GEORGE MASON UNIVERSITY

GMU CS695 Advanced Computer Architecture

Spring 2023

Course Project

Lishan Yang

Course Project

- 3/27: Project proposal presentation
- 5/1: Final project presentation
- 5/8: Written report due

- Group size: 1~4 students
- It is your responsibility to find reliable teammates. Students in the same group share the same grade of the course project.
  - In rare cases, please talk to the instructor

- (We will talk about how to do the presentation later in the semester)

Course Project

1. Find your teammate and topic
2. Start to work on the project and try to see if it is doable
   - ➢ Hardware requirement? Coding load? Too easy? Too difficult?
3. Proposal presentation
   - ➢ What's the problem? What's your goal? What's your plan?
4. Continue working on the project…
   - ➢ More debugging, discussion, …
5. Final presentation
   - ➢ What did you accomplish? What's your conclusion?
6. Written report

Office hours!
Discuss with the instructor and students

Course Project

- Written report:
  - It is a paper (We will talk about how to write it later in the semester)

Group size	Paper Length
1	6
2	7
3	8
4	9

- Some suggestions
  - Get started early
  - Communication! Regular meeting
    - Split your work and responsibility
    - Always summarize the next steps at the end of the meeting
  - A shared doc/folder and github

The code and experiments of your project needs to be submitted with Github history

Course Project: Decide the problem

- Bad problems (as a course project for CS695)
  - Build an Intel Xeon CPU from scratch
  - Build an A100 GPU from scratch
  - …
  - Check the size of Cache for a CPU
  - Check the DRAM size of a GPU
  - …
- Possible problems (these still need further clarification):
  - Evaluate a memory system, find out the bottle neck, and improve it
  - Evaluate the reliability of different hardware structures and improve system reliability
  - Which scheduling mechanism works the best? Under what condition?

Example

- Evaluate the reliability of different hardware structures and improve system reliability

An *Architecture* Project

➢ Is this an architecture project?

- When discussing the project idea, ask yourself: **Is it related to architecture?**
  - An easy way is to change the underlying hardware.
  - Saying, We are working on a CPU project. If I move the whole design to the GPU, and nothing changes, everything is working, then *likely* this is not an architecture project. Because the whole thing is **independent** to the underlying architecture.
  - Your problem and the solution should be related to the underlying architecture.

This is an open project.

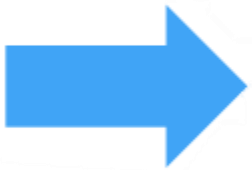
It is okay to have negative results :)

But you have to work on it, learn something, and get your hands dirty.

Instrumentation

- A technique that inserts code into a program to collect run-time information

```
movzx   ecx, [rax+0x2]
call    0x77ef7870
cmp     rax, rdx
jz      0x77f1eac9
```



```
 ..some code
 ..some code
movzx  ecx, [rax+0x2]
 ..some code
 ..some code
call   0x77ef7870
 ..some code
 ..some code
cmp    rax, rdx
 ..some code
 ..some code
jz     0x77f1eac9
```

Reference: Intel Pin Tutorial at CGO2013
https://www.intel.com/content/dam/develop/external/us/en/documents/cgo2013-256675.pdf

Instrumentation Types

- Different usages
  - Program analysis:
    - performance profiling
    - Error detection
    - Capture & replay
  - Architectural study:
    - Processor and cache simulation
    - trace collection
  - Binary translation:
    - Modify program behaviour
    - emulate unsupported instructions
- Different types
  - Source code instrumentation
  - Static binary instrumentation
  - Dynamic binary instrumentation

Reference: Intel Pin Tutorial at CGO2013
https://www.intel.com/content/dam/develop/external/us/en/documents/cgo2013-256675.pdf

Dynamic Binary Instrumentation

- Instrument binary code right before it runs
  - a.k.a. Just in time, or JIT

- Benefits
  - No need to recompile or re-link
  - Discover code at runtime
  - Handle dynamically generated code
  - Attach to running processes

Reference: Intel Pin Tutorial at CGO2013
https://www.intel.com/content/dam/develop/external/us/en/documents/cgo2013-256675.pdf

