Pointers

- Pointers are **variables** that hold the memory address of **another** variable

- Declare variables using the * modifier
  - Also called a “reference” variable
  - `int x;  // regular variable`
  - `int * y;  // pointer to an (undefined) integer`
Working with Pointers

- To make a pointer “point” to something, you need to get its address
  
  ```
  int x; // regular variable
  int * y = &x;
  ```

- To change the value of `x`:
  
  ```
  x = 5; // or
  *y = 5; // “dereferences” y
  ```
Dynamic Allocation

- You can dynamically allocate variables using pointers
  ```
  int * y = new int;
  ```
  - `y` points to a new, un-named integer
  ```
  int *z = y;
  ```
  - `z` now points to the same un-named integer

- Variables allocated with new do not belong to a particular function - they are in the **heap**
Deleting memory

- Regular variables are destroyed when their scope ends
- Dynamic variables do not - we must manually delete them
  
  ```
  delete y;
  ```
  
  - now what does `z` point to?
    - `*z = 5; // illegal, our program might crash!`
    - dangling pointer
Memory Leaks

```c
int *y = new int;
int z;
y = &z;
```

- Uh oh! How do we delete our dynamic variable?
- Pointer are very useful, but also very dangerous!
Dynamic Arrays

- We can create new arrays using pointers:

  ```
  int x = 50
  ... user enters a value for x
  int myArray[x];
  // Error: Size must be known at compile time

  int * myArray = new int [x];
  ...
  delete [] a;
  ```
Arrays as Pointers

- Note the syntax in the previous slide...
  - C++ array names are pointers
  - `int list[10];`
  - `list[2] = 5`
  - `*(list+2) = 5`
Lab #5

- Write a program that allows the user to type any amount of input numbers (-1 to stop):
  - Print out the sorted result
- Start by creating a dynamic array of size 5.
- Whenever the user enters too many numbers, grow the size of the array by 2
  - For example, when the 6th number is entered:
    - Create a new dynamic array of size 10
    - Transfer the existing 5 numbers
    - Delete the old array, change the pointer.
    - Add the 6th number