操作系统(D)

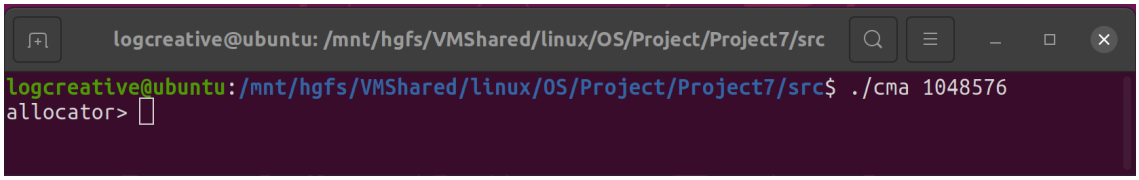
项目 7

Log Creative

2021 年 6 月 15 日

连续内存分配

一 主框架



这里采用一个 alloc 的结构存储进程内存信息：起始、大小和进程名、下一个进程：

```
#define MAXLINE 30
int MAX;

struct alloc
{
    int start;
    int size;
    char process[MAXLINE];
    struct alloc* next;
};
```

采用一个单链表存储内存信息，定义空间起始位置：

```
// List
struct alloc* space_head;
```

获取内存大小：

```
int main(int argc, char* argv[]){
    if(argc==1){
        fprintf(stderr, "Please assign the initial amount of memory.\n");
        return -1;
    }
    MAX = atoi(argv[1]);
```

分配初始内存块：

```
    space_head = (struct alloc*) malloc(sizeof(struct alloc));
    space_head->start = 0;
    space_head->size = MAX;
    strcpy(space_head->process,"Unused");
    space_head->next = NULL;
```

获取命令：

```
    char command[MAXLINE];
    do{
        fprintf(stdout, "allocator> ");
        fscanf(stdin, "%s", command);
        if(strcmp(command,"RQ")==0){
            char process[MAXLINE];
            int size;
            char flag[2];

            fscanf(stdin, "%s", process);
            fscanf(stdin, "%d", &size);
            fscanf(stdin, "%s", flag);

            if(request(process, size, flag))
                fprintf(stderr, "No sufficient memory!\n");

        } else if (strcmp(command,"RL")==0){
            char process[MAXLINE];
            fscanf(stdin, "%s", process);

            if(release(process))
                fprintf(stderr, "No such process to be released!\n");

        } else if (strcmp(command,"C")==0)
            compat();
        else if (strcmp(command,"STAT")==0)
            status();
    } while(strcmp(command,"X")!=0);
}
```

二　状态

```
void status() {
    struct alloc* tmp = space_head;
    while(tmp){
        char process_name[MAXLINE];
        if(strcmp(tmp->process,"Unused")==0) strcpy(process_name,"Unused");
        else {
            strcpy(process_name, "Process ");
            strcat(process_name, tmp->process);
        };
        fprintf(stdout,"Addresses [%d:%d] %s\n", tmp->start, tmp->start + tmp->size - 1, process_name);
        tmp = tmp->next;
    }
}
```

三　分配内存

请求两个进程，一个需要产生碎片，另一个是正好分配。

```
logcreative@ubuntu: /mnt/hgfs/VMShared/linux/OS/Project/Projec...
logcreative@ubuntu:/mnt/hgfs/VMShared/linux/OS/Project/Project7/src$ ./cma 1048576
allocator> RQ P0 40000 W
allocator> STAT
Addresses [0:39999] Process P0
Addresses [40000:1048575] Unused
allocator> RQ P1 1008576 W
allocator> STAT
Addresses [0:39999] Process P0
Addresses [40000:1048575] Process P1
allocator>
```

通过 `flag` 定义分配内存的方式。

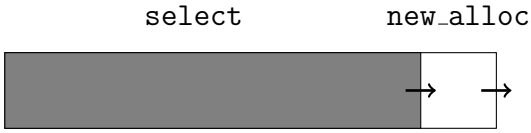
```
int request(char* process, int size, char* flag){
    struct alloc* tmp = space_head;
    struct alloc* select = NULL;
    int besthole;
    switch(flag[0]){
        //...
    }
```

如果没有选择出孔，则会返回错误指标，终止分配。

```
logcreative@ubuntu: /mnt/hgfs/VMShared/linux/OS/Project/Projec...
allocator> STAT
Addresses [0:299999] Process P1
Addresses [300000:1048575] Unused
allocator> RQ P2 10000000 W
No sufficient memory!
allocator>
```

```
    if(!select) return 1;
```

