Rustboy

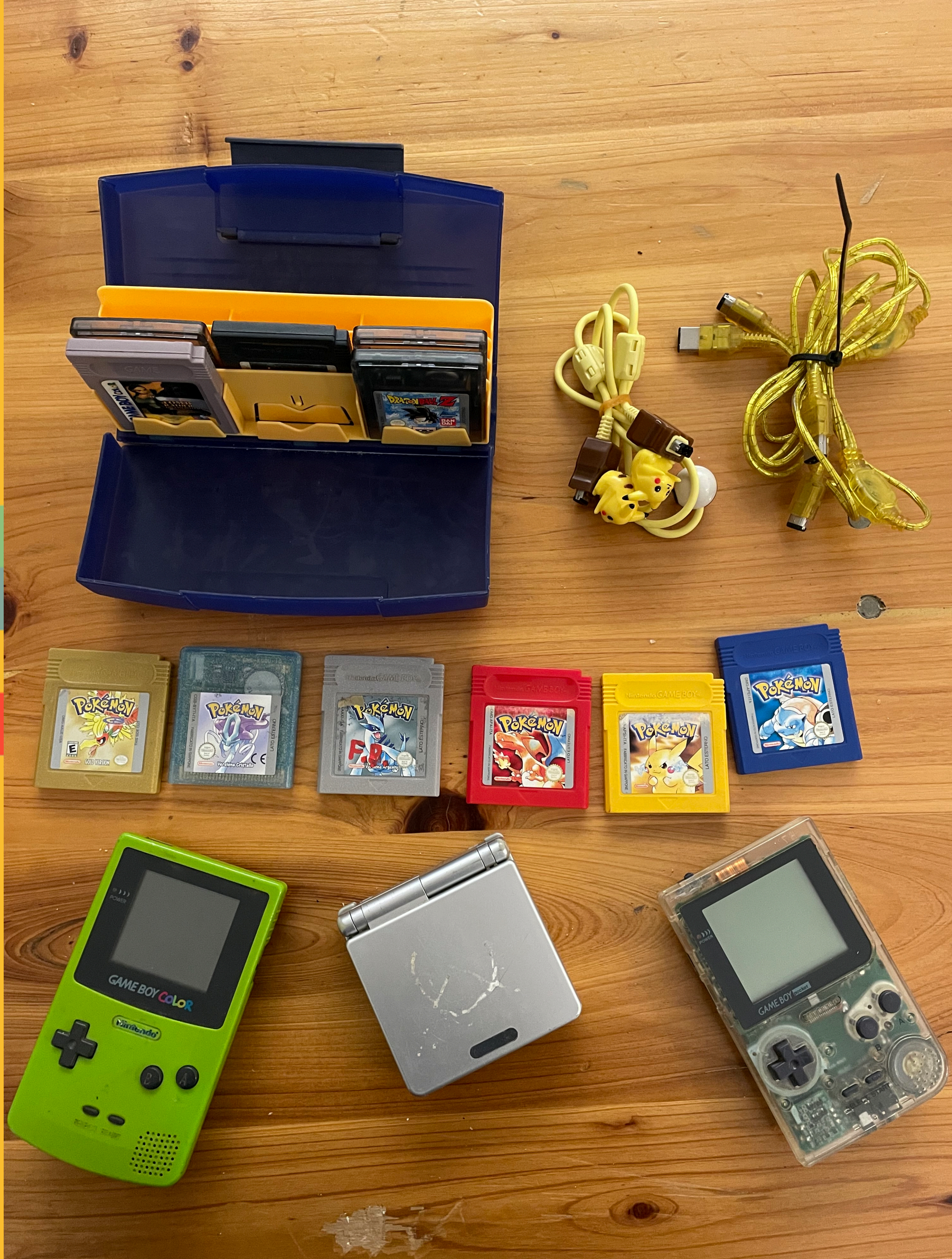
A Rust journey into Game Boy dev

ffex @ fosdem2026

01. Introduction

My story

My gameboys



My story

Me and the gameboy

The not-so-exciting life of a programmer

In the daily routine

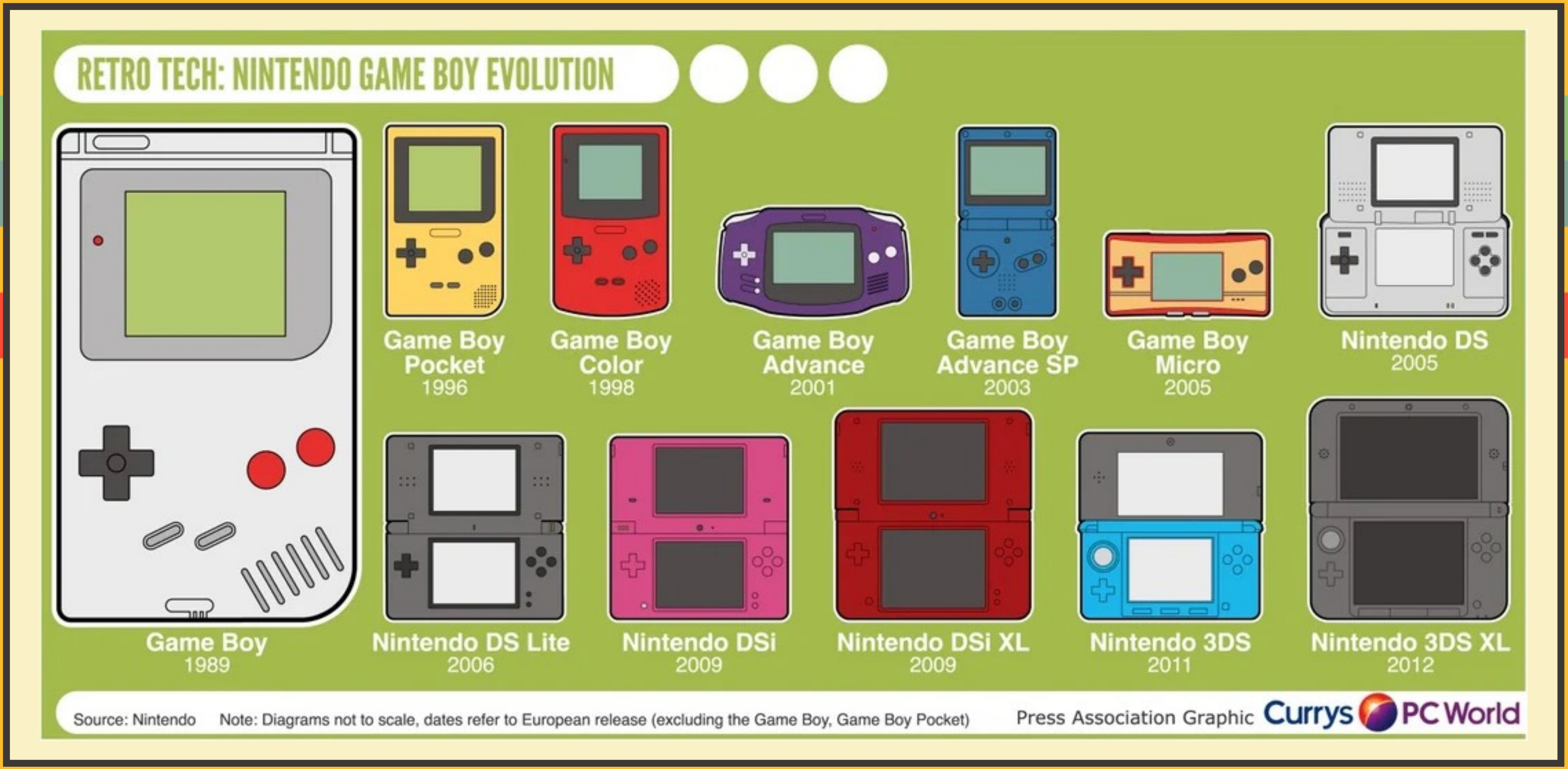
- We have a **problem**
- Find and replicate the **problem**
- Search for the **problem** online
- Ask AI about the **problem**
- Copy a *solution* of the **problem**
- Test the *solution*
- Is it the best *solution*?
- Search for the best *solution* online
- ....

Fosdem 2025

Boom!

02. Hardware

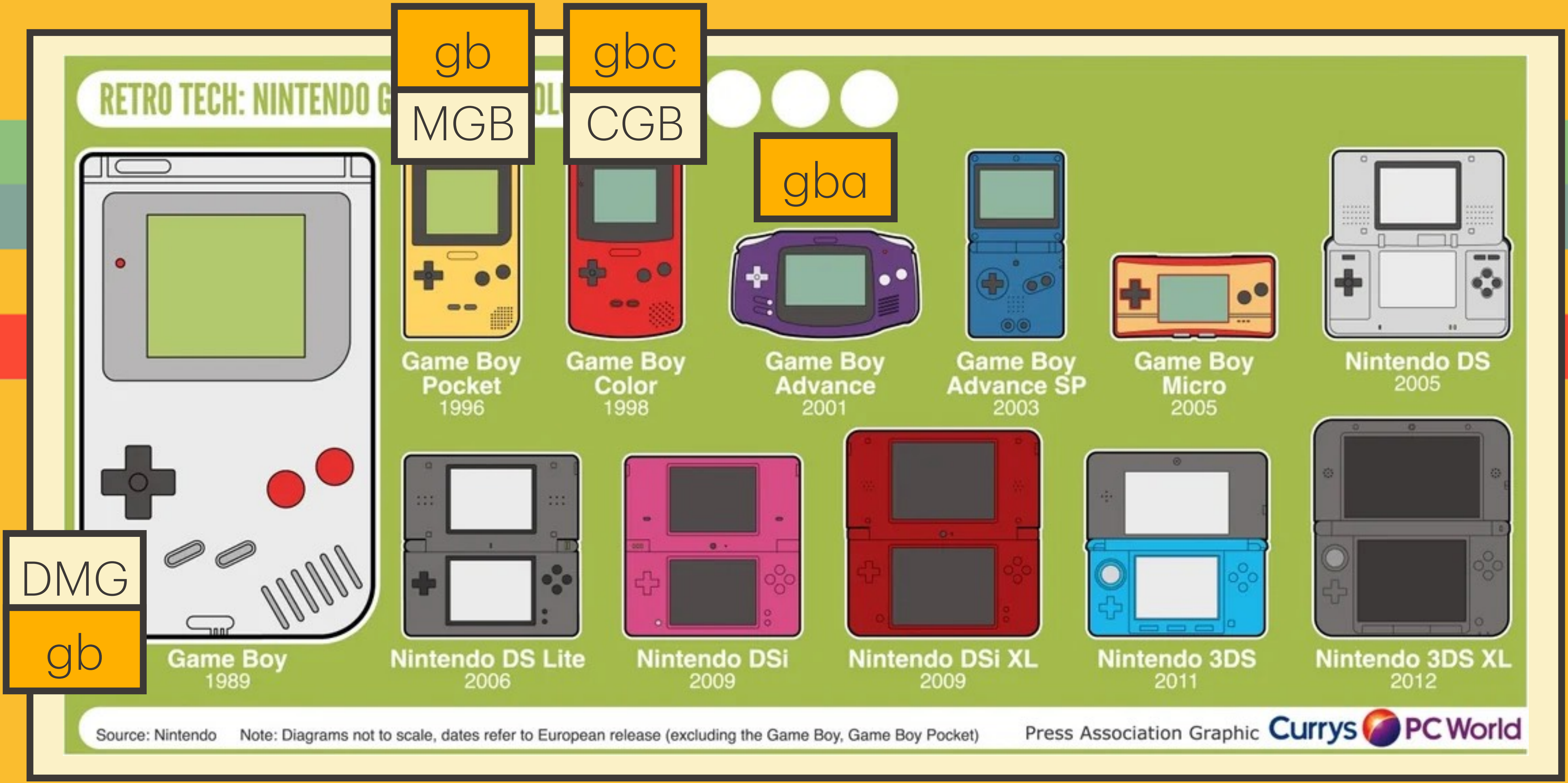
All the game boys



RETRO TECH: NINTENDO GAME BOY EVOLUTION

Source: Nintendo Note: Diagrams not to scale, dates refer to European release (excluding the Game Boy, Game Boy Pocket) Press Association Graphic

All the game boys



Source: Nintendo Note: Diagrams not to scale, dates refer to European release (excluding the Game Boy, Game Boy Pocket)

gb
MGB

gbc
CGB

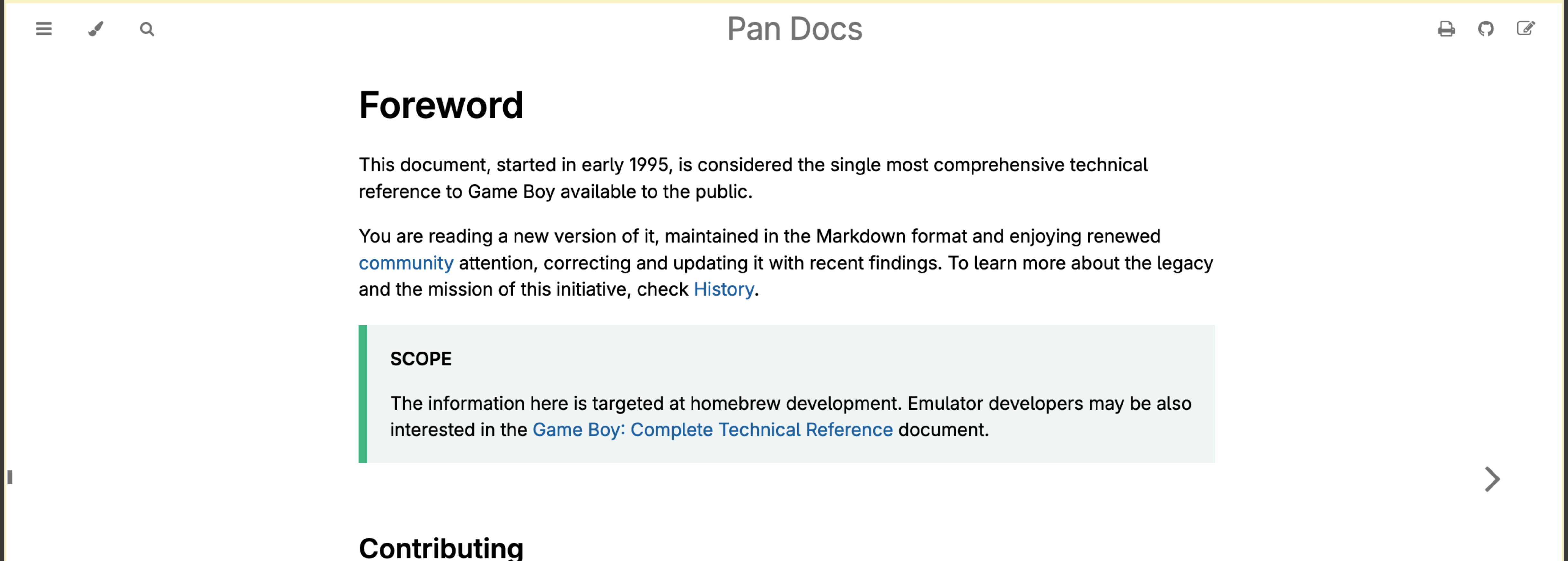
gba

DMG
gb

Pandocs

This document, started in early 1995, is considered the single most comprehensive technical reference to Game Boy available to the public.

Link: **https://gbdev.io/pandocs/**



Pan Docs

Foreword

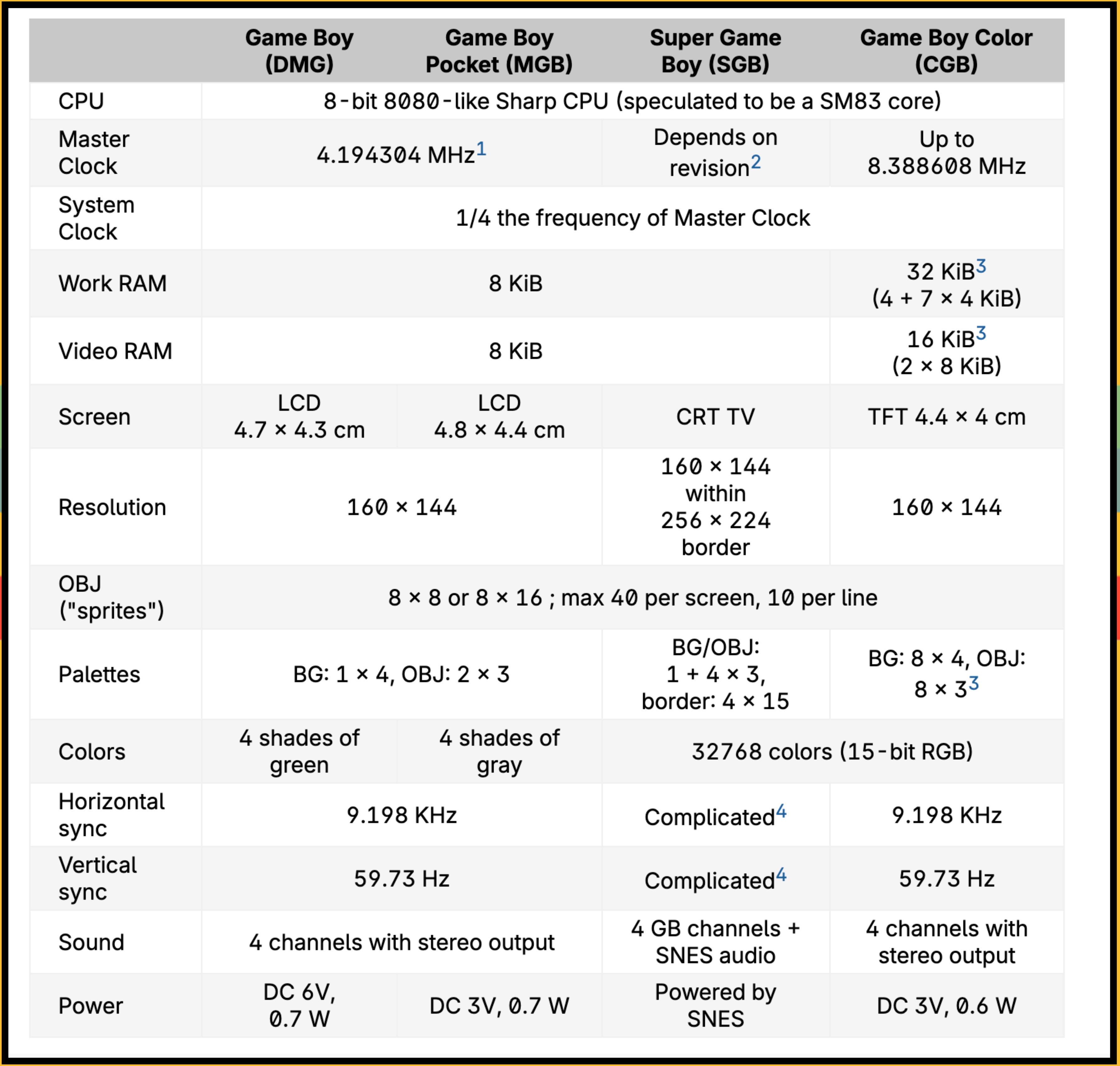
This document, started in early 1995, is considered the single most comprehensive technical reference to Game Boy available to the public.

You are reading a new version of it, maintained in the Markdown format and enjoying renewed community attention, correcting and updating it with recent findings. To learn more about the legacy and the mission of this initiative, check History.

> SCOPE
>
> The information here is targeted at homebrew development. Emulator developers may be also interested in the Game Boy: Complete Technical Reference document.

