CSCI 136:
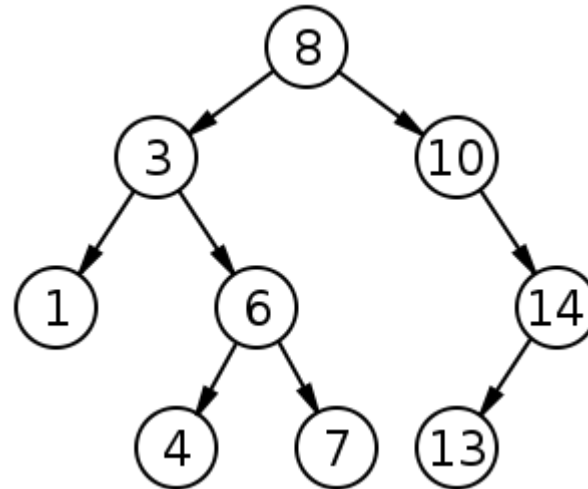# Fundamentals of Computer Science II
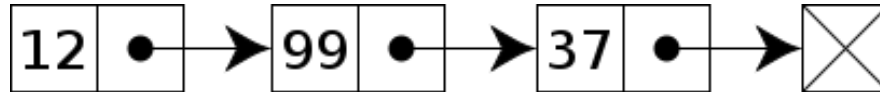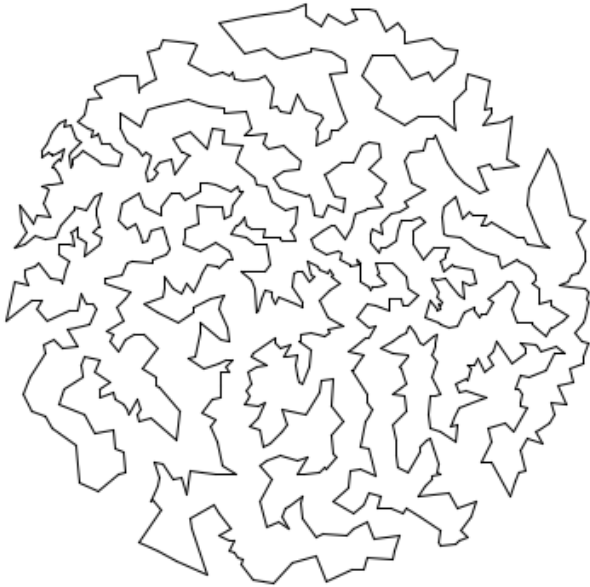
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Resources

- Textbook
  - We'll use Head First Java
  - First 4 chapters are review
    - But worth reading anyway
  - Covers more advanced topics
    - Exceptions
    - File I/O
    - Inheritance
    - Interfaces
    - Networking
    - Object serialization
    - Graphical User Interfaces
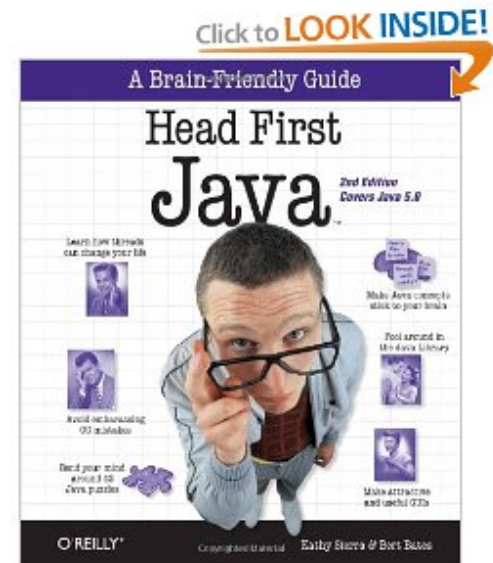
Where we've been

- ## We covered most of the Java language & various class APIs…

- primitive data types
- boolean expressions
- if-else statements
- switch-case
- for-loop
- while-loop
- do-while loop
- arrays, 1D, 2D
- static methods
- instance variables
- instance methods
- enumerations
- recursive methods

- Math
- String
- ArrayList
- Double
- Integer

Course topics

- ## 1: More on data structures

  - How we store and organize data in our programs

    > "I will, in fact, claim that the difference between a bad programmer and a good one is whether he considers his code or his data structures more important. Bad programmers worry about the code. Good programmers worry about data structures and their relationships."
    >
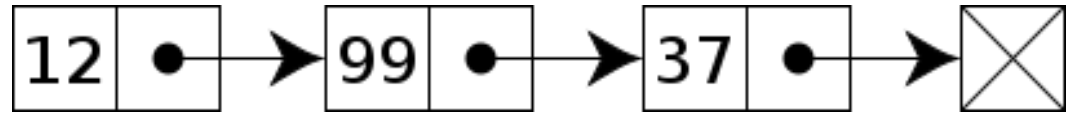   > -Linus Torvalds, creator of Linux

  - Opens up the types of programs we can build

    - Not everything works if shoved in an array!

