CRICOS PROVIDER 00123M

School of Computer Science

COMP SCI 2103/7103 Algorithm Design & Data Structure

Review of Pointers

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Review of Pointers

In this lecture, we are going to:

- Review the concepts of pointers
- Talk about pointer arithmetic
- Discuss arrays and pointers

Review of Pointers

- What are pointer variables?
  - A pointer variable is a variable pointing to the memory address of another variable. It gives us more control on the computer's memory.
- How do we create them?
  - You can create a pointer variable by using the *

```
double *ptr1, ptr2;

double* ptr1, ptr2;

double *ptr1, *ptr2;
```

```
typedef double* DoublePtr;

DoublePtr ptr1, ptr2;
```

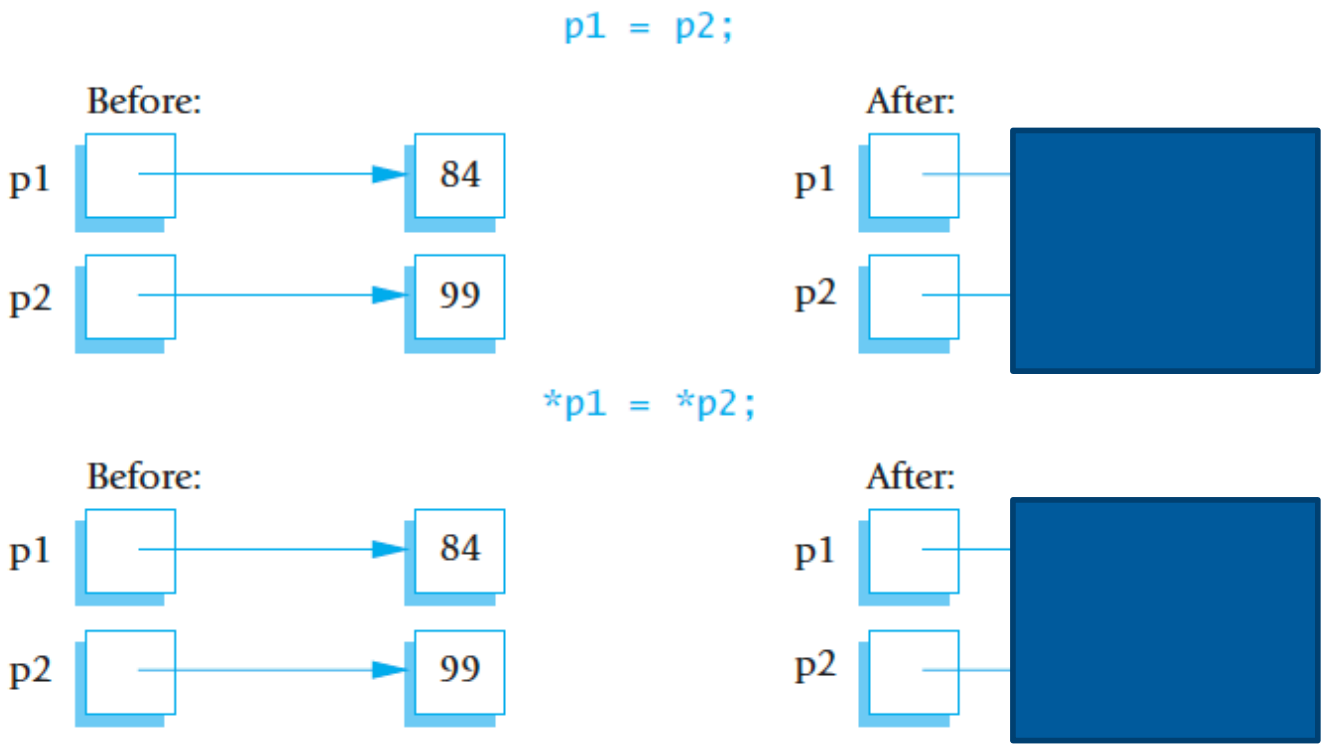
- How do we use them in C++?
  - You can refer to the address of a variable using &

```
double *p, v;
p = &v;
*p = 100;
```

v = ?

Dereferencing Operator

- The variable pointed to by *ptr* -> **ptr*.
- What's the difference between ptr1 = ptr2 and *ptr1 = *ptr2?



Example 2

```
1   int main (void) {
2       char c='c';
3       char * cp = &c;
4       int i = 100;
5       int * ip = &i;
6       int j=*ip;
7   }
```

Questions:

1. *ip = 99; i = ?
2. *cp = *cp + 1; c = ?
3. &ip = ?

Addr	Name	Value
0xbffff374	i	100
0xbffff375		
0xbffff376		
0xbffff377		
0xbffff378	?	?
0xbffff379		
0xbffff37a		
0xbffff37b	c	'c'
0xbffff37c	cp	0xbffff37b
0xbffff37d		
0xbffff37e		
0xbffff37f		
0xbffff380	ip	0xbffff374
0xbffff381		
0xbffff382		
0xbffff383		
0xbffff384	j	100
0xbffff385		
0xbffff386		
0xbffff387		

Why Pointers/references?

