

# HPC & Parallel Programming

## Introduction

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<https://kevinsuo.github.io/>

# Outline

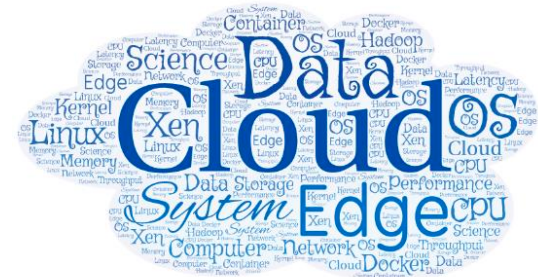
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- Why study HPC & parallel programming?
- What to learn?
- Course structure
- Course policy
- An example of HPC & parallel programming



# Self Introduction

- Kun Suo, Ph.D.
  - Homepage, <https://kevinsuo.github.io/>
- Research interests:
  - Cloud computing and virtualization;
  - Parallel and Distributed Computation, containers and kubernetes;
  - Software defined network (SDN) and network function virtualization (NFV)
  - Big data systems and machine learning systems
- Projects you may be interested in:
  - Several projects in Cloud & Data & Edge
  - <https://kevinsuo.github.io/code-lab.html>



# Now it's your turn

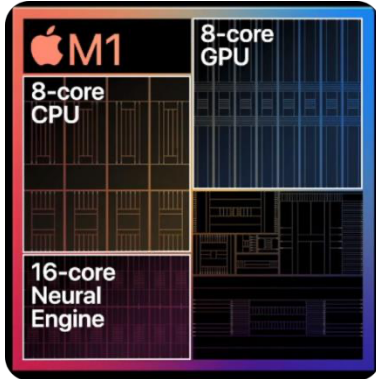
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- Name, program/year, where from <https://www2.eecs.berkeley.edu/Research/Areas/CS/>
- Your interests in Computer Science
- Have you ever used or heard of parallel and distributed system? Can you name some of them? What do you expect from this course?

If you are in the online course, introduce yourself in D2L, Discussions → Self-Introduction



# Example of HPC & Parallel Programming



personal computer



internet



cloud



Social system



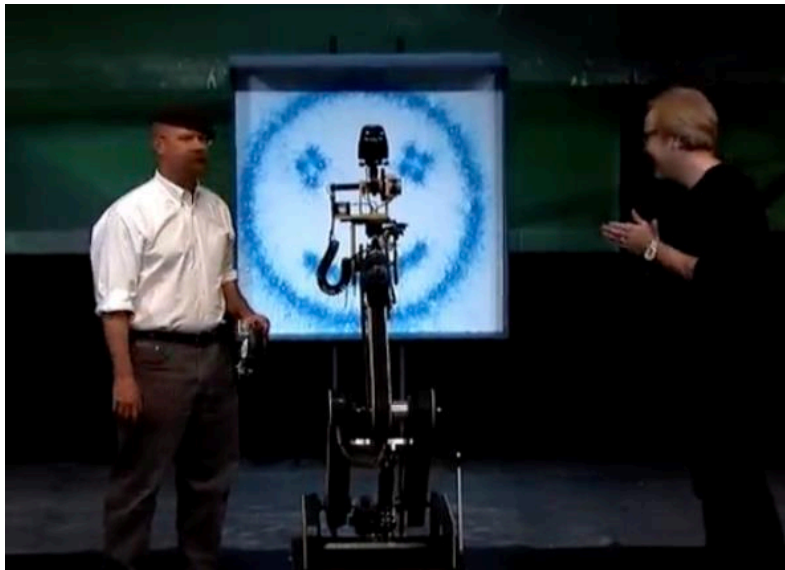
# An Example of Parallel Computing

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- CPU v.s. GPU

Single core

[NVIDIA: Adam and Jamie explain parallel processing on GPU's \(youtube.com\)](https://www.youtube.com/watch?v=93108364100)



