Evaluation

• Fill out course evaluation on ACES
• On Sakai (under announcements) please rate your Lab UTAs and any other UTAs you interacted with

Announcements

• Submit works now!
• Final Exam – accommodations/reschedule?
  – Fill out form by Dec 5
• APT 10 due Friday, last late day is Dec 7
• Asg 8 due tonight!, Last late day is Dec 6
• Asg 9 due Friday night, not accepted after midnight!
• Today
  – More on sorting, Classwork, CS story

More Announcements

• Be a UTA
  – http://www.cs.duke.edu/csed/uta/
• Next course
  – CompSci 201
  – Start all over again with Java
  – Java has if, loops, lists, maps (dictionaries), sets
  – Is that familiar?
  – Learn about nonlinear structures that can be more efficient
Final Exam

- Sec 01 (White Lect. Hall) – Sat Dec 13 2pm
- Sec 02 (LSRC B101) – Wed Dec 10 7pm
- 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)
- Fall 2014 tests – see other section tests

Final Exam (cont)

- Test format
  - Multiple choice
  - Writing code
- Topics include:
  - if, loops, lists, sets, maps, files, functions
  - recursion and regular expressions – reading level only

Calculate Your Grade

- From “About” tab on course web page

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>labs</td>
<td>10%</td>
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<tr>
<td>quizzes</td>
<td>10%</td>
</tr>
<tr>
<td>apts</td>
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<tr>
<td>assignments</td>
<td>20%</td>
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<tr>
<td>two exams</td>
<td>25%</td>
</tr>
<tr>
<td>final exam</td>
<td>25%</td>
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</table>

More on Grades

- Lecture – drop the first two weeks (drop/add period) plus 3 more
- Reading Quizzes – will drop 20 points
- Lab – drop 8 points (each lab is 4 pts)
### Wrap up Sorting

- Different ways to sort?
  - Over 50 sorting algorithms
- What sorting algorithm does Python sort use?
- Does President Obama know his sorts?
- Sorting animations

### Merge Sort

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

- Learn about this and other sorts in CompSci 201, also how to analyze them to determine which one works best.
- Timsort
- Shellsort

### Classwork


### Growth of functions

- As the size of the data increases, how many steps are there for an algorithm/method?
Timings

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<tr>
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<th>$\log_2 N$</th>
<th>$N^2$</th>
<th>$N^3$</th>
<th>$2^N$</th>
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<tbody>
<tr>
<td>10</td>
<td>3.3</td>
<td>100</td>
<td>1000</td>
<td>1024</td>
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<td>4.3</td>
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</table>

Timings

<table>
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<tr>
<th>N</th>
<th>$\log_2 N$</th>
<th>$N^2$</th>
<th>$N^3$</th>
<th>$2^N$</th>
</tr>
</thead>
<tbody>
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</table>

Look at the timings of the sorts

- How do the sorts compare?
  - With size as they grow
  - With different types of data
    - Random
    - Reverse
    - Almost sorted

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?

How long?

<table>
<thead>
<tr>
<th>Number of Cities</th>
<th>All paths – N!</th>
<th>Time to solve - $10^9$ Instructions per second</th>
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<tbody>
<tr>
<td>10</td>
<td>3 million</td>
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</tr>
<tr>
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<tr>
<td>25</td>
<td>$10^{25}$</td>
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</table>

P = NP?

• P: Problems with polynomial time solutions
  – N, N²
  – Example: Selection sort
  – Easy to solve
• NP: problems with not polynomial time solutions
  – $2^n$, N!
  – Hard to solve

Does P = NP?

• Famous CS question
• If yes, a whole class of difficult problems can be solve efficiently, one problem is reducible to another
• If no, none of the hard problems can be solved efficiently
A CS Story