Introduction to Computational Thinking and Python Programming

Instructor: Sarom Leang, PhD (Teacher/Professor)

Assistant: Romin Katre

Innovation Hall 203

Pronouns

- Instructor: Sarom Leang, Ph.D. (Teacher/Professor/Instructor)
- Assistant: Romin Katre

Schedule

- 10:00 AM – 10:15 AM (Homeroom)
- **10:15 AM** – **11:35 AM** (G1)
- 11:40 AM – 12:35 PM (Lunch)
- **12:40 PM** – **02:00 PM** (G2)

Student Expectations

- **NO FOOD**
- **NO DRINKS** (on the table)
- Be respectful to individuals and property
- Be open to learning
- Be open to not understanding
- Be patient with yourself
- Ask questions
- Explore
- **Embrace failure**

G1

- If we start class 5 minutes early (e.g., at 10:10 AM), then the class will be dismissed to lunch 5 minutes early at 11:30 AM.

G2

- If you arrive in your seat by 12:40 PM then you have the option to finish your lunch in the hallway – if needed.

Course Overview

- This course introduces the fundamental building blocks of computational thinking and computer programming using the Python language.
- Upon successful completion of this course, students will be able to:
  - Improve their problem-solving skills
  - Write, read, and execute Python code using basic data types and operators

Course Overview (cont.)

Exploratory Topics

- ~~Session #1 – October 23, 2023~~
  - ~~Entrance Survey~~
  - ~~How Computers Work~~
- Session #2 – December 2, 2023
  - Parallel Computing
- Session #3 – February 10, 2024
  - Generative Artificial Intelligence
- Session #4 – March 23, 2024
  - Quantum Computing
- Session #5 – April 20, 2024
  - Future of Computing
  - Exit survey

Topics

- Algorithms and Problem Solving
- Debugging and Troubleshooting
- Loops
- Algorithms and Syntax
- Variables and Conditionals
- Variable Arithmetic
- Conditionals (If/Else)
- Compound Conditionals

Entrance Survey (Results)

Question	G1	G2
Computer access at home?	100% Yes	96% Yes
Computer access at school?	100% Yes	100% Yes
Taken this course before?	3 - Yes	2 - Yes
Previous computer programming experience?	7 - Yes	13 - Yes
Grade level	100% - 9th	96% - 9th
Keyboard is an **input** device	92%	52%
CPU is known as the brain of a computer	78%	64%
A **speaker** is an example of an output device.	74%	56%
Hard disk, **floppy disk**, **USB disk** are examples of storage devices.	92%	68%
Storage device can hold data and programs even it the power is off.	91%	84%
Internet, a worldwide collection of networks that connect institutions and people.	74%	72%
A **supercomputer** is the fastest, most powerful computer.	70%	60%
Data is raw, unprocessed facts including text, numbers, images, and sounds.	70%	72%
Computer can execute code in **machine language**.	17%	24%

Use of Class Time

- Course is capped at 60 seats
- Each seat costs $50
- EIP has invested $3000 to offer this course
- Bring in schoolwork to occupy yourself

Supercomputing Conference

SC23

Denver, CO | i am hpc.

HPC = high performance computing

High Performance

Example	General	High	Metrics
Cars	Consumer e.g., Ford Fusion	Performance e.g., Formula-1, Koenigsegg Agera	• Speed • Torque (force) • Horse-power (force x distance)
Computers	Consumer e.g., Alienware Area 51	Performance e.g., HPE Cray Frontier	• Operations per second • Number of CPUs • Aggregate memory

