CPU 大作业发布

2022.10.14

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1. 作业概述

作业概述

- 2021 级 ACM 班 大二 计算机系统(1) 大作业
- 时间：2022-2023 学年秋季学期 **Week 6 - 18**
- 成绩占课程总分**至少 35%**

大助教：**郑文鑫**

CPU 助教：**仇天元**

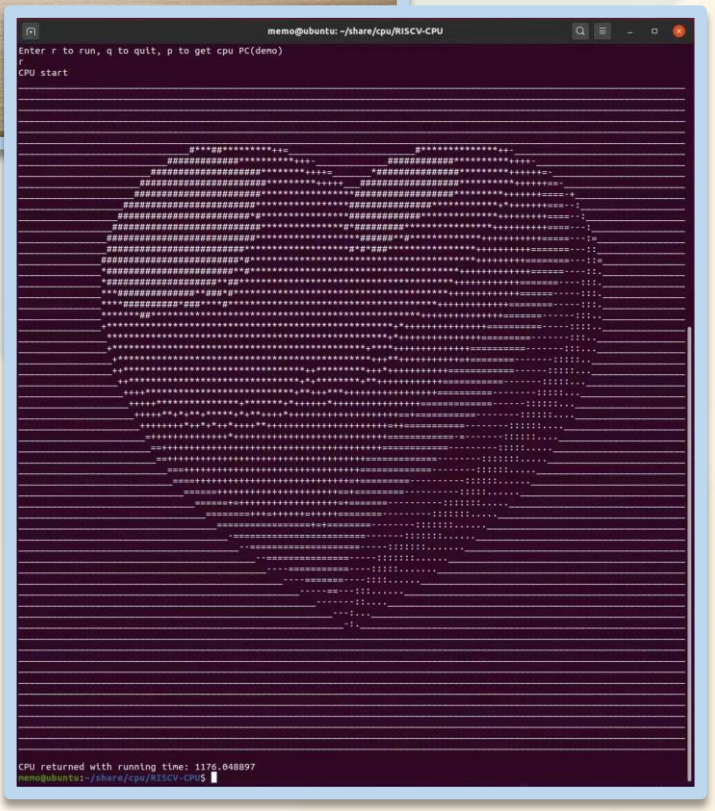
杨淦翔

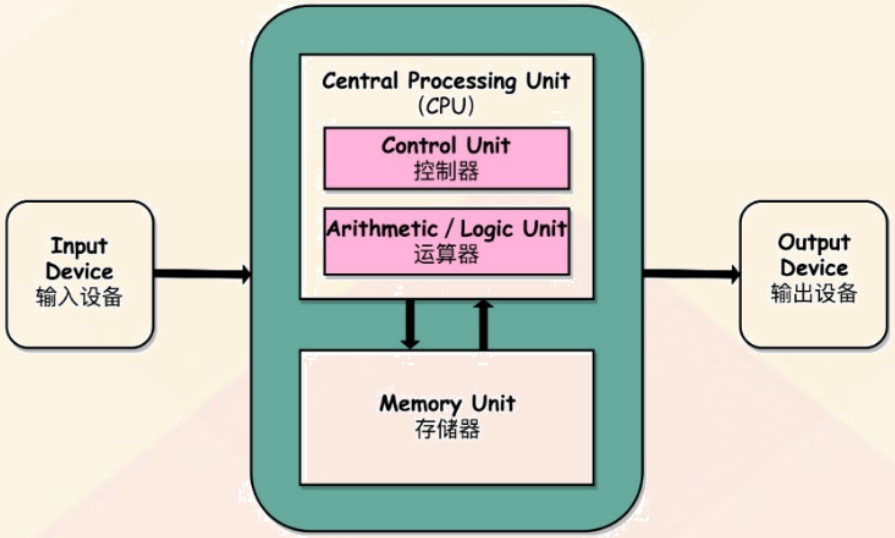
题面 Repo：

https://github.com/ACMClassCourses/RISCV-CPU

作业概述

- 以 Verilog 语言设计一块简单的 RISC-V 架构的 CPU
- 指令集为 RV32I（32 位，整数，无乘除运算）
- 实现控制器与运算器，内存与 I/O 代码均已提供
- 通过 iVerilog 进行软件仿真运行 / 将代码烧录至 FPGA 板运行