如果选择出了孔，如果这个孔的大小比所需要的内存大，则会产生内部碎片。



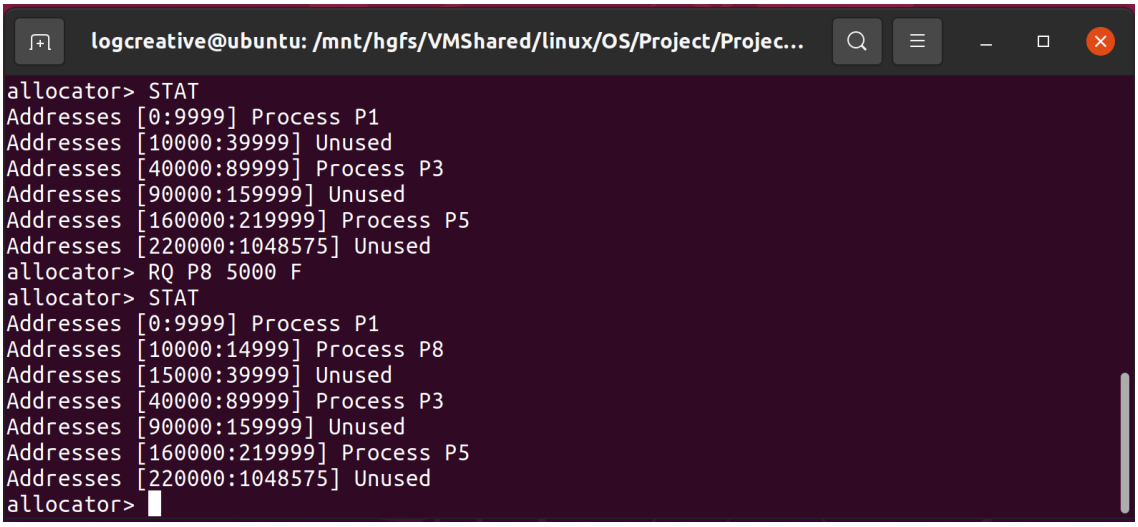

```
    if(select->size > size){
        struct alloc* new_alloc = (struct alloc*) malloc(sizeof(struct alloc));
        new_alloc->start = select->start + size;
        new_alloc->size = select->size - size;
        strcpy(new_alloc->process,"Unused");
        new_alloc->next = select->next;

        select->size = size;
        strcpy(select->process, process);
        select->next = new_alloc;
    }
```

如果刚好，就直接赋予该空间该进程即可。

```
    else if (select->size == size){
        strcpy(select->process, process);
    }
    return 0;
}
```

