

CS111, C Programming

Lab / Structure

黄嘉炜

huangjw3@mail.sustech.edu.cn



深港微电子学院
SCHOOL OF MICROELECTRONICS



Outline

- Review
- structure
- Assignment



Review: binary search ?

```
42 int find_position_in_desc_list(int* array, int size, int target)
43 {
44     // TODO: finish this function
45     for(int i=0;i<=size;++i)
46     {
47         if(*(array+i)==target)
48         {
49             return i;
50         }
51     }
52     return -1;
53 }
```

OJ 初步测试
+
现场 Code Review



Review: bytes encoder

Description

Given N students' information. Each student's information includes:

- Student ID: an unsigned 64-bit integer
- Age: an unsigned 8-bit integer
- Height: a 32-bit float number.

Please encode these students' information into a compact byte stream.

One student takes 13 bytes:

- byte $[0, 8)$: Student ID
- byte 8: Age
- byte $[9, 13)$: Height



Outline

- Review
- **structure**
- Assignment



struct: basic intro

struct definition:

- Groups different types of data together
- Self-defined data structure

```
3  struct Student
4  {
5      /* data members*/
6      unsigned long long uid;
7      unsigned char age;
8      float height;
9  };
```

variable definition

- Has bug ?

```
11  int main()
12  {
13      Student aStudent;
```



struct: basic intro

struct definition:

- Groups different types of data together
- Self-defined data structure

```
3  typedef struct Student
4  {
5      /* data members*/
6      unsigned long long uid;
7      unsigned char age;
8      float height;
9  } Student;
```

variables definition

```
11  int main()
12  {
13      Student aStudent;
```

Keyword: typedef

- Name you own type with typedef



struct: basic intro

Accessing data member:

- Use "." for variables of struct

```
11  int main()
12  {
13      Student aStudent;
14
15      int line = 0;
16      scanf("%d", &line);
17
18      for (int i = 0; i < line; i++) {
19
20          scanf("%llu %hhu %f", &aStudent.uid, &aStudent.age, &aStudent.height);
21
22          unsigned char* pchar = (unsigned char *)(&aStudent);
23          for (int j = 0; j < sizeof(Student); j++) {
24              printf("0x%02x ", *(pchar + j));
25          }
26      }
27  }
```


struct: basic intro

Accessing data member:

- Use `"->"` for pointer to struct

```
11  int main()
12  {
13      Student aStudent;
14
15      int line = 0;
16      scanf("%d", &line);
17
18      for (int i = 0; i < line; i++) {
19
20          // scanf("%llu %hhu %f", &aStudent.uid, &aStudent.age, &aStudent.height);
21          Student* pStudent = &aStudent;
22          scanf("%llu %hhu %f", &pStudent->uid, &pStudent->age, &pStudent->height);
23
24          unsigned char* pchar = (unsigned char*)(pStudent);
25          for (int j = 0; j < sizeof(Student); j++) {
26              printf("0x%02x ", *(pchar + j));
27          }
28      }
29  }
```

Output as expected?



struct: basic i

```
11 int main()
12 {
13     Student aStudent;
14
15     int line = 0;
16     scanf("%d", &line);
17
18     for (int i = 0; i < line; i++) {
19
20         // scanf("%llu %hhu %f", &aStudent.uid, &aStudent.age, &aStudent.height);
21         Student* pStudent = &aStudent;
22         scanf("%llu %hhu %f", &pStudent->uid, &pStudent->age, &pStudent->height);
23
24         unsigned char* pchar = (unsigned char*)(pStudent);
25         for (int j = 0; j < sizeof(Student); j++) {
26             printf("0x%02x ", *(pchar + j));
27         }
28     }
29 }
```

Output NOT as expected !!

-> DO NOT COPY THIS !!

1

1 18 1.75

0x01 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x12 0x00 0x00 0x00 0x00 0x00 0xe0 0x3f

Extra 3 Bytes ?

struct: more

More: how many bytes for a variables of struct ?

```
13      Student aStudent;  
14      printf("sizeof(aStudent): %d \n", sizeof(aStudent));  
15      printf("sizeof(aStudent.uid): %d \n", sizeof(aStudent.uid));  
16      printf("sizeof(aStudent.age): %d \n", sizeof(aStudent.age));  
17      printf("sizeof(aStudent.height): %d \n", sizeof(aStudent.height));
```



struct: more

More: how many bytes for a variables of struct ?

```
13  Student aStudent;  
14  printf("sizeof(aStudent): %d \n", sizeof(aStudent));  
15  printf("sizeof(aStudent.uid): %d \n", sizeof(aStudent.uid));  
16  printf("sizeof(aStudent.age): %d \n", sizeof(aStudent.age));  
17  printf("sizeof(aStudent.height): %d \n", sizeof(aStudent.height));
```

```
sizeof(aStudent): 16  
sizeof(aStudent.uid): 8  
sizeof(aStudent.age): 1  
sizeof(aStudent.height): 4
```