常规芯片：逻辑门（与或非）

FPGA：可编程门（自定义真值表）

2. 作业要求

分数说明

- 本作业总成绩为 100%
- **五级流水：至多 50%**
  - 需要处理各类 Hazard
- **托马斯洛：至多 100%**
  - 需要实现乱序执行并处理各类 Hazard
- 特权指令 Bonus：课程平时分 5% / 15% / 30%

阶段检查

- **每两周一次检查**，除最末数周外，形式均为 Code Review
  - 需要通过 Github 提交最新代码

最终提交

- 提交比特流文件，并在 FPGA 板上通过所有测试
  - 通常而言上板前需要在仿真中通过所有测试

3. 特权指令说明

Privileged Instruction: Our topics

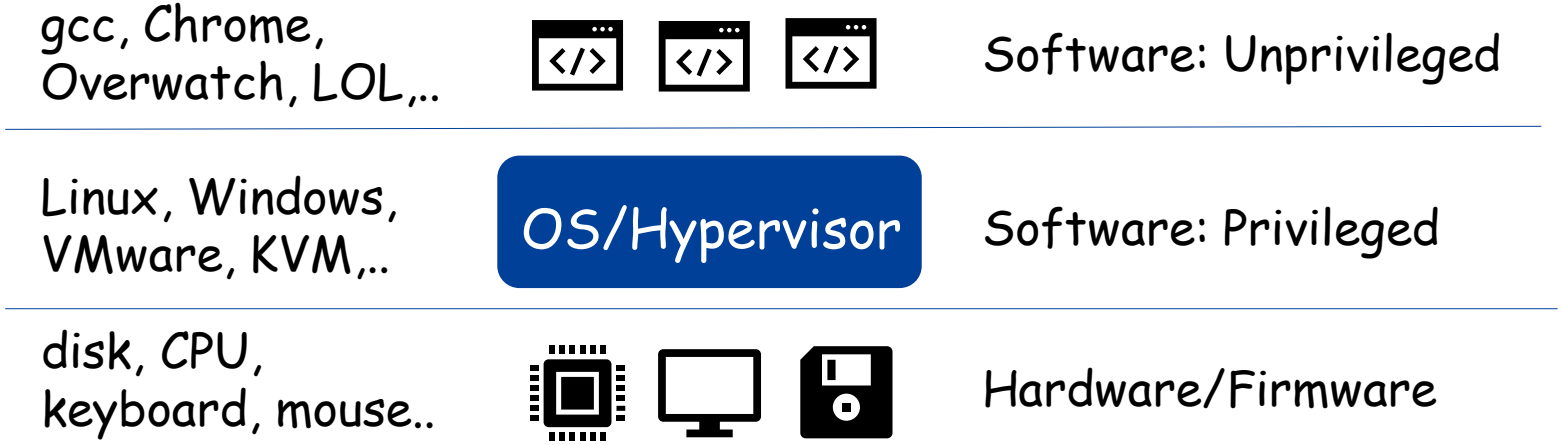
- 1. What is Privileged Instruction?
- 2. Privileged Instruction in our RISCV-CPU project..

Privileged Instruction: A view from Software

- Process: a running program.
  - CPU speedup & More devices → We need a Computer Manager!

