DKU Advanced Mobile Lab 1

CA Tutor

Graphic Simulator of MIPS ISA

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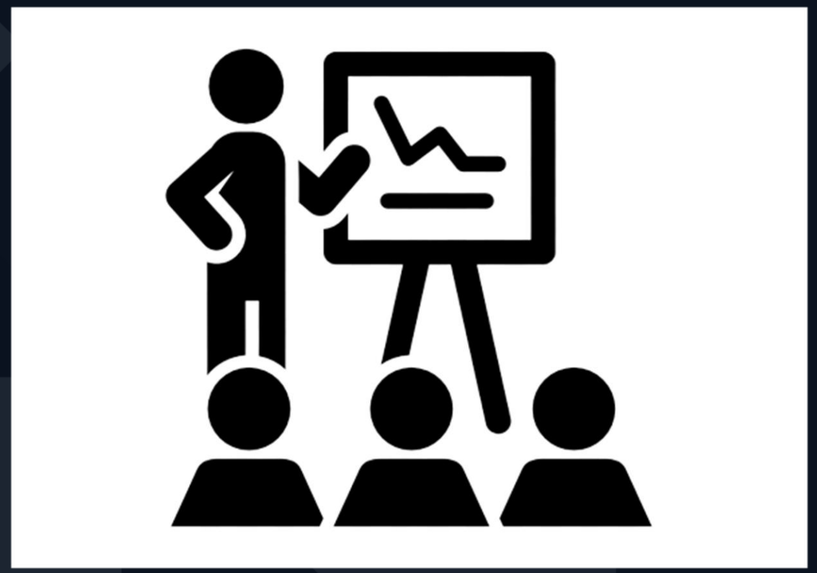

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CA Tutor

Graphic Simulator of MIPS ISA

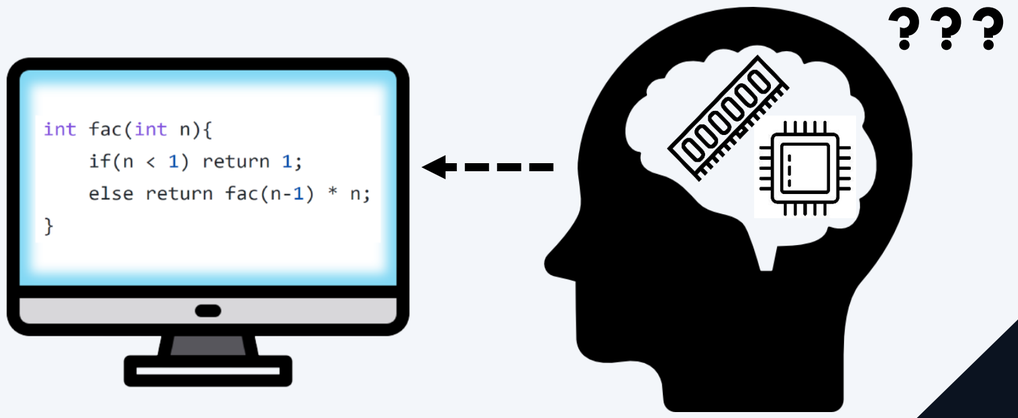
1. Project Introduction

Why we need CA Tutor?

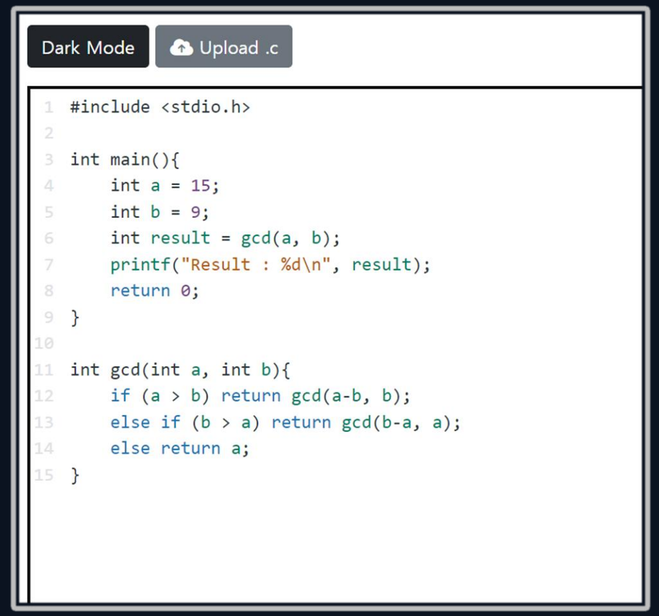
Think about how memory and registers work during program execution. → so difficult.

