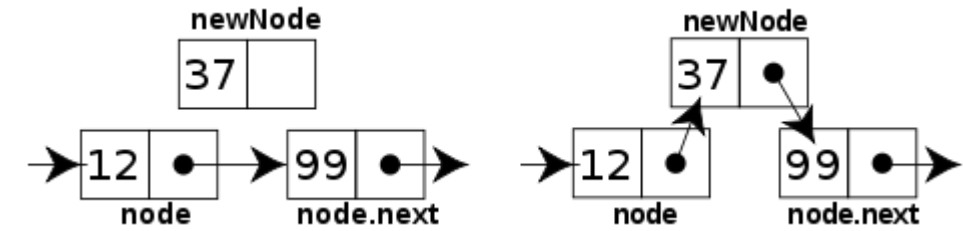


```

INSERTION-SORT(A)
1  for j = 2 to A.length
2    key = A[j]
3    // Insert A[j] into the sorted
      sequence A[1 .. j - 1].
4    i = j - 1
5    while i > 0 and A[i] > key
6      A[i + 1] = A[i]
7      i = i - 1
8    A[i + 1] = key

```

cost	times
c_1	n
c_2	$n - 1$
c_3	$n - 1$
c_4	$n - 1$
c_5	$\sum_{j=2}^n t_j$
c_6	$\sum_{j=2}^n (t_j - 1)$
c_7	$\sum_{j=2}^n (t_j - 1)$
c_8	$n - 1$



WELCOME TO CS 24!

Problem Solving with Computers-II

Instructor: Diba Mirza

C++

```

#include <iostream>
using namespace std;

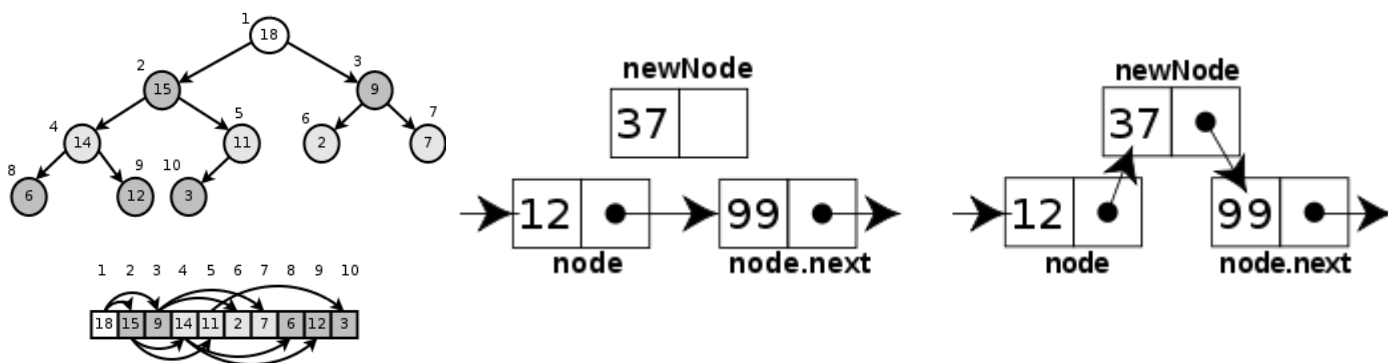
int main() {
    cout << "Hola Facebook!\n";
    return 0;
}

```

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

About this course

- 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**



```

INSERTION-SORT(A)
1  for j = 2 to A.length
2    key = A[j]
3    // Insert A[j] into the sorted
    sequence A[1 .. j - 1].
4    i = j - 1
5    while i > 0 and A[i] > key
6      A[i + 1] = A[i]
7      i = i - 1
8    A[i + 1] = key
  
```

<i>cost</i>	<i>times</i>
c_1	n
c_2	$n - 1$
0	$n - 1$
c_4	$n - 1$
c_5	$\sum_{j=2}^n t_j$
c_6	$\sum_{j=2}^n (t_j - 1)$
c_7	$\sum_{j=2}^n (t_j - 1)$
c_8	$n - 1$

Data Structures and C++

Complexity Analysis

About the team



Diba Mirza

- Prof. Mirza's Office hours: M 2:00 - 3:30p, HFH 1155, or by appointment
- Communication with staff via **Piazza**
- Include [CS24] in the subject line of any email communication with me
- Sections start this week on Thursday
- Office hours start next week

