200行Python代码实现2048

一、实验说明

1. 环境登录

无需密码自动登录，系统用户名shiyanlou

2. 环境介绍

本实验环境采用带桌面的Ubuntu Linux环境，实验中会用到桌面上的程序：

1. LX终端（LXTerminal）：Linux命令行终端，打开后会进入Bash环境，可以使用Linux命令

3. 环境使用

使用GVim编辑器输入实验所需的代码及文件，使用LX终端（LXTerminal）运行所需命令进行操作。

实验报告可以在个人主页中查看，其中含有每次实验的截图及笔记，以及每次实验的有效学习时间（指的是在实验桌面内操作的时间，如果没有操作，系统会记录为发呆时间）。这些都是您学习的真实性证明。

4. 知识点

本节实验中将学习和实践以下知识点：

a. Python基本知识

二、实验内容

是的，又是2048，这回我们是用 Python 实现，只需要200行代码，不用很麻烦很累就可以写一个 2048 游戏出来。

实验楼上已有的 2048 课程：

- GO语言开发2048
- 网页版2048
- C语言制作2048

游戏玩法这里就不再赘述了，还会有比亲自玩一遍体会规则更快的的吗：）

2048 原版游戏地址：http://gabrielecirulli.github.io/2048

创建游戏文件 2048.py

首先导入需要的包：

```
import curses
from random import randrange, choice
```

```
from collections import defaultdict
```

1. 主逻辑

1.1 用户行为

所有的有效输入都可以转换为"上，下，左，右，游戏重置，退出"这六种行为，用 `actions` 表示

```
actions = ['Up', 'Left', 'Down', 'Right', 'Restart', 'Exit']
```

有效输入键是最常见的 W（上），A（左），S（下），D（右），R（重置），Q（退出），这里要考虑到大写键开启的情况，获得有效键值列表：

```
letter_codes = [ord(ch) for ch in 'WASDRQwasdrq']
```

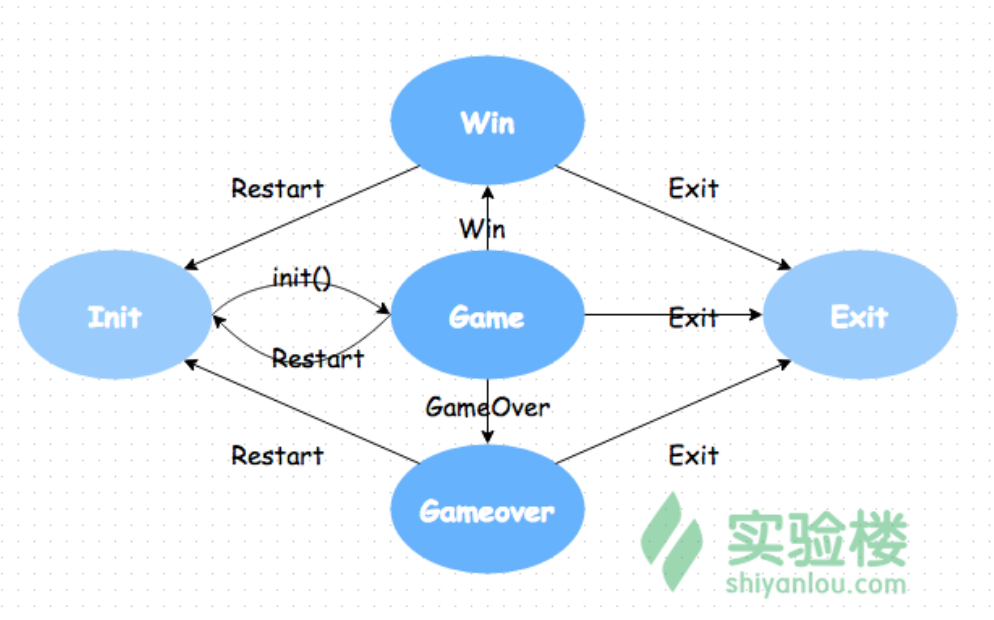
将输入与行为进行关联：

```
actions_dict = dict(zip(letter_codes, actions * 2))
```

1.2 状态机

处理游戏主逻辑的时候我们会用到一种十分常用的技术：状态机，或者更准确的说是有限状态机（FSM）

你会发现 2048 游戏很容易就能分解成几种状态的转换。



`state` 存储当前状态， `state_actions` 这个词典变量作为状态转换的规则，它的 key 是状态，value 是返回下一个状态的函数：

- Init: init()
  - Game
- Game: game()
  - Game
  - Win
  - GameOver
  - Exit
- Win: lambda: not_game('Win')
  - Init
  - Exit
- Gameover: lambda: not_game('Gameover')
  - Init
  - Exit
- Exit: 退出循环