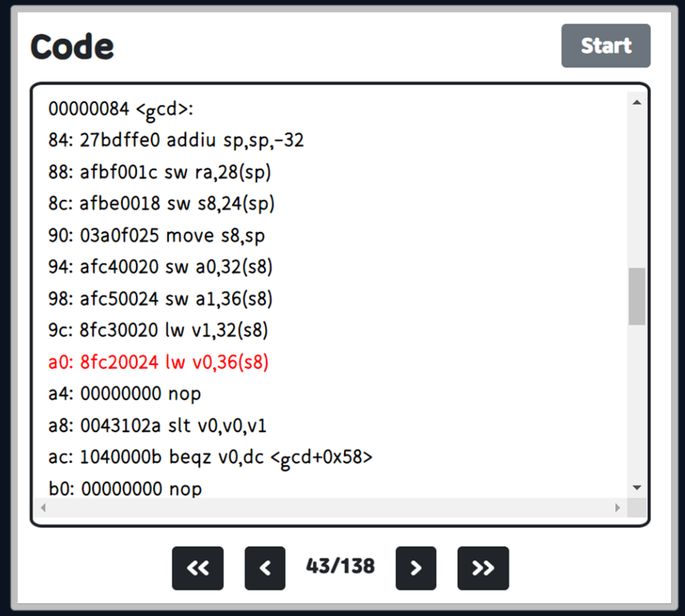
It's hard to learn system programming and computer architecture for the first time.

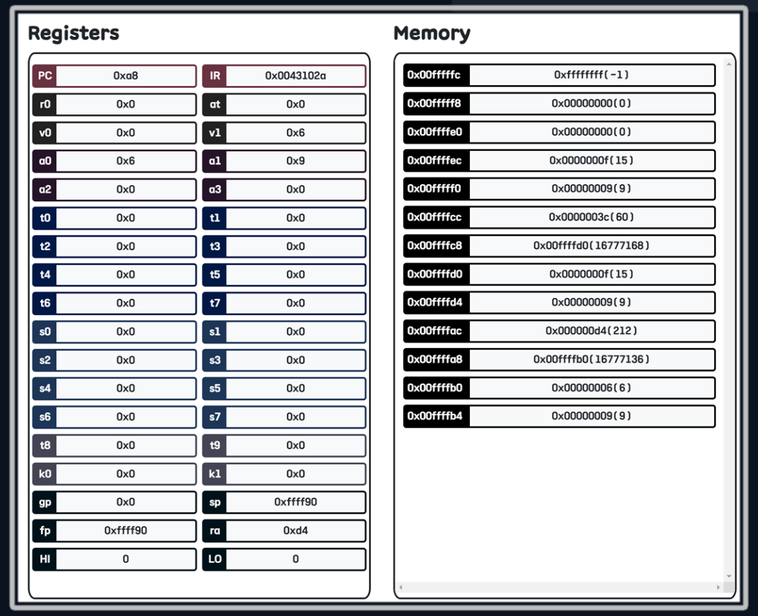
Visualization of memory and register structures is required!



Easy-to-understand MIPS simulator!







User enter C code on our website.
You can write code yourself or import.

CA Tutor changes C code to assembly code and shows it.

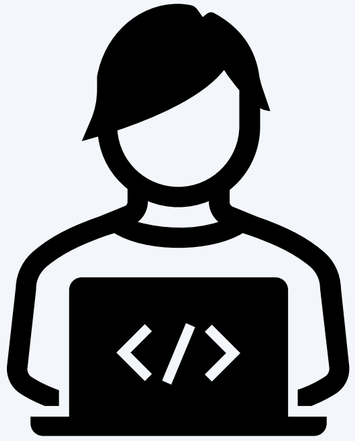
Then check memory and register status step-by-step.