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

TA Nawal TA Joseph TA Shinda



LA Zack

LA Ally

LA Sanjana

TA Xinli TA Yaoyi

Course Logistics

- Course website: <https://ucsb-cs24.github.io/w24>
- Read the syllabus
- If you have a section conflict, you may informally switch your section time.
- No makeup on exams unless its a real emergency!

iClicker Cloud

- Join the class CMPSC24: Problem Solving with Computers-2:
<https://join.iclicker.com/GLRN> or use the QR code

Recommended textbook

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



About lectures

- I will not be a talking textbook
- 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,
 - experience in CS so far, and
 - what you hope to get out of this class!

About you: When did you take CS16 or an equivalent course?

- A. Fall 2023
- B. Summer 2023
- C. Spring 2023
- D. Winter 2023 or earlier

About you...

What is your familiarity/confidence in C++?

- 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...

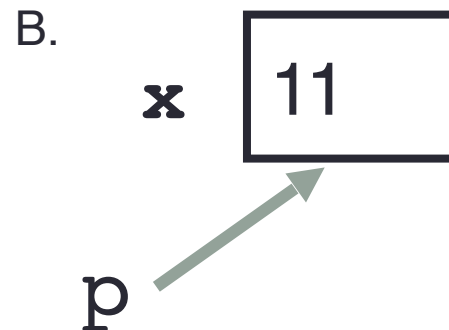
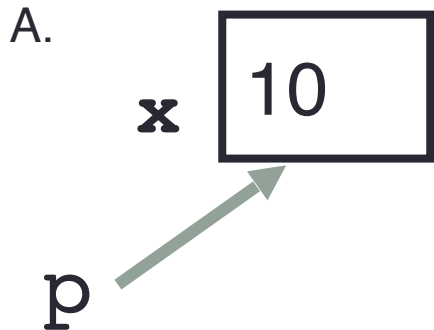
What is your familiarity/confidence with using git or any version control system?

- 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.

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?



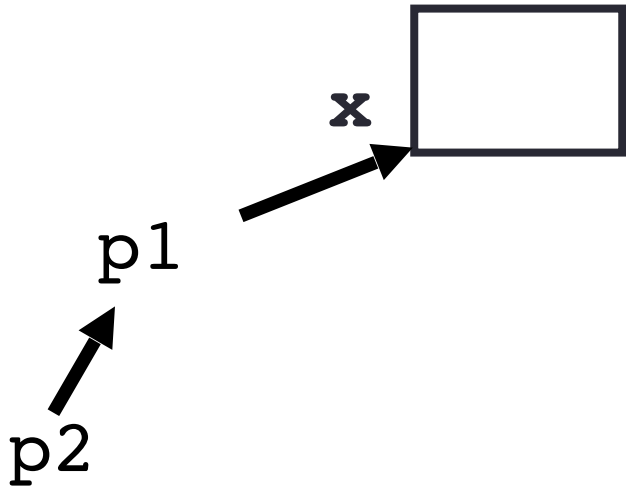
C. Neither, the code is incorrect

Review: Pointer assignment

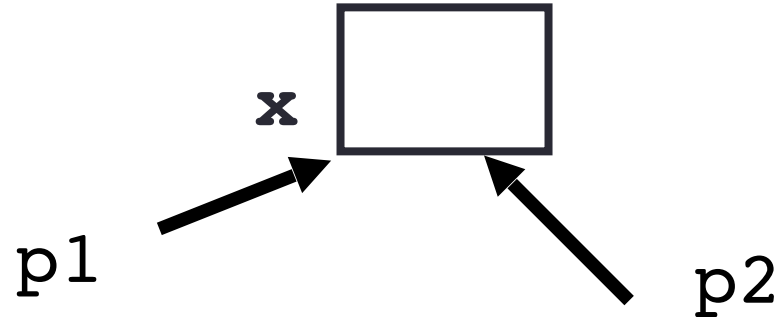
```
int* p1, *p2, x;  
p1 = &x;  
p2 = p1;
```

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

A.