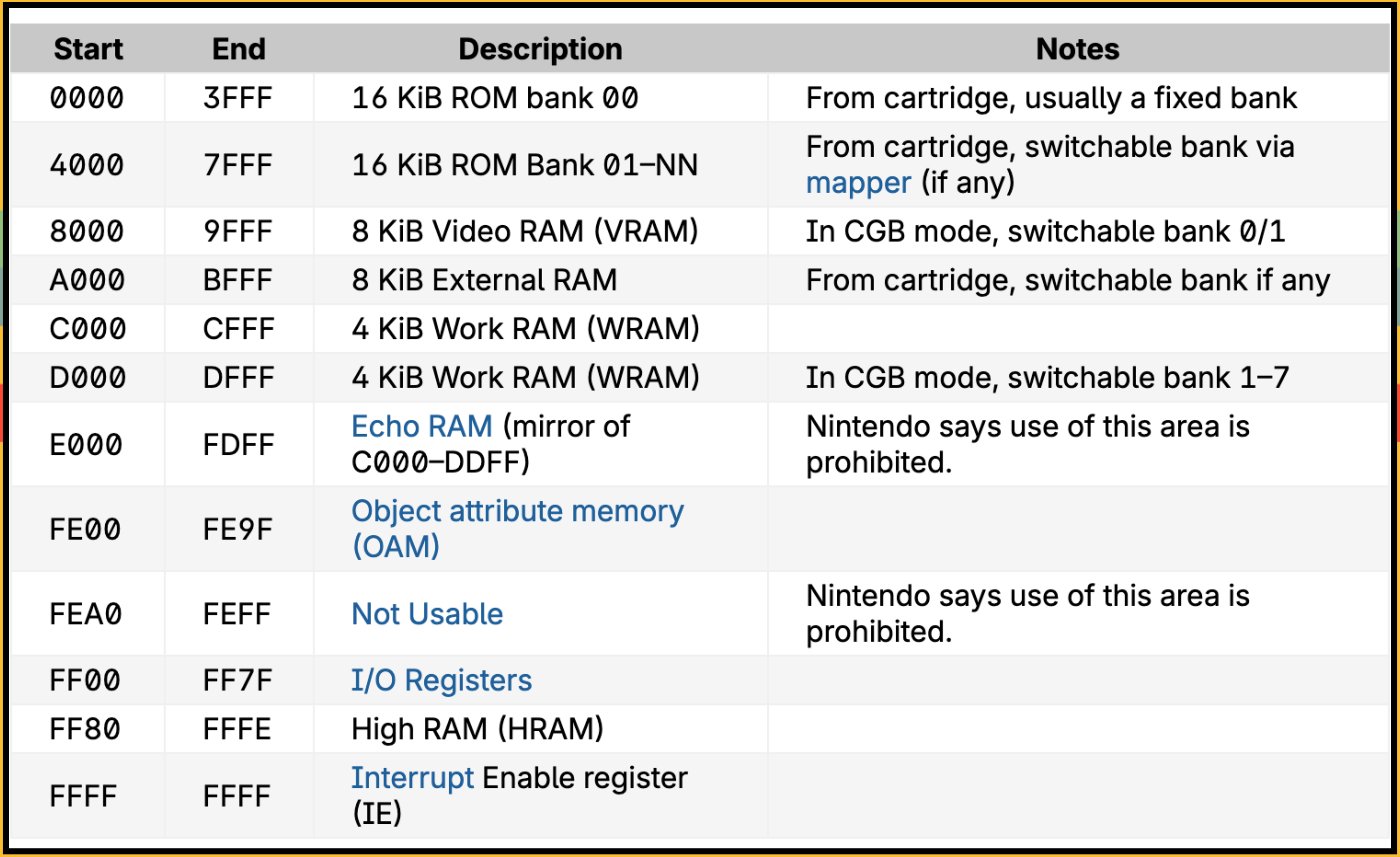
Contributing

Specs



	Game Boy (DMG)	Game Boy Pocket (MGB)	Super Game Boy (SGB)	Game Boy Color (CGB)
CPU	8-bit 8080-like Sharp CPU (speculated to be a SM83 core)			
Master Clock	4.194304 MHz[1]		Depends on revision[2]	Up to 8.388608 MHz
System Clock	1/4 the frequency of Master Clock			
Work RAM	8 KiB			32 KiB[3] (4 + 7 × 4 KiB)
Video RAM	8 KiB			16 KiB[3] (2 × 8 KiB)
Screen	LCD 4.7 × 4.3 cm	LCD 4.8 × 4.4 cm	CRT TV	TFT 4.4 × 4 cm
Resolution	160 × 144		160 × 144 within 256 × 224 border	160 × 144
OBJ ("sprites")	8 × 8 or 8 × 16 ; max 40 per screen, 10 per line			
Palettes	BG: 1 × 4, OBJ: 2 × 3		BG/OBJ: 1 + 4 × 3, border: 4 × 15	BG: 8 × 4, OBJ: 8 × 3[3]
Colors	4 shades of green	4 shades of gray	32768 colors (15-bit RGB)	
Horizontal sync	9.198 KHz		Complicated[4]	9.198 KHz
Vertical sync	59.73 Hz		Complicated[4]	59.73 Hz
Sound	4 channels with stereo output		4 GB channels + SNES audio	4 channels with stereo output
Power	DC 6V, 0.7 W	DC 3V, 0.7 W	Powered by SNES	DC 3V, 0.6 W

Memory Map



Start	End	Description	Notes
0000	3FFF	16 KiB ROM bank 00	From cartridge, usually a fixed bank
4000	7FFF	16 KiB ROM Bank 01–NN	From cartridge, switchable bank via mapper (if any)
8000	9FFF	8 KiB Video RAM (VRAM)	In CGB mode, switchable bank 0/1
A000	BFFF	8 KiB External RAM	From cartridge, switchable bank if any
C000	CFFF	4 KiB Work RAM (WRAM)	
D000	DFFF	4 KiB Work RAM (WRAM)	In CGB mode, switchable bank 1–7
E000	FDFF	Echo RAM (mirror of C000–DDFF)	Nintendo says use of this area is prohibited.
FE00	FE9F	Object attribute memory (OAM)	
FEA0	FEFF	Not Usable	Nintendo says use of this area is prohibited.
FF00	FF7F	I/O Registers	
FF80	FFFE	High RAM (HRAM)	
FFFF	FFFF	Interrupt Enable register (IE)	

SoC

gb, gbc, gba

- Game Boys use only a single integrated System-on-a-Chip (SoC)
- SoC includes the processor (CPU) core, some memories, and various peripherals
- The Game Boy SoC is sometimes called the “CPU”

More about CPU: https://gekkio.fi/files/gb-docs/gbctr.pdf
Photos: https://raphaelstaebler.medium.com/

SoC

gb, gbc, gba

- Architectural differences:
- GB: the original Game Boy architecture with a Sharp SM83 CPU
- GBC: a GB architecture that adds color graphics and small improvements
- GBA: a completely different architecture based on the ARM processor instruction set and a completely redesigned set of peripherals.

More about CPU: https://gekkio.fi/files/gb-docs/gbctr.pdf
Photos: https://raphaelstaebler.medium.com/

CPU

gb, gbc

- The CPU core in the Game Boy SoC is a custom Sharp design without a name.

- Some sources claim Game Boy uses a “modified” Zilog Z80 or Intel 8080.

- Using old datasheets and databooks, the core has been identified to be a **Sharp SM83.**

More about CPU: https://gekkio.fi/files/gb-docs/gbctr.pdf
Photos: https://www.copetti.org/writings/consoles/game-boy/

CPU

gb, gbc

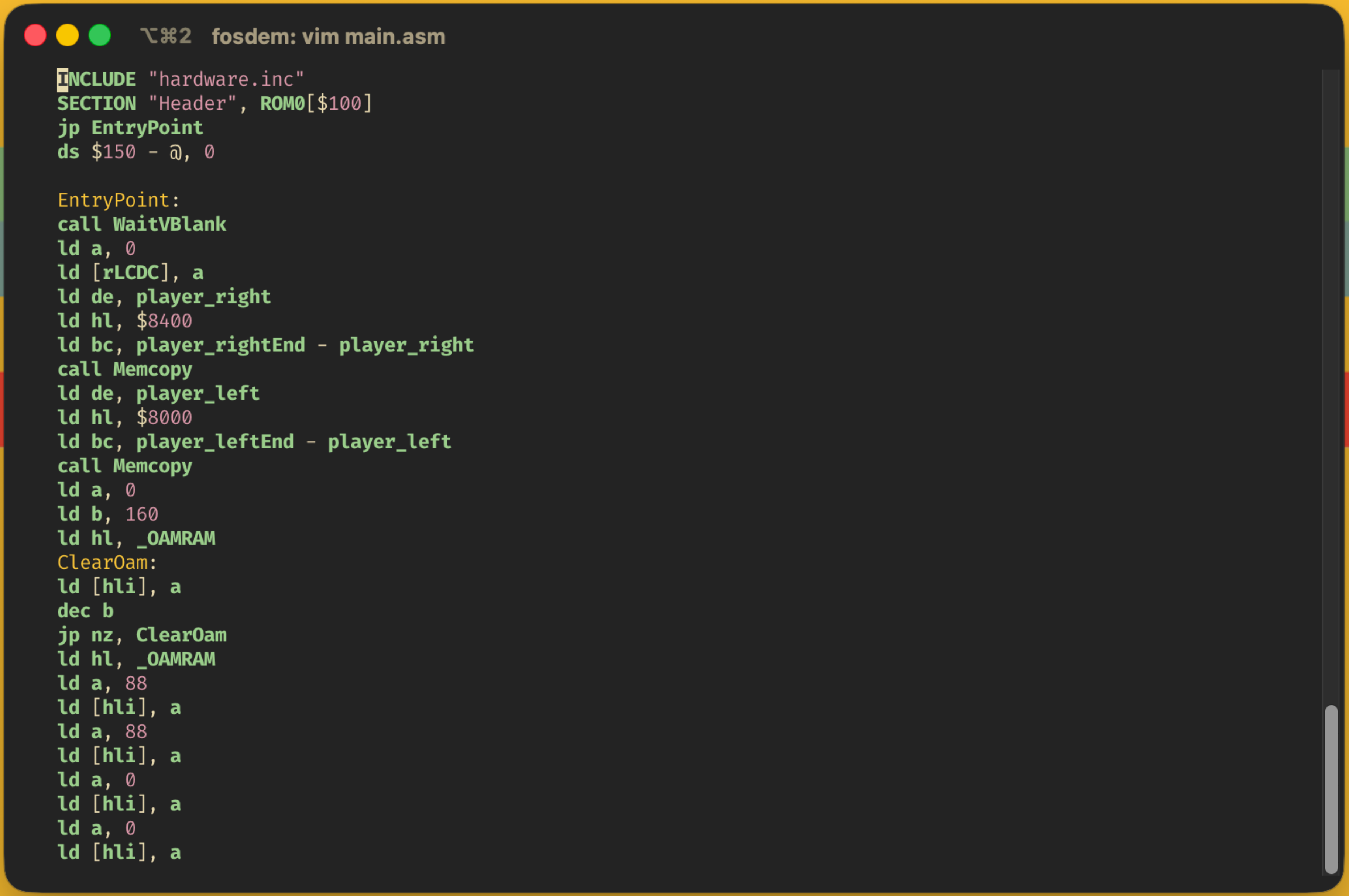
- SM83 is an 8-bit CPU core with a 16-bit address bus.

- The Instruction Set Architecture (ISA) is based on both Z80 and 8080.

More about CPU: https://gekkio.fi/files/gb-docs/gbctr.pdf
Photos: https://www.copetti.org/writings/consoles/game-boy/

03. Software

ASM



```
INCLUDE "hardware.inc"
SECTION "Header", ROM0[$100]
jp EntryPoint
ds $150 - @, 0

EntryPoint:
call WaitVBlank
ld a, 0
ld [rLCDC], a
ld de, player_right
ld hl, $8400
ld bc, player_rightEnd - player_right
call Memcopy
ld de, player_left
ld hl, $8000
ld bc, player_leftEnd - player_left
call Memcopy
ld a, 0
ld b, 160
ld hl, _OAMRAM
ClearOam:
ld [hli], a
dec b
jp nz, ClearOam
ld hl, _OAMRAM
ld a, 88
ld [hli], a
ld a, 88
ld [hli], a
ld a, 0
ld [hli], a
ld a, 0
ld [hli], a
```

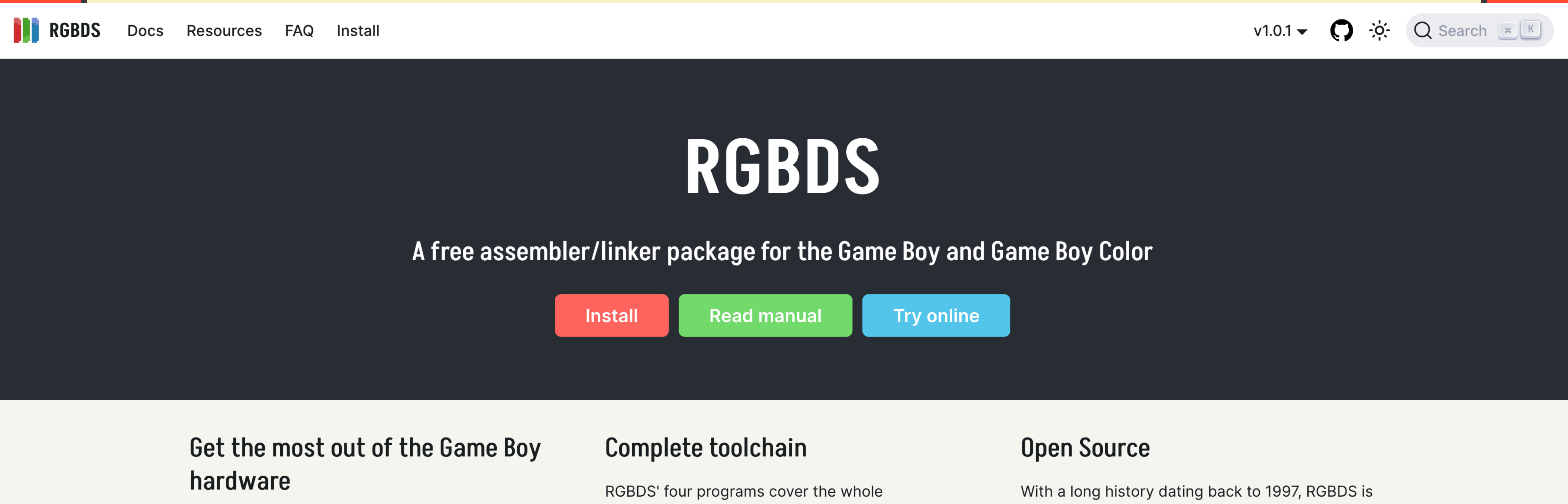
https://gbdev.io/gb-asm-tutorial/

ASM

Rednex Game Boy Development System

- Four programs to cover the whole compilation pipeline:
- Image converter / Assembler / Linker / Fixer

https://rgbds.gbdev.io/



RGBDS

A free assembler/linker package for the Game Boy and Game Boy Color

Get the most out of the Game Boy hardware

Complete toolchain

RGBDS' four programs cover the whole

Open Source

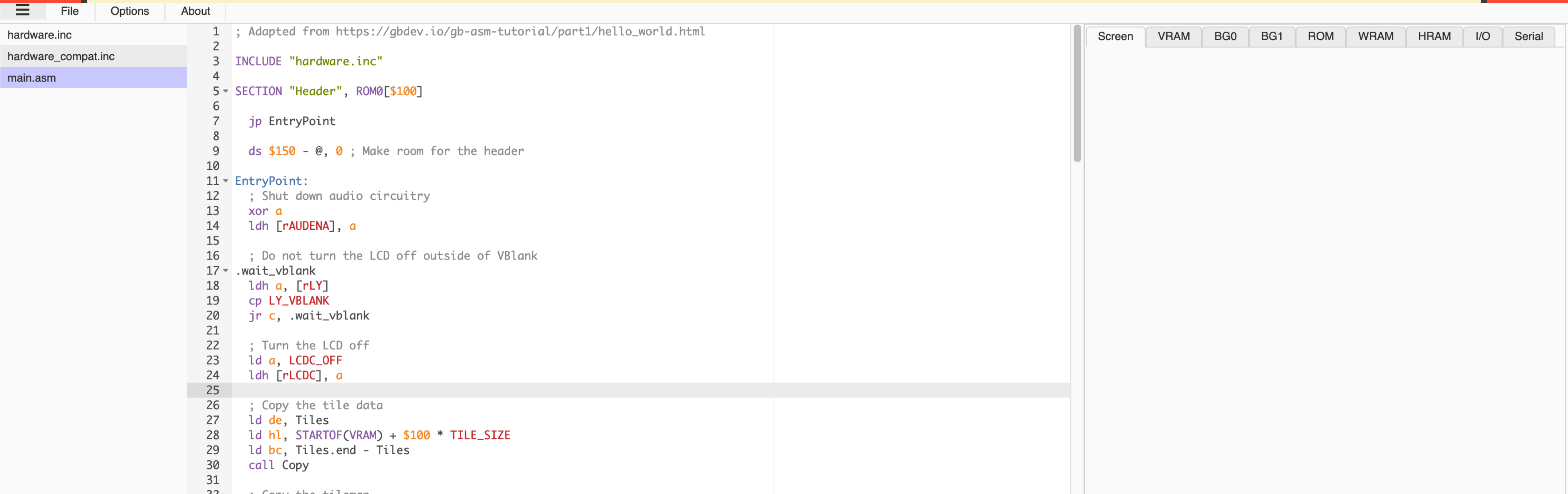
With a long history dating back to 1997, RGBDS is

ASM

RGBDS - Editor Online

- There is also an online editor!

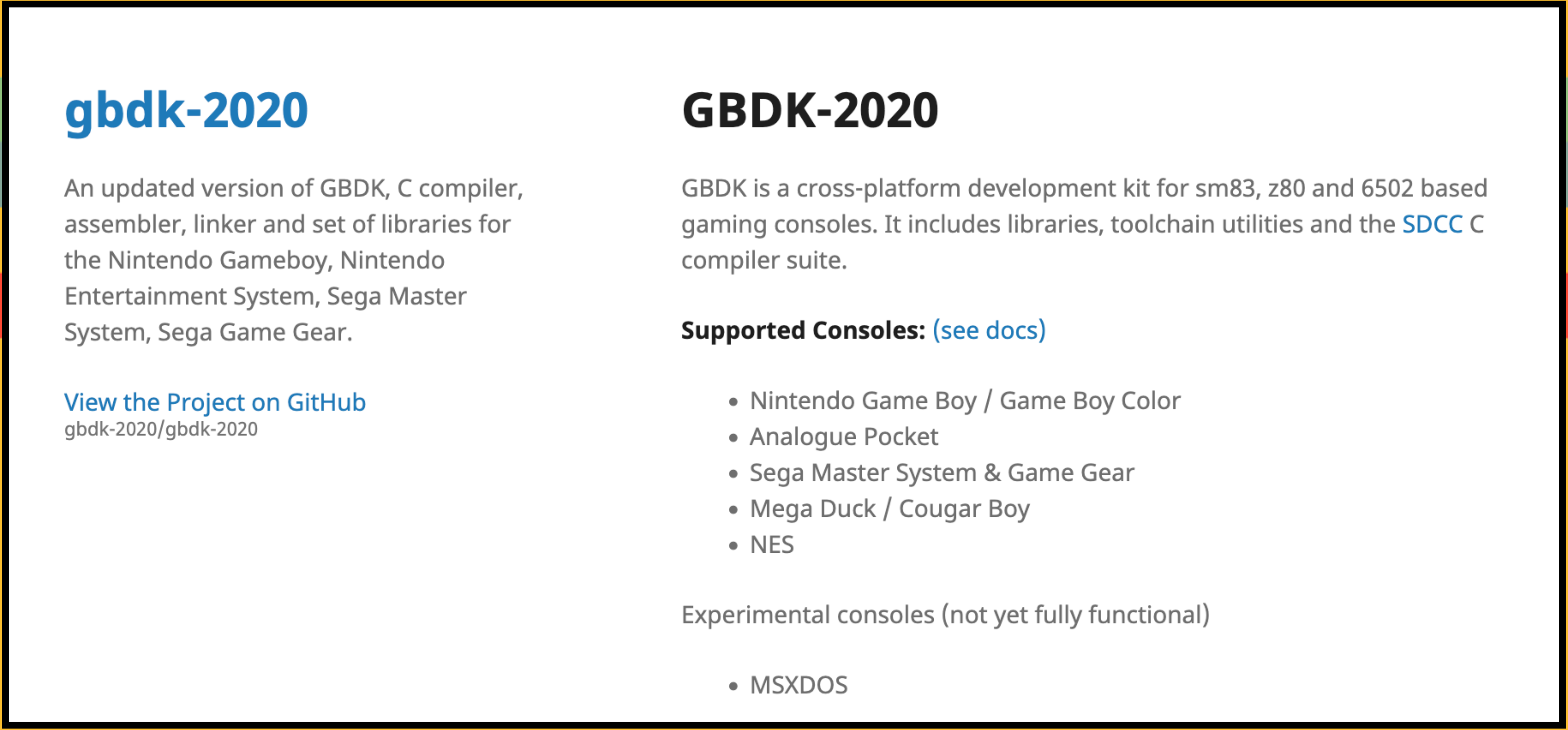
https://gbdev.io/rgbds-live/



```
; Adapted from https://gbdev.io/gb-asm-tutorial/part1/hello_world.html

INCLUDE "hardware.inc"

SECTION "Header", ROM0[$100]

  jp EntryPoint

  ds $150 - @, 0 ; Make room for the header

EntryPoint:
  ; Shut down audio circuitry
  xor a
  ldh [rAUDENA], a

  ; Do not turn the LCD off outside of VBlank
.wait_vblank
  ldh a, [rLY]
  cp LY_VBLANK
  jr c, .wait_vblank

  ; Turn the LCD off
  ld a, LCDC_OFF
  ldh [rLCDC], a

  ; Copy the tile data
  ld de, Tiles
  ld hl, STARTOF(VRAM) + $100 * TILE_SIZE
  ld bc, Tiles.end - Tiles
  call Copy

```

C

GBDK-2020 - Game Boy Development Kit



gbdk-2020

An updated version of GBDK, C compiler, assembler, linker and set of libraries for the Nintendo Gameboy, Nintendo Entertainment System, Sega Master System, Sega Game Gear.

View the Project on GitHub
gbdk-2020/gbdk-2020

GBDK-2020

GBDK is a cross-platform development kit for sm83, z80 and 6502 based gaming consoles. It includes libraries, toolchain utilities and the SDCC C compiler suite.