- Instead of passing large quantities of data between functions, we can
  - just pass the pointer to the start of the data
  - saves memory and data transfer
- Dynamic memory usage
- Pass parameters to a function by reference

Pass-by-reference

```
void swapByValue(int x, int y){
  int temp;
  temp = x;
  x = y;
  y = temp;
}


void swapByPointer(int* x, int* y){
  int temp;
  temp = *x;
  *x = *y;
  *y = temp;
}
```

Dynamic Variables

- What are dynamic variables?
  - Variables that are created by using *new* operator.
  - They are created and destroyed while the program is running.

```
1  //Program to demonstrate pointers and dynamic variables.
2  #include <iostream>
3  using namespace std;
4
5  int main( )
6  {
7      int *p1, *p2;
8
9      p1 = new int;
10     *p1 = 42;
11     p2 = p1;
12     cout << "*p1 == " << *p1 << endl;
13     cout << "*p2 == " << *p2 << endl;

14     *p2 = 53;
15     cout << "*p1 == " << *p1 << endl;
16     cout << "*p2 == " << *p2 << endl;

17     p1 = new int;
18     *p1 = 88;
19     cout << "*p1 == " << *p1 << endl;
20     cout << "*p2 == " << *p2 << endl;
21     cout << "Hope you got the point of this example!\n";
22     return 0;
23 }
```

```
*p1 == 42
*p2 == 42

*p1 == 53
*p2 == 53

*p1 == 88
*p2 == 53
```

Dynamic Variables

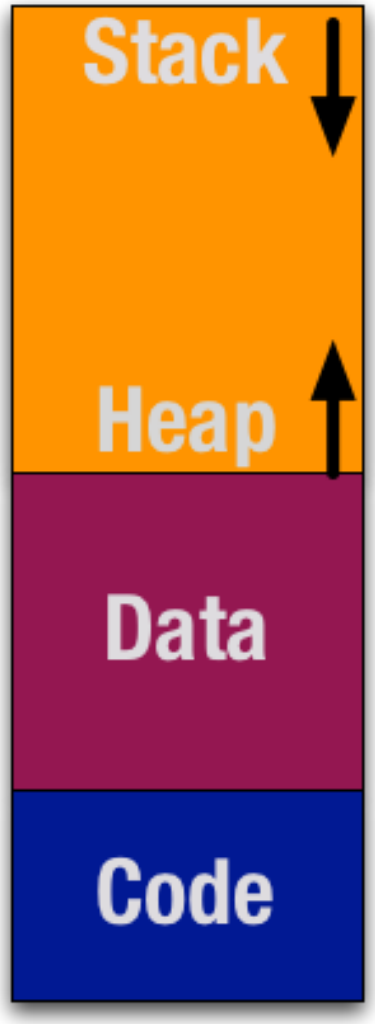
- “new” allocates a part of memory as the dynamic variable.
- We need to “delete” dynamic variables after use, to prevent memory leak

  – type * ptr= new type;
  – Set a value to *ptr and use it
  – When you no longer need it:
    delete ptr;

- The C++ standard specifies that if there is no sufficient memory available to create the new variable -> the new operator, by default, terminates the program.

Where are the variables stored?

- Static variables and parameters are stored in Stack.
- The rest of the allocated memory is used as the heap; for dynamic memory allocation
- The stack and heap are in a shared area.
- The memory that is allocated to variables and parameters from stack is not released until their function is returned. Unlike memory allocation in Heap.



Pointer Arithmetic

- You cannot perform the normal arithmetic operations on pointers.
  - multiplication or division is not allowed
  - Addition and subtraction are different
- The pointer arithmetic depends on the size of the type that pointer is of that type.
- Pointer arithmetic (+/-) shifts the address by a number of bytes equal to the size of the pointer type

```
int i=100;
int* ip=&i;
```

Addr	Name	Value
0xbffff380	ip	0xbffff374
0xbffff381		
0xbffff382		
0xbffff383		

What is the value of ip+1?
0xbffff378

Pointers and Arrays

- In C++, an array variable is actually a pointer variable that points to the first indexed variable of the array.

```
int *ptr;
int a[10];
int i;

for(i = 0; i<10; i++){
  a[i] = i*2;
 }

ptr = a;

for(i = 0; i<10; i++){
  cout << ptr[i] << " ";
 }
cout << endl;

ptr[5] = 5;

for(i = 0; i<10; i++){
  cout << a[i] << " ";
 }
cout << endl;
```

By the way! You can go beyond the size of the array

0 2 4 6 8 10 12 14 16 18

Iterating through ptr is the same as iterating through array a.

0 2 4 6 8 5 12 14 16 18

C-string

- A pointer-based string in C++ is an array of characters ending with the null terminator ('\0').
- The null terminator indicates where a string terminates in memory.
- A C-string can be accessed via a pointer

```
char city[9] = "Adelaide";
char *ptrCity = "Adelaide";
```

char city[] = {'A', 'd', 'e', 'l', 'a', 'i', 'd', 'e'}; not equivalent!

```
cout << city[1] << endl;
cout << *(city+1) << endl;
cout << ptrCity[1] << endl;
cout << *(ptrCity+1) << endl;
```

All output the second element of the string.

Summary

- Pointers allow you to access storage but it's extremely manual. Misjudging your pointer arithmetic will have strange results.
- Space is finite - management is important.
- C++ arrays and pointers are very easy to cause problems!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Questions?