PetaBricks and Julia

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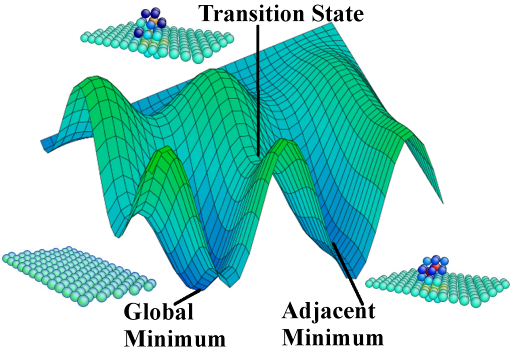
Massachusetts Institute of Technology

December 11th, 2013

Motivation

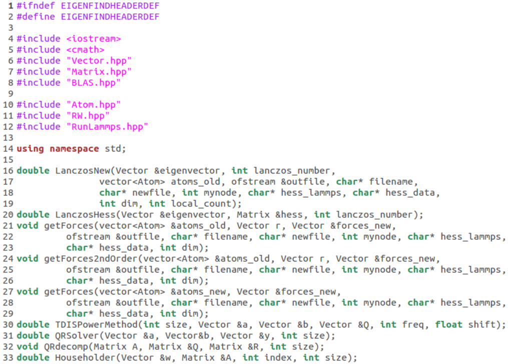
The Programmer's Dilemma

a personal example— energy landscapes



The Programmer's Dilemma

which algorithm is best?



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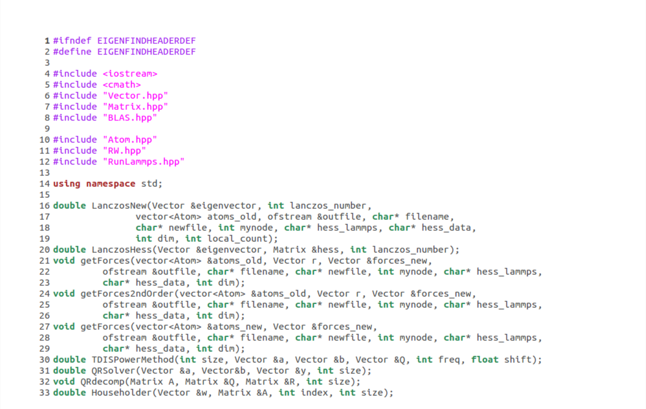

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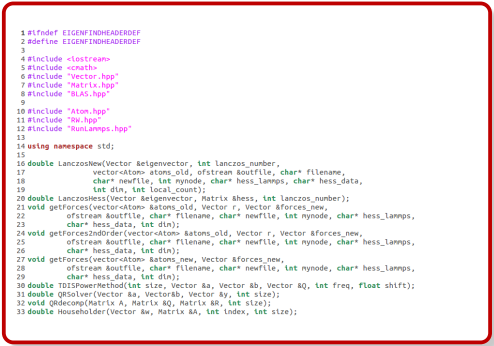
Goal: determine the best algorithm for the application–
which may be machine dependent

Parallel Programming



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- many parts of these algorithms can be written in parallel
- often they can be parallelized in many different ways
- optimizing these options is a challenge

Determine the best way to parallelize the program–
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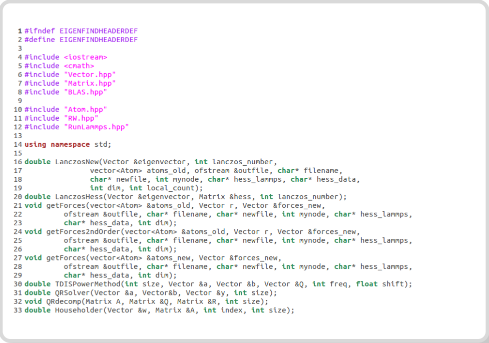
Parallel Programming



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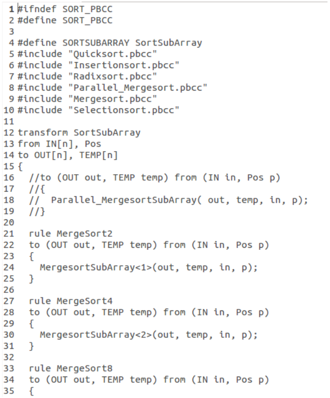
Background

