Common Misunderstandings from Exam 1 Material

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Stack and Heap Allocation with Pointers

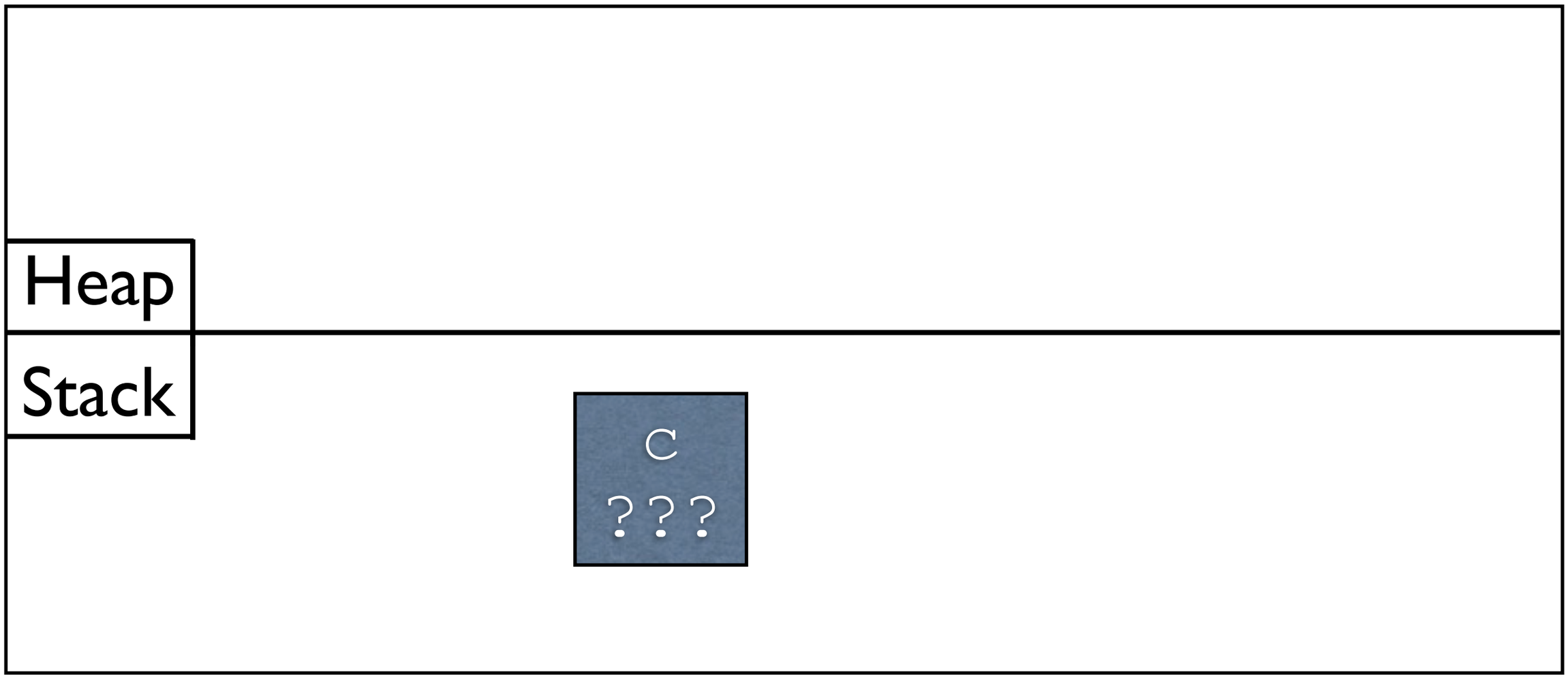
```
char c = 'c';
char* p1 = malloc(sizeof(char));
char** p2 = &p1;
```

- Where is `c` allocated?
- Where is `p1` itself allocated?
- Where is what `p1` points to allocated?
- Where is `p2` itself allocated?
- Where is what `p2` points to allocated?
  - Nearly everyone got this one wrong

