Disclaimer

The slides presented here are a combination of the CS251 course notes from previous terms, the work of Xiao-Bo Li, and material from the required textbook "Computer Organization and Design, ARM Edition," by David A. Patterson and John L. Hennessy. It is being used here with explicit permission from the authors.

CS251 course policy requires students to delete all course files after the term. Therefore, please do not post these slides to any website or share them.

CS251 - Computer Organization and Design

Introduction to Course and Outline

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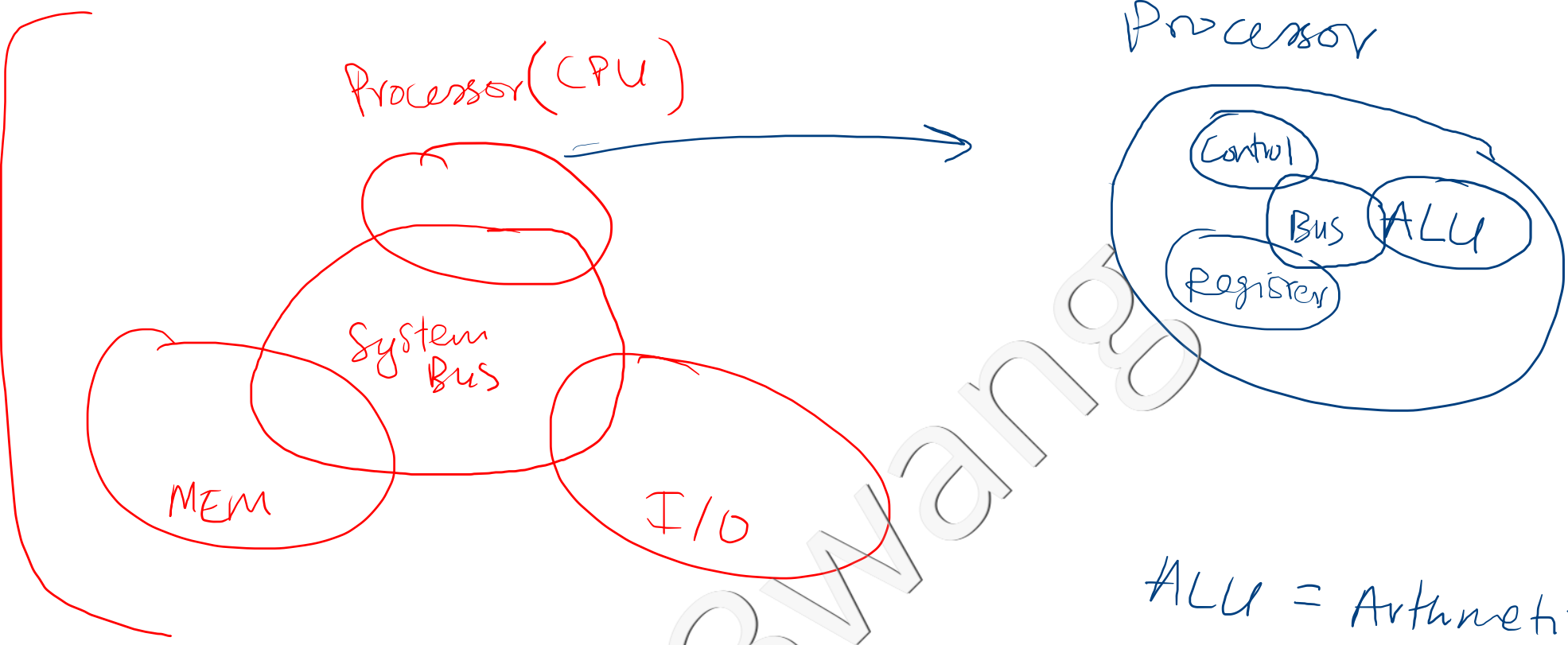
University of Waterloo

Spring 2023

Introduction

- Course goals:
  Understanding of computer architecture, structure and evolution
- Computer architecture = instruction set architecture plus computer organization
- Instruction Set Architecture (ISA):
  Conceptual structure and functional behaviour of computing system as seen by programmer
- Computer organization:
  - Physical implementation of functional units
  - The interaction of these functional units to control flow of information

  to realize the ISA.



