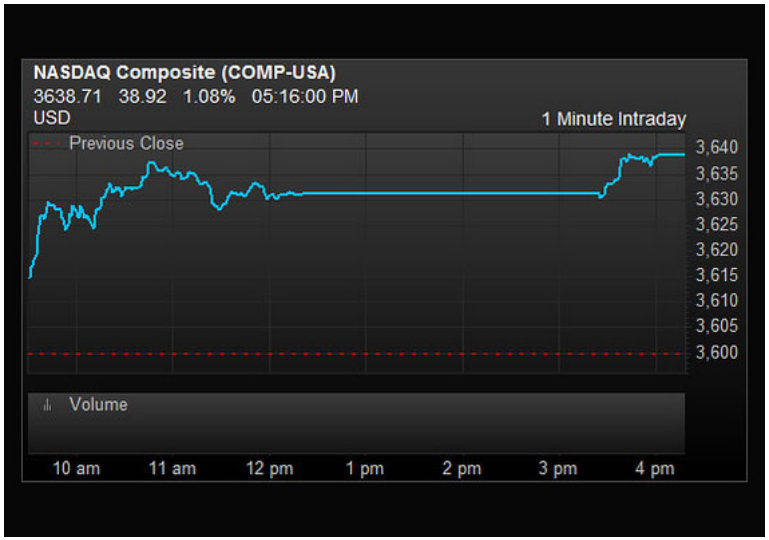
CS 310: Prelude

Chris Kauffman

Week 1-1

Noteworthy

Trading resumes on NYSE after nearly 4-hour outage, CNN 7/8/2015



Pricing Problem Suspends Nasdaq for Three Hours, NYT 8/22/2013

Make Some Money

You get hired by an investment firm (cha-ching).
First task: analyze historical stock performances to locate good times to buy and sell.

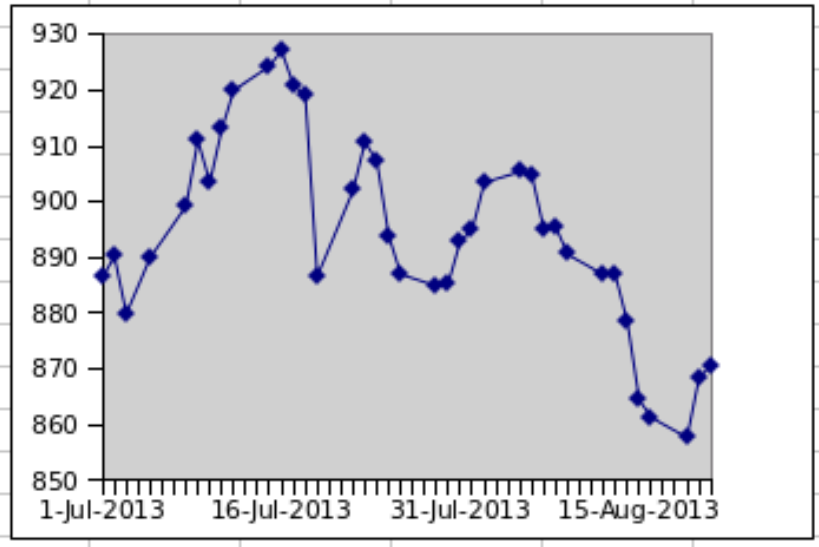
- Buy low and Sell high
- Or don't play at all