Key to Solving

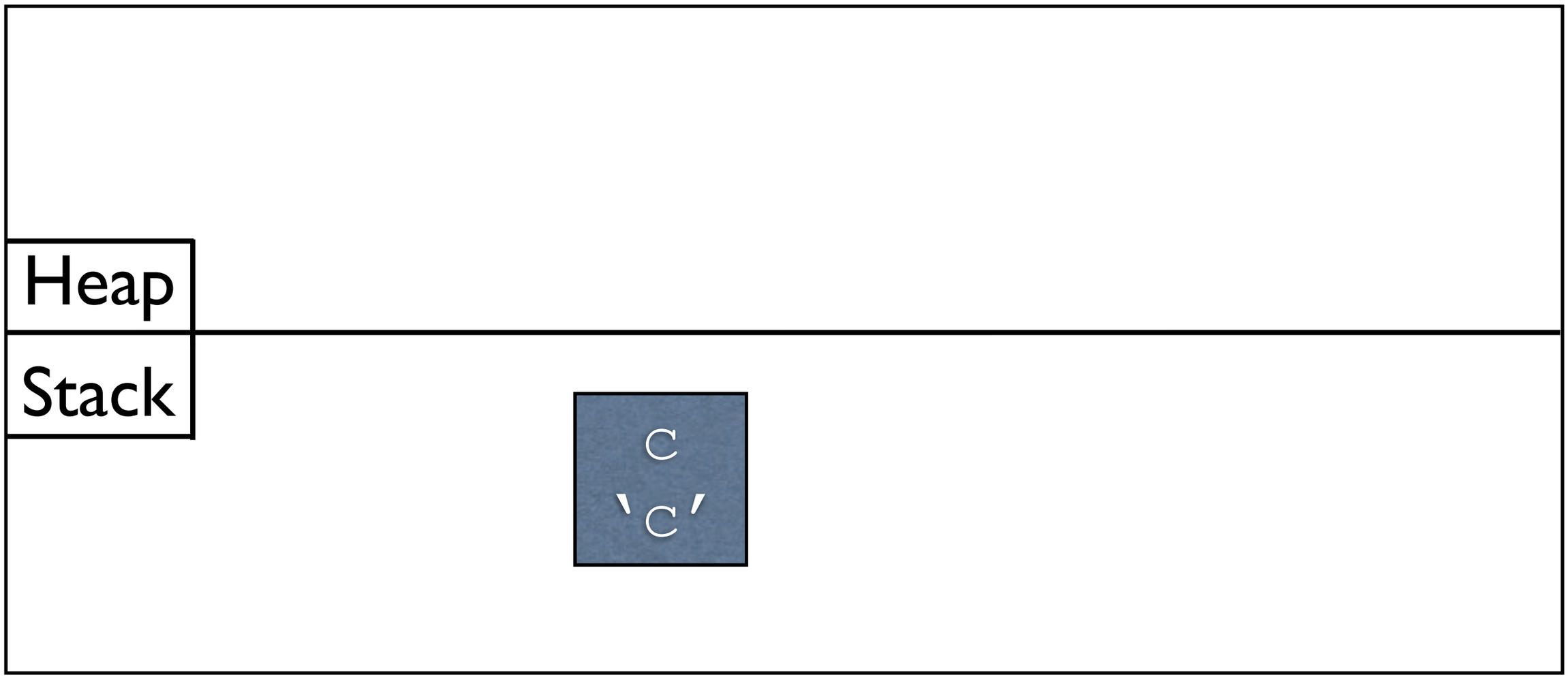
- Draw out a memory diagram
- The following slides go through this process

```
char c = ...;
```



