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…

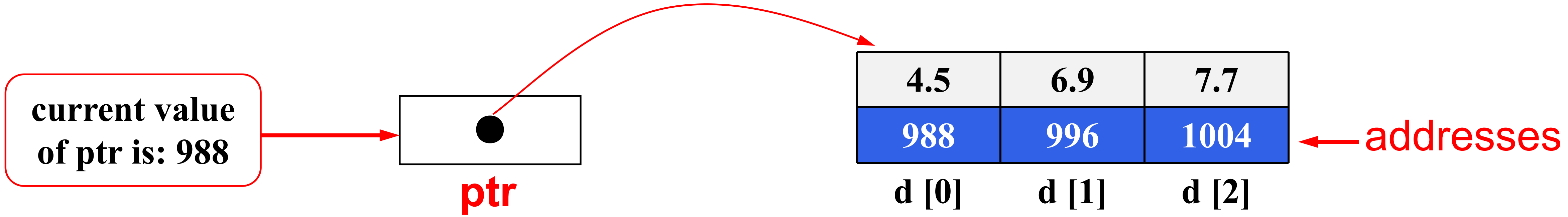
Pointer Arithmetic

- "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:

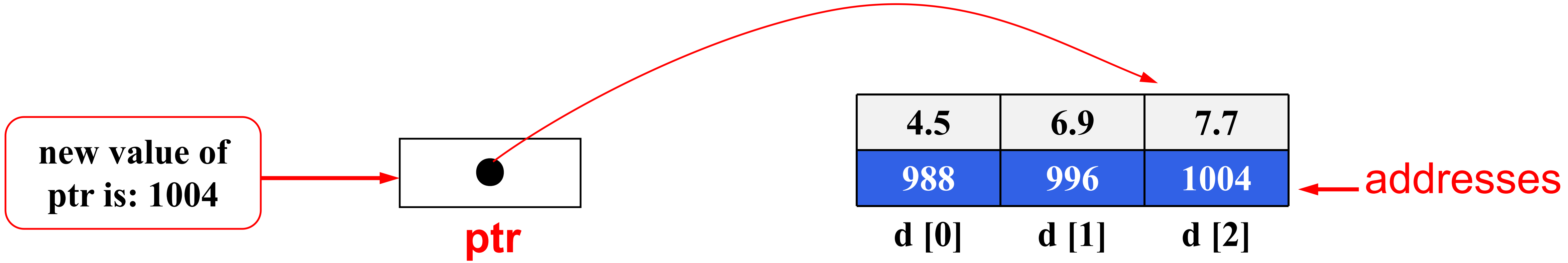
  pointer + n = = address_value + n * sizeof (type)
- Example:

```
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*8 = 1004
```



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

Pointer Arithmetic

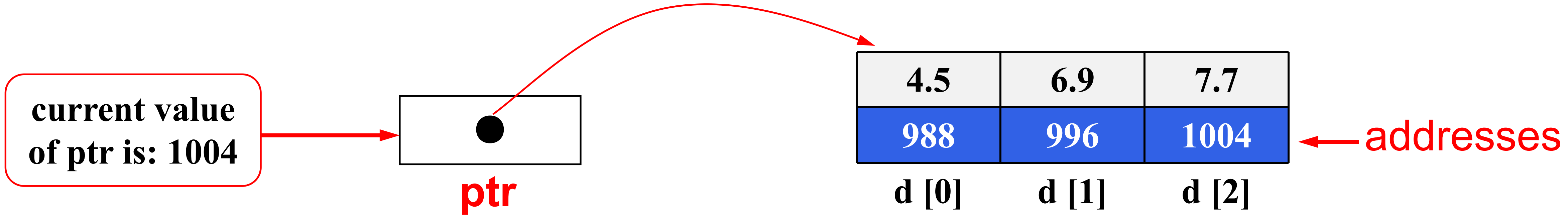
- Assuming **n** is an integer and the **pointer** has a valid address value:

  pointer - n = = address_value - n * sizeof (type)

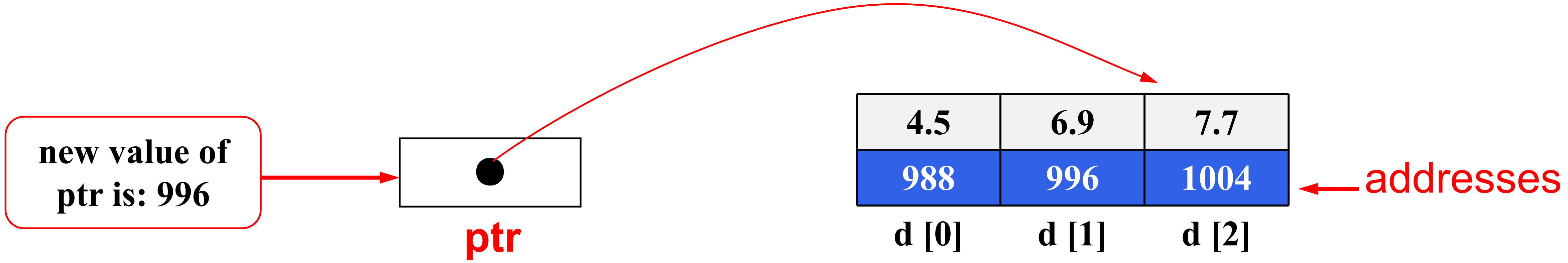
- Example:

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

Pointer Arithmetic



```
ptr--;    // The new value of ptr is 1004 - (1*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:

diff = (1020 – 1000)/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++;
     }
     return i;
 }
```

- Now, lets 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++;
    }
    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++;
    }
    return i;
}
```

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

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THE END

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