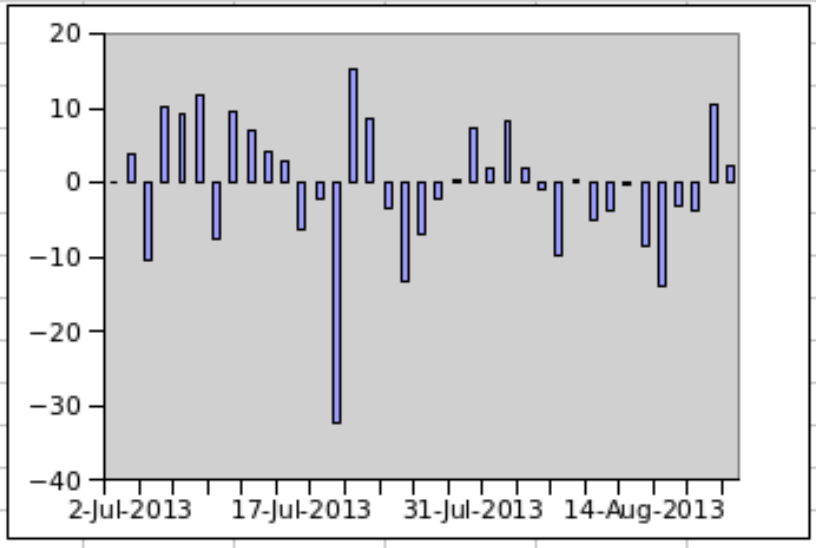
Many Options

Don't play: 0 gain

The Best Buy

1	1-Jul-2013	886	0
2	2-Jul-2013	890	4
3	3-Jul-2013	880	−10
4	5-Jul-2013	890	10
5	8-Jul-2013	899	9
6	9-Jul-2013	911	12
7	10-Jul-2013	903	−8
8	11-Jul-2013	913	10
9	12-Jul-2013	920	7
10	15-Jul-2013	924	4
11	16-Jul-2013	927	3
12	17-Jul-2013	921	−6
13	18-Jul-2013	919	−2
14	19-Jul-2013	887	−32
15	22-Jul-2013	902	15
16	23-Jul-2013	911	9
17	24-Jul-2013	907	−3
18	25-Jul-2013	894	−13
19	26-Jul-2013	887	−7
20	29-Jul-2013	885	−2
21	30-Jul-2013	885	1
22	31-Jul-2013	893	8
23	1-Aug-2013	895	2
24	2-Aug-2013	903	8
25	5-Aug-2013	905	2
26	6-Aug-2013	905	−1
27	7-Aug-2013	895	−10
28	8-Aug-2013	895	0





How Would you find Best Increase?

price	i	delta
886		
890	0	4
880	1	-10
890	2	10
899	3	9
911	4	12
903	5	-8
913	6	10
920	7	7
924	8	4
927	9	3
921	10	-6
919	11	-2
887	12	-32
902	13	15

How is `payoff` computed for `start=1` and `end=3`?
For `start=6` and `end=10`?

Several names for the Problem

- Maximum contiguous subsequence sum (text)
- Maximum Subarray (wikip)
- Find `start` and `end` time with largest `payoff` out of all possible

Find a Solution

- Input is the array `delta[]`
- Output: `(start, end, payoff)` such that payoff is as large as possible
- Can optionally *not invest* for no payoff; return (-1,-1,0)

Algorithm 1: Brute Force

```
maxSubsequenceCube(int A[]){
  bestPayoff = 0
  bestStart = -1
  bestEnd = -1
  for start=0 to A.length-1 {
    for end=start to A.length-1 {
      currentPayoff = 0
      for i=start to end {
        currentPayoff += A[i]
      }
      if(currentPayoff > bestPayoff){
        bestPayoff = currentPayoff
        bestStart = start
        bestEnd = end
      }
    }
  }
  return bestPayoff, bestStart, bestEnd
}
```

- `A[]` contains deltas
- Try every possible `start` and `end` (outer loops)
- Calculate increase from `start` to `end`
- Track the best seen
- Complexity?
- Anything better

Algorithm 2: Skip the inner loop

```
maxSubsequenceQuad(int A[]){
  bestPayoff = 0
  bestStart = -1
  bestEnd = -1
  for start=0 to A.length-1 {
    currentPayoff = 0
    for end=start to A.length-1 {
      currentPayoff += A[end]
      if(current > best){
        bestPayoff = currentPayoff
        bestStart = start
        bestEnd = end
      }
    }
  }
  return bestPayoff, bestStart, bestEnd
}
```

- Try every `start` and `end`
- Don't recalculate `currentPayoff` in a loop
- 'Remember' last `currentPayoff` as `end` changes

Algorithm 2 Alternative: Convert to global Prices

```
maxSubsequenceQuad(int A[]){
  B = new array size A.length
  B[0] = A[0]
  for i=1 to B.length-1
    B[i] = B[i-1] + A[i]

  best = 0
  bestStart = -1
  bestEnd = -1
  for start=0 to A.length-1 {
    for end=start to A.length-1 {
      current = B[end] - B[start]
      if(current > best){
        best = current
        bestStart = start
        bestEnd = end
      }
    }
  }
  return best, bestStart, bestEnd
}
```

- Initially convert deltas in `A` to global prices in `B`
- First price doesn't matter as interested in changes
- Try every `start` and `end`
- Easy to calculate `currentPayoff`
- Memory overhead?

