



Programming with C I

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Pointer Arithmetic



All programming languages support using binary operators such as addition and subtraction for the purpose of standard computer arithmetic, such as:

```
double a = 2, b=4;
```

```
double y = a + b;
```



C in addition to standard arithmetic operations supports pointer arithmetic operations. It means you can use operators + (addition) and – (subtraction) to perform arithmetic operations on pointers.

- Pointer arithmetic is generally useful only to refer to the elements of an array.
- Adding an integer to or subtracting an integer from a pointer yields a pointer with the same type.

Pointer Arithmetic



Legal pointer arithmetic in C

- Pointer + Integer
- Integer + Pointer
- Pointer – Integer
- Pointer – Pointer
- Pointer++
- ++Pointer
- Pointer--
- --Pointer



Other arithmetic operations are **illegal**.



Examples of Illegal pointer arithmetic

- Integer – Pointer
- Pointer + Pointer.
- Pointer * Integer
- Pointer / Integer
- Etc...

Pointer Arithmetic

“pointer + n” refers to the address of nth element , from the current address.

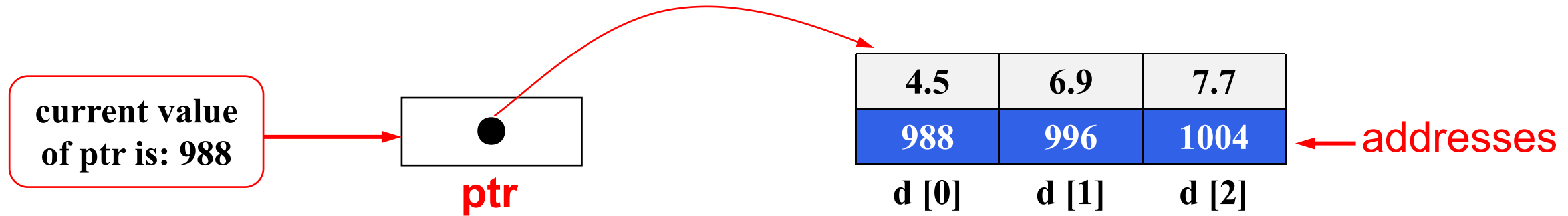
Assuming **n** is an integer and the **pointer** has a valid address value:

$$\text{pointer} + n == \text{address_value} + n * \text{sizeof (type)}$$

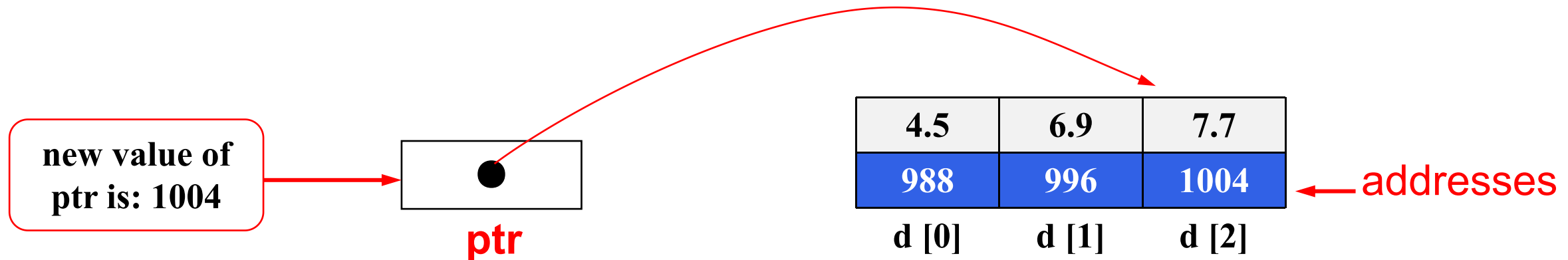
Example:

```
double d[3] = {4.5, 6.9, 7.7};  
double* ptr = &d[0];
```

Pointer Arithmetic



`ptr = ptr + 2;` // The new value of ptr is $988 + 2 \times 8 = 1004$



- The new value of ***ptr** is 7.7

Pointer Arithmetic

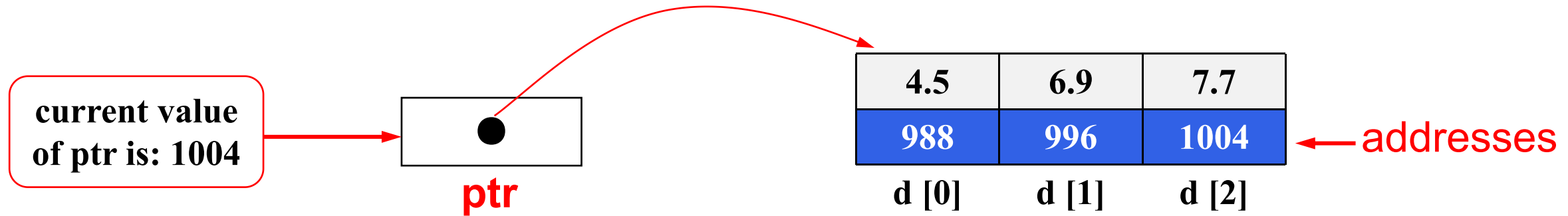
Assuming **n** is an integer and the **pointer** has a valid address value:

