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CSC-11

Survival RPG

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Introduction

Title: Survival RPG

The project is an assembly implementation of very basic coordinate system and battle system. These systems are key elements of a huge range of RPGs. Once set up, these systems are easy to build upon. For example, a shop could be added later or a more complex map system to make exploring a much more diverse world possible.

Summary

The c code version is about 200 lines of code, while the assembly version is about 500 lines. This 500 lines does not include the modulus function imported from a previous homework. The most challenging aspect was managing the string that was the visual aspect of the map. Registers are designed to deal with 4 bytes at a time, so writing to just one byte requires some byte manipulation to not change the values of the surrounding 3 bytes. As such, the use of bitwise operators were required for that. To not change the values of the surrounding 3 bytes, they were copied and combined with the single byte that was to be written. This causes the surrounding 3 bytes to be overwritten with the same value they started with before the write. For a non-threaded program, this is equivalent to writing 1 byte. For the combination of the 3 bytes and 1 byte, the inclusive or bitwise operator was used after ensuring the other bytes of each registered were zeroed out. Zeroing out the other bytes of the register was achievable with bit shifting. The one useful aspect of the 4 byte register dealing with an array of bytes is that multiple bytes of the array can be written at once. This is used during the initialization of the map since they are all set to the same character. For the entire project, it took a few days for the assembly code. The use of memory addresses to access structures as memory blocks complicated the assembly code greatly in comparison to c code.

Description

The program was developed piece by piece. The first piece created was the overall control flow. I checked to make sure that the while loop in main worked and would exit. After the general flow of it was laid out, more and more logic would be implemented. It went from creating battlers, to creating the battle function, and then finally to the text visual of seeing yourself traveling through the map. When errors occurred, gdb was used a lot to find where the segfault occurred. To make the code manageable, commenting was used to provide additional information. In particular, structures were commented to keep track of which order the variables were in an a structure. For functions, arguments required were typically commented to keep in mind which input it's meant to work with. While working with the floating point processor, a bus error occurred for vldr, which caused a little confusion at first. Had it been a regular ldr operation, it would've just segfaulted. Gdb easily found where it occurred once the backtrace was looked at for the bus error.

Screenshots

r

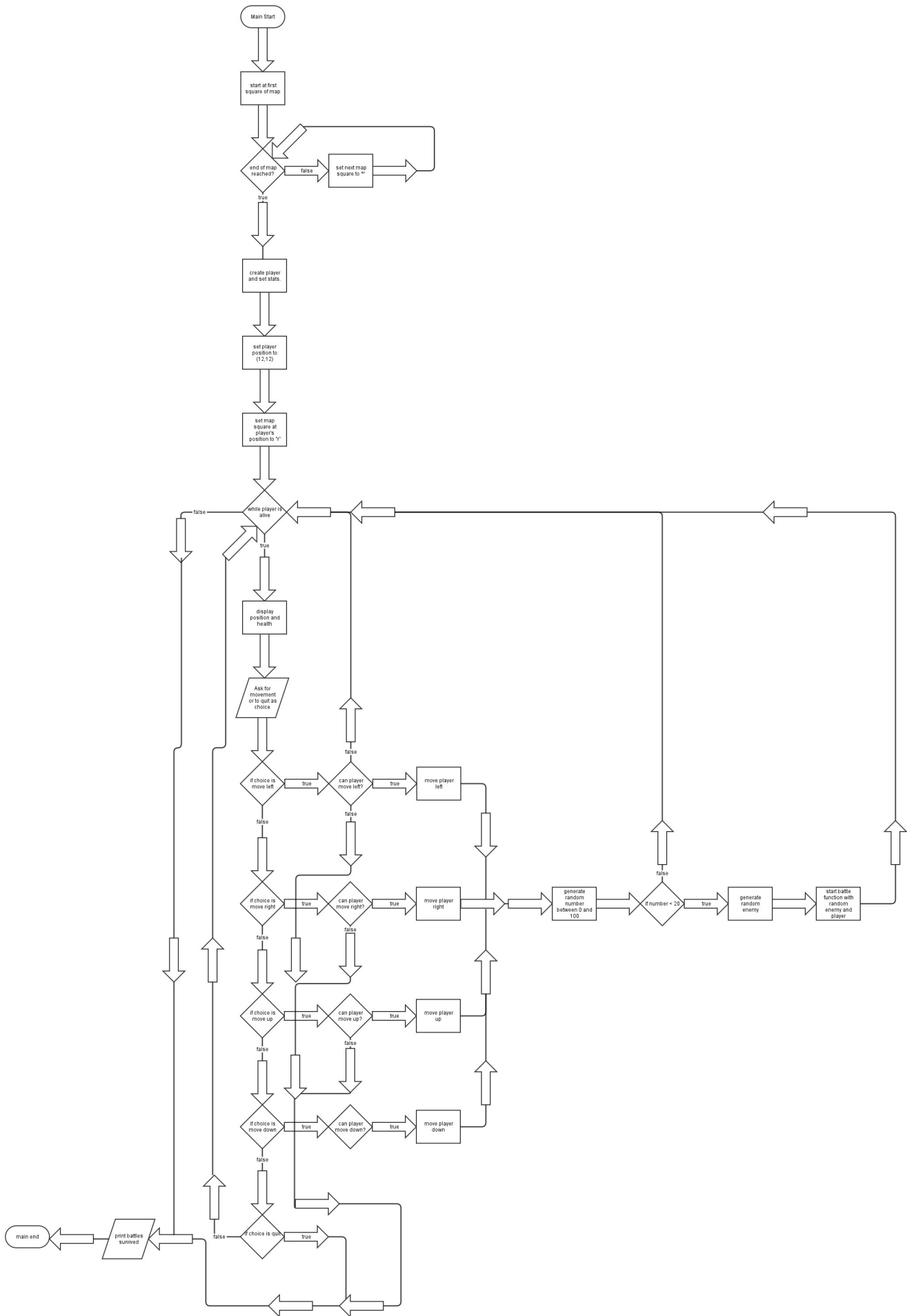
[illegible]