Anything Better?

- `maxSubsequenceCube()`: most straight-forward enumeration of all possible solutions
- `maxSubsequenceQuad()`: used a trick to speed up enumeration

Increasing speed now calls for some deeper insight

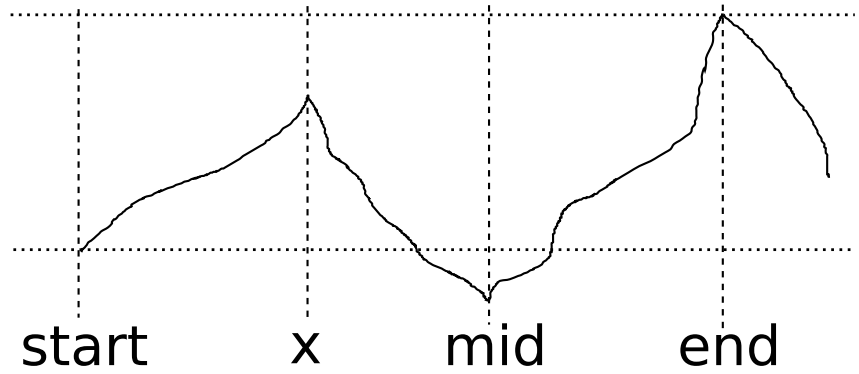
A Helpful Property

Proposition: The shortest maximum subsequence beginning at `start` and finishing at `end` contains no point `mid` between them with a lower value than `start`.

Proof by Contradiction:

- Suppose shortest max subsequence exists, looks like picture.
- `x` must be lower than `end`, o/w could form a shorter maximum subsequence `start` to `x`
- But if `mid` is lower then `start`, sequence `mid` to `end` has a larger increase than `start` to end.

Contradiction □



Consequence: If `mid` drops below `start`, reset `start` to `mid` Create a faster algorithm based on this property.

Algorithm 3: Scan

```
maxSubsequenceLinear(int A[]){
  best = 0
  current = 0
  bestStart = -1
  bestEnd = -1
  start = 0
  for end=0 to A.length-1 {
    current += A[end]
    if(current > best){
      best = current
      bestStart = start
      bestEnd = end
    }
    else if(current < 0){
      start = end+1;
      current = 0;
    }
  }
  return best,bestStart,bestEnd;
}
```

- `A[]` contains deltas
- When sum `current` falls below zero, move `start` to `end` and reset
- Single pass over entire array

Max Subsequence Algorithms Synopsis

Comparisons

- `maxSubsequenceCube()`: triply nested loops over entire array, $O(N^3)$
- `maxSubsequenceQuad()`: doubly nested loops over entire array, $O(N^2)$
- `maxSubsequenceLinear()`: single loop over entire array, $O(N)$
- N: size of the array of deltas

Intuition: for large arrays, `maxSubsequenceLinear()` will produce answers faster

Demonstration

This happens in practice, see `MaxSumTestBetter.java` for implementations with timing.

Course Synopsis

- Look at problems
- Identify solutions
- Evaluate solution for its "goodness"
  - What metrics of goodness exist for code?
  - Which metrics are most important
- Most solutions will involve an algorithm and a data structure
  - What's an algorithm?
  - What's a data structure?

Syllabus and Schedule

Both linked on Piazza, tons of info on

- Grading
- Assignment submission
- Policies (late work, etc.)
- Schedule of events

Highlights to follow...

Preconditions

This is a 3rd programming class.

- CS 211 Prereq
- Know Java
- You have easy access to a computer with java

Not sure if you're ready?