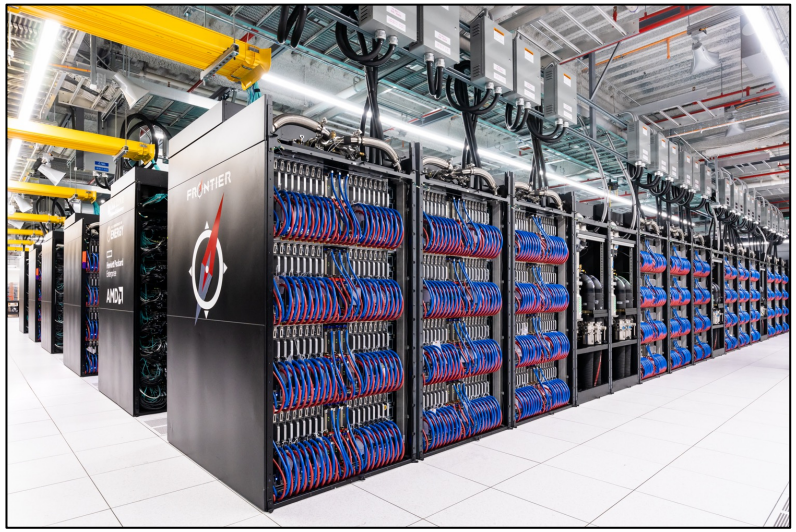
High Performance Computing

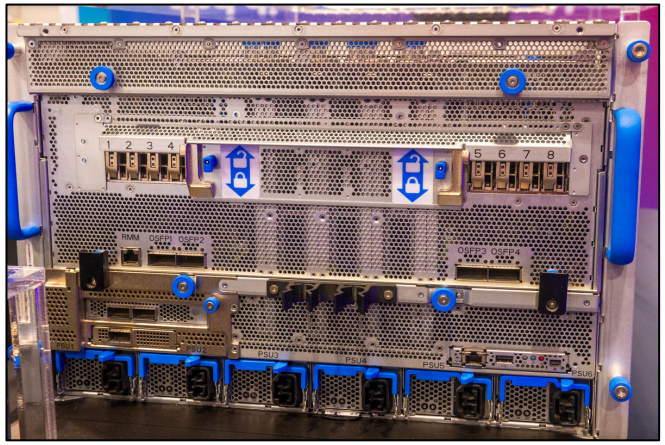
Specs	Alienware Area 51	IBM Summit (4,608 nodes) #7
CPU	1x AMD Ryzen 2950X 16-core/32-threads 4.4 GHz	2x IBM Power9 22-core/96-threads 3.07 GHz
GPU	2x NVIDIA RTX 2080 Ti	6x NVIDIA Volta V100
Memory	64 GB	512 GB
Floating point operations per second (FLOPS)	700 GFLOPS	42000 GFLOPS (per node) 42 TFLOPS (per node) **60x** 200000000 GFLOPS (total) 200 PFLOPS (total) **285,714x**

