C Pointers

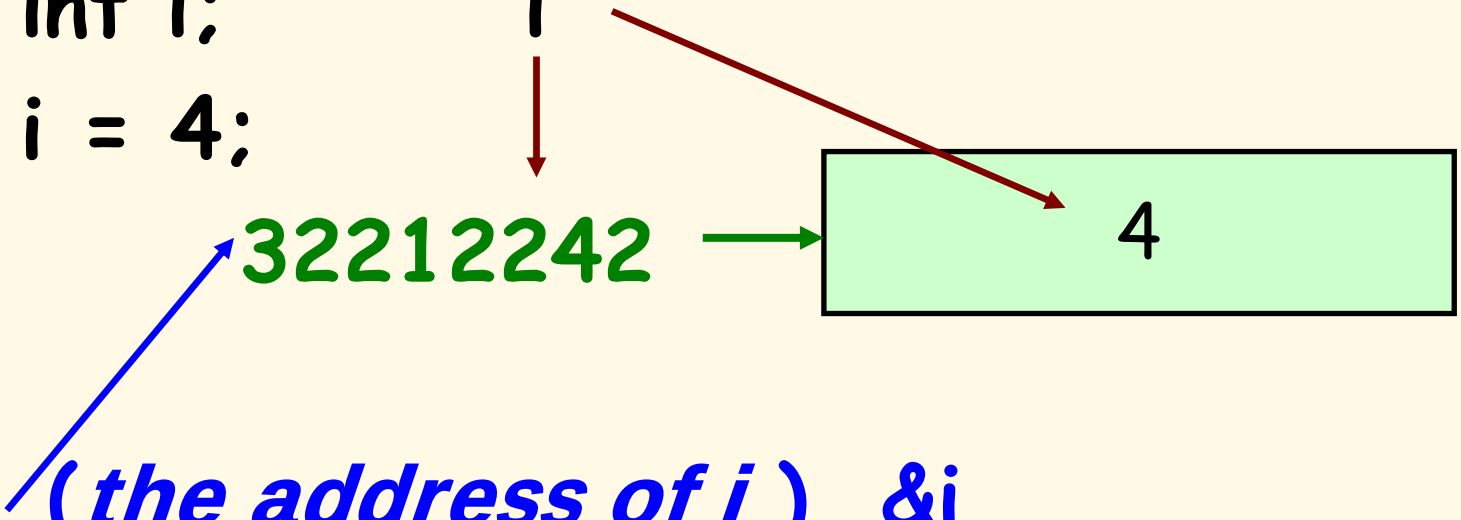
Pointers

- Pointers and Addresses
- Pointers
- Using Pointers in Call by Reference
- Swap – A Pointer Example
- Pointers and Arrays
- Operator Precedence Example

Variables

- Variable names correspond to memory locations in memory. Every variable has a type, a name and a value.

```
int i;
i = 4;
```



Print an Address

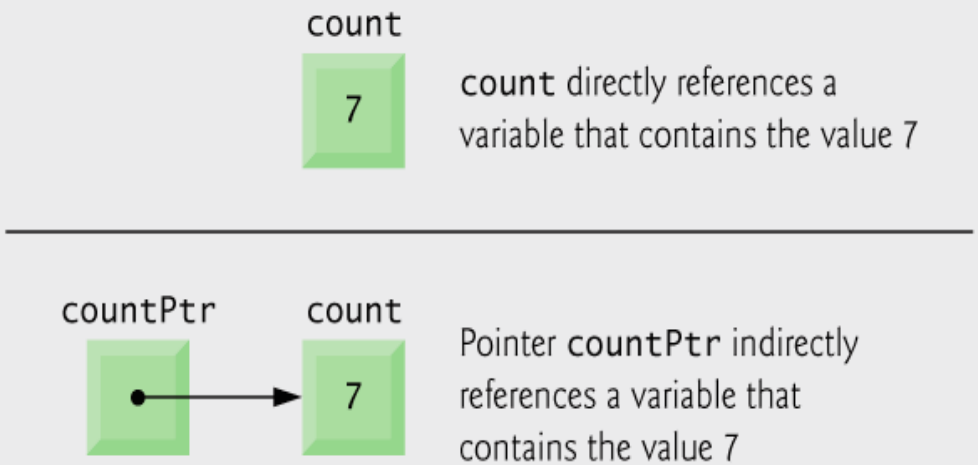
```
int main ()
{
    int i;
    i = 4;
    printf("i = %d, address of i = %u\n", i, &i);
    return 0;
}
```

```
$./ptr1
i = 4, address of i = 3220392980
```

Pointers

- What is a pointer?
  - a variable that contains a memory address as its value.
  - Pointers contain the address of a variable that has a specific value (an indirect reference).
- Pointers in C are typed.
  - a pointer to a variable of type int
  - a pointer to a variable of type char
  - a pointer to a defined type or an object.

