

Pointers

- Special case of bounded-size natural numbers
 - Maximum memory limited by processor word-size
 - 2^{32} bytes = 4GB, 2^{64} bytes = 16 exabytes
- A pointer is just another kind of value
 - A basic type in C++ `int *ptr;`

The variable “ptr” is a pointer to an “int”.

Pointer Operations in C++

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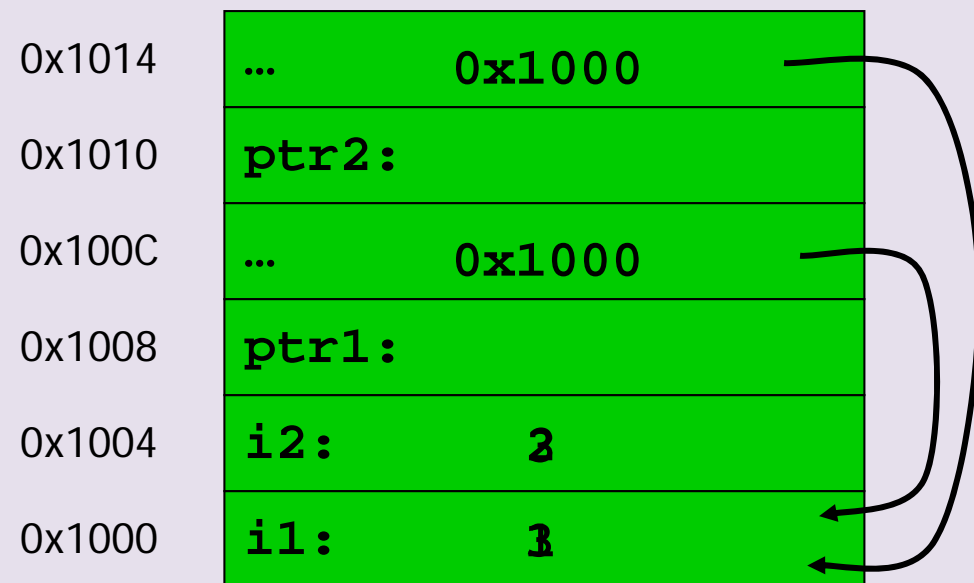
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- Creation
 & *variable* Returns variable's memory address
- Dereference
 * *pointer* Returns contents stored at address
- Indirect assignment
 * *pointer* = *val* Stores value at address
- Of course, still have...
- Assignment
 pointer = *ptr* Stores pointer in another variable



Using Pointers

```
int i1;  
int i2;  
int *ptr1;  
int *ptr2;  
  
i1 = 1;  
i2 = 2;  
  
ptr1 = &i1;  
ptr2 = ptr1;  
  
*ptr1 = 3;  
i2 = *ptr2;
```





Using Pointers (cont.)

```
int  int1      = 1036;  /* some data to point to */
int  int2      = 8;

int  *int_ptr1 = &int1; /* get addresses of data */
int  *int_ptr2 = &int2;

*int_ptr1 = int_ptr2;

*int_ptr1 = int2;
```

What happens?

Type check warning: `int_ptr2` is not an `int`

`int1` becomes 8



Using Pointers (cont.)

```
int  int1      = 1036;  /* some data to point to */
int  int2      = 8;

int *int_ptr1 = &int1;  /* get addresses of data */
int *int_ptr2 = &int2;

int_ptr1 = *int_ptr2;

int_ptr1 = int_ptr2;
```

What happens?

Type check warning: `*int_ptr2` is not an `int`

Changes `int_ptr1` – doesn't change `int1`



Example

```
int x = 1, y = 2, z[10];
int *ip;                // ip is a pointer to an int, so it can point
                        // to x, y, or an element of z
ip = &x;                // ip now points at the location where x is stored
y = *ip;                // set y equal to the value pointed to by ip, or y = x
*ip = 0;                // now change the value that ip points to to 0,
                        // so now x = 0 but notice that y is unchanged
ip = &z[0];              // now ip points at the first location in the array z

*ip = *ip + 1;           // the value that ip points to (z[0]) is incremented
```

```
int x, *y, z, *q;
x = 3;
y = &x;                // y points to x
printf("%d\n", x);     // outputs 3
printf("%d\n", y);     // outputs x's address, will seem like a random number
printf("%d\n", *y);    // outputs what y points to, or x (3)
printf("%d\n", *y+1);  // outputs 4 (print out what y points to + 1)
printf("%d\n", *(y+1)); // this outputs the item after x in memory - what is it?
z = *(&x);              // z equals 3 (what &x points to, which is x)
q = &*y;                // q points to x, just like y; note *& and &* cancel out
```

Pointer Arithmetic

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pointer + number

pointer – number

E.g., *pointer + 1*

adds something to a pointer

```
char *p;  
char a;  
char b;  
  
p = &a;  
p += 1;
```

```
int *p;  
int a;  
int b;  
  
p = &a;  
p += 1;
```

← In each, p now points to b
(Assuming compiler doesn't
reorder variables in memory)

Adds $1 * \text{sizeof}(\text{char})$ to
the memory address

Adds $1 * \text{sizeof}(\text{int})$ to
the memory address

Pointer arithmetic should be used cautiously

The Simplest Pointer in C++

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- Special constant pointer `NULL`
 - Points to no data
 - Dereferencing illegal – causes *segmentation fault*

Pointer as Parameters

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```
#include <iostream>
using namespace std;

void swap(int *a, int *b)
{
    int temp;
    temp = *a;
    *a = *b;
    *b = temp;
}

int main ()
{
    int m=3,n=4;
    cout<< m <<" " << n<<endl;
    swap(&m,&n);
    cout<< m <<" " << n<<endl;
    return 0;
}
```

Pointer Vs Arrays

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Pointers and arrays are strongly related. In fact, pointers and arrays are interchangeable in many cases.

Pointer Vs Arrays

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```
#include <iostream>
using namespace std;

double calMean(int *arr, int size)
{
    int    i, sum = 0;
    double mean;

    for (i = 0; i < size; ++i)
    {
        sum += arr[i];
    }

    mean = double(sum) / size;

    return mean;
}

int main ()
{
    // an int array with 5 elements.
    int score[5] = {1000, 12, 111, 170, 150};
    double mean;
    // pass pointer to the array as an argument.
    mean = calMean( score, 5 ) ;
    // output the returned value
    cout << "Mean value is: " << mean << endl;

    return 0;
}
```

Pointer Vs Arrays

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However, pointers and arrays are not completely interchangeable.

```
#include <iostream>

using namespace std;
const int MAX = 3;

int main ()
{
    int var[MAX] = {10, 100, 200};

    for (int i = 0; i < MAX; i++)
    {
        *var = i;    // This is a correct syntax
        var++;       // This is incorrect.
    }
    return 0;
}
```