CS2100 COMPUTER ORGANISATION

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Lecture #5a

Arrays, Strings and Structures

NUS National University of Singapore | School of Computing

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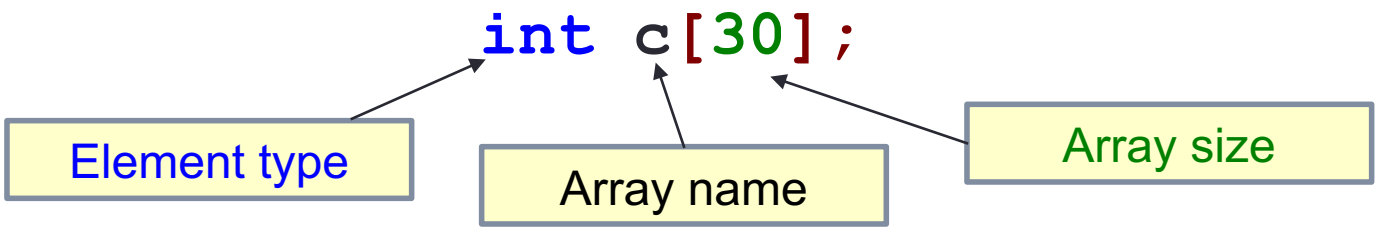
1. Collection of Data

- Besides the basic data types (int, float, double, char, etc.), C also provides means to organise data for the purpose of more logical representation and ease of manipulation.
- We will cover the following in this lecture:
  - Arrays
  - Strings
  - Structures

2. Arrays (1/2)

- An array is a homogeneous collection of data
- The declaration of an array includes the element type, array name and size (maximum number of elements)
- Array elements occupy contiguous memory locations and are accessed through indexing (from index 0 onwards)

Example: Declaring a 30-element integer array c.



2. Arrays (2/2)

ArraySumV1.c

```
#include <stdio.h>
#define MAX 5

int main(void) {
   int numbers[MAX];
   int i, sum = 0;

   printf("Enter %d integers: ", MAX);
   for (i=0; i<MAX; i++) {
      scanf("%d", &numbers[i]);
   }

   for (i=0; i<MAX; i++) {
      sum += numbers[i];
   }

   printf("Sum = %d\n", sum);
   return 0;
}
```

- Summing all elements in an integer array

ArraySumV2.c

```
#include <stdio.h>
#define MAX 5

int main(void) {
   int numbers[MAX] = {4,12,-3,7,6};
   int i, sum = 0;

   for (i=0; i<MAX; i++) {
      sum += numbers[i];
   }

   printf("Sum = %d\n", sum);
   return 0;
}
```

2.1 Array Declaration with Initializers

- As seen in ArraySumV2.c, an array can be initialized at the time of declaration.

```
// a[0]=54, a[1]=9, a[2]=10
int a[3] = {54, 9, 10};

// size of b is 3 with b[0]=1, b[1]=2, b[2]=3
int b[] = {1, 2, 3};

// c[0]=17, c[1]=3, c[2]=10, c[3]=0, c[4]=0
int c[5] = {17, 3, 10};
```

Note what happens when fewer initial values are provided.

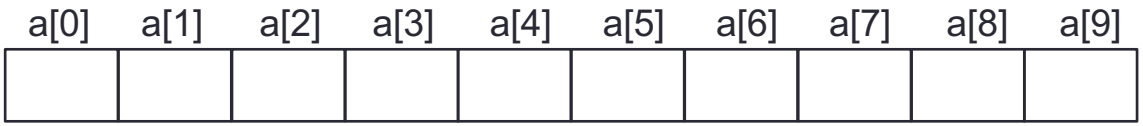
- The following initializations are incorrect:

```
int e[2] = {1, 2, 3};  // warning issued: excess elements

int f[5];
f[5] = {8, 23, 12, -3, 6}; // too late to do this;
                           // compilation error
```

2.2 Arrays and Pointers

- Example: `int a[10]`



- When the array name `a` appears in an expression, it refers to the address of the first element (i.e. `&a[0]`) of that array.

```
int a[3];
printf("%p\n", a);
printf("%p\n", &a[0]);
printf("%p\n", &a[1]);
```

```
ffbff724
ffbff724
ffbff728
```

These 2 outputs will always be the same.

