PD_10_Kushagra Suryawanshi

HPC LAB ASSIGNMENT 2

Title:
Application Case Study of HPC

Aim:
Demonstration of an application case study of High-Performance Computing

Objective:
To demonstrate an application case study of High-Performance Computing and its importance in the real world.

Theory:

Write the technical concepts of the selected application of HPC [High Performance Computing]

a) A supercomputer is a large array of smaller computers and processing equipment that are aggregated to make one large computer.
b) They are built for the purpose of solving problems too complex for an ordinary desktop or workstation to process.
c) As a result, they utilise large amounts of computing power harnessed from each individual node.
d) This method is typically referred to as High-Performance Computing (HPC). HPC can be used to run intricate models for forecasting the weather. This is commonly known as Numerical Weather Prediction (NWP) where weather data is processed by the computer for modelling purposes.
e) For weather forecasting, and before the supercomputer processes data, the data needs to be obtained from somewhere.
f) Devices such as radar, weather stations, satellite images, profilers, and other sensors measure different atmospheric parameters, collect data and send the data to a central database for storage (e.g. NAS – Network Attached Storage) that can then be used by the supercomputer. After that, they are sent to an archive for long term storage.
g) NWP utilizes supercomputing to calculate the equations that define the flow of fluids in the atmosphere and oceans. The supercomputer implements the method of NWP by translating the governing equations of dynamical meteorology, numerical methods, parameterized physical processes, and initial and boundary conditions into computer code which is then analysed and determined over a specific geographic domain.

FAQs:

1.Write Scope of High-Performance Computing in Medical Domain.

Ans:

a) Structured and unstructured data are both increasing exponentially. To make sense and use of this data, more and more medical solutions and devices are incorporating AI and computing at all levels of the hierarchy.

For example, a test for a pathogen deployed at a rural health clinic may have the internal intelligence to provide a result for a patient almost instantly. However, the clinic and larger health systems may also need access to this data to combine with their own in order to understand spread characteristics and communicate the latest in diagnostic advice to the practitioner. In turn, this data may also need to be further anonymized and combined securely and privately with data of multiple types from sources across the country, or even the world, for analysis and development of better drugs and treatment plans

b) HPC is helping to advance medical research in other ways. For example, it has led to the creation of a non-invasive robotic arm controlled by the brain—a potentially life-changing breakthrough for people living with paralyzed limbs. HPC is also accelerating drug discovery for many diseases.

2. List top 3 Supercomputers of the World with their specification from ww.top500.org.

Ans:

1. SUPERCOMPUTER FUGAKU - SUPERCOMPUTER FUGAKU, A64FX 48C 2.2GHZ:

Site:	RIKEN Center for Computational Science
System URL:	https://www.r-ccs.riken.jp/en/fugaku/project
Manufacturer:	Fujitsu
Cores:	7,630,848
Memory:	5,087,232 GB
Processor:	A64FX 48C 2.2GHz
Interconnect:	Tofu interconnect D
Performance	
Linpack Performance (Rmax)	442,010 TFlop/s
Theoretical Peak (Rpeak)	537,212 TFlop/s
Nmax	21,288,960
HPCG [TFlop/s]	16,004.5
Power Consumption	
Power:	29,899.23 kW (Optimized: **26248.36** kW)
Power Measurement Level:	2
Software	
Operating System:	Red Hat Enterprise Linux
Compiler:	FUJITSU Software Technical Computing Suite V4.0
Math Library:	FUJITSU Software Technical Computing Suite V4.0

MPI:	FUJITSU Software Technical Computing Suite V4.0

2. Summit - IBM Power System AC922:

Site:	DOE/SC/Oak Ridge National Laboratory
System URL:	http://www.olcf.ornl.gov/olcf-resources/compute-systems/summit/
Manufacturer:	IBM
Cores:	2,414,592
Memory:	2,801,664 GB
Processor:	IBM POWER9 22C 3.07GHz
Interconnect:	Dual-rail Mellanox EDR Infiniband
	Performance
Linpack Performance (Rmax)	148,600 TFlop/s
Theoretical Peak (Rpeak)	200,795 TFlop/s
Nmax	16,473,600
HPCG [TFlop/s]	2,925.75
	Power Consumption
Power:	10,096.00 kW (Submitted)
Power Measurement Level:	3
	Software
Operating System:	RHEL 7.4
Compiler:	XLC, nvcc
Math Library:	ESSL, CUBLAS 9.2
MPI:	Spectrum MPI

3. SIERRA - IBM POWER SYSTEM AC922:

Site:	DOE/NNSA/LLNL
System URL:	https://hpc.llnl.gov/hardware/platforms/sierra
Manufacturer:	IBM / NVIDIA / Mellanox
Cores:	1,572,480
Memory:	1,382,400 GB
Processor:	IBM POWER9 22C 3.1GHz
Interconnect:	Dual-rail Mellanox EDR Infiniband
	Performance
Linpack Performance (Rmax)	94,640 TFlop/s
Theoretical Peak (Rpeak)	125,712 TFlop/s
Nmax	11,902,464
HPCG [TFlop/s]	1,795.67
	Power Consumption
Power:	7,438.28 kW (Submitted)
Power Measurement Level:	2

	Software
Operating System:	Red Hat Enterprise Linux
Compiler:	IBM XLC
Math Library:	ESSL, CUBLAS 9.2
MPI:	IBM Spectrum MPI

3.What is Quantum Computing and its relevance for HPC?

Ans: 1.

a) Quantum computing relies upon quantum theory, which deals with physical phenomena at the nano-scale. One of the most important aspects of quantum computing is the quantum bit (Qubit), a unit of quantum information that exists in two states (horizontal and vertical polarization) at the same time, thanks to the superposition principle of quantum physics.

b) While quantum computing does not utilize a faster clock-speed than classical computing, it is much faster than traditional computing infrastructure for solving certain problems as quantum computers can handle exponentially larger data sets. Accordingly, quantum computing is well-positioned to support certain industry verticals and solve certain problems such as cybersecurity and cryptocurrencies that rely upon prime factoring.

2. Relevance of Quantum computing for HPC:

a) Searching unstructured data via traditional methods requires brute force. Because the data is unstructured, the traditional algorithm would need to look at each entry in the database.

b) This would mean the number of steps required to search the entire database would be O(n) where n is the size of the database.

c) The quantum algorithm takes a different approach. This approach is to first put a series of qubits equal to the number of input bits in the index in superposition.

d)This means that these qubits have an equal opportunity to collapse to every answer when observed. The number of steps it takes to achieve this result is $\sqrt{n}$ where n is the size of the database.

e) This makes the algorithm $O(\sqrt{n})$ & we can see that how it can be extremely useful.

Conclusion: In this lab, we have learnt various application of HPC and need of HPC in various domain