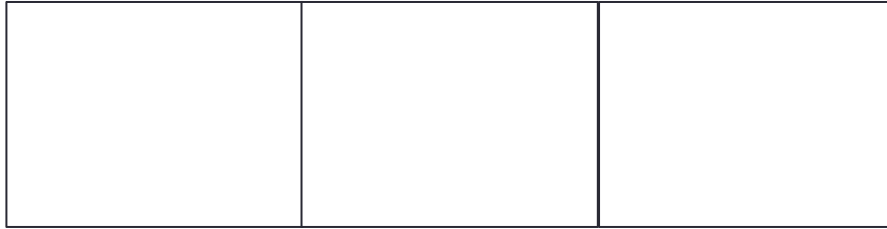
B.



C. Neither, the code is incorrect

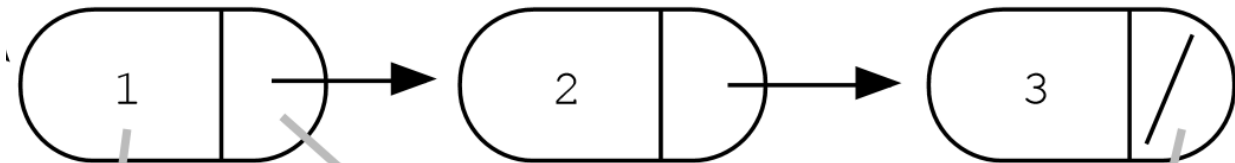
Linked list vs Array

Array



Defining the type Node

The overall list is built by connecting the nodes together by their next pointers. The nodes are all allocated in the heap.



Each node stores one data element (int in this example).

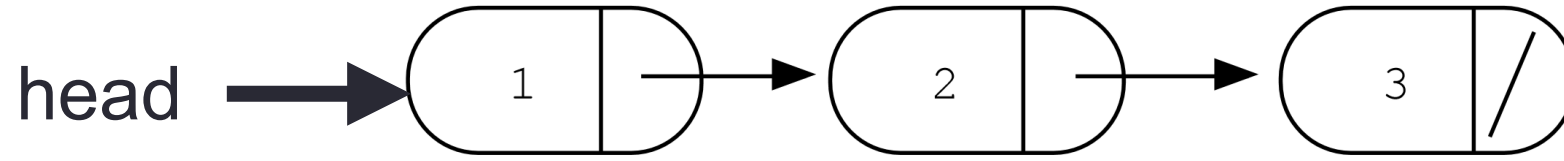
Each node stores one next pointer.

The next field of the last node is NULL.

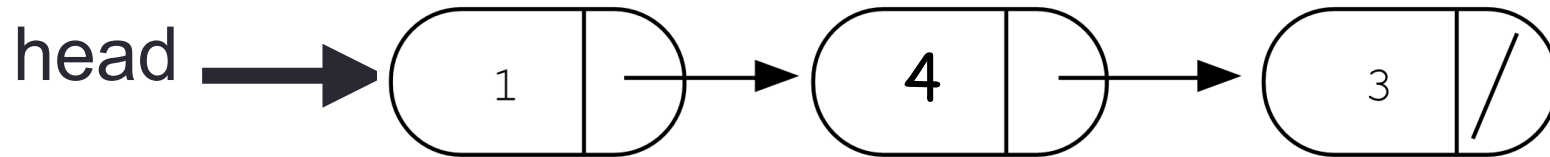
How does the given code modify the provided linked list?

```
Node* p = head;  
p = p->next;  
p->data = 4;
```

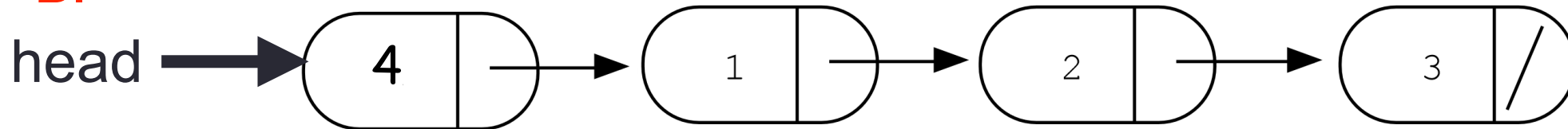
```
struct Node {  
    int data;  
    Node* next;  
};
```



A.