Fig. 7.1 Directly and indirectly referencing a variable



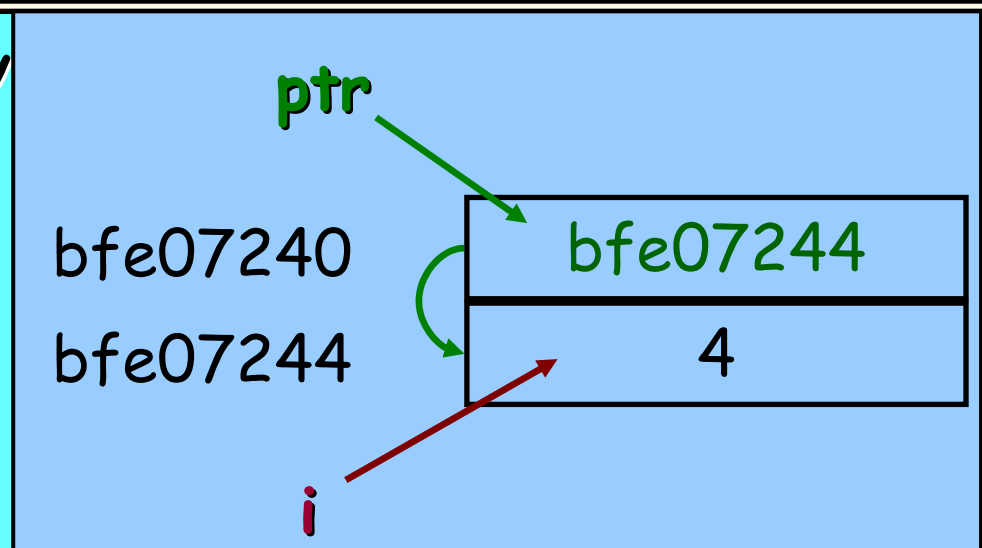
Pointers

```
/* Welcome to the world of Pointers!
Pointers are a powerful tool */
int main ()
{
  int i;
  int *ptr; /* pointer declaration */

  i = 4;
  ptr = &i;
  printf(" i = %d\n address of i = %u\n address of pointer = %u\n",
          i, ptr, &ptr);
  return 0;
}
```

```
./ptr2
 i = 4
 address of i = 3219352564
 address of pointer = 3219352560
```

Pointers

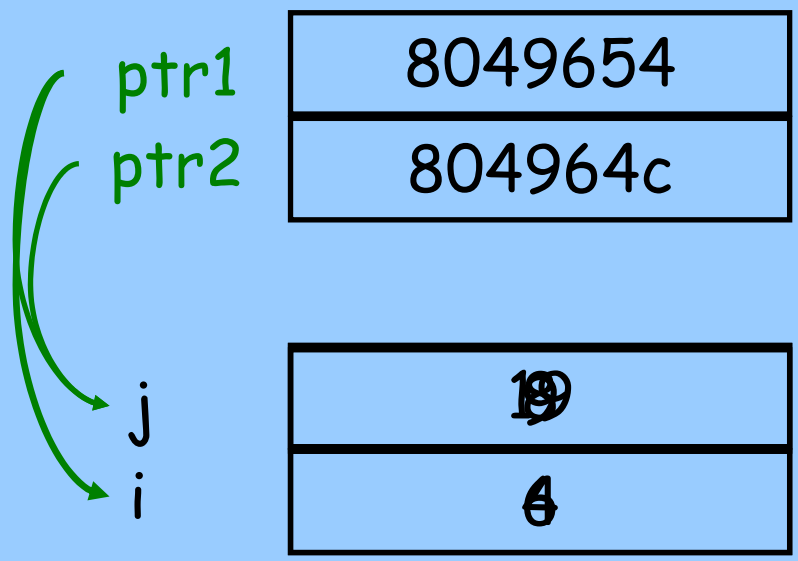
```
/* Do you think in Hex ?*/

int main ()
{
  int i;
  int *ptr;

  i = 4;
  ptr = &i;
  printf(" i = %d\n address of i
          i, ptr, &ptr);
  return 0;
}
```




```
./ptr3
 i = 4
 address of i = 0xbfe07244
 address of pointer = 0xbfe07240
```