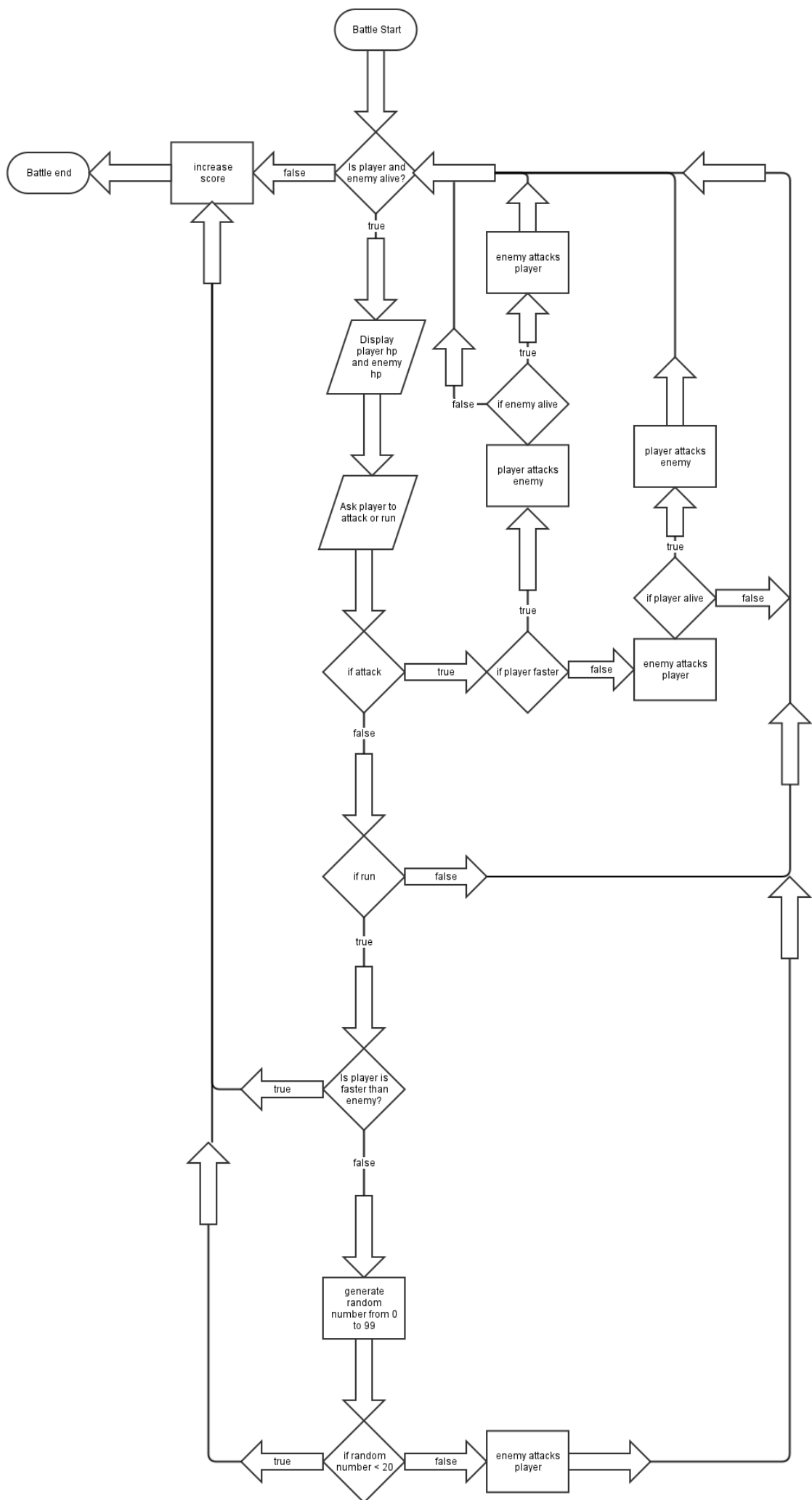
r

```
-----
| a)Attack    b)Run
```


[illegible]