ALU = Arthmetic Logic Unit

What is a computer?

How to design a computer

processor

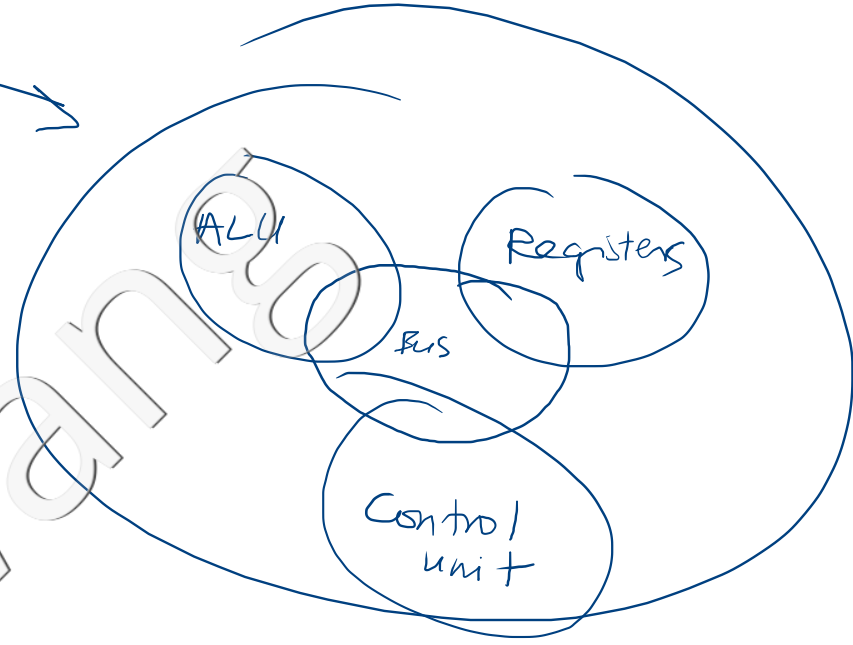
H/W components

ALU

Arthmetic

Logic

Unit



What is a computer

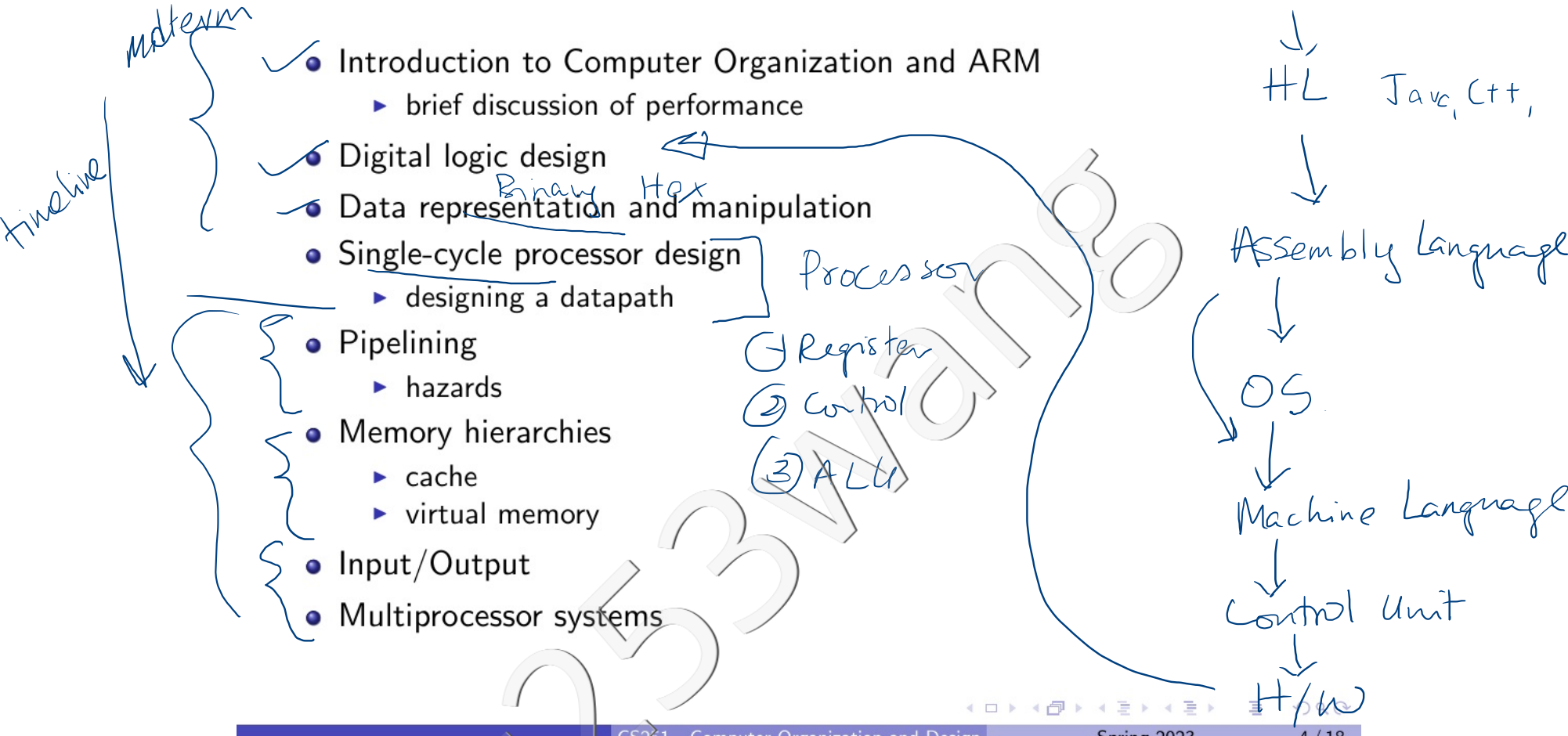
ISA

- interface
allows
op on H/W

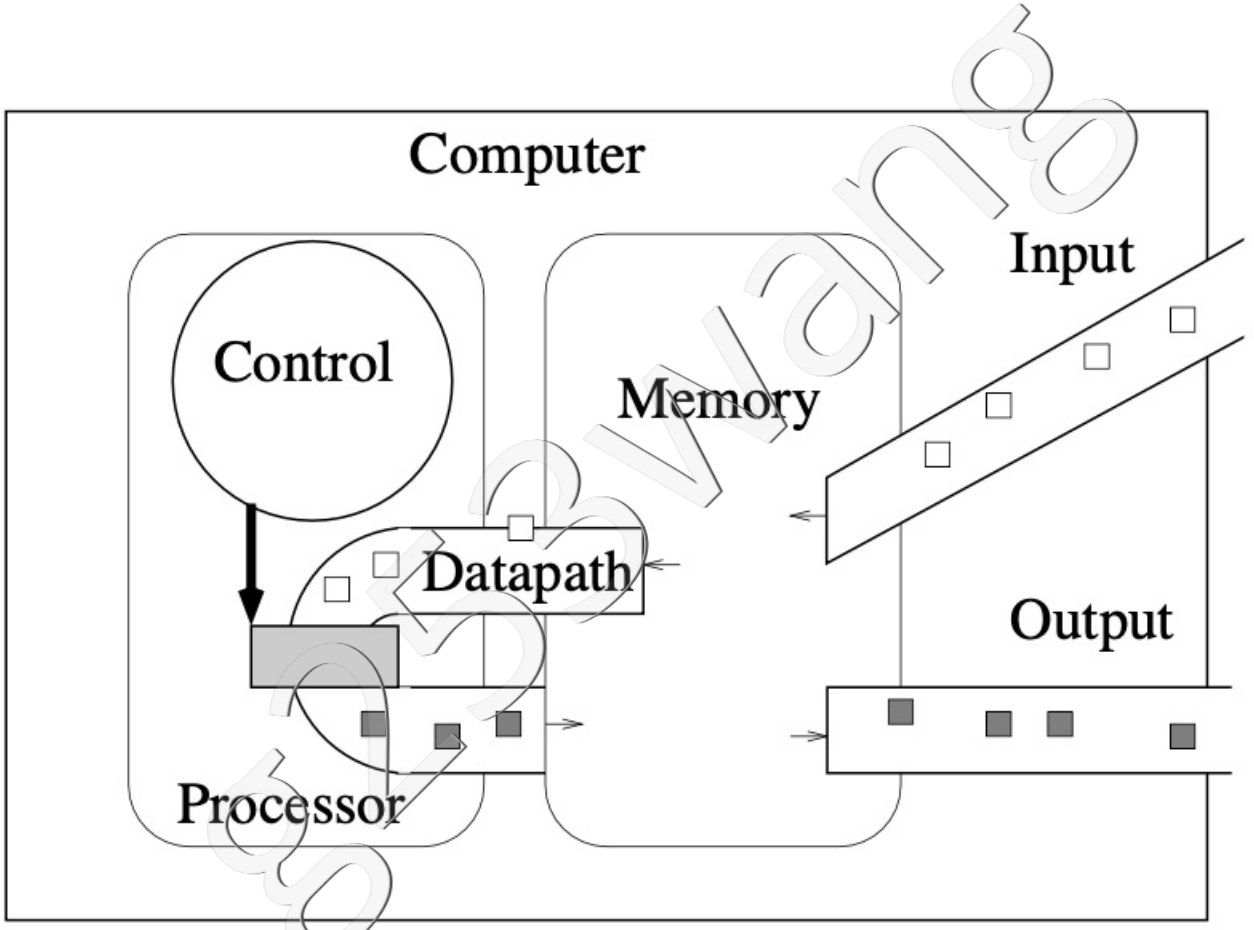
What is computer design

Course outline

- Introduction to Computer Organization and ARM
  - brief discussion of performance
- Digital logic design
- Data representation and manipulation
- Single-cycle processor design
  - designing a datapath
- Pipelining
  - hazards
- Memory hierarchies
  - cache
  - virtual memory
- Input/Output
