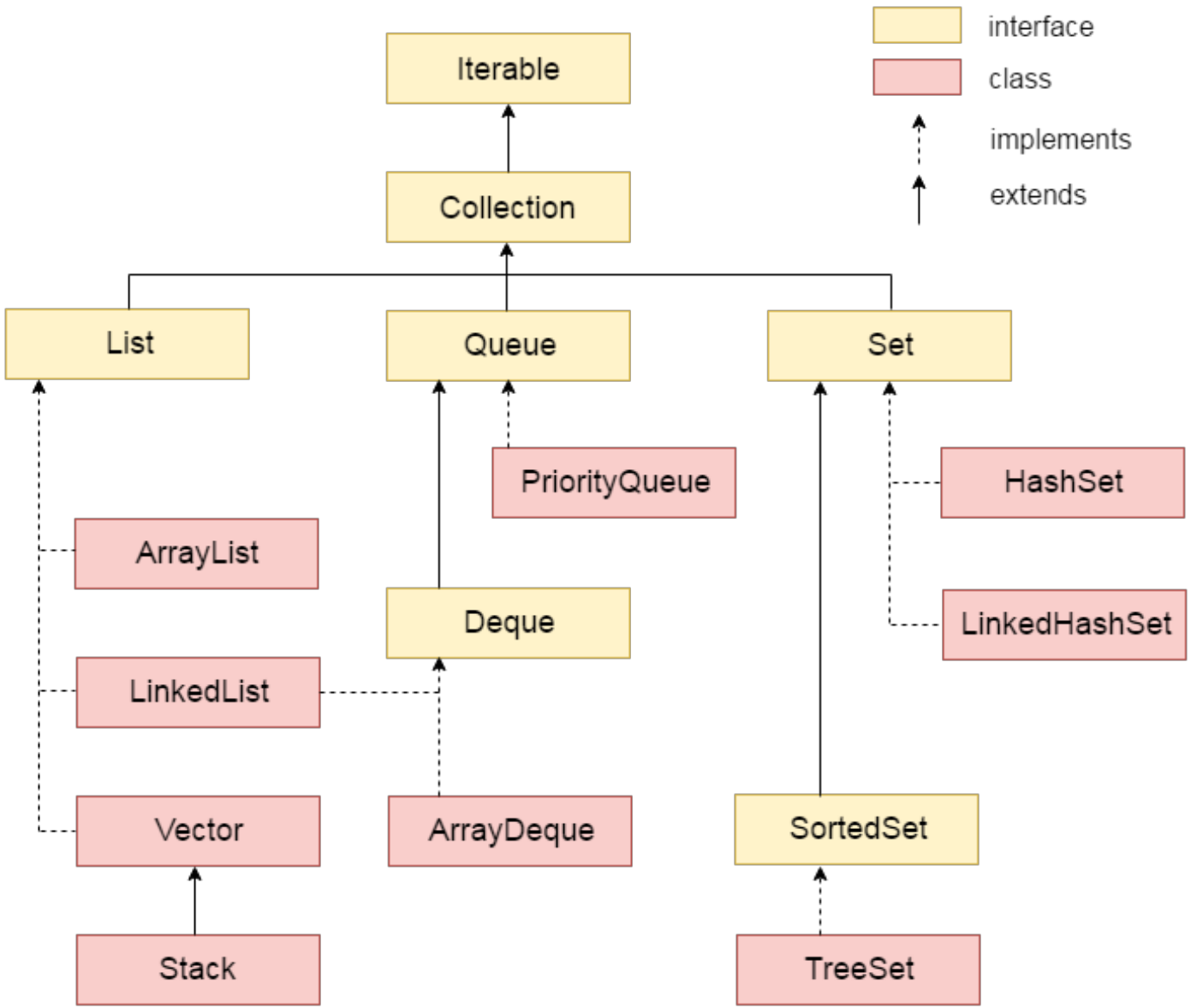
CS 310

The end

Java Collections



Interfaces and Classes

Interface	Hash Table	Resizable Array	Balanced Tree	Linked List	Hash Table + Linked List
Set	HashSet		TreeSet		LinkedHashSet
List		ArrayList		LinkedList	
Deque		ArrayDeque		LinkedList	
Map	HashMap		TreeMap		LinkedHashMap

Deque: double ended queue

Also: java.util.SortedMap, java.util.NavigableMap interfaces

Other

- Concurrent Collections
  - Interfaces:
    - BlockingQueue
    - TransferQueue
    - BlockingDeque
    - ConcurrentMap
    - ConcurrentNavigableMap
  - Classes
    - LinkedBlockingQueue
    - ArrayBlockingQueue
    - PriorityBlockingQueue
    - DelayQueue
    - ….