Supported Consoles: (see docs)

- Nintendo Game Boy / Game Boy Color
- Analogue Pocket
- Sega Master System & Game Gear
- Mega Duck / Cougar Boy
- NES

Experimental consoles (not yet fully functional)

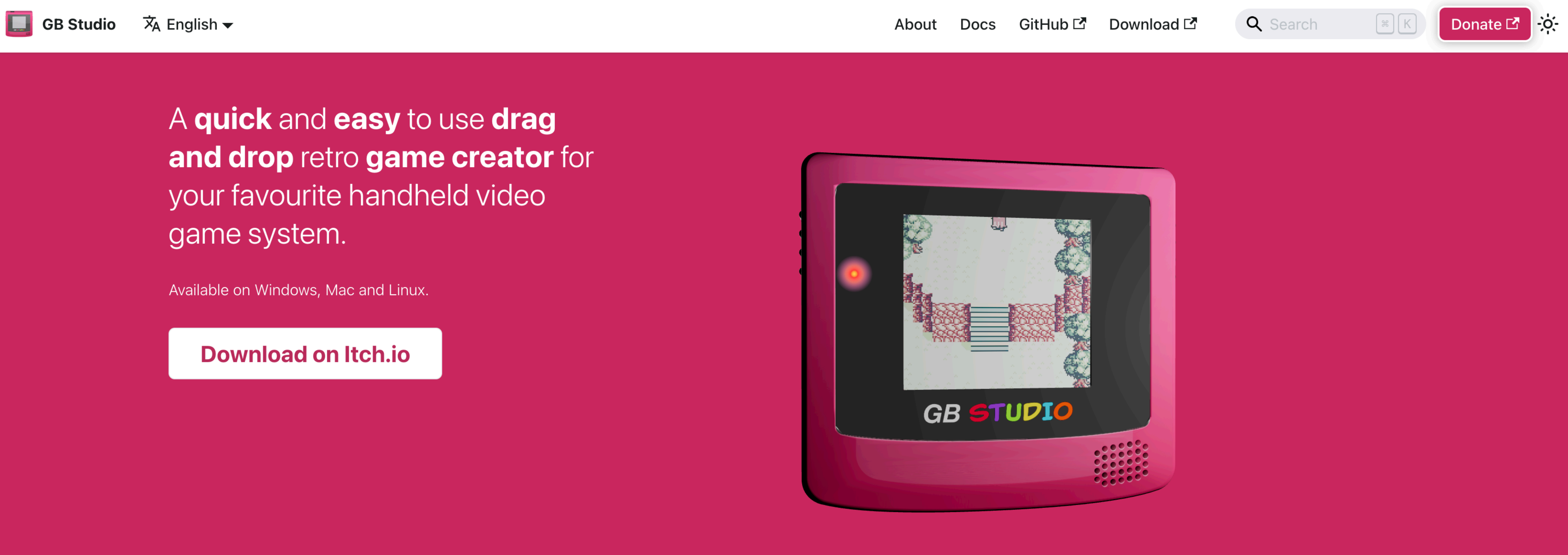
- MSXDOS

https://gbdk.org/

GB Studio

- It is the most advanced retro game creator. It is a complete engine to create complete games

https://www.gbstudio.dev/



A **quick** and **easy** to use **drag and drop** retro **game creator** for your favourite handheld video game system.

Available on Windows, Mac and Linux.

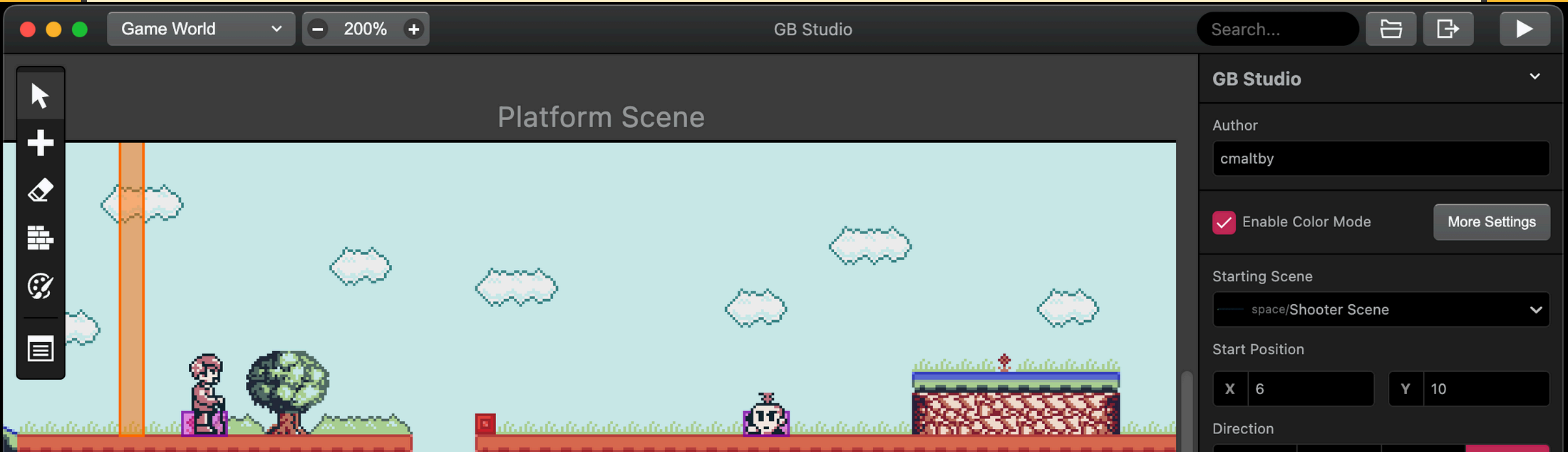
Download on Itch.io

GB Studio

GBDK and GBVM

- It is based on **GBDK** and **GBVM**
- **GBVM**: is a VM for script-driven gb games

https://github.com/chrismaltby/gbvm



GB Studio

Author
cmaltby

☑ Enable Color Mode

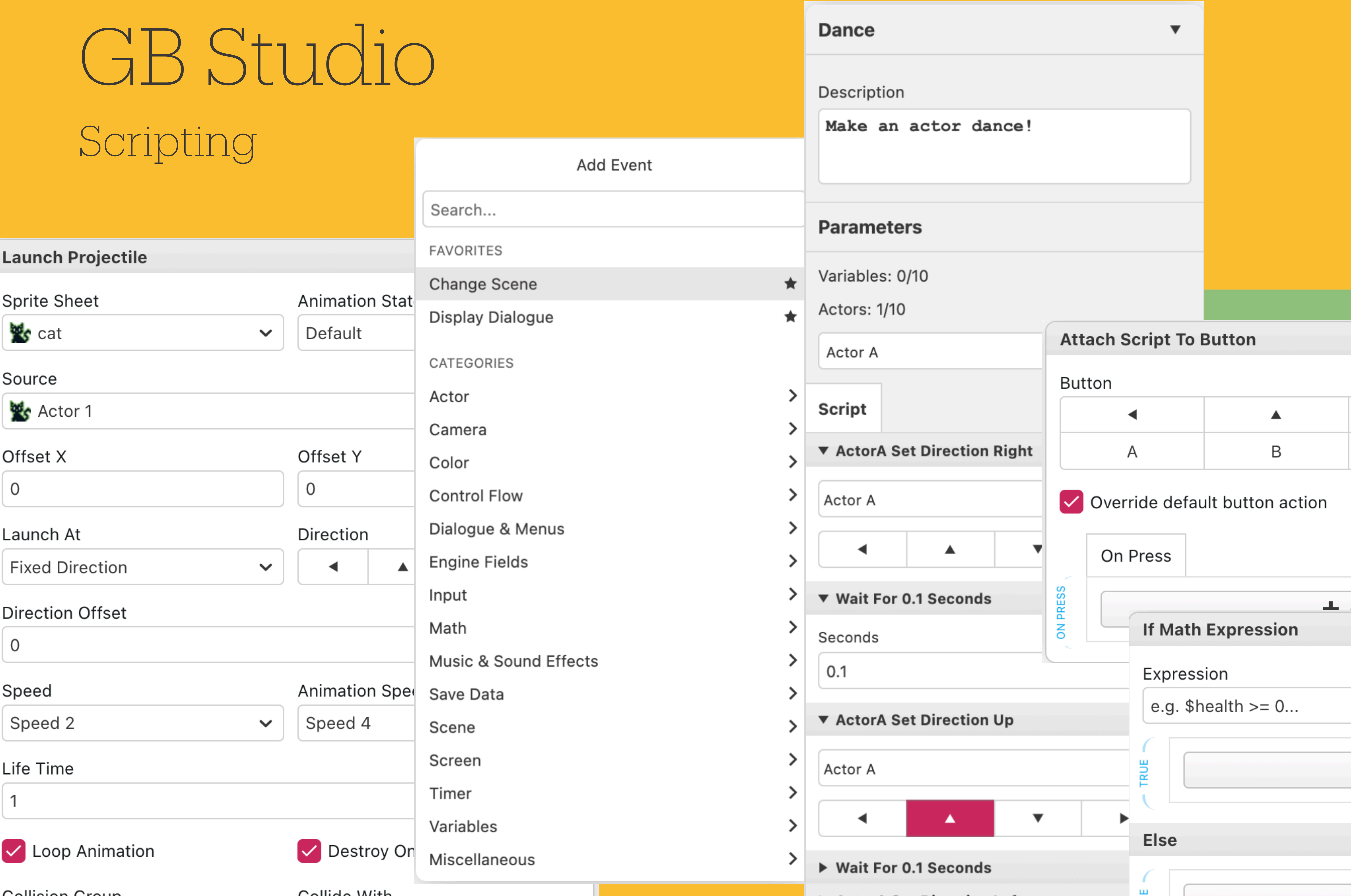
Starting Scene
space/Shooter Scene

Start Position
X 6 Y 10

Direction

GB Studio

Scripting



Launch Projectile

Sprite Sheet: cat

Animation Stat: Default

Source: Actor 1

Offset X: 0

Offset Y: 0

Launch At: Fixed Direction

Direction

Direction Offset: 0

Speed: Speed 2

Animation Spe: Speed 4

Life Time: 1

☑ Loop Animation

☑ Destroy On

Collision Group

Collide With

Dance

Description: Make an actor dance!

Parameters

Variables: 0/10

Actors: 1/10

Actor A

Script

ActorA Set Direction Right

Actor A

Wait For 0.1 Seconds

Seconds: 0.1

ActorA Set Direction Up

Actor A

Wait For 0.1 Seconds

Attach Script To Button

Button

☑ Override default button action

On Press

If Math Expression

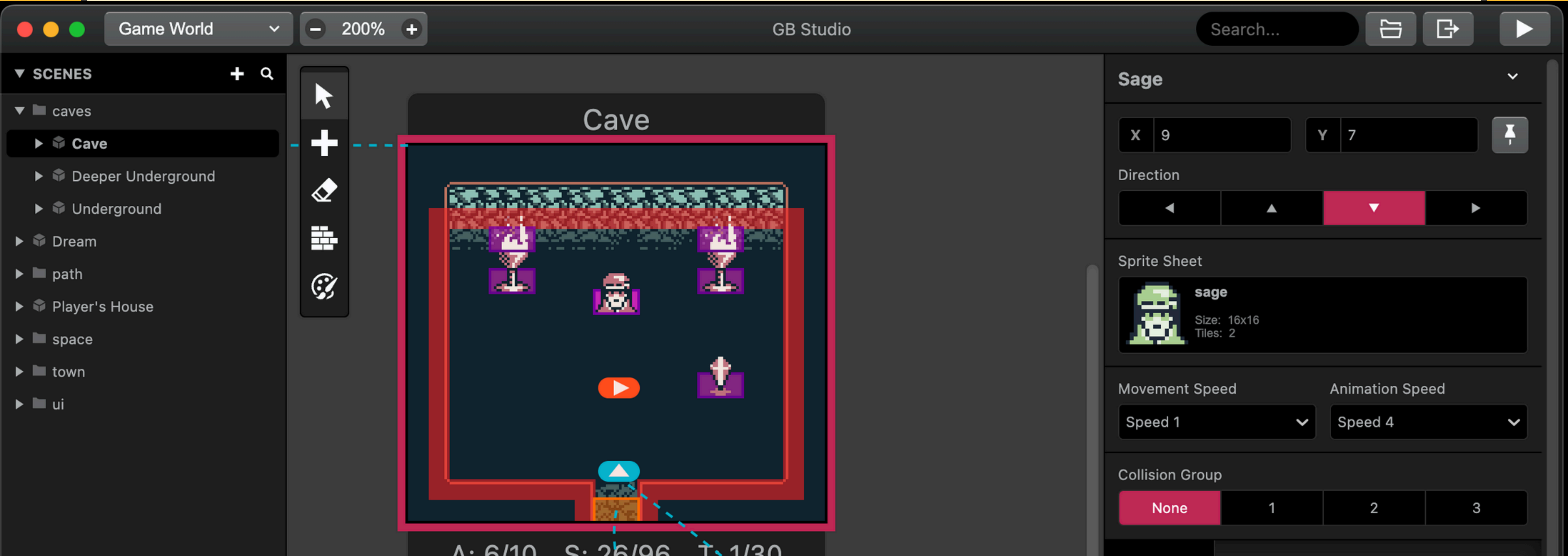
Expression: e.g. $health >= 0...

Else

GB Studio

- Also GB Studio also can be interesting for our scope!
- Also **GBVM.**

https://www.gbstudio.dev/



X 9 Y 7

Direction: ▼

Sprite Sheet: sage
Size: 16x16
Tiles: 2

Movement Speed: Speed 1

Animation Speed: Speed 4

Collision Group: None 1 2 3

04. …and Rust?

What we have

Emulators! Emulators everywhere!

- **Mooneye GB** – A Game Boy research project and emulator written in Rust
  - Code: https://github.com/Gekkio/mooneye-gb
- **Boytacean** – Full-featured Rust emulator with Web, SDL & Libretro frontends
  - Code: https://github.com/joamag/boytacean
- **RBoy** – Gameboy Color emulator in Rust
  - Code: https://github.com/mvdnes/rboy
- **GB-RS** – Game Boy emulator written in Rust
  - Code: https://github.com/simias/gb-rs
- **gameboy** – Game Boy emulator written in Rust
  - Code: https://github.com/raphamorim/gameboy

What we have

Emulators! Emulators everywhere!

- **Retro Boy –** Cycle-accurate emulator compiled to WebAssembly
  - Code: https://github.com/smparsons/retroboy

- **Wasm-GB –** Game Boy emulator in WebAssembly + WebGL 2.0 (Rust)
  - Code: https://github.com/andrewimm/wasm-gb

- **gameboy** – Game Boy emulator written in Rust
  - Code: https://github.com/raphamorim/gameboy

What we have

Emulators! Emulators everywhere!

- There are a lot of educational projects created to learn about:
  - **Emulation**
  - **Gameboy**
  - **Rust**

What we have

Crates for gba

- There are some crates to make games for gba:
  - **gba**
  - **agb**
  - Others project educational / list of utilities

gb/gbc?

- As said, the gba has a different architecture and a different processor. gba have an ARM CPU.

- On the board is also the SM83 to maintain compatibility

https://www.copetti.org/writings/consoles/game-boy-advance/

Rust

Platform support

- Support for different platforms (“targets”) are organized into three tiers:
  - Tier 1 -> targets can be thought of as “guaranteed to work”.
  - Tier 2 -> targets can be thought of as “guaranteed to build”.
  - Tier 3 -> targets are those which the Rust codebase has support for, but which the Rust project does not build or test automatically, so they may or may not work. Official builds are not available. ***Here we have our gba CPU***

gb/gbc?

Platform support

- There are not support for the SM83.
- Rust can’t be compiled
- But something exist…

Rust-GB

By zlfn

- Is a project work in progress…

- And try to obtain the build with a “workaround.”

1. The **Rust** compiler can generate **LLVM-IR** for the **ATMega328**

2. **LLVM-IR** can be converted in **C** with *llvm-cbe*

3. **C** compiled to **Z80 assembly** with *sdasgb*

4. **Z80 Assembly** can be assembled into **GBZ80** with *sdasgb*

5. **GBZ80 object code** can be linked in a **ROM gb** with *GBDK*

https://github.com/zlfn/rust-gb

cranelift-z80

By zlfn

- New project by zlfn.
- Remove all the steps of rust-gb using cranelift:
  - Cranelift is a compiler backend that translates a target-independent intermediate representation into executable machine code.
  - Is in early stage
  - The main idea is to compile in only two steps

https://github.com/zlfn/cranelift-z80

https://cranelift.dev/

gbc-rs

By BonsaiDen

- **gbc** is a Rust-based compiler for Gameboy Z80 assembly code.
- The syntax is handmade and similar to the assembly with some high level blocks
- It is interesting and inspirating

https://gitlab.com/BonsaiDen/gbc-rs

05. Rustboy

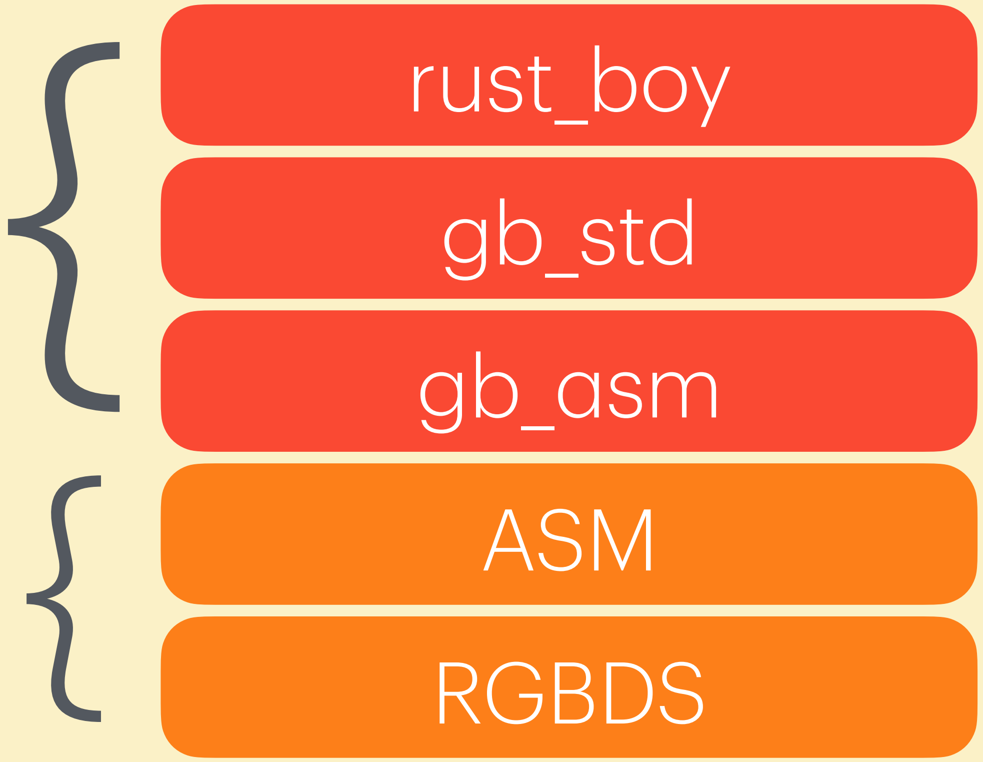
The idea

- We have in front of us only one CPU...
- Can we do a specific Rust compiler for the **SM83**?
- **Great idea!** I always develop a compiler!

https://github.com/ffex/rust-boy

PoC

Proof of concept

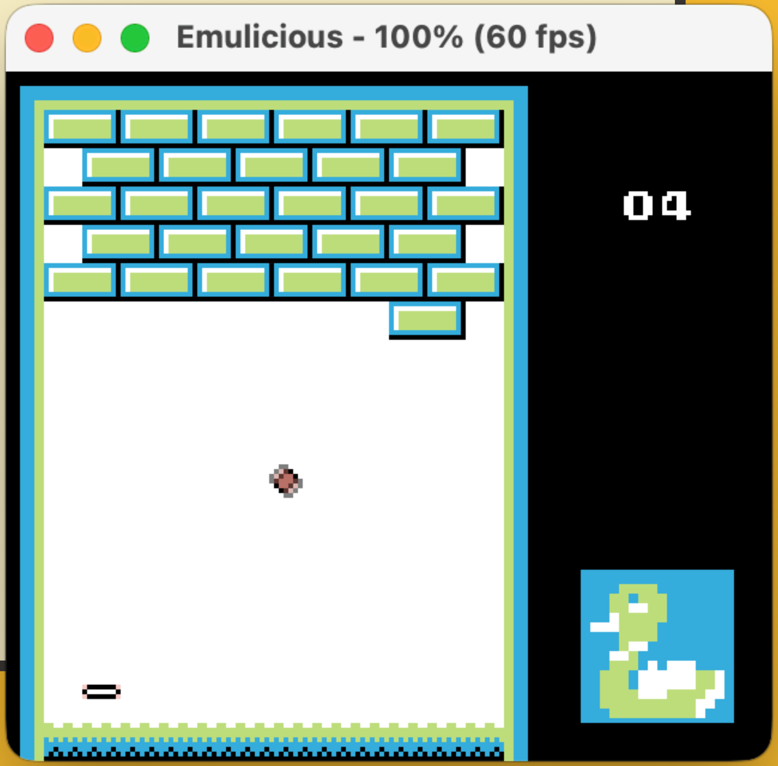


To speed up the development, I put a solid working base.

How show results?

