PIC 10B Discussion
Week 9

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Heaps

• Largest element at the top
• Elements get smaller as you go down
• Completeness: All levels are filled except lowest level, lowest level fills from left to right
• Insertion: Insert at the bottom and swap up
• Deletion: Swap with the last element X, delete, then swap X with its largest child, if it is smaller, and repeat until heap structure restored
Demonstration: Heaps

• Using `std::vector` instead of node objects
• Indexing at 0:
  • Parent index: \((\text{index}-1)/2\), using integer division
  • Child index: \(\text{index}*2 + 1\), \(\text{index}*2 + 2\)
• Implement insert and delete:
  • Insert at end and move up
  • Swap end with deleted element, delete, and move down
• Heapsort:
  • Insert all the elements, then remove the head one by one
Final Exam Review

• Common style errors:
  • Const correctness
  • size_t for containers
  • Initializer lists
  • Proper use of public/private
  • Avoiding magic numbers/being descriptive
  • return 0; in main

• More serious common errors:
  • Not following instructions
  • Not doing the problem
Review: Pointers and References

• Pointers: memory addresses, can be changed
• References: bound to block of memory, can’t be changed
• New/delete
• Smart pointers: unique_ptr, shared_ptr, weak_ptr
• PR, X, and L-values
• Copy and move constructors
Review: Inheritance and Polymorphism

- Inheritance: child class inherits from base class
  - Virtual keyword: allows base class pointers to invoke child functions
- Polymorphism: handle multiple child types with same base class
- Destructor must be virtual
- Most derived version of object
- Casting: dynamic vs. static
  - Static: doesn’t care
  - Dynamic: enforces proper polymorphism or returns error/null pointer
- Try/catch
Review: Operator Overloading

- Overloading: function defined differently for different types
- Operators are just special functions, so they can be overloaded
- Member vs. non-member:
  - Member: implicit first argument is class object
  - Non-member: First argument must be explicit
- Friend: grant class member access to other class/function
- “this” pointer
- Lambdas
- Switch statements
Review: Recursion and Costing

• Call a function from within itself
• Sometimes, makes problems easier to think about/handle
• Should always have a definite end
• Costing: Big-O notation – how does runtime scale as input size grows?
  • Sorts: selection, bubble, merge
  • Searches: sequential, binary
• Ordering: $O(1) < O(\log n) < O(n) < O(n \log n) < O(n^2) < O(2^n)$