CMPSC 24: Lecture 3
Pointers & Linked Lists

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Announcements

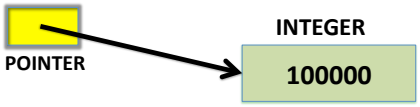
- Make sure each of you join the Google Group created for CMPSC 24 (both Lecture Sections):
  - http://groups.google.com/group/cs-24-spring-2010

Lecture outline

- Discussion of pointers
- Recursive Data Structures:
  - Linked Lists

Definitions

- An address is a location in memory:
  - All data (variables) in a program have addresses
- A pointer is a variable that stores "address" of other data/variables.

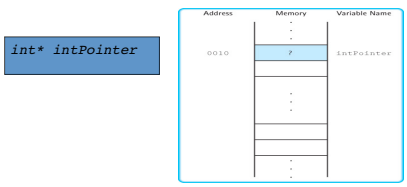


Definitions

- Dynamic Data is memory that is allocated within your program while the program is executing, i.e., at run-time:
  - Does not have name
  - Run-time system dynamically assigns an address based on the allocation
  - Access needs to managed via pointer variable that stores the address
  - The pointer has a name but the memory location it points to does not have a name
  - Program must de-allocate the data when no longer needed

Pointer Types

- **Pointer variable**
- A variable whose value is the address of a location in memory



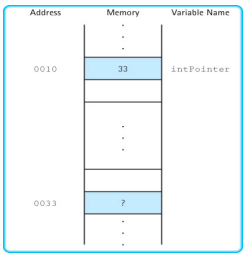
6

Pointer Types

```
int alpha;
int* intPointer;

intPointer = &alpha;
```

If alpha is at address 33, memory looks like this

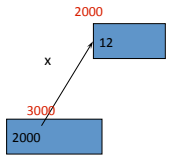


7

Pointer Types

int x;
x = 12;

int* ptr;
ptr = &x;



Because ptr holds the address of x, we say that ptr "points to" x

8

Pointer Types

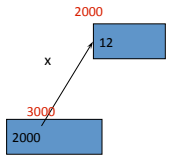
- **Dereference operator (*)**
  - An operator that, when applied to a pointer variable, denotes the variable to which the pointer points
- **Dynamic allocation (new operator)**
  - Allocation of memory space for a variable at run time (as opposed to static allocation at compile time)

9

Pointer Types

```
int  x;
x = 12;

int*  ptr;
ptr = &x;
std::cout  <<  *ptr;
```



Because ptr holds the address of x, we say that ptr "points to" x.

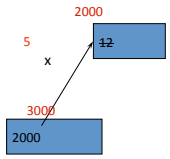
`*ptr` is the value in the place to which `ptr` points

10

Pointer Types

```
int  x;
x = 12;

int*  ptr;
ptr = &x;
*ptr = 5;
```



// changes the value of x to 5

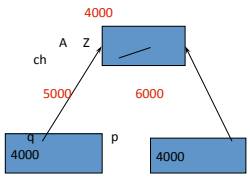
11

Pointer Types

```
char  ch;
ch =  'A';

char*  q;
q  = &ch;

*q = 'Z';
char*  p;
p = q;
```

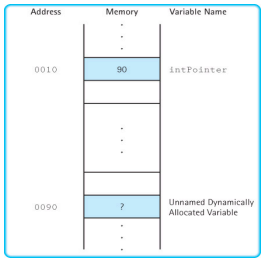


// now p and q both point to ch

12

Dynamic allocation

```
intPointer = new int;
```



13

Pointer Types

- **NULL Pointer**
  - A pointer that points to nothing
- **Memory Leak**
  - The loss of available memory space that occurs when memory is allocated dynamically but never deallocated
- **Garbage**
  - Memory locations that can no longer be accessed

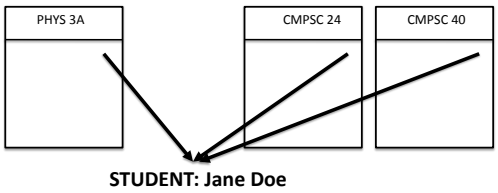
14

Why Pointers?

- Used in manipulating dynamic data structures:
  - Data-structures that grow and shrink over time
  - E.g., Arrays and Strings using pointers
  - Linked structures

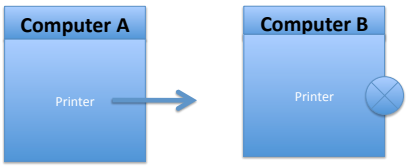
Why Pointers?

- Used to share data:
  - Two different data objects need to access the same piece of data



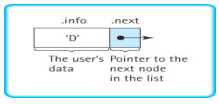
Why Pointers?

- Optional Data:

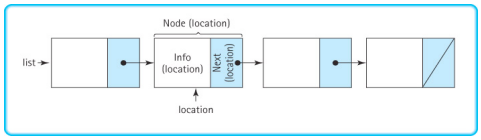


LINKED LISTS

Linked List Using Pointers

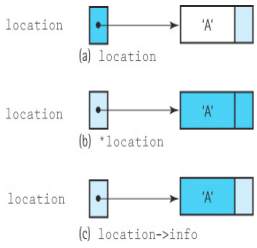



```
struct NodeType {
  int info;
  NodeType* next;
  };
NodeType* list;
NodeType* location;
```



20

Linked List



Be sure you understand the differences among `location`, `*location`, *and* `location->info`

location ->info is the same as (*location).info

21

Linked List Operations

- Set list to empty
- Add a new node to list
- Count the number of nodes in list
- Remove the last node from list

22