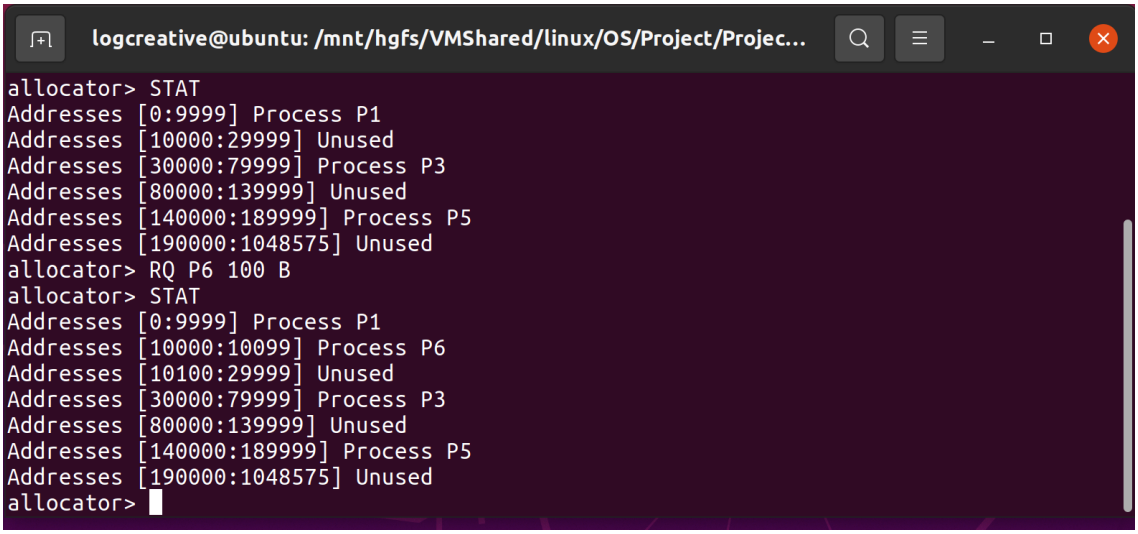
不同的分配方式：

首次适应 选择第一个满足分配空间的孔。



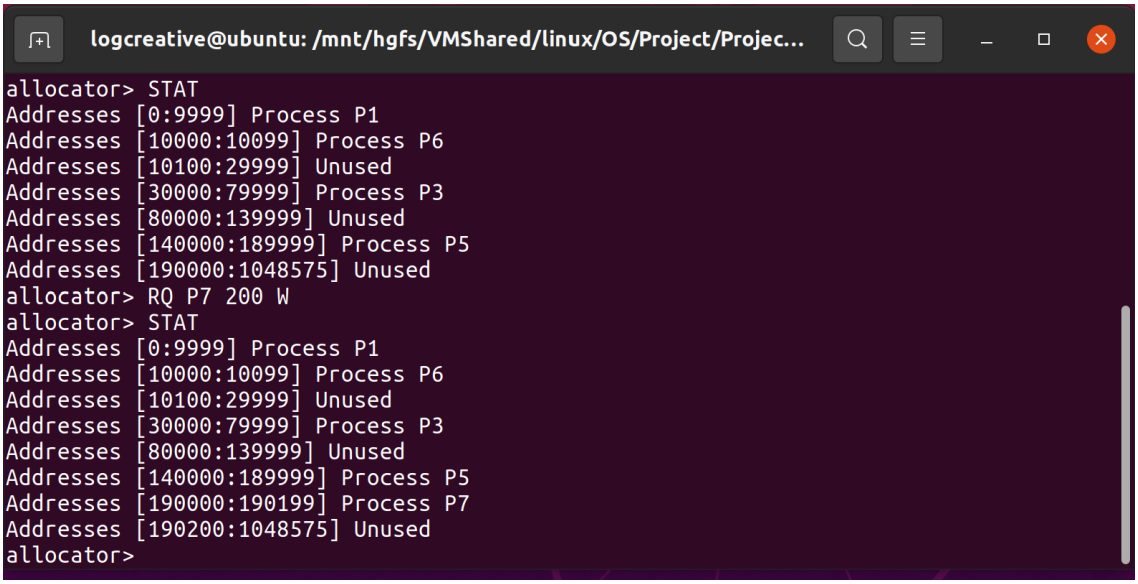

```
        case 'F':
        // First-fit
        while(tmp){
            if(strcmp(tmp->process,"Unused")==0 && tmp->size >= size){
                select = tmp;
                break;
            }
            tmp = tmp -> next;
        }
        break;
```

最优适应 遍历所有的孔，选择能够使得碎片大小最小的孔。



```
            case 'B':
            // Best-fit
            besthole = MAX;
            while(tmp){
                if(strcmp(tmp->process,"Unused")==0 && tmp->size >= size && tmp->size - size <
                     besthole){
                    select = tmp;
                    besthole = tmp->size - size;
                }
                tmp = tmp->next;
            }
            break;
```

最差适应 遍历所有的孔，选择能够使碎片大小最大的孔。




```
            case 'W':
            // Worst-fit
            besthole = -1;
            while(tmp){
                if(strcmp(tmp->process,"Unused")==0 && tmp->size >= size && tmp->size - size >
                     besthole){
                    select = tmp;
                    besthole = tmp->size - size;
                }
                tmp = tmp -> next;
            }
            break;
```

四　释放内存

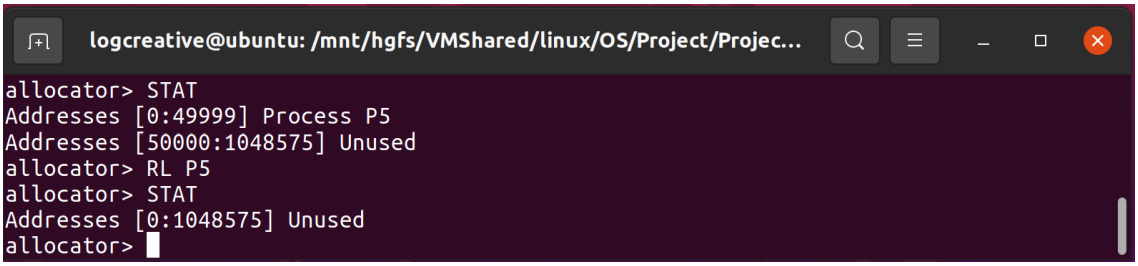
先单独考虑释放的进程是开头的进程。

```
int release(char *process){
    struct alloc* tmp = space_head;
    if(strcmp(tmp->process, process)==0){

        // X -> 0
```

```
    // X X -> O X
    // X O -> O
```