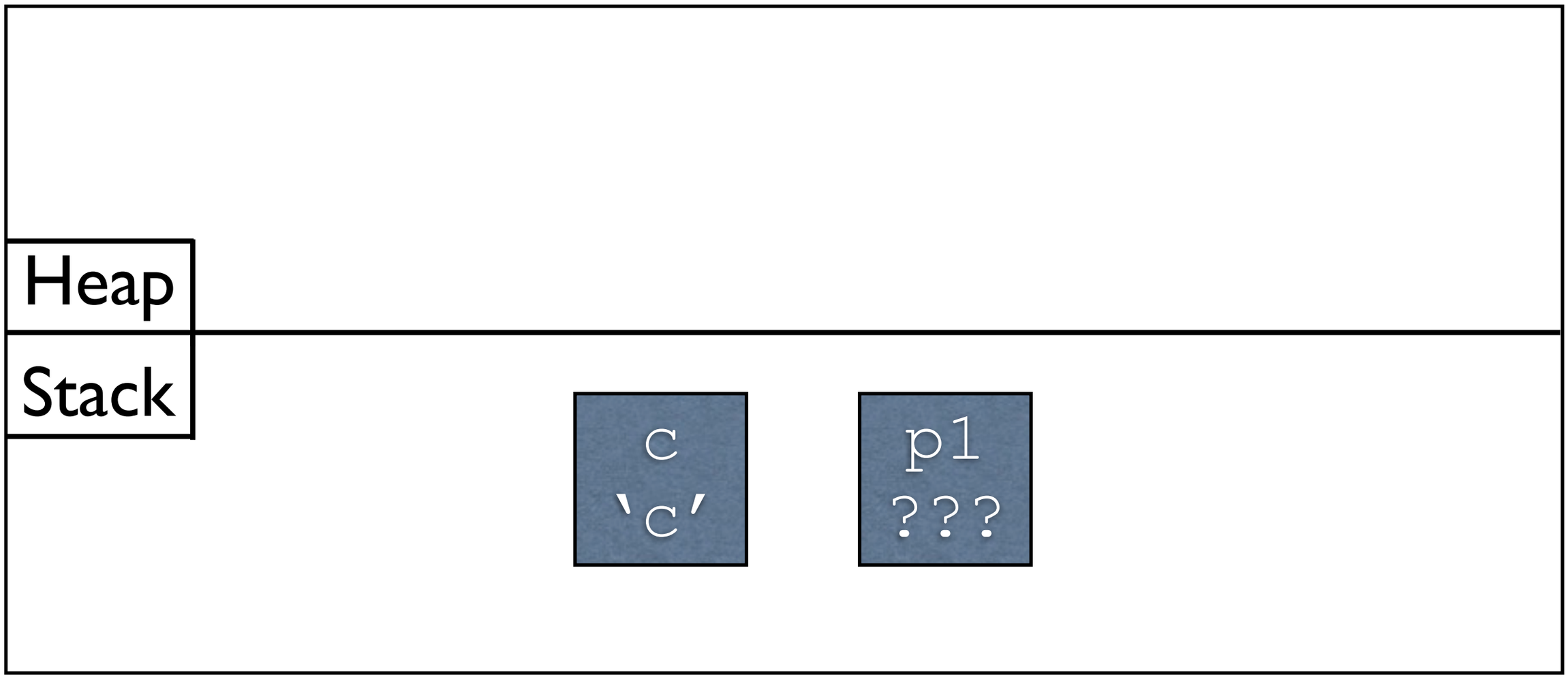
- `c` is a local variable, and local variables are allocated on the stack
- The value is initially undefined

```
char c = 'c';
```



