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

```
lab02();
lab03()
…
main(){
    lab02();
    lab03();
    …
    lab05();
}
```

Design

1. We can use the operator '**%**' to implement the residual operation.
2. We can use the structure of **LinkList** 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

```c
#include<stdio.h>
#include<stdlib.h>
#include<conio.h>
```

2. The Structure

```c
/*Structure of LinkList*/
typedef struct LinkList{
    int             data;
    struct LinkList *next;
}LinkList;
```

3. The function declaration

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

4. Lab02

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

5. Lab03

```c
void lab03(LinkList *L){
    int i = 0,j = 0,num = 0,temp;
    LinkList *p,*q1,*q2;
    if (!L->next)   return;
    for(p = L->next;p;p = p->next)  num++;
    for (i = 0; i < num - 1; i++) {//Bubble Sort
        p = L->next;
        for (j = 0; j < num - i - 1; j++) {
            q1 = p;
            q2 = p->next;
            if (q1->data > q2->data) {
                temp = p->data;
                q1->data = q2->data;
                q2->data = temp;
            }
            p = p->next;
        }
    }
}
```

6. Lab04

```c
void PrintRocks(int a,int b,int c){
    printf("\nROW A:");
    for(;a > 0;a--) printf("o");
    printf("\nROW B:");
    for(;b > 0;b--) printf("o");
    printf("\nROW C:");
    for(;c > 0;c--) printf("o");
}

void Calculate(int *n,int ROCKS,int *flag){
    if(*n < ROCKS || ROCKS < 0){
        *flag = 1;
        printf("\nInvalid move. Try again.");
        return;
    }
    *n -= ROCKS;
}

void lab04(){
    int i = 1,flag = 0;
    int a = 3,b = 5,c = 8,ROCKS;
    char ROW;
    printf("\n-------The NIM Game-------\n");
    while(1){
        if(!a && !b && !c)  break;
        PrintRocks(a,b,c);
        if(i%2)
            printf("\nPlayer 1, choose a row and number of rocks: ");
        else
            printf("\nPlayer 2, choose a row and number of rocks: ");
        getchar();
        scanf("%c",&ROW);
        scanf("%d",&ROCKS);
        if(ROW != 'A' && ROW != 'B' && ROW != 'C'){
            printf("\nInvalid move. Try again.");
            continue;//Ends the current loop.
        }
        if(ROW == 'A')  Calculate(&a,ROCKS,&flag);
        if(ROW == 'B')  Calculate(&b,ROCKS,&flag);
        if(ROW == 'C')  Calculate(&c,ROCKS,&flag);
        if(flag)    continue;
        flag = 0;
        i++;//Player Rotation.
    }
    if(i%2) printf("\n\nPlayer 2 Wins.\n");
    else    printf("\n\nPlayer 1 Wins.\n");
    printf("\n-------Game Over-------\n");
}
```

7. Lab05

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

```
}

void lab05(){
    char c;
    int a;
    printf("\nPlease stop the loop by pressing P\n");
    while(1){
        printf("ICS2020 ");
        for(a = 5E8;a > 0;a--);
        if(kbhit()){
            getchar();//Read redundant characters.
            c = getchar();
            if(c >= '0' && c <= '9') printf("%c is a decimal digit.\n",c);
            else if(c == 'p'){
                printf("\n 【End】\n");
                return;
            }
            else printf("%c is not a decimal digit.\n",c);
        }
    }
}
```