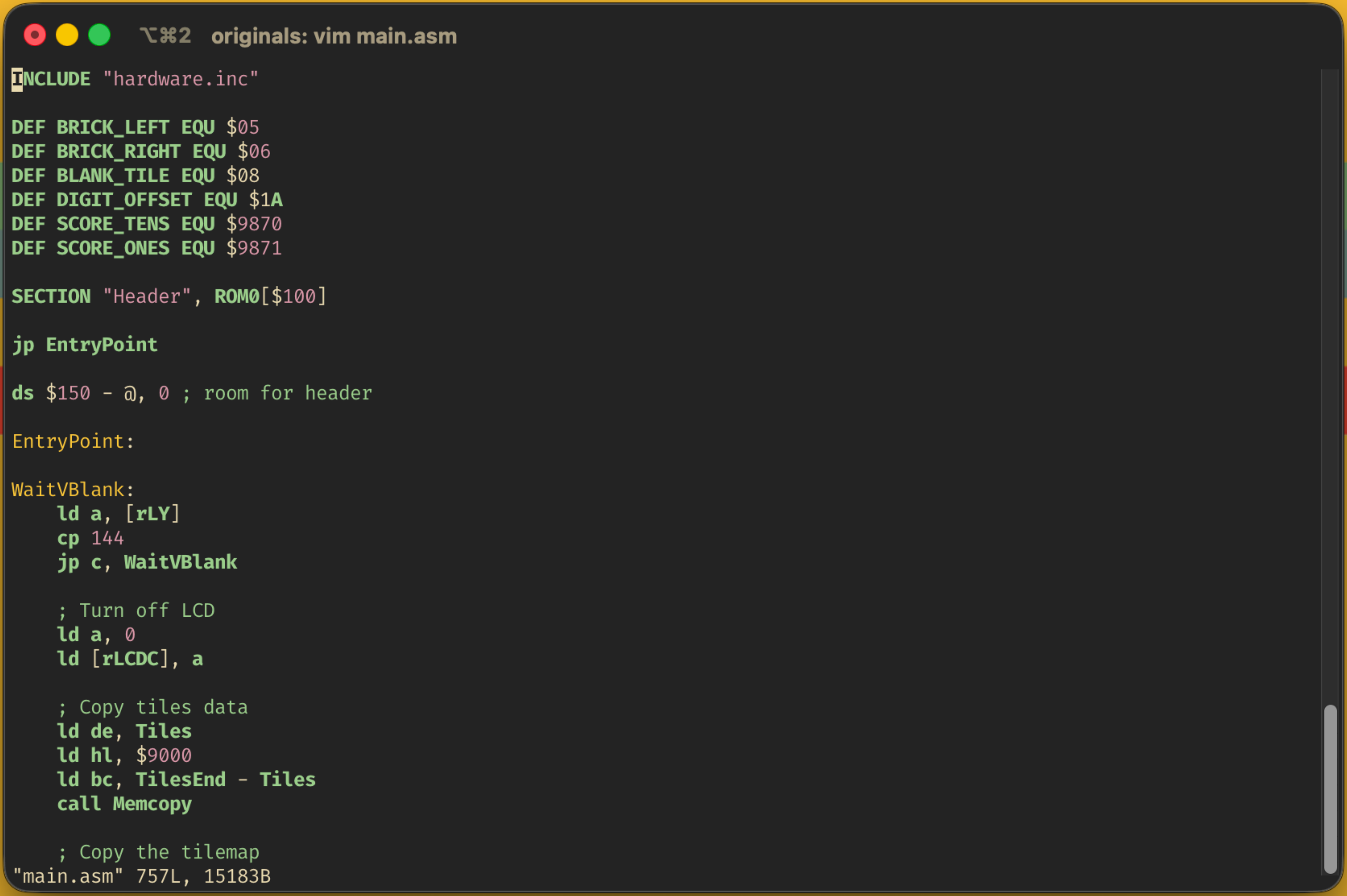
Unbricked - an Arkanoid copy

- In gbdev.io, as an example to illustrate how to create games in asm, the initial example is a copy of the famous Arkanoid.
- This example is important to see what happens when we go up to the high level to the code
- So let me explain some part of this game in asm



Unbricked - originals

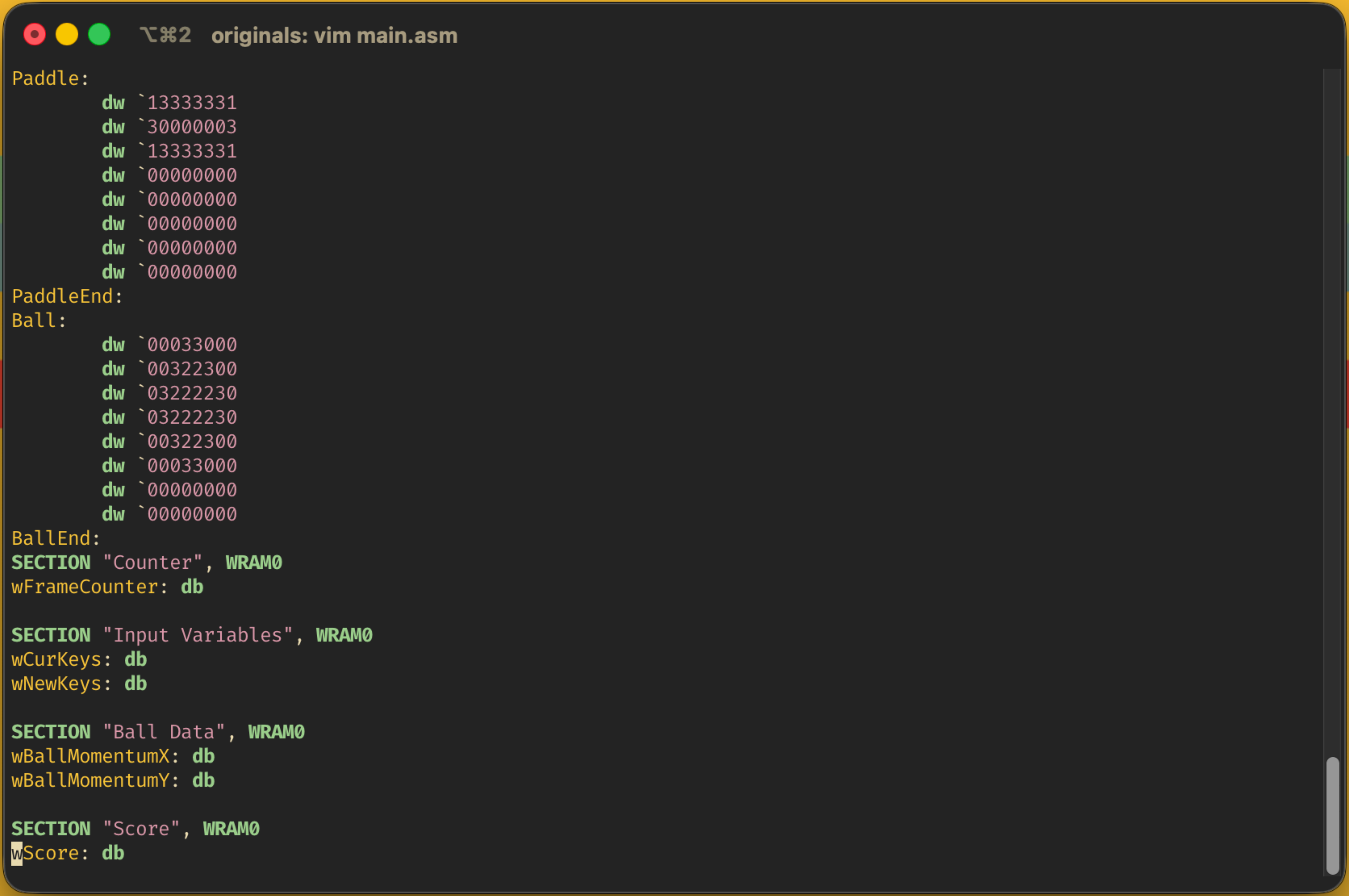
Inits



```
INCLUDE "hardware.inc"

DEF BRICK_LEFT EQU $05
DEF BRICK_RIGHT EQU $06
DEF BLANK_TILE EQU $08
DEF DIGIT_OFFSET EQU $1A
DEF SCORE_TENS EQU $9870
DEF SCORE_ONES EQU $9871

SECTION "Header", ROM0[$100]

jp EntryPoint

ds $150 - @, 0 ; room for header

EntryPoint:

WaitVBlank:
    ld a, [rLY]
    cp 144
    jp c, WaitVBlank

    ; Turn off LCD
    ld a, 0
    ld [rLCDC], a

    ; Copy tiles data
    ld de, Tiles
    ld hl, $9000
    ld bc, TilesEnd - Tiles
    call Memcopy

    ; Copy the tilemap
"main.asm" 757L, 15183B
```

Unbricked - originals

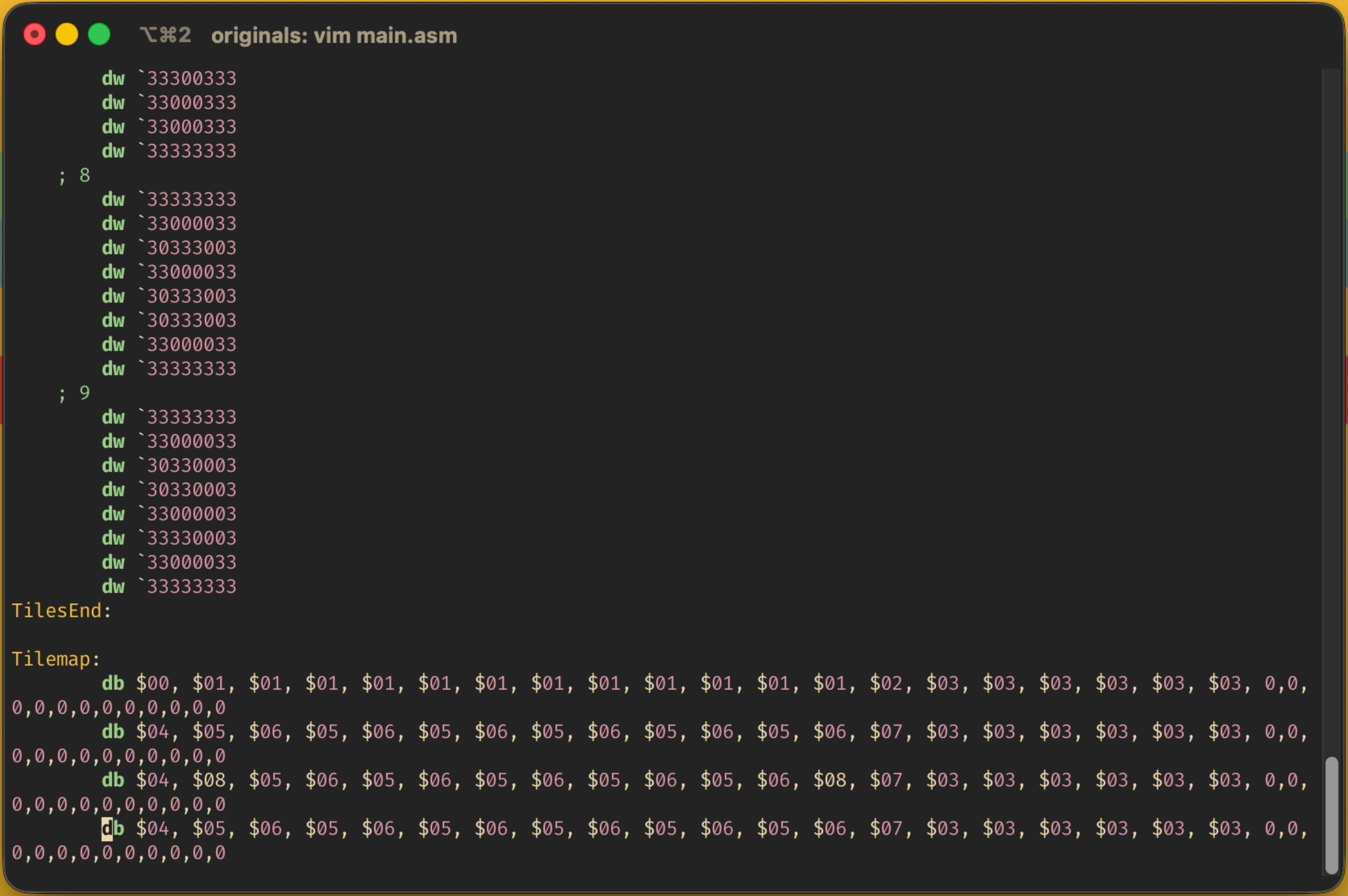
Variables



```
Paddle:
        dw `13333331
        dw `30000003
        dw `13333331
        dw `00000000
        dw `00000000
        dw `00000000
        dw `00000000
        dw `00000000
PaddleEnd:
Ball:
        dw `00033000
        dw `00322300
        dw `03222230
        dw `03222230
        dw `00322300
        dw `00033000
        dw `00000000
        dw `00000000
BallEnd:
SECTION "Counter", WRAM0
wFrameCounter: db

SECTION "Input Variables", WRAM0
wCurKeys: db
wNewKeys: db

SECTION "Ball Data", WRAM0
wBallMomentumX: db
wBallMomentumY: db

SECTION "Score", WRAM0
wScore: db
```

Unbricked - originals

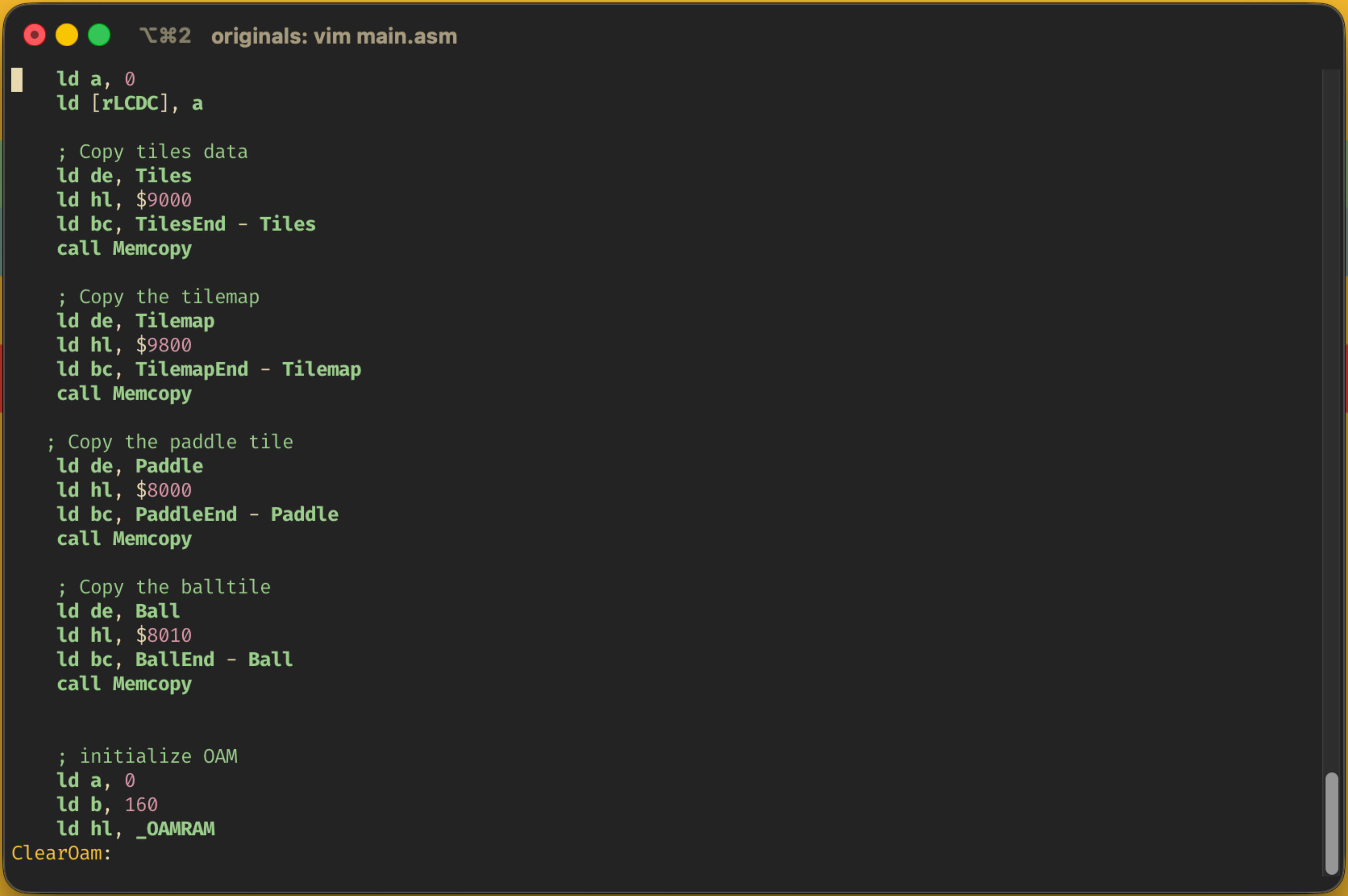
Tiles and Tilemap



```
        dw `33300333
        dw `33000333
        dw `33000333
        dw `33333333
    ; 8
        dw `33333333
        dw `33000033
        dw `30333003
        dw `33000033
        dw `30333003
        dw `30333003
        dw `33000033
        dw `33333333
    ; 9
        dw `33333333
        dw `33000033
        dw `30330003
        dw `30330003
        dw `33000003
        dw `33330003
        dw `33000033
        dw `33333333
TilesEnd:

Tilemap:
        db $00, $01, $01, $01, $01, $01, $01, $01, $01, $01, $01, $01, $01, $02, $03, $03, $03, $03, $03, $03, 0,0,
0,0,0,0,0,0,0,0,0,0
        db $04, $05, $06, $05, $06, $05, $06, $05, $06, $05, $06, $05, $06, $07, $03, $03, $03, $03, $03, $03, 0,0,
0,0,0,0,0,0,0,0,0,0
        db $04, $08, $05, $06, $05, $06, $05, $06, $05, $06, $05, $06, $08, $07, $03, $03, $03, $03, $03, $03, 0,0,
0,0,0,0,0,0,0,0,0,0
        db $04, $05, $06, $05, $06, $05, $06, $05, $06, $05, $06, $05, $06, $07, $03, $03, $03, $03, $03, $03, 0,0,
0,0,0,0,0,0,0,0,0,0
```

Unbricked - originals

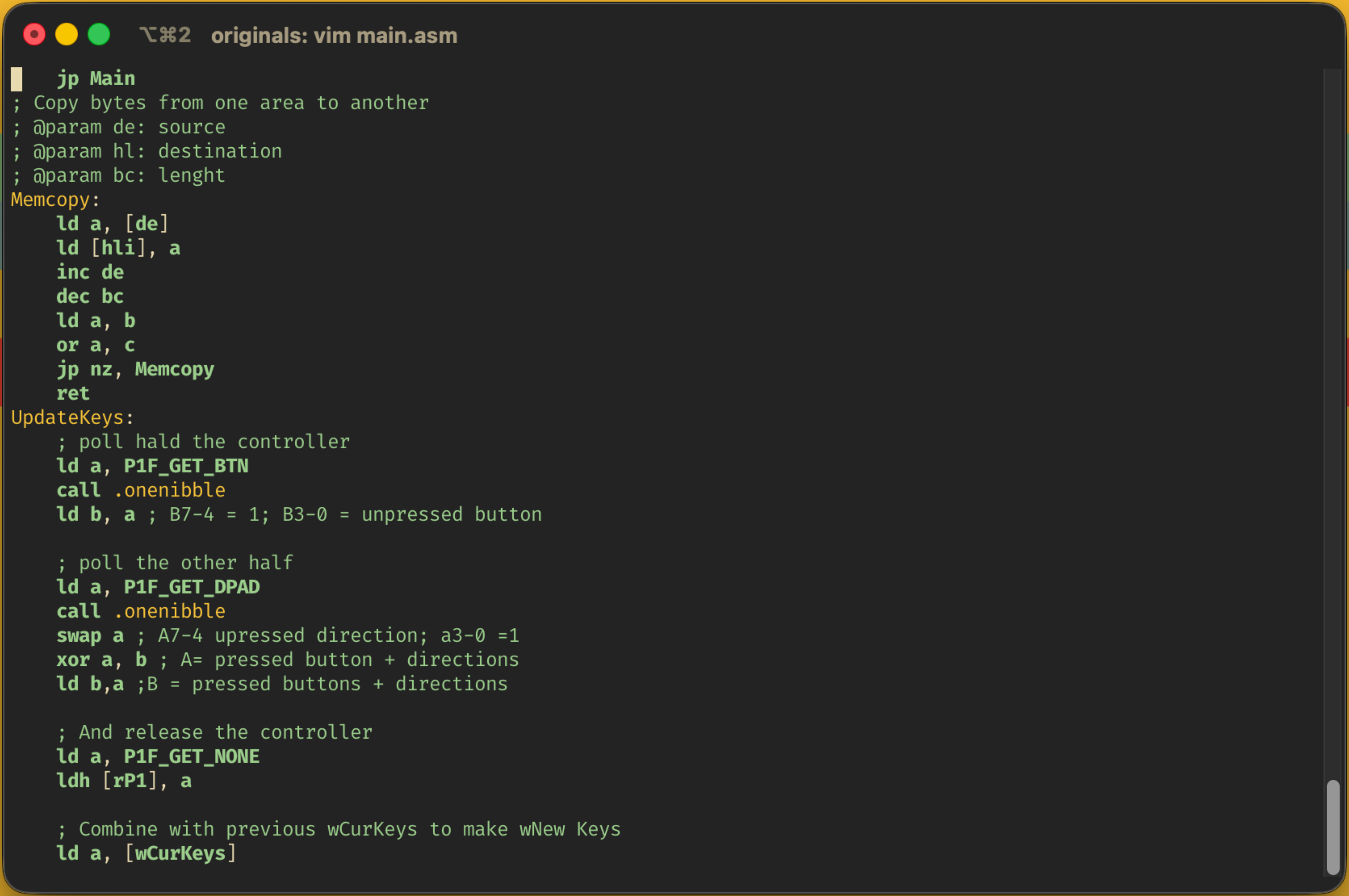
Memcopy



```
    ld a, 0
    ld [rLCDC], a

    ; Copy tiles data
    ld de, Tiles
    ld hl, $9000
    ld bc, TilesEnd - Tiles
    call Memcopy

    ; Copy the tilemap
    ld de, Tilemap
    ld hl, $9800
    ld bc, TilemapEnd - Tilemap
    call Memcopy

   ; Copy the paddle tile
    ld de, Paddle
    ld hl, $8000
    ld bc, PaddleEnd - Paddle
    call Memcopy

    ; Copy the balltile
    ld de, Ball
    ld hl, $8010
    ld bc, BallEnd - Ball
    call Memcopy


    ; initialize OAM
    ld a, 0
    ld b, 160
    ld hl, _OAMRAM
ClearOam:
```

