

REPORT

LAB06 C Programming

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Requirements

- Implement lab02 to lab05 again but in C language.
- Think about and write down the difference between low-level programming language and high-level programming language.

Details, Notes and Suggestions:

1. You can do anything you want to make lab02 to lab05 suitable for C.
2. Any direct memory access operation for input or output can be replaced by scanf or printf or any other functions.
3. You can use array, struct and any features supported by C.
4. Please include all labs in one file, like

```
1 lab02();
2 lab03()
3 ...
4 main(){
5     lab02();
6     lab03();
7     ...
8     lab05();
9 }
```

Design

1. We can use the operator '%' to implement the residual operation.
 2. We can use the structure of **LinkedList** to implement the sort operation.
 3. We can use **while** to implement the loop operation.
 4. We can use **kbhit** function in the **conio.h** header files to check the status of keyboard.
 5. We can use subfunctions to make the program clear. And we can use pointers to enable the passing of parameter changes in subfunctions.
-

Code Writing

1. The header files

```
1  #include<stdio.h>
2  #include<stdlib.h>
3  #include<conio.h>
```

2. The Structure

```
1  /*Structure of LinkList*/
2  typedef struct LinkList{
3      int      data;
4      struct LinkList *next;
5  }LinkList;
```

3. The function declaration

```
1  LinkList* Createlist();//Create a list for lab03
2  void PrintList(LinkList *L);//Print the list we created
3  void PrintRocks(int a,int b,int c);//Print the status of game for lab04
4  void Calculate(int *n,int ROCKS,int *flag);//Calculate the changes of rocks for lab04
5  void Interrupt(char *c);//Interrupt the loop for lab05
6  int lab02(int a,int b);//Greatest Common Divisor
7  void lab03(LinkList *L);//The Linked-List Sort
8  void lab04();//The Game of Nim
9  void lab05();//Interrupt a Running Program
```

4. Lab02

```
1  int lab02(int a,int b){
2      if(a%b == 0)    return b;
3      else    return lab02(b,a%b);//Euclidean Algorithm
4  }
```

5. Lab03

```
1  void lab03(LinkList *L){
2      int i = 0,j = 0,num = 0,temp;
3      LinkList *p,*q1,*q2;
4      if (!L->next)    return;
5      for(p = L->next;p;p = p->next)    num++;
6      for (i = 0; i < num - 1; i++) { //Bubble Sort
7          p = L->next;
8          for (j = 0; j < num - i - 1; j++) {
9              q1 = p;
10             q2 = p->next;
11             if (q1->data > q2->data) {
12                 temp = p->data;
13                 q1->data = q2->data;
14                 q2->data = temp;
15             }
16             p = p->next;
17         }
18     }
19 }
```

6. Lab04

```

1 void PrintRocks(int a,int b,int c){
2     printf("\nROW A:");
3     for(;a > 0;a--) printf("o");
4     printf("\nROW B:");
5     for(;b > 0;b--) printf("o");
6     printf("\nROW C:");
7     for(;c > 0;c--) printf("o");
8 }
9
10 void Calculate(int *n,int ROCKS,int *flag){
11     if(*n < ROCKS || ROCKS < 0){
12         *flag = 1;
13         printf("\nInvalid move. Try again.");
14         return;
15     }
16     *n -= ROCKS;
17 }
18
19 void lab04(){
20     int i = 1,flag = 0;
21     int a = 3,b = 5,c = 8,ROCKS;
22     char ROW;
23     printf("\n-----The NIM Game-----\n");
24     while(1){
25         if(!a && !b && !c) break;
26         PrintRocks(a,b,c);
27         if(i%2)
28             printf("\nPlayer 1, choose a row and number of rocks: ");
29         else
30             printf("\nPlayer 2, choose a row and number of rocks: ");
31         getchar();
32         scanf("%c",&ROW);
33         scanf("%d",&ROCKS);
34         if(ROW != 'A' && ROW != 'B' && ROW != 'C'){
35             printf("\nInvalid move. Try again.");
36             continue;//Ends the current loop.
37         }
38         if(ROW == 'A') Calculate(&a,ROCKS,&flag);
39         if(ROW == 'B') Calculate(&b,ROCKS,&flag);
40         if(ROW == 'C') Calculate(&c,ROCKS,&flag);
41         if(flag) continue;
42         flag = 0;
43         i++;//Player Rotation.
44     }
45     if(i%2) printf("\n\nPlayer 2 Wins.\n");
46     else printf("\n\nPlayer 1 Wins.\n");
47     printf("\n-----Game Over-----\n");
48 }