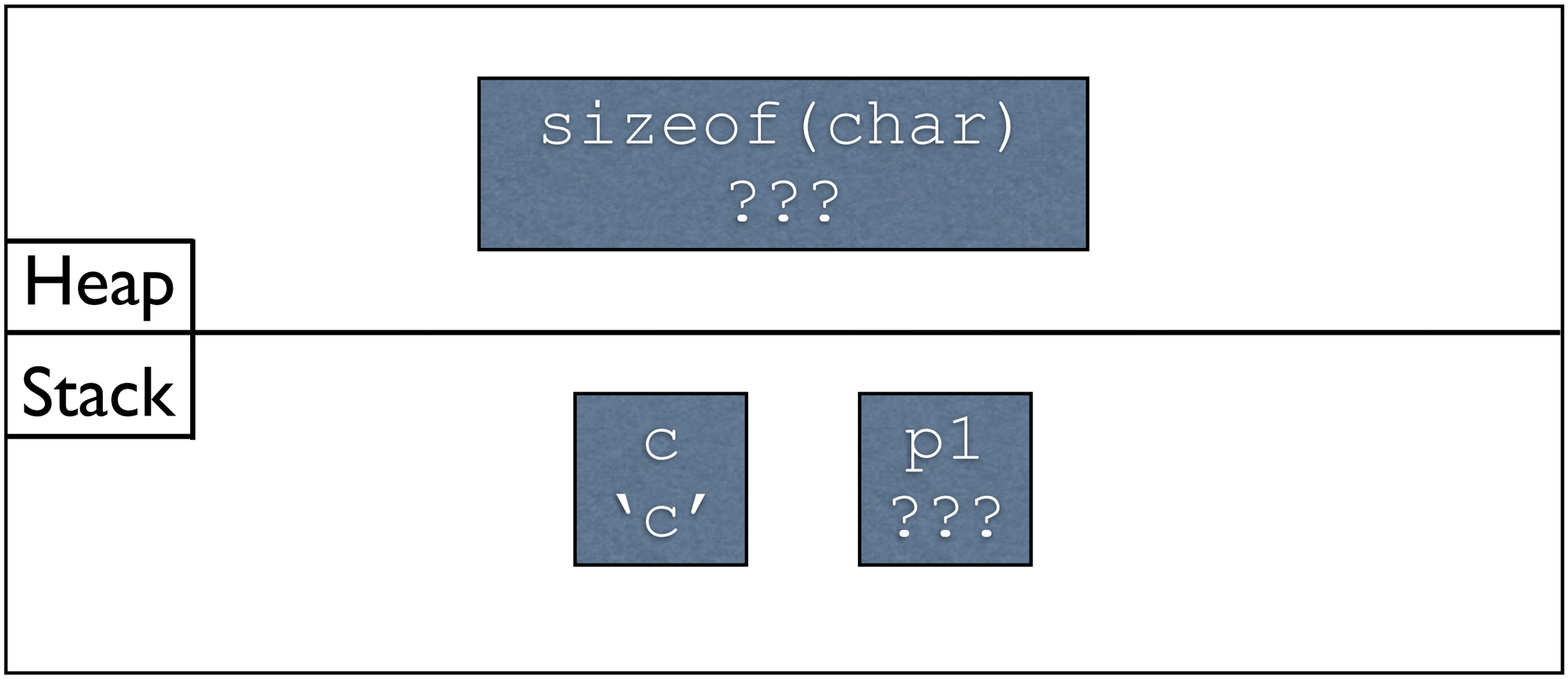
- Any time = is used, it assigns to that place directly, so since `c` is on the stack, `'c'` gets put into that place on the stack

```
char c = 'c';
char* p1 = ...;
```



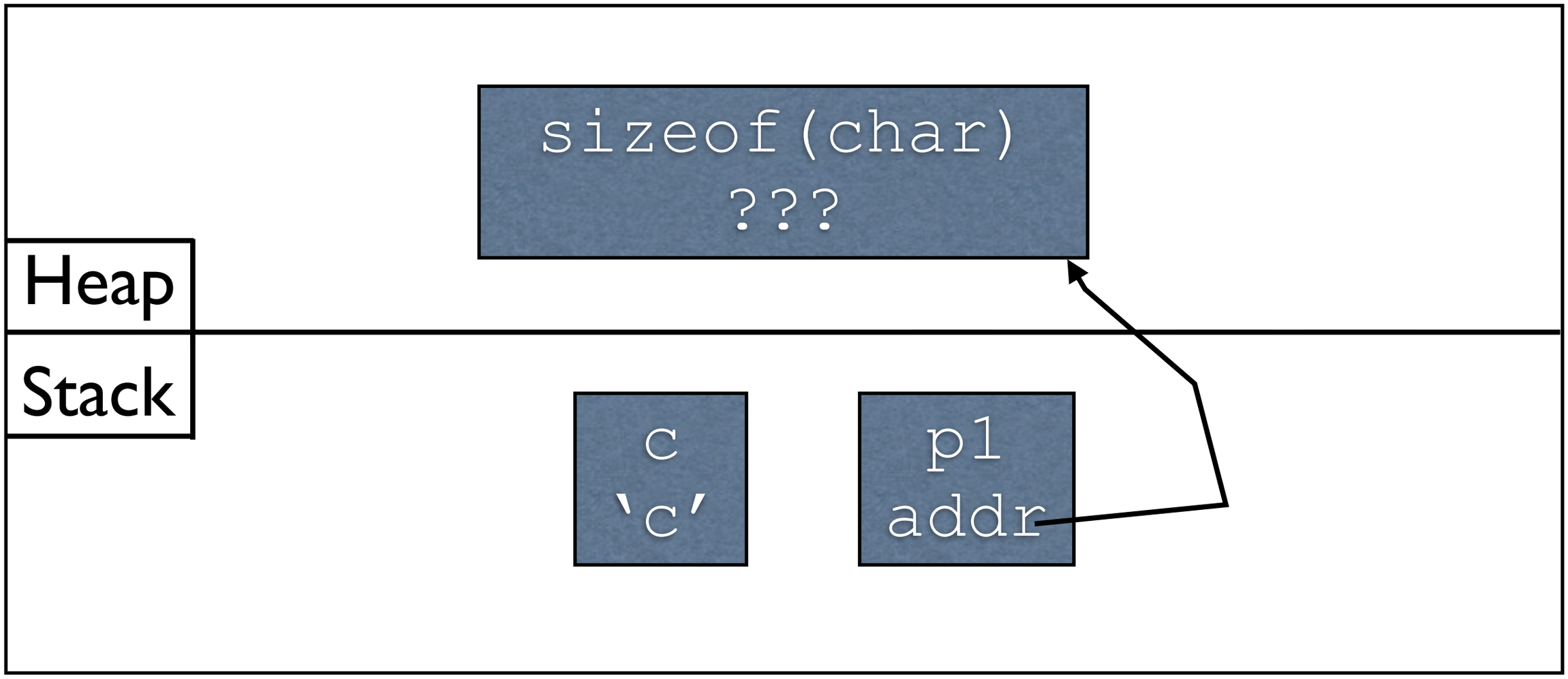
- `p1` is a local variable, and local variables are allocated on the stack
- The value is initially undefined

```
char c = 'c';
... = malloc(sizeof(char));
```