Pointers

```
/* Never trust a Compiler. */
  int j, i;              /* think globally! */
  int *ptr1, *ptr2;
void printit ()
  {
  printf(" i = %2d, ptr1 = %p\n", i, ptr1);
  printf(" j = %2d, ptr2 = %p\n", j, ptr2);
  }
int main ()
{
   i = 4;  j = 8;
   ptr1 = &i;
   ptr2 = &j;
   printit ();
   *ptr2 = *ptr2 + 1;
   ptr1 = ptr1 - 2;    /* You cannot k
   printit ();
   i = 6;
   *ptr1 = *ptr1 + 10;
   printit ();
   return 0;
}
```




```
./ptr4
 i =  4, ptr1 = 0x8049654
 j =  8, ptr2 = 0x804964c
 i =  4, ptr1 = 0x804964c
 j =  9, ptr2 = 0x804964c
 i =  6, ptr1 = 0x804964c
 j = 19, ptr2 = 0x804964c
```

7.4 Calling Functions by Reference

- Call by reference with pointer arguments
  - Pass address of argument using & operator
  - Allows you to change the actual location in memory
  - Arrays are not passed with & because the array name is already a pointer.
- * operator
  - Used as alias/nickname for variable inside of function

```
void double( int *number )
 {
  *number = 2 * ( *number );
 }
```

  - *number used as nickname for the variable passed.

Using Pointers in Call by Reference


```
1  /* Fig. 7.7: fig07_07.c
2     Cube a variable using call-by-reference with a pointer argument */
3
4  #include <stdio.h>
5
6  void cubeByReference( int *nPtr ); /* prototype */
7
8  int main( void )
9  {
10    int number = 5; /* initialize number */
11
12    printf( "The original value of number is %d", number );
13
14    /* pass address of number to cubeByReference */
15    cubeByReference( &number );
16
17    printf( "\nThe new value of number is %d\n", number );
18
19    return 0; /* indicates successful termination */
20
21 } /* end main */
22
23 /* calculate cube of *nPtr; modifies variable number in main */
24 void cubeByReference( int *nPtr )
25 {
26    *nPtr = *nPtr * *nPtr * *nPtr;  /* cube *nPtr */
27 } /* end function cubeByReference */
```

Function prototype takes a pointer argument

Function **cubeByReference** is passed an address, which can be the value of a pointer variable

In this program, ***nPtr** is **number**, so this statement modifies the value of **number** itself.

```
The original value of number is 5
The new value of number is 125
```

Swap: A Pointer Example

```
/* A simple memory swap using pointers */

void swap (int *i, int *j)
{
  int temp;

  temp = *i;
  *i   = *j;
  *j   = temp;
}
```

Swap: A Pointer Example

```
int main ( )
{
  int i;
  int mem1,

  mem1 = 12;
  mem2 = 81;
  swap (&mem1, &mem2);  /* swap two integers */
  printf("mem1:%4d mem2:%4d\n", mem1, mem2);

  for (i = 0; i < 4; i++)
  {
    ray1[i] = 10*i;
    printf("ray1[%d] =%4d ", i, ray1[i]);
  }
  printf("\n");
```

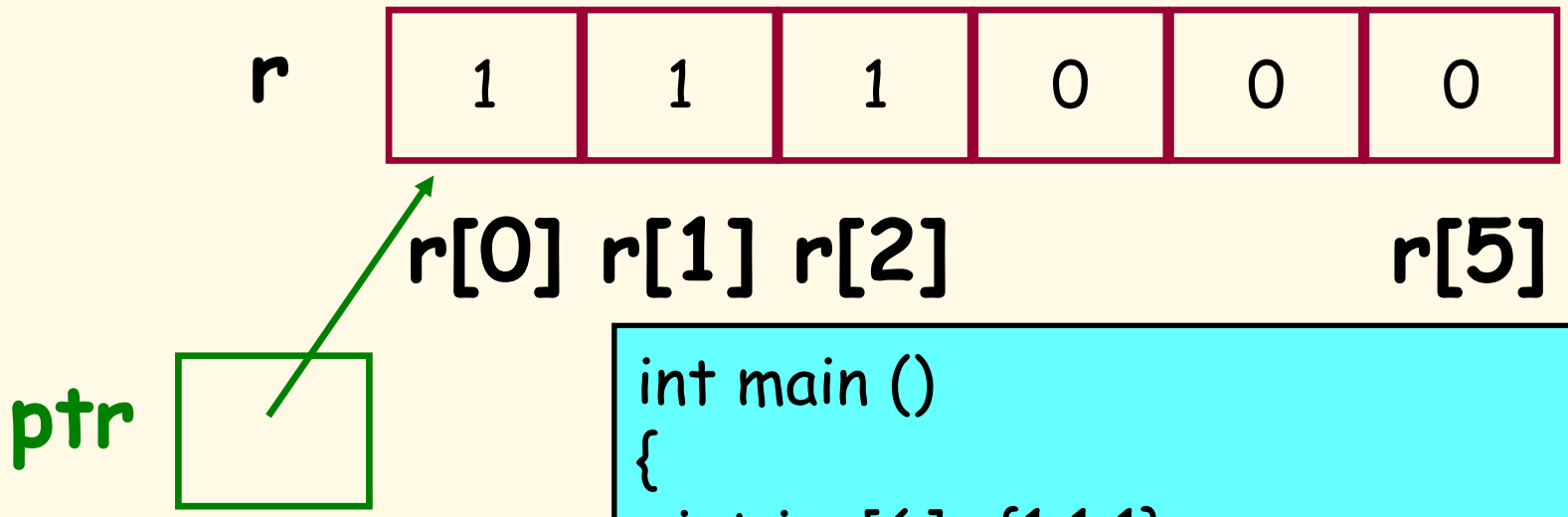
```
./swap
mem1:  81 mem2:  12
ray1[0] =   0 ray1[1] =  10 ray1[2] =  20 ray1[3] =  30
```