扩展：内存对齐 (Padding)

- 提高内存访问速度
- 硬件和编译器相关
- 如何分布？

Struct & Array

```
11  int main()
12  {
13      Student students[10000];
14
15      int line = 0;
16      scanf("%d", &line);
17
18      for (int i = 0; i < line; i++) {
19
20          scanf("%llu %hhu %f", &students[i].uid, &students[i].age, &students[i].height);
21          // Student* pStudent = &students[i];
22          // scanf("%llu %hhu %f", &pStudent->uid, &pStudent->age, &pStudent->height);
23      }
24  }
```



Struct & function

```
11 Student getStudentFromInput() {
12     Student aStudent;
13     scanf("%llu %hhu %f", &aStudent.uid, &aStudent.age, &aStudent.height);
14     return aStudent;
15 }
```

```
17 void outputStudentBytes(Student* pStudent) {
18
19     unsigned char* pchar = (unsigned char *)&pStudent->uid;
20
21     for (int i = 0; i < sizeof(unsigned long long); i++) {
22         printf("0x%02x ", pchar[i]);
23     }
24
25     pchar = (unsigned char *)&pStudent->age;
26     printf("0x%02x ", *pchar);
27
28     pchar = (unsigned char *)&pStudent->height;
29     for (int i = 0; i < sizeof(float); i++) {
30         printf("0x%02x ", pchar[i]);
31     }
32 }
```

```
34 int main()
35 {
36     int line = 0;
37     scanf("%d", &line);
38     for (int i = 0; i < line; i++) {
39         Student aStudent = getStudentFromInput();
40         outputStudentBytes(&aStudent);
41     }
42 }
```

Highlight

- Passing & return multi-data by 1 struct variables
- Value copying: struct to struct

Outline

- Review
- structure
- **Assignment**



Assignment)

OJ 初步测试 + 现场 Code Review



Description

Write a program to store N students details (including scores), and sort by the students' total scores, and output Top-K students details (include total score).

Input

- 1st line: N , the number of students for input. $N \leq 1000$
- 2nd ~ $(N+1)$ th lines: each line contain 1 student information, including: student ID, name, Math score, Physics score, English score, and Physical education score. The student ID is 8-digital number. The length of name is less than 50, and not space inside. The score of each course is 100-point scale.
- last line: K , the number of students for output (aka, Top-K). $K \leq N$



Assignment)

OJ 初步测试 + 现场 Code Review



Output

You need to sort the N students by their total score, and finally output Top-K the students' in descending order.

And the each output line contains: 1 student ID, name, Math score, Physics score, English score, Physical education score, and **total score**.

Note that:

- when $(K + 1)$ th students is same total score with the K th student, also output $(K + 1)$ th student, until the total score not the same.
- The output order of students in the same total score, order by the student ID by ascending.

Require

Use the **struct** to solve this problem.



Assignment)

Samples

OJ 初步测试 + 现场 Code Review



输入数据 1

```
3
10011110 jiaran 94 51 44 88
10111100 Kaiming 99 99 80 77
10001111 cutie 90 89 90 97
2
```

Copy

输出数据 1

```
10001111 cutie 90 89 90 97 366
10111100 Kaiming 99 99 80 77 355
```

输入数据 2

```
10
12010401 jij 90 90 90 90
12190001 jo 91 91 91 91
19201099 j1 92 92 92 92
12013417 j1i1 93 93 93 93
41098762 aoao 94 94 94 94
41909000 jcnm 95 95 95 99
41900012 nassy 96 96 96 96
14100001 hllowold 97 97 97 97
11623333 null 98 98 98 98
12001000 joj 100 100 100 100
4
```

Copy

输出数据 2

```
12001000 joj 100 100 100 100 400
11623333 null 98 98 98 98 392
14100001 hllowold 97 97 97 97 388
41900012 nassy 96 96 96 96 384
41909000 jcnm 95 95 95 99 384
```



Appendix, 字符串输入, 夹在数字中间 ?

```
unsigned int id;  
int score;  
char name[50] = {'\0'};  
scanf("%u %s %d", &id, name, &score);  
printf("id %d, name %s, score: %d\n", id, name, score);
```

```
1 tom 100  
id 1, name tom, score: 100
```



THANK YOU

