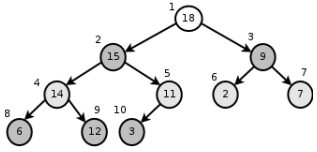
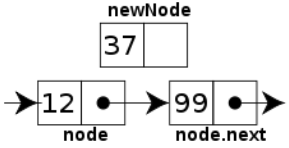
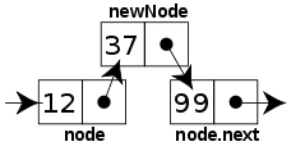


INSERTION-SORT(A)

		cost	times
1	**for** $j = 2$ **to** $A.length$	c_1	n
2	$key = A[j]$	c_2	$n-1$
3	// Insert $A[j]$ into the sorted sequence $A[1..j-1]$.	0	$n-1$
4	$i = j - 1$	c_4	$n-1$
5	**while** $i > 0$ and $A[i] > key$	c_5	$\sum_{j=2}^{n} t_j$
6	$A[i+1] = A[i]$	c_6	$\sum_{j=2}^{n} (t_j - 1)$
7	$i = i - 1$	c_7	$\sum_{j=2}^{n} (t_j - 1)$
8	$A[i+1] = key$	c_8	$n-1$

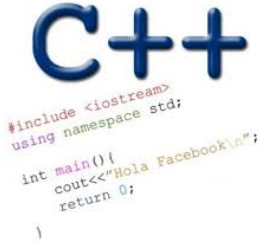




WELCOME TO CS 24!

Problem Solving with Computers-II

Instructor: Diba Mirza



Read the syllabus. Know what's required. Know how to get help.

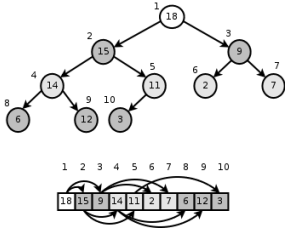
About this course

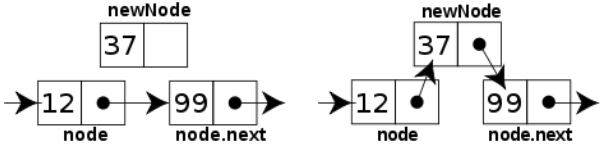
You will learn to:

- Design and implement **larger programs** that **run fast**
- Organize **data** in programs using **data structures**
- **Analyze** the **complexity** of your programs
- Understand what goes on **under the hood of programs**

use C++ libraries

implement from scratch





INSERTION-SORT(A)	*cost*	*times*
1 **for** $j = 2$ **to** $A.length$	c_1	n
2 $key = A[j]$	c_2	$n-1$
3 // Insert $A[j]$ into the sorted sequence $A[1..j-1]$.	0	$n-1$
4 $i = j-1$	c_4	$n-1$
5 **while** $i > 0$ and $A[i] > key$	c_5	$\sum_{j=2}^{n} t_j$
6 $A[i+1] = A[i]$	c_6	$\sum_{j=2}^{n}(t_j-1)$
7 $i = i-1$	c_7	$\sum_{j=2}^{n}(t_j-1)$
8 $A[i+1] = key$	c_8	$n-1$

Data Structures and C++

Complexity Analysis

About the team

Instructor: Diba Mirza

- **TAs:** Lucas, Ganesh, Roman
- **ULAs:** Tina and Zack

- Communication with staff via **Piazza**
- Include [CS24] in the subject line of any email communication with me
- Sections start this week, office hours start next week

** Ask questions about class examples, assignment questions, or other CS topics. **

Course Logistics

- Coure website: https://ucsb-cs24.github.io/s22
- If you have a section conflict, you may informally switch your section time. Post to the “section swap” thread on Piazza to announce the switch.
- NO MAKEUPS ON EXAMS!
- Start assignments early and get a “timeliness” bonus!
- To complete the labs you need a college of engineering account. If you don’t have one yet, send an email to help@engineering.ucsb.edu

iClicker Cloud

- Instructions to register for iclicker cloud for free are on Gauchospace
- Download the iclicker REEF app to participate in class
  1. Login: https://app.reef-education.com/#/login
  2. Join the class: CMPSC24: Problem Solving with Computers-2

Required textbook

Zybook: CMPSC 24: Problem Solving with Computers II

Recommended textbook

- Problem Solving with C++, Walter Savitch, Edition 9

You must attend class and lab sections
You must prepare for class
You must participate in class

About you…

What is your familiarity/confidence with C++ memory-management (stack vs heap)?