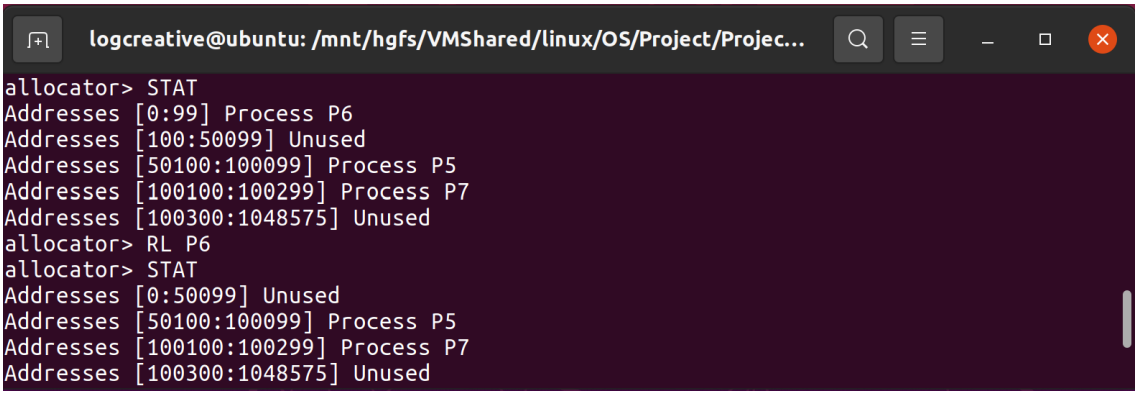
对于开头进程的释放有三种情况：

1. 如果开始的进程后面没有进程了，就直接置零。




```
    int after = (tmp->next ? strcmp(tmp->next->process,"Unused") == 0 : 0);
```

2. 如果开头的进程后面是碎片，就需要将释放后的空间与该碎片合并。




```
    if (after){
        space_head = tmp->next;
        space_head->start -= tmp->size;
        space_head->size += tmp->size;
    }
```

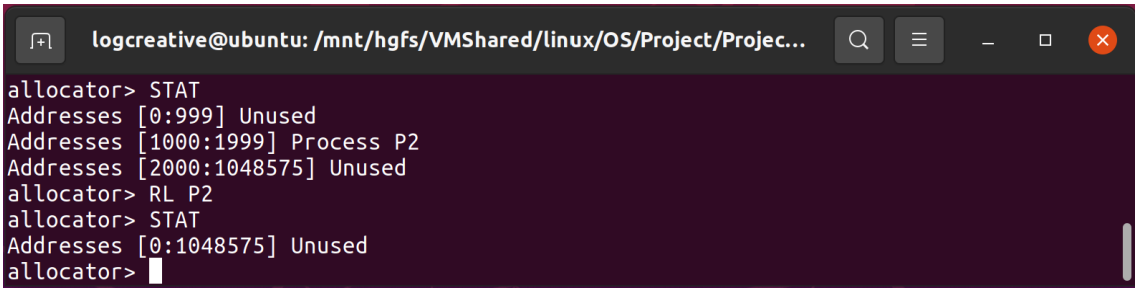
3. 如果开头的进程后面是进程，就直接置零。


```
        else {
            strcpy(space_head->process, "Unused");
        }
        return 0;
    }
```

类似的，对于中间进程的释放，需要分成四种情况：

```
    while(tmp->next){
        if(strcmp(tmp->next->process,process)==0){
            struct alloc* del = tmp->next;

            // O X O -> O
            // X X O -> X O
            // O X X -> O X
            // X X X -> X O X

            int before = strcmp(tmp->process,"Unused") == 0;
            int after = (tmp->next->next ? strcmp(tmp->next->next->process,"Unused") == 0 : 0);
```