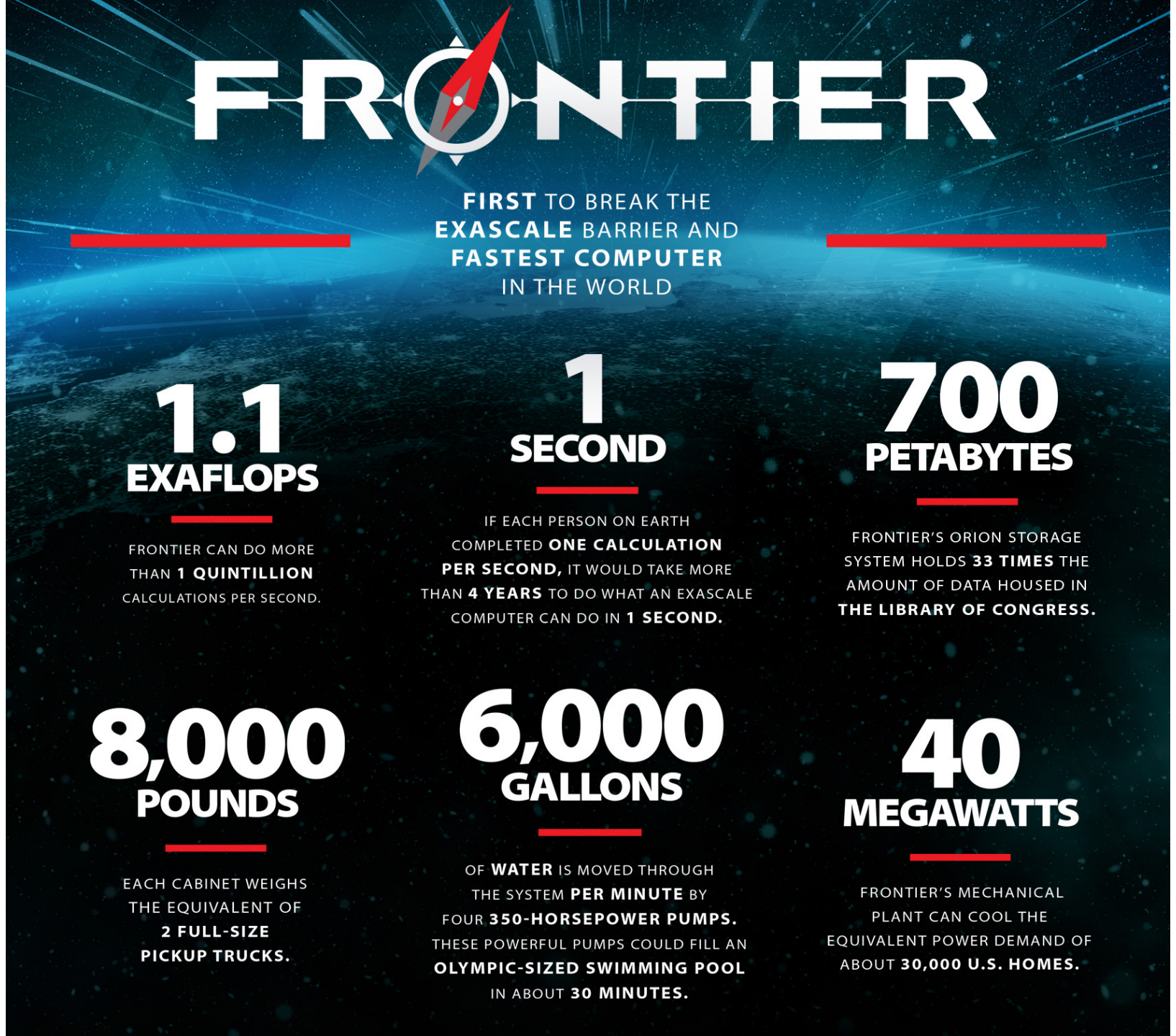
Top 5 Supercomputers

Rank	Country / System	Rpeak (PFlops/s)
1	**USA** / Frontier AMD Optimized 3rd Generation EPYC 64C 2GHz, AMD Instinct MI250X, Slingshot-11, HPE	1,685
2	**USA** / Aurora Intel Xeon CPU Max 9470 52C 2.4 GHz, Intel Data Center GPU, Slingshot-11, Intel	1,059
3	**USA** / Eagle NVIDIA H100, NVIDIA Infiniband NDR, Microsoft	846
4	**Japan** / Fugaku A64FX 48C 2.2GHz, Tofu interconnect D, Fujitsu	537
5	**Finland** / LUMI AMD Optimized 3rd Generation EPYC 64C 2GHz, AMD Instinct MI250X, Slingshot-11, HPE	531

