Introduction to Computer Programming and Computational Thinking

November 23, 2019

Session 2

Innovation 129

Supercomputing Conference

HPC = high performance computing

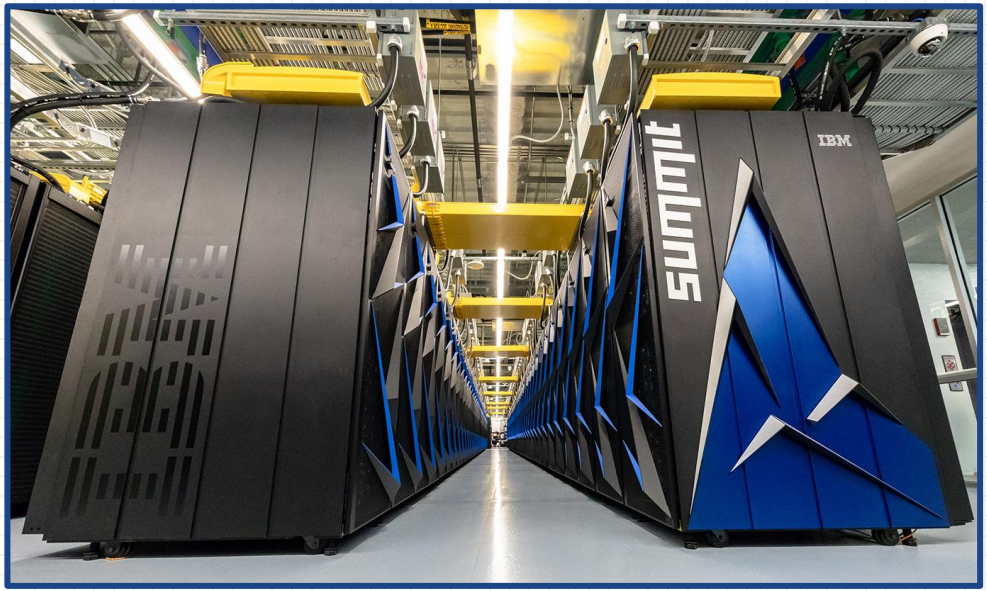
High Performance

Example	General	High	Metrics
Cars	Consumer e.g., Ford Fusion	Performance e.g., Formula-1, Koenigsegg Agera	• Speed • Torque • Horse-power
Computers	Consumer e.g., Alienware Area 51	Performance e.g., IBM Summit	• Operations per second • Number of CPUs • Aggregate memory

High Performance Computing

Specs	Alienware Area 51	IBM Summit (4,608 nodes)
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**

IBM Summit

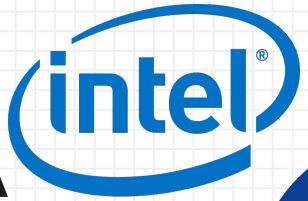


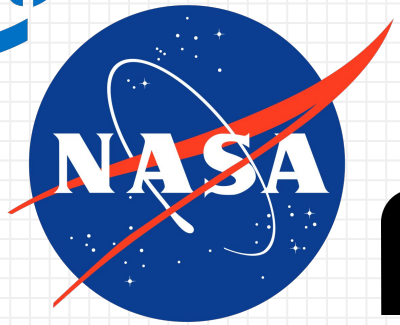
TOP 500
The List.

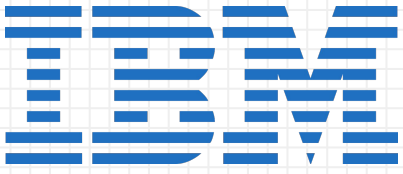
https://www.top500.org/lists/2019/11/

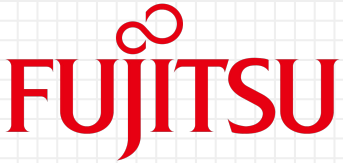
STEM FUSION!

Who is interested in HPC?









