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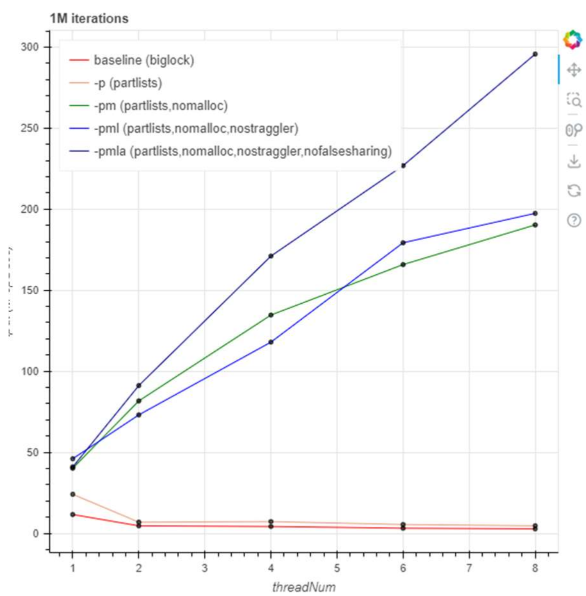
Should you use granger1 or granger2?
https://fxlin.github.io/p2-concurrency/#which-server
For p2, this is a soft suggestion, not a hard requirement.

Scalability

0. Reproduce the benchmarks

Repeat what has been described in the project description.

- Attach a scalability plot (ONLY the one showing all the program versions) you generated. (10)
  To generate the plot, you can use any tool. There's a boilerplate script (p2-concurrency/scripts/plot.py) that may help; but you are not required to use it.



- Compare your observation with the given results. What are the same? What are different? (10)
  - The observations are very similar to each other. The general shape of each line is very similar for both the generated graphs and the given results; that is, in both graphs, the `-pm`, `-pml`, and `-pmla` generally follow a positive linear slope and `baseline` and `-p` generally plateau. There are a couple of differences between

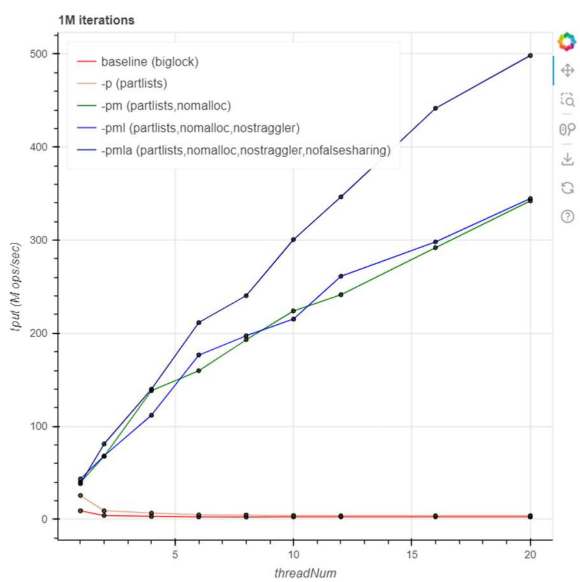
both graphs. The -p program seems to drop less between the first two threadNum in the generated graph than it does in the given graph and there seems to have less noise in the generated graph. The -pm programs seem to have a higher throughput than the -pml in the generated graph than the given graph. The -pmla program seems to generally have a higher slope in the generated graph than the given graph.

- Explain your observation. (10)
  - The graphs are similar because the benefits of implementing the improvements is shared regardless of the settings or configuration of the machines. In other words, we will always see a general linear positive trend for -pmla unless there is a DRASTIC change in the configuration and settings of the machine when the given results were created and when the generated results were created. At the same the time, the difference between the two graphs are explained by the simple differences between the configuration and settings of the machine that generated the generated results versus the machine that generated the given results.

1. The unfinished scalability quest

How does the program scale to more than 8 cores?

- Attach a scalability plot (ONLY the one showing all the program versions) with core count = {1 2 4 6 8 10 12 16 20}. You may want to tweak `run.sh` and `plot.py` (10)



- Describe and explain your observation. (10)
  - It seems as if baseline and -p had an ok throughput for the 1-2 threads and essentially plateaued around 0 at higher threads. The baseline and -p do not

scale well with higher threads because the throughput issue is more correlated with issues with the expensive computation of `malloc()`, processes waiting for stragglers, and false sharing. Specializing memory allocation (`-pm`) and assigning the same amount of work to every worker (`-pml`) both target a similar facet of the problem, that is, allocation of tasks to various worker threads. This explains why the `-pm` and `-pml` scale similarly with higher threads. Both of these programs scale better than `baseline` and `-p` because with higher threads more worker threads will share and fight for the same resources calling `malloc()` many times and creating a bottleneck for more time-consuming tasks. There is a significant boost in the `-pmla` scaling because the program addresses another facet of a lower throughput, that is, cache misses which can drastically increase runtime.

- If there's any scalability bottleneck, profile the execution with VTune (e.g. consider trying VTune's "microarchitecture exploration"). Can you make the program scale better? If so, show your code and profiling results; if not, reason about possible bottlenecks. (5)

  - A possible bottleneck could be a specific function in the program since the CPU Time seems to be present in a specific portion of the entire process as shown in the figure below from calling with parameter `-iterations=1M -thread=8 -parts=32`. Another bottleneck could be with the data structure that is used which is linear in insertion. The workload of individual threads could be made to be more equal with each other.