Data structures

- Queue

- Stack

- Linked list

- Set

- Hash Table

- Tree

- Graph

```
private class Node
{
    private int num;
    private Node next;
}
```

Course topics

- 2: More on algorithms
  - Steps we take to solve a problem
  - Embodies the cleverness to solve problem correctly and efficiently
  - Smart algorithm + right data structure
    - Makes the seemingly impossible possible
    - (but still can't do everything)

Travelling salesman

- Travelling salesman problem (TSP)
  - Locations of a bunch of cities
  - Find shortest possible tour visiting each city exactly once

1000 cities   optimal tour

SW24978 - Sweden Computation Log
Instance Created: July 29, 2001
Number of Cities: 24,978
Optimal Value: 855,597
Solution Method: Concorde, CPlex 6.5 LP Solver, LKH
Solution Time: 84.8 years, Intel Xeon 2.8 GHz

http://www.tsp.gatech.edu/sweden/index.html
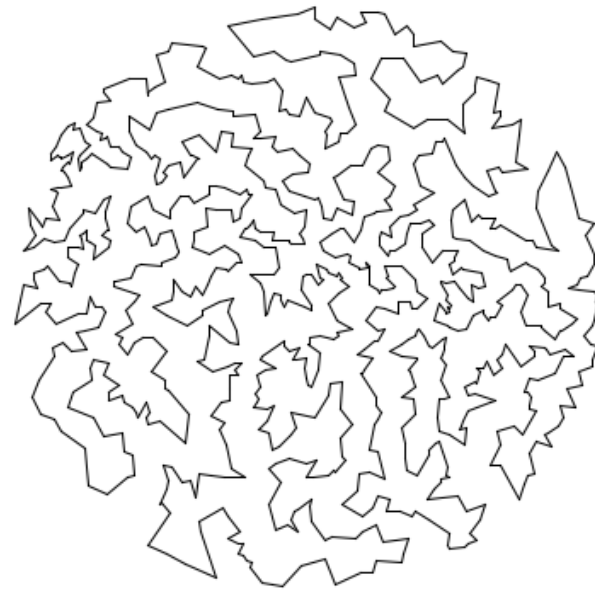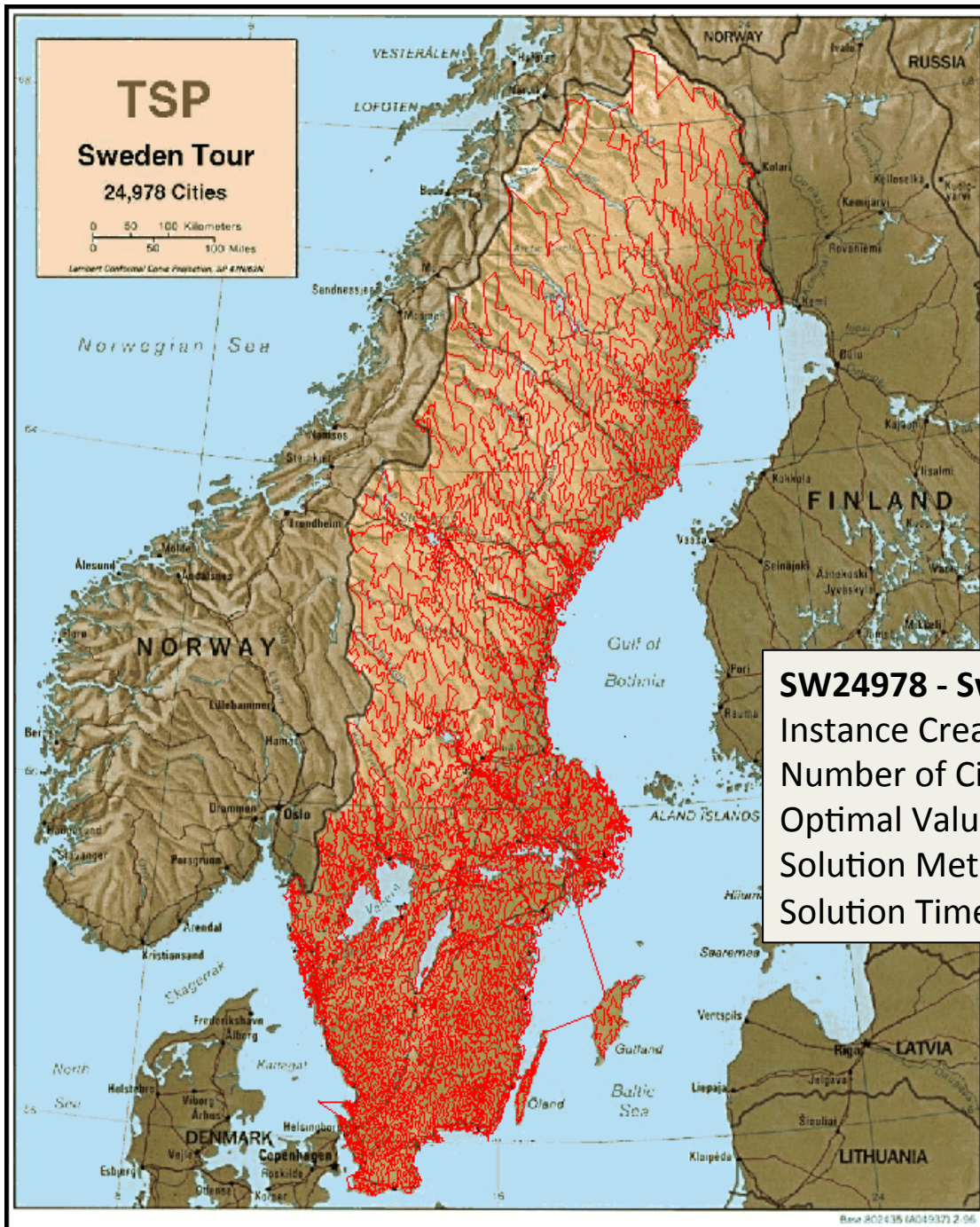
Travelling salesman