1. 前后都为孔，就需要将三孔合一。




```
            if(before && after){
                tmp->size += del->size + tmp->next->next->size;
                tmp->next = tmp->next->next;
            }
```

2. 后为孔，后两个合一。

```
            else if (after){
                tmp->next->next->start -= del->size;
                tmp->next->next->size += del->size;
                tmp->next = tmp->next->next;
            }
```

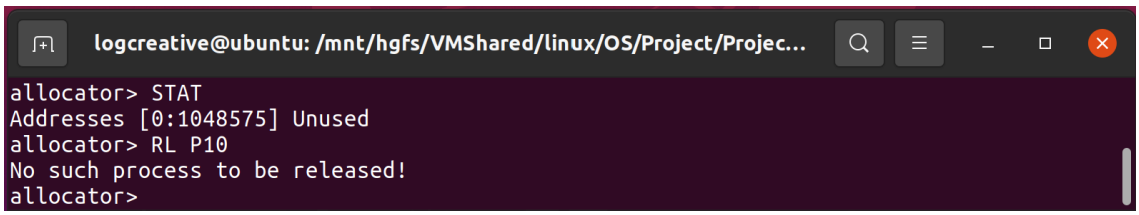
3. 前为孔，前两个合一。

```
            else if (before){
                tmp->size += del->size;
                tmp->next = tmp->next->next;
            }
```

4. 都不为孔，直接置零。

```
            else {
                strcpy(del->process,"Unused");
            }
```

最后移动指标。如果遍历到最后都没有找到，就会返回未找到。




```
            return 0;
        }
        tmp = tmp->next;
    }
    return 1;
}
```

五　紧缩

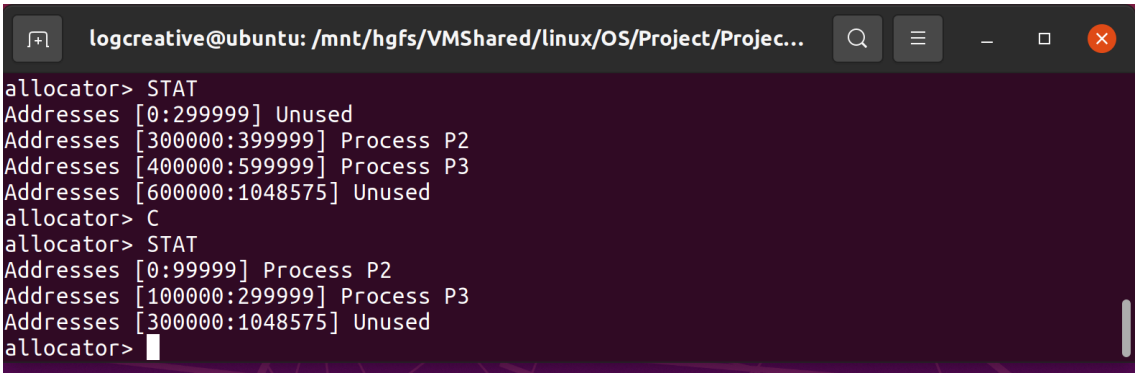
首先寻找尾部，并存储遍历的块次数 count。

```
void compat() {

    struct alloc* tail = space_head;
    int count = 1;
    while(tail->next){
        tail = tail->next;
        ++count;
    }

    // Move to tail
    // O O X X X -> O X X X O -> X X X O O
    // O X X X X -> X X X X O
    // X O X O X -> X X O X O -> X X X O O
```