Flow Chart





Pseudo Code

map is an array of ASCII characters

position is a point (x,y)

stats are hp, attack, defense, and speed

battlers are a combination of stats, position, and a name

hit (attacker, receiver) {

 if attacker's attack not greater than the receiver's defense:

 receiver lost 1 hp

 else:

 receiver's hp drops by the difference between the two

}

battle (player, enemy) {

 print enemy encountered

 while enemy and player are alive:

 ask player whether to run or attack

 if attack:

 if player faster:

 have player hit enemy

 if enemy alive:

 have enemy hit player

 else:

 have enemy hit player

if player alive:

 have player hit enemy

if run:

 if run successful

 print run successful

 quit battle

 else have enemy hit player

 print run failed

 have enemy hit player

}

display_map (map) {

for each square in map, print square

}

main() {

Both player and enemy are battlers.

while player is alive:

 display position, hp, and map

 ask player which option he/she chooses

 if player choses to move left, move player left

 if player chooses to move right, move player right

 if player chooses to move up, move player up

 if player chooses to move down, move player down

 if player chooses to quit, print battles encountered and quit

 if player has chosen any of the movements above,

 if player would've moved outside the map

```

        prevent the move

    else

        randomly decide if to generate a random enemy.

        If random enemy generated,

            start battle between player and random enemy

if player died

    print game over

    print battles encountered

    quit
}

```

Major Variables

Type	Variable Name	Description	Location
Byte array	map	Visual representation of Map as text	main.s
word	score	Number of battles encountered	main.s
Battler Array	battlers	Array of all battlers needed to be allocated at once. One for the player and one for the enemy.	main.s

Structures

Coordinate: Contains the position of something on the map.

word X

word Y

Stats: Contains all the stats necessary for calculations in battle.

Word HP

word Attack

word Defense

float Speed

Battler: A structure containing all the data necessary for the main player as well as enemies.

Stats stats

Coordinate position

String name

Language Constructs

C-level view of assembly

for loop: used to initialize the map

while loop: used for main loop and battle loop

if else: used in many places, such as checking if a player is faster than the enemy during attempting to run

switch-case: used for choices in main loop and battle

function calls: used in many places, such as for printing, and for doing battling

assembly level view

branching: used everywhere, including main loop

printf: used for printing, such as in main loop

scanf: used for getting input, such as in reply to asking what to do in main loop

mov: used everywhere, including main loop

.balign 4: used for most data to align it

.global: used to make a function or data accessible to other assembly files during linking

push: used for functions that required more than 4 arguments, such as initBattler

pop: used for same reason as pop, but to take out the arguments instead of placing them

ldr: used in many places to load from memory or to load values too big for a mov

add: used for adding, such as pointers offset

sub: used for subtracting, such as decreasing health during an attack

lsl: used to shift bits around for dealing with the map, which was a byte array

lsr: same as lsl, but shifts bits to the right instead of left

orr, used to combine the bits to two registers when dealing with the map, one register holding 3 bytes that are already in the map, and the other holding the byte to write. Mnemonic for bitwise operator inclusive or.

.macro/.endm: used to create a copy and paste macro similar to what the c preprocessor can do.

labels: used to name sections of code to jump to in a branch

.ascii: used to make null terminated strings

.ascii: used to make a string

.byte: used to put my name into the executable as seen in the end of main.s. Also used for data such as inputChar

mul: used for multiplication for finding which map index an (x,y) coordinate is in mapCoordinateToIndex

vldr: used to load speed into the float point processor

vcmp: used to compare speeds in the float point processor

vmrs: used to move status flags from speed comparison to the regular status flags so they can be used for later branching

memory addresses: used to refer to allocated variables with label names

.text: used to denote code section and constants

.data: used to denote data section

.include: used to include other assembler files that contain macros and symbols that the linker doesn't deal with

.skip: used to allocate map as a byte array

References

Code from the modulus homework was placed into the project to use it as part of the range for random number generation and for the display of the map to make sure each row gets printed on it's own line. In addition to that, a few functions from the standard c library were used. The c functions used were printf, scanf, getchar, srand, and rand. printf and scanf were imported for the purpose of output and input respectively. The fucntion getchar was necessary to keep the input and output working as expected by clearing out any newlines left by scanf. For random values, srand, rand, and time was imported so that I could make enemy encounters random.

Program

attack.s

.balign 4

.text

.global attack

/*args

 R0 is pointer to attacker

 R1 is pointer to receiver*/

attack:

 /*HP*/

 ldr R2, [R1]

 /*Defense*/

 ldr R3, [R1,#8]

 /*Attack*/


```

        ldr R0, [R0,#4]

        cmp R0, R3

        bls oneDamage

/*normal damage calculation*/

        sub R0, R0, R3

        sub R2, R2, R0

        b attackReturn

oneDamage:

        mov R3, #1

        sub R2, R2, R3

attackReturn:

        str R2, [R1]

        bx LR

```

battle.s

```

.data

.balign 4

return: .word 0

.balign 4

inputChar: .word 0


.balign 4

.text

.global battle

.include "battler.s"