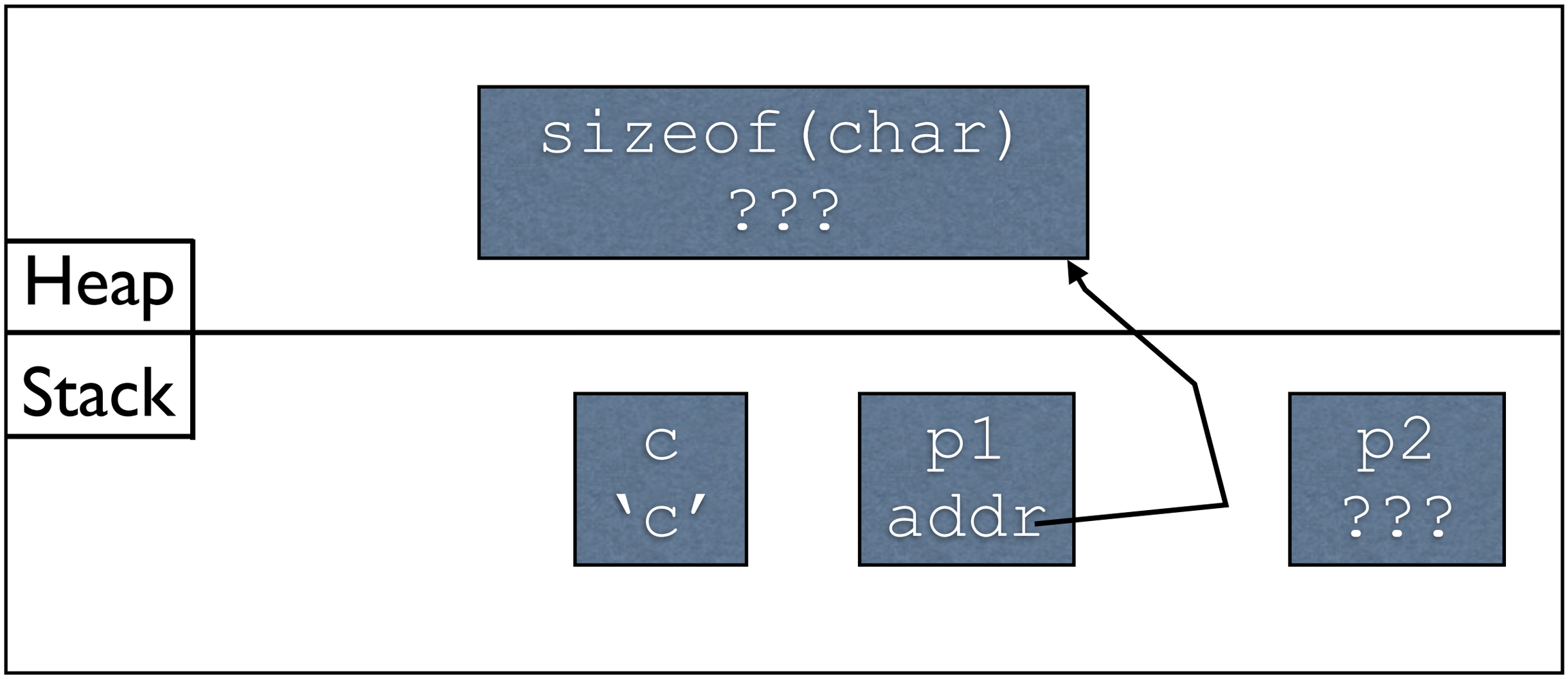
- `malloc` allocates something on the heap
- The value is initially undefined

```
char c = 'c';
char* p1 = malloc(sizeof(char));
```