```

7. Lab05

```

1 void Interrupt(char *c){
2     if(kbhit()){//Check the Keyboard.
3         c = getchar();
4         if(c >= '0' && c <= '9')
5             printf("\n%c is a decimal digit.\n",c);
6         else printf("\n%c is not a decimal digit.\n",c);
7     }

```

```

8   }
9
10  void lab05(){
11      char c;
12      int a;
13      printf("\nPlease stop the loop by pressing P\n");
14      while(1){
15          printf("ICS2020 ");
16          for(a = 5E8;a > 0;a--);
17          if(kbhit()){
18              getchar();//Read redundant characters.
19              c = getchar();
20              if(c >= '0' && c <= '9') printf("%c is a decimal digit.\n",c);
21              else if(c == 'p'){
22                  printf("\n 【End】 \n");
23                  return;
24              }
25              else printf("%c is not a decimal digit.\n",c);
26          }
27      }
28  }

```

8. Main function

```

1  int main(){
2      int flag = 1,menu = 0,a,b;
3      LinkList *L;
4      while(flag == 1){
5          printf("\n-----ICS LAB-----\n");
6          printf("\n 【2】 lab02   【3】 lab03");
7          printf("\n 【4】 lab04   【5】 lab05");
8          printf("\n\nPlease choose the number of lab:");
9          scanf("%d",&menu);
10         switch(menu){
11             case 2:{
12                 printf("Please enter two integers, separated by a space:");
13                 scanf("%d %d",&a,&b);
14                 printf("The GCD of %d and %d is %d.\n",a,b,lab02(a,b));
15                 break;
16             }
17             case 3:{
18                 L = CreateList();
19                 printf("\nThe initial linklist: \n");
20                 PrintList(L);
21                 lab03(L);
22                 printf("\nAfter sorting: \n");
23                 PrintList(L);
24                 break;
25             }
26             case 4:{
27                 lab04();
28                 break;
29             }
30             case 5:{
31                 lab05();
32                 break;
33             }
34             default:{
35                 printf("\n 【Wrong input! Please check your input and try again!】 \n");
36                 break;

```

```
37         }
38     }
39     printf("\nPlease continue by pressing 1:");
40     scanf("%d",&flag);
41 }
42 printf("\nProgram termination!\n");
43 return 0;
44 }
```

Result Test

1. Lab02

```
-----ICS LAB-----

【2】 lab02      【3】 lab03
【4】 lab04      【5】 lab05

Please choose the number of lab:2
Please enter two integers, separated by a space:118 16
The GCD of 118 and 16 is 2.

Please enter two integers, separated by a space:64 36
The GCD of 64 and 36 is 4.
```

```
Please enter two integers, separated by a space:177 53
The GCD of 177 and 53 is 1.
```

2. Lab03

```

-----ICS LAB-----

【2】 lab02      【3】 lab03
【4】 lab04      【5】 lab05

Please choose the number of lab:3

Please enter the data,end by pressing 2020.

Please enter the data of the node 1: 35

Please enter the data of the node 2: 54

Please enter the data of the node 3: 12

Please enter the data of the node 4: 88

Please enter the data of the node 5: 6

Please enter the data of the node 6: -3

Please enter the data of the node 7: 0

Please enter the data of the node 8: 2020

The initial linklist:
 35 54 12 88 6 -3 0
After sorting:
-3 0 6 12 35 54 88

```

3. Lab04

```

-----ICS LAB-----

【2】 lab02      【3】 lab03
【4】 lab04      【5】 lab05

Please choose the number of lab:4

-----The NIM Game-----

ROW A:ooo
ROW B:ooooo
ROW C:ooooooooo
Player 1, choose a row and number of rocks: B2

ROW A:ooo
ROW B:ooo
ROW C:ooooooooo
Player 2, choose a row and number of rocks: A1

ROW A:oo
ROW B:ooo
ROW C:ooooooooo
Player 1, choose a row and number of rocks: C6

ROW A:oo
ROW B:ooo
ROW C:oo
Player 2, choose a row and number of rocks: G1

```

```

Invalid move. Try again.
ROW A:oo
ROW B:ooo
ROW C:oo
Player 2, choose a row and number of rocks: B3

ROW A:oo
ROW B:
ROW C:oo
Player 1, choose a row and number of rocks: A3

Invalid move. Try again.
ROW A:oo
ROW B:
ROW C:oo
Player 1, choose a row and number of rocks: C2

ROW A:oo
ROW B:
ROW C:
Player 1, choose a row and number of rocks: A1

ROW A:o
ROW B:
ROW C:
Player 1, choose a row and number of rocks: A1

Player 2 Wins.

-----Game Over-----