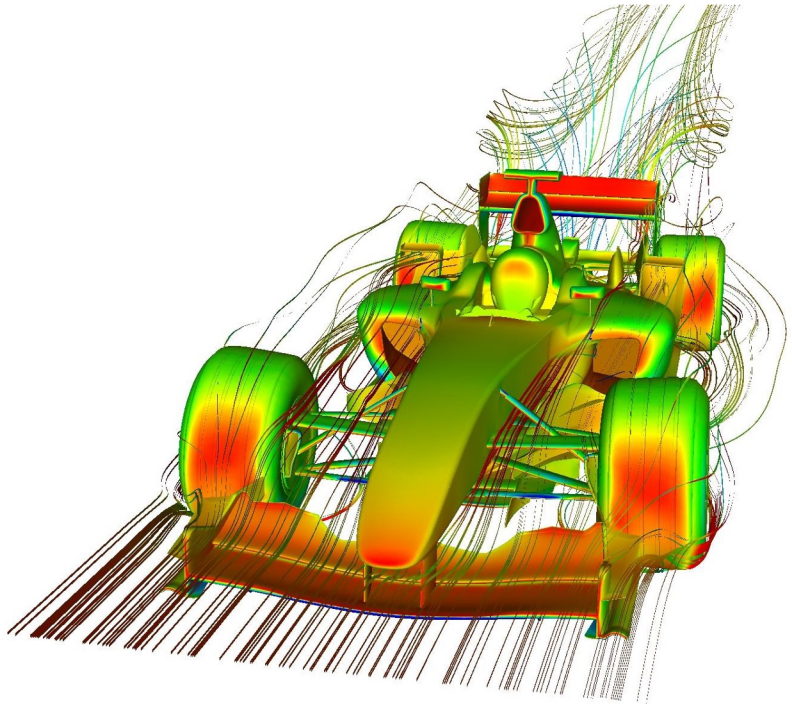
Top 5 Supercomputers

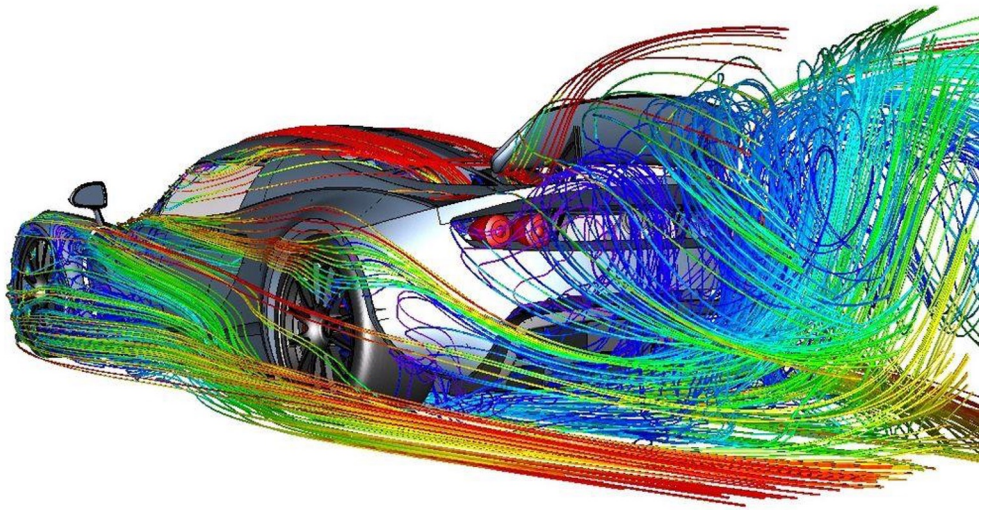





FRONTIER
FIRST TO BREAK THE EXASCALE BARRIER AND FASTEST COMPUTER IN THE WORLD
1.1 EXAFLOPS
FRONTIER CAN DO MORE THAN 1 QUINTILLION CALCULATIONS PER SECOND.
1 SECOND
IF EACH PERSON ON EARTH COMPLETED ONE CALCULATION PER SECOND, IT WOULD TAKE MORE THAN 4 YEARS TO DO WHAT AN EXASCALE COMPUTER CAN DO IN 1 SECOND.
700 PETABYTES
FRONTIER'S ORION STORAGE SYSTEM HOLDS 33 TIMES THE AMOUNT OF DATA HOUSED IN THE LIBRARY OF CONGRESS.
8,000 POUNDS
EACH CABINET WEIGHS THE EQUIVALENT OF 2 FULL-SIZE PICKUP TRUCKS.
6,000 GALLONS
OF WATER IS MOVED THROUGH THE SYSTEM PER MINUTE BY FOUR 350-HORSEPOWER PUMPS. THESE POWERFUL PUMPS COULD FILL AN OLYMPIC-SIZED SWIMMING POOL IN ABOUT 30 MINUTES.
40 MEGAWATTS
FRONTIER'S MECHANICAL PLANT CAN COOL THE EQUIVALENT POWER DEMAND OF ABOUT 30,000 U.S. HOMES.