A. Know nothing or almost nothing about it.
B. Used it a little, beginner level.
C. Some expertise, lots of gaps though.
D. Lots of expertise, a few gaps.
E. Know too much; I have no life.

About you…

What is your familiarity/confidence with using git version control ?

A. Know nothing or almost nothing about it.
B. Used it a little, beginner level.
C. Some expertise, lots of gaps though.
D. Lots of expertise, a few gaps.
E. Know too much; I have no life.

About you…

Have you implemented a linked list before in any programming language?

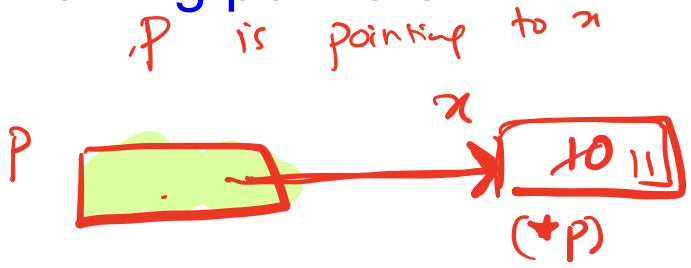
A. Yes
B. No

About lectures

- I will not be a talking textbook
- I love interaction: Ask questions anytime!
- I'll ask you questions too! Be ready to discuss with the people near you and respond to multiple choice questions (using the clickers).
- Take a moment to introduce yourself to the people sitting near you.
  - Talk about your background and what you hope to get out of this class!

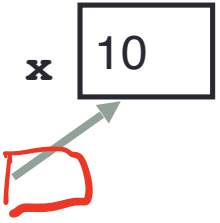
Review: Tracing code involving pointers

```
int* p;
int x = 10;
p = &x;
*p = *p + 1;
```

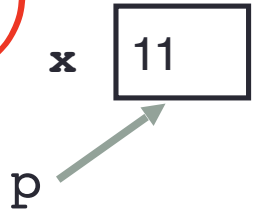


Q: Which of the following pointer diagrams best represents the outcome of the above code?

A.



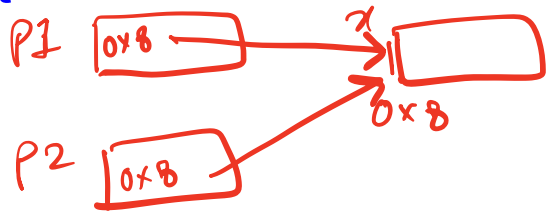
B.



C. Neither, the code is incorrect

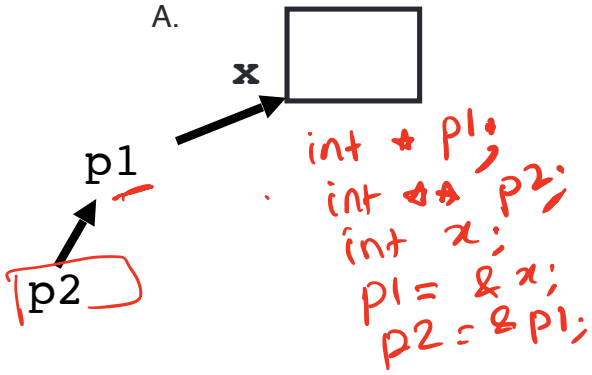
Review: Pointer assignment

```
int* p1, *p2, x;
p1 = &x;
p2 = p1;
```

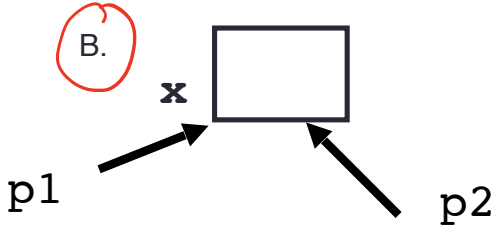


Q: Which of the following pointer diagrams best represents the outcome of the above code?