```

```
.include "usefulMacros.s"
```

```
/* args:
```

```
    R0 is pointer to controllable battler
```

```
    R1 is pointer to AI battler */
```

```
battle:
```

```
    /*save return address*/
```

```
    ldr R5, =return
```

```
    str LR, [R5]
```

```
    mov R5, R0
```

```
    mov R6, R1
```

```
    ldr R0, =encounterMessage
```

```
    add R1, #(sizeofStats+sizeofCoord)
```

```
    ldr R1, [R1]
```

```
    bl printf
```

```
battleLoop:
```

```
    /*check if enemy and player are still alive*/
```

```
    mov R0, R5
```

```
    ldr R0, [R0]
```

```
    mov R1, R6
```

```
    ldr R1, [R1]
```

```
    cmp R1, #0
```

```
    ble battleLoopEnd
```

```
    cmp R0, #0
```

```

ble battleLoopEnd

/*display battle menu*/

ldr R0, =battleLoopMessage

ldr R1, [R5]

ldr R2, [R6]

bl printf

ldr R0, =inputFormat

ldr R1, =inputChar

bl scanf

bl getchar

/* compare input to A */

compareBothCase 0x41 attackEnemy

/* compare input to B */

compareBothCase 0x42 run

b battleLoop

```

attackEnemy:

```

/*compare speed*/

vldr S0, [R5,#12]

vldr S1, [R6,#12]

vcmp.f32 S0, S1

vmrs APSR_nzcv, FPSCR

/*player attacks first if faster*/

movge R0, R5

movge R1, R6

/*else enemy attacks first*/

```

```

movlt R1, R5

movlt R0, R6

push {R0, R1}

bl attack

pop {R0, R1}

/*checks if receiver of attack died*/

ldr R2, [R1]

cmp R2, #0

ble battleLoopEnd

/*counter attack if alive*/

mov R2, R0

mov R0, R1

mov R1, R2

bl attack

b battleLoop

```

run:

```

/*compare speed*/

mov R0, R5

vldr S0, [R0,#12]

mov R1, R6

vldr S1, [R1,#12]

vcmp.f32 S0, S1

vmrs APSR_nzcv, FPSCR

bhi runSuccess

bl rand

```

```
mov R1, #100
```

```
bl mod
```

```
/* 20 percent chance of running when slower*/
```

```
cmp R0, #20
```

```
blo runSuccess
```

```
ldr R0, =runFailMsg
```

```
bl printf
```

```
mov R1, R5
```

```
mov R0, R6
```

```
bl attack
```

```
b battleLoop
```

```
runSuccess:
```

```
ldr R0, =runSuccessMsg
```

```
bl printf
```

```
battleLoopEnd:
```

```
ldr R0, =score
```

```
ldr R1, [R0]
```

```
add R1, R1, #1
```

```
str R1, [R0]
```

```
/*return*/
```

```
ldr R5, =return
```

```
ldr LR, [R5]
```

```
bx LR
```

```
.balign 4
```

encounterMessage:

```
.asciz "%s encountered!\n"
```

```
.balign 4
```

battleLoopMessage:

```
.ascii "HP: %d   Enemy HP: %d\n"
```

```
.ascii "-----\n"
```

```
.ascii "| a)Attack   b)Run   |\n"
```

```
.ascii "-----\n"
```

```
.asciz "Which option do you choose?\n"
```

```
.balign 4
```

```
inputFormat: .asciz "%c"
```

```
runFailMsg: .asciz "You couldn't escape!\n"
```

```
runSuccessMsg: .asciz "You ran away!\n"
```

```
.global printf
```

```
.global scanf
```

```
.global getchar
```

```
.global rand
```

battler.s

```
/* File for inclusion to make symbols available to assembler
```

```
(.global is for making symbols available to linker) */
```

```
/* STRUCTURES
```

```
-----*/
```

```
/* coordinate structure
```

1 word X

1 word Y*/

sizeofCoord=8

/* stats structure

1 word HP

1 word Attack

1 word Defense

1 float Speed */

sizeofStats=16

/* battler structure layout

1 stats

1 coordinate position

1 word (address to string) name */

sizeofBattler=sizeofStats+sizeofCoord+4

battlerInit.s

.data

.balign 4

return2: .word 0

.balign 4

.text

.include "battler.s"

/* Init Functions */

.global initCoord

.global initBattler

.global initStats

/*args:

R0 is memory pointer to coordinate structure

R1 is X value

R2 is Y value

*/

initCoord:

/* X = 0 */

str R1, [R0]

/* Y = 0 */

str R2, [R0,#4]

bx LR

/*args:

R0 is memory pointer to stats structure

R1 is HP

R2 is Attack

R3 is Defense

on stack: Speed

*/

initStats:

/*set HP*/

str R1, [R0]


```

/*set Attack*/

str R2, [R0,#4]

/*set Defense */

str R3, [R0,#8]

mov R5, R0

pop {R0, IP}

/*set Speed */

str R0, [R5,#12]

bx LR

```

/*args:

R0 is memory pointer to battler structure

R1 is coordinate X

R2 is coordinate Y

R3 is pointer to name

on stack: Speed, HP, Attack,Defense

*/

initBattler:

```

/* save return address */

```

```

ldr R5, =return2

```

```

str LR, [R5]