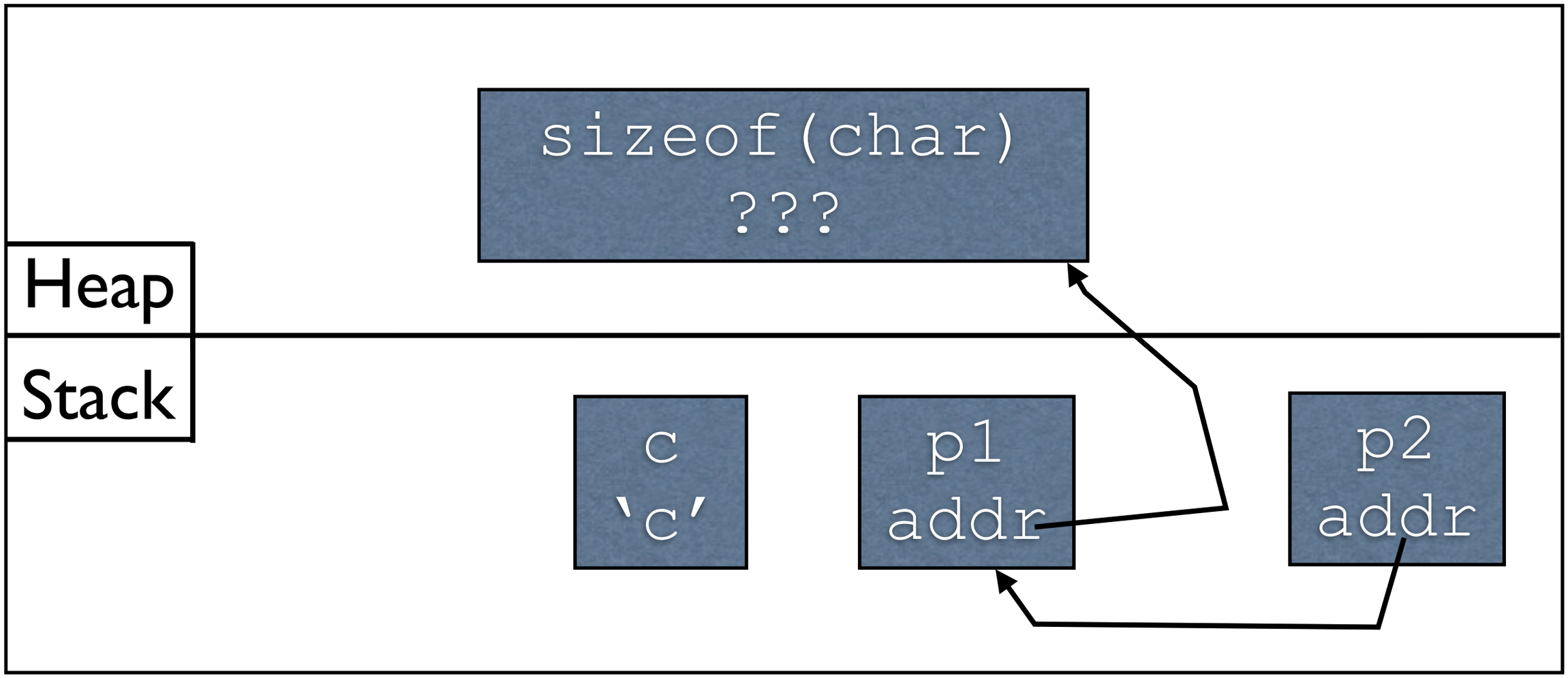
- = puts something in place directly
- This means `p1` holds a pointer to the space allocated on the heap

```
char c = 'c';
char* p1 = malloc(sizeof(char));
char** p2 = ...;
```