紧缩共分两步：移动碎片到尾部、碎片合一。

对于移动碎片，分两种情形：

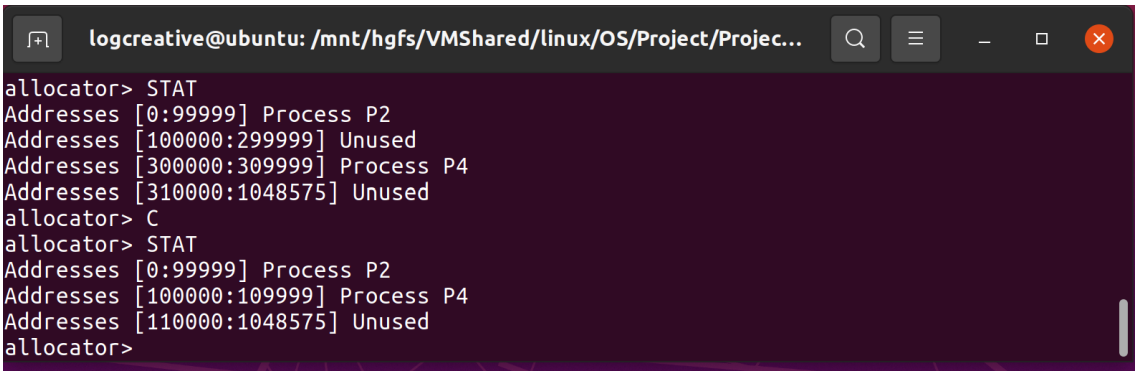
1. 头部是碎片。需要移动空间头 space_head 标记的位置，并遍历到尾部将所有的块开始位置前移，再将碎片挂载在尾部。




```
        struct alloc* tmp = space_head;
        while (tmp->next && strcmp(tmp->process,"Unused")==0){
            space_head = tmp->next;

            struct alloc* ch_tmp = space_head;
```

```
            while(ch_tmp){
                ch_tmp->start -= tmp->size;
                ch_tmp = ch_tmp->next;
            }

            tmp->next = tail->next;
            tmp->start = tail->start + tail->size;
            tail->next = tmp;
            tail = tmp;
            tmp = space_head;
            --count;
            if(!count) break;
        }
```

2. 中间某处是碎片。需要多计算一次移动次数，因为移动了一个指针，并移动了一个块。




```
    while(count) {
        if(!tmp->next) break;
        if(tmp->next->next && strcmp(tmp->next->process,"Unused")==0){
            struct alloc* mover = tmp->next;
            tmp->next = tmp->next->next;

            struct alloc* ch_tmp = tmp->next;
            while(ch_tmp){
                ch_tmp->start -= mover->size;
                ch_tmp = ch_tmp->next;
            }

            mover->next = tail->next;
            mover->start = tail->start + tail->size;
            tail->next = mover;
            tail = mover;
            --count;
        }
        tmp = tmp->next;
        --count;
    }
```

最后将所有的碎片紧缩为一个空余空间。

```
    // Compat the space
    while(tmp && tmp->next){
        tmp->size += tmp->next->size;
```

```
            tmp->next = tmp->next->next;
        }
    }
```

A 全部代码

Listing 1: src/Makefile

```
all:
    gcc -g cma.c -o cma
clean:
    rf cma
```

Listing 2: src/cma.c

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

#define MAXLINE 30
int MAX;

struct alloc
{
    int start;
    int size;
    char process[MAXLINE];
    struct alloc* next;
};

// List
struct alloc* space_head;

int request(char* process, int size, char* flag){
    struct alloc* tmp = space_head;
    struct alloc* select = NULL;
    int besthole;
    switch(flag[0]){
        case 'F':
            // First-fit
            while(tmp){
                if(strcmp(tmp->process,"Unused")==0 && tmp->size >= size){
                    select = tmp;
                    break;
                }
                tmp = tmp -> next;
            }
            break;
        case 'B':
            // Best-fit
            besthole = MAX;
            while(tmp){
                if(strcmp(tmp->process,"Unused")==0 && tmp->size >= size && tmp->size - size < besthole){
```

```
                select = tmp;
                besthole = tmp->size - size;
            }
            tmp = tmp->next;
        }
        break;
    case 'W':
        // Worst-fit
        besthole = -1;
        while(tmp){
            if(strcmp(tmp->process,"Unused")==0 && tmp->size >= size && tmp->size - size > besthole){
                select = tmp;
                besthole = tmp->size - size;
            }
            tmp = tmp -> next;
        }
        break;
  }
  if(!select) return 1;
  if(select->size > size){
      struct alloc* new_alloc = (struct alloc*) malloc(sizeof(struct alloc));
      new_alloc->start = select->start + size;
      new_alloc->size = select->size - size;
      strcpy(new_alloc->process,"Unused");
      new_alloc->next = select->next;

      select->size = size;
      strcpy(select->process, process);
      select->next = new_alloc;
  } else if (select->size == size){
      strcpy(select->process, process);
  }
  return 0;
}

int release(char *process){
  struct alloc* tmp = space_head;
  if(strcmp(tmp->process, process)==0){