Operating System (OS)

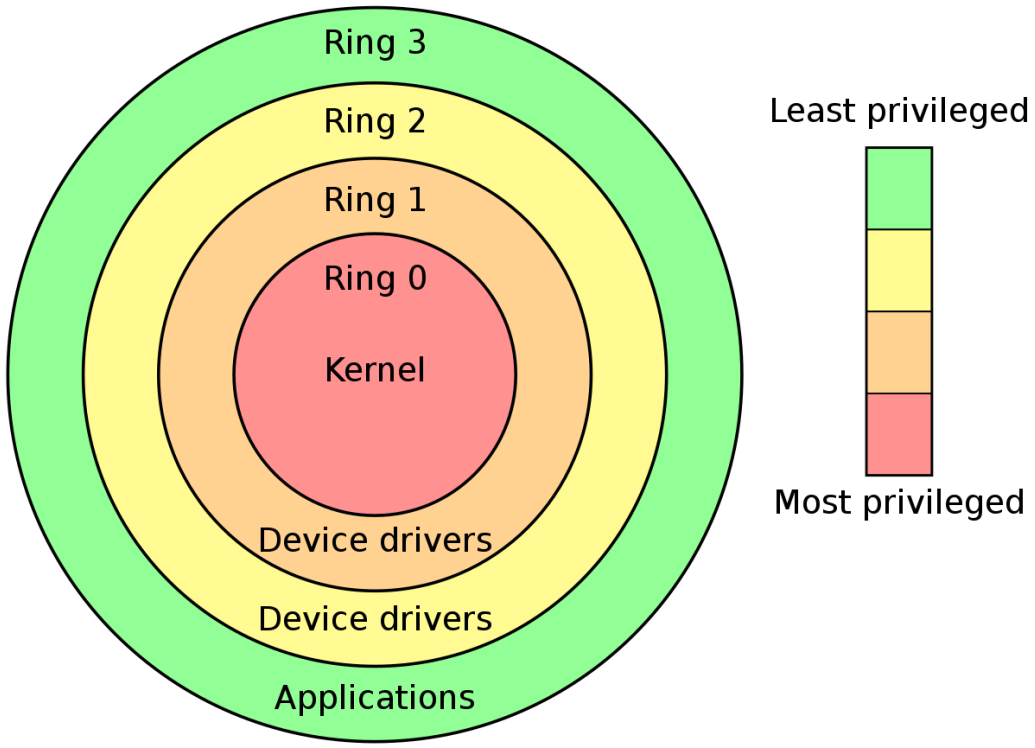
- OS will manage resources and schedule the processes.
- OS is the boss! It has a higher privilege than normal process.



Privileged Instruction: A view from Software

- Privileged Levels

Privileged Level (from high to low)
Ring 0 (kernel mode)
Ring 1 (Hypervisor mode)
Ring 2 (Supervisor mode)
Ring 3 (user mode)



Privileged Instruction: A view from Software

- Since we have privileged levels, we will also need privileged instructions:

  Privileged Instruction is instructions related to the Privileged Mode.

- 1. ENTER the Privileged Modes (ecall, ebreak)
- 2. EXIT the Privileged Modes (mret, sret)
- 3. Handle the exceptions (CSR Instructions: csrrw, csrrs, csrrc, …)

- More details? Please read the RISC-V Specification!

Privileged Instruction: As a bonus

- Privileged Instruction is a bonus part and we propose 3 levels in this bonus.

Level \ Feature	Privil Reg	Privil Mode	Page Table Switch	Exception Code
Level 1 (5 pts)	**Yes**	**No**	**No**	**No**
Level 2 (15 pts)	**Yes**	**Yes**	**No**	**No**
Level 3 (30 pts)	**Yes**	**Yes**	**Yes**	**Yes**

- Bonus Precondition

  You must complete your Tomasulo CPU and pass all standard testcases on FPGA

- Testcases

  Will be available soon.

Issues: knowledge/homework

- Maybe you still have confusion/argument on/against some concepts.

  Let me guess:

  - Kernel? Exception? Interrupt?

- Maybe you still have question about our RISCV-CPU project?

  Let me guess:

  - Is it possible to run my own OS in my own CPU?
  - How much is the workload of level 1/2/3 ?

