

## Education

### North Carolina State University

Ph.D. in Computer Science; Advisors: Prof. Xipeng Shen and Prof. Yan Solihin

Raleigh, North Carolina, USA

Aug. 2018 - Present

### Tsinghua University

M.E. in Computer Science; Advisor: Prof. Wei Xue

Beijing, China

Aug. 2015 - Jul. 2018

### Jilin University

B.E. in Software Engineering; Ranking: 3/332

Changchun, Jilin, China

Aug. 2011 - Jul. 2015

## Research Experience

### Computer Science Department, North Carolina State University

Raleigh, NC, USA

Aug. 2018 - Present

Research Assistant; Advisors: Prof. Xipeng Shen and Prof. Yan Solihin

#### • **Memory Exposure Reduction and Randomization for Persistent Memory Objects (ASPLOS'2020)**

- Proposed a new approach to reduce memory disclosure/corruption vulnerabilities by reducing memory exposure time using attachment and detachment of a persistent memory object (PMO).
- Designed a novel hardware support to make attachment/detachment fast by embedding a page table subtree into a PMO.
- Designed an architecture support for providing process-specific PMO-wide permission.

#### • **Hardware Domain Virtualization for Intra-process Isolation of Persistent Memory Objects (ISCA'2020)**

- Proposed to improve security of PMOs from memory attacks by assigning each attached PMO to a protection domain, providing intra-process isolation of PMOs
- Designed an architecture support for efficient memory protection key (MPK) virtualization, which supports a large number of domains sharing a limited number of protection keys.
- Designed an architecture support for domain virtualization, which manages per-thread permission directly on domains, completely removing the mapping of domains to a limited number of keys.
- Achieved 10X and 52X speedups over the state-of-art MPK virtualization.

#### • **Temporal Exposure Reduction-Based Protection for Persistent Memory**

- Explored and formalizing semantics of temporal exposure reduction protection (TERP).
- Designed compiler and runtime system support to reduce TERP adoption difficulty

#### • **Crash Recovery-Aware Persistent Program Bug Detection and Repairing**

- Redefined crash-safe bugs in persistent memory programming and quantify the relationship of bugs to crashes.
- Leveraged the compiler support to detect and repair persistent bugs in polynomial time.

#### • **Improving Persistent Memory Security in Virtualized Environment**

- Propose a mechanism that improves persistent memory security in virtualized and cross-process environments by combining memory encryption virtualization (AMD SEV), authentication and permission control.

#### • **Hardware-Based Address-Centric Acceleration of Key-Value Store (HPCA'2021)**

- Designed an address-centric accelerator with hardware and software support to reduce address translation overhead in key-value store systems.
- Leveraged the opportunities on the new tradeoffs between hashing complexities and overhead.

### Future Technologies Group, Oak Ridge National Laboratory

Oak Ridge, TN, USA

May. 2019 - Aug. 2019

Research Assistant; Advisor: Prof. Mehmet E. Belviranli

#### • **Hardware-Centric co-location Performance Modeling on Heterogeneous System-on-chip**

- Designed a novel processor-centric performance modeling methodology and a new three region interference-conscious performance model
- Provided memory-interference-aware hardware design insights by integrating our model with standalone bandwidth roofline model
- Reduced average prediction errors of the state-of-art model from 24.8% to 8.7% on GPU, and from 13.0% to 3.3% on CPU, demonstrating much improved efficacy in guiding SoC designs.

## Computer Science Department, North Carolina State University

Research Assistant; Advisors: Prof. Xipeng Shen and Prof. Isil Dillig

Raleigh, NC, USA

April. 2020 - Present

### • **Translating UDFs to SQL through Lazy Inductive Synthesis**

- Achieved a good trade-off between expressiveness and scalability using a technique that we dub *lazy inductive synthesis*
- Implemented our method in a tool and evaluated it on real-world SQL queries with UDFs targeting the Spark system. This tool is effective at translating UDFs to SQL expressions and significantly improves performance.

## Department of Computer Science, Tsinghua University

Research Assistant; Advisor: Prof. Wei Xue

Beijing, China

Aug. 2015 - Jul. 2018

### • **Performance Modeling and Optimization on the Heterogeneous Many-core Processor (IPDPS'2018, SC'16)**

- Built a purely static performance model of SW26010, the heterogeneous many-core processor that powers Sunway TaihuLight. This model achieves an average accuracy as high as 95% on 17 benchmarks from Rodinia.
- Designed a static compiler auto-tuning tool based on the performance model. This tool reduces 97% tuning time and achieves nearly optimal optimization (1.6X-3.7X speedup).
- Designed a memory footprint analysis and code refactoring tool to fit the frequently-accessed variables into scratchpad memory.

## Computer Science Department, ETH Zurich

Research Assistant; Advisors: Prof. Torsten Hoefer and Dr. Tobias Grosser

Zurich, Switzerland

Apr. 2017 - Sep. 2017

### • **Performance Model Generator**

- Developed a Domain-specific Language (DSL) based on polyhedral model to generate performance models on different configurations.

## Publication

HPCA'2021	ChenCheng Ye, <b>Yuanchao Xu</b> , Xipeng Shen, Xiaofei Liao, Hai Jin and Yan Solihin, "Hardware-Based Address-Centric Acceleration of Key-Value Store", 27th IEEE International Symposium on High-Performance Computer Architecture, Seoul, South Korea, February 2021, <b>Accepted, to appear</b>
ISCA'2020	<b>Yuanchao Xu</b> , ChenCheng Ye, Yan Solihin, Xipeng Shen, "Hardware-Based Domain Virtualization for Intra-Process Isolation of Persistent Memory Objects", 47th ACM/IEEE International Symposium on Computer Architecture, Valencia, Spain, June 2020, <a href="#">[Paper]</a> <a href="#">[Slides]</a>
ASPLOS'2020	<b>Yuanchao Xu</b> , Yan Solihin, Xipeng Shen, "MERR: Improving Security of Persistent Memory Objects via Efficient Memory Exposure Reduction and Randomization", 25th ACM International Conference on Architectural Support for Programming Languages and Operating Systems, Lausanne, Switzerland, March 2020. <a href="#">[Paper]</a> <a href="#">[Slides]</a>
IPDPS'2018	Shizhen Xu, <b>Yuanchao Xu</b> , Wei Xue, Xipeng Shen, Xiaomeng Huang, Guangwen Yang. "Taming the "Monster": Overcoming Program Optimization Challenges on SW26010 Through Precise Performance Modeling", 32nd IEEE International Parallel and Distributed Processing Symposium, Vancouver, Canada, May 2018. <a href="#">[Paper]</a>

## Honors & Awards

2013	<b>Silver Medal</b> , ACM-ICPC Asia Regional Programming Contest	China
2014	National Scholarships of China (highest scholarship for Chinese undergraduate)	China

## Skills

<b>Programming Languages:</b>	C, C++, Rust, FORTRAN, JAVA, MATLAB
<b>HPC Programming Models:</b>	OpenMP, MPI, CUDA, OpenACC
<b>Frameworks:</b>	TensorRT, LLVM, Spark, Hadoop