```

```

add R0, R0, #sizeofStats

```

```

bl initCoord

```

```

add R0, R0, #sizeofCoord

```

```

str R3, [R0]

```

```

sub R0, R0, #(sizeofStats+sizeofCoord)

mov R5, R0

pop {R0, R1, R2, R3}

push {R0, IP}

mov R0, R5

bl initStats

/* return */

ldr R5, =return2

ldr LR, [R5]

bx LR

```

main.s

```
.data
```

```
.global score
```

```
.balign 4
```

```
score: .word 0
```

```
mapBoundHigh = 25
```

```
.balign 4
```

```
/*map is a square that's top left tile or coordinate is (0,0)*/
```

```
map: .skip mapBoundHigh*mapBoundHigh
```

```
/* memory allocation for battlers */
```

```
.balign 4
```

```
battlers: .skip sizeOfBattler*2
```

```
.balign 4
```

```
inputChar: .byte 0
```

```
.balign 4
```

```
return: .word 0
```

```
.balign 4
```

```
.text
```

```
.include "battler.s"
```

```
.include "usefulMacros.s"
```

```
    .global main
```

```
/*returns back to main loop after battle*/
```

```
.macro initBattle HP, Attack, Defense, Speed, NameAddress
```

```
    ldr R1, =\HP
```

```
    ldr R2, =\Attack
```

```
    ldr R3, =\Defense
```

```
    ldr R0, =\Speed
```

```
    push {R0, R1, R2, R3}
```

```
    ldr R0, =(battlers+sizeOfBattler)
```

```
    mov R1, #0
```

```
    mov R2, #0
```

```
    ldr R3, =\NameAddress
```

```
    bl initBattler

    ldr R1, =(battlers+sizeOfBattler)

    ldr R0, =battlers

    ldr LR, =mainLoop

    b battle

.endm
```

```
.macro moveSwapMapBytes difference

    ldr R0, =(battlers+sizeOfStats)

    mov R1, #mapBoundHigh

    bl mapCoordinateToIndex

    ldr R1, =map

    add R0, R0, R1

    add R2, R0, #\difference

    #swap characters in map

    ldr R1, [R0]

    ldr R3, [R2]

    str R1, [R2]

    str R3, [R0]

.endm
```

main:

```
    /* save return address*/

    ldr R5, =return

    str LR, [R5]
```

```
/*initialization*/

mov R0, #0

bl time

bl srand

/* initialize map*/

ldr R0, =map

/* ASCII '^' */

mov R1, #0x5E

ldr R2, =(mapBoundHigh*mapBoundHigh)

bl mapInit

/* initializes main player*/

mov R1, #100

mov R2, #51

mov R3, #5

/*load float 6.0f*/

ldr R0, =0x40C00000

push {R0, R1, R2, R3}

ldr R0, =battlers

mov R1, #12

mov R2, #12

ldr R3, =playerName

bl initBattler

ldr R0, =(battlers+sizeOfStats)

mov R1, #mapBoundHigh

bl mapCoordinateToIndex
```

```

ldr R1, =map

add R1, R1, R0

/*shifts map pointer over 3 bytes so write places
'Y' in correct byte*/

sub R1, R1, #3

/*load map bytes for later inclusive or*/

ldr R2, [R1]

lsl R2, #8

lsr R2, #8

/* player represented by 'Y' */

mov R3, #0x59

lsl R3, #24

/*keep map bytes since registers are 4 bytes*/

orr R3, R2

str R3, [R1]

```

mainLoop:

```

ldr R5, =battlers

ldr R0, [R5]

cmp R0, #0

ble gameOver

ldr R0, =mainLoopStatusMessage

ldr R3, [R5]

add R5, R5, #sizeofStats

ldr R1, [R5]

```

```

add R5, R5, #(sizeofCoord/2)

ldr R2, [R5]

bl printf

ldr R0, =map

mov R1, #mapBoundHigh

ldr R2, =(mapBoundHigh*mapBoundHigh)

bl mapDisplay

ldr R0, =mainLoopControlsMessage

bl printf

ldr R0, =mainInputFormat

ldr R1, =inputChar

bl scanf

/* remove newline still in buffer

(newline in buffer will printf to print twice when loop repeats)*/

bl getchar


/* compare to ASCII L */

compareBothCase 0x4C, moveLeft

/* compare to ASCII R */

compareBothCase 0x52, moveRight

/* compare to ASCII U */

compareBothCase 0x55, moveUp

/* compare to ASCII D */

compareBothCase 0x44, moveDown

/* compare to ASCII Q*/

