Computer Programming 143 – Lecture 21
Pointers IV

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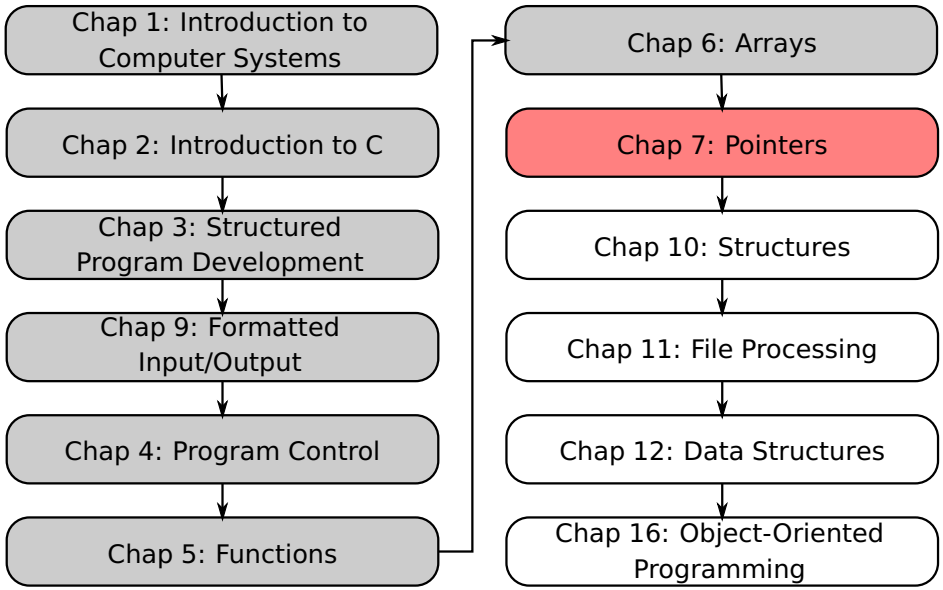
Module Overview



Lecture Overview

7.8 Pointer Expressions

Arithmetic operations can be performed on pointers

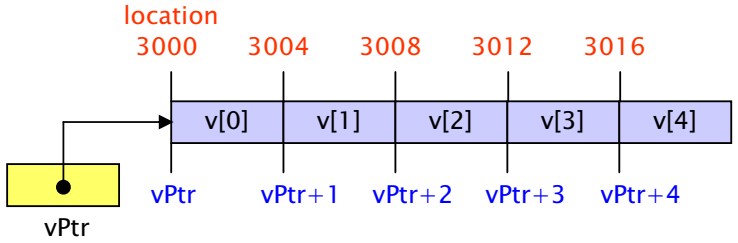
- Increment/decrement pointer (++ or - -)
- Add an integer to a pointer(+ or += , - or -=)
- Pointers may be subtracted from each other
- Operations meaningless unless performed on an array

7.8 Pointer Expressions (cont...)

5-element int array on computer with 4-byte ints

```
int v[5];
int *vPtr = &v[0]; /* or int *vPtr = v; */
```

- vPtr points to first element v[0]
  - at address 3000 (vPtr == 3000)
- vPtr ++; sets vPtr to 3004
- vPtr += 2; sets vPtr to 3008
  - vPtr points to v[2] (incremented by 2), but the machine has 4-byte ints, so it points to address 3008



7.8 Pointer Expressions (cont...)

Subtracting pointers

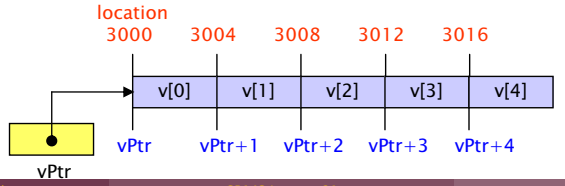
- Returns number of elements from one to the other.

```
int v[5], *vPtr0, *vPtr2; /* correct multi-pointer declaration */
vPtr0 = &v[0];
vPtr2 = &v[2];
```

vPtr2 - vPtr0 would produce 2

Pointer comparison (<, == , >)

- See which pointer points to the earlier/later numbered array element
- (vPtr+1) > vPtr will return true
- Also, see if a pointer points to nothing (NULL or 0)



7.8 Pointer Expressions (cont...)

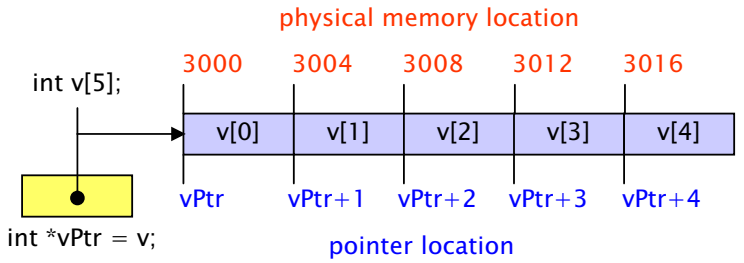
Pointers of the same type can be assigned to each other

