all do!

Problem: Traveling Band

- Band wants you to schedule their concerts.
- They don't like to travel. Minimize the time they are on the bus!
- Given N cities, what is the best schedule (shortest distance) to visit all N cities once?



How do you calculate the best path?

- Try all paths
  - Atlanta, Raleigh, Dallas, Reno, Chicago
  - Dallas, Atlanta, Raleigh, Reno, Chicago
  - Etc.
- Would you agree to code this up?

Answer questions
bit.ly/101f16-1208-4

How long?

Number of Cities	All paths – N!	Time to solve - 10^9 Instructions per second
10	3 million	
15	10^{12}	
18	10^{15}	
20	10^{18}	
25	10^{25}	

How long?

Number of Cities	All paths – N!	Time to solve - 10^9 Instructions per second
10	3 million	< sec
15	10^{12}	
18	10^{15}	
20	10^{18}	
25	10^{25}	

How long?

Number of Cities	All paths – N!	Time to solve - 10^9 Instructions per second
10	3 million	< sec
15	10^{12}	16 min
18	10^{15}	
20	10^{18}	
25	10^{25}	

How long?

Number of Cities	All paths – N!	Time to solve - 10^9 Instructions per second
10	3 million	< sec
15	10^{12}	16 min
18	10^{15}	11 days
20	10^{18}	
25	10^{25}	

How long?

Number of Cities	All paths – N!	Time to solve - 10^9 Instructions per second
10	3 million	< sec
15	10^{12}	16 min
18	10^{15}	11 days
20	10^{18}	31 years
25	10^{25}	

How long?

Number of Cities	All paths – N!	Time to solve - 10^9 Instructions per second
10	3 million	< sec
15	10^{12}	16 min
18	10^{15}	11 days
20	10^{18}	31 years
25	10^{25}	10^8 years

How is Python like all other programming languages, how is it different?

A Rose by any other name…C or Java?

- Why do we use [Python | Java] in courses ?
  - [is | is not] Object oriented
  - Large collection of libraries
  - Safe for advanced programming and beginners
  - Harder to shoot ourselves in the foot
- Why don't we use C++ (or C)?
  - Standard libraries weak or non-existant (comparatively)
  - Easy to make mistakes when beginning
  - No GUIs, complicated compilation model
  - What about other languages?

Find all unique/different words in a file, in sorted order

Unique Words in Python

```
def main():
    f = open('/data/melville.txt', 'r')
    words = f.read().strip().split()
    allWords = set(words)

    for word in sorted(allWords):
        print word

if __name__ == "__main__":
    main()
```

Unique words in Java

```
import java.util.*;
import java.io.*;
public class Unique {
  public static void main(String[] args)
                           throws IOException{
    Scanner scan =
            new Scanner(new File("/data/melville.txt"));
    TreeSet<String> set = new TreeSet<String>();
    while (scan.hasNext()){
        String str = scan.next();
        set.add(str);
    }
    for(String s : set){
        System.out.println(s);
    }
  }
}
```


Unique words in C++

```
#include <iostream>
#include <fstream>
#include <set>
using namespace std;

int main(){
  ifstream input("/data/melville.txt");
  set<string> unique;
  string word;
  while (input >> word){
    unique.insert(word);
  }
  set<string>::iterator it = unique.begin();
  for(; it != unique.end(); it++){
    cout << *it << endl;
  }
  return 0;
}
```


Unique words in PHP

```
<?php

$wholething = file_get_contents("file:///data/melville.txt");
$wholething = trim($wholething);

$array = preg_split("/\s+/",$wholething);
$uni = array_unique($array);
sort($uni);
foreach ($uni as $word){
   echo $word."<br>";
}

?>
```


End with A CS Story
bit.ly/101f16-1208-5