```

compareBothCase 0x51, endMainLoop

b mainLoop

moveLeft:

ldr R2, =(battlers+sizeOfStats)

ldr R1, [R2]

sub R3, R1, #1

/*branch on overflow (subtracting from 0)*/

cmp R3, R1

bhi mainLoop

str R3, [R2]

moveSwapMapBytes 1

b chanceEncounter

moveRight:

ldr R2, =(battlers+sizeOfStats)

ldr R1, [R2]

add R3, R1, #1

cmp R3, #(mapBoundHigh-1)

bhi mainLoop

str R3, [R2]

moveSwapMapBytes (-1)

b chanceEncounter

moveDown:

ldr R2, =(battlers+sizeOfStats+sizeOfCoord/2)

ldr R1, [R2]

add R3, R1, #1


```
cmp R3, #(mapBoundHigh-1)

bhi mainLoop

str R3, [R2]

moveSwapMapBytes (-mapBoundHigh)

b chanceEncounter
```

moveUp:

```
ldr R2, =(battlers+sizeOfStats+sizeOfCoord/2)

ldr R1, [R2]

sub R3, R1, #1

/*branch on overflow (subtracting from 0)*/

cmp R3, R1

bhi mainLoop

str R3, [R2]

moveSwapMapBytes mapBoundHigh

b chanceEncounter
```

chanceEncounter:

```
bl rand

mov R1, #100

bl mod

/* 5 percent chance of enemy encounter */

cmp R0, #15

blo genEnemy

b mainLoop
```

genEnemy:

```
bl rand
```

mov R1, #6

bl mod

enemyOne:

cmp R0, #0

bne enemyTwo

/*50, 11, 2, 5.0*/

initBattle 50 11 2 0x40A00000 enemyOneName

enemyTwo:

cmp R0, #1

bne enemyThree

/*55, 12, 2, 5.1*/

initBattle 55 12 2 0x40A33333 enemyTwoName

enemyThree:

cmp R0, #2

bne enemyFour

/*60, 13, 3, 5.2*/

initBattle 60 13 3 0x40A66666 enemyThreeName

enemyFour:

cmp R0, #3

bne enemyFive

/*60, 13, 3, 6.0*/

initBattle 60 13 3 0x40C00000 enemyFourName

enemyFive:

cmp R0, #4

bne enemySix

```
/*78, 17, 2, 7.0*/
```

```
initBattle 78 17 2 0x40E00000 enemyFiveName
```

```
enemySix:
```

```
/*210, 35, 10, 8.0*/
```

```
initBattle 210 35 10 0x41000000 enemySixName
```

```
gameOver:
```

```
ldr R0, =deathMessage
```

```
bl printf
```

```
endMainLoop:
```

```
ldr R0, =scoreMessage
```

```
ldr R1, =score
```

```
ldr R1, [R1]
```

```
bl printf
```

```
/*return*/
```

```
ldr R5, =return
```

```
ldr LR, [R5]
```

```
bx LR
```

```
/*constants*/
```

```
.balign 4
```

```
mainLoopStatusMessage:
```

```
.ascii "Position: (%d,%d)\n"
```

```
.asciz "HP: %d\n"
```

```
mainLoopControlsMessage:
```

```
.ascii "\nPress r for Right, l for Left, u for Up, or d for down.\n"
```

```
.asciz "or... Press q to quit\n"
```

```
deathMessage:
```

```
.asciz "You have died!\n  GAME OVER!\n\n"
```

```
scoreMessage:
```

```
.asciz "You entered %d battles.\n"
```

```
.balign 4
```

```
mainInputFormat: .asciz "%c"
```

```
.global printf
```

```
.global scanf
```

```
.global getchar
```

```
.global srand
```

```
.global rand
```

```
.global time
```

```
.balign 4
```

```
playerName: .asciz "Hero"
```

```
.balign 4
```

```
enemyOneName: .asciz "Enemy V1"
```

```
.balign 4
```

```
enemyTwoName: .asciz "Enemy V2"
```

```
.balign 4
```

```
enemyThreeName: .asciz "Enemy V3"
```

```
.balign 4
```

```
enemyFourName: .asciz "Enemy V4"
```

.balign 4

enemyFiveName: .asciz "Enemy V5"

.balign 4

enemySixName: .asciz "Enemy V6"

.byte 0x43, 0x61, 0x73, 0x65, 0x79, 0x20, 0x20, 0x43

.byte 0x6F, 0x70, 0x65, 0x6C, 0x61, 0x6E, 0x64, 0x00

map.s

.data

mapWidth: .word 0

mapSize: .word 0

mapPointer: .word 0

mapStart: .word 0

mapEnd: .word 0

return: .word 0

.balign 4

.text

.global mapInit

/* args:

 R0 = address to char array of map to fill

 R1 = character to fill array of map with

 R2 = size of map*/

mapInit:

 mov R3, R0

 add R3, R3, R2

```
mov R4, R1
```

```
/*R1 is 4 bytes, so fill all 4 bytes with same pattern*/
```

```
lsl R4, #8
```

```
orr R1, R4
```

```
mov R4, R1
```

```
lsl R4, #16
```

```
orr R1, R4
```

```
mapInitLoop:
```

```
cmp R0, R3
```

```
bhs mapInitEnd
```

```
str R1, [R0]
```

```
add R0, R0, #4
```

```
b mapInitLoop
```

```
mapInitEnd:
```

```
bx LR
```

```
.global mapDisplay
```

```
/* args:
```

```
    R0 is address to char array of map
```

```
    R1 is map width
```

```
    R2 is map size */
```

```
mapDisplay:
```

```
ldr R3, =return
```

```
str LR, [R3]
```

```
ldr R3, =mapStart
```

```
str R0, [R3]

ldr R3, =mapPointer

str R0, [R3]

ldr R3, =mapEnd

add R0, R0, R2

str R0, [R3]

ldr R3, =mapWidth

str R1, [R3]

ldr R3, =mapSize

str R2, [R3]

ldr R0, =mapPointer

ldr R0, [R0]
```