- Review first chapters of Weiss for Java refresher, should mostly be stuff you already know
- Inspect past CS 211 projects: could you solve them in given times?

https://cs.gmu.edu/~kauffman/cs211/p3.html (7 days)
https://cs.gmu.edu/~kauffman/cs211/p6.html (10-14 days)

Cheating

Don't cheat

- Easy to catch
- Pain for you
- Pain for me (makes me ornery)
- If you don't get caught, you'll still suck at programming

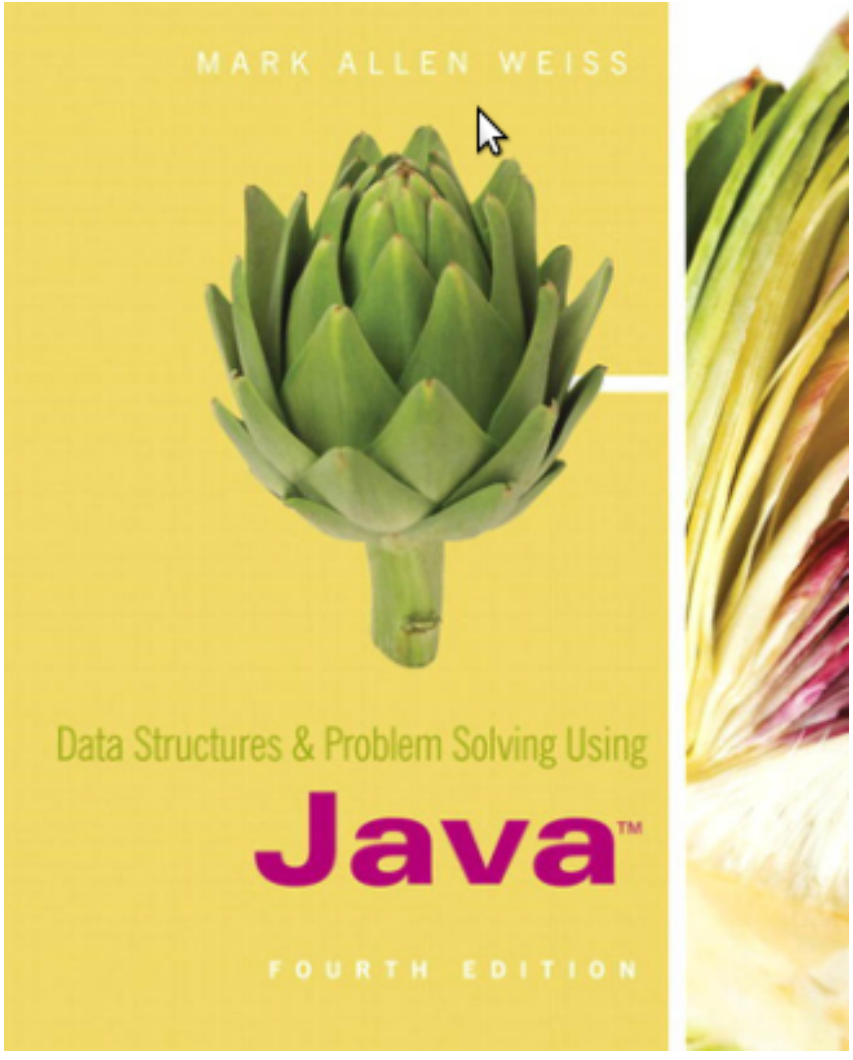
Cooperation is not automatically cheating.

- Examples discussed

Hot Seats

- Each session, first few rows are hot seats
- First come, first serve (adjust if needed)
- Don't want/need participation, sit elsewhere
- Just try: answer questions, give feedback, get cards
- Return and count cards at end of each session
- Up to 3% overall bonus
  - Luke and Leia have 20 cards, max in class, 3% bonus each
  - Han and Chewie have 10 cards, 1.5% bonus each
  - Greedo has 0 part pts, 0.0% bonus
- Scoring described in Syllabus
- Participation is only opportunity for extra credit
- May be a few other opportunities for participation

Textbook



Weiss is pretty good

- I'll assume you're reading it
- Likely want to get the text source code

We're on Piazza

Should all have received an invitation to join the Piazza class (piazza.com)

- Discussion
- Announcements
- Schedule

Blackboard only for

- Assignment submission
- Grades

95% of the time you should post, not email

Mail me for

- Personal appointments
- Unresolvable grading disputes

Your Teaching Team and Office Hours

See Piazza Staff Section

- Kauffman Plans Office Hours Tue 3-5pm (OK?)
- Remaining course staff will have office hours posted on Piazza by week's end

Name	Email	
Chris Kauffman	kauffman@cs.gmu.edu	Prof
Fardin Alam	falam5@masonlive.gmu.edu	GTA

Tools

The official java tools of the course are

- jdk 1.8, official build and run tools from Oracle
- DrJava, a simple, superior java IDE (if you're into IDEs)

