



Oregon State  
University



**SC23**  
Denver, CO | i am hpc.

# Automatically Testing Correctness of HPC Scientific Applications



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# Why Test HPC Scientific Applications?



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Improve  
application quality

Accuracy & Reliability

Reproducibility

Error Prevention

Verification & Validation



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Prevent resource  
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Performance  
Optimization

Resource Efficiency



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Improve application quality

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Reproducibility

Error Prevention

Verification & Validation

Prevent resource wastage

Performance Optimization

Resource Efficiency

Ease software management

Debugging and Maintenance

Code Evolution

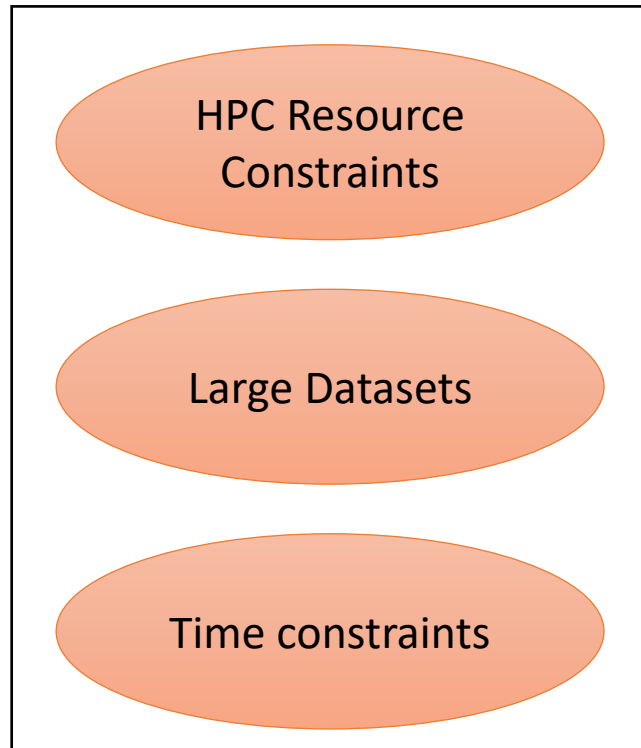
Documentation & Collaboration

Compliance & Regulation



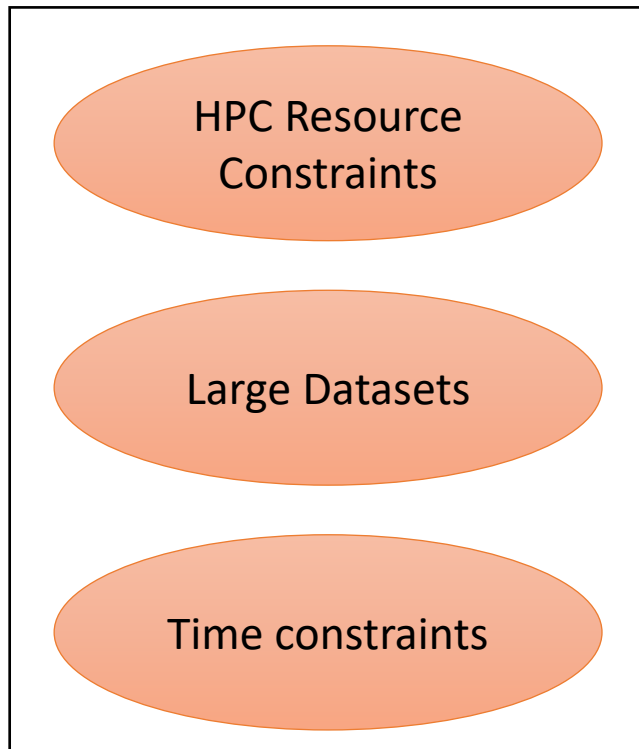
# Challenges in Testing HPC Scientific Applications