状态机会不断循环，直到达到 Exit 终结状态结束程序。

下面是经过提取的主逻辑的代码，会在后面进行补全：

```
def main(stdscr):

    def init():
        #重置游戏棋盘
        return 'Game'

    def not_game(state):
        #画出 GameOver 或者 Win 的界面
        #读取用户输入得到action，判断是重启游戏还是结束游戏
        responses = defaultdict(lambda: state) #默认是当前状态，没有行为就会一直在当前界面循环
        responses['Restart'], responses['Exit'] = 'Init', 'Exit' #对应不同的行为转换到不同的状态
        return responses[action]

    def game():
        #画出当前棋盘状态
        #读取用户输入得到action
        if action == 'Restart':
            return 'Init'
        if action == 'Exit':
            return 'Exit'
        #if 成功移动了一步:
            if 游戏胜利了:
                return 'Win'
            if 游戏失败了:
                return 'Gameover'
        return 'Game'


    state_actions = {
            'Init': init,
            'Win': lambda: not_game('Win'),
            'Gameover': lambda: not_game('Gameover'),
            'Game': game
        }

    state = 'Init'
```

```
    #状态机开始循环
    while state != 'Exit':
        state = state_actions[state]()
```

2. 用户输入处理

阻塞 + 循环，直到获得用户有效输入才返回对应行为：

```
def get_user_action(keyboard):
    char = "N"
    while char not in actions_dict:
        char = keyboard.getch()
    return actions_dict[char]
```

3. 矩阵转置与矩阵逆转

加入这两个操作可以大大节省我们的代码量，减少重复劳动，看到后面就知道了。

矩阵转置：

```
def transpose(field):
    return [list(row) for row in zip(*field)]
```

矩阵逆转（不是逆矩阵）：

```
def invert(field):
    return [row[::-1] for row in field]
```

4. 创建棋盘

初始化棋盘的参数，可以指定棋盘的高和宽以及游戏胜利条件，默认是最经典的 4x4～2048。

```
    class GameField(object):
        def __init__(self, height=4, width=4, win=2048):
            self.height = height        #高
            self.width = width          #宽
            self.win_value = 2048       #过关分数
            self.score = 0              #当前分数
            self.highscore = 0          #最高分
            self.reset()                #棋盘重置
```

4.1 棋盘操作

随机生成一个 2 或者 4

```
def spawn(self):
        new_element = 4 if randrange(100) > 89 else 2
        (i,j) = choice([(i,j) for i in range(self.width) for j in range(self.height) if self.field[i][j] == 0])
        self.field[i][j] = new_element
```

重置棋盘

```
def reset(self):
    if self.score > self.highscore:
        self.highscore = self.score
    self.score = 0
    self.field = [[0 for i in range(self.width)] for j in range(self.height)]
    self.spawn()
    self.spawn()
```

一行向左合并

(注：这一操作是在 move 内定义的，拆出来是为了方便阅读)

```
def move_row_left(row):
    def tighten(row): # 把零散的非零单元挤到一块
        new_row = [i for i in row if i != 0]
        new_row += [0 for i in range(len(row) - len(new_row))]
        return new_row

    def merge(row): # 对邻近元素进行合并
        pair = False
        new_row = []
        for i in range(len(row)):
            if pair:
                new_row.append(2 * row[i])
                self.score += 2 * row[i]
                pair = False
            else:
                if i + 1 < len(row) and row[i] == row[i + 1]:
                    pair = True
                    new_row.append(0)
                else:
                    new_row.append(row[i])
        assert len(new_row) == len(row)
        return new_row
    #先挤到一块再合并再挤到一块
    return tighten(merge(tighten(row)))
```

棋盘走一步

通过对矩阵进行转置与逆转，可以直接从左移得到其余三个方向的移动操作

```
def move(self, direction):
    def move_row_left(row):
        #一行向左合并

    moves = {}
    moves['Left']  = lambda field: [move_row_left(row) for row in field]
    moves['Right'] = lambda field: invert(moves['Left'](invert(field)))
    moves['Up']    = lambda field: transpose(moves['Left'](transpose(field)))
    moves['Down']  = lambda field: transpose(moves['Right'](transpose(field)))

    if direction in moves:
        if self.move_is_possible(direction):
            self.field = moves[direction](self.field)
            self.spawn()
            return True
        else:
            return False
```