mapDisplayLoop:

```
ldr R3, =mapEnd

ldr R3, [R3]

cmp R0, R3

beq mapDisplayEnd

ldr R1, =mapStart

ldr R1, [R1]

sub R0, R0, R1

ldr R1, =mapWidth

ldr R1, [R1]

bl mod

cmp R0, #0

bne printMapSquare
```

```
ldr R0, =newLineMessage
```

```
bl printf
```

```
printMapSquare:
```

```
ldr R0, =mapSquareMessage
```

```
ldr R1, =mapPointer
```

```
ldr R1, [R1]
```

```
ldr R1, [R1]
```

```
bl printf
```

```
ldr R0, =mapPointer
```

```
ldr R1, [R0]
```

```
add R1, R1, #1
```

```
str R1, [R0]
```

```
mov R0, R1
```

```
b mapDisplayLoop
```

```
mapDisplayEnd:
```

```
ldr LR, =return
```

```
ldr LR, [LR]
```

```
bx LR
```

```
.global mapCoordinateToIndex
```

```
/*args:
```

```
    R0 is pointer to coordinate
```

```
    R1 is map width*/
```

```
mapCoordinateToIndex:
```

```
ldr R3, =return
```



```
str LR, [R3]

mov R2, R0

add R2, R2, #4

ldr R0, [R0]

ldr R2, [R2]

mul R3, R2, R1

add R0, R0, R3

ldr LR, =return

ldr LR, [LR]

bx LR
```

```
.global mapSwapCoordinates
```

```
/*args:
```

```
    R0 is pointer to coordinate
```

```
    R1 is pointer to other coordinate
```

```
    R2 is map width*/
```

```
mapSwapCoordinates:
```

```
    ldr R3, =return
```

```
    str LR, [R3]
```

```
    ldr R3, =mapWidth
```

```
    str R2, [R3]
```

```
    mov R4, R1
```

```
    mov R1, R2
```

```
    bl mapCoordinateToIndex
```

```
    mov R3, R0
```

```
mov R0, R4

mov R4, R3

ldr R1, =mapWidth

ldr R1, [R1]

bl mapCoordinateToIndex

ldr R2, [R4]

ldr R1, [R0]

str R2, [R0]

str R1, [R4]

ldr LR, =return

ldr LR, [LR]

bx LR
```

```
mapSquareMessage: .asciz "%c"
```

```
newLineMessage: .asciz "\n"
```

```
mod.s
```

```
.text
```

```
.global mod
```

```
/* args:
```

```
    R0 unsigned value being divided, remainder should be in here at end
```

```
    R1 unsigned divisor, assumed to be greater than 1 */
```

```
mod:
```

```
    mov R2, R1
```

```
    cmp R1, R0
```

```

        bgt end

        b mod_start

/*bit shift left*/

modLoop:

        cmp R1, R0

        bhi result

mod_start:

        sub R0, R0, R1

        lsl R1, #1

        b modLoop

/*subtract and bit shift right*/

result:

        lsr R1, #1

        cmp R1, R2

        blo end

        cmp R1, R0

        bhi result

        sub R0, R0, R1

        b result

end:

        bx LR

```

usefulMacros.s

```

.macro compareBothCase upperChar, trueBranch

        ldr R0, =inputChar

        ldr R0, [R0]

```

```
    cmp R0, #\upperChar
    beq \trueBranch
    cmp R0, #(\upperChar+0x20)
    beq \trueBranch
```

```
.endm
```

main.c

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

```
#include<time.h>
```

```
#define MAP_WIDTH 25
```

```
#define MAP_SIZE 625
```

```
char map [MAP_SIZE];
```

```
int score = 0;
```

```
struct Coord {
```

```
    int x;
```

```
    int y;
```

```
};
```

```
struct Stats {
```

```
    int hp;
```

```
    int attack;
```

```
    int defense;
```

```
    float speed;
```

```
};
```

```
struct Battler {  
    struct Stats stats;  
    struct Coord pos;  
    const char* name;  
};
```

```
void attack (struct Battler* attacker,struct Battler* receiver) {  
    if (attacker->stats.attack > receiver->stats.defense) {  
        receiver->stats.hp-=attacker->stats.attack-receiver->stats.defense;  
    } else {  
        receiver->stats.hp-=1;  
    }  
}
```

```
void battle (struct Battler* player,struct Battler* enemy) {  
    char choice;  
    int run;  
    int odds;  
    printf("%s encountered!\n",enemy->name);  
    while (1) {  
        if (player->stats.hp <= 0) {  
            score+=1;  
            return;  
        } else if (enemy->stats.hp <= 0) {
```

```

        score+=1;

        return;

    }

    printf("HP: %d    Enemy HP: %d\n",player->stats.hp,enemy->stats.hp);

    printf("-----\n");

    printf("| a)Attack  b)Run  |\n");

    printf("-----\n");

    printf("Which option do you choose?\n");

    scanf("%c",&choice);

    getchar();

    switch(choice) {

        case 'a':

        case 'A':

            if (player->stats.speed > enemy->stats.speed) {

                attack(player,enemy);

                if (enemy->stats.hp > 0) {

                    attack(enemy,player);

                }

            } else {

                attack(enemy,player);

                if (player->stats.hp > 0) {

                    attack(player,enemy);

                }

            }

        }

        break;

