Mean, Variance, Standard Deviation

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1 Introduction

STAPL (Standard Template Adaptive Parallel Library) is the parallel version of the C++ STL, created in Parasol Lab at Texas A&M University. Parallel computing involves distributing the work required to run a program over several processors to decrease the run time. Test cases are created to evaluate the performance of basic algorithms and demonstrate their usability. This particular test case calculates the average time of an algorithm that finds the mean, variance, and standard deviation of a vector of floating-point numbers.

2 Design

The general design of the code is as follows:

```
create and fill vector/view (parse command line arguments for vector size
and filename)
calculate mean by summing the elements of the vector and dividing by the
size
calculate variance by squaring each element minus the mean, adding them,
and dividing by the size of the vector minus 1
calculate standard deviation by taking the square root of the variance
output results
```

Algorithm 1: Mean, Variance, Standard Deviation

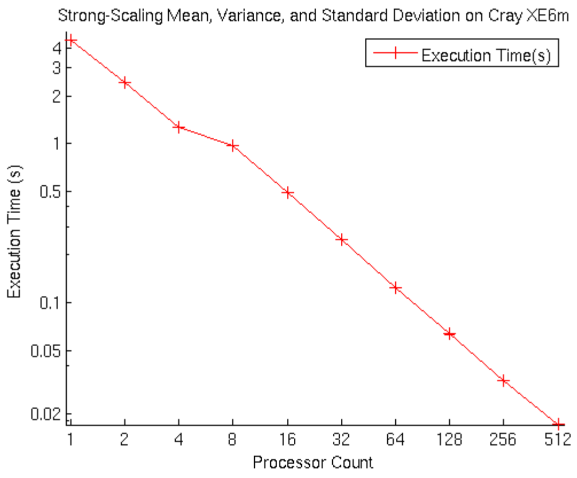
3 STAPL Components

The following parts of the STAPL library were used:
vector/vector view: store elements of data set to be processed
accumulate: sums all the elements of the vector
stream: wrapper for an STL ifstream that is used to create an input stream to read from a file
serial_io: successively applies input operations to elements of the input view on

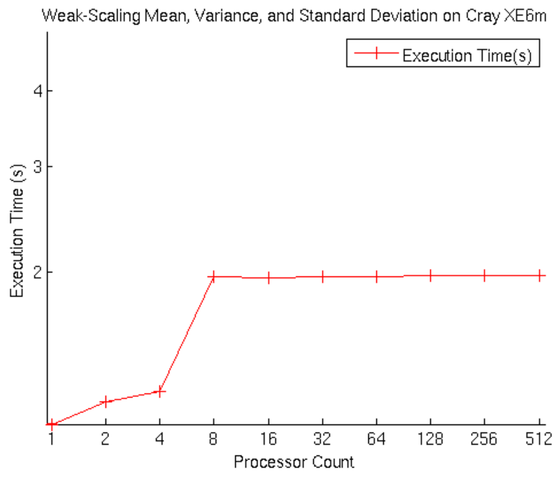
location 0
map_reduce: applies multiple work functions to the elements of multiple views and reduces to a single answer to be assigned to a variable
repeat_view: repeats the mean value in the computation of variance
do_once: performs action on only one location
plus(): return the sum of its arguments, used for calculating variance

4 Results

The experiments were run on the Rain system, a Cray XE6m supercomputer with 576 cores at Texas A&M. Strong-scaling and weak-scaling trials were performed. The difference between strong and weak scalabilty refers to the amount of work the processor must perform. Strong-scaling is when a constant amount of work is loaded into an increasing number of processors, so each processor has an increasingly smaller workload. Weak-scaling invloves increasing the workload and the processor count at the same rate. The graphs below show the mean execution times of 32 samples with respect to the core count and 95 percent confidence intervals.



(a) Strong-scaling



(b) Weak-scaling

5 Analysis

The anticipated outcomes were for the times to decrease dramatically for strong-scaling and hold steady for weak-scaling. For strong-scaling, the execution time drops quickly as the processor count is increased since the work is being split among the processors. The weak-scaling results were as predicted, varying only slightly, except for a small jump when going from 4 to 8 cores. This is due to the memory bandwidth being completely utilized, as all 8 cores were placed by the batch system onto a single die that has limited bandwidth to the memory on the compute node. The confidence intervals were small enough to suggest that the mean times were well within reason.

6 Conclusion

In conclusion, simple statistics algorithms can easily be written in STAPL, which speeds up the execution time by distributing the work over a chosen number of processors.