判断输赢

```
def is_win(self):
    return any(any(i >= self.win_value for i in row) for row in self.field)

def is_gameover(self):
    return not any(self.move_is_possible(move) for move in actions)
```

判断能否移动

```
def move_is_possible(self, direction):
    def row_is_left_movable(row):
        def change(i):
            if row[i] == 0 and row[i + 1] != 0: # 可以移动
                return True
            if row[i] != 0 and row[i + 1] == row[i]: # 可以合并
                return True
            return False
        return any(change(i) for i in range(len(row) - 1))

    check = {}
    check['Left']  = lambda field: any(row_is_left_movable(row) for row in field)

    check['Right'] = lambda field: check['Left'](invert(field))

    check['Up']    = lambda field: check['Left'](transpose(field))

    check['Down']  = lambda field: check['Right'](transpose(field))

    if direction in check:
        return check[direction](self.field)
```

```
    else:
        return False
```

4.2 绘制游戏界面

（注：这一步是在棋盘类内定义的）

```
def draw(self, screen):
    help_string1 = '(W)Up (S)Down (A)Left (D)Right'
    help_string2 = '     (R)Restart (Q)Exit'
    gameover_string = '           GAME OVER'
    win_string = '          YOU WIN!'
    def cast(string):
        screen.addstr(string + '\n')

    #绘制水平分割线
    def draw_hor_separator():
        line = '+' + ('+------' * self.width + '+')[1:]
        separator = defaultdict(lambda: line)
        if not hasattr(draw_hor_separator, "counter"):
            draw_hor_separator.counter = 0
        cast(separator[draw_hor_separator.counter])
        draw_hor_separator.counter += 1

    def draw_row(row):
        cast(''.join('|{: ^5} '.format(num) if num > 0 else '|      ' for num in row) + '|')

    screen.clear()

    cast('SCORE: ' + str(self.score))
    if 0 != self.highscore:
        cast('HIGHSCORE: ' + str(self.highscore))

    for row in self.field:
        draw_hor_separator()
        draw_row(row)

    draw_hor_separator()

    if self.is_win():
        cast(win_string)
    else:
        if self.is_gameover():
            cast(gameover_string)
        else:
            cast(help_string1)
    cast(help_string2)
```

5. 完成主逻辑

完成以上工作后，我们就可以补完主逻辑了！

```
def main(stdscr):
    def init():
        #重置游戏棋盘
        game_field.reset()
        return 'Game'

    def not_game(state):
        #画出 GameOver 或者 Win 的界面
        game_field.draw(stdscr)
        #读取用户输入得到action，判断是重启游戏还是结束游戏
        action = get_user_action(stdscr)
        responses = defaultdict(lambda: state) #默认是当前状态，没有行为就会一直在当前界面循环
        responses['Restart'], responses['Exit'] = 'Init', 'Exit' #对应不同的行为转换到不同的状态
        return responses[action]

    def game():
        #画出当前棋盘状态
        game_field.draw(stdscr)
        #读取用户输入得到action
        action = get_user_action(stdscr)

        if action == 'Restart':
            return 'Init'
        if action == 'Exit':
            return 'Exit'
        if game_field.move(action): # move successful
            if game_field.is_win():
                return 'Win'
            if game_field.is_gameover():
                return 'Gameover'
        return 'Game'


    state_actions = {
            'Init': init,
            'Win': lambda: not_game('Win'),
            'Gameover': lambda: not_game('Gameover'),
            'Game': game
        }

    curses.use_default_colors()
    game_field = GameField(win=2048)


    state = 'Init'

    #状态机开始循环
    while state != 'Exit':
        state = state_actions[state]()
```