```

4. Lab05

```

-----ICS LAB-----

【2】 lab02      【3】 lab03
【4】 lab04      【5】 lab05

Please choose the number of lab:5

Please stop the loop by pressing P
ICS2020 ICS2020 ICS2020 ICS2020 4
4 is a decimal digit.
ICS2020 ICS2020 ICS2020 ICS2020 f
f is not a decimal digit.
ICS2020 ICS2020 ICS2020 h
h is not a decimal digit.
ICS2020 ICS2020 ICS2020 ICS2020 #
# is not a decimal digit.
ICS2020 ICS2020 ICS2020 ICS2020 ICS2020 9
9 is a decimal digit.
ICS2020 ICS2020 p

【End】

```

Thinking

The difference between low-level programming language and high-level programming language:

1. High-level programming language

C, C++, Java, Python, Pascal, Lisp, Prolog, FoxPro, and Easy Language are all high-level languages. Compared to low-level languages, high-level languages use characters that are easy to recognize and remember as keywords, and are also closer to the human way of thinking, written to be easy to read and write, with high implementation efficiency, low execution efficiency, weak controllability of hardware, large target code, and good maintainability.

The point is that high-level languages are portable, and with few or no modifications, code can be run on computers of different platforms.

2. Low-level programming language

Machine instructions are the most efficient because they do not need to be translated. However, machine language is not human-friendly, with a long list of 0 and 1 that are difficult to recognize and remember, and prone to errors.

In assembly language, on the other hand, helper symbols are used instead of the operation codes of machine instructions, and address symbols or markers are used instead of the addresses of instructions or operands. In different devices, assembly language corresponds to different sets of machine language instructions, which are converted into machine instructions by the assembly process. Generally speaking, a specific assembly language and a specific machine language instruction set are one-to-one correspondence and are not directly portable between different platforms.

3. Above all

The lower the language the friendlier it is to machines, the more it conforms to the way machines think, and therefore the more efficient it is to execute.

The higher the language the friendlier it is to humans, the more it conforms to the human way of thinking, and therefore the more efficient it is to develop.

Appendix

Complete code:

C:

```
1  /*****
2  ** School:  School Of Data Science, USTC
3  ** auth:    PB19010450 和泳毅
4  ** date:    2021/1/8 16:37:16
5  ** desc:    ICS Lab06--Implement lab02 to lab05 in C language
6  *****/
7
8  #include<stdio.h>
9  #include<stdlib.h>
10 #include<conio.h>
11
12 /*Structure of LinkList*/
13 typedef struct LinkList{
14     int          data;
15     struct LinkList *next;
16 }LinkList;
17
18 /***** Function declaration *****/
19 LinkList* CreateList();//Create a list for lab03
20 void PrintList(LinkList *L);//Print the list we created
21 void PrintRocks(int a,int b,int c);//Print the status of game for lab04
22 void Calculate(int *n,int ROCKS,int *flag);//Calculate the changes of rocks for lab04
23 void Interrupt(char *c);//Interrupt the loop for lab05
24 int lab02(int a,int b);//Greatest Common Divisor
```



```

25 void lab03(LinkList *L); //The Linked-List Sort
26 void lab04(); //The Game of Nim
27 void lab05(); //Interrupt a Running Program
28 /*****
29
30 LinkList* CreateList(){
31     int n = 1,a;
32     LinkList *L = (LinkList*)malloc(sizeof(LinkList));
33     LinkList *p,*rear = L;
34     printf("\nPlease enter the data,end by pressing 2020.\n");
35     printf("\nPlease enter the data of the node %d: ",n++);
36     scanf("%d",&a);
37     while(a != 2020){
38         p = (LinkList*)malloc(sizeof(LinkList));
39         p->data = a;
40         p->next = NULL;
41         rear->next = p;
42         rear = rear->next;
43         printf("\nPlease enter the data of the node %d: ",n++);
44         scanf("%d",&a);
45     }
46     if(rear != NULL) rear->next = NULL;
47     return L;
48 }
49
50 void PrintList(LinkList *L){
51     LinkList *p = L->next;
52     while(p){
53         printf(" %d ",p->data);
54         p = p->next;
55     }
56 }
57
58 void PrintRocks(int a,int b,int c){
59     printf("\nROW A:");
60     for(;a > 0;a--) printf("o");
61     printf("\nROW B:");
62     for(;b > 0;b--) printf("o");
63     printf("\nROW C:");
64     for(;c > 0;c--) printf("o");
65 }
66
67 void Calculate(int *n,int ROCKS,int *flag){
68     if(*n < ROCKS || ROCKS < 0){
69         *flag = 1;
70         printf("\nInvalid move. Try again.");
71         return;
72     }
73     *n -= ROCKS;
74 }
75
76 void Interrupt(char *c){
77     if(kbhit()){
78         c = getchar();
79         if(c >= '0' && c <= '9')
80             printf("\n%c is a decimal digit.\n",c);
81         else printf("\n%c is not a decimal digit.\n",c);
82     }
83 }
84
85 int lab02(int a,int b){

