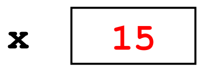
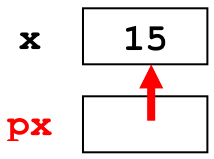
Box-and-Pointer Diagrams – How to make and use them in C

Summary:

1. In a ***box-and-pointer diagram***, ordinary variables have a ***box*** associated with them, depicting the place in memory where the variable's value is stored. We draw the variable's value inside the box.



2. ***Pointer*** variables also have a box associated with them. However, pointer variables have a memory location as their value. Hence, we don't put a value inside the box for a pointer variable; instead, we draw an ***arrow*** from that box to the box at the location specified by the pointer. That is, we draw an arrow from the pointer to its ***pointee***.



3. ***Notation*** for pointers:

   - We declare pointer variables by appending an asterisk to their type:

```
double* px;
```

   - For any variable ***x***, the notation **`&x`** means the address (i.e., location) of variable ***x***:

```
double x = 15;
double* px;
px = &x;
```

Note how pointer variables are declared:

Establishes the pointer's pointee.

   - We refer to a pointer's ***pointee*** by the notation **`*px`**.

     For example, the following statement (continuing the example above) increments variable ***x***, since ***x*** is ***px***'s pointee.

```
 *px = *px + 1;
```

Don't be confused by these two uses of asterisk: one to declare that a variable is a pointer, and the other to refer to the pointer's pointee (which we call ***dereferencing***).

4. ***Space for variables is allocated*** in several ways, including:

   - ***Declaring a local variable*** creates a box for the variable.
   - ***Calling a function*** creates boxes for each of the ***parameters*** of the function. The initial values of those boxes are copies of the boxes of the corresponding ***actual arguments*** in the function call.

   Here is an example (on the next page):

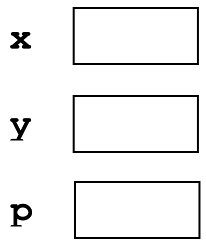
These declarations:

```
int x = 10;

int y = 7;

int* p = &x;
```

create these boxes:



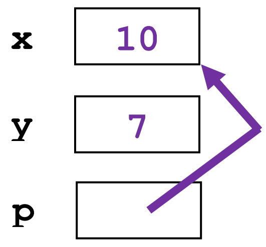
Subsequently, these assignments:

```
x = 10;

y = 7;

p = &x;
```

put values into the boxes (the boxes contain garbage values until the assignments):



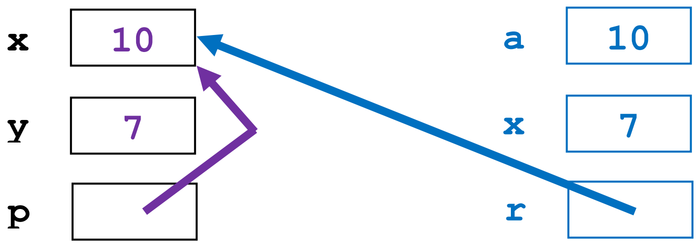
Now suppose there is a function ***foo*** whose prototype is as follows:

```
void foo(int a, int x, int* r) {
    ...
}
```

Continuing the example, this function call:

```
foo(x, y, p);
```

creates and initializes the additional boxes show below in blue.



The boxes created by the function call are new boxes; the variable called ***x*** in function ***foo*** has nothing to do with the variable called ***x*** in the calling code.

The new boxes are initialized by copying the values from the caller's boxes. ***Copying a pointer's value means creating a new arrow that points to the same place as the old arrow.***