**Siyuan Chai** Contact: siyuanc3@illinois.edu https://schai.me

## Education

**University of Illinois**, Urbana Champaign, IL
Computer Science Ph.D. Start Aug. 2021
Advisor: Prof. Tianyin Xu

**Northwestern University**, Evanston, IL
M.S. Computer Science, B.S. Electrical Engineering Graduated June 2021
GPA: 4.0/4.0 (Summa Cum Laude)

## Publications

1. **[ASPLOS 2022]** Brian Suchy, Souradip Ghosh, Drew Kersnar, **Siyuan Chai**, Zhen Huang, Aaron Nelson, Michael Cuevas, Alex Bernat, Gaurav Chaudhary, Nikos Hardavellas, Simone Campanoni, and Peter Dinda. "CARAT CAKE: replacing paging via compiler/kernel cooperation". In Proceedings of *Architectural Support for Programming Languages and Operating Systems*.

2. **[Radiology]** Ramsey M Wehbe, Jiayue Sheng, Shinjan Dutta, **Siyuan Chai**, Amil Dravid, Semih Barutcu, Yunan Wu, Donald R. Cantrell, Nicholas Xiao, Hatice Savas, Rishi Agrawal, Nishant Parekh, Aggelos K. Katsaggelos. "DeepCOVID-XR: An Artificial Intelligence Algorithm to Detect COVID-19 on Chest Radiographs Trained and Tested on a Large U.S. Clinical Data Set." *Radiological Society of North America*.

## Research Experience

**UIUC Xlab**, Prof. Tianyin Xu Aug. 2021 to Present
*Support Linux Kernel for Elastic Cuckoo Page Table*
- Adapting Linux kernel, primarily the memory management portion, to have a more versatile support for non tree page table designs like Elastic Cuckoo Page Table (ECPT), a hash page table with memory-level parallelism
- Analyzed and addressed the adaptation challenges at kernel level including page table management interface, transparent huge pages, and page table isolation
- Extensively modified address translation portion of QEMU to simulate ECPT's hardware behavior

**NU Compilers Group**, Prof. Simone Campanoni Jan. 2021 to July 2021
*Enhance Parallelism by Utilizing Commutative Loop Iterations*
- Coded a LLVM pass to transform serial code to parallel by telling the commutativity of <load, ALU operation, store> triplet across loop iterations

**NU Parallelism Group**, Prof. Peter Dinda June 2020 to May 2021
*CARAT CAKE: Replacing Paging via Compiler/Kernel Cooperation*
- Designed and implemented CARAT CAKE, an allocation level address space which aims to replace virtual memory and paging with protection checks inserted at compile time and allocations tracked in runtime
- Implemented a competitive paging address space with support for red black tree and splay tree data structures to track VA-PA mapping, transparent huge pages, and PCID; performance measured with performance monitoring counter
- Designed runtime protection check with address mapping data structures

**Image & Video Processing Lab**, Prof. Aggelos Katsaggelos June 2019 to July 2021
*DeepCOVID-XR*
- Designed and implemented a CNN model to flag out positive COVID cases based on patients' chest X-ray images
- Outperformed experienced radiologists with an accuracy of 85% compared to 76 - 82% and AUC of 0.935 compared to 0.819 - 0.856

## Work Experience

**Software Engineering Intern**, Google Cloud Infrastructure May 2022 to Aug. 2022
*Machine Model Population Pipeline*

- Designed a distributed pipeline to collect data of all Google's server machines (4M+) to model their physical topology. It implements batch reads from Bigtable and capacitor or makes RPC calls with rate limitation
- Validated mac address of machines with as-maintained models across three data sources. Results will be stored in Spanner

**Research Intern**, Tencent Network Group June 2021 to Aug. 2021
*Service Driven Network Verification tool*

- Contributed to design a network verification tool for routing configurations (e,g. BGP, OSPF); it supports quantitative query and covers all data plane with global formal modeling and local simulation
- Designed easy-to-use geo-based intent language for network verification

## Projects

**CPU-GPU Simulator for Collaborative Workloads Modeling**

- Analyzed pros and cons of state-of-art simulators (gem5, gem5-GPU, and UVMSmart) when modeling memory performance of CPU-GPU collaborative workloads
- Designed and prototyped a CPU-GPU memory subsystem simulator for workloads running on CPU-GPU unified virtual memory.
- Integrated gem5 and UVMSmart with IPC to model performance of CPU, GPU and on-demand page migration between them

**Log-Structured Merge-Trees (LSM-trees) Optimization with eBPF**

- Conducted a comprehensive study of optimizing LSM-trees with eBPF
- Developed two designs to offload the LSM compaction to eBPF with hook point at FS layer or NVMe driver layer

**Distributed Machine Learning Inference Framework**

- Developed a fault-tolerant resource-fair ML inference framework from scratch
- Coded a totally ordered KV distributed file system with quorum consensus to support the ML model inference and data storage
- Designed and implemented failure detection with a ring-based membership protocol

**C-style Language Compiler**, CS 322 Compiler Construction

- Created, from scratch, a compiler to translate C-style language to x86_64 assembly
- Implemented features including graph-coloring register allocation, liveness analysis, instruction selection with tiling, control flow graph, and memory access checking

**Middle End Analysis for a C-based API**, CS 323 Code Analysis & Transformation

- Coded a LLVM pass to reduce calls to a custom C-based API by implementing analysis like reaching-definition, constant propagation and folding, alias analysis, function inlining, and dead code elimination.

## Skills

**Programming languages**:
C/C++, Assembly, Python, Java, Go, JavaScript, MATLAB
**System-level Development**:
Linux Kernel Development, QEMU, Docker, GDB, Make, Linker, LLVM, OpenMP
**Artificial Intelligence**:
CUDA, PyTorch, Tensorflow, Keras, Image Processing, Computer Vision
**Hardware**:
Raspberry Pi, Arduino, VHDL, Verilog
**Web Development**:
HTML, CSS, Flask, Django, React

## Professional Activities

**OSDI/ATC 2022**: Artifact Evaluation Committee
**SOSP 2021**: Artifact Evaluation Committee, Slack Co-chair

## Teaching Experience

**Teaching Assistant** - University of Illinois Urbana-Champaign

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|---|---|---|
| Fall 2022 | CS 423: Operating System Design | with Prof. Tianyin Xu |
| Spring 2022 | CS 598XU: Reliability of Cloud-Scale Systems | with Prof. Tianyin Xu |

**Peer Mentor (Undergraduate TA)** - Northwestern University

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|---|---|---|
| Spring 2021 | CS 336 - Design & Analysis of Algorithms | with Prof. Jason Hartline |
| Winter 2021 | CS 343 - Operating Systems | with Prof. Peter Dinda |
| Winter 2020 | CS 336 - Design & Analysis of Algorithms | with Prof. Konstantin Makarychev |
| Fall 2019 | CS 336 - Design & Analysis of Algorithms | with Prof. Jason Hartline |
| Spring 2019 | CS 336 - Design & Analysis of Algorithms | with Prof. Jason Hartline |

**Teaching Assistant** - Washington University in St. Louis

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| Spring 2018 | ESE 205 Introduction to Engineering Design | with Prof. James Feher |