

# Yifan Yang

Tel: +1 617-909-9768, Email: [yifany@csail.mit.edu](mailto:yifany@csail.mit.edu), <https://yang-yifan.github.io/>

## RESEARCH INTERESTS

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Computer Architecture, Accelerator for Sparse and Irregular Applications (transformer, CNN, tensor algebra, graph analytics), HW/SW Co-design, Domain-specific Accelerator, FPGA

## EDUCATION

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Massachusetts Institute of Technology, EECS

Ph.D. in Electrical Engineering and Computer Science

S.M. in Electrical Engineering and Computer Science

Cambridge, MA

September 2019 - present

September 2019 - June 2021

- GPA: 5.0/5.0
- Thesis advisor: Prof. Daniel Sanchez and Prof. Joel Emer
- Thesis title: Architectural Support for Efficient Processing of Sparse and Irregular Applications
- Coursework: Computer System Architecture, Hardware Architecture for Deep Learning, TinyML and Efficient Deep Learning Computing, Advances in Computer Vision, Theory of Computation

Tsinghua University, Department of Physics

B.S. in Mathematics and Physics

Beijing, China

August 2015 - July 2019

- GPA: 3.90/4.00
- Thesis advisor: Prof. Leibo Liu
- Thesis title: A Message Passing-based Graph Processing Framework on CPU-FPGA Heterogeneous System
- Selected coursework: Fundamental of Digital Logic and Processor, Digital Integrated Circuit Analysis and Design (English), Computer Organization and Architecture, Operating System, Principles and Practice of Compiler Construction, Distributed Computing, Principles of Analog Circuits, Data Structure, Introduction to Artificial Intelligence, Autonomous Driving

## RESEARCH EXPERIENCE

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Graduate Research Assistant

MIT Computer Science and Artificial Intelligence Laboratory

September 2019 - present

Cambridge, MA

- Advisor: Prof. Daniel Sanchez and Prof. Joel Emer
- (Ongoing) A Versatile Accelerator for Dense and Sparse Matrix Multiplications
  - Conduct performance analysis of matrix multiplication on a broad set of application domains and sparsity levels (transformer, CNN, tensor algebra, graph analytics scientific computing, etc.)
  - Codesign dataflow and hardware architecture to efficiently support dense, mildly sparse, and highly sparse matrix multiplication with modest area overhead
- Worked on leveraging inter-layer pipelining to accelerate sparse CNNs
  - Proposed input-stationary output-stationary (IS-OS) dataflow that minimizes inter-layer storage requirement
  - Designed the **ISOSceles** accelerator that implements IS-OS dataflow to efficiently pipeline multiple sparse layers in CNNs
  - Conducted end-to-end evaluation of ISOSceles on several sparse CNNs and achieved large speedup and off-chip traffic reduction over state-of-the-art accelerators
- Worked on offering architectural support to accelerate irregular applications using data compression

Designed **SpZip**, specialized hardware support for traversing and generating compressed data structures in irregular applications

Proposed the Dataflow Configuration Language (DCL) for the SpZip programmable hardware

Evaluated SpZip using zsim simulation on a broad set of irregular applications, results show large performance gains and data movement reductions over prior systems

#### **Undergraduate Research Assistant**

*Research Center for Mobile Computing, Tsinghua University*

*March 2017 - August 2019*

*Beijing, China*

- Advisor: Prof. Leibo Liu
- Worked on designing graph processing framework across the hardware software interface

Proposed the asynchronous Block Coordinate Descent (BCD) view of iterative graph algorithms to reveal the algorithmic and system trade-offs on achieving fast algorithm convergence

Designed **GraphABCD**, an asynchronous graph processing framework on heterogeneous system

Prototyped GraphABCD whole system in Verilog on Intel HARPv2 CPU-FPGA heterogeneous platform

#### **Undergraduate Research Assistant**

*Berkeley Artificial Intelligence Research Lab (BAIR), UC Berkeley*

*July 2018 - September 2018*

*Berkeley, CA*

- Advisor: Prof. Kurt Keutzer, collaboration with Kees Vissers and Michaela Blott from Xilinx Research Labs
- Worked on co-designing Convolutional Neural Network and its hardware accelerator

Designed **DiracDeltaNet**, a hardware efficient neural network targeting image classification task

Quantized DiracDeltaNet down to 4bit weight and 4bit activations with minor accuracy loss

Designed and implemented **Synetgy**: the hardware accelerator for DiracDeltaNet on embedded FPGA using HLS

## **PUBLICATIONS**

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1. **Yifan Yang**, Joel S. Emer, and Daniel Sanchez, "[ISOSceles: Accelerating Sparse CNNs through Inter-Layer Pipelining](#)", in Proceedings of the 29th international symposium on High Performance Computer Architecture (HPCA-29), 2023.
2. **Yifan Yang**, Joel S. Emer, and Daniel Sanchez, "[SpZip: Architectural Support for Effective Data Compression In Irregular Applications](#)", in Proceedings of the 48th annual International Symposium on Computer Architecture (ISCA-48), 2021.
3. **Yifan Yang**, Zhaoshi Li, Yangdong Deng, Zhiwei Liu, Shouyi Yin, Shaojun Wei, and Leibo Liu, "[GraphABCD: Scaling Out Graph Analytics with Asynchronous Block Coordinate Descent](#)", in Proceedings of the 47th annual International Symposium on Computer Architecture (ISCA-47), 2020.
4. **Yifan Yang**, Qijing Huang, Bichen Wu, Tianjun Zhang, Liang Ma, Giulio Gambardella, Michaela Blott, Luciano Lavagno, Kees Vissers, John Wawrzynek, and Kurt Keutzer, "[Synetgy: Algorithm-hardware Co-design for ConvNet Accelerators on Embedded FPGAs](#)", in Proceedings of the 2019 ACM/SIGDA International Symposium on Field-Programmable Gate Arrays (FPGA), 2019.

## INDUSTRY & TEACHING EXPERIENCE

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### Platform Architecture Intern

Platform Architecture, Apple

- CPU cache subsystem performance research

May 2022 - August 2022

Cupertino, CA

### Graduate Teaching Assistant

6.812/6.825 *Hardware Architecture for Deep Learning*, MIT

- Held recitations and office hours
- Developed and graded lab assignments and paper review sessions
- Mentored and graded final design projects

January 2022 - May 2022

Cambridge, MA

## HONORS & AWARDS

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- MIT Jacobs Presidential Fellowship Cambridge, 2019
- Chi-sun Yeh Nominee Prize (8%) Beijing, 2019
- CNPC Scholarship (5%) Beijing, 2018
- National Scholarship (1/91) Beijing, 2017
- Outstanding Award in the 35<sup>th</sup> Tsinghua 'Challenge Cup' (Top 6/381)  
(Student Extracurricular Academic Science and Technology Works Competition) Beijing, 2017
- Zhang Mingwei Scholarship (10%) Beijing, 2016
- Bronze Medal in the 31<sup>st</sup> China Physics Olympiad Hangzhou, 2014

## TECHNICAL SKILLS

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**Programming:** C/C++, Python, Verilog, System Verilog, Vivado HLS, Unix/Linux, Golang, R, MATLAB, Assembly

**Tools:** Pytorch, Intel Pin, zsim, Intel(Altera) toolchain (Quartus, Qsys), Xilinx toolchain (Vivado, Vivado HLS, PYNQ), Modelsim, VCS

Updated on November 15, 2023