# Course Information

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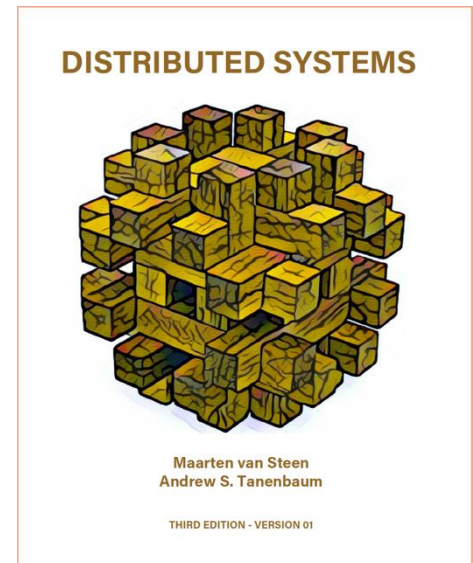
- Instructor: Dr. Kun Suo
- Office: J-3230
- Email: ksuo@kennesaw.edu
  - Only reply to e-mails that are sent from KSU student email accounts and title the course number [CS4522]
- Office Hours:
  - Email or Microsoft Teams
  - By appointment
- Course Materials
  - Homework assignments, lecture slides, and other materials will be posted in the webpage (<https://kevinsuo.github.io/teaching.html>) and D2L.



# Reference Book

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- “Distributed Systems 3rd edition (2017)” by M. van Steen and A.S. Tanenbaum:
  - ISBN-13: 978-1543057386
  - You can get a digital copy of this book for free: <https://www.distributed-systems.net/index.php/books/ds3/>





# Prerequisites

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- Computer basics that are supposed to be covered in *(CS 3502) Operating Systems*, *(CS 3503) Computer Organization and Architecture* course, *(CS 4504) Parallel System* course.
- **C** programming (code reading, kernel development and debugging). ([Famous projects in C](#))
- **Linux** command line environment (compiling, Makefile, debugging, simple shell programming).



# For C and Linux beginners

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- C tutorial

- <https://www.tutorialspoint.com/cprogramming/>
- <https://www.learn-c.org>
- <https://www.cprogramming.com/tutorial/c-tutorial.html>

- Linux tutorial

- <https://ryanstutorials.net/linuxtutorial/>
- <http://www.ee.surrey.ac.uk/Teaching/Unix/>
- <https://www.tutorialspoint.com/unix/>



# Project Environment

- Recommend project environment (local)