Resource  
limitations

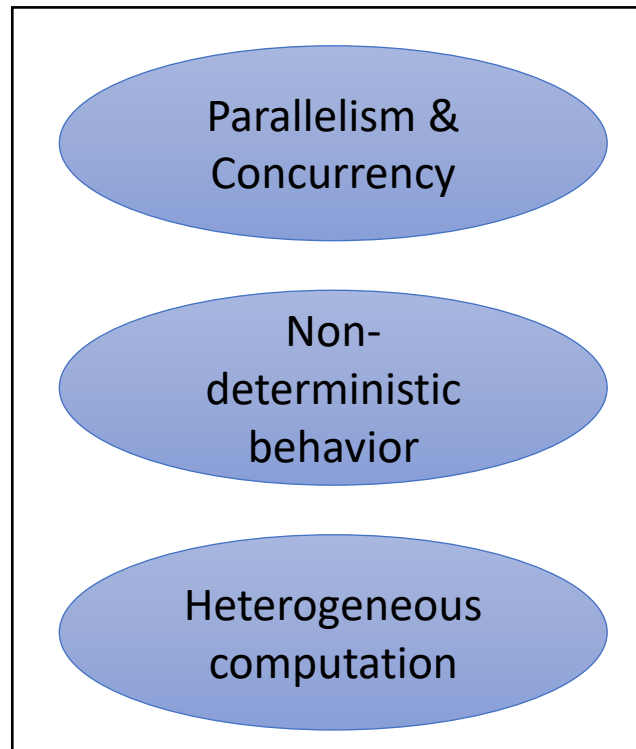


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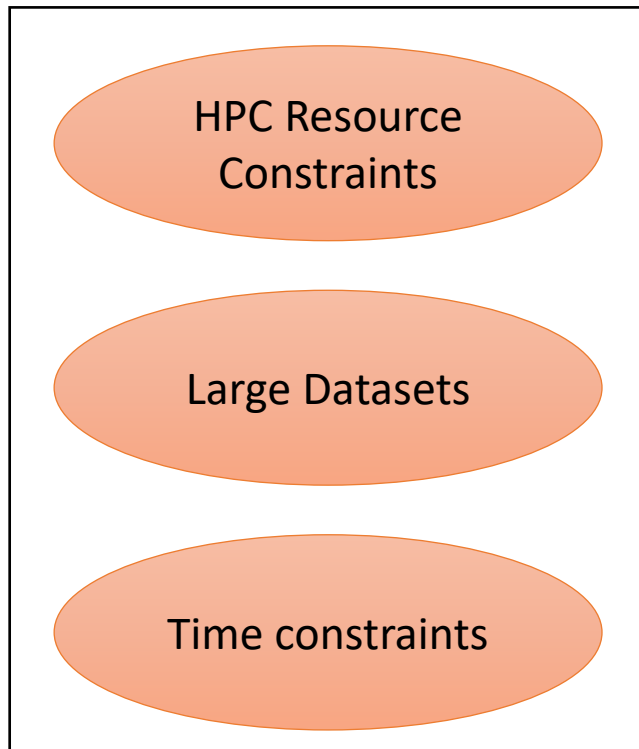