- Travelling salesman problem (TSP)
  - Finding optimal tour is easy
    - Try all possible combinations
      - Exponential in number of cities
    - This takes an enormous amount of time!
  - Can we find optimal tour faster?
    - Most people *think* the answer is no
    - No one has proved it

TSP algorithm 1

- Approximate solution
  - Data structure = linked list
    - Makes it quick to insert next city anywhere in the list
  - Algorithm = add city into list next to closest existing city
    - Heuristic, not provably optimal but usually does okay

```
536.6211   476.8667
716.6871   433.0017
505.1939   323.8175
613.9327   443.7259
694.1236   218.8665
819.1546   396.5130
...
```

File with locations of 13509 US cities.

Algorithm 1: nearest neighbor


Tour distance = 77449.98

TSP algorithm 2

- Approximate solution
  - Data structure = linked list
    - Makes it quick to insert next city anywhere in the list
  - Algorithm = add city into list wherever it causes least increase in total tour length
    - Heuristic, not provably optimal but usually does okay

```
536.6211   476.8667
716.6871   433.0017
505.1939   323.8175
613.9327   443.7259
694.1236   218.8665
819.1546   396.5130
...
```

File with locations of 13509 US cities.

Algorithm 2: smallest increase
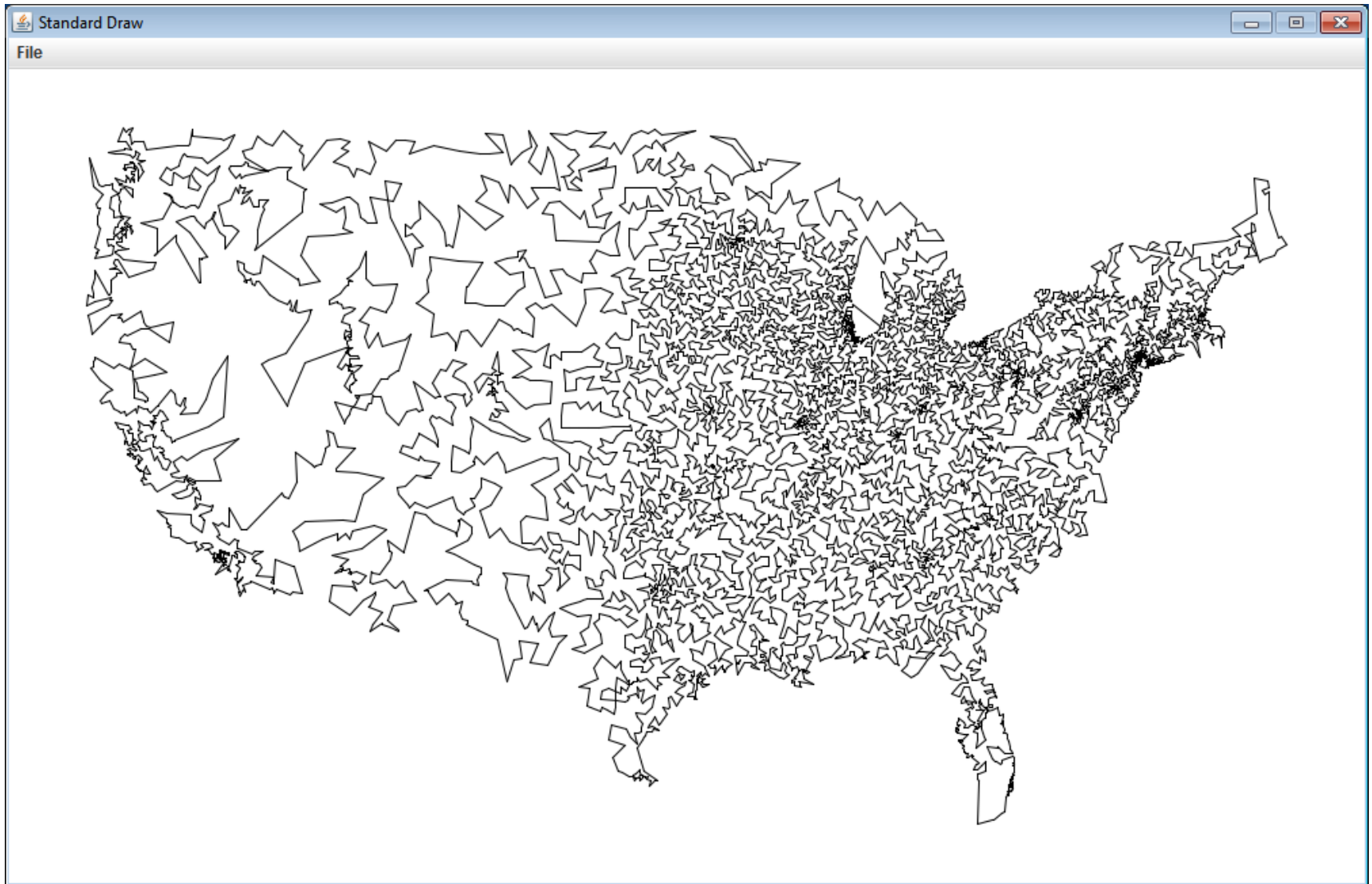
Tour distance = 45075.78

Course topics

- ## 3: More on recursion
  - Methods calling themselves
  - Often useful technique for solving a problem

Training a language model

Call me Ishmael. Some years ago- never mind how long precisely- having little or no money in my purse, and nothing particular to interest me on shore, I thought I would sail about a little and see the watery part of the world. It is a way I have of driving off the spleen and regulating the circulation. Whenever I find myself growing grim about the mouth; whenever it is a damp, drizzly November in my soul; whenever I find myself involuntarily pausing before coffin warehouses, and bringing up the rear of every funeral I meet; and

