Fall 2024 COMS E6998

One of the most significant transformations in the computer sector over the last decade has been the rise of cloud computing. Companies are progressively transferring their tasks to external cloud platforms and utilizing advanced global services that were previously unattainable within individual data centers. Nonetheless, the construction and utilization of cloud systems entails tackling numerous intricate research challenges. This research seminar will explore both industrial and academic contributions to cloud computing, focusing on systems for machine learning and machine learning for systems. Participants will analyze and guide discussions on research papers, and collaborate in small groups to undertake a research project throughout the semester.

Time and place

Fridays 10:10am - 12:00pm
Location: TBD

Instructors

Konstantinos Kaffes
kkaffes@cs.columbia.edu

TA: Vahab Jabrayilov

Prerequisites

Appropriate for EE/CS grad students or advanced undergraduates that have taken OS 1 (COMS W4118) or an equivalent course.

Format

Reading, writing about, and discussing research papers. Short presentations. Research projects in small groups. Participation will be required.

The grading rubric will be 50% project, 25% participation, and 25% paper presentations and summaries.

Schedule

September 6: Introduction

1. How to read a paper
2. Always measure a level deeper

3. [The datacenter as a computer](#)

September 13: Cluster Management

1. [Borg: The next generation](#)
2. [Twine: A Unified Cluster Management System for Shared Infrastructure](#)
3. [Protean: VM Allocation Service at Scale](#)
4. Bonus: [RAS: Continuously Optimized Region-Wide Datacenter Resource Allocation](#)

September 20: Serverless

1. [A Berkeley View on Serverless Computing](#)
2. [Serverless in the Wild: Characterizing and Optimizing the Serverless Workload at a Large Cloud Provider](#)
3. [XFaaS: Hyperscale and Low Cost Serverless Functions at Meta](#)
4. Bonus: [On-demand Container Loading in AWS Lambda](#)

September 27: ML for Systems: Offline Systems

1. [Autopilot: workload autoscaling at Google](#)
2. [Cilantro: Performance-Aware Resource Allocation for General Objectives via Online Feedback](#)
3. [SelfTune: Tuning Cluster Managers](#)

October 4: ML for Systems: Online Systems

1. [SmartHarvest: harvesting idle CPUs safely and efficiently in the cloud](#)
2. [LinnOS: Predictability on Unpredictable Flash Storage with a Light Neural Network](#)
3. TBD

October 11: ML for Systems: Frameworks

1. [SOL: safe on-node learning in cloud platforms](#)
2. [Flash: Fast Model Adaptation in ML-Centric Cloud Platforms](#)
3. [Towards a Machine Learning-Assisted Kernel with LAKE](#)

October 18: Systems for ML: Classic Serving

1. [Clipper: A Low-Latency Online Prediction Serving System](#)
2. [INFaaS: Automated Model-less Inference Serving](#)
3. [Paella: Low-latency Model Serving with Software-defined GPU Scheduling](#)

October 25: Systems for ML: LLM Serving

1. [Efficient Memory Management for Large Language Model Serving with PagedAttention](#)
2. [Taming Throughput-Latency Tradeoff in LLM Inference with Sarathi-Serve](#)

3. [DistServe: Disaggregating Prefill and Decoding for Goodput-optimized Large Language Model Serving](#)

November 1: Systems for ML: Models and the things around them

1. [DSPy: Compiling Declarative Language Model Calls Into Self-Improving Pipelines](#)
2. [Where Is My Training Bottleneck? Hidden Trade-Offs in Deep Learning Preprocessing Pipelines](#)
3. [cedar: Composable and Optimized Machine Learning Input Data Pipelines](#)
4. Bonus: [Milvus: A Purpose-Built Vector Data Management System](#)

November 8: Systems for ML: Training

1. [Efficient Large-Scale Language Model Training on GPU Clusters Using Megatron-LM](#)
2. [Alpa: Automating Inter- and Intra-Operator Parallelism for Distributed Deep Learning](#)
3. [MegaBlocks: Efficient Sparse Training with Mixture-of-Experts](#)
4. Bonus: [MegaScale: Scaling Large Language Model Training to More Than 10,000 GPUs](#)

November 15: Systems for ML in the Cloud

1. [Singularity: Planet-Scale, Preemptive and Elastic Scheduling of AI Workloads](#)
2. [MLaaS in the Wild: Workload Analysis and Scheduling in Large-Scale Heterogeneous GPU Clusters](#)
3. [MAST: Global Scheduling of ML Training across Geo-Distributed Datacenters at Hyperscale](#)
4. Bonus: [Distributed Inference and Fine-tuning of Large Language Models Over The Internet](#)

November 22: Analytics Systems

1. [Lakehouse: A New Generation of Open Platforms that Unify Data Warehousing and Advanced Analytics](#)
2. [Photon: A Fast Query Engine for Lakehouse Systems](#)
3. [Building An Elastic Query Engine on Disaggregated Storage](#)

November 29: No class - Thanksgiving

December 6: Project Presentations