CSCI 136
Data Structures & Advanced Programming

Fall 2018

Instructors

Bill Lenhart & Bill Jannen

Administrative Details

- Class roster: Who's here?
  - And who's trying to get in?
- Handout: Class syllabus
- Lecture location: TPL 205
- Lab: Wed 12-2 or 2-4 (go to assigned lab!)
- Lab location: TCL 217a (Lenhart) & 216 (Jannen)
- Lab entry code: I hope you memorized it!
- Course Webpage:

  http://cs.williams.edu/~cs136/index.html

Today's Outline

- Course Preview
- Course Bureaucracy
- Java (re)fresher–Part 1

Why Take CS136?

- To learn about:
  - Data Structures
    - Effective ways to store and manipulate data
  - Advanced Programming
    - Use structures and techniques to write programs that solve interesting and important problems
  - Basics of Algorithm Analysis
    - Measuring algorithm complexity
    - Determining algorithm correctness

Squad* Goals

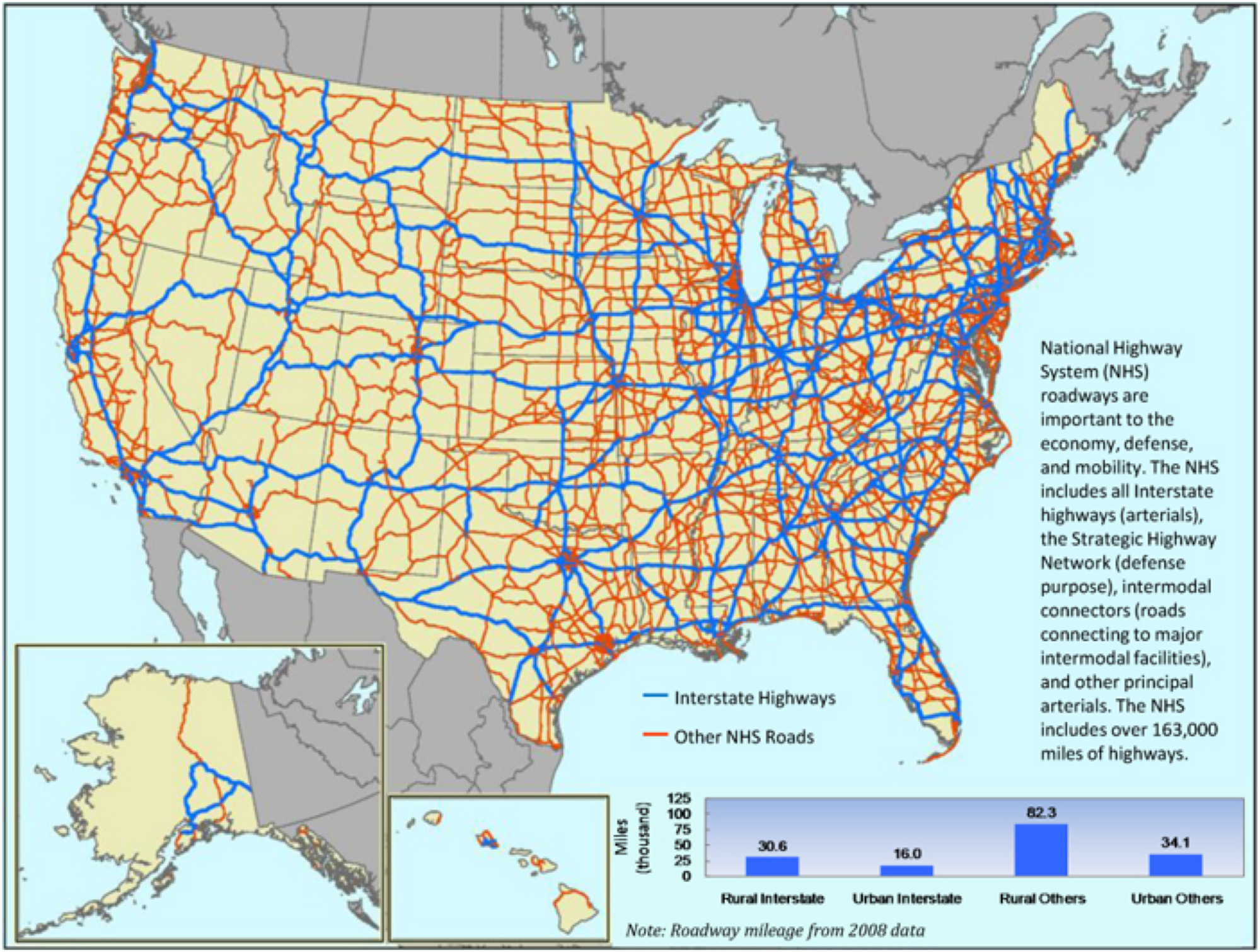
- Identify basic data structures
  - list, stack, array, tree, graph, hash table, and more
- Implement these structures in Java
- Learn how to evaluate and visualize data structures
  - Linked lists and arrays both represent lists of items
  - Different representations of data
  - Different algorithms for manipulating/accessing/storing data
- Learn how to design larger programs that are easier to modify, extend, and debug
- **Have fun!**