Petabricks – Algorithmic Choice

PetaBricks was developed to alleviate some of the optimization responsibility from the programmer

the transform



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#define SORTSUBARRAY SortSubArray
#include "Quicksort.pbcc"
#include "Insertionsort.pbcc"
#include "Radixsort.pbcc"
#include "Parallel_Mergesort.pbcc"
#include "Mergesort.pbcc"
#include "Selectionsort.pbcc"

transform SortSubArray
from IN[n], Pos
to OUT[n], TEMP[n]
{
  //to (OUT out, TEMP temp) from (IN in, Pos p)
  //{
  //  Parallel_MergesortSubArray( out, temp, in, p);
  //}

  rule MergeSort2
  to (OUT out, TEMP temp) from (IN in, Pos p)
  {
    MergesortSubArray<1>(out, temp, in, p);
  }

  rule MergeSort4
  to (OUT out, TEMP temp) from (IN in, Pos p)
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  rule MergeSort8
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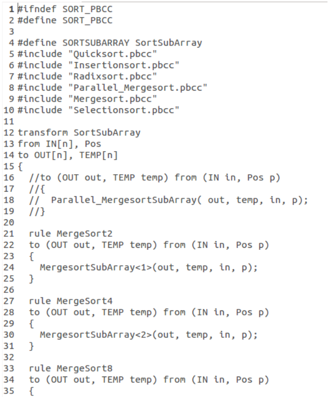

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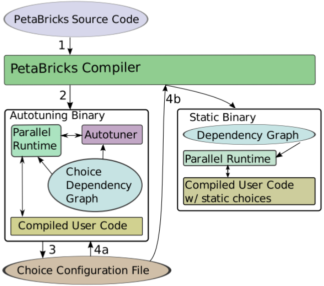
compiling framework

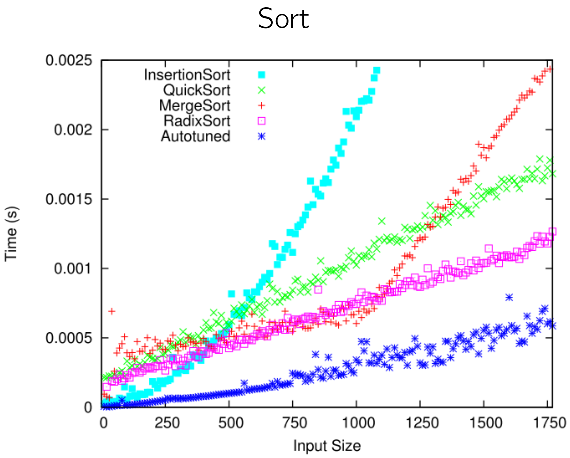


Ansel, et al. ACM SIGPLAN Conference (2009).

Petabricks – Autotuning

the autotuner determines the best configuration for the machine under the tuning constraints

Petabricks – Autotuning



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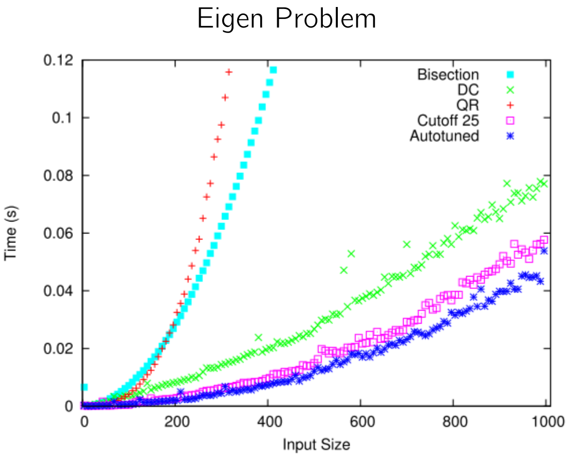

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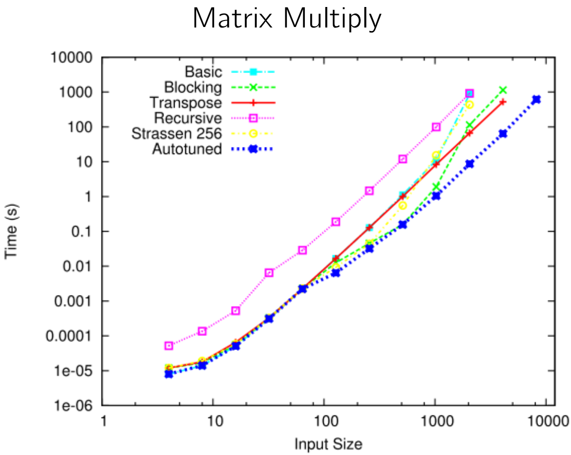

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