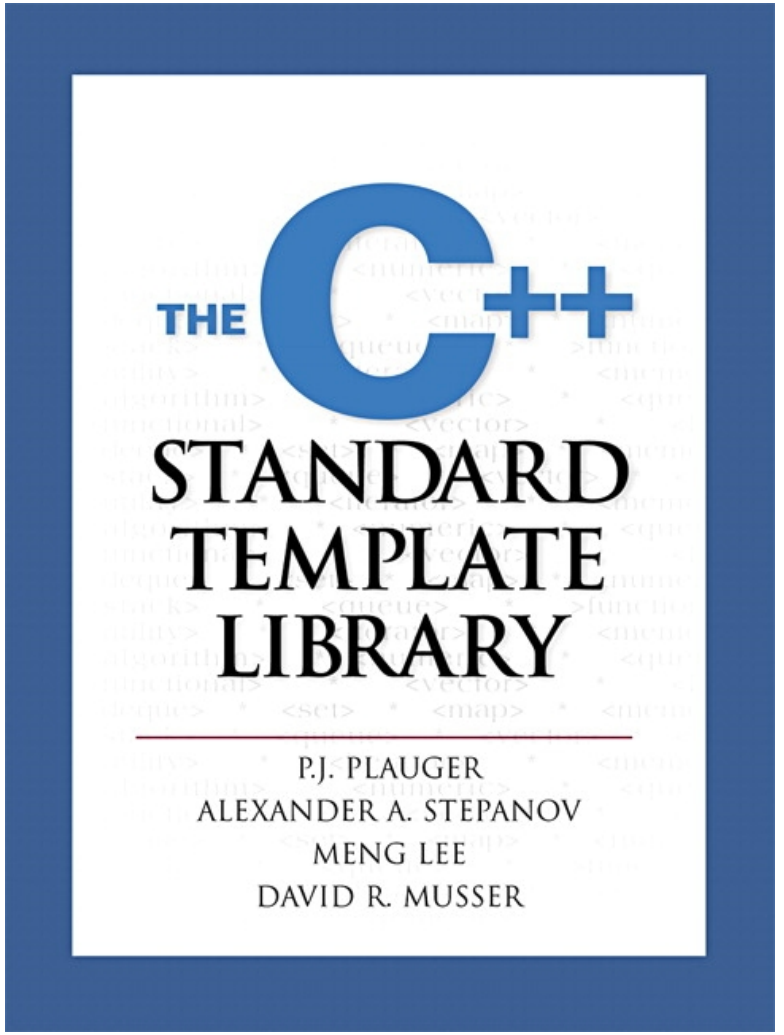
Python

- Python's built-in containers, dict, list, set, and tuple.
- Python's collections (from Lib/collections.py and Lib/_abcoll.py)
  - Deque: generalization of stacks and queues
    - list-like container with fast appends and pops on either end
  - Counter: support convenient and rapid tallies
    - dict subclass for counting hashable objects
  - OrderedDict: remember the order that items were inserted
    - dict subclass that remembers the order entries were added
  - Defaultdict (add __missing__(*key*))
    - dict subclass that calls a factory function to **supply missing values**