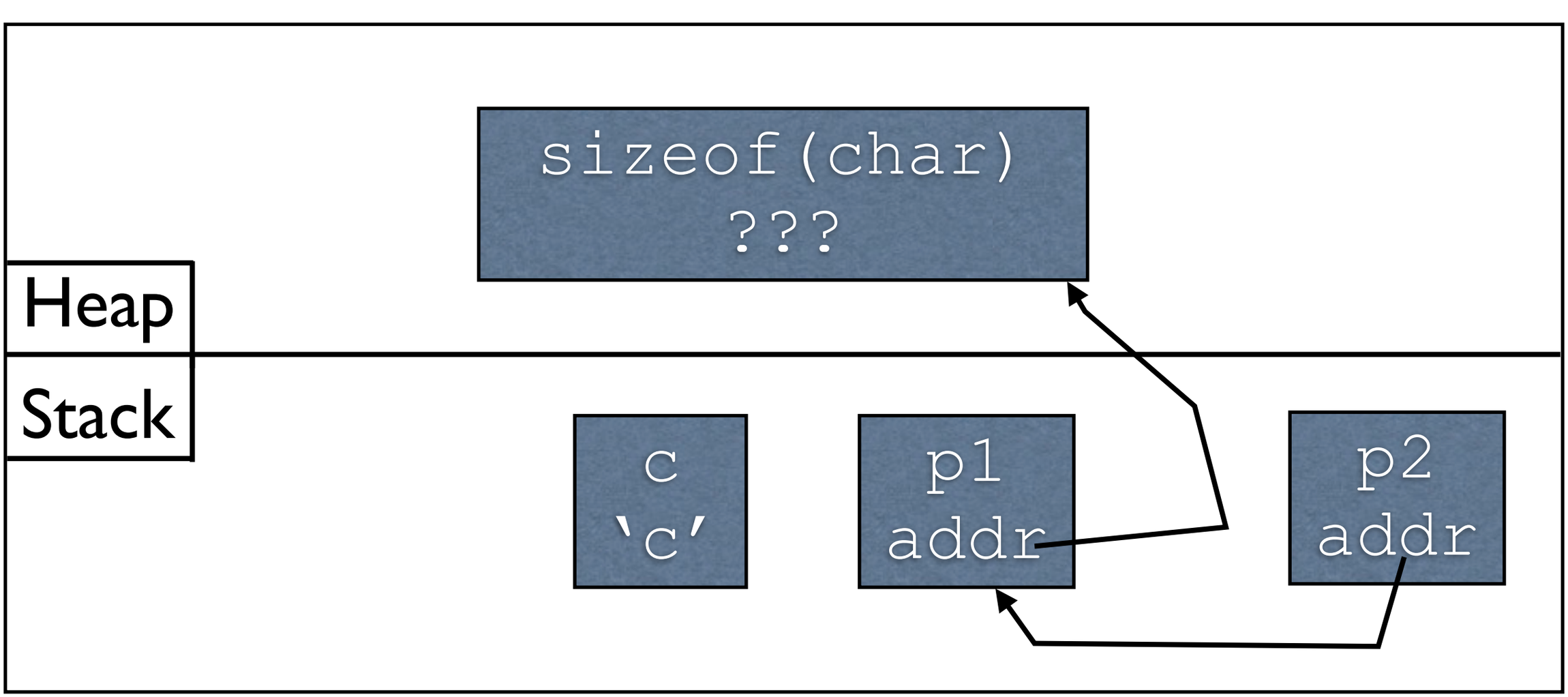
- `p2` is a local variable, and local variables are allocated on the stack
- The value is initially undefined

```
char c = 'c';
char* p1 = malloc(sizeof(char));
char** p2 = &p1;
```



- = puts something in place directly
- The `&` operator creates a pointer to `p1`

- Where is `c` allocated?
- Where is `p1` itself allocated?
- Where is what `p1` points to allocated?
- Where is `p2` itself allocated?
- Where is what `p2` points to allocated?