- Multiprocessor systems



Computer Organization: The Big Picture



Why We Teach This Course

- Understanding of what's inside the computer
- Introduction to material in future courses
- Architecture issues influence programming

CS 251 topics continued in other courses

- CS 240: memory management
- CS 350: operating systems
- CS 343: concurrency
- CS 370: scientific computation
- CS 454: distributed systems
- CS 456: networks

Logistics

- Course notes (lecture slides):
  - not comprehensive
  - no substitute for lectures
  - posted on course website
- Required textbook:
  - "Computer Organization and Design", David Patterson and John Hennessy, ARM edition, 2017.
- 7 assignments, clickers, midterm, final exam
- Course Webpage: `http://student.cs.uwaterloo.ca/~cs251`
- Course newsgroup:
  `https://piazza.com/uwaterloo.ca/spring2023/cs251`

Assignments

- 7 assignments
  - No late submissions, unless explicitly stated.
- Submit via Crowdmark
  - Flexible options to upload to crowdmark
- Solutions online
- See ISA for assignment remarks
- See instructor for exam remarks

Clicker Questions

- Clicker questions worth 5% of course mark
- Lowest 30% clicker marks discarded before computing final clicker marks
  Accommodates for missed classes, illness, interviews, etc.
- Check your clicker marks during term!