Team Members

MIPS Architecture : Implemented by all members

Choi. Y. H

- UI/UX & PPT
- Front-End



Yang. Y. S

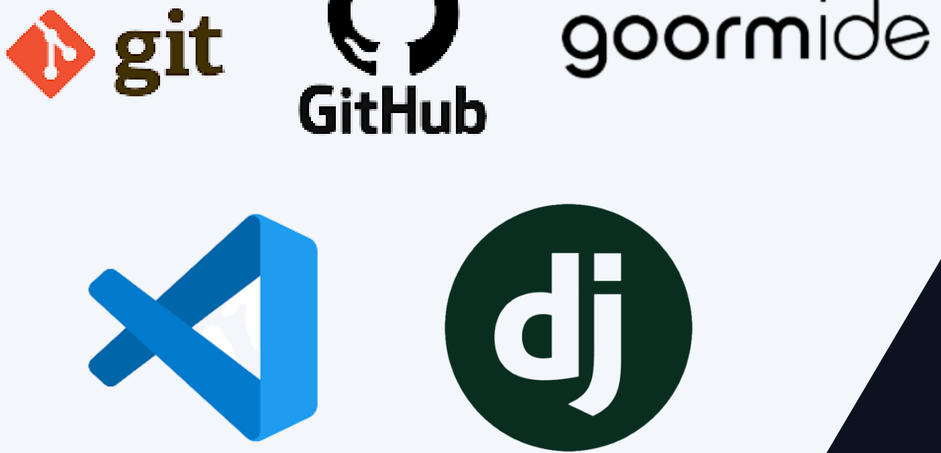
Cho. J. H

- Server & Process
- Event Processing

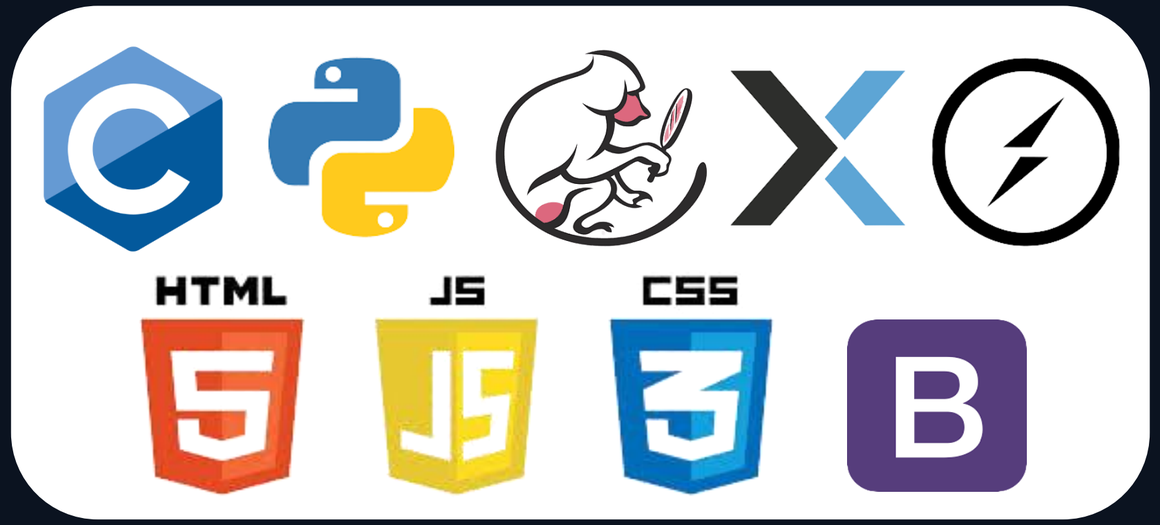
