Introduction to Computer Architecture
Project 1

MIPS Binary Code Read

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Project Schedule

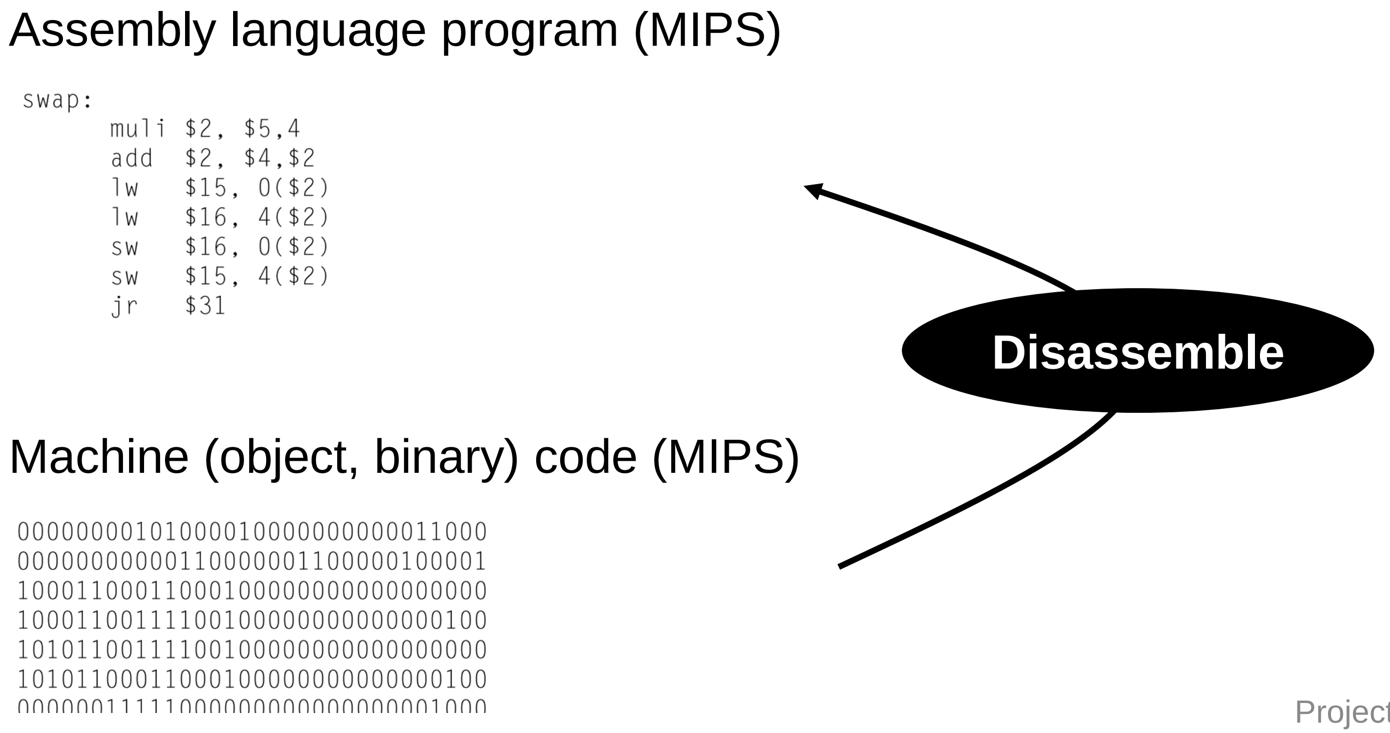
- Project 1: Interpret MIPS binary code
- Project 2: Simulate a Single-cycle CPU
- Project 3: Simulate a Pipelined CPU

- Every step depends on the previous one.

Project 1 Requirement

- Your program reads a binary file filled with MIPS machine code, and print the assembly representation of the code

- Not a full simulator yet..



Assembly language program (MIPS)

```
swap:
      muli $2, $5,4
      add  $2, $4,$2
      lw   $15, 0($2)
      lw   $16, 4($2)
      sw   $16, 0($2)
      sw   $15, 4($2)
      jr   $31
```

Machine (object, binary) code (MIPS)

```
00000000101000010000000000011000
00000000000110000001100000100001
10001100011000100000000000000000
10001100111100100000000000000100
10101100111100100000000000000000
10101100011000100000000000000100
00000011111000000000000000001000
```

Test Sample

- You can obtain test input files from the following location of the department server (`swui.skku.edu`, `swye.skku.edu`, `swji.skku.edu`)
  - ❖ `~swe3005/2021s/proj1/test1.bin`
  - ❖ `~swe3005/2021s/proj1/test2.bin`
  - ❖ `~swe3005/2021s/proj1/test3.bin`

```
00000000: 0022 0020 8d42 0020 2230 0008 1440 0004
00000010: 0000 0000 03e0 0008 0000 0000 a7c4 0008
00000020: 0013 5940 0000 000d
```

Test Result

- The expected results files are in the following location
  - ~swe3005/2021s/proj1/test1.txt
  - ~swe3005/2021s/proj1/test2.txt
  - ~swe3005/2021s/proj1/test3.txt

```
inst 0: 00220020 add $0, $1, $2
inst 1: 8d420020 lw $2, 32($10)
inst 2: 22300008 addi $16, $17, 8
inst 3: 14400004 bne $2, $0, 4
inst 4: 00000000 sll $0, $0, 0
inst 5: 03e00008 jr $31
inst 6: 00000000 sll $0, $0, 0
inst 7: a7c40008 sh $4, 8($30)
inst 8: 00135940 sll $11, $19, 5
inst 9: 0000000d unknown instruction
```

Program Interface

- Executable name
  - The name of the executable file should be "`mips-sim`"
  - If you're using a language that needs an interpreter (e.g., python), you need to provide a shell script (example on page 13).