Q&A

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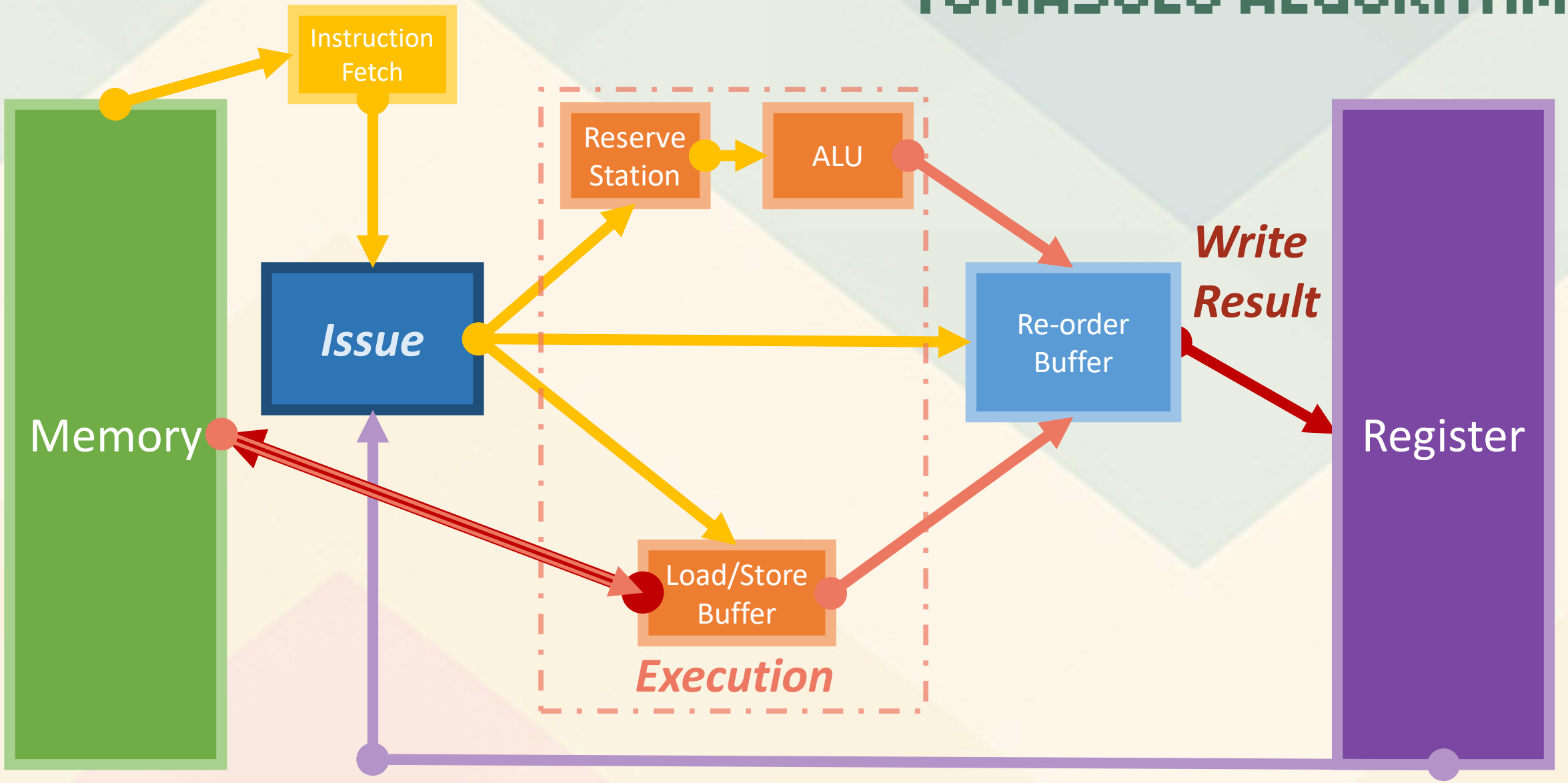
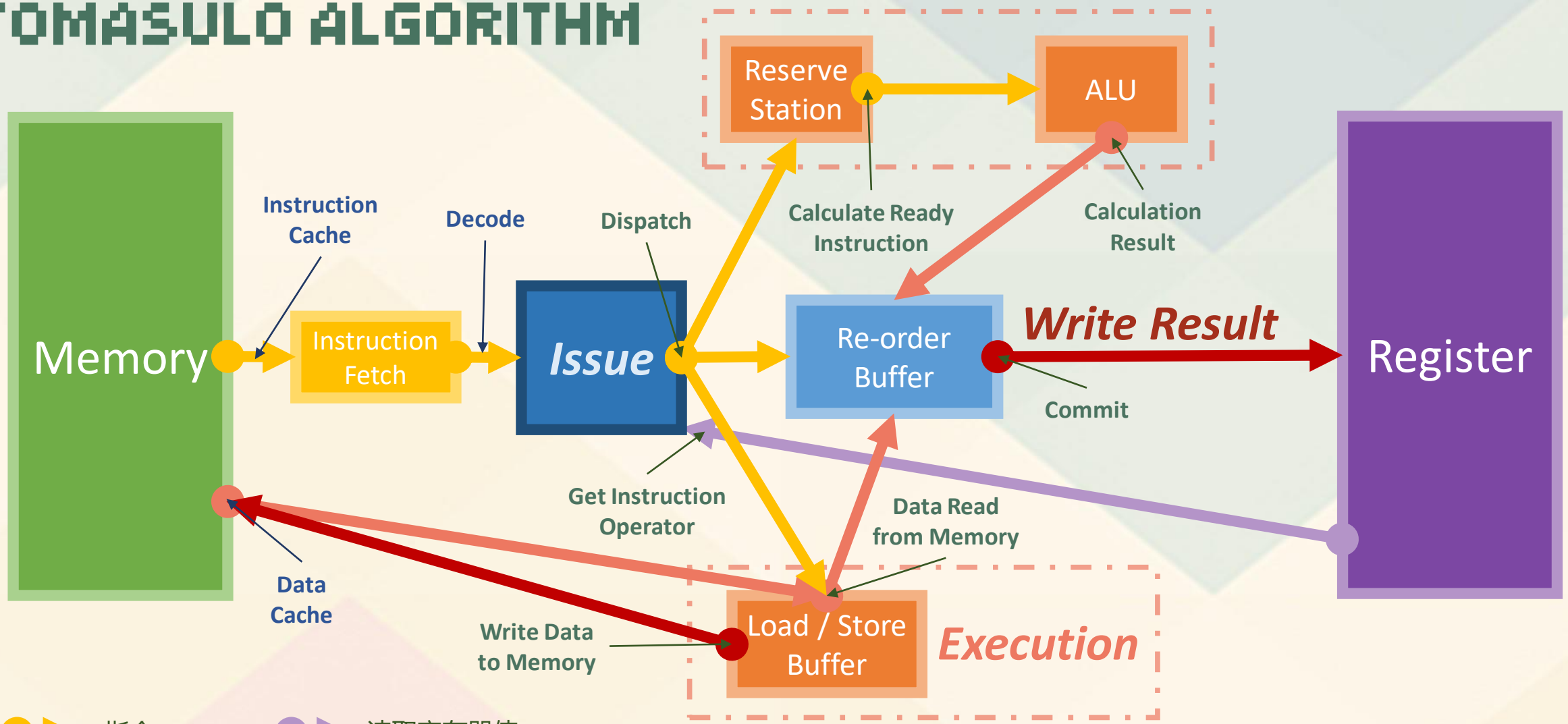
如本作业发布课件与 Github 题面有内容冲突，以后者为准。本作业最终解释权属助教所有。

5. 托马斯治复习

TOMASULO ALGORITHM



TOMASULO ALGORITHM



指令　读取寄存器值

指令执行结果　指令执行结果写入内存 / 寄存器

Module 电路模块　ABC 托马斯洛算法三要素

指令缓存 需实现的功能

分发指令 名称 / 功能说明

本图为 PaperL 为 ACM 2022 系统课程制作，仅供理解托马斯洛算法，非完整设计。算法内容参考 Wikipedia：Tomasulo's algorithm，如有理解错误之处请以老师 / 教材为准。