Kim. J. H

2. Technical Structure

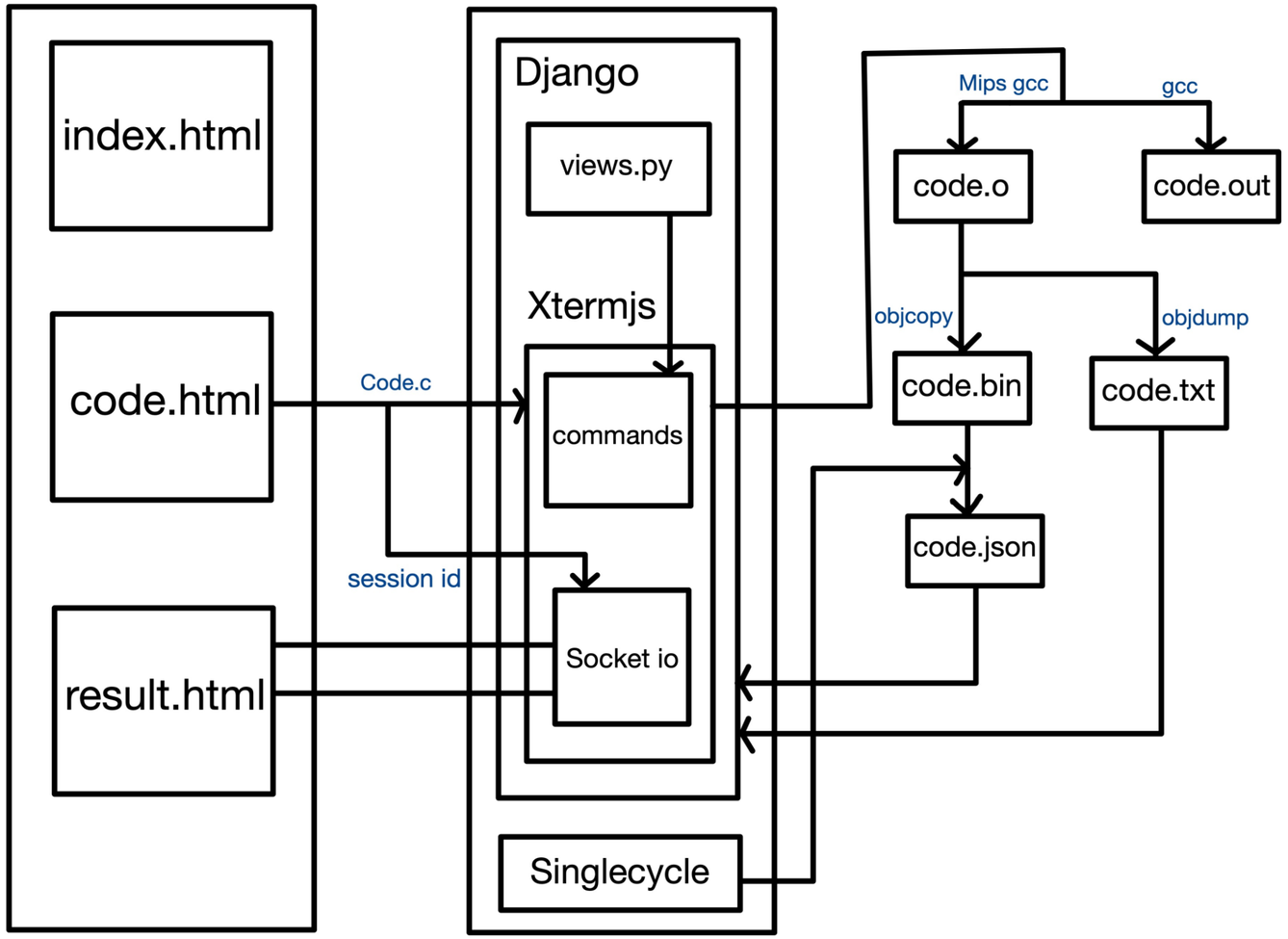
Develop Environment



Tech Stack



System Architecture



Bootstrap : Front-End Framework

1. Responsive Web

Bootstrap helps to easily implementation of responsive web design.