Minor support given for (though not official)

- jGrasp, a decent IDE with drawing capabilities, used for some in-class examples

Special Note:

- *I probably don't know how to use IDE X and won't be learning this semester*
- *TAs may be able to help you but are not required to do so.*
- *In class I will use Emacs, command line, DrJava, JGrasp.*
- *If you have questions on those I'm happy to help.*

Special Note on DrJava

We've made some improvements at GMU

- Better test result printing
- Fixed debugger activation bug
- Unofficial, trying to get into main distrib
- Strongly encourage DrJava users to grab this version
- Download here: https://cs.gmu.edu/~kauffman/drjava/

Slides

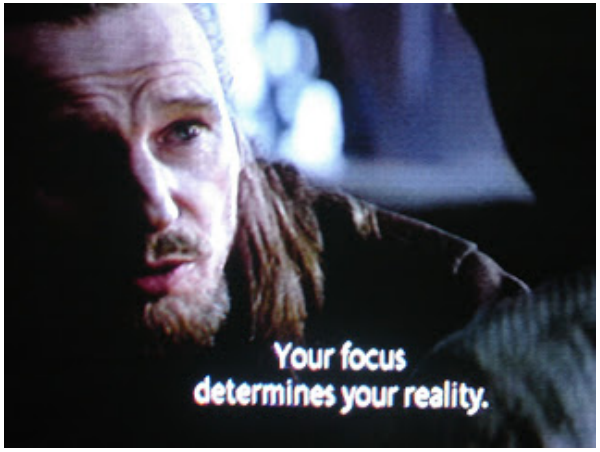
- Will try to make slides available before class
- Slides always available sometime after class
- Slides are not much good without accompanying conversation
- Code examples posted after class
- Link to slide page: Pizza/Resources

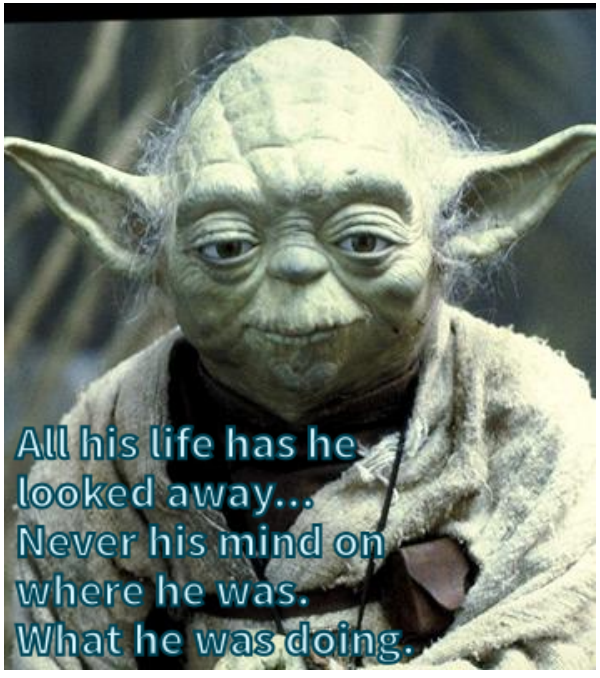
Programming Assignments

3-4 of them during the semester

- 35% of you grade
- Medium-large implementations using data structures
- Grading in three parts
  - Milestone JUnit test cases
  - Automated JUnit test cases
  - Manual GTA inspection for quality
- Submit to blackboard, 11:59 p.m. Saturdays

Focus





A Study

The students in the first experiment who were asked to multitask [during lecture] averaged 11 per cent lower on their quiz.
The students in the second experiment who were surrounded by laptops scored 17 per cent lower.
Laptop use lowers student grades, experiment shows, The Canadian Press, 8-14-2013

Effective Procrastination

- Adam Grant: Can Slowing Down Help You Be More Creative?
  - Start something early (Milestone Deadline)
  - Then take a break
  - Then finish strong (Final Deadline)
- Tim Urban: What Happens In The Brain Of An Extreme Procrastinator?

Early

Later....

Logistics

At Home

- Read Weiss Ch 1-4: Java Review
- Read Weiss Ch 5: Big-O
- Get your java environment set up

Goals Today

- More Course Mechanics
- Basic understanding of Big O and friends
- This Chapter 5 material