```

```

case 'b':

case 'B':

    if (player->stats.speed > enemy->stats.speed) {

        printf("You ran away!\n");

        run = 1;

        score+=1;

    } else {

        odds = rand() % 100;

        if (odds < 20) {

            printf("You ran away!\n");

            run = 1;

            score+=1;

        } else {

            printf("You couldn't escape!\n");

            attack(enemy,player);

        }

    }

    break;

}

if (run == 1) {

    break;

}

}

}

```

```

void initBattle (struct Battler* player, int hp, int attack,
                int defense, float speed, const char* name) {
    struct Battler enemy;

    enemy.stats.hp = hp;

    enemy.stats.attack = attack;

    enemy.stats.defense = defense;

    enemy.stats.speed = speed;

    enemy.name = name;

    battle(player,&enemy);
}

```

```

void chanceEncounter (struct Battler* player) {
    int odds = rand() % 100;

    if (odds < 15) {
        odds = rand() % 6;

        switch(odds) {
            case 0:
                initBattle(player,50,11,2,5.0f,"Enemy V1");
                break;

            case 1:
                initBattle(player,55,12,2,5.1f,"Enemy V2");
                break;

            case 2:
                initBattle(player,60,13,3,5.2f,"Enemy V3");
                break;

```



```

        case 3:

            initBattle(player,67,15,5,6.0f,"Enemy V4");

            break;

        case 4:

            initBattle(player,78,17,2,7.0f,"Enemy V5");

            break;

        case 5:

            initBattle(player,210,35,10,8.0f,"Enemy V6");

            break;

    }

}

}

```

```

int main() {

    struct Battler player;

    char choice;

    int i;

    srand(time(NULL));

    for (i=0;i<MAP_SIZE;++i) {

        map[i] = '^';

    }

    player.stats.hp = 100;

    player.stats.attack = 51;

    player.stats.defense = 5;

    player.stats.speed = 6.0f;

```

```

player.pos.x = 12;

player.pos.y = 12;

map[player.pos.x+MAP_WIDTH*player.pos.y]='Y';

player.name = "Hero";

while (1) {

    if (player.stats.hp <= 0) {

        printf("You have died!\n  GAME OVER!\n\n");

        printf("You entered %d battles.\n",score);

        return;

    }

    printf("Position: (%d,%d)\n",player.pos.x,player.pos.y);

    printf("HP: %d\n",player.stats.hp);

    for (i=0;i<MAP_SIZE;++i) {

        if (i%MAP_WIDTH == 0) {

            printf("\n");

        }

        printf("%c",map[i]);

    }

    printf("\n\nPress r for Right, l for Left, u for Up, or d for down.\n");

    printf("or... Press q to quit\n");

    scanf("%c",&choice);

    getchar();

    switch(choice) {

        case 'r':

        case 'R':

```

```

    player.pos.x+=1;

    if (player.pos.x >= MAP_WIDTH) {

        player.pos.x=MAP_WIDTH-1;

        break;

    }

    map[player.pos.x-1+MAP_WIDTH*player.pos.y]='^';

    map[player.pos.x+MAP_WIDTH*player.pos.y]='Y';

    chanceEncounter(&player);

    break;

case 'I':

case 'L':

    player.pos.x-=1;

    if (player.pos.x < 0) {

        player.pos.x=0;

        break;

    }

    map[player.pos.x+1+MAP_WIDTH*player.pos.y]='^';

    map[player.pos.x+MAP_WIDTH*player.pos.y]='Y';

    chanceEncounter(&player);

    break;

case 'u':

case 'U':

    player.pos.y-=1;

    if (player.pos.y < 0) {

        player.pos.y=0;

```

```

        break;

    }

    map[player.pos.x+MAP_WIDTH*(player.pos.y+1)]='^';

    map[player.pos.x+MAP_WIDTH*player.pos.y]='Y';

    chanceEncounter(&player);

    break;

case 'd':

case 'D':

    player.pos.y+=1;

    if (player.pos.y >= MAP_WIDTH) {

        player.pos.y=MAP_WIDTH-1;

        break;

    }

    map[player.pos.x+MAP_WIDTH*(player.pos.y-1)]='^';

    map[player.pos.x+MAP_WIDTH*player.pos.y]='Y';

    chanceEncounter(&player);

    break;

case 'q':

case 'Q':

    printf("You entered %d battles.\n",score);

    return 0;

}

}

}

```