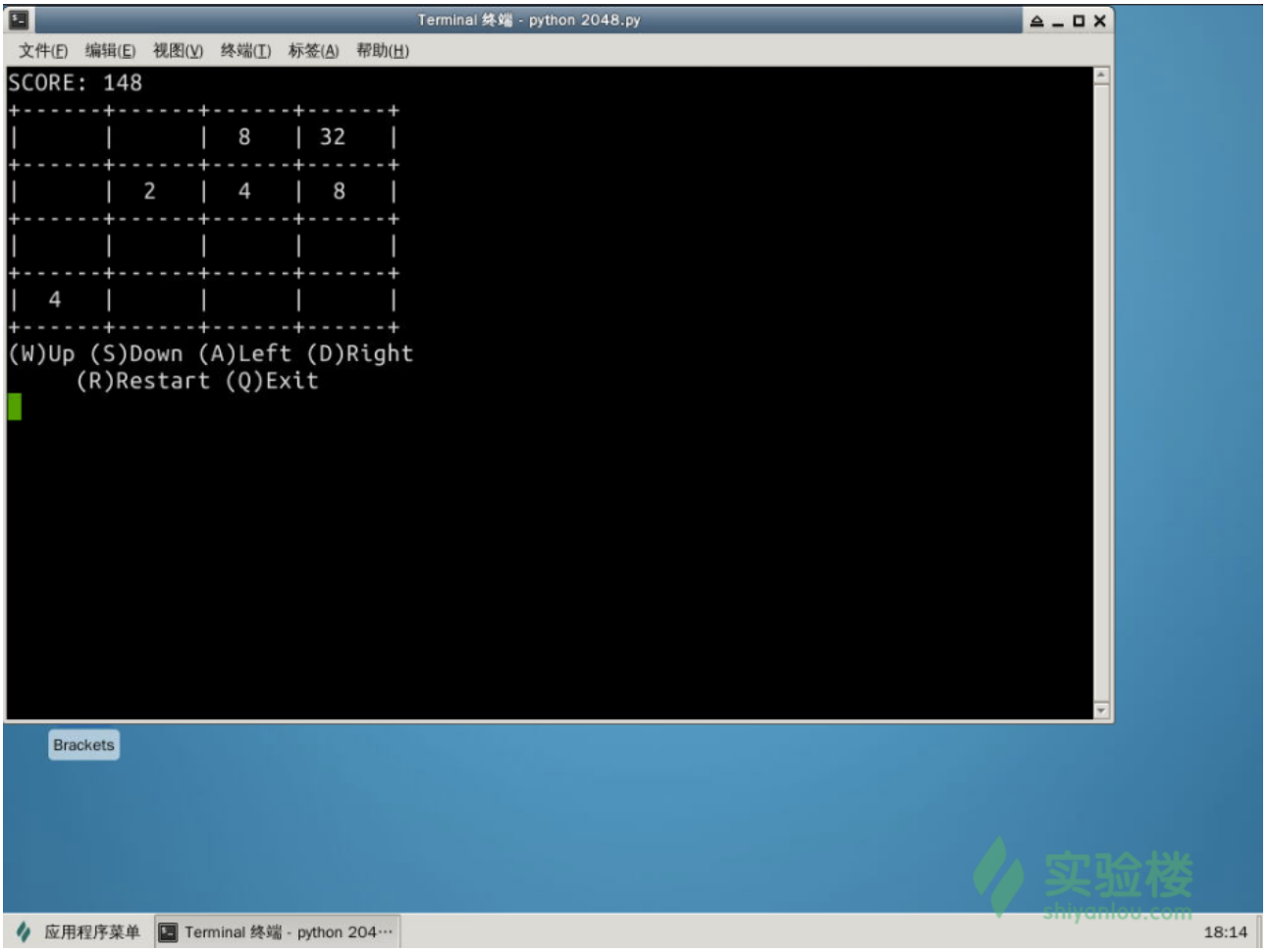
6. 运行

填上最后一行代码：

```
curses.wrapper(main)
```

运行看看吧！

```
$ python 2048.py
```



全部代码

```
#-*- coding:utf-8 -*-

import curses
from random import randrange, choice # generate and place new tile
from collections import defaultdict

letter_codes = [ord(ch) for ch in 'WASDRQwasdrq']
actions = ['Up', 'Left', 'Down', 'Right', 'Restart', 'Exit']
actions_dict = dict(zip(letter_codes, actions * 2))

def get_user_action(keyboard):
    char = "N"
    while char not in actions_dict:
        char = keyboard.getch()
    return actions_dict[char]

def transpose(field):
    return [list(row) for row in zip(*field)]
```

```
def invert(field):
    return [row[::-1] for row in field]

class GameField(object):
    def __init__(self, height=4, width=4, win=2048):
        self.height = height
        self.width = width
        self.win_value = win
        self.score = 0
        self.highscore = 0
        self.reset()

    def reset(self):
        if self.score > self.highscore:
            self.highscore = self.score
        self.score = 0
        self.field = [[0 for i in range(self.width)] for j in range(self.height)]
        self.spawn()
        self.spawn()

    def move(self, direction):
        def move_row_left(row):
            def tighten(row): # squeese non-zero elements together
                new_row = [i for i in row if i != 0]
                new_row += [0 for i in range(len(row) - len(new_row))]
                return new_row

            def merge(row):
                pair = False
                new_row = []
                for i in range(len(row)):
                    if pair:
                        new_row.append(2 * row[i])
                        self.score += 2 * row[i]
                        pair = False
                    else:
                        if i + 1 < len(row) and row[i] == row[i + 1]:
                            pair = True
                            new_row.append(0)
                        else:
                            new_row.append(row[i])
                assert len(new_row) == len(row)
                return new_row
            return tighten(merge(tighten(row)))

        moves = {}
        moves['Left']  = lambda field:                              \
                [move_row_left(row) for row in field]
        moves['Right'] = lambda field:                              \
                invert(moves['Left'](invert(field)))
        moves['Up']    = lambda field:                              \
                transpose(moves['Left'](transpose(field)))
        moves['Down']  = lambda field:                              \
                transpose(moves['Right'](transpose(field)))

        if direction in moves:
            if self.move_is_possible(direction):
                self.field = moves[direction](self.field)
                self.spawn()
                return True
            else:
                return False

    def is_win(self):
```

```
        return any(any(i >= self.win_value for i in row) for row in self.field)

    def is_gameover(self):
        return not any(self.move_is_possible(move) for move in actions)

    def draw(self, screen):
        help_string1 = '(W)Up (S)Down (A)Left (D)Right'
        help_string2 = '     (R)Restart (Q)Exit'
        gameover_string = '           GAME OVER'
        win_string = '          YOU WIN!'
        def cast(string):
            screen.addstr(string + '\n')

        def draw_hor_separator():
            line = '+' + ('+------' * self.width + '+')[1:]
