1. Pointer Lesson 2 Outline
2. Pass by Reference Bad Example
3. Pass by Reference Good Example
4. Is Pass by Reference Really by Reference?
5. More on the Address Operator &
6. Pass by Reference via Pass by Copy?
7. How Pass by Reference Works in C
8. Pass by Reference in C
9. Pass by Reference Bad Example
10. Pass by Reference Good Example
11. More on Pointers
12. Pointer Variables
13. An Array Variable Is a Pointer
Pass by Reference Bad Example

```c
#include <stdio.h>

int main ()
{
    int henrys_house;
    void who(int dr_neemans_house);

    who(henrys_house);
    printf("%d people live in Henry's house.\n",
          henrys_house);
}

void who (int dr_neemans_house)
{
    printf("How many people live in Dr Neeman's house?\n");
    scanf("%d", &dr_neemans_house);
}

% gcc -o henrys_house_bad henrys_house_bad.c
% henrys_house_bad

How many people live in Dr Neeman's house?
4

134513624 people live in Henry's house.
```
Pass by Reference Good Example

```c
#include <stdio.h>

int main ()
{
    int henrys_house;
    void who(int* dr_neemans_house);

    who(&henrys_house);
    printf("%d people live in Henry's house.\n", henrys_house);
}

void who (int* dr_neemans_house)
{
    printf("How many people live in Dr Neeman's house?\n");
    scanf("%d", dr_neemans_house);
}
```

```bash
% cat henrys_house_good.c
% gcc -o henrys_house_good henrys_house_good.c
% henrys_house_good
How many people live in Dr Neeman's house?
4
4 people live in Henry's house.
```
Is Pass by Reference Really by Reference?

In C, the only passing strategy is pass by copy.

To pass by reference, we have to piggyback on top of pass by copy – because in C, everything is pass by copy.

So, the value that we have to pass by copy is the address of the argument whose value we want to change, which we achieve using the address operator &.

In other words, in C pass by reference is actually pass by copy: you copy the address.
More on the Address Operator &

% cat addr.c
#include <stdio.h>
int main ()
{ /* main */
    double dub = 5.0;
    float flo = 4.0;
    int in  = 3;

    printf("dub = %f, &dub = %d\n", dub, &dub);
    printf("flo = %f, &flo = %d\n", flo, &flo);
    printf("in  = %d, &in  = %d\n", in,  &in);
} /* main */
%
% gcc -o addr addr.c
% addr
dub = 5.000000, &dub = 536869704
flo = 4.000000, &flo = 536869696
in  = 3, &in  = 536869688
Pass by Reference via Pass by Copy?

How does this help us in converting from pass by copy to pass by reference?

Well, the value of the expression \&dub is the address of dub. If we pass a copy of the value of \&dub, then we’re passing the address of dub, so we’re passing dub by reference. Eh?
How Pass by Reference Works in C

Okay, so we’ve decided that, if we pass the value of \&dub, then we’re passing dub by reference, because we’re passing the address of dub.

What’s that all about?

Well, **pass by reference** means that the formal argument **refers** to the actual argument, in the sense that the formal argument has the same memory address as the actual argument.

But **pass by value** means that the value of the actual argument is **copied** into a new memory location, which is the memory location of the formal argument.
Pass by Reference in C

So let’s say we’re doing pass by value. If the value that we pass is the *address of the actual argument*, then the formal argument *knows* the memory location of the actual argument.

In which case, if we can figure out how to *dereference* the address contained in the formal argument – to use it to get to the contents of that address – then we’d have the address of the actual argument.

Which would be pass by reference.

So, what we need is a way to dereference an address.

Happily, C provides a *dereference operator*:

```
*  
```

We use the dereference operator with pretty much the same syntax that we use for the address operator:

```
*dub  
```
Pass by Reference Bad Example

% cat henrys_house_bad.c
#include <stdio.h>
int main ()
{ /* main */
    int henrys_house;
    void who(int dr_neemans_house);

    who( henrys_house);
    printf("%d people live in Henry’s house.\n", henrys_house);
} /* main */

void who (int dr_neemans_house)
{ /* who */
    printf("How many people live in Dr Neeman’s house?\n");
    scanf("%d", &dr_neemans_house);
} /* who */
%
gcc -o henrys_house_bad henrys_house_bad.c
% henrys_house_bad
How many people live in Dr Neeman's house?
4
134513624 people live in Henry's house.
Pass by Reference Good Example

```c
#include <stdio.h>
int main ()
{ /* main */
    int henrys_house;
    void who(int* dr_neemans_house);

    who (&henrys_house);
    printf("%d people live in Henry's house.\n",
           henrys_house);
} /* main */

void who (int* dr_neemans_house)
{ /* who */
    printf("How many people live in Dr Neeman’s house?\n")
    scanf("%d", dr_neemans_house);
} /* who */

% gcc -o henrys_house_good henrys_house_good.c
% henrys_house_good
How many people live in Dr Neeman's house?
4
4 people live in Henry's house.
```
More on Pointers

So, a \textit{pointer} is a variable whose value is a reference (that is, an address of a location in memory). It \textit{points} to the location in memory.

Notice that, to assign a value to a pointer, we apply the dereference operator \texttt{*} to the pointer:

\begin{verbatim}
*dr_neemans_house = 4;
\end{verbatim}

Likewise, to use the value of the variable pointed to by a pointer, we also apply the dereference operator \texttt{*} to the pointer:

\begin{verbatim}
printf("%d people\n", *dr_neemans_house);
\end{verbatim}
Pointer Variables

```c
#include <stdio.h>
int main ()
{ /* main */
    int q; int *p;

    q = 5; p = &q;
    printf("q = %d, &q = %d\n", q, &q);
    printf("p = %d, *p = %d\n", p, *p);
} /* main */
```

```
% cat pointer.c
#include <stdio.h>
int main ()
{ /* main */
    int q; int *p;

    q = 5; p = &q;
    printf("q = %d, &q = %d\n", q, &q);
    printf("p = %d, *p = %d\n", p, *p);
} /* main */
% gcc -o pointer pointer.c
% pointer
q = 5, &q = 536869704
p = 536869704, *p = 5
```
An Array Variable Is a Pointer

In C, when we declare an array statically

```c
float static_array[100];
```

we are setting up a block in memory,
but we’re doing it at compile time instead of at runtime.

Otherwise, an array is identical to a pointer. Specifically,
it’s a **pointer** to the block of memory that holds the array.

In fact, you can think of a statically allocated array as
a **pointer constant**: its value (the address that it points to)
is set at compile time and cannot change at runtime.