A.



B.



C. Neither, the code is incorrect

Two important facts about Pointers

1) A pointer can only point to one type –(basic or derived) such as `int`, `char`, a `struct`, a class another pointer, etc

int * * p;
String * p;

2) After declaring a pointer: `int *ptr;`

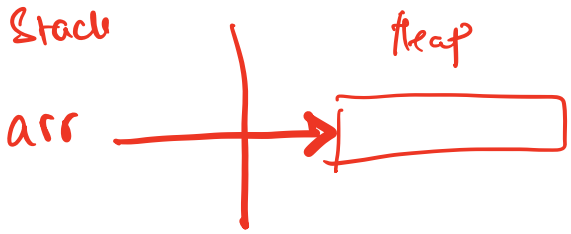
int * ptr = nullptr;

`ptr` doesn't actually point to anything yet.

We can either:

- make it point to something that already exists, OR
- allocate room in memory for something new that it will point to

Review: Heap vs. stack




```
1 #include <iostream>
2 using namespace std;
3
4 int* createAnIntArray(int len){
5
6     int arr[len];
7     return arr;
8
9 }
```

int * arr = new int [len]
return arr;

Where does the above function create the array of integers?

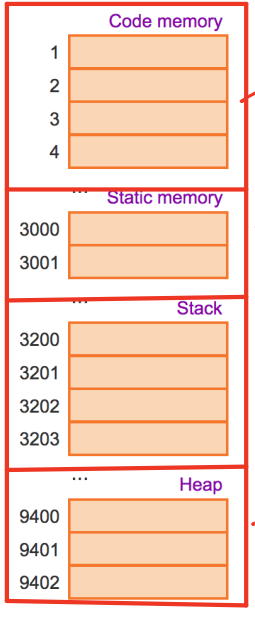
A. Stack

B. Heap

C. Don't know, what do you mean by stack and heap?

Review: C++ Program's Memory Regions

```
#include <iostream>
using namespace std;

// Program is stored in code memory

int myGlobal = 33;     // In static memory

void MyFct() {
   int myLocal;        // On stack
   myLocal = 999;
   cout << " " << myLocal;
}

int main() {
   int myInt;             // On stack
   int* myPtr = nullptr; // On stack
   myInt = 555;

   myPtr = new int;       // In heap
   *myPtr = 222;
   cout << *myPtr << " " << myInt;
   delete myPtr; // Deallocated from heap

   MyFct(); // Stack grows, then shrinks

   return 0;
}
```



instructions (machine code)

global & static

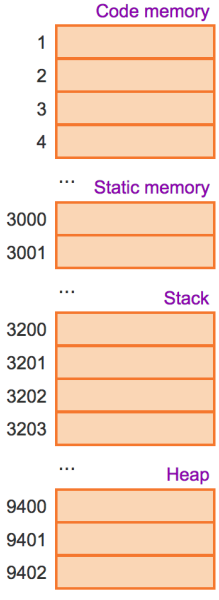
local variables [Managed automatically]

Managed by the programmer
Programmer explicitly creates and deletes heap data.

The code regions store program instructions. myGlobal is a global variable and is stored in the static memory region. Code and static regions last for the entire program execution.

Review: C++ Program's Memory Regions

```
#include <iostream>
using namespace std;

// Program is stored in code memory

int myGlobal = 33;     // In static memory

void MyFct() {
   int myLocal;        // On stack
   myLocal = 999;
   cout << " " << myLocal;
}

int main() {
   int myInt;             // On stack
   int* myPtr = nullptr; // On stack
   myInt = 555;

   myPtr = new int;       // In heap
   *myPtr = 222;
   cout << *myPtr << " " << myInt;
   delete myPtr; // Deallocated from heap

   MyFct(); // Stack grows, then shrinks

   return 0;
}
```



- Stack: Segment of memory managed automatically using a Last in First Out (LIFO) principle.
- Heap: Segment of memory managed by the programmer
  - Data created on the heap stays there
  - FOREVER or
  - until the programmer explicitly deletes it

The code regions store program instructions. myGlobal is a global variable and is stored in the static memory region. Code and static regions last for the entire program execution.

Next time

- Linked lists.