Inherent code complexity

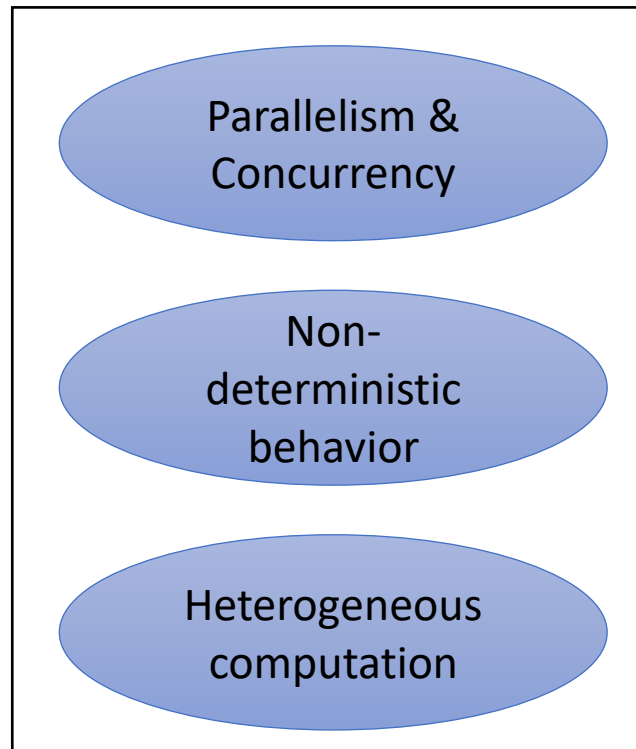


# Challenges in Testing HPC Scientific Applications

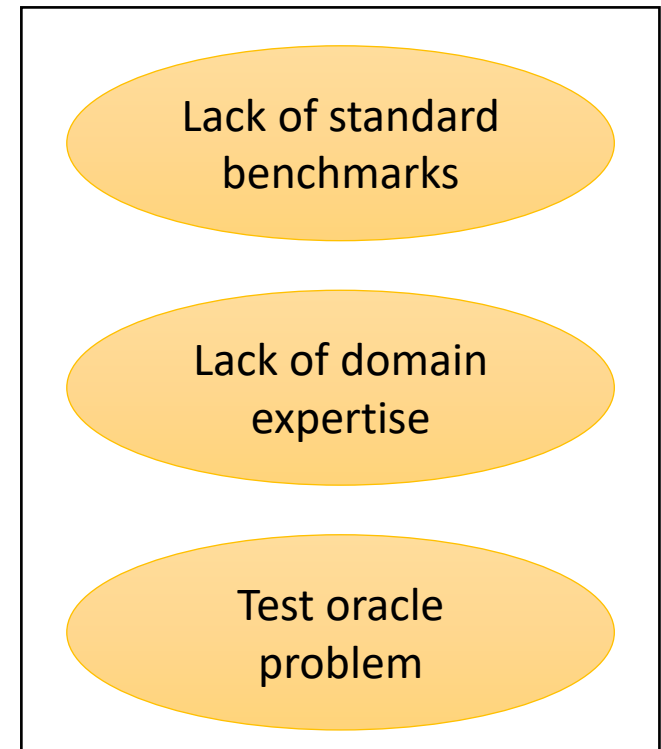
Resource limitations



Inherent code complexity

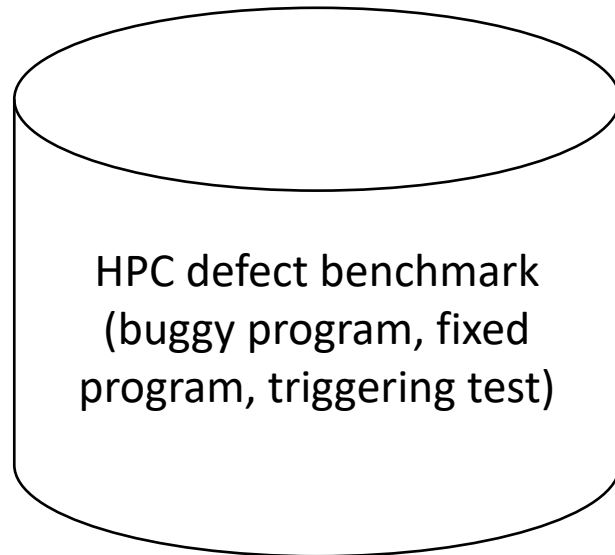


Oracle absence





# Automatically Detecting Memory Bugs in HPC Scientific Applications



Incorrect synchronization between host and device due to API misuse

Accessing device space from host

Missed synchronization between host and device

Concurrent modification of shared variable from device and host

Incorrect copying of data between host and device

Use of stale data

Missed copying of data between host and device

Data race



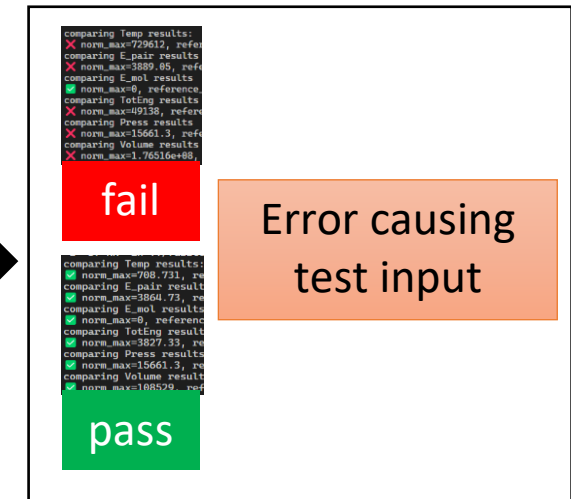
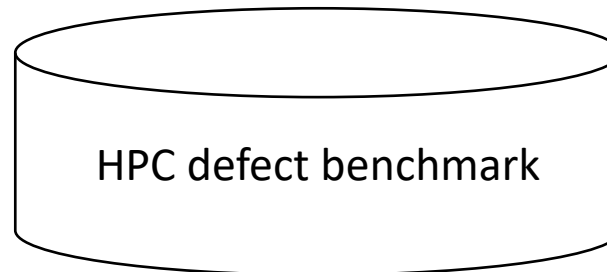
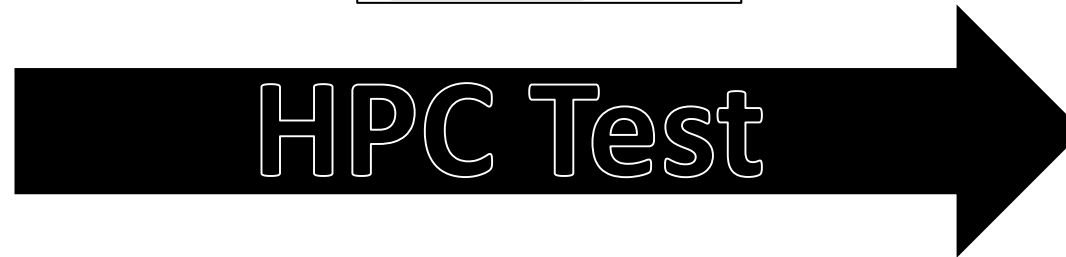
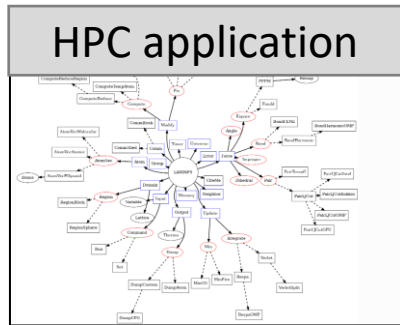
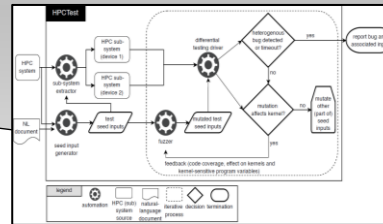
# Automatically Detecting Memory Bugs in HPC Scientific Applications