➔ Increase compatibility between different browsers and devices

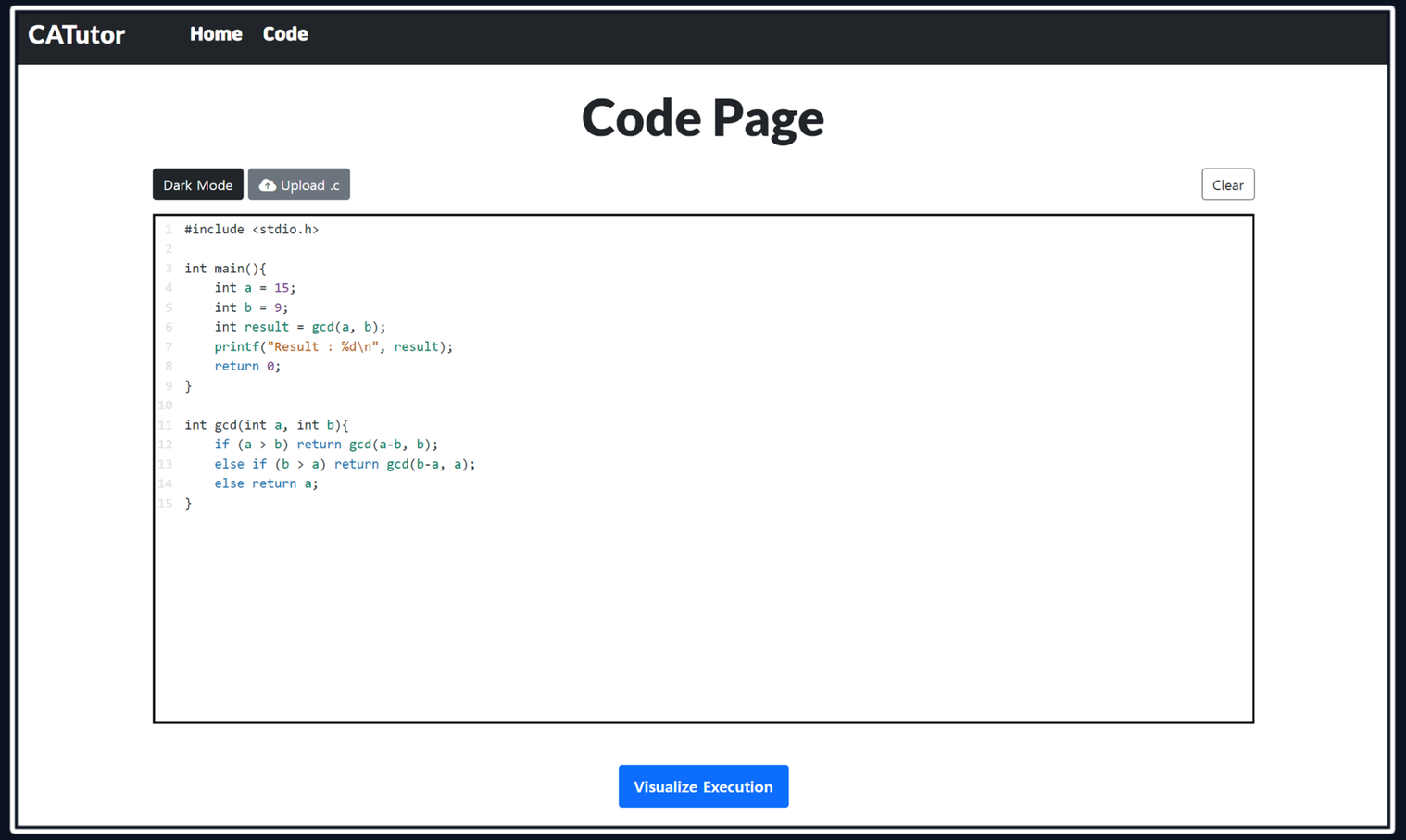
2. UI/UX Design

Bootstrap provides a variety of pre-styled UI components.

➔ Reduce development time and maintain consistent design

Code Page

- Code writing
- Code import
- Send code to server



CodeMirror

- Versatile text editor implemented in JavaScript for use in browsers
- Provides some functions for different programming language
- Provides customizable APIs and plug-in systems → Flexible

Use as C code editor in CA Tutor

```
var editor = CodeMirror.fromTextArea(document.getElementById("codearea"), {
    mode: "text/x-csrc",
    indentWithTabs: true,
    smartIndent: function(state, textBefore) {
        //... 여러 기능 적용
```

- Mode : text/x-scrc (emphasize C language grammar)
- smartIndent : Ability to adjust indentation automatically

Implementation

1. Apply background option (dark mode)

```
function setColorMode() {
    //var textarea = document.getElementById("codearea");
    var button = document.getElementById("color-mode-btn");
    var currentTheme = editor.getOption("theme");
    var newTheme = currentTheme === "neo" ? "3024-night" : "neo";
    editor.setOption("theme", newTheme);
    if (newTheme === "neo") {
        button.innerText = "Dark Mode"
        button.className = "btn btn-dark"
    }
    else {
        button.innerText = "Light Mode"
        button.className = "btn btn-light"
    }
}
```