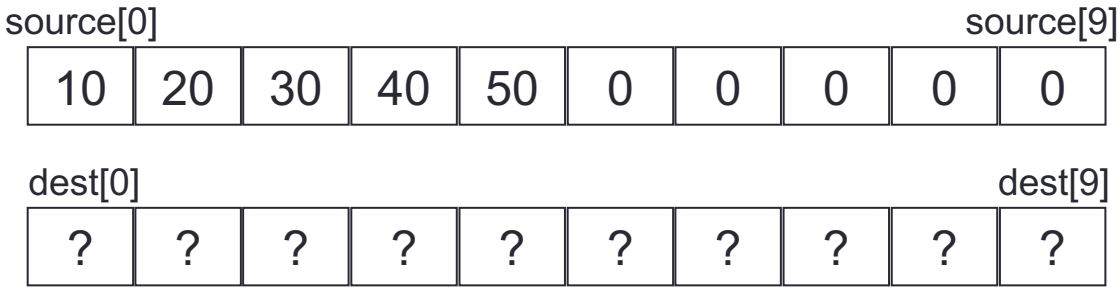
Output varies from one run to another. Each element is of int type, hence takes up 4 bytes (32 bits).

2.3 Array Assignment (1/2)

- The following is illegal in C:

ArrayAssignment.c

```
#define N 10
int source[N] = { 10, 20, 30, 40, 50 };
int dest[N];
dest = source;  // illegal!
```



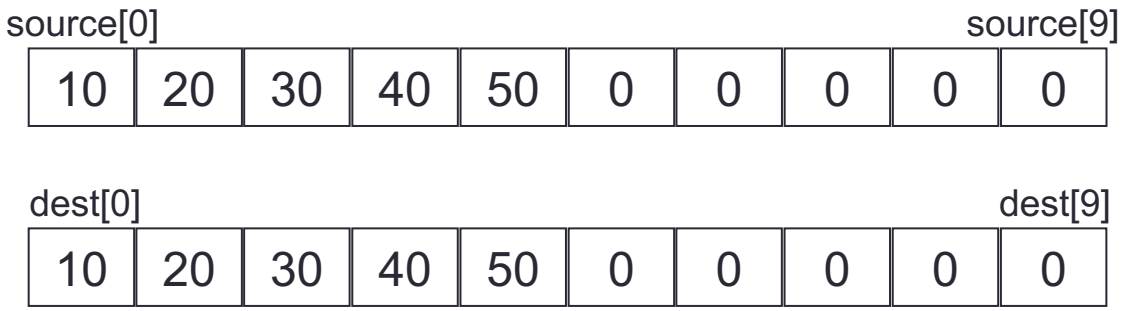
- Reason:
  - An array name is a fixed (constant) pointer; it points to the first element of the array, and this cannot be altered.
  - The code above attempts to alter **`dest`** to make it point elsewhere.

2.3 Array Assignment (2/2)

- How to do it properly? Write a loop:

ArrayCopy.c

```
#define N 10
int source[N] = { 10, 20, 30, 40, 50 };
int dest[N];
int i;
for (i = 0; i < N; i++) {
   dest[i] = source[i];
}
```



- (There is another method – use the <string.h> library function memcpy(), but this is outside the scope of this module.)