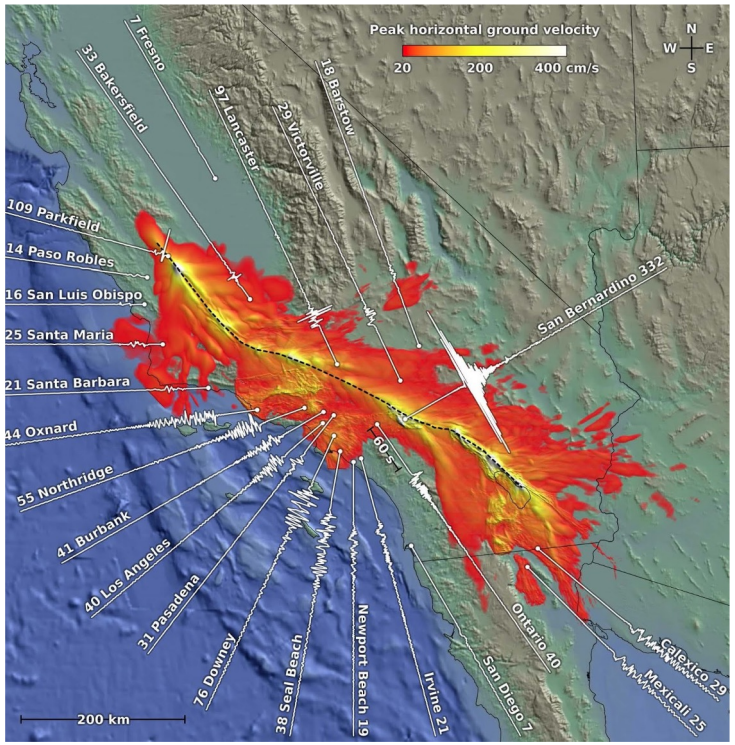
Supercomputing Applications

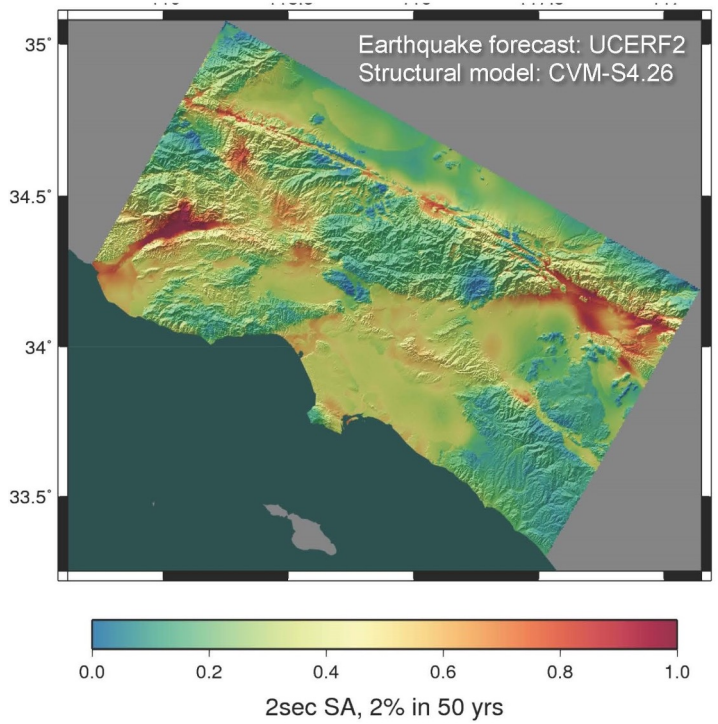




Computational Fluid Dynamics (CFD)