*Bill L has a teenage daughter....

Common Themes

1. Identify data for problem
2. Identify questions to answer about data
3. Design data structures and algorithms to answer questions *correctly* and *efficiently* (Note: not all correct solutions are efficient, and vice versa!)
4. Implement solutions that are robust, adaptable, and reusable

Example: Shortest Paths in Networks


Interstate Highways
Other NHS Roads
National Highway System (NHS) roadways are important to the economy, defense, and mobility. The NHS includes all Interstate highways (arterials), the Strategic Highway Network (defense purpose), intermodal connectors (roads connecting to major intermodal facilities), and other principal arterials. The NHS includes over 163,000 miles of highways.
Miles (thousand)
125
100
75
50
25
0
30.6
16.0
82.3
34.1
Rural Interstate
Urban Interstate
Rural Others
Urban Others
Note: Roadway mileage from 2008 data

Finding Shortest Paths

- The data: road segments
  - Road segment: Source, destination, length (weight)
- The question
  - Given source and destination, compute the shortest path from source
- The algorithm: Dijkstra's Algorithm
- The data structures (spoiler alert!)
  - Graph: holds the road network in some useful form
  - Priority Queue: holds not-yet-inspected edges
  - Also uses: Lists, arrays, stacks, ...
- A quick demo….

Course Outline

- Java review
- Basic structures
  - Lists, vectors, queues, stacks
- Advanced structures
  - Graphs, heaps, trees, dictionaries
- Foundations (throughout semester)
  - Vocabulary
  - Analysis tools
  - Recursion & Induction
  - Methodology

Syllabus Highlights

- How to contact us
  - Bill Lenhart (TPL 304)
    - Office hours: Tues & ThursM/T/Th 2:00-3:50pm; T: 9:00-10:00
    - mailto:wlenhart@williams.edu
  - Bill Jannen (TCL 306)
    - Office hours:
    - mailto:jannen@cs.williams.edu
- Textbook
  - Java Structures: Data Structures in Java for the Principled Programmer, √7 Edition (by Duane Bailey)
  - Take one: You're already paying for it!
- Weekly labs, problem sets, mid-term & final exams....