- VirtualBox + Ubuntu + Linux

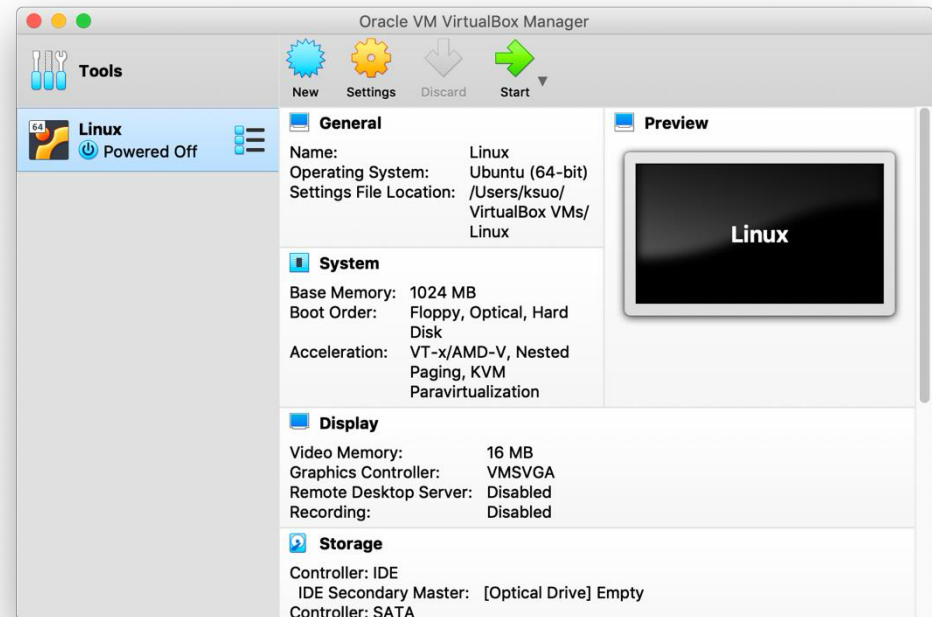
Virtual machine

<https://www.virtualbox.org/>

VM OS

<https://ubuntu.com/download/desktop>

VM OS Kernel



# Project Environment

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- Recommend project environment (local)
  - VirtualBox + Ubuntu + Linux
- New to VirtualBox?
  - <https://oracle-base.com/articles/vm/virtualbox-creating-a-new-vm>
  - [https://www.youtube.com/watch?v=sB\\_5fqiySi4](https://www.youtube.com/watch?v=sB_5fqiySi4)
  - <https://youtu.be/GDoCrfPma2k> (MacOS)
- You can access to VMs in KSU data centers (cloud) through <https://cseview.kennesaw.edu/>,
  - username: administration; password: linuxadmin



# Why study HPC & Parallel Programming?

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- Most computer systems today are a certain form of HPC/parallel/distributed systems
  - Internet, datacenters, super computers, mobile devices
  - Most of the applications are parallel or even distributed apps (example: debug decompress file app, [link](#), starts at 2:33)
- To learn useful techniques to build large systems
  - A system with 10,000 nodes is different from one with 100 nodes
- How to deal with imperfections
  - Machines can fail; network is slow; topology is not flat



# What to learn

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- HPC & Parallel Programming:
  - Parallel hardware
  - Matrix multiplication optimization
  - Pthread programming
  - MPI programming
  - OpenMP programming
  - GPU programming



# Expected Outcomes

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- Familiar with popular parallel programming libraries (Pthread, OpenMP, MPI, GPU)
- Familiar with fundamentals of program optimization
- The ability to
  - Evaluate the performance of parallel and HPC systems
  - Write simple parallel and HPC programs
  - Understand the tradeoffs in program design



# Course Structure

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- Lectures
  - Time/Location
  - D2L/Course website
- Projects
  - 5 programming assignments
  - 1 paper/project presentation
- Exams (open books)
  - Midterm: online D2L, TBA.
  - Final: online D2L, TBA





# Course Policy

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- Grading scale

Percentage	Grade
90 - 100	A
80 - 89	B
70 - 79	C
60 - 69	D
Below 60	F



# Grading Policy (cont.)

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- Grading percentage
  - Projects (x5): 50%
  - Presentation: 10%, including project or paper presentation
  - Midterm: 20%
  - Final exam: 20%

Late submission policy: late submission will **not be accepted** and **no credits**



# Academic Integrity

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- Academic dishonesty

[https://scai.kennesaw.edu/KSU\\_Codes\\_of\\_Conduct\\_2019-2020.pdf](https://scai.kennesaw.edu/KSU_Codes_of_Conduct_2019-2020.pdf)

- Cheating

Receiving, attempting to receive, knowingly giving or attempting to give unauthorized assistance...

- Plagiarism

- Collusion

Do not upload course documents to 3<sup>rd</sup> party website without author's permission

- The submission for credit of any work or materials that are attributable in whole or in part to another person

- Taking an examination for another person

- Any act designed to give unfair advantage to a student or the attempt to commit



# Where to go for help ?

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- Ask questions in class
- Ask questions outside class
  - Classmates and friends
- Attend office hours
  - Send Dr. Kun Suo emails or leave message on teams
- Search on the web
  - Stand on the shoulder of giants