a) Save dark mode buttons and them objects to variables button and currentTheme

b) Replace with "Neo" ↔ "3024-night" for if-else statement

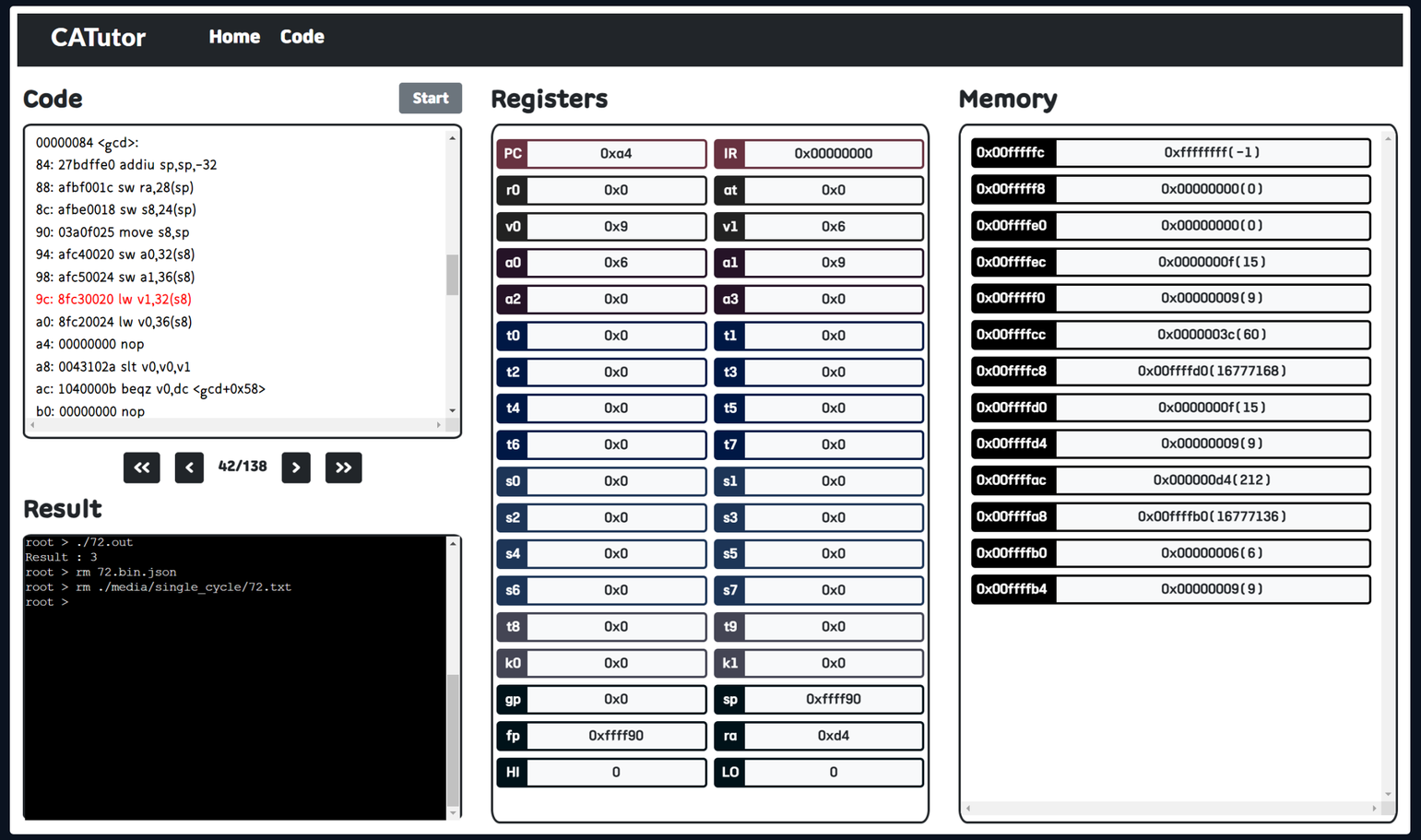
2. Code import (load to code editor)

```
function loadFile() {
    var input = document.getElementById("input-file");
    var file = input.files[0];
    var reader = new FileReader();
    reader.onload = function() {
      editor.setValue(reader.result);
      input.value = "";
    };
    reader.readAsText(file);
}
```

Create a file object imported into FileReader() and write it to the codemirror editor as setValue()

Result Page

- Real-Time Communication
- Apply single-cycle logic
- Reallocate



Xterm & Socket.IO

- Web-based terminal emulator
- Emulates terminal environment in a web browser
- Provides ability for users to enter commands and run programs

- JavaScript library for building real-time web applications
- Enable two-way communication between clients and servers based on web socket protocol.
- Define some events and process them to exchange data

Implementation

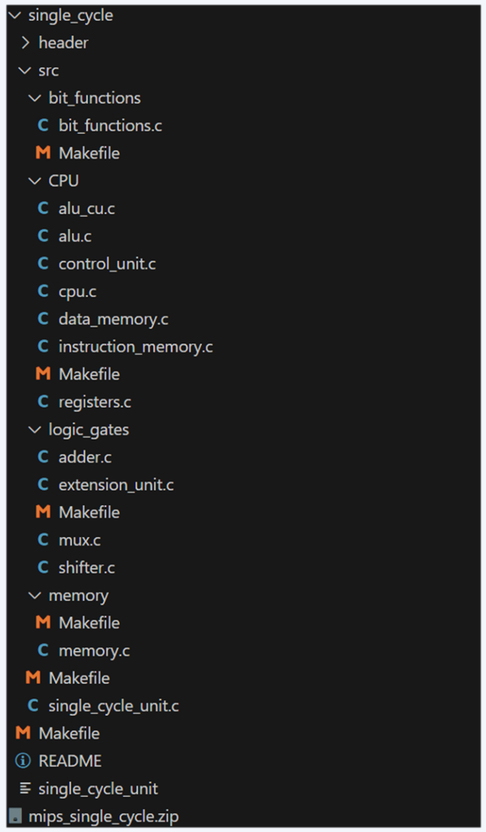
```
Terminal.applyAddon(fit)

var socket = io.connect('https://xtermjs.run.goorm.site',
{transports: ["polling"], extraHeaders: {"test": document.cookie.match('test=([^;]*)')[1]}});

var term = new Terminal({ ···
});

term.open(document.getElementById('terminal'));


socket.on("pty_output", function(output){ ···
})

var dispose = 0;

term.on('key', (key, ev) => { ···
});

socket.on("dispose", function(){ ···
})

var reg_dict = {};


function load_register(){ ···
}

socket.on("send_register", function(output){ ···
})

socket.on("send_code", function(output){ ···
})
```