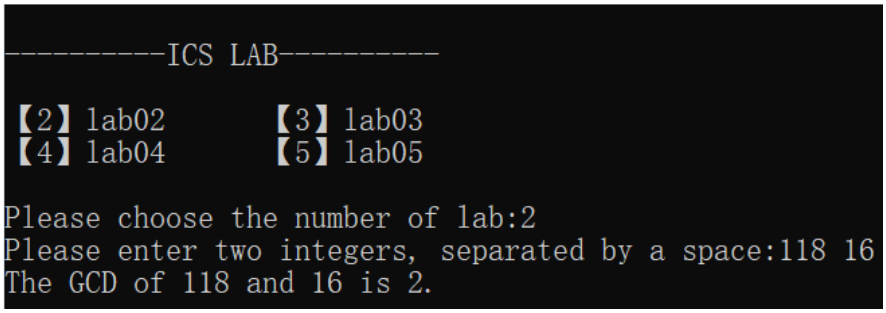
8. Main function

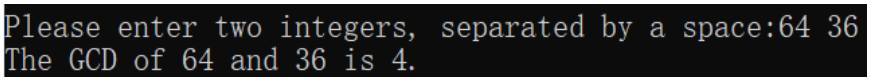
```
int main(){
    int flag = 1,menu = 0,a,b;
    LinkList *L;
    while(flag == 1){
        printf("\n----------ICS LAB----------\n");
        printf("\n【2】lab02  【3】lab03");
        printf("\n【4】lab04  【5】lab05");
        printf("\n\nPlease choose the number of lab:");
        scanf("%d",&menu);
        switch(menu){
            case 2:{
                printf("Please enter two integers, separated by a space:");
                scanf("%d %d",&a,&b);
                printf("The GCD of %d and %d is %d.\n",a,b,lab02(a,b));
                break;
             }
            case 3:{
                L = CreateList();
                printf("\nThe initial linklist: \n");
                PrintList(L);
                lab03(L);
                printf("\nAfter sorting: \n");
                PrintList(L);
                break;
             }
            case 4:{
                lab04();
                break;
            }
            case 5:{
                lab05();
                break;
            }
            default:{
                printf("\n【Wrong input! Please check your input and try again!】\n");
                break;
```

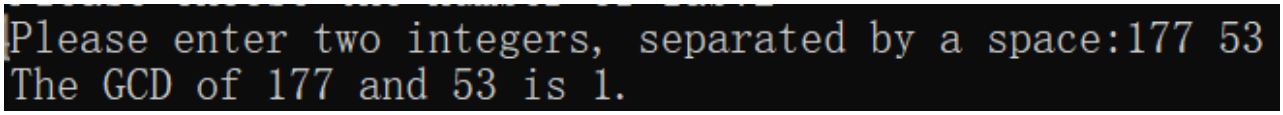
```
            }
         }
        printf("\nPlease continue by pressing 1:");
        scanf("%d",&flag);
     }
    printf("\nProgram termination!\n");
    return 0;
}
```

Result Test

1. Lab02







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:oooooooo
Player 1, choose a row and number of rocks: B2

