

## Lecture #40: Course Summary

- Autograder will start running this weekend.
- Please use bug-submit for problems with submission, your code, the skeleton, or tools like test-loc.
- **Study suggestion:** The auto-graders for the homeworks are still running. Do them for real!
- **Readers and lab assistants needed.** Consider volunteering to be a reader or lab assistant for CS 10, self-paced courses, CS 61A, or CS 61B next semester.
- **Programming Contest:** Visit my web page for information about the annual programming contest, which we hold each fall. There are large collections of programming problems you can try your hand on.

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## Course Topic Summary

- Programming language: Java
- Program Analysis
- Categories of data structure: Java library structure
- Sequences
- Trees
- Searching
- Sorting
- Pseudo-random numbers
- Threads
- Graphs
- Pragmatic implementation topics

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## Programming-Language Topics

- Object-based programming: organizing around data types
- Object-oriented programming:
  - Dynamic vs. static type
  - Inheritance
  - Idea of interface vs. implementation
- Generic programming (the `<...>` stuff).
- Memory model: containers, pointers, arrays
- Numeric types
- Java syntax and semantics
- Scope and extent
- Standard idioms, patterns:
  - Objects used as functions (e.g., Comparator)
  - Partial implementations (e.g., AbstractList)
  - Iterators
  - Views (e.g., sublists)

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## Analysis

- Asymptotic analysis
- $O(\cdot)$ ,  $\omega(\cdot)$ ,  $\Omega(\cdot)$ ,  $\Theta(\cdot)$  notations
- Worst case, average case.
- Amortized time

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## Major Categories of Data Structure

- Collection interface and its subtypes
- Map interface and its subtypes
- Generic skeleton implementations of collections, lists, maps (AbstractList, etc.)
- Complete concrete collection and map classes in Java library

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## Sequences

- Linking:
  - Single and double link manipulations
  - Sentinels
- Linking vs. arrays
- Stacks, queues, dequeues
- Circular buffering
- Trade-offs: costs of basic operations

## Trees

- Uses of trees: search, representing hierarchical structures
- Basic operations: insertion, deletion
- Tree traversals
- Representing trees
- Game trees

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## Searching

- Search trees, range searching
- Multidimensional searches: quad trees.
- Hashing
- Priority queues and heaps
- Balanced trees
  - Rebalancing by rotation (red-black trees)
  - Balance by construction (B-trees)
  - Probabilistic balance (skip lists)
  - Tries
- Search times, trade-offs

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## Sorting

- Uses of sorting
- Insertion sort
- Selection sorting
- Merge sort
- Heap sort
- Quicksort and selection
- Distribution sort
- Radix sort
- Complexity of various algorithms, when to use them?

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## Random numbers

- Possible uses
- Idea of a pseudo-random sequence
- Linear congruential and additive generators
- Changing distributions:
  - Changing the range
  - Non-uniform distributions
- Shuffling, random selection

## Threading

- Creating multiple threads of control in Java
- Need and mechanisms for mutual exclusion in Java
- Use of mailboxes for communication

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## Graph structures

- Definition
- Uses: things represented by graphs
- Graph traversal: the generic traversal template
- Depth-first traversal, breadth-first traversal
- Topological sort
- Shortest paths
- Minimal spanning trees, union-find structures
- Memory management as a graph problem.

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## Debugging

- What debuggers can do
- How to use to pin down bugs
- Details of some debugger (Eclipse, gjdb, various Windows/Sun products).
- Unit testing: what it means, how to use it.
- JUnit mechanics.

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## Version Control

- What's it for?
- Basic concepts behind our particular system:
  - Working copy vs. repository copy
  - Committing changes
  - Updating and merging changes.
  - Tagging

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