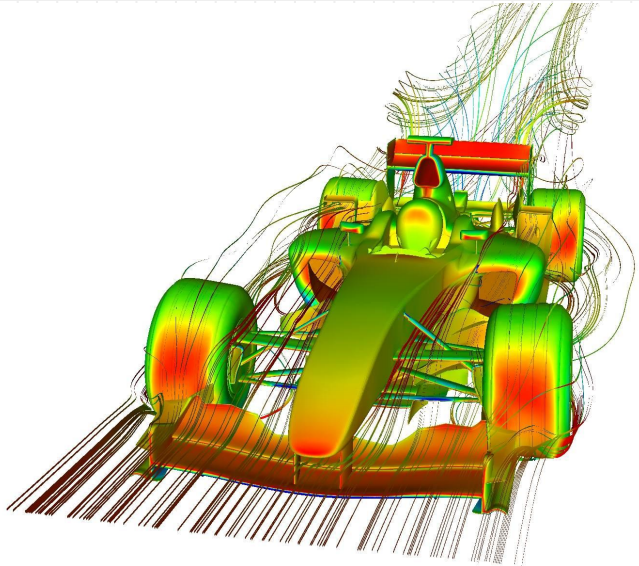

NVIDIA

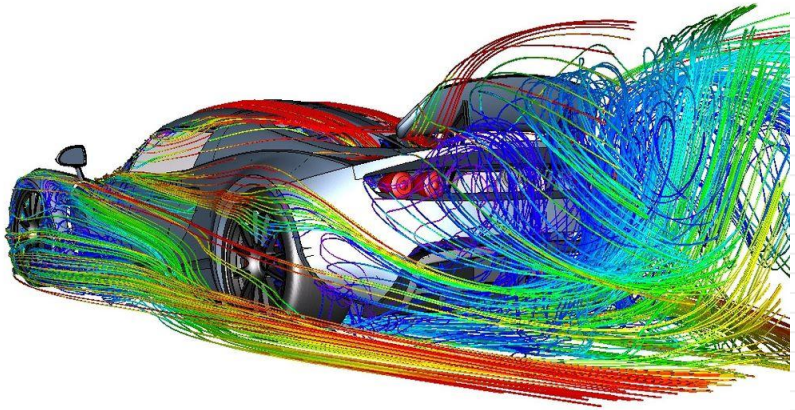

intel
PURDUE


Hewlett Packard Enterprise
BEYOND SUPER
Hewlett Packard Enterprise
IBM


Google Cloud
TACC
FRONTERA
Code Lab Challenge

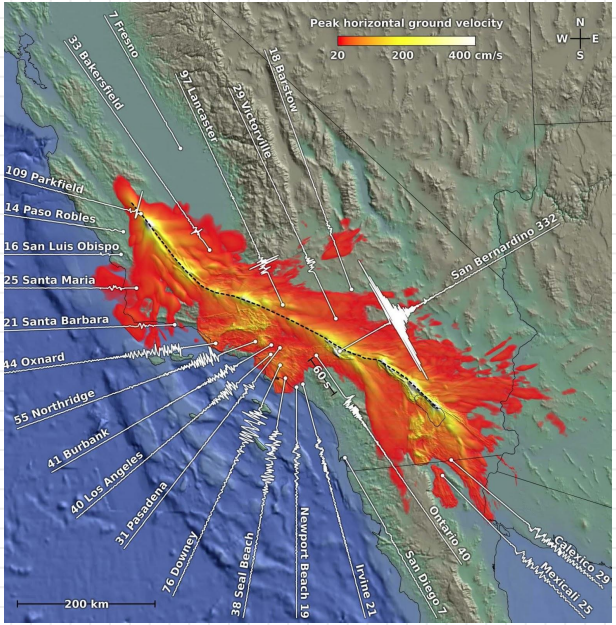
What types of problems are explored with HPC?

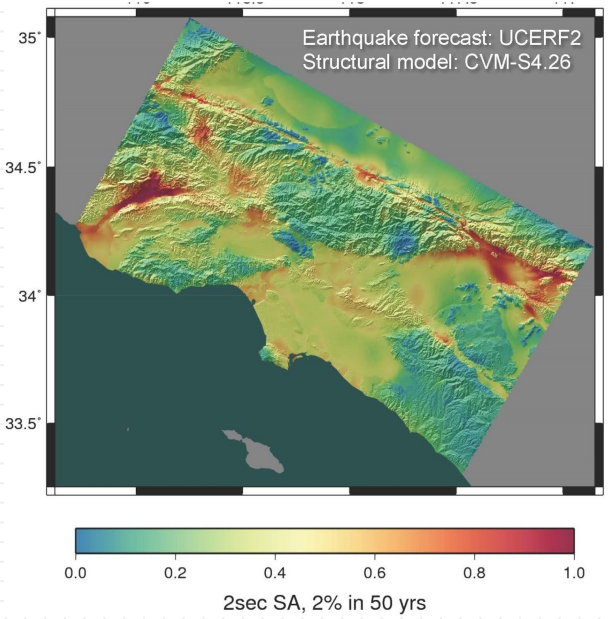




Computational Fluid Dynamics (CFD)

What types of problems are explored with HPC?





