CSCI-UA 480.4: APS
Algorithmic Problem Solving

Linear Data Structures

Instructor: Joanna Klukowska

created based on materials for this class by
Bowen Yu and materials shared by the authors of
the textbook Steven and Felix Halim

Questions

- homework 1 questions ?

Basic Linear Data Structures

- list
  - array
  - linked
- stack
- queue

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Most of the linear data structures are implemented in built-in libraries.

Lists

List as a Static Array

static array = fixed size, no need to resize it

- natively supported by both C/C++ and Java
- can be declared with appropriate size up-front if the problem specifies the maximum input size (HINT: use extra buffer for safety to avoid going out of bounds)
- can be multi-dimensional: 1D, 2D, 3D, ...

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- performance of operations
  - insert/delete in the back O(1)
  - insert/delete in the front or *middle* O(N)
  - update/modify O(???)
  - find O(???)

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  - find O(N) if not sorted, O(logN) if sorted

List as a Static Array

Java 1D and 2D static array

C/C++

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List as a Linked Structure (a Linked List)

- implementation provided by buil-in classes:
  - in C++ STL
  - in Java
- rarely used due to poor performance of accessing elements
- (good exercise: implement your own in both Java and C++ to practice reference/pointer operations)
- performance of operations
  - insert/delete in the back/front O(1) (assume a doubly linked)
  - insert/delete in the *middle* O(N)
  - update/modify: O(N) (except for in the front/back)
  - find O(N)

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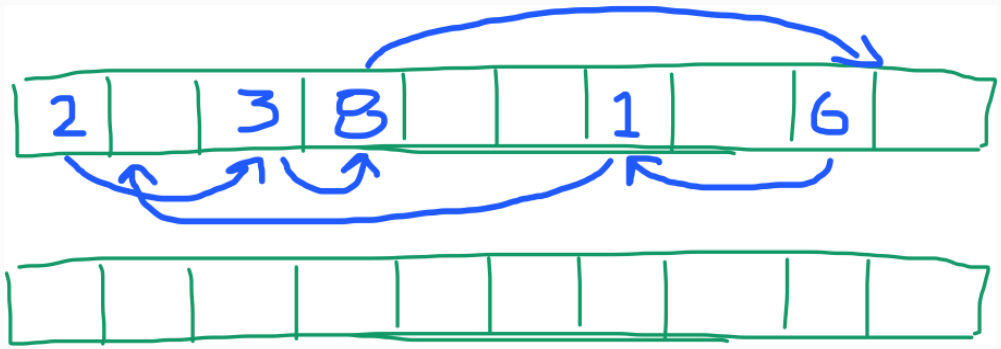
- linked list in which the "links" are provided by indexes in a separate array



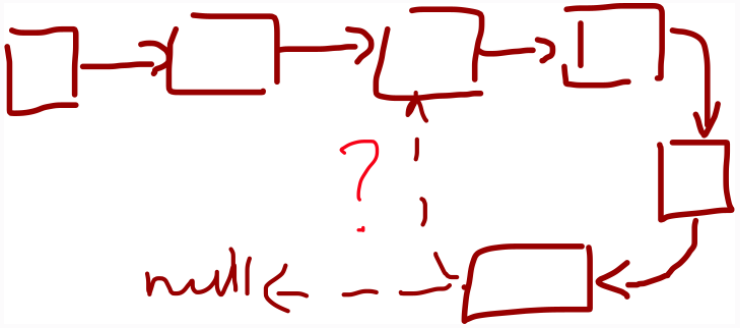
Challenge

Given a pointer/reference to a singly linked list, determine if it has a loop.

Determine the length of the loop if it exists.

Restrictions:

- Elements in the list are not unique.
- Do not use extra storage.



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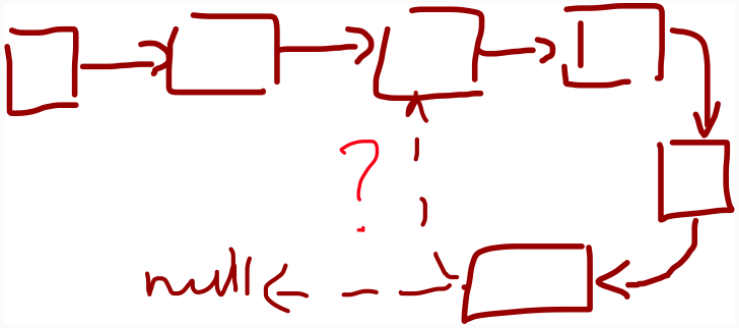

Solution Rabbit and Turtle (two pointers)

- start two pointers at head
- advance rabbit two steps per iteration
- advance turtle one step per iteration
- if they meet (i.e., rabbit does not find the end of the list) then there is a loop and a note at which they meet is somewhere on the loop
- trace through the loop with one of them to determine the number of nodes in the loop

Challenge

- Can a singly linked list be circular?
- Can a doubly linked list be circular?
- Can a doubly linked list have a loop?

Stacks

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- used in many algorithms for solving problems
  - postfix, prefix calculations and conversions
  - graph algorithms

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