Unbricked - originals

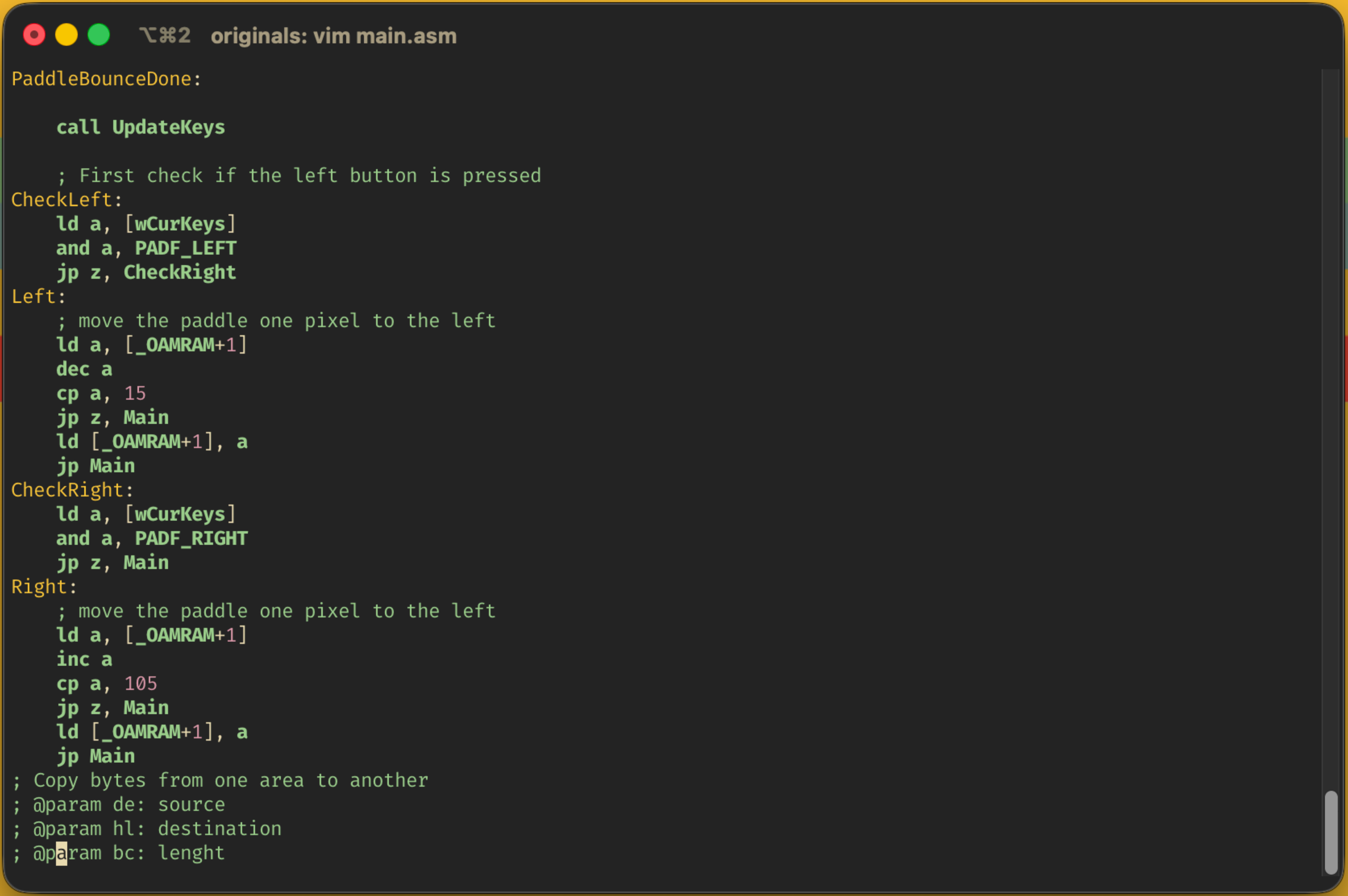
Functions



```
    jp Main
; Copy bytes from one area to another
; @param de: source
; @param hl: destination
; @param bc: lenght
Memcopy:
    ld a, [de]
    ld [hli], a
    inc de
    dec bc
    ld a, b
    or a, c
    jp nz, Memcopy
    ret
UpdateKeys:
    ; poll hald the controller
    ld a, P1F_GET_BTN
    call .onenibble
    ld b, a ; B7-4 = 1; B3-0 = unpressed button

    ; poll the other half
    ld a, P1F_GET_DPAD
    call .onenibble
    swap a ; A7-4 upressed direction; a3-0 =1
    xor a, b ; A= pressed button + directions
    ld b,a ;B = pressed buttons + directions

    ; And release the controller
    ld a, P1F_GET_NONE
    ldh [rP1], a

    ; Combine with previous wCurKeys to make wNew Keys
    ld a, [wCurKeys]
```

Unbricked - originals

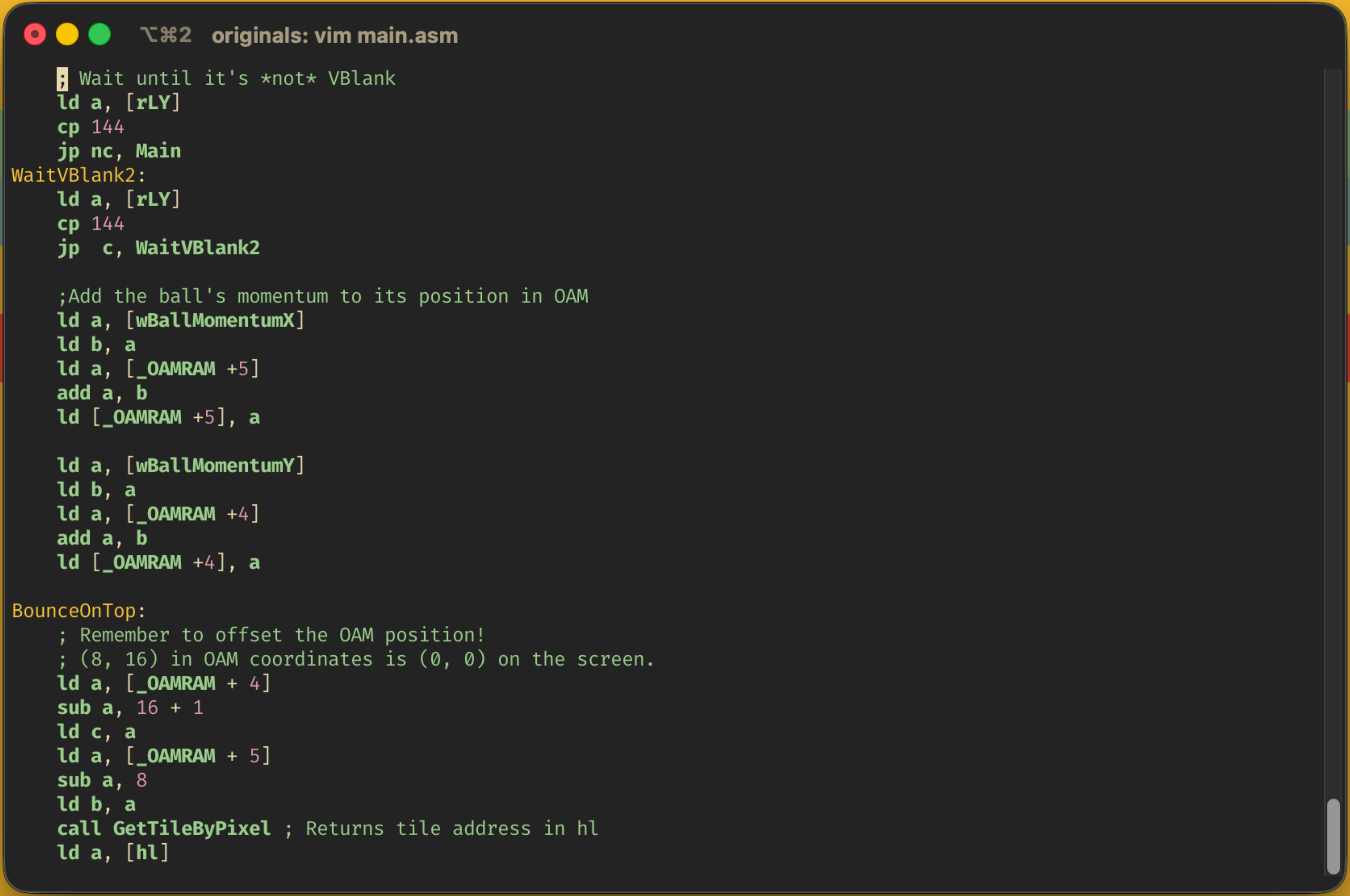
Main loop - Input



```
PaddleBounceDone:

    call UpdateKeys

    ; First check if the left button is pressed
CheckLeft:
    ld a, [wCurKeys]
    and a, PADF_LEFT
    jp z, CheckRight
Left:
    ; move the paddle one pixel to the left
    ld a, [_OAMRAM+1]
    dec a
    cp a, 15
    jp z, Main
    ld [_OAMRAM+1], a
    jp Main
CheckRight:
    ld a, [wCurKeys]
    and a, PADF_RIGHT
    jp z, Main
Right:
    ; move the paddle one pixel to the left
    ld a, [_OAMRAM+1]
    inc a
    cp a, 105
    jp z, Main
    ld [_OAMRAM+1], a
    jp Main
; Copy bytes from one area to another
; @param de: source
; @param hl: destination
; @param bc: lenght
```

Unbricked - originals

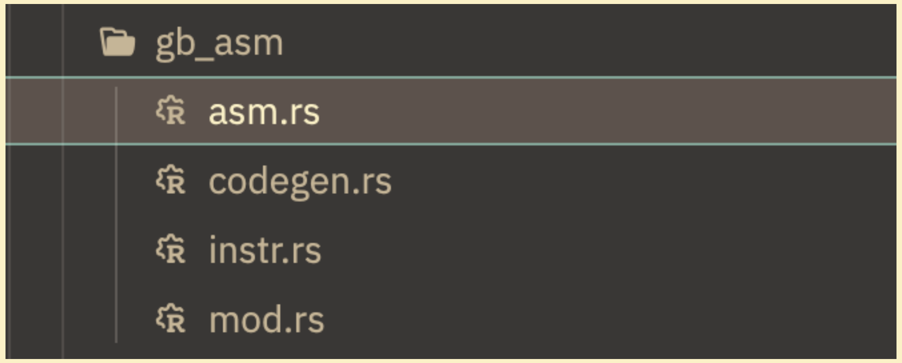
Main loop - Movement



```
    ; Wait until it's *not* VBlank
    ld a, [rLY]
    cp 144
    jp nc, Main
WaitVBlank2:
    ld a, [rLY]
    cp 144
    jp  c, WaitVBlank2

    ;Add the ball's momentum to its position in OAM
    ld a, [wBallMomentumX]
    ld b, a
    ld a, [_OAMRAM +5]
    add a, b
    ld [_OAMRAM +5], a

    ld a, [wBallMomentumY]
    ld b, a
    ld a, [_OAMRAM +4]
    add a, b
    ld [_OAMRAM +4], a

BounceOnTop:
    ; Remember to offset the OAM position!
    ; (8, 16) in OAM coordinates is (0, 0) on the screen.
    ld a, [_OAMRAM + 4]
    sub a, 16 + 1
    ld c, a
    ld a, [_OAMRAM + 5]
    sub a, 8
    ld b, a
    call GetTileByPixel ; Returns tile address in hl
    ld a, [hl]
```

gb_asm

- It is the most low-level library.
- Almost one-to-one with the asm but in Rust!



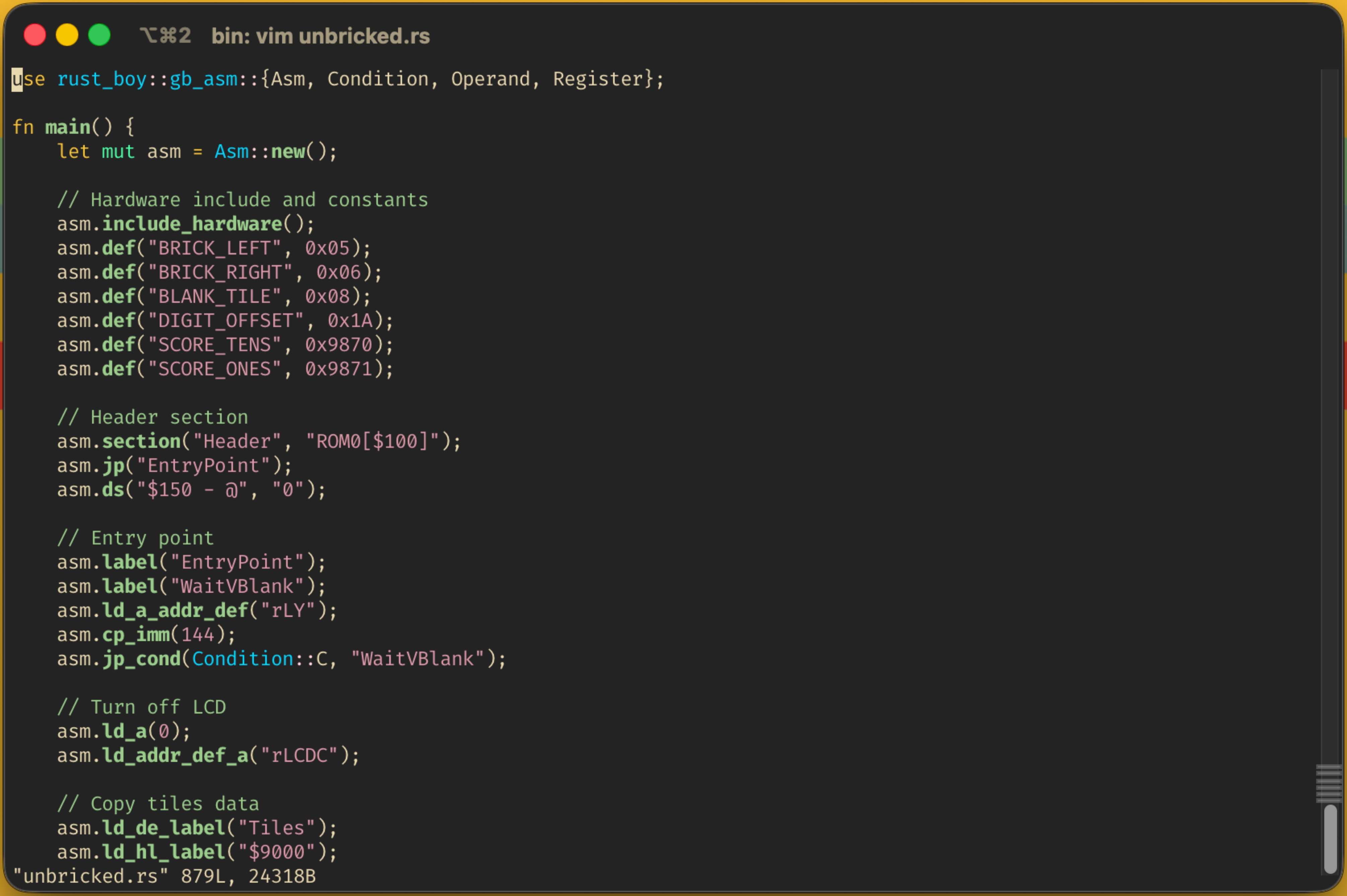
```
gb_asm
  asm.rs
  codegen.rs
  instr.rs
  mod.rs
```

- Instructions are something like: asm.ld(...), asm.cp(...), ...
- Link to an article that inspire me:

https://tinycomputers.io/posts/building-z80-roms-with-rust-a-modern-approach-to-retro-computing.html

gb_asm

unbricked.rs

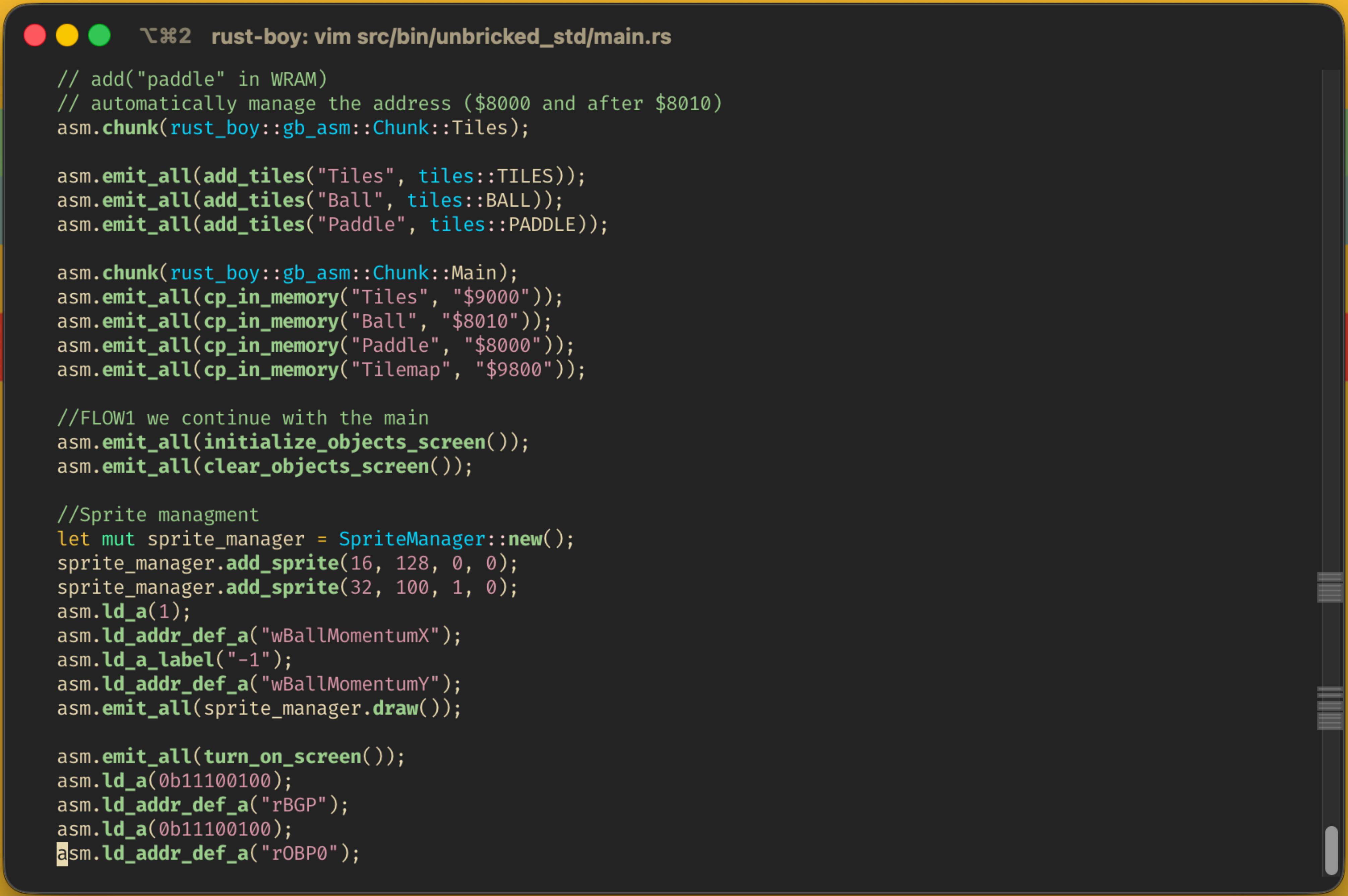


```
use rust_boy::gb_asm::{Asm, Condition, Operand, Register};

fn main() {
    let mut asm = Asm::new();

    // Hardware include and constants
    asm.include_hardware();
    asm.def("BRICK_LEFT", 0x05);
    asm.def("BRICK_RIGHT", 0x06);
    asm.def("BLANK_TILE", 0x08);
    asm.def("DIGIT_OFFSET", 0x1A);
    asm.def("SCORE_TENS", 0x9870);
    asm.def("SCORE_ONES", 0x9871);

    // Header section
    asm.section("Header", "ROM0[$100]");
    asm.jp("EntryPoint");
    asm.ds("$150 - @", "0");

    // Entry point
    asm.label("EntryPoint");
    asm.label("WaitVBlank");
    asm.ld_a_addr_def("rLY");
    asm.cp_imm(144);
    asm.jp_cond(Condition::C, "WaitVBlank");

    // Turn off LCD
    asm.ld_a(0);
    asm.ld_addr_def_a("rLCDC");

    // Copy tiles data
    asm.ld_de_label("Tiles");
    asm.ld_hl_label("$9000");
"unbricked.rs" 879L, 24318B
```

gb_std

- This lib is more of a high-level and implements:
    - A chunk system (Main, Functions, Tiles, etc.) so you can put code from everywhere, and at the time of the generation are put in the right section.
    - Tile and tilemap utilities
    - A sprite manager
- The initial attempt at an if statement.