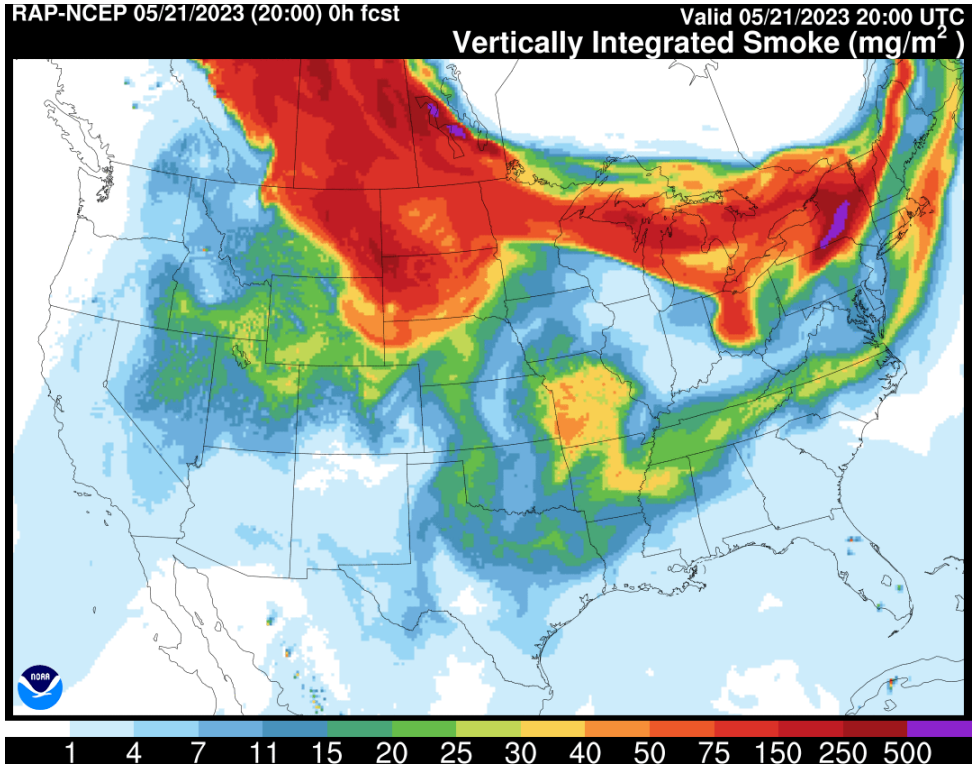
Supercomputing Applications

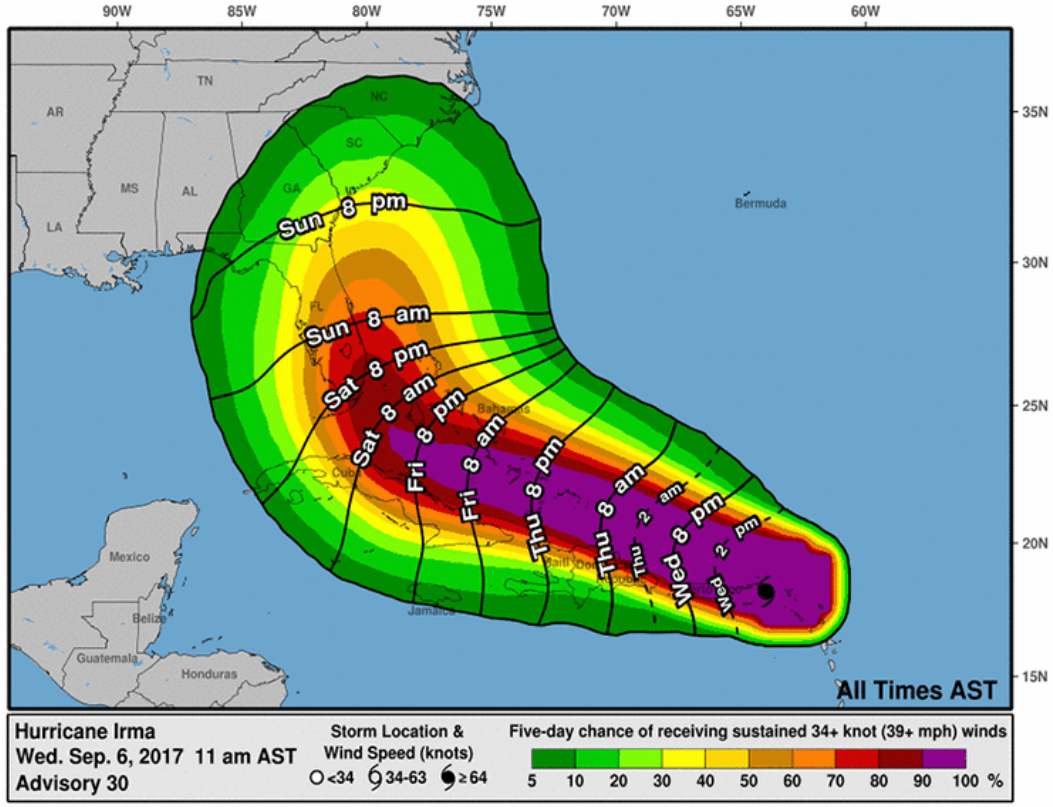




Seismic Modeling

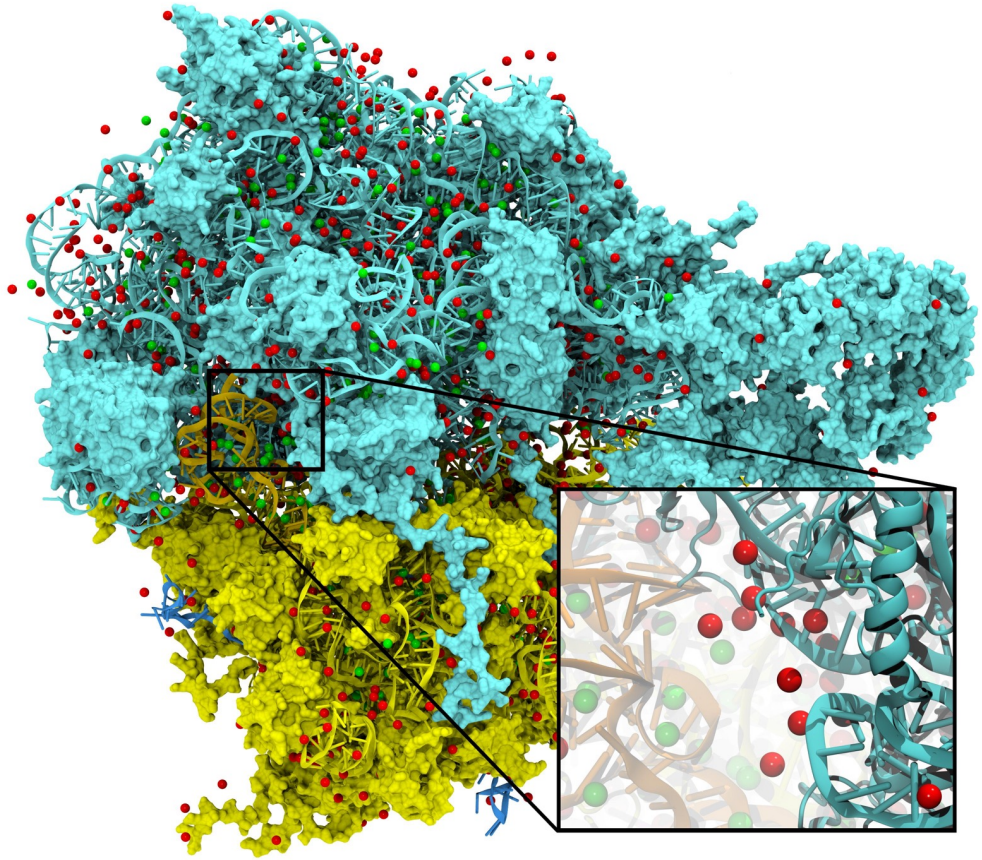
Supercomputing Applications

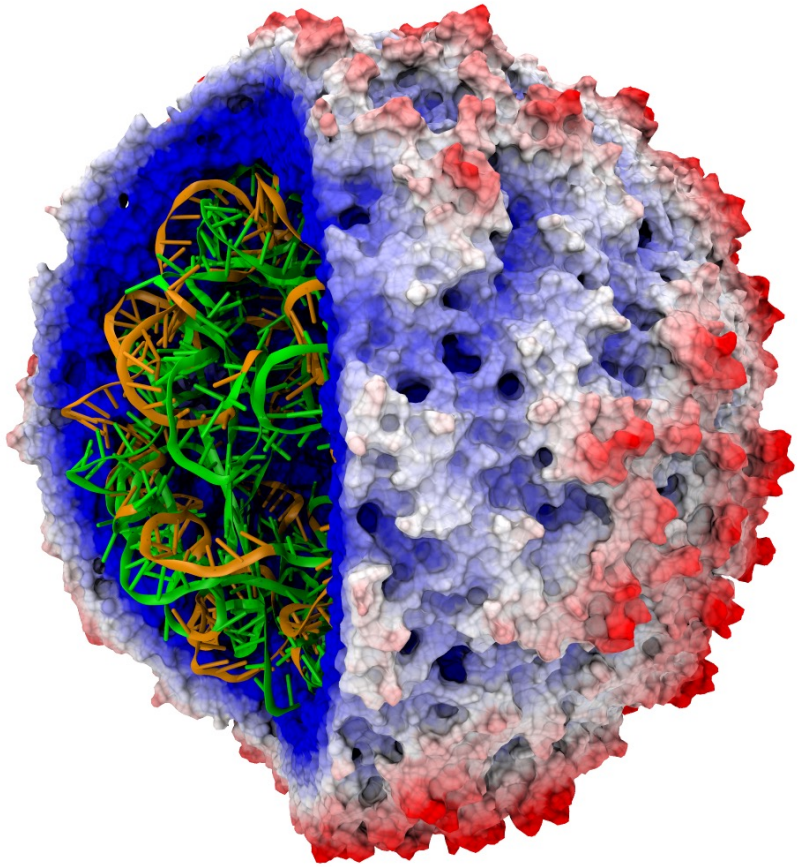




Weather Modeling

Supercomputing Applications





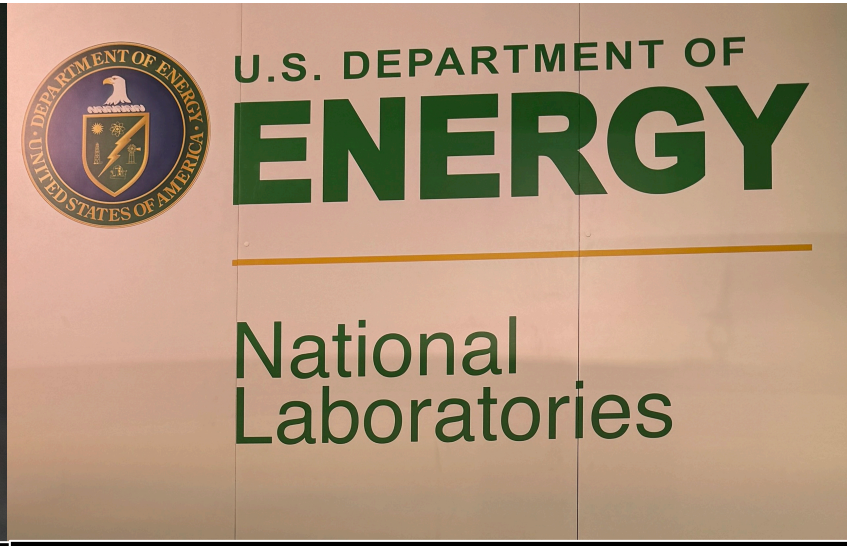
Molecular Simulations

Who is Interested in HPC?

Who is Interested in HPC?

Generative AI

Dr. Hakeem Oluseyi, Astrophysicist



Featured Presentation

Meow Wolf Art Installation

Networking Receptions

Exercise – Human Supercomputer?

- **Challenge**: 500 piece jigsaw puzzle
- **Goal**: Get the most number of correctly connected pieces within the established time frame
- We will assign groups of (or close to):
  - 1
  - 2
  - 4
  - 8
  - 16

Exercise – Human Supercomputer?