Instrumentation

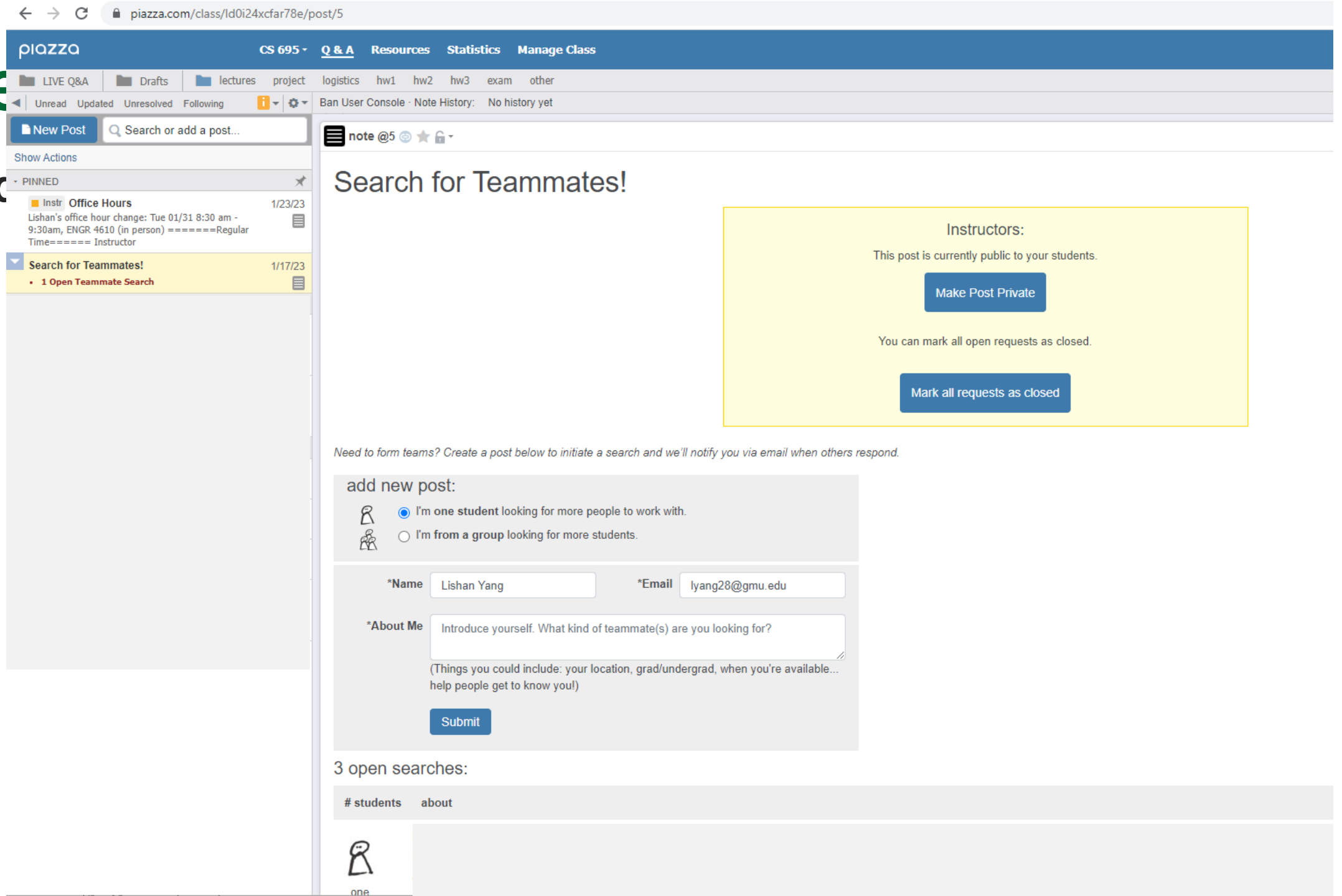
- Example: (CPU) Intel Pin
  - https://www.intel.com/content/www/us/en/developer/articles/tool/pin-a-dynamic-binary-instrumentation-tool.html
  - User's Manual: https://software.intel.com/sites/landingpage/pintool/docs/98690/Pin/doc/html/index.html
  - Can run on Zeus
- Exampe: (GPU) NVIDIA NVBit
  - https://github.com/NVlabs/NVBit
  - Requires an ORC account (please discuss with me before requesting the account)

The first step

- Find your teammates

The

- Find


piazza.com/class/ld0i24xcfar78e/post/5
piazza
CS 695
Q & A
Resources
Statistics
Manage Class
LIVE Q&A
Drafts
lectures
project
logistics
hw1
hw2
hw3
exam
other
Unread
Updated
Unresolved
Following
Ban User Console · Note History: No history yet
New Post
Search or add a post...
Show Actions
PINNED
Instr Office Hours
1/23/23
Lishan's office hour change: Tue 01/31 8:30 am - 9:30am, ENGR 4610 (in person) =======Regular Time====== Instructor
Search for Teammates!
1/17/23
1 Open Teammate Search
note @5
Search for Teammates!
Instructors:
This post is currently public to your students.
Make Post Private
You can mark all open requests as closed.
Mark all requests as closed
Need to form teams? Create a post below to initiate a search and we'll notify you via email when others respond.
add new post:
I'm one student looking for more people to work with.
I'm from a group looking for more students.
*Name
Lishan Yang
*Email
lyang28@gmu.edu
*About Me
Introduce yourself. What kind of teammate(s) are you looking for?
(Things you could include: your location, grad/undergrad, when you're available... help people get to know you!)
Submit
3 open searches:
students
about
one

The first step

- Find your teammates
  - What topic?
    - CPU? GPU? Memory? Cache? Instructions?
    - Reliability? Security? Performance?
    - Characterization? Optimization?
    - Simulator? Instrumentation?
  - Your working style
    - Start early? Postpone till last minute? Stay up late at night?
    - In-person meetings? Zoom preferred?
  - Your anticipated grade? - A/B/C?
  - Your strength & weakness?
    - Good at writing? Presentation? Linux? C?
- The course project grading is independent of the posts you wrote.
- You can also work alone, if you want.

Second step

- Come to Lishan’s office hours & brainstorm the ideas