- If not the same type, a cast operator must be used

```
int *vPtr0;
char *vPtr2;
vPtr2 = (char*)vPtr0;
```

- Exception: pointer to void (type void *)
  - Generic pointer, represents any type
  - No casting needed to convert a pointer to void pointer
  - void pointers cannot be dereferenced

7.9 Pointers and Arrays



Element v[3]

- Can be accessed by *(vPtr + 3)
  - Where 3 is the offset. Called pointer/offset notation
- Can be accessed by vPtr[3]
  - Called pointer/subscript notation
  - vPtr[3] same as v[3]
- Can be accessed by performing pointer arithmetic on the array itself
  - *(v + 3)

```c
/* Using subscripting and pointer notations with arrays */

#include <stdio.h>

int main()
{
   int b[] = { 10, 20, 30, 40 }; /* initialize array b */
   int *bPtr = b;                /* set bPtr to point to array b */
   int i;                        /* counter */
   int offset;                   /* counter */

   /* output array b using array subscript notation */
   printf( "Array b printed with:\nArray subscript notation\n" );
   /* loop through array b */
   for ( i = 0; i < 4; i++ ) {
      printf( "b[ %d ] = %d\n", i, b[ i ] );
   } /* end for */

   /* output array b using array name and pointer/offset notation */
   printf( "\nPointer/offset notation where\n"
           "the pointer is the array name\n" );
```



```c
   /* loop through array b */
   for ( offset = 0; offset < 4; offset++ ) {
      printf( "*( b + %d ) = %d\n", offset, *( b + offset ) );
   } /* end for */

   /* output array b using bPtr and array subscript notation */
   printf( "\nPointer subscript notation\n" );
   /* loop through array b */
   for ( i = 0; i < 4; i++ ) {
      printf( "bPtr[ %d ] = %d\n", i, bPtr[ i ] );
   } /* end for */
   /* output array b using bPtr and pointer/offset notation */
   printf( "\nPointer/offset notation\n" );

   /* loop through array b */
   for ( offset = 0; offset < 4; offset++ ) {
      printf( "*( bPtr + %d ) = %d\n", offset, *( bPtr + offset ) );
   } /* end for */

   return 0;
}
```



```
Array b printed with:
Array subscript notation
b[ 0 ] = 10
b[ 1 ] = 20
b[ 2 ] = 30
b[ 3 ] = 40

Pointer/offset notation where the pointer is the array name
*( b + 0 ) = 10
*( b + 1 ) = 20
*( b + 2 ) = 30
*( b + 3 ) = 40

Pointer subscript notation
bPtr[ 0 ] = 10
bPtr[ 1 ] = 20
bPtr[ 2 ] = 30
bPtr[ 3 ] = 40

Pointer/offset notation
*( bPtr + 0 ) = 10
*( bPtr + 1 ) = 20
*( bPtr + 2 ) = 30
*( bPtr + 3 ) = 40
```


12.3 Dynamic Memory Allocation

malloc()

- Contained in `stdlib.h`
- Allocates memory during execution time
- `newPtr = malloc( numberOfElements * sizeof( int ) );`
  - Allocates memory for an array with `numberOfElements` number of `int` elements
  - Starting address of memory block is stored in `newPtr`

free()

- Contained in `stdlib.h`
- Frees memory allocated previously
- Always free dynamically allocated memory to prevent memory leaks

```c
#include <stdio.h>
#include <stdlib.h>
int main( void )
{
     int size; //number of memory units needed
     int counter;
     float *newPtr; // pointer to a float;
     float *myFloat; // pointer to a float
     float *myArray; // pointer for our "dynamic" array

     /*allocates memory using 'malloc' and set our float
     pointer to newPtr*/
     newPtr = malloc( sizeof( float ) );
     myFloat = newPtr;
     *myFloat = 42.13;

     printf( "Enter the number of array elements: " );
     scanf( "%d", &size );
     /*allocates memory for an array with 'size' number of type float
     elements and set our array pointer to newPtr*/
     newPtr = malloc( size * sizeof( float ) );
     myArray = newPtr;
```



```c
     // assigns values to array elements
     for ( counter = 0; counter < size; counter++ ) {
          myArray[ counter ] = (float)counter/2;
     }
     // displays all the array elements
     printf( "\nArray is:\n" );
     for ( counter = 0; counter < size; counter++ ) {
          printf( "%3.2f  ", myArray[ counter ] );
          if ( ( counter + 1 ) % 20 == 0 ) {
               printf( "\n" );
          }
     }
     free( myFloat ); // frees the memory allocated to 'myFloat'
     free( myArray ); // frees the memory allocated to 'myArray'
     return 0; // indicates successful termination
} // end main
```


Perspective

Today

Pointers IV

- Pointer expressions and arithmetic
- Pointers and arrays
- Dynamic memory allocation

Next lecture

Pointers V

Homework

1. Study Sections 7.7-7.9 in Deitel & Deitel
2. Do Self Review Exercises 7.2, 7.3 in Deitel & Deitel
3. Do Exercises 7.9, 7.21 in Deitel & Deitel