      // X -> O
      // X X -> O X
      // X O -> O

      int after = (tmp->next ? strcmp(tmp->next->process,"Unused") == 0 : 0);

      if (after){
          space_head = tmp->next;
          space_head->start -= tmp->size;
          space_head->size += tmp->size;
      } else {
          strcpy(space_head->process, "Unused");
      }

      return 0;
  }
  while(tmp->next){
```

```
        if(strcmp(tmp->next->process,process)==0){
            struct alloc* del = tmp->next;

            // O X O -> O
            // X X O -> X O
            // O X X -> O X
            // X X X -> X O X

            int before = strcmp(tmp->process,"Unused") == 0;
            int after = (tmp->next->next ? strcmp(tmp->next->next->process,"Unused") == 0 : 0);

            if(before && after){
                tmp->size += del->size + tmp->next->next->size;
                tmp->next = tmp->next->next->next;
            } else if (after){
                tmp->next->next->start -= del->size;
                tmp->next->next->size += del->size;
                tmp->next = tmp->next->next;
            } else if (before){
                tmp->size += del->size;
                tmp->next = tmp->next->next;
            } else {
                strcpy(del->process,"Unused");
            }

            return 0;
        }
        tmp = tmp->next;
    }
    return 1;
}

void compat() {

    struct alloc* tail = space_head;
    int count = 1;
    while(tail->next){
        tail = tail->next;
        ++count;
    }

    // Move to tail
    // O O X X X -> O X X X O -> X X X O O
    // O X X X X -> X X X X O
    // X O X O X -> X X O X O -> X X X O O

    struct alloc* tmp = space_head;
    while (tmp->next && strcmp(tmp->process,"Unused")==0){
        space_head = tmp->next;

        struct alloc* ch_tmp = space_head;
        while(ch_tmp){
            ch_tmp->start -= tmp->size;
            ch_tmp = ch_tmp->next;
        }
```

```
        tmp->next = tail->next;
        tmp->start = tail->start + tail->size;
        tail->next = tmp;
        tail = tmp;
        tmp = space_head;
        --count;
        if(!count) break;
    }

    while(count) {
        if(!tmp->next) break;
        if(tmp->next->next && strcmp(tmp->next->process,"Unused")==0){
            struct alloc* mover = tmp->next;
            tmp->next = tmp->next->next;

            struct alloc* ch_tmp = tmp->next;
            while(ch_tmp){
                ch_tmp->start -= mover->size;
                ch_tmp = ch_tmp->next;
            }

            mover->next = tail->next;
            mover->start = tail->start + tail->size;
            tail->next = mover;
            tail = mover;
            --count;
        }
        tmp = tmp->next;
        --count;
    }

    // Compat the space
    while(tmp && tmp->next){
        tmp->size += tmp->next->size;
        tmp->next = tmp->next->next;
    }
}

void status() {
    struct alloc* tmp = space_head;
    while(tmp){
        char process_name[MAXLINE];
        if(strcmp(tmp->process,"Unused")==0) strcpy(process_name,"Unused");
        else {
            strcpy(process_name, "Process ");
            strcat(process_name, tmp->process);
        };
        fprintf(stdout,"Addresses [%d:%d] %s\n", tmp->start, tmp->start + tmp->size - 1, process_name);
        tmp = tmp->next;
    }
}

int main(int argc, char* argv[]){
    // if(argc==1){
    //     fprintf(stderr, "Please assign the initial amount of memory.\n");
    //     return -1;
```

```
    // }
    // MAX = atoi(argv[1]);
    MAX = 1048576;

    space_head = (struct alloc*) malloc(sizeof(struct alloc));
    space_head->start = 0;
    space_head->size = MAX;
    strcpy(space_head->process,"Unused");
    space_head->next = NULL;

    char command[MAXLINE];
    do{
        fprintf(stdout, "allocator> ");
        fscanf(stdin, "%s", command);
        if(strcmp(command,"RQ")==0){
            char process[MAXLINE];
            int size;
            char flag[2];

            fscanf(stdin, "%s", process);
            fscanf(stdin, "%d", &size);
            fscanf(stdin, "%s", flag);

            if(request(process, size, flag))
                fprintf(stderr, "No sufficient memory!\n");

        } else if (strcmp(command,"RL")==0){
            char process[MAXLINE];
            fscanf(stdin, "%s", process);

            if(release(process))
                fprintf(stderr, "No such process to be released!\n");

        } else if (strcmp(command,"C")==0)
            compat();
        else if (strcmp(command,"STAT")==0)
            status();
    } while(strcmp(command,"X")!=0);
}
```