Swap: A Pointer Example

```
  swap (&mem1, &ray1[3]);
  swap (&mem2, &ray1[2]);
  printf("mem1:%4d mem2:%4d\n", mem1, mem2);

  for (i = 0; i < 4; i++)
    printf("ray1[%d] =%4d ", i, ray1[i]);

  printf("\n");
  return 0;
}
```

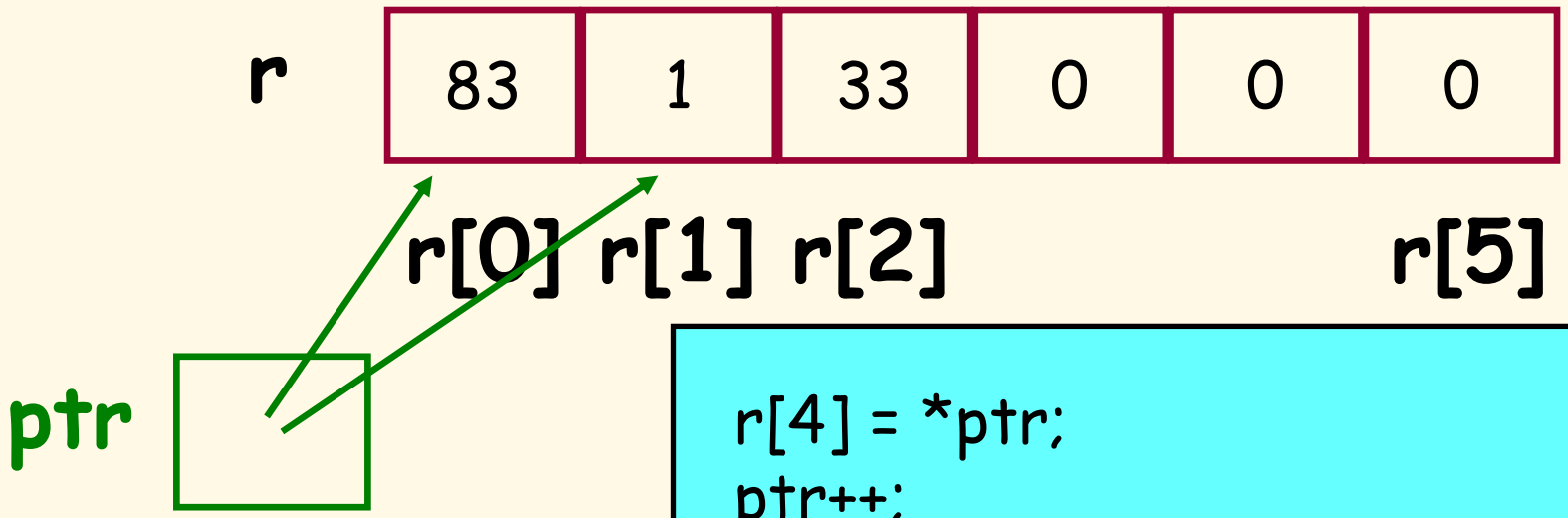
```
mem1:  30 mem2:  20
ray1[0] =   0 ray1[1] =  10 ray1[2] =  12 ray1[3] =  81
```