- Xterm in result.html

```
async_mode = "eventlet"
sio = socketio.Server(async_mode=async_mode,
                      cors_allowed_origins='*')

@sio.event
def resize(sid, message):    ···

@sio.event
def pty_input(sid, message): ···

@sio.event
def load_register(sid): ···

@sio.event
def load_code(sid): ···

@sio.event
def disconnect_request(sid): ···

@sio.event
def connect(sid, environ): ···

@sio.event
def disconnect(sid): ···
```

- Socket.IO in views.py

Convert MIPS and Compile



- Single-Cycle Directory

```
os.write(fd, "export PS1=\"\\u > \"\n".encode())
os.write(fd, "mips-linux-gnu-gcc -c media/{}.c -mips1 -mfp32\n".format(test).encode())
os.write(fd, "mips-linux-gnu-objcopy -O binary -j .text {}.o {}.bin\n".format(test, fd).encode())
os.write(fd, "readelf -r {}.o > {}_rel.txt\n".format(test, fd).encode())
os.write(fd, "python test.py {}\n".format(fd).encode())
os.write(fd, "cd media/single_cycle\n".encode())
os.write(fd, "chmod +x single_cycle_unit\n".encode())
os.write(fd, "./single_cycle_unit ../../{}.bin\n".format(fd).encode())
os.write(fd, "mips-linux-gnu-objdump -dS ../../{}.o > {}.txt\n".format(test, fd).encode())
os.write(fd, "rm ../../{}.o\n".format(test).encode())
os.write(fd, "rm ../../{}.bin\n".format(fd).encode())
os.write(fd, "rm ../../{}_rel.txt\n".format(fd).encode())
os.write(fd, "cd ../../\n".encode())
os.write(fd, "gcc media/{}.c -o {}.out\n".format(test, fd).encode())
os.write(fd, "rm media/{}.c\n".format(test).encode())
os.write(fd, "clear\n".encode())
os.write(fd, "./{}.out\n".format(fd).encode())
```

- Event process function connect()

  Compile to os.write on Xterm terminal (variable fd)

  MIPS cross compile, gcc, etc.

Print Single-Cycle Data

```c
sprintf(s1, "%s.json", argv[1]);

freopen(s1, "w", stdout);
printf("{\"total\": [{\"cycle\": 0, \"pc\": \"0x%x\", \"ir\": \"0x00000000\"", pc);
for (int i = 0; i<32; i++){
    printf(", \"reg[%d]\": \"0x%x\"", i, reg[i]);
}
printf("}\n");

while (pc != 0xffffffff){
    fetch(&cpu, mem);
    decode(&cpu);
    execute(&cpu);
    memory_operation(&cpu, mem);
    write_back(&cpu, mem);
    pc_update(&cpu);
    print_result();
}
printf("]}");
//print_result();
fclose(stdout);
```

- single_cycle_unit.c

  Write each cycle's register and memory status in .json file

```python
@sio.event
def load_register(sid):
    global dic
    fd = dic.get(sid)[1]
    data={}

    file_name = str(dic.get(sid)[1])+".bin.json"


    with open(file_name, 'r') as file:
        data = json.load(file)
        data["sid"] = sid

    sio.emit("send_register", data)
    os.write(fd, "rm {}.bin.json\n".format(fd).encode())
```

- Event process function load_register()

  Send .json file as dictionary form

Reallocate

```
file_name = sys.argv[1]
txtfile = file_name + "_rel.txt"
binfile = file_name + ".bin"

f = open(txtfile,"r")
lines = f.readlines()
f.close()

isText = False
relText = []
for i in lines:
    if i == "\n":
        isText = False
    if isText:
        if i.find("Offset") != -1:
            continue
        relText.append(i)
    if i.find(".rel.text" ) != -1:
        isText = True

arr = []

for i in relText:
    tmp = i.split()
    arr.append( ((int(tmp[0],16)),(int(tmp[3],16))) )
```