$$\text{pointer} - n == \text{address_value} - n * \text{sizeof}(\text{type})$$

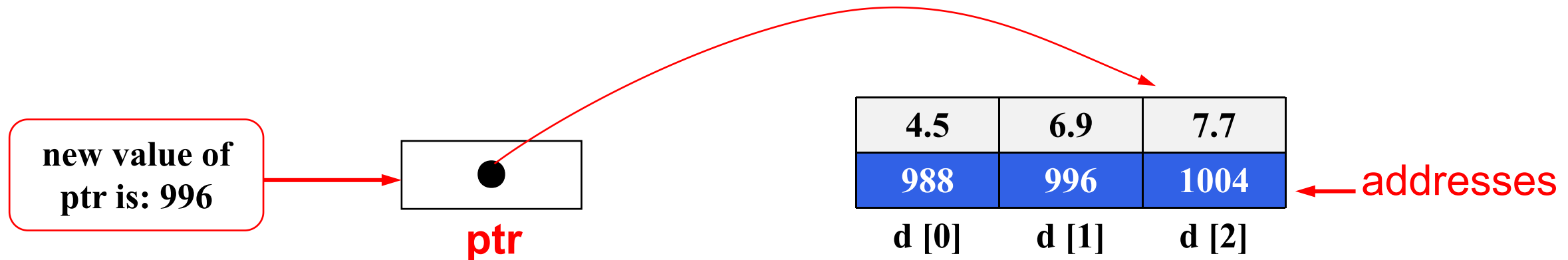
Example:

```
double d[3] = {4.5, 6.9, 7.7};  
double* ptr = &d[2];
```

Pointer Arithmetic



`ptr--;` // The new value of ptr is $1004 - (1 \times 8) = 996$



- The new value of ***ptr** is 6.9

Pointer Arithmetic



“Pointer1 – Pointer2”, results in an integer value that represents the number of elements between the two pointers:

```
int arr[5] = {2, 6, 4, 7, 9};
```

```
int* ptr;
```

```
int diff;
```

```
ptr = arr + 5; // ptr points to arr[5] after the last element
```

```
// Allowed to write: ptr = 5 + arr;
```

```
diff = ptr - arr;
```

- In this example the value of diff will be 5. Why?
 - If the address of first element of arr is 1000, the value of ptr will be 1020, assuming that size of int is 4 bytes, the value of diff is calculated as follows:

$$\text{diff} = (1020 - 1000) / \text{sizeof(int)} = 20 / 4 = 5$$

More on Arrays and Pointers Notations

- Array notations and pointer notations are interchangeable.
- Based on pointer arithmetic rules explained in previous slides, you can replace a square bracket notation that refers to an element of the array with a pointer notation.
- Consider the following declarations:

```
int myArray[5] = { 31, 41, 22, 66, 90};  
int* ptr = myArray + 2;
```

More on Arrays and Pointers Notations



The following statements are all true:

`myArray == &myArray[0]`

`myArray[0] == *myArray`

`myArray[2] == *(myArray+2)`

`myArray + 2 == &myArray[2]`

`2 + myArray == &myArray[2]`

`ptr + 2 == &ptr[2]`

`ptr + 2 == &myArray[4]`

`ptr - 2 == &ptr[-2];`

`*(ptr - 2) == ptr [-2]`

Pointer Arithmetic



To learn some of the applications of pointer arithmetic, let's take a look at different versions of a small c-string function that calculates the length of its c-string argument.



The next few slides shows:

- How array notations and pointer notations are interchangeable
- How the same problem can be solved, using different ways
 - In terms of performance efficiency, they are all almost the same.

Version 1 – Using Array Notation

```
int main ()
{
    int length;
    const char *s = "xyz";
    length = my_strlen ( s );
    printf ("The string length is %d.", length);
    return 0;
}
```

```
int my_strlen (const char* string)
{
    int i = 0;
    while (string [i] != '\0')
    {
        i++;
    }
    // Draw AR diagram at this point
    return i;
}
```

- Now, let's write a different version of my_strlen that uses pointer arithmetic.

Version 2 – Using Pointer Notation and Pointer Arithmetic

```
int main ()
{
    int length;
    const char *s = "xyz";
    length = my_strlen ( s );
    printf ("The string length is %d.", length);
    return 0;
}
```

```
int my_strlen (const char* string)
{
    int i = 0;
    while (*(string + i) != '\0')
    {
        i++;
    }
    // Draw AR diagram at this point
    return i;
}
```

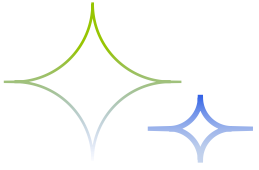
- Is there still another way to write this function.
The answer is yes. See the next slide

Version 3 - This is another possible way

```
int main ()
{
    int length;
    const char *s = "xyz";
    length = my_strlen ( s );
    printf ("The string length is %d.",
length);
    return 0;
}
```

```
int my_strlen (const char* string)
{
    int i = 0;
    while (*string != '\0')
    {
        string++;
        i++;
    }
    // Draw AR diagram at this point
    return i;
}
```

- What about another version? The answer will be discussed during the lecture.



THE END

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