CSE 326
Lecture 1

Spring Quarter 1998

Course Information

- Instructor: Richard Ladner

  311 Sieg Hall

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  Office Hours: Wed - Thurs 12:30-1:30
- TAs: Jim Suruda jsuruda@cs
  Mondays 1:00 - 2:00
  Wednesdays 8:30 - 9:30
  Kevin Zatloukal kevinz@cs
  Tuesdays 2:30 - 3:30
  Thursdays 1:30 - 2:30

  Office Hours: 326 Sieg Hall at times to be announced
- Text: Data Structures and Algorithm Analysis in C++, by Mark Allen Weiss

Course Policies

- Midterm on Friday, May 1, 1998
- Final on Wednesday, June 10,1998, 2:30 am
- Written homework is due every Friday (except on the midterm day)

  Homework is due at the beginning of class and no late homework accepted.
- A number of programming projects

  - Projects turned in electronically before 11:30 pm.

  - No late projects accepted.
- Grading

  - midterm 20%
  - final 35%
  - homework 20%
  - projects 25%

Course Mechanics

- CSE 326 homepage
- CSE 326 class directory /cse/courses/cse326
- CSE 326 mailing list - subscribe using majordomo, see homepage
- Course Laboratory is 329 Sieg Hall

  - Unix workstation lab
  - C++ using the compiler g++
  - See homepage for help with unix and compiler

Goals of Course

- Improve ability to think and solve problems abstractly
  - abstraction is a powerful tool in problem solving
- Improve ability to analyze algorithms
  - proof of correctness
  - time complexity analysis
- Become facile with some of the basic data structures used in computer science and engineering
  - at the abstract data type level (ADT)
  - at the algorithm level
  - at the program design level where C++ used as a tool
- Become modestly skilled with the Unix operating system and X-windows. These will be used in future CSE courses.

Basic Terminology

- Abstract Data Type - ADT

  Mathematical description of an object and set of related operations on the object.
- Algorithm

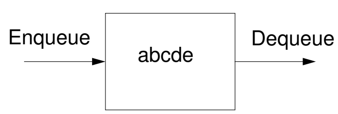
  A high level, language independent, description of a step-by-step process for solving a problem.
- Data Structure

  A family of algorithms for implementing the operations of a given abstract data type. Often, the term "data structure" refers to abstract data type that is of general use in a diversity of applications. Data structures are the infrastructure of programs, the plumbing and wiring that you don't see.
- Implementation of a data structure

  The computer code that realizes the ADT and its data structure. The code can be written in C++ or other object oriented language.

FIFO Queue ADT

- Queue operation
  - Create
  - Destroy
  - Enqueue
  - Dequeue
  - Is_Empty
  - Is_Full

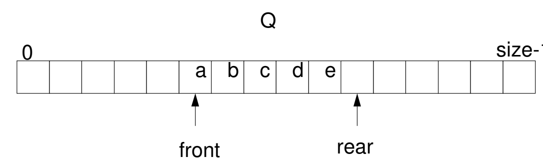


- ADT "axioms" defining the queue (example)
  - If x is Enqueued before y is Enqueued then x will be Dequeued before y will be Dequeued.

  This distinguishes the FIFO Queue ADT from the LIFO Stack ADT where, if x is Pushed before y is Pushed then y will be Popped before x will be Popped.

One Data Structure for a Queue

- The circular array.



- Enqueue(Q: queue, x: integer):

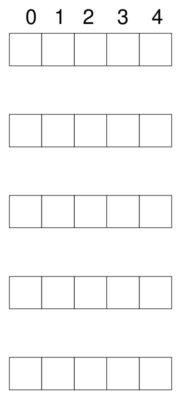
  Q[rear] := x
  rear := (rear + 1) mod size;
- Dequeue(Q: queue) : integer

  x: local integer;
  x := Q[front];
  front := (front +1) mod size;
  return(x)
- Is_Empty(Q: queue) : boolean

  return (front = rear)
- Is_Full(Q: queue) : boolean

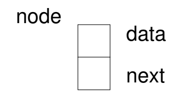
  return (front = (rear + 1) mod size)

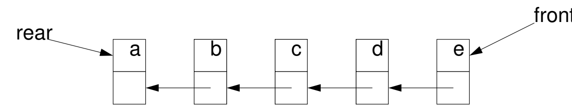
Queue Example



Another Data Structure for a Queue

- Linked list





- Enqueue(x: integer)

  p: local node pointer;

  p := new node;
  p.data := x;
  p.next:= null;
  rear.next := p;
  rear := p

- Dequeue() : integer

  x: local integer;

  x := front.data;
  front := front.next;
  return(x)

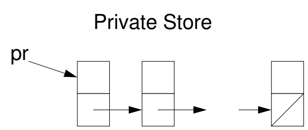
Private Store

- Private store is implement as a list pr of nodes:
  - Enqueue(x: integer)

    p: local node pointer;
    if pr = null then p := new node
    else {p := pr; pr := pr.next};
    p.data := x;
    p.next := null;
    rear.next := p;
    rear := p

  - Dequeue() : integer

    p: local node pointer; x: local integer
    p := front;
    x := front.data;
    front := front.next;
    p.next := pr;
    pr := p:
    return(x)



Memory Management

- Private store - get blocks from a private store when possible, return blocks to the private store.

  + efficiently uses blocks of a specific size

  - may use too much storage if private store grows unnecessarily large
- Global allocator's store - always get and return blocks to global allocator.

  + blocks of various sizes can be merged into larger blocks

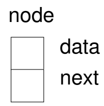
  - allocator may ineffectively handle different size blocks

  - allocator may be slow compared to a private store
- Garbage Collection - run time system recovers inaccessible blocks from time to time. Used in Smalltalk, Lisp, and Java.

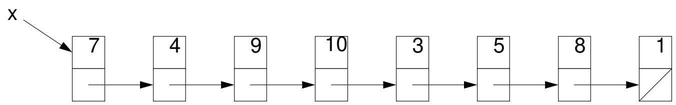
  + no need to bother with returning blocks at all, however care must be taken to make sure that unneeded blocks are inaccessible

  - when a garbage collection occurs there may be an undesirable response time

Recursion Example



- Finding the maximum in a list.



- max(x: node pointer) : integer

  m: local integer;

  if x = null then return(-infinity)
    else { m := max(x.next);
      if m > x.data then return(m)
        else return(x.data) }

Guides in Recursion

- Recursive algorithms on well designed data structures are often short, elegant, and efficient.
- In some cases recursive algorithms can be easily converted to interative algorithms improving efficiency.
- Guides:

  1. There must be some base case or cases.

  2. Progress toward the base cases must be made at each recursive call.

  3. In designing a recursive algorithm always assume that the recursive calls work.

  4. Never duplicate a recursive call on the same data. (This is different than number 2 above.)

Causes of Lack of Progress

- Inadequate basis

  bad(n: integer) integer

    if n = 0 then return(0)

      else return(bad(n/3 + 1) + n)

- Data has a cycle, so basis is never reached.