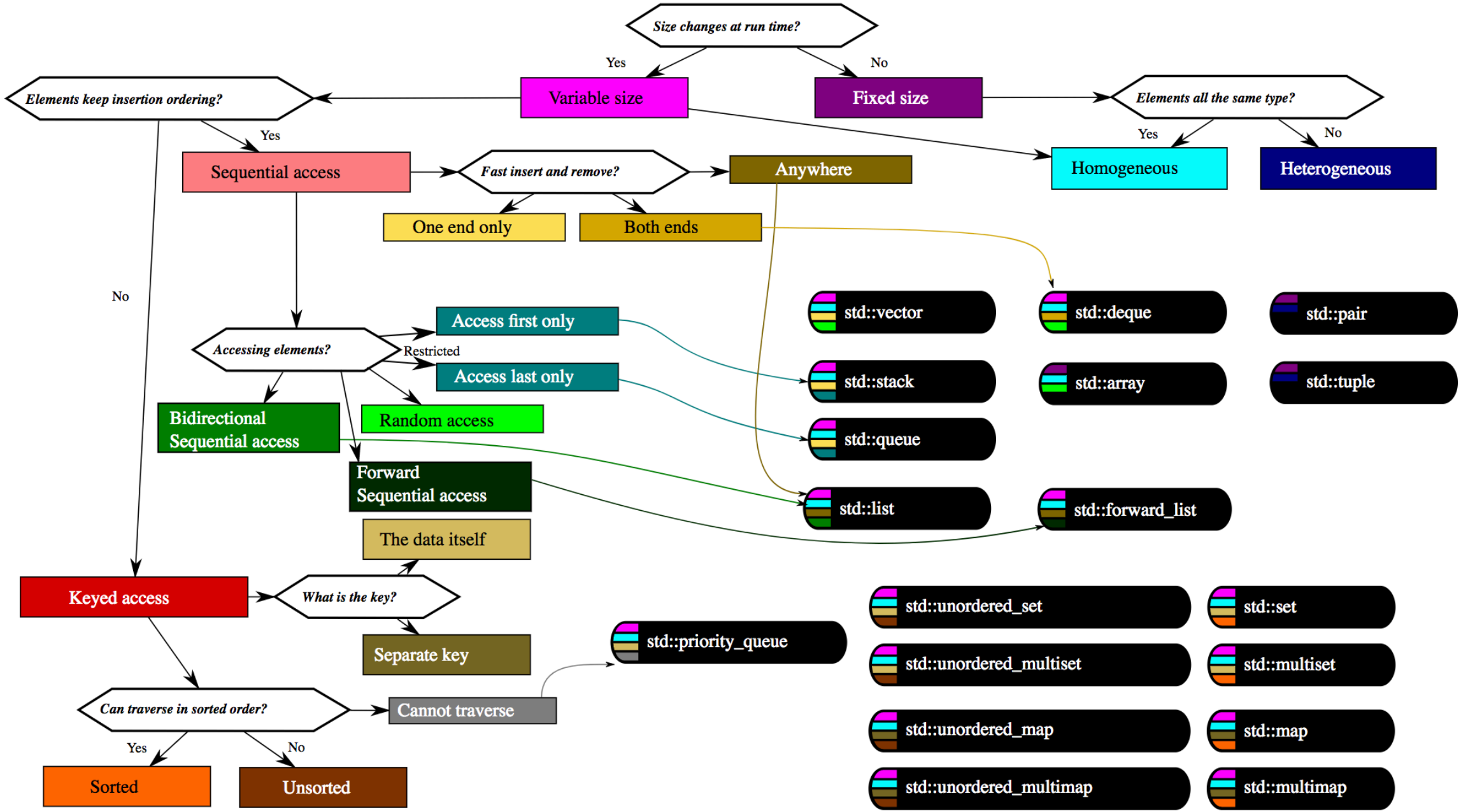
See more (e.g., ChainMap, UserList, UserDict, etc) at https://docs.python.org/3/library/collections.html

C++

- STL (Standard Template Library)
  - Algorithms (Sort, search, partition, permutation, etc)
  - Containers (Data stuctures)
  - Functions (function objects, e.g. comparator)
  - Iterators



The C++ standard library generic containers



Multi-map and Multi-set

- They are very similar to map and set but they keys do not have to be unique
  - For multi-map the key-value pair has to be unique

What are missing?

- What are not provided in Java Collections, Python, or C++ STL?

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  Google Guava (Java)
  https://github.com/google/guava

  Apache Commons Collections (Java)
  http://commons.apache.org/proper/commons-collections/

  The Boost Graph Library (C++)
  http://www.boost.org/doc/libs/1_65_1/libs/graph/doc/index.html

What are missing?

- CGAL (Computational Geometry Algorithms Library) for spatial data structures
  - Trees: binary space partitioning tree, K-D tree, Range-tree, Quad-tree, …
  - Graph: subdivisions, doubly-linked edge list, …
- Out of Core Data structures
  - B+ tree,
  - Log Structured Merge (LSM) trees
    - Multiple levels of B-tree for fast write
    - Used by Google, Apache, Yahoo!, and many modern databases
    - But much more complex than a B-Tree…

http://www.benstopford.com/2015/02/14/log-structured-merge-trees/

What are missing?

- Hashing
- Data structures for specific architectures, e.g. GPU
- Data structures related to time, temporal sequence
- Data structures for high-dimensional data (>100 dimensions)
- Data structures for parallelization and concurrent computation

What is Next?

- CS 483
  - More graphs
  - More complexity analysis
  - More problem solving techniques

- Advanced data structures
  - https://courses.csail.mit.edu/6.851/fall17/lectures/
  - http://jeffe.cs.illinois.edu/teaching/datastructures/
    - There is a “similar courses elsewhere” that would take you to more courses
  - I-O aware http://www.daimi.au.dk/~large/ioS13/
  - http://cglab.ca/~morin/teaching/5408/