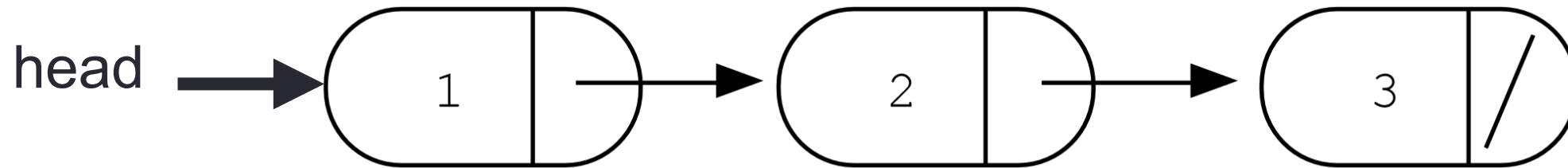
B.



C. Something else

Assume the following linked list exists

```
struct Node {  
    int data;  
    Node *next;  
};
```



Evaluate each of the following expressions?

1. head->data
2. head->next->data
3. head->next->next->data
4. head->next->next->next->data

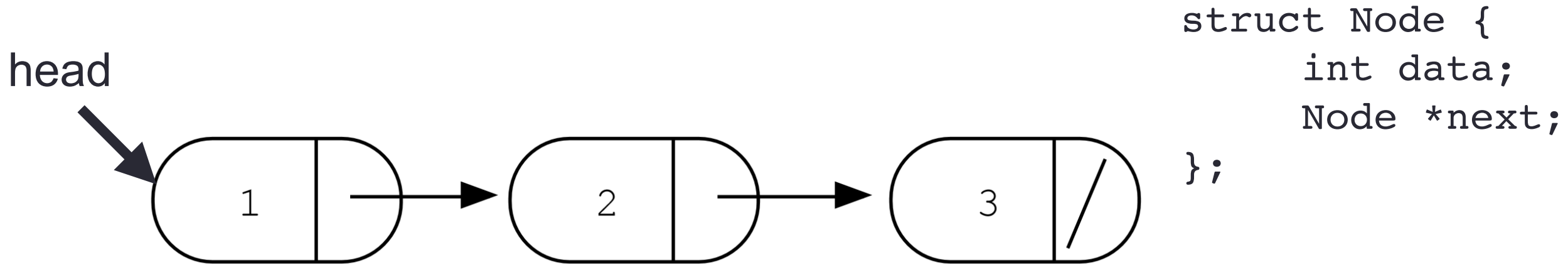
- A. 1
- B. 2
- C. 3
- D. nullptr
- E. Run time error

Simplest Linked List (just a head pointer)

- Create an empty list

```
struct Node {  
    int data;  
    Node* next;  
};
```


Write a C++ function to add a node to the head of the list



Review: C++ Program's Memory Regions

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

// Program is stored in code memory

int myGlobal = 33;    // In static memory

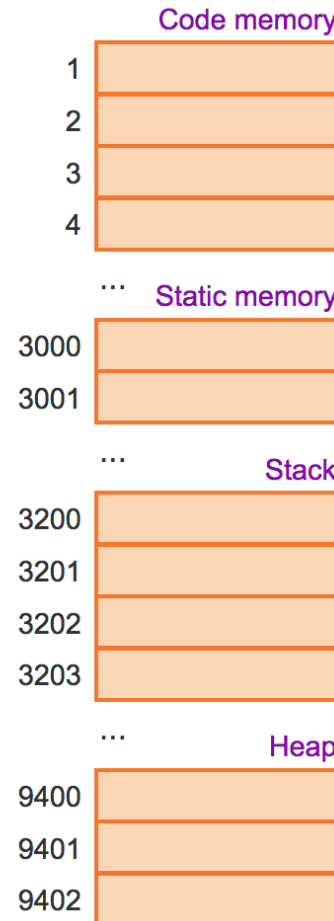
void MyFct() {
    int myLocal;      // On stack
    myLocal = 999;
    cout << " " << myLocal;
}

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;
}
```



- Which of the following is true about data created on the **heap** region of memory?
 - A. Stores the local variables of a function
 - B. Stores global variables
 - C. Any 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.

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

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

Next time

- Abstract Data Types