Honor Code and Ethics

- College Honor Code and Computer Ethics guidelines can be found here:
  - https://sites.williams.edu/honor-system/
  - https://oit.williams.edu/policies/ethics/
- You should also know the CS Department computer usage policy.
  - https://csci.williams.edu/the-cs-honor-code-and-computer-usage-policy/
  - If you are not familiar with these items, please review them.
- We take these things very seriously…

Your Responsibilities

- Come to lab and lecture on time
- Read assigned material before class and lab
  - Bring textbook to lab (or be prepared to use PDF)
  - Bring paper/pen(cil) to lab for brain-storming, …
- **Come to lab prepared**
  - Bring design docs for program
  - 1 Prof + 1TA == help for you: take advantage of this
- Do NOT accept (prolonged) confusion! Ask questions
- Your work should be your own. Unsure? Ask!
- Participate

Accounts and Passwords

- Mandatory: Before the first lab
  - Talk to Mary Bailey about your CS account
- Mary manages our systems. She will be available

  - Today: 9/7: 1:00 - 2:15 pm
  - Monday, 9/10: 9:30 - 11:30 am , 3:00 - 4:30 pm
  - Tuesday, 9/11: 10:30 - noon, 3:00 - 4:30 pm
  - Wednesday, 9/12: 9:30 - 11:30 am

- Her office is in the 3rd floor CS lab (TCL 312)
- Get this sorted out before lab on Wednesday!

Why Java?

- There are lots of programming languages…
  - C, Pascal, C++, Java, C#, Python
- Java was designed in 1990s to support Internet programming
- Why Java?
  - It's easier (than predecessors like C++) to write correct programs
  - Object-oriented – good for large systems
  - Good support for abstraction, extension, modularization
  - Automatically handles low-level memory management
  - Very portable

Why Not BlueJ?

- Learn to use Unix
  - Command-line tools
  - Emacs standard unix-based editor
- Emphasis will move from user interface programming to data structuring and efficient algorithm design
- Take advantage of opportunity to become Unix-savvy!

Java Review (Crash Course)

Java

- Variable types
  - Primitive: int, double, boolean, ...
  - Object (class-based): String (special), Point, Jbutton, ...
  - Arrays

Java

- Statements
  - `int x;  // declare variable x`
  - `int x = 3; // declare & initialize x`
  - `x = x + 1;`
  - `x++;`

  - `if (x > 3) { … } else { … }`

  - `while (x < 2) { … }`

  - `for (int i = 0; i < x; i++) { … }`

Java

- Comments
  - `// this is a single-line comment`
  - `/* this can span multiple lines */`

- Aside: *good* comments make code readable
  - Explain the "why" not the "what"
  - State assumptions or non-obvious logic

```
return  x+1; // returns sum of x+1
while (y < 2) /* continue as long
                 * as y is < 2
                 */
```

Primitive Types

- Provide numeric, character, and logical values
  - 11, -23, 4.21, 'c', false
- Can be associated with a name (*variable*)
- Variables *must* be declared before use

```
int age;      // A simple integer value
float speed; // A number with a 'decimal' part
char grade;  // A single character
bool loggedIn; // Either true or false
```

- Variables *can* be initialized when declared

```
int age = 21;
float speed = 47.25;
char grade = 'A';
bool loggedIn = true;
```

Array Types

- Holds a collection of values of some type
- Can be of any type

```
int[] ages;         // An array of integeras
float[] speeds;     // An array of floats
char[] grades;      // An array of characters
bool[] loggedIn;    // Either true or false
```

- Arrays can be initialized when declared

```
int[] ages = { 21, 20, 19, 19, 20 };
float[] speeds = { 47.25, 3.4, -2.13, 0.0 };
char[] grades = { 'A', 'B', 'C', 'D'  };
bool[] loggedIn = { true, true, false, true };
```

- Or just created with a standard default value

```
int[] ages = new int[15]; // array of 15 0s
```

"Everything is a class"

- Typically put the code for each class in a file with the same name as the class
  - The `Person` class' code would be in `Person.java`
- The method `'main'` is the entry point to a Java program
  - `main` has a specific method signature:

```
public static void main(String[] args)
```

- In grand CS tradition, we will write and run `Hello.java`

Simple Sample Programs

- Hello.java
  - Write a program that prints “Hello” to the terminal.
  - Now let’s run it.
- Of Note:
  - `public static void main(String[] args){...}`
  - System.out is of type PrintStream
  - javac and java commands