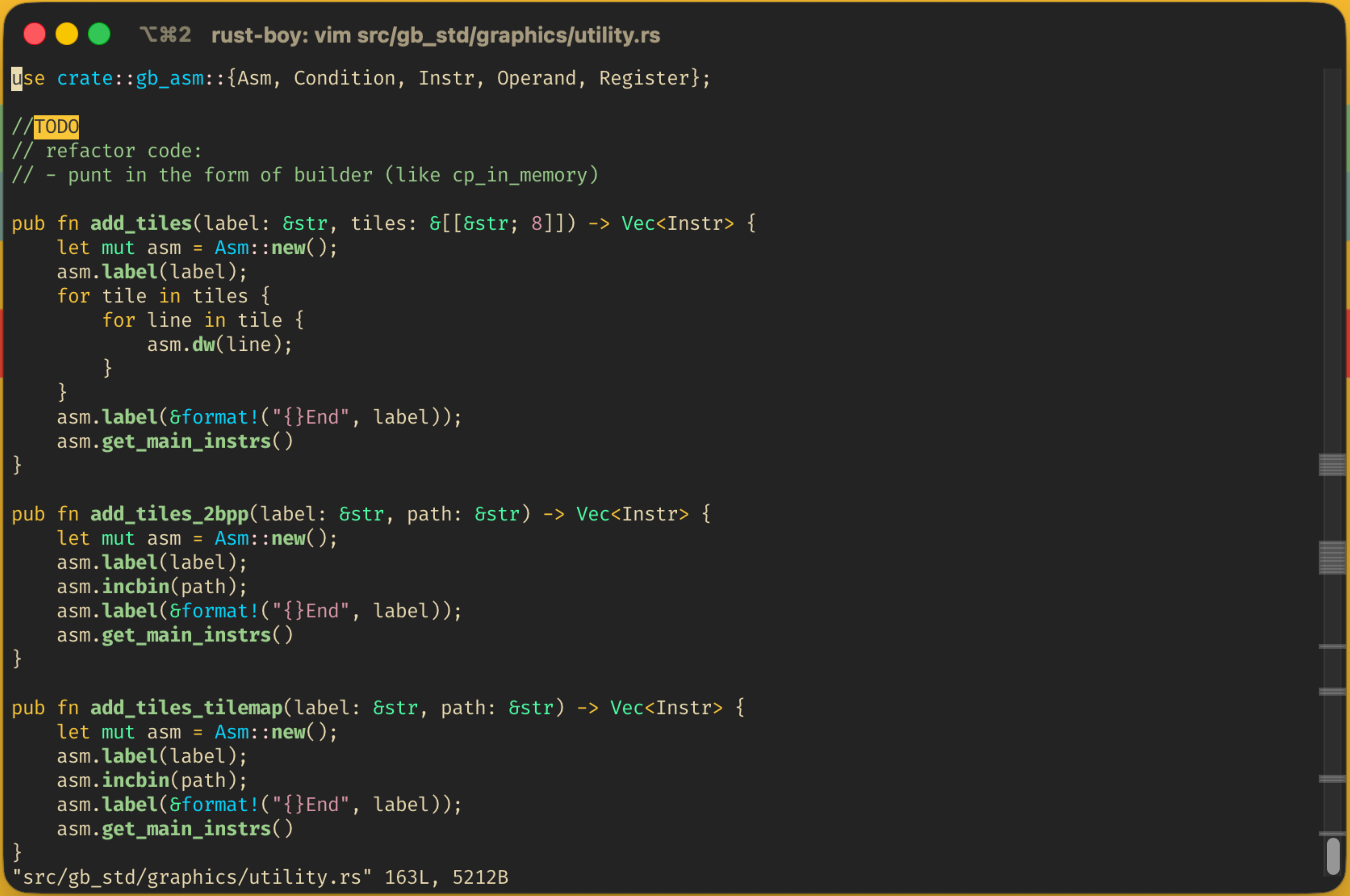
gb_std



```
// add("paddle" in WRAM)
// automatically manage the address ($8000 and after $8010)
asm.chunk(rust_boy::gb_asm::Chunk::Tiles);

asm.emit_all(add_tiles("Tiles", tiles::TILES));
asm.emit_all(add_tiles("Ball", tiles::BALL));
asm.emit_all(add_tiles("Paddle", tiles::PADDLE));

asm.chunk(rust_boy::gb_asm::Chunk::Main);
asm.emit_all(cp_in_memory("Tiles", "$9000"));
asm.emit_all(cp_in_memory("Ball", "$8010"));
asm.emit_all(cp_in_memory("Paddle", "$8000"));
asm.emit_all(cp_in_memory("Tilemap", "$9800"));

//FLOW1 we continue with the main
asm.emit_all(initialize_objects_screen());
asm.emit_all(clear_objects_screen());

//Sprite managment
let mut sprite_manager = SpriteManager::new();
sprite_manager.add_sprite(16, 128, 0, 0);
sprite_manager.add_sprite(32, 100, 1, 0);
asm.ld_a(1);
asm.ld_addr_def_a("wBallMomentumX");
asm.ld_a_label("-1");
asm.ld_addr_def_a("wBallMomentumY");
asm.emit_all(sprite_manager.draw());

asm.emit_all(turn_on_screen());
asm.ld_a(0b11100100);
asm.ld_addr_def_a("rBGP");
asm.ld_a(0b11100100);
asm.ld_addr_def_a("rOBP0");
```

gb_std

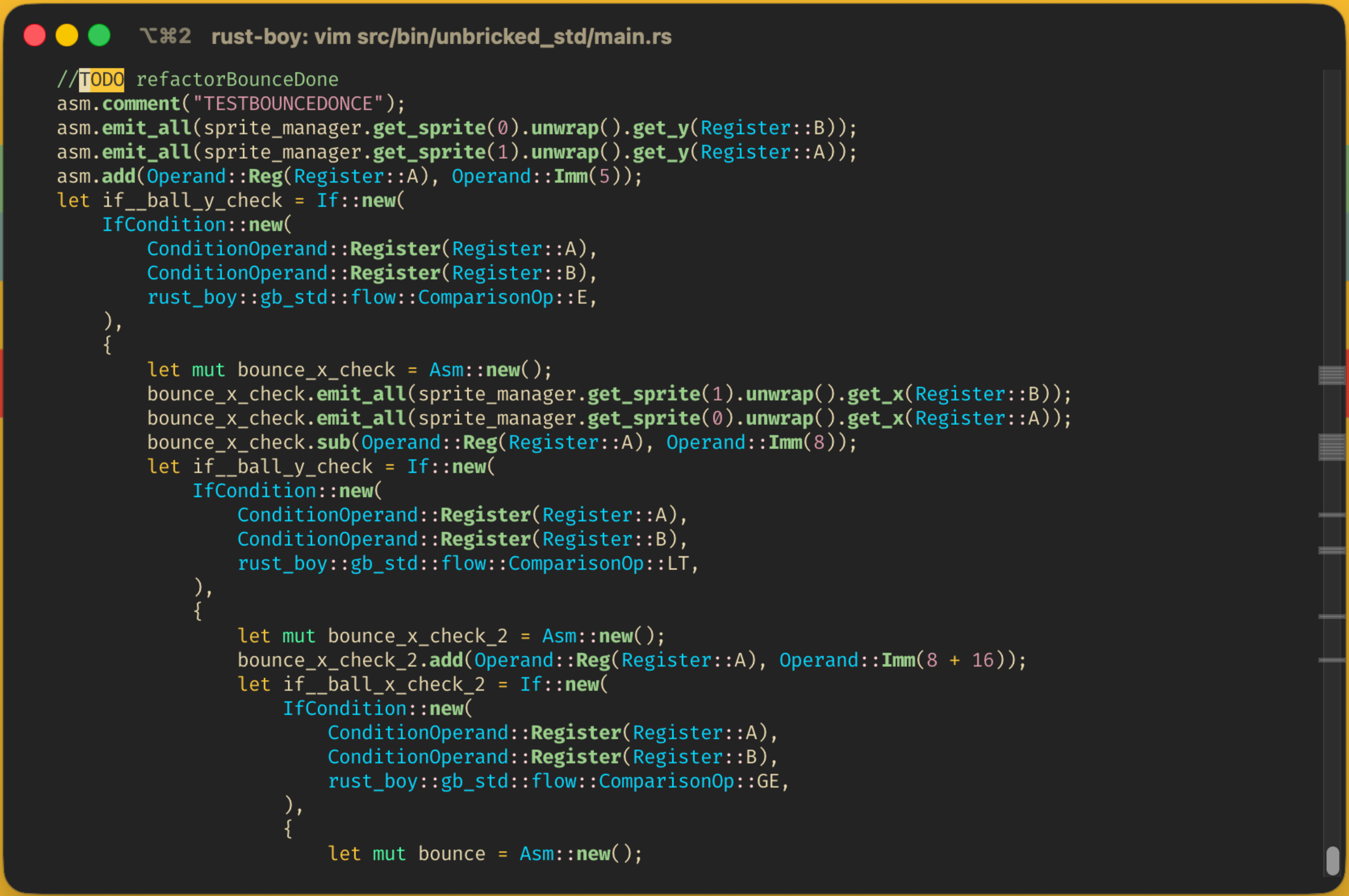
Utilities



```
use crate::gb_asm::{Asm, Condition, Instr, Operand, Register};

//TODO
// refactor code:
// - punt in the form of builder (like cp_in_memory)

pub fn add_tiles(label: &str, tiles: &[[&str; 8]]) -> Vec<Instr> {
    let mut asm = Asm::new();
    asm.label(label);
    for tile in tiles {
        for line in tile {
            asm.dw(line);
        }
    }
    asm.label(&format!("{}End", label));
    asm.get_main_instrs()
}

pub fn add_tiles_2bpp(label: &str, path: &str) -> Vec<Instr> {
    let mut asm = Asm::new();
    asm.label(label);
    asm.incbin(path);
    asm.label(&format!("{}End", label));
    asm.get_main_instrs()
}

pub fn add_tiles_tilemap(label: &str, path: &str) -> Vec<Instr> {
    let mut asm = Asm::new();
    asm.label(label);
    asm.incbin(path);
    asm.label(&format!("{}End", label));
    asm.get_main_instrs()
}
"src/gb_std/graphics/utility.rs" 163L, 5212B
```

gb_std

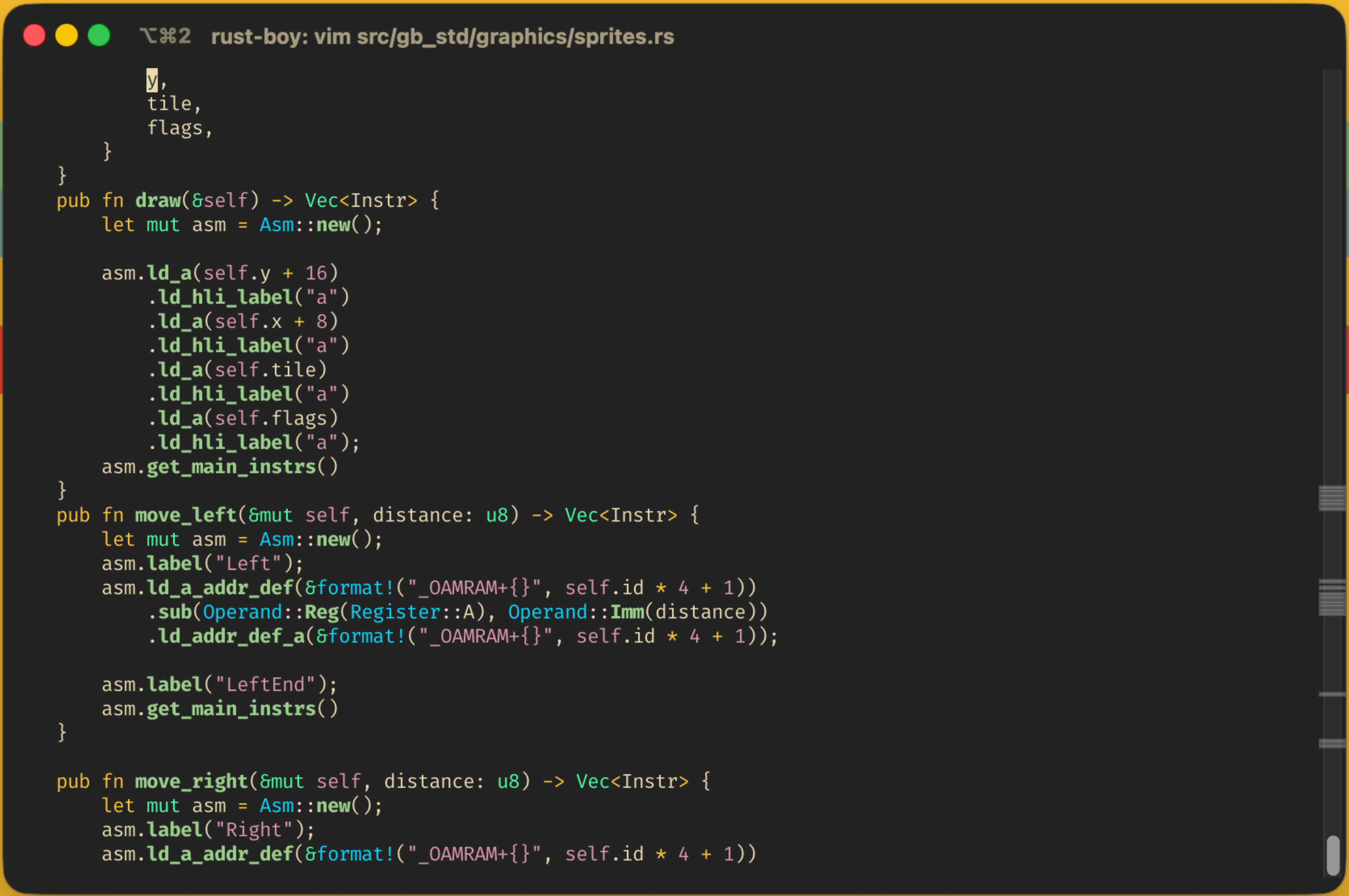
If statement



```
//TODO refactorBounceDone
asm.comment("TESTBOUNCEDONCE");
asm.emit_all(sprite_manager.get_sprite(0).unwrap().get_y(Register::B));
asm.emit_all(sprite_manager.get_sprite(1).unwrap().get_y(Register::A));
asm.add(Operand::Reg(Register::A), Operand::Imm(5));
let if__ball_y_check = If::new(
    IfCondition::new(
        ConditionOperand::Register(Register::A),
        ConditionOperand::Register(Register::B),
        rust_boy::gb_std::flow::ComparisonOp::E,
    ),
    {
        let mut bounce_x_check = Asm::new();
        bounce_x_check.emit_all(sprite_manager.get_sprite(1).unwrap().get_x(Register::B));
        bounce_x_check.emit_all(sprite_manager.get_sprite(0).unwrap().get_x(Register::A));
        bounce_x_check.sub(Operand::Reg(Register::A), Operand::Imm(8));
        let if__ball_y_check = If::new(
            IfCondition::new(
                ConditionOperand::Register(Register::A),
                ConditionOperand::Register(Register::B),
                rust_boy::gb_std::flow::ComparisonOp::LT,
            ),
            {
                let mut bounce_x_check_2 = Asm::new();
                bounce_x_check_2.add(Operand::Reg(Register::A), Operand::Imm(8 + 16));
                let if__ball_x_check_2 = If::new(
                    IfCondition::new(
                        ConditionOperand::Register(Register::A),
                        ConditionOperand::Register(Register::B),
                        rust_boy::gb_std::flow::ComparisonOp::GE,
                    ),
                    {
                        let mut bounce = Asm::new();
```

gb_std

sprite_manager

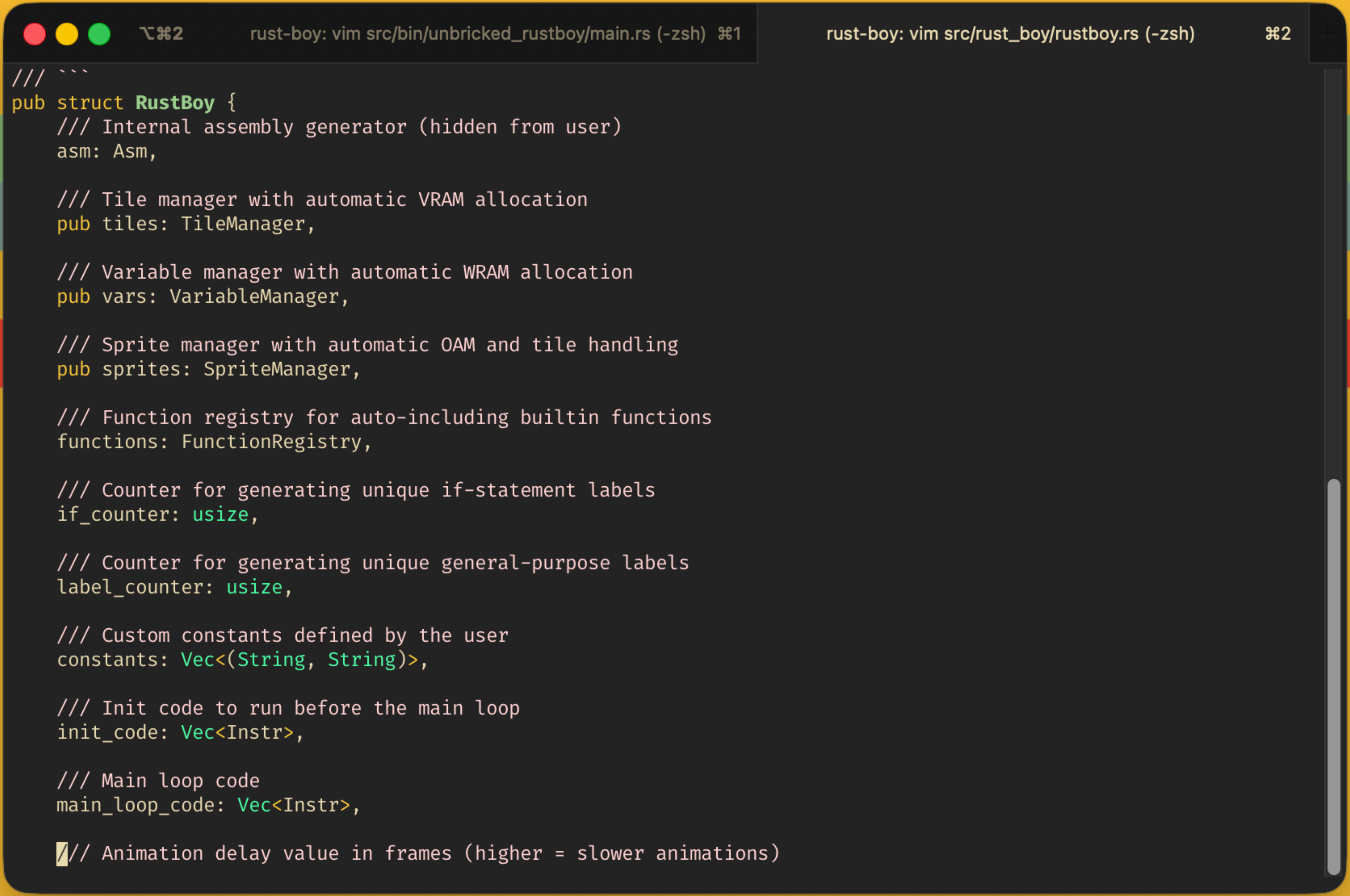


```
        y,
        tile,
        flags,
    }
}
pub fn draw(&self) -> Vec<Instr> {
    let mut asm = Asm::new();

    asm.ld_a(self.y + 16)
        .ld_hli_label("a")
        .ld_a(self.x + 8)
        .ld_hli_label("a")
        .ld_a(self.tile)
        .ld_hli_label("a")
        .ld_a(self.flags)
        .ld_hli_label("a");
    asm.get_main_instrs()
}
pub fn move_left(&mut self, distance: u8) -> Vec<Instr> {
    let mut asm = Asm::new();
    asm.label("Left");
    asm.ld_a_addr_def(&format!("_OAMRAM+{}", self.id * 4 + 1))
        .sub(Operand::Reg(Register::A), Operand::Imm(distance))
        .ld_addr_def_a(&format!("_OAMRAM+{}", self.id * 4 + 1));

    asm.label("LeftEnd");
    asm.get_main_instrs()
}

pub fn move_right(&mut self, distance: u8) -> Vec<Instr> {
    let mut asm = Asm::new();
    asm.label("Right");
    asm.ld_a_addr_def(&format!("_OAMRAM+{}", self.id * 4 + 1))
```

rust_boy

- With gb_std we understood what we can level up:
  - If statements have to be simpler
  - The init instructions must be written in an automatic way
  - There are some functions that can be considered “BuiltIn (UpdateKeys, WaitVBlank, Memcopy, etc.)
  - Make more managers (Tiles, Inputs, etc.)
  - Hide every reference to the memory address