- Process _rel.txt header information which contain reallocation data

```
f = open(binfile, "rb")
a = bytearray(f.read())

f.close()

f = open(binfile, "wb")
for i in arr:

    index = i[0]
    adr = i[1] >>2
    ins = (a[index]<<24) + (a[index+1]<<16) + (a[index+2]<<8) + (a[index+3])
    opcode = ins & 0xfc000000
    tmp = opcode >> 26
    if (tmp == 0x2) or (tmp == 0x3):
        relins = opcode + adr
    else:
        relins = (ins & 0xffff0000) + i[1]


    a[index] = (relins >> 24) & 0xff
    a[index+1] = (relins >> 16) & 0xff
    a[index+2] = (relins >> 8) & 0xff
    a[index+3] = (relins) & 0xff

f.write(a)
f.close()
```

- Modify bin file with processed information

3. Achievements

Initial goal

- ✓ Implement single-cycle structure
- ✓ Save code and convert MIPS
- ✓ Real-time communication
- ✓ Print result step-by-step
- ✓ Create graphic simulator
- ✓ Complete to make web page
- ▲ Login and sign-up

Accomplishment %

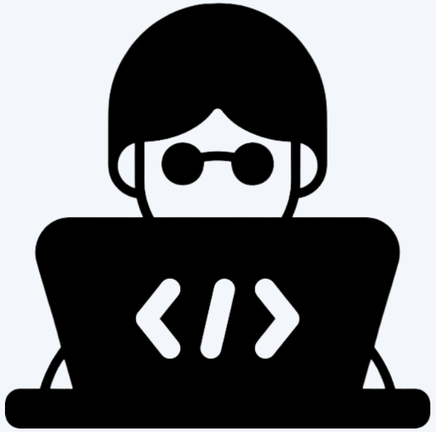
Team technical achievements

1. Study about computer architecture
   (Especially MIPS ISA and Single-Cycle)

2. Improve a variety of language skills
   (C, Python, HTML, CSS, JavaScript)

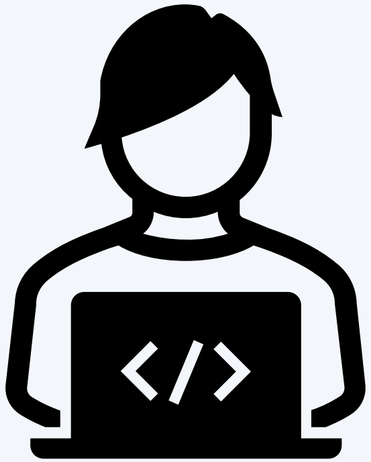
3. Learn many new technologies
   (Django, Bootstrap, Xterm, SocketIO · · ·)

Personal Lessons



When doing a project, I realized that it is necessary to respect each other's ideas and opinions, and through this, we can make the most of each other's strengths.

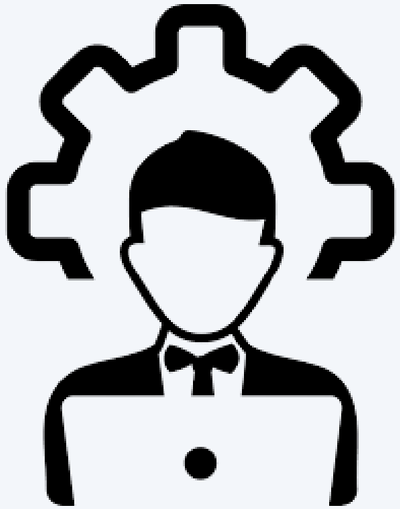
Choi. Y. H



I was able to improve my front-end development skills and had deep understanding of the computer's instruction execution method.

Yang. Y. S

Personal Lessons



I realized the importance of clearly expressing my thoughts and handling exceptions. And I could clearly learn the structure and use of the elf file.

Cho. J. H

I was able to gain various knowledge by working with my team members on troubles shooting, and now I think I will be able to design project more specifically.

Kim. J. H

4. Demonstration

Github Repository

(https://github.com/judemario-kim/ca-tutor)

Our Website

(https://xtermjs.run.goorm.site/catutor/)

It works well on smart phone, too.

DKU Advanced Mobile Lab 1

Thank You

For Your Attention

CA Tutor

Graphic Simulator of MIPS ISA