```

```

86     if(a%b == 0)    return b;
87     else    return lab02(b,a%b);
88 }
89
90 void lab03(LinkList *L){
91     int i = 0,j = 0,num = 0,temp;
92     LinkList *p,*q1,*q2;
93     if (!L->next)    return;
94     for(p = L->next;p;p = p->next)    num++;
95     for (i = 0; i < num - 1; i++) {
96         p = L->next;
97         for (j = 0; j < num - i - 1; j++) {
98             q1 = p;
99             q2 = p->next;
100             if (q1->data > q2->data) {
101                 temp = p->data;
102                 q1->data = q2->data;
103                 q2->data = temp;
104             }
105             p = p->next;
106         }
107     }
108 }
109
110 void lab04(){
111     int i = 1,flag = 0;
112     int a = 3,b = 5,c = 8,ROCKS;
113     char ROW;
114     printf("\n-----The NIM Game-----\n");
115     while(1){
116         if(!a && !b && !c)    break;
117         PrintRocks(a,b,c);
118         if(i%2)
119             printf("\nPlayer 1, choose a row and number of rocks: ");
120         else
121             printf("\nPlayer 2, choose a row and number of rocks: ");
122         getchar();
123         scanf("%c",&ROW);
124         scanf("%d",&ROCKS);
125         if(ROW != 'A' && ROW != 'B' && ROW != 'C'){
126             printf("\nInvalid move. Try again.");
127             continue;
128         }
129         if(ROW == 'A')    Calculate(&a,ROCKS,&flag);
130         if(ROW == 'B')    Calculate(&b,ROCKS,&flag);
131         if(ROW == 'C')    Calculate(&c,ROCKS,&flag);
132         if(flag)    continue;
133         flag = 0;
134         i++;
135     }
136     if(i%2)    printf("\n\nPlayer 2 Wins.\n");
137     else    printf("\n\nPlayer 1 Wins.\n");
138     printf("\n-----Game Over-----\n");
139 }
140
141 void lab05(){
142     char c;
143     int a;
144     printf("\nPlease stop the loop by pressing P\n");
145     while(1){
146         printf("ICS2020 ");

```

```

147     for(a = 5E8;a > 0;a--);
148     if(kbhit()){
149         getchar();
150         c = getchar();
151         if(c >= '0' && c <= '9') printf("%c is a decimal digit.\n",c);
152         else if(c == 'p'){
153             printf("\n 【End】 \n");
154             return;
155         }
156         else printf("%c is not a decimal digit.\n",c);
157     }
158 }
159 }
160
161 int main(){
162     int flag = 1,menu = 0,a,b;
163     LinkList *L;
164     while(flag == 1){
165         printf("\n-----ICS LAB-----\n");
166         printf("\n 【2】 lab02   【3】 lab03");
167         printf("\n 【4】 lab04   【5】 lab05");
168         printf("\n\nPlease choose the number of lab:");
169         scanf("%d",&menu);
170         switch(menu){
171             case 2:{
172                 printf("Please enter two integers, separated by a space:");
173                 scanf("%d %d",&a,&b);
174                 printf("The GCD of %d and %d is %d.\n",a,b,lab02(a,b));
175                 break;
176             }
177             case 3:{
178                 L = CreateList();
179                 printf("\nThe initial linklist: \n");
180                 PrintList(L);
181                 lab03(L);
182                 printf("\nAfter sorting: \n");
183                 PrintList(L);
184                 break;
185             }
186             case 4:{
187                 lab04();
188                 break;
189             }
190             case 5:{
191                 lab05();
192                 break;
193             }
194             default:{
195                 printf("\n 【Wrong input! Please check your input and try again!】 \n");
196                 break;
197             }
198         }
199         printf("\nPlease continue by pressing 1:");
200         scanf("%d",&flag);
201     }
202     printf("\nProgram termination!\n");
203     return 0;
204 }

```