What letter comes next???

It was a_

I want to go to t_

n-gram	count
aa	4
…	
am	1695
an	10435
ao	14
…	
tg	2
th	15570
ti	4246
…	
zz	42

Need to map an n-gram String to an integer count.

data structure = binary search tree

Using the language model

- Message corrupted in transmission
  - Given language model
  - Recursive algorithm to find most likely messages

```
% java FixCorruptedNbest 5 5 "it wa~~t~~~b~~t~o~~t~m~s~
~t~~as~t~~~~ors~~~~ ti~~~." < wiki_100k.txt

Noisy   : it wa~~t~~~b~~t~o~~t~m~s~ ~t~~as~t~~~~ors~~~~ ti~~~.
Nbest 0 : it was the best of times, it was the worst of times.
Nbest 1 : it was the best of times, it was the worships title.
Nbest 2 : it was the best of times, it was the worsenic times.
Nbest 3 : it was the best of times, it was the horse of times.
Nbest 4 : it was the best of times, it was the worsenic title.
```

Course topics

- 4: Threads and concurrency
  - One program with multiple threads of execution
    - e.g. background thread to animate progress bar while main program downloads file
  - Sometimes can help simplify program
    - Spawn thread to do a job, go back to something else
  - Processors no longer getting faster
    - Instead they add more and more cores, 2, 4, 6, …
    - A multi-threaded programs may be able to use multiple cores at same time, getting job done faster

Course topics

- 5: Networking and socket communication
  - Send information between two programs
    - On the same computer
    - On computers next to each other
    - On computers on different sides of the globe
  - e.g. Building a multi-player network game

Course topics

- **6: Graphical User Interfaces (GUIs)**
  - Building interfaces with buttons, etc.
  - Dealing with events
  - Learn to do draw ourselves rather than relying on StdDraw