- Input
  - Input file name is given by the first command-line argument
  - You can assume that the maximum length of the input file name is 255

- Output
  - Read the binary file named <filename> and prints the disassembled instruction
  - Each line prints in the following format

```
inst <instruction number>: <32-bit binary code in hex format> <disassembled instruction>
```

Execution Results

```
$ ./mips-sim test1.bin
inst 0: 00220020 add $0, $1, $2
inst 1: 8d420020 lw $2, 32($10)
inst 2: 22300008 addi $16, $17, 8
inst 3: 14400004 bne $2, $0, 4
inst 4: 00000000 sll $0, $0, 0
inst 5: 03e00008 jr $31
inst 6: 00000000 sll $0, $0, 0
inst 7: a7c40008 sh $4, 8($30)
inst 8: 00135940 sll $11, $19, 5
inst 9: 0000000d unknown instruction
$          ⋮
```

Disassemble Format

- Instruction name in lowercase
  - `add, sub, sw, jal, …`
- Registers are all represented in numbers
  - `$0, $1, $20`, …
  - Do not to use their name (`$s0, $t2`, …)
- Immediate and address values are represented in **signed decimal**
  - `sw $16, `**`20`**`($29)`
  - `addi $29, $29, `**`-16`**

Instructions to support

- `add, addu, and, div, divu, jalr, jr, mfhi, mflo, mthi, mtlo, mult, multu, nor, or, sll, sllv, slt, sltu, sra, srav, srl, srlv, sub, subu, syscall, xor, addi, addiu, andi, beq, bne, lb, lbu, lh, lhu, lui, lw, ori, sb, slti, sltiu, sh, sw, xori, j, jal`

- If there is an instruction that can’t be interpreted, print “`unknown instruction`”

Things to Consider

- Endianness!
  - Input file (e.g., **test.bin**) uses the big endian format
  - Your computer uses the little endian format
- Shift instructions

Project Rule – IMPORTANT!

- You can use any language you'd like to use, but **it must be compliable and executable on the department server**

- You need to provide a `Makefile` to compile your code
  - Do not need if you're using a script language (e.g., python)
  - The name of the executable should be `mips-sim`
  - If your build fails, your project score is 0.

- If you're using a script language, you need to provide a shell script that can accept an argument, and the name of the script file should be `mips-sim`

Makefile Example

- C

Makefile

```
CC=gcc
CCFLAGS=

#add C source files here
SRCS=main.c

TARGET=mips_sim

OBJS := $(patsubst %.c,%.o,$(SRCS))

all: $(TARGET)

%.o:%.c
		$(CC) $(CCFLAGS) $< -c -o $@

$(TARGET): $(OBJS)
		$(CC) $(CCFLAGS) $^ -o $@

.PHONY=clean

clean:
		rm -f $(OBJS) $(TARGET)
```

- C++

Makefile

```
CXX=g++
CXXFLAGS=

#add C++ source files here
SRCS=main.cc

TARGET=mips_sim

OBJS := $(patsubst %.cc,%.o,$(SRCS))

all: $(TARGET)

%.o:%.cc
		$(CXX) $(CXXFLAGS) $< -c -o $@

$(TARGET): $(OBJS)
		$(CXX) $(CXXFLAGS) $^ -o $@

.PHONY=clean

clean:
		rm -f $(OBJS) $(TARGET)
```

Script Example

- Python (if your python file is mips_sim.py)

```
mips_sim
```

Don’t forget to give the excute permission: `chmod +x mips_sim`

```
python3 mips_sim.py $1
```

- Also, be aware of the python version on the server
  - python: python 2.7.17
  - python3: python 3.6.9

Project Environment

- We will use the department's In-Ui-Ye-Ji cluster
  - `swui.skku.edu`
  - `swye.skku.edu`
  - `swji.skku.edu`
  - ssh port: 1398

- First time users :
  - ID: your student ID (e.g., 2020123456)
  - Use the default password (unless you already changed your password…)
    - "PW"+Student_ID (last 8 digits)
    - e.g., The initial password for 2020123456 is `PW20123456`
  - MUST change your password after the first login (Use **`yppasswd`** command)

Submission

- Clear the build directory
  - Do not leave any executable or object file in the submission
  - `make clean`

- Use the `submit` program
  - `~swe3005/bin/submit project_id path_to_submit`
  - If you want to submit the 'project_1' directory…
    - **`~swe3005/bin/submit proj1 project_1`**

```
Submitted Files for proj1:
File Name                                File Size       Time
--------------------------------------------------------------------------------
proj1-2020123456-Sep.05.17.22.388048074        268490                  Thu Sep  5 17:22:49 2020
```

- Verify the submission
  - **`~swe3005/bin/check-submission proj1`**

Project 1 Due Date

- 2021 Apr 2nd, 23:59:59

- **No late submission**

Test Submission (Proj0)

- If you want to test the submission process, you may try the test submission.
- This test submission is optional. You may skip this submission without any penalty
- We will give you a feedback whether if your test submission is correctly submitted.
- No such service will be provided for future projects.

Test Submission (Proj0) – What to submit

- Just create a simple program (either using C or Python) that prints "Hello World"

- You need to follow the same rule (pages 11-13)
    - You must include Makefile

Test Submission (Proj0) – Submission Period

- 2021 Mar. 29th - 2021 Apr. 1st

- Once you submit proj0, we will periodically check if your submission can be correctly evaluated. Please wait for the TA’s notice on test submission results.