- **Challenge**: 500 piece jigsaw puzzle
- **Goal**: Get the most number of correctly connected pieces within the established time frame
- We will assign groups of (or close to):
  - 1
  - 2
  - 4
  - 8
  - 16

# Solvers	G1 (# connected)	G2 (# connected)
1		
2		
4		
8		
16		

Before You Begin

- Spend 5 minutes to strategize your approach.
- Assign 1 person as the leader of your group.
- The group leader will assign tasks the other members of the group.

Discussion – Human Supercomputer

- Expected results?
- Approaches/strategies?
- Benefits of working in your environment?
- Challenges of working in your environment?
- What do you expect to happen to the results if the number of puzzle pieces increased (more puzzle pieces)?
- What do you expect to happen to the results if the number of puzzle pieces decreased (less puzzle pieces)?

Computational Thinking

- Decomposition – breaking up the problem into smaller tasks
  - Sorting
    - Identifying edge pieces
    - Identifying similar colored pieces
  - Connecting
    - Edge pieces
    - Different sections of the puzzle based on color pattern
  - Combining
    - Joining together connected pieces from different sections of the puzzle

Computational Thinking

- Algorithm – your approach to solving a problem or set of problems
  - Consist of a sequence of instructions
    1. Flip all puzzle pieces upwards
    2. Sort edge pieces from non-edge pieces
    3. Sort pieces based on color similarity
    4. Connect edge pieces
    5. Connect pieces based on color similarity
    6. Joining connected pieces
    7. Connect pieces based on shape similarity