Large Language Model

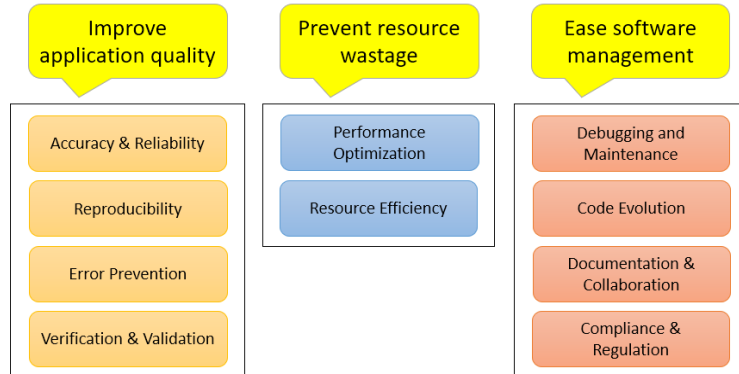
Fuzzing

Differential Testing

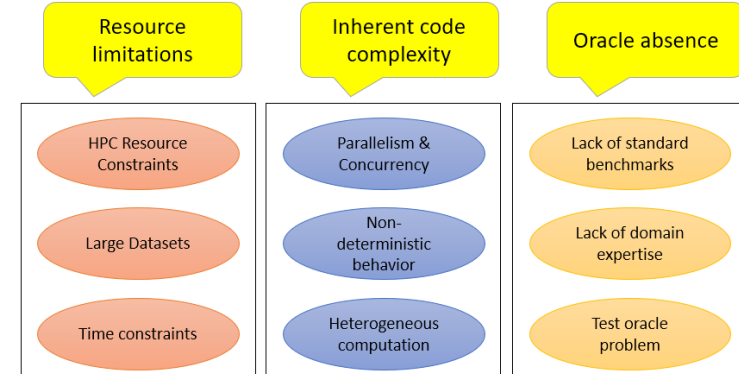
Program Analysis



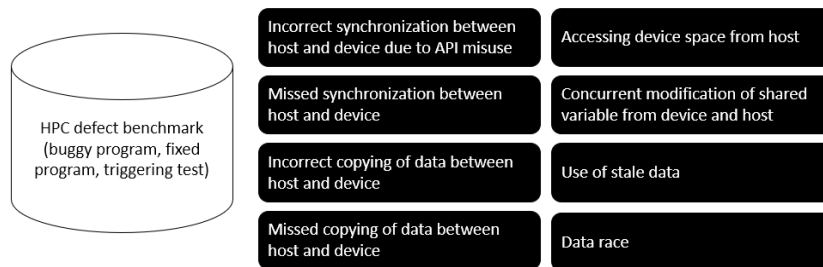
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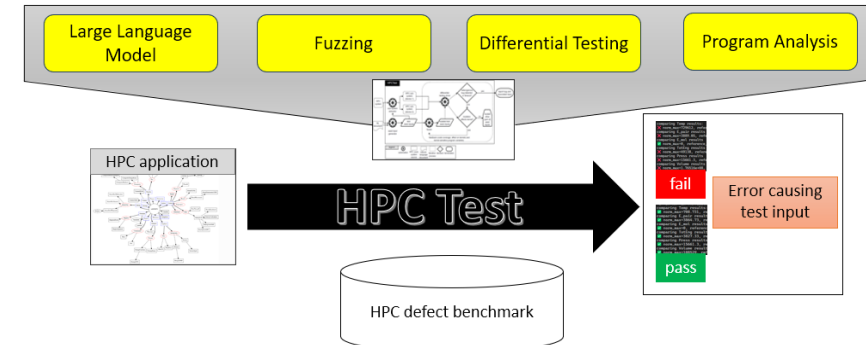
## Challenges in Testing HPC Scientific Applications



## Automatically Detecting Memory Bugs in HPC Scientific Applications



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