2.4 Array Parameters in Functions (1/3)

ArraySumFunction.c

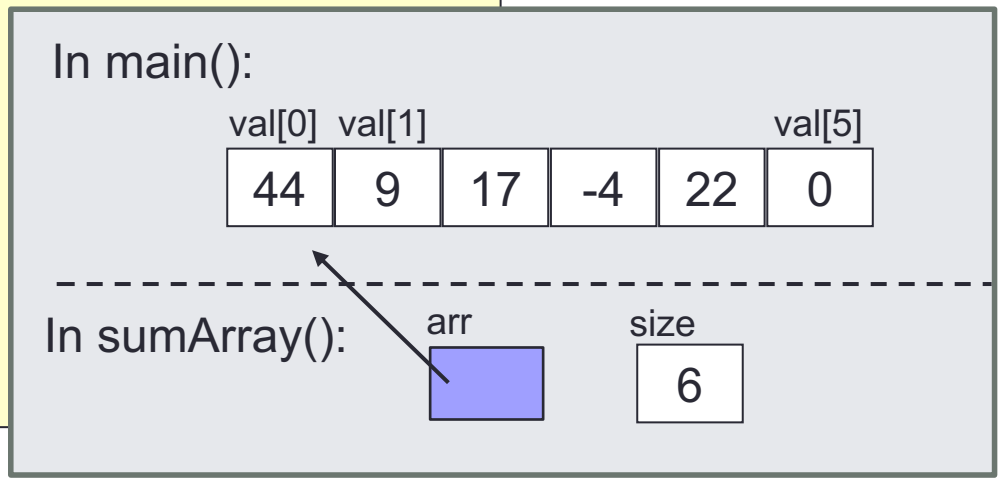
```
#include <stdio.h>

int sumArray(int [], int);

int main(void) {
  int val[6] = {44, 9, 17, -4, 22};
  printf("Sum = %d\n", sumArray(val, 6));
  return 0;
}

int sumArray(int arr[], int size) {
  int i, sum=0;

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



2.4 Array Parameters in Functions (2/3)

- Function prototype:
  - As mentioned before, name of parameters in a function prototype are optional and ignored by the compiler. Hence, both of the following are acceptable and equivalent:

```
int sumArray(int [], int);
```

```
int sumArray(int arr[], int size);
```

- Function header in function definition:
  - No need to put array size inside [ ]; even if array size is present, compiler just ignores it.
  - Instead, provide the array size through another parameter.

```
int sumArray(int arr[], int size) { ... }
```

```
int sumArray(int arr[8], int size) { ... }
```

Ignored by compiler

Actual number of elements you want to process

2.4 Array Parameters in Functions (3/3)

- Since an array name is a pointer, the following shows the alternative syntax for array parameter in function prototype and function header in the function definition

```
int sumArray(int *, int); // fn prototype
```

```
// function definition
int sumArray(int *arr, int size) {
    ...
}
```

- Compare this with the [ ] notation

```
int sumArray(int [], int); // fn prototype
```

```
// function definition
int sumArray(int arr[], int size) {
    ...
}
```

2.5 Modifying Array in a Function (1/2)

- We have learned that for a function to modify a variable (eg: v) outside it, the caller has to passed the address of the variable (eg: &v) into the function.
- What about an array? Since an array name is a pointer (address of its first element), there is no need to pass its address to the function.
- This also means that whether intended or not, a function can modify the content of the array it received.

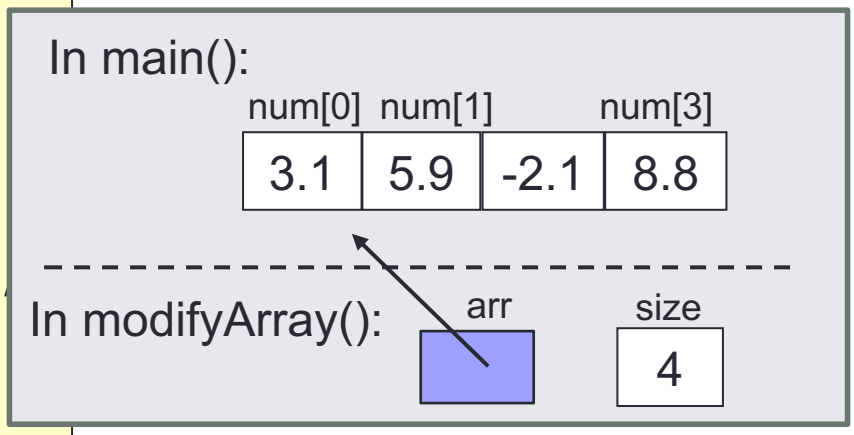
2.5 Modifying Array in a Function (2/2)

ArrayModify.c

```
#include <stdio.h>

void modifyArray(float [], int);
void printArray(float [], int);

int main(void) {
   float num[4] = {3.1, 5.9, -2.1, 8.8};
   modifyArray(num, 4);
   printArray(num, 4);
   return 0;
}
```




```
6.20 11.80 -4.20 17.60
```

```
void modifyArray(float arr[], int size) {
   int i;

   for (i=0; i<size; i++) {
      arr[i] *= 2;
   }
}
```

```
void printArray(float arr[], int size) {
   int i;

   for (i=0; i<size; i++) {
      printf("%.2f", arr[i]);
   }
   printf("\n");
}
```

modifyArray() modifies the array; printArray() does not.

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