`main`'s return value

`main`'s Return Value

```
int main() {
  return 0;
}
```

- What is returned is a code to the operating system
- It is **not** part of the output
- By convention, `0` means "everything ok", and non-zero is an error code of some sort

When Destructors are Called

Destructor Call

- The destructor for an object is called **automatically** right before the object is deallocated
  - Which two ways can memory be deallocated? (Hint: which two ways can we allocate memory?)

Destructor Call

- The destructor for an object is called **automatically** right before the object is deallocated

- Which two ways can memory be deallocated?
  - Stack: function return
  - Heap: `delete`

```
void test() {
  Des d(1);
  ...; // some other code
}

int main() {
  Des* p = new Des(0);
  test();
  delete p;
  return 0;
}
```

```
void test() {
  Des d(1); // allocates d on stack
  ...; // some other code
  // d is deallocated off of stack
  // right before test returns
}

int main() {
  // allocates on heap below
  Des* p = new Des(0);
  test();
  delete p; // deallocated off heap
  return 0;
}
```

```
void test() {
  Des d(1); // allocates d on stack
  ...; // some other code
  // d is deallocated off of stack
  // right before test returns
  // destructor called
}

int main() {
  // allocates on heap below
  Des* p = new Des(0);
  test();
  delete p; // deallocated off heap
            // destructor called
  return 0;
}
```

`bool` and Boolean

Expressions

Booleans

- C++ has a special `bool` type, which permits values of `true` and `false`
- Something is either less than something else or isn't: `bool` is perfect here

```
bool firstLessThanSecond(int x, int y);
```

Boolean Expressions

- Tests (e.g., `x < y`) already return `bool`
- There is no need to add another conditional to it

```
bool firstLessThanSecond(int x, int y) {
  // if isn't needed here
  if (x < y) {
    return true;
  } else {
    return false;
  }
}
```

Boolean Expressions

- Tests (e.g., `x < y`) already return `bool`
- There is no need to add another conditional to it

```
bool firstLessThanSecond(int x, int y) {
  // if isn't needed here
  return x < y;
}
```

public / private

`public` / `private`

- A particular class has access to all its own `private` members
- This includes
  - All methods
  - Constructors
  - Destructors
  - **Methods that take in other instances of the same class**

```
class Square {
  public:
  // constructor
  // other methods

  bool lessThan(const Square& o) const {
    return size < o.size;
  }

  private:
    int size;
};
```

```
class Square {
  public:
  // constructor
  // other methods

  bool lessThan(const Square& o) const {
    return size < o.size;
  }

  private:
    int size;
};
```

Access ok: `size` **is an instance variable of** `Square`**, and** `lessThan` **is a method on** `Square`**.**

```
class Square {
  public:
  // constructor
  // other methods

  bool lessThan(const Square& o) const {
    return size < o.size;
  }

  private:
   int size;
};
```

Access ok: `size` **is an instance variable of** `Square`**,** `lessThan` **is a method on** `Square`**, and** `o` **is an instance of** `Square`**.**

insertAtSecond/

removeFromSecond

`insertAtSecond` / `removeFromSecond`

- Memory diagrams are very helpful here
- Loops aren't needed (can just grab the first, second, and third elements directly)
- No need to implement your own `length` method
  - **Length 0:** `head == NULL`
  - **Length 1:** `head != NULL && head->getNext() == NULL`

Command-line Arguments

```
int main(int argc, char** argv) {
   ...
   return 0;
}
```

- `argc` holds the number of arguments, including how the command was invoked
- `argv` holds the actual arguments

```
int main(int argc, char** argv) {
   ...
   return 0;
}
```

Command: `./a.out`

```
argc: 1
argv: { “./a.out” }
```

```
int main(int argc, char** argv) {
   ...
   return 0;
}
```

Command: `./a.out foo`

```
argc: 2
argv: { “./a.out”, “foo” }
```

```
int main(int argc, char** argv) {
   ...
   return 0;
}
```

Command: `./a.out foo bar`

```
argc: 3
argv: { “./a.out”, “foo”, “bar” }
```