            separator = defaultdict(lambda: line)
            if not hasattr(draw_hor_separator, "counter"):
                draw_hor_separator.counter = 0
            cast(separator[draw_hor_separator.counter])
            draw_hor_separator.counter += 1

        def draw_row(row):
            cast(''.join('|{: ^5} '.format(num) if num > 0 else '|      ' for num in row) + '|')

        screen.clear()
        cast('SCORE: ' + str(self.score))
        if 0 != self.highscore:
            cast('HIGHSCORE: ' + str(self.highscore))
        for row in self.field:
            draw_hor_separator()
            draw_row(row)
        draw_hor_separator()
        if self.is_win():
            cast(win_string)
        else:
            if self.is_gameover():
                cast(gameover_string)
            else:
                cast(help_string1)
        cast(help_string2)

    def spawn(self):
        new_element = 4 if randrange(100) > 89 else 2
        (i,j) = choice([(i,j) for i in range(self.width) for j in range(self.height) if self.field[i][j] == 0])
        self.field[i][j] = new_element

    def move_is_possible(self, direction):
        def row_is_left_movable(row):
            def change(i): # true if there'll be change in i-th tile
                if row[i] == 0 and row[i + 1] != 0: # Move
                    return True
                if row[i] != 0 and row[i + 1] == row[i]: # Merge
                    return True
                return False
            return any(change(i) for i in range(len(row) - 1))

        check = {}
        check['Left']  = lambda field:                              \
                any(row_is_left_movable(row) for row in field)

        check['Right'] = lambda field:                              \
                 check['Left'](invert(field))

        check['Up']    = lambda field:                              \
```

```
                check['Left'](transpose(field))

        check['Down']  = lambda field:                              \
                check['Right'](transpose(field))

        if direction in check:
            return check[direction](self.field)
        else:
            return False

def main(stdscr):
    def init():
        #重置游戏棋盘
        game_field.reset()
        return 'Game'

    def not_game(state):
        #画出 GameOver 或者 Win 的界面
        game_field.draw(stdscr)
        #读取用户输入得到action，判断是重启游戏还是结束游戏
        action = get_user_action(stdscr)
        responses = defaultdict(lambda: state) #默认是当前状态，没有行为就会一直在当前界面循环
        responses['Restart'], responses['Exit'] = 'Init', 'Exit' #对应不同的行为转换到不同的状态
        return responses[action]

    def game():
        #画出当前棋盘状态
        game_field.draw(stdscr)
        #读取用户输入得到action
        action = get_user_action(stdscr)

        if action == 'Restart':
            return 'Init'
        if action == 'Exit':
            return 'Exit'
        if game_field.move(action): # move successful
            if game_field.is_win():
                return 'Win'
            if game_field.is_gameover():
                return 'Gameover'
        return 'Game'


    state_actions = {
            'Init': init,
            'Win': lambda: not_game('Win'),
            'Gameover': lambda: not_game('Gameover'),
            'Game': game
        }

    curses.use_default_colors()
    game_field = GameField(win=32)


    state = 'Init'

    #状态机开始循环
    while state != 'Exit':
        state = state_actions[state]()

curses.wrapper(main)
```

b. 状态机的概念

2. GVim：非常好用的编辑器，最简单的用法可以参考课程Vim编辑器