Midterm and Final Exams

- Exam information is on `http://student.cs.uwaterloo.ca/~cs251/S23/examinfo.shtml`
- Midterm is scheduled for Thursday, June 22 from 4:30pm to 6:20pm.
- Final will be announced on June 2
- Contact ISC for exam relief

Copyright Issues

- Course notes contain figures from the textbook
- We have copyright permission to use them in our slides.
- Assignments contain figures from the textbook
  Solutions online in restricted access area
- Student copies of course notes, solutions to assignments, etc., should not be posted or shared online

Intellectual Property

Intellectual property includes items such as

- Lecture content, spoken and written
- Lecture handouts, presentations
- Questions or solution sets from assignments, clicker questions, exams
- Work protected by copyright

Must ask instructor for permission before uploading or sharing

- Online
- With students taking the same/similar courses in subsequent terms/years

Excessive Collaboration

- In the past, as many as 10%-20% of students in the course have been caught and penalized for excessive collaboration.
- Previous terms: encouraged to talk/discuss, but must write up solutions on your own without checking with other students. Excessive similarities are treated as excessive collaboration.

- This term (S23): Discussions fine. Hand in own copy of assignment.
- **Caution:** Doing assignments is critical for learning the material: *"I feel lost sometimes in lectures, but the assignments help a lot."*
- **Caution:** Reading course text is critical for learning the material.

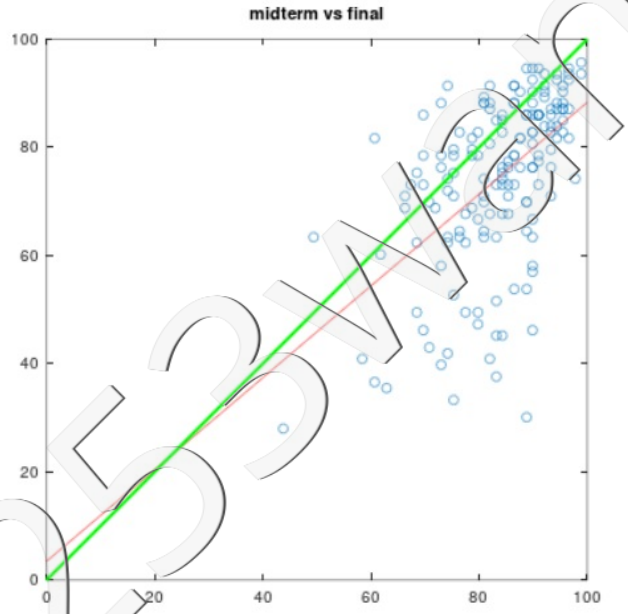
Excessive Collaboration - continued

- What's not allowed:
  - Looking for solutions on the internet
  - Using solutions from previous terms
  - Photocopying (!) another student's assignment
  - Word-for-word copying
- Standard Penalty for first offense at Waterloo: no marks on the assignment and a deduction of 5% from the course grade, letter to associate dean.
  Additional penalties may apply depending on marking scheme.
- Standard Penalty for second offense: suspension for one term.

This Course is Easier/Harder Than It Looks

Hard:

- First part (digital design) easy!
  Second part (architecture, cache, VM) HARD!



- Conceptually different

Easy:

- Average close to 80
  Attend lectures, turn off phone, do clickers, do assignments

Pandemic Plans

- Pandemic may require shifting to online
  Readings, videos (Learn)
  Quizzes instead of clickers
- Exams might be online instead of in-person
  Learn/Crowdmark
- Adjusting of marking scheme
- Illness, quarantine

See course outline for more details

Pandemic Plans - continued

- Quizzes - If in-person classes are disrupted
- Weekly quizzes if course goes online
- Lowest quiz mark will be discarded before computing quiz mark
  Accommodates for internet issues, etc.
- Typically 6 questions
- Meant to be easy if you've read the required sections and watched the videos
  But: Each question is graded all or nothing