Simulations

Recap of Session 1: Hello World

- ✘ Install ATOM editor
- ✘ Install Python
  - ✗ **Add Python 3.8 to PATH** during the installation
- ✘ Open up a blank document in the ATOM editor
- ✘ Type: `print("Hello World!")`
- ✘ Save the file as **hello.py** into your **Documents** folder
- ✘ Open up the command prompt
- ✘ Execute your script:
  - ✗ Switch into the directory containing hello.py
    - `cd Documents`
  - ✗ Call the python program to interpret and execute your code
    - `python hello.py`

Basic Data Types in Python

- ✘ **Integer**
- ✘ **Floating-point**
- ✘ **String**
- ✘ Boolean
- ✘ Array
- ✘ List
- ✘ Tuple
- ✘ Dictionary

Integer

In Python, any number **without** a decimal is considered an integer:

```
1
100
10000000000000000000000000001
```

Floating-point

In Python, any number **with** a decimal is considered an floating-point:

```
1.0
100.0
10000000000000000000000000001.0
```

Math Operators in Python

Operation	Result
`x + y`	Sum of `x` and `y`
`x - y`	Difference of `x` and `y`
`-x`	Change the sign of x
`x * y`	Product of `x` and `y`
`x / y`	Quotient of `x` and `y`
`x // y`	Quotient from floor division of `x` and `y`
`x % y`	Remainder (modulus) of `x / y`
`x ** y`	`x` to the `y` power

Math Operators in Python

Let x = 4 and y = 2	Result
`print(x + y)`	
`print(x - y)`	
`print(-x)`	
`print(x * y)`	
`print(x / y)`	
`print(x // y)`	
`print(x % y)`	
`print(x ** y)`	

Python `type()` function

Returns the type of the argument passed as a parameter.

```
print(type(1))
print(type(1.0))
```

Math Operators in Python

Let x = 4 and y = 2	Result
`print(type(x + y))`	
`print(type(x - y))`	
`print(type(-x))`	
`print(type(x * y))`	
`print(type(x / y))`	
`print(type(x // y))`	
`print(type(x % y))`	
`print(type(x ** y))`	

Math Operators in Python

Let x = 4.0 and y = 2	Result
`print(type(x + y))`	
`print(type(x - y))`	
`print(type(-x))`	
`print(type(x * y))`	
`print(type(x / y))`	
`print(type(x // y))`	
`print(type(x % y))`	
`print(type(x ** y))`	

Operator Precedence

In Python, operators will be evaluated in order of precedence.

Order of operation - PEDMAS

1. Parentheses ( )
2. Exponent **
3. Multiplication *
4. Division / // %
5. Addition +
6. Subtraction -

After PEDMAS, order goes left to right.
Use parentheses to override order.

Operator Precedence

```
1 + 2 * 4 = ?
(1 + 2) * 4 = ?
5 + (4 - 2) * 2 + 4 % 2 - 4 // 3 - (5 - 3) / 1 = ?
```

Operator Precedence

Order of operation - PEDMAS

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```
1 + 2 * 4 = ?

(1 + 2) * 4 = ?

5 + (4 - 2) * 2 + 4 % 2 - 4 // 3 - (5 - 3) / 1 = ?
```

Operator Precedence

```
5 + (4 - 2) * 2 + 4 % 2 - 4 // 3 - (5 - 3) / 1 = ?
5 + (4 - 2) * 2 + 4 % 2 - 4 // 3 - (5 - 3) / 1 = ?
5 + 2 * 2 + 4 % 2 - 4 // 3 - 2 / 1 = ?
5 + 2 * 2 + 4 % 2 - 4 // 3 - 2 / 1 = ?
5 + 4 + 4 % 2 - 4 // 3 - 2 / 1 = ?
5 + 4 + 4 % 2 - 4 // 3 - 2 / 1 = ?
5 + 4 + 0 - 1 - 2 = ?
5 + 4 + 0 - 1 - 2 = ?
9 + 0 - 1 - 2 = ?
9 - 1 - 2 = ?
8 - 2 = ?
6
```

String

In Python, a string is a sequence of characters.

```
print("Early Identification Program")
print('Early Identification Program')
print("""Early Identification Program""")
print("""Early
Identification
Program""")
```

String Methods

Method	Result
String.capitalize()	Converts first character to capital letter
String.upper()	Returns uppercased string
String.lower()	Returns lowercased string
String.swapcase()	Returns string with casing swapped
String.count(*substring*)	Returns occurrences of substring within string

String Methods

```
"Early Identification Program".capitalize()
"Early Identification Program".upper()
"Early Identification Program".lower()
"Early Identification Program".swapcase()
"Early Identification Program".count("ti")
```

Type Casting (Type Conversion)

```
print(type(1))
print(type(1.0))
print(type('1'))
```

Type Casting (Type Conversion)

```
print(float(1))
print(int(1.0))
print(str(1.0))
print(str(1)+1)
print(str(1)+'1')
print(int(1.0)+'1')
print(int(1.0)+int('1'))
```