Pointers and Arrays



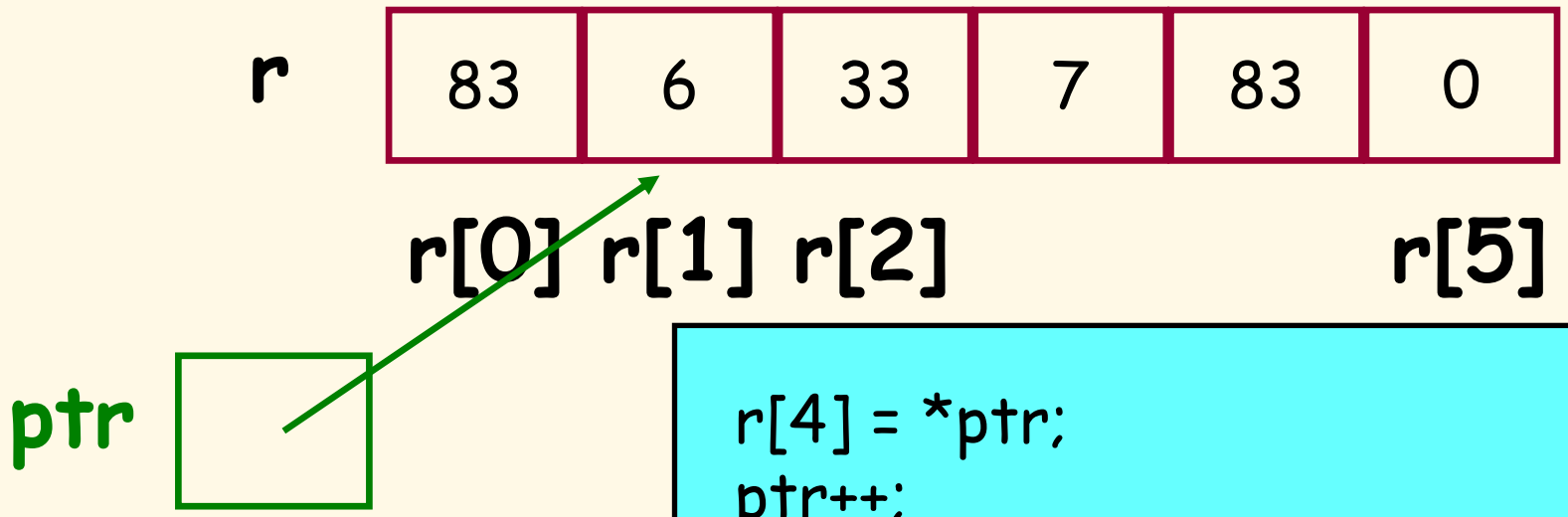

```
int main ()
{
  int i, r[6] ={1,1,1};
  int *ptr;
  ptr = r;
  *ptr = 83;
  *(ptr +2) = 33;
  for (i=0; i < 6; i++)
    printf (" r[%d] = %d\n", i, r[i]);
```

Pointers and Arrays




```
  r[4] = *ptr;
  ptr++;
  *ptr = 6;
  *(ptr +2) = 7;
  for (i=0; i < 6; i++)
    printf (" r[%d] = %d\n", i, r[i]);
  return 0;
}
```

Pointers and Arrays




```
  r[4] = *ptr;
  ptr++;
  *ptr = 6;
  *(ptr +2) = 7;
  for (i=0; i < 6; i++)
    printf (" r[%d] = %d\n", i, r[i]);
  return 0;
}
```

Operator Precedence Example

```
/* An example of operator precedence trouble */
int main ()
{
  float x,y,z;
  float *ptr1, *ptr2, *ptr3;

  x =2.0; y = 8.0; z = 4.0;

  ptr1 = &x;
  ptr2 = &y;
  ptr3 = &z;
  printf (" %u %u %u\n", ptr1, ptr2, ptr3);

  *ptr3++;
  printf (" %f %f %f\n", x, y, z);
  printf (" %u %u %u\n", ptr1, ptr2, ptr3);
  printf (" %f %f %f\n", *ptr1, *ptr2, *ptr3);
```

```
$ ./prec
 3220728372 3220728368 3220728364
 2.000000 8.000000 4.000000
 3220728372 3220728368 3220728368
 2.000000 8.000000 8.000000
```

Precedence Example

```
  (*ptr1)++;
  printf (" %f %f %f\n", *ptr1, *ptr2, *ptr3);

  --*ptr2;
  printf (" %f %f %f\n", *ptr1, *ptr2, *ptr3);
  return 0;
}
```

```
3.000000 8.000000 8.000000
3.000000 7.000000 7.000000
```

Summary

- This section demonstrated the relationship between pointers and addresses and introduced the respective operators & and * .
- Showed the use of pointers in simple examples.
- Introduced call by reference with pointers.
- Detailed the relationship between pointers and arrays.