rust_boy

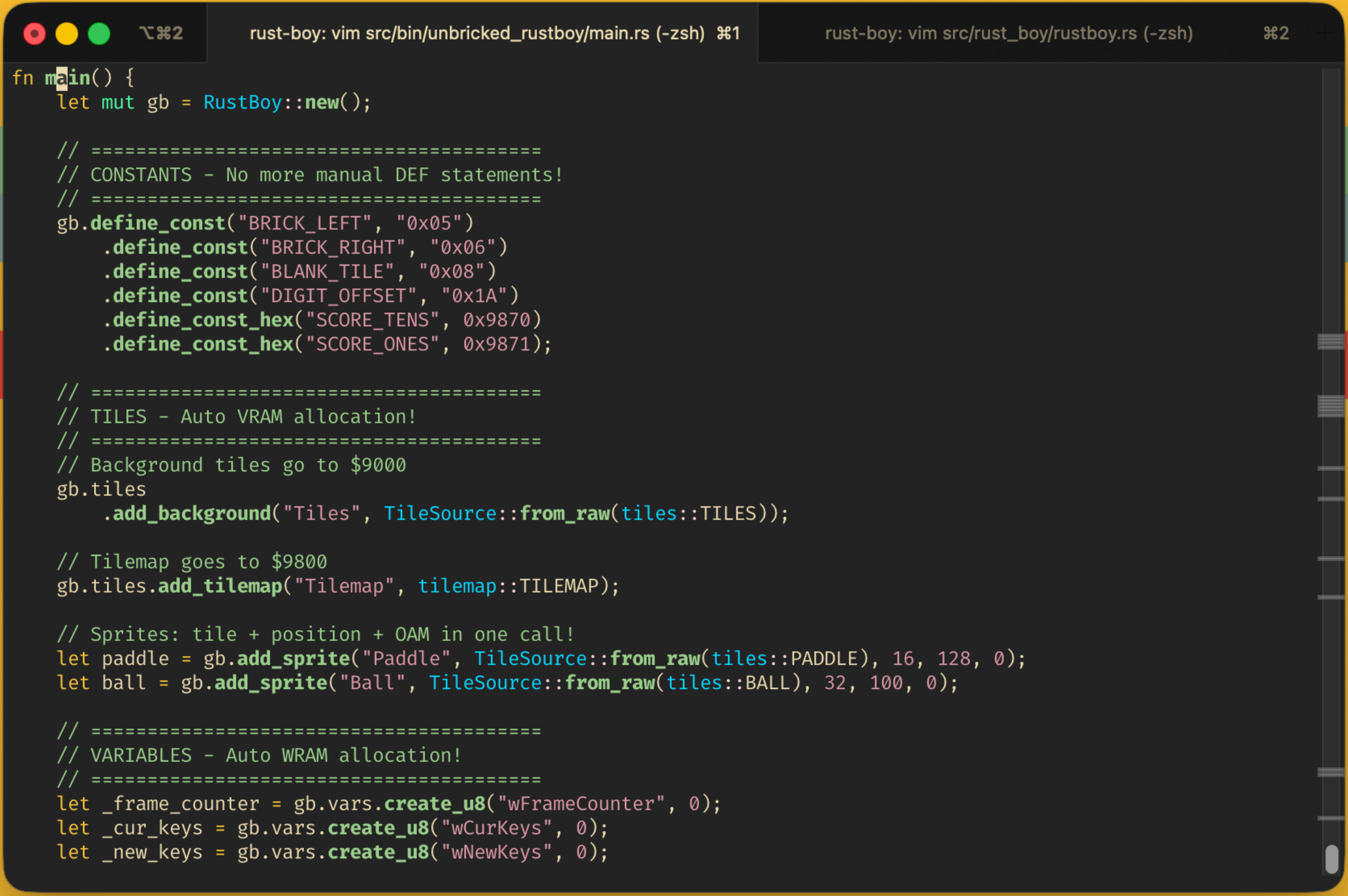


⌥⌘2
rust-boy: vim src/bin/unbricked_rustboy/main.rs (-zsh) ⌘1
rust-boy: vim src/rust_boy/rustboy.rs (-zsh)
⌘2

```
/// ```
pub struct RustBoy {
    /// Internal assembly generator (hidden from user)
    asm: Asm,

    /// Tile manager with automatic VRAM allocation
    pub tiles: TileManager,

    /// Variable manager with automatic WRAM allocation
    pub vars: VariableManager,

    /// Sprite manager with automatic OAM and tile handling
    pub sprites: SpriteManager,

    /// Function registry for auto-including builtin functions
    functions: FunctionRegistry,

    /// Counter for generating unique if-statement labels
    if_counter: usize,

    /// Counter for generating unique general-purpose labels
    label_counter: usize,

    /// Custom constants defined by the user
    constants: Vec<(String, String)>,

    /// Init code to run before the main loop
    init_code: Vec<Instr>,

    /// Main loop code
    main_loop_code: Vec<Instr>,

    /// Animation delay value in frames (higher = slower animations)
```

rust_boy

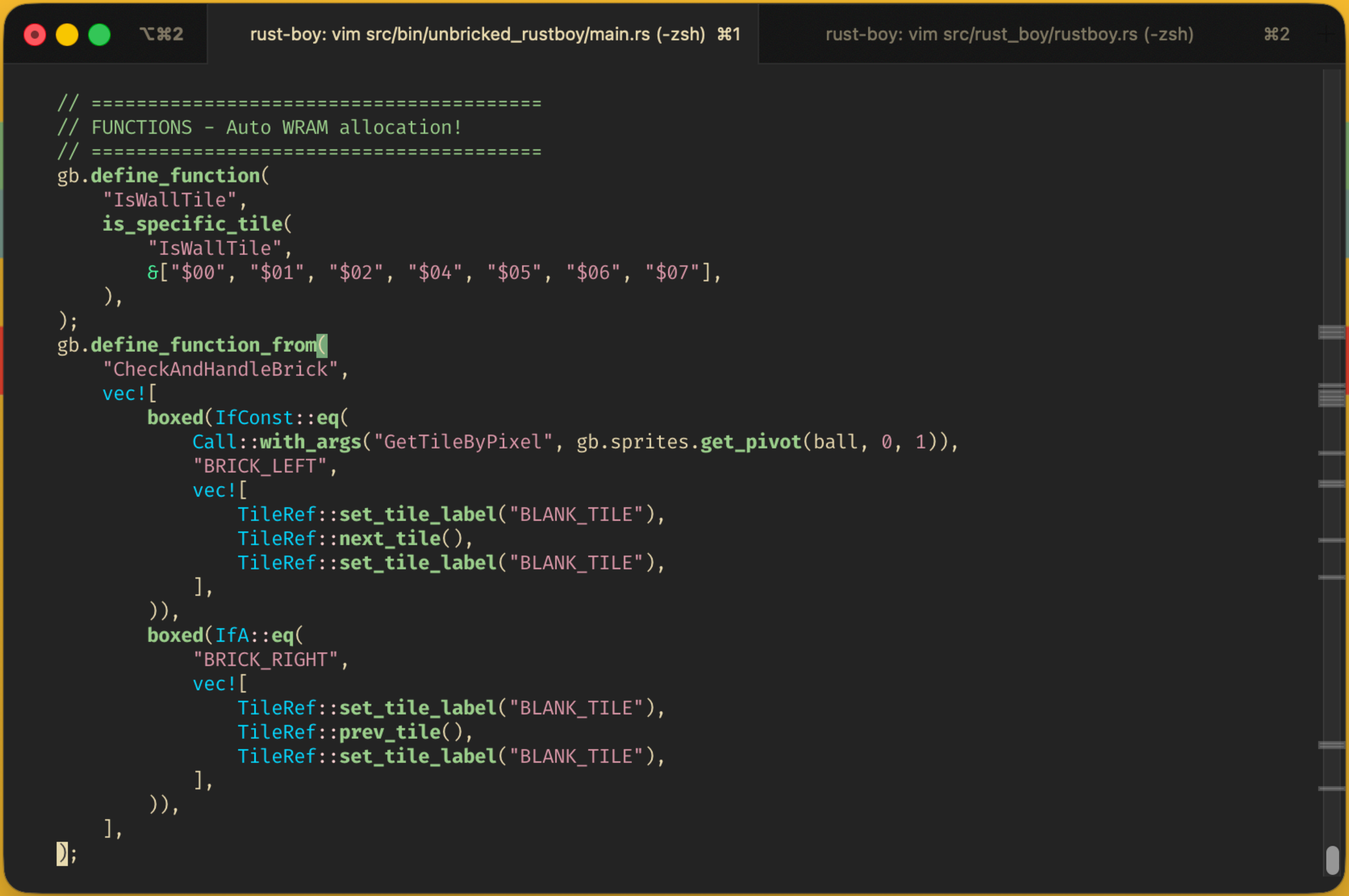
unbricked.rs


⌥⌘2
rust-boy: vim src/bin/unbricked_rustboy/main.rs (-zsh) ⌘1
rust-boy: vim src/rust_boy/rustboy.rs (-zsh) ⌘2

```
fn main() {
    let mut gb = RustBoy::new();

    // ========================================
    // CONSTANTS - No more manual DEF statements!
    // ========================================
    gb.define_const("BRICK_LEFT", "0x05")
        .define_const("BRICK_RIGHT", "0x06")
        .define_const("BLANK_TILE", "0x08")
        .define_const("DIGIT_OFFSET", "0x1A")
        .define_const_hex("SCORE_TENS", 0x9870)
        .define_const_hex("SCORE_ONES", 0x9871);

    // ========================================
    // TILES - Auto VRAM allocation!
    // ========================================
    // Background tiles go to $9000
    gb.tiles
        .add_background("Tiles", TileSource::from_raw(tiles::TILES));

    // Tilemap goes to $9800
    gb.tiles.add_tilemap("Tilemap", tilemap::TILEMAP);

    // Sprites: tile + position + OAM in one call!
    let paddle = gb.add_sprite("Paddle", TileSource::from_raw(tiles::PADDLE), 16, 128, 0);
    let ball = gb.add_sprite("Ball", TileSource::from_raw(tiles::BALL), 32, 100, 0);

    // ========================================
    // VARIABLES - Auto WRAM allocation!
    // ========================================
    let _frame_counter = gb.vars.create_u8("wFrameCounter", 0);
    let _cur_keys = gb.vars.create_u8("wCurKeys", 0);
    let _new_keys = gb.vars.create_u8("wNewKeys", 0);
```

rust_boy

unbricked.rs

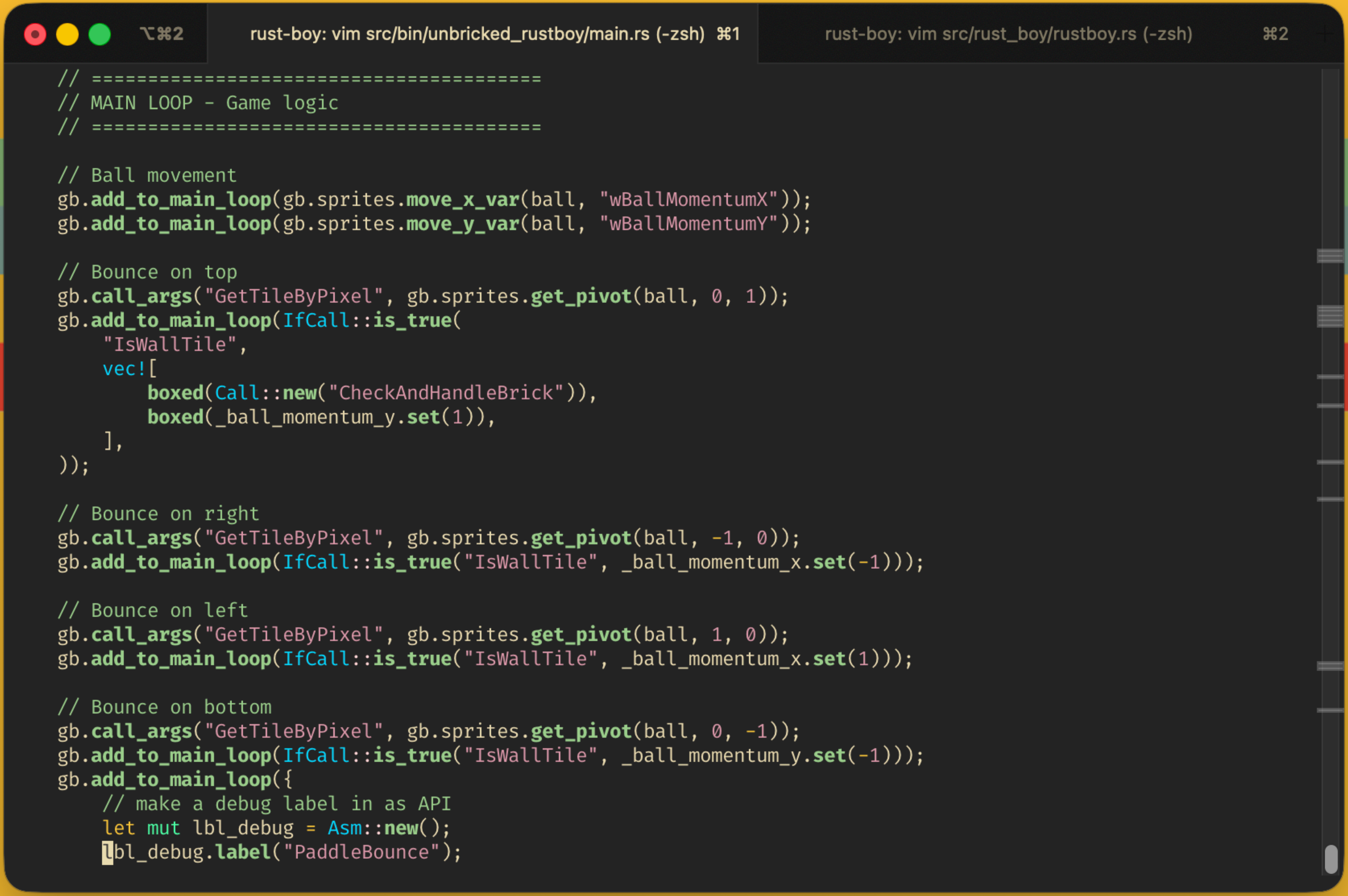


⌥⌘2
rust-boy: vim src/bin/unbricked_rustboy/main.rs (-zsh) ⌘1
rust-boy: vim src/rust_boy/rustboy.rs (-zsh) ⌘2

```
// ========================================
// FUNCTIONS - Auto WRAM allocation!
// ========================================
gb.define_function(
    "IsWallTile",
    is_specific_tile(
        "IsWallTile",
        &["$00", "$01", "$02", "$04", "$05", "$06", "$07"],
    ),
);
gb.define_function_from(
    "CheckAndHandleBrick",
    vec![
        boxed(IfConst::eq(
            Call::with_args("GetTileByPixel", gb.sprites.get_pivot(ball, 0, 1)),
            "BRICK_LEFT",
            vec![
                TileRef::set_tile_label("BLANK_TILE"),
                TileRef::next_tile(),
                TileRef::set_tile_label("BLANK_TILE"),
            ],
        )),
        boxed(IfA::eq(
            "BRICK_RIGHT",
            vec![
                TileRef::set_tile_label("BLANK_TILE"),
                TileRef::prev_tile(),
                TileRef::set_tile_label("BLANK_TILE"),
            ],
        )),
    ],
);
```

rust_boy

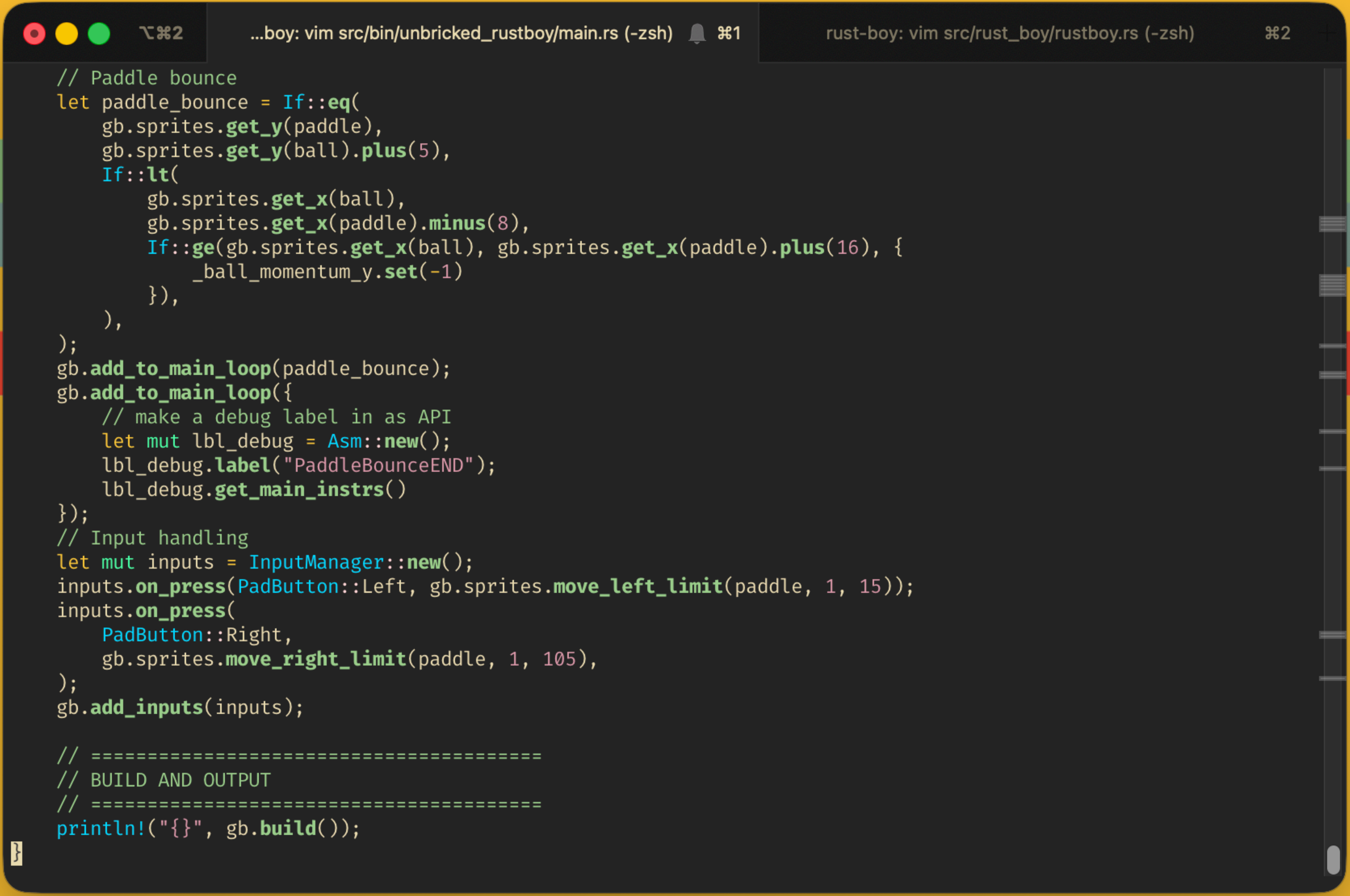
unbricked.rs


⌥⌘2
rust-boy: vim src/bin/unbricked_rustboy/main.rs (-zsh) ⌘1
rust-boy: vim src/rust_boy/rustboy.rs (-zsh)
⌘2

```
// ========================================
// MAIN LOOP - Game logic
// ========================================

// Ball movement
gb.add_to_main_loop(gb.sprites.move_x_var(ball, "wBallMomentumX"));
gb.add_to_main_loop(gb.sprites.move_y_var(ball, "wBallMomentumY"));

// Bounce on top
gb.call_args("GetTileByPixel", gb.sprites.get_pivot(ball, 0, 1));
gb.add_to_main_loop(IfCall::is_true(
    "IsWallTile",
    vec![
        boxed(Call::new("CheckAndHandleBrick")),
        boxed(_ball_momentum_y.set(1)),
    ],
));

// Bounce on right
gb.call_args("GetTileByPixel", gb.sprites.get_pivot(ball, -1, 0));
gb.add_to_main_loop(IfCall::is_true("IsWallTile", _ball_momentum_x.set(-1)));

// Bounce on left
gb.call_args("GetTileByPixel", gb.sprites.get_pivot(ball, 1, 0));
gb.add_to_main_loop(IfCall::is_true("IsWallTile", _ball_momentum_x.set(1)));

// Bounce on bottom
gb.call_args("GetTileByPixel", gb.sprites.get_pivot(ball, 0, -1));
gb.add_to_main_loop(IfCall::is_true("IsWallTile", _ball_momentum_y.set(-1)));
gb.add_to_main_loop({
    // make a debug label in as API
    let mut lbl_debug = Asm::new();
    lbl_debug.label("PaddleBounce");
```

rust_boy

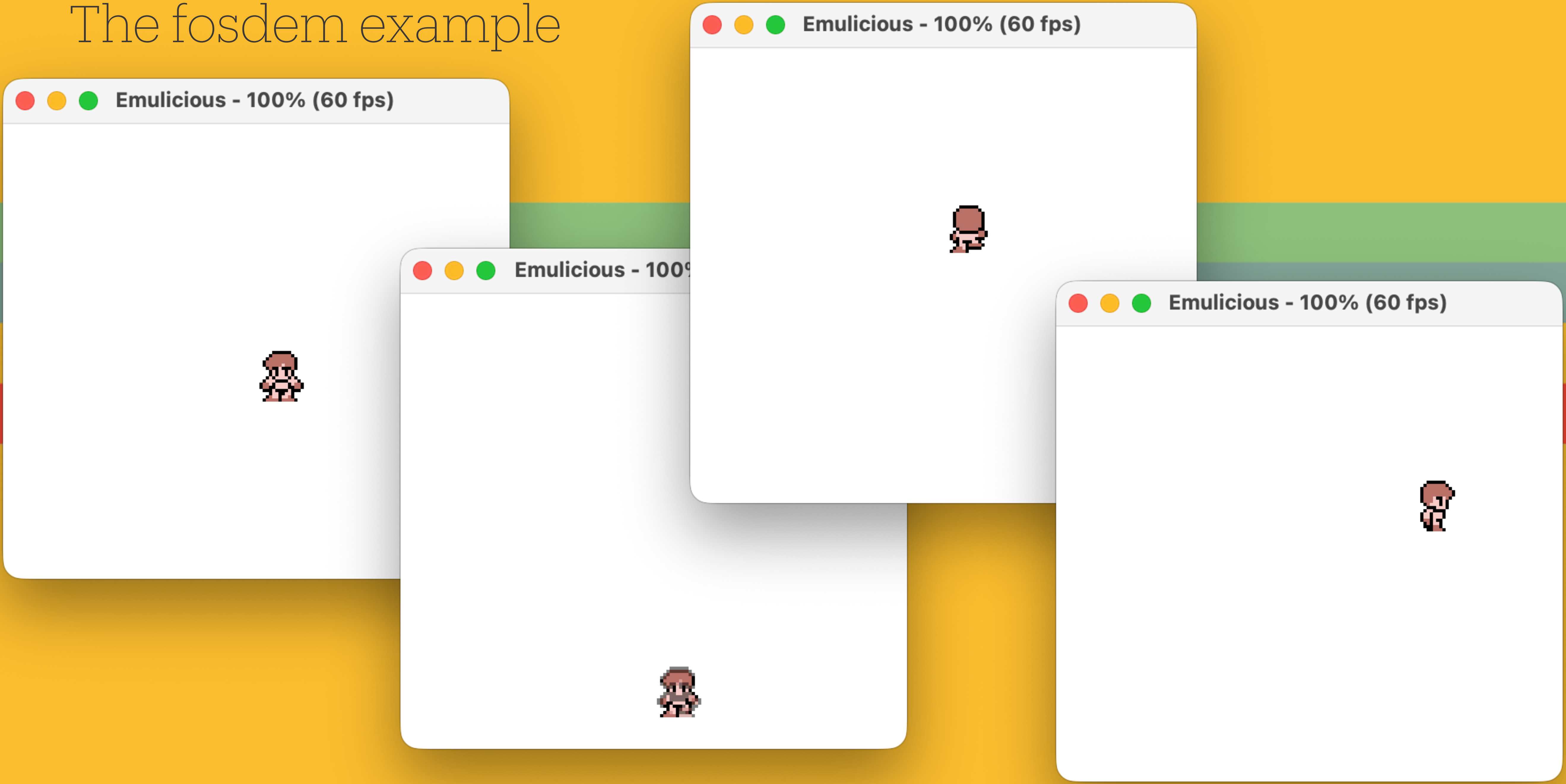
unbricked.rs


⌥⌘2
...boy: vim src/bin/unbricked_rustboy/main.rs (-zsh)
⌘1
rust-boy: vim src/rust_boy/rustboy.rs (-zsh)
⌘2