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

ROW A:oo
ROW B:ooo
ROW C:oooooooo
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:

```c
/*************************************************************
** School:  School Of Data Science, USTC
** auth:    PB19010450 和泳毅
** date:    2021/1/8 16:37:16
** desc:    ICS Lab06--Implement lab02 to lab05 in C language
*************************************************************/

#include<stdio.h>
#include<stdlib.h>
#include<conio.h>

/*Structure of LinkList*/
typedef struct LinkList{
    int             data;
    struct LinkList *next;
}LinkList;

/*********  Function declaration    *********/
LinkList* CreateList();//Create a list for lab03
void PrintList(LinkList *L);//Print the list we created
void PrintRocks(int a,int b,int c);//Print the status of game for lab04
void Calculate(int *n,int ROCKS,int *flag);//Calculate the changes of rocks for lab04
void Interrupt(char *c);//Interrupt the loop for lab05
int lab02(int a,int b);//Greatest Common Divisor
```

```c
void lab03(LinkList *L);//The Linked-List Sort
void lab04();//The Game of Nim
void lab05();//Interrupt a Running Program
/*****************************************/

LinkList* CreateList(){
    int n = 1,a;
    LinkList *L = (LinkList*)malloc(sizeof(LinkList));;
    LinkList *p,*rear = L;
    printf("\nPlease enter the data,end by pressing 2020.\n");
    printf("\nPlease enter the data of the node %d: ",n++);
    scanf("%d",&a);
    while(a != 2020){
        p = (LinkList*)malloc(sizeof(LinkList));
        p->data = a;
        p->next = NULL;
        rear->next = p;
        rear = rear->next;
        printf("\nPlease enter the data of the node %d: ",n++);
        scanf("%d",&a);
    }
    if(rear != NULL)    rear->next = NULL;
    return L;
}

void PrintList(LinkList *L){
    LinkList *p = L->next;
    while(p){
        printf(" %d ",p->data);
        p = p->next;
    }
}

void PrintRocks(int a,int b,int c){
    printf("\nROW A:");
    for(;a > 0;a--) printf("o");
    printf("\nROW B:");
    for(;b > 0;b--) printf("o");
    printf("\nROW C:");
    for(;c > 0;c--) printf("o");
}

void Calculate(int *n,int ROCKS,int *flag){
    if(*n < ROCKS || ROCKS < 0){
        *flag = 1;
        printf("\nInvalid move. Try again.");
        return;
    }
    *n -= ROCKS;
}

void Interrupt(char *c){
    if(kbhit()){
        c = getchar();
        if(c >= '0' && c <= '9')
        printf("\n%c is a decimal digit.\n",c);
        else printf("\n%c is not a decimal digit.\n",c);
    }
}

int lab02(int a,int b){
```

```c
    if(a%b == 0)    return b;
    else    return lab02(b,a%b);
}

void lab03(LinkList *L){
    int i = 0,j = 0,num = 0,temp;
    LinkList *p,*q1,*q2;
    if (!L->next)   return;
    for(p = L->next;p;p = p->next)  num++;
    for (i = 0; i < num - 1; i++) {
        p = L->next;
        for (j = 0; j < num - i - 1; j++) {
            q1 = p;
            q2 = p->next;
            if (q1->data > q2->data) {
                temp = p->data;
                q1->data = q2->data;
                q2->data = temp;
            }
            p = p->next;
        }
    }
}

void lab04(){
    int i = 1,flag = 0;
    int a = 3,b = 5,c = 8,ROCKS;
    char ROW;
    printf("\n-------The NIM Game-------\n");
    while(1){
        if(!a && !b && !c)  break;
        PrintRocks(a,b,c);
        if(i%2)
            printf("\nPlayer 1, choose a row and number of rocks: ");
        else
            printf("\nPlayer 2, choose a row and number of rocks: ");
            getchar();
        scanf("%c",&ROW);
        scanf("%d",&ROCKS);
        if(ROW != 'A' && ROW != 'B' && ROW != 'C'){
            printf("\nInvalid move. Try again.");
            continue;
        }
        if(ROW == 'A')  Calculate(&a,ROCKS,&flag);
        if(ROW == 'B')  Calculate(&b,ROCKS,&flag);
        if(ROW == 'C')  Calculate(&c,ROCKS,&flag);
        if(flag)    continue;
        flag = 0;
        i++;
    }
    if(i%2) printf("\n\nPlayer 2 Wins.\n");
    else    printf("\n\nPlayer 1 Wins.\n");
    printf("\n-------Game Over-------\n");
}

void lab05(){
    char c;
    int a;
    printf("\nPlease stop the loop by pressing P\n");
    while(1){
        printf("ICS2020 ");
```

```
        for(a = 5E8;a > 0;a--);
        if(kbhit()){
            getchar();
            c = getchar();
            if(c >= '0' && c <= '9') printf("%c is a decimal digit.\n",c);
            else if(c == 'p'){
                printf("\n 【End】\n");
                return;
            }
            else printf("%c is not a decimal digit.\n",c);
        }
    }
}

int main(){
    int flag = 1,menu = 0,a,b;
    LinkList *L;
    while(flag == 1){
        printf("\n----------ICS LAB----------\n");
        printf("\n【2】lab02  【3】lab03");
        printf("\n【4】lab04  【5】lab05");
        printf("\n\nPlease choose the number of lab:");
        scanf("%d",&menu);
        switch(menu){
            case 2:{
                printf("Please enter two integers, separated by a space:");
                scanf("%d %d",&a,&b);
                printf("The GCD of %d and %d is %d.\n",a,b,lab02(a,b));
                break;
             }
            case 3:{
                L = CreateList();
                printf("\nThe initial linklist: \n");
                PrintList(L);
                lab03(L);
                printf("\nAfter sorting: \n");
                PrintList(L);
                break;
             }
            case 4:{
                lab04();
                break;
            }
            case 5:{
                lab05();
                break;
            }
            default:{
                printf("\n【Wrong input! Please check your input and try again!】\n");
                break;
            }
         }
        printf("\nPlease continue by pressing 1:");
        scanf("%d",&flag);
     }
    printf("\nProgram termination!\n");
    return 0;
 }
```