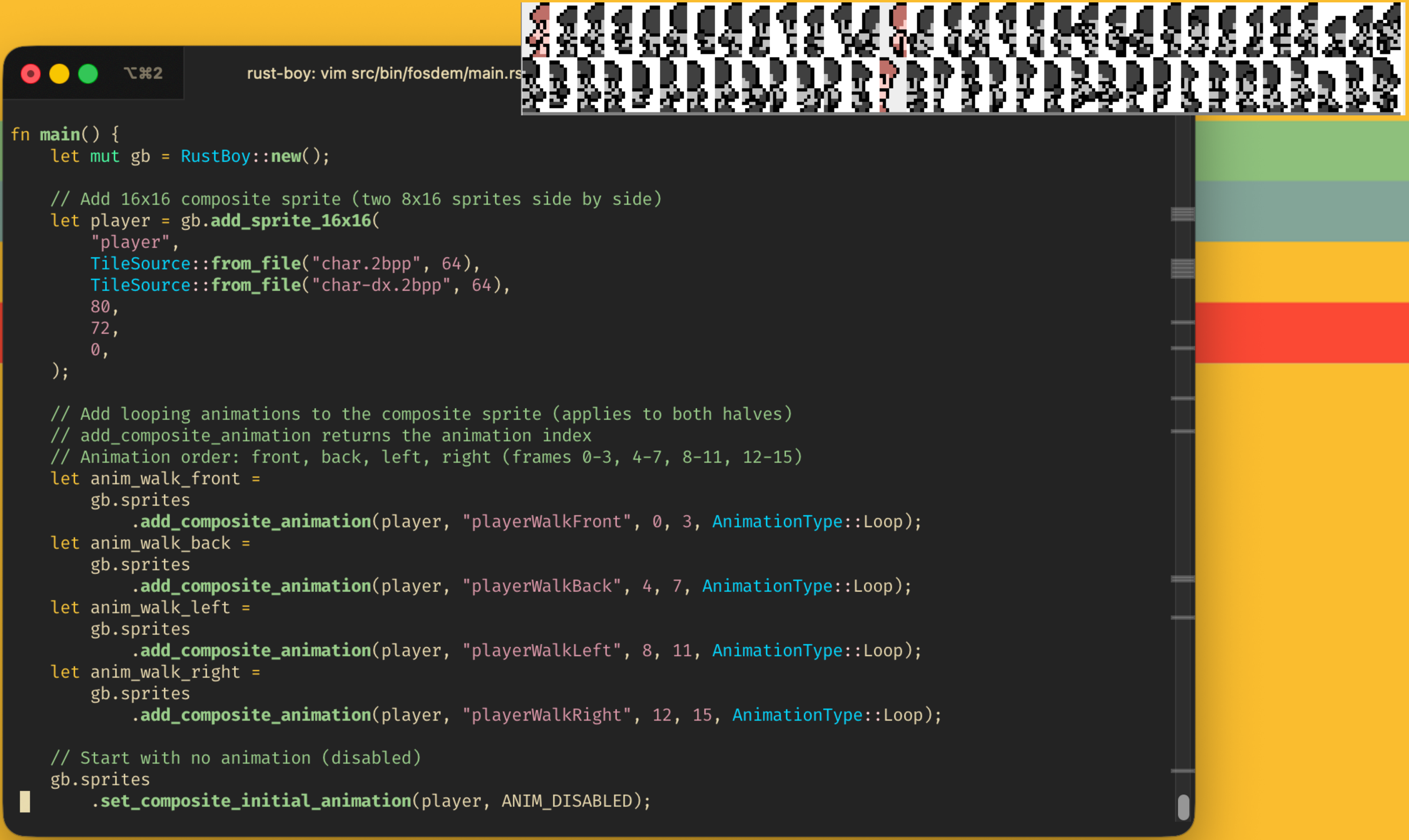
```
    // Paddle bounce
    let paddle_bounce = If::eq(
        gb.sprites.get_y(paddle),
        gb.sprites.get_y(ball).plus(5),
        If::lt(
            gb.sprites.get_x(ball),
            gb.sprites.get_x(paddle).minus(8),
            If::ge(gb.sprites.get_x(ball), gb.sprites.get_x(paddle).plus(16), {
                _ball_momentum_y.set(-1)
            }),
        ),
    );
    gb.add_to_main_loop(paddle_bounce);
    gb.add_to_main_loop({
        // make a debug label in as API
        let mut lbl_debug = Asm::new();
        lbl_debug.label("PaddleBounceEND");
        lbl_debug.get_main_instrs()
    });
    // Input handling
    let mut inputs = InputManager::new();
    inputs.on_press(PadButton::Left, gb.sprites.move_left_limit(paddle, 1, 15));
    inputs.on_press(
        PadButton::Right,
        gb.sprites.move_right_limit(paddle, 1, 105),
    );
    gb.add_inputs(inputs);

    // ========================================
    // BUILD AND OUTPUT
    // ========================================
    println!("{}", gb.build());
}
```

Try rust_boy!

The fosdem example

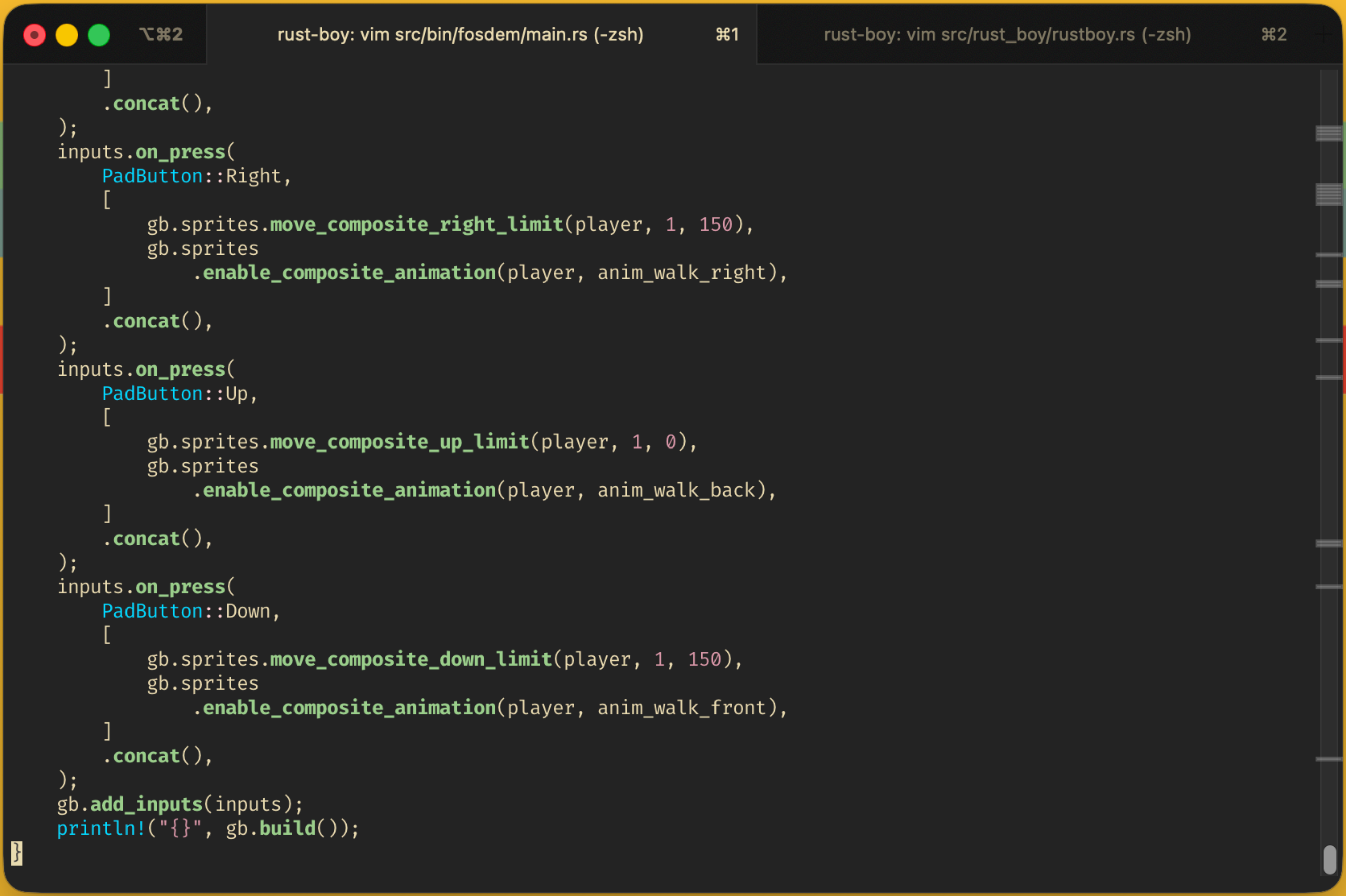

Emulicious - 100% (60 fps)
Emulicious - 100%
Emulicious - 100% (60 fps)
Emulicious - 100% (60 fps)

rust_boy at Fosdem!



```rust
fn main() {
    let mut gb = RustBoy::new();

    // Add 16x16 composite sprite (two 8x16 sprites side by side)
    let player = gb.add_sprite_16x16(
        "player",
        TileSource::from_file("char.2bpp", 64),
        TileSource::from_file("char-dx.2bpp", 64),
        80,
        72,
        0,
    );

    // Add looping animations to the composite sprite (applies to both halves)
    // add_composite_animation returns the animation index
    // Animation order: front, back, left, right (frames 0-3, 4-7, 8-11, 12-15)
    let anim_walk_front =
        gb.sprites
            .add_composite_animation(player, "playerWalkFront", 0, 3, AnimationType::Loop);
    let anim_walk_back =
        gb.sprites
            .add_composite_animation(player, "playerWalkBack", 4, 7, AnimationType::Loop);
    let anim_walk_left =
        gb.sprites
            .add_composite_animation(player, "playerWalkLeft", 8, 11, AnimationType::Loop);
    let anim_walk_right =
        gb.sprites
            .add_composite_animation(player, "playerWalkRight", 12, 15, AnimationType::Loop);

    // Start with no animation (disabled)
    gb.sprites
        .set_composite_initial_animation(player, ANIM_DISABLED);
```

rust_boy at Fosdem!



⌥⌘2
rust-boy: vim src/bin/fosdem/main.rs (-zsh)
⌘1
rust-boy: vim src/rust_boy/rustboy.rs (-zsh)
⌘2

```
        ]
        .concat(),
    );
    inputs.on_press(
        PadButton::Right,
        [
            gb.sprites.move_composite_right_limit(player, 1, 150),
            gb.sprites
                .enable_composite_animation(player, anim_walk_right),
        ]
        .concat(),
    );
    inputs.on_press(
        PadButton::Up,
        [
            gb.sprites.move_composite_up_limit(player, 1, 0),
            gb.sprites
                .enable_composite_animation(player, anim_walk_back),
        ]
        .concat(),
    );
    inputs.on_press(
        PadButton::Down,
        [
            gb.sprites.move_composite_down_limit(player, 1, 150),
            gb.sprites
                .enable_composite_animation(player, anim_walk_front),
        ]
        .concat(),
    );
    gb.add_inputs(inputs);
    println!("{}", gb.build());
}
```

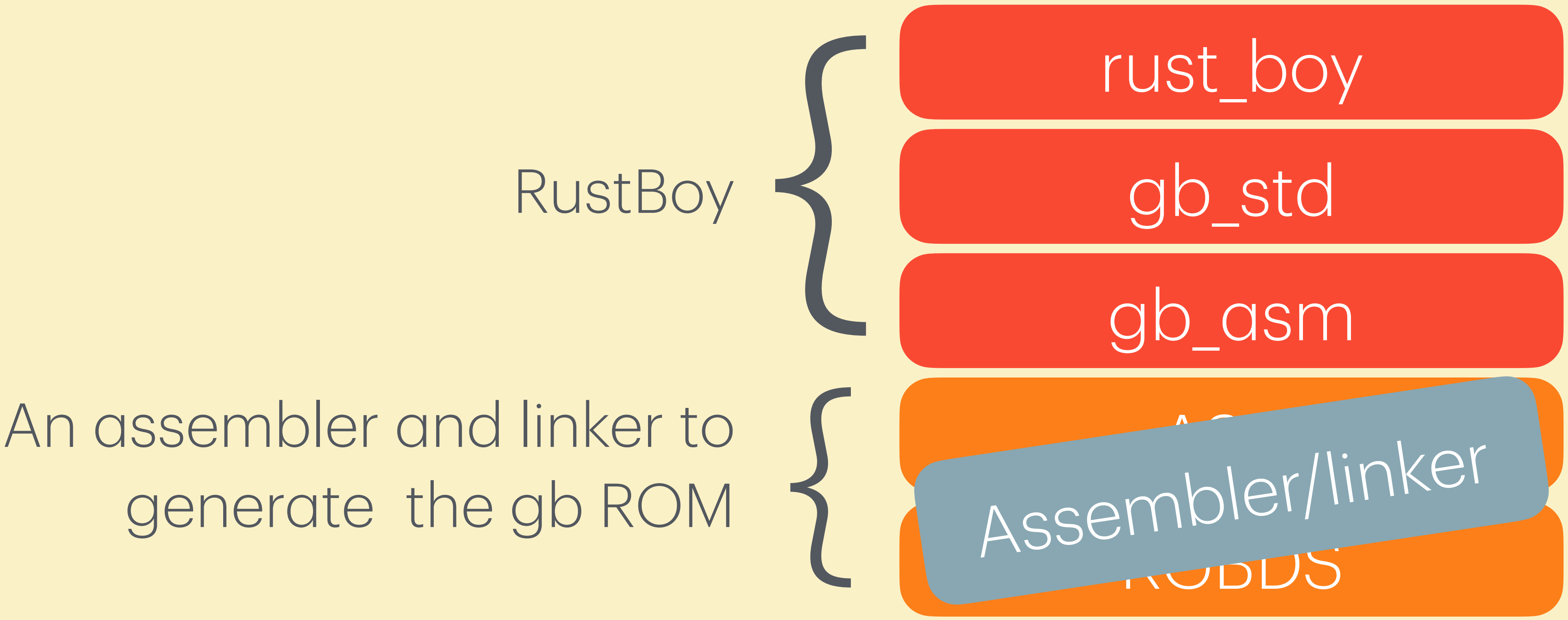
What's next?

Improvment

- Refactor the code.
- Try to write new examples to find new builtin functions
- Implement the sound manager.

What’s next?

Low-level

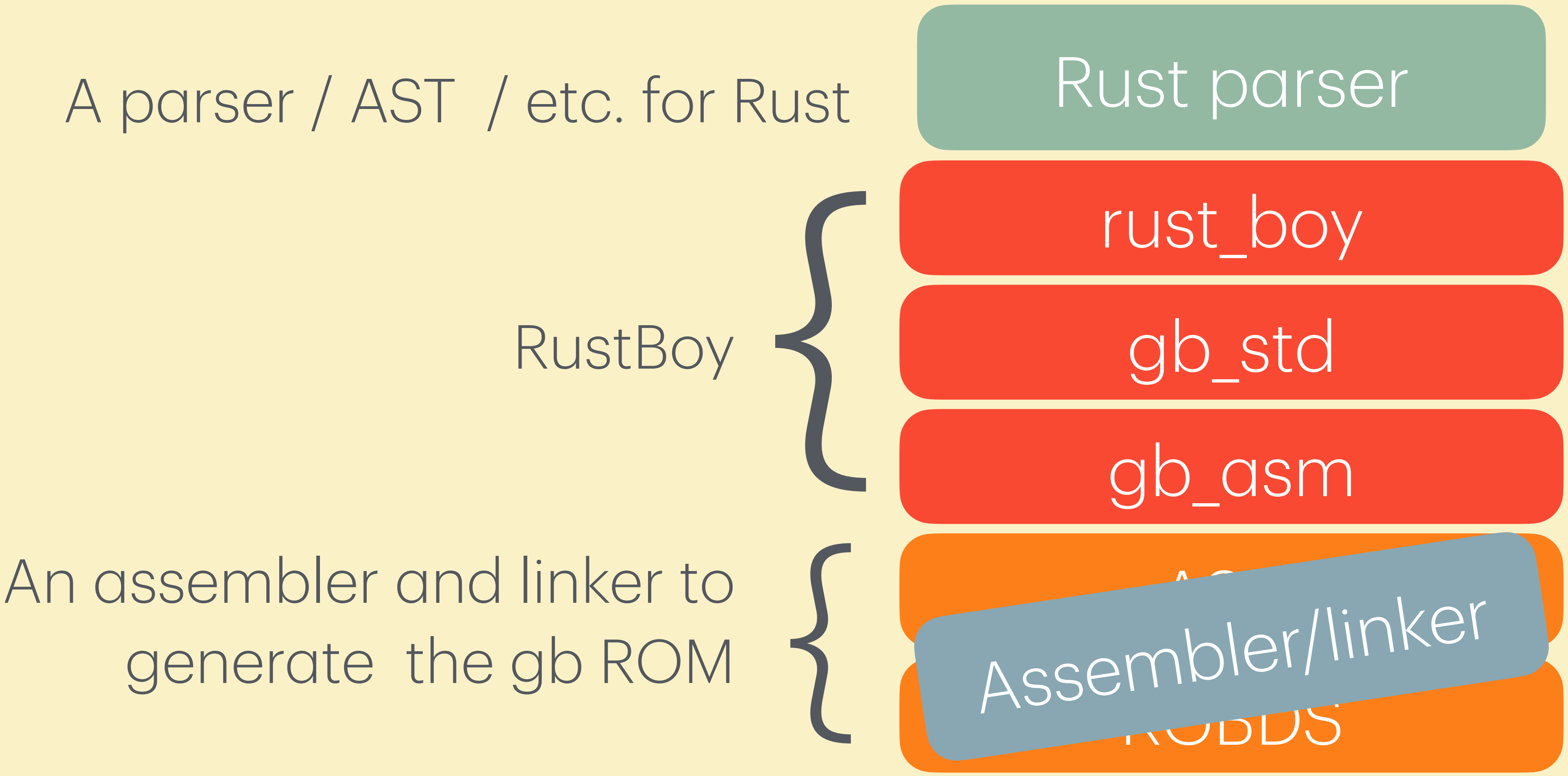


RustBoy

An assembler and linker to generate the gb ROM

What’s next?

High-level

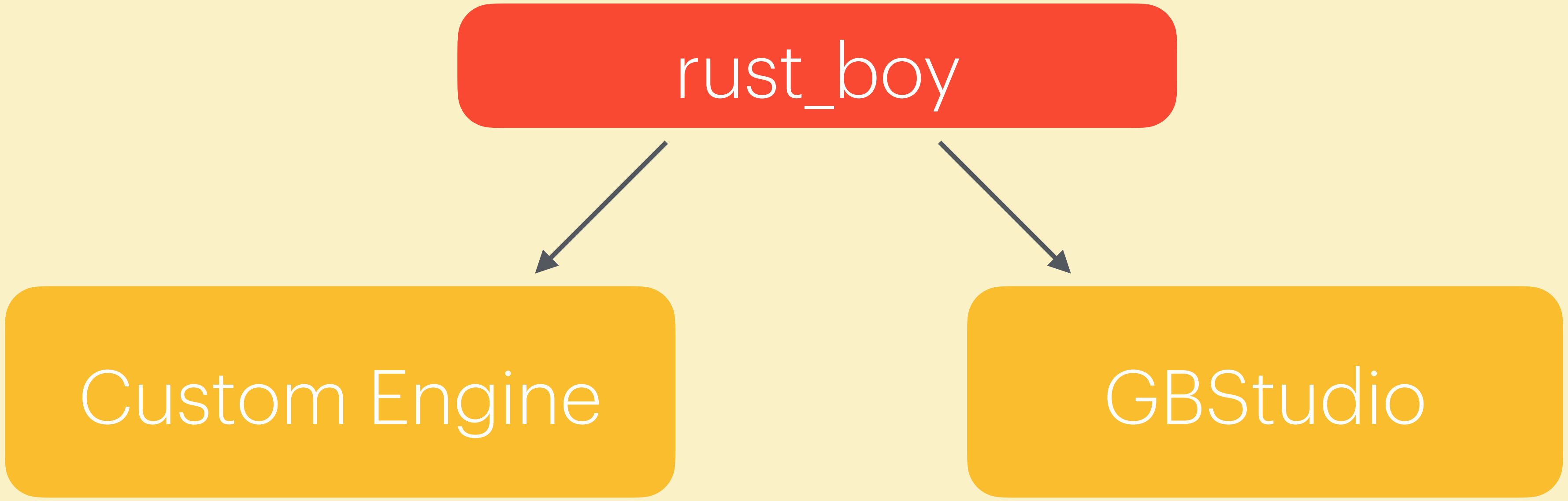


A parser / AST / etc. for Rust

RustBoy

An assembler and linker to generate the gb ROM

One more thing…



Thank you

rust-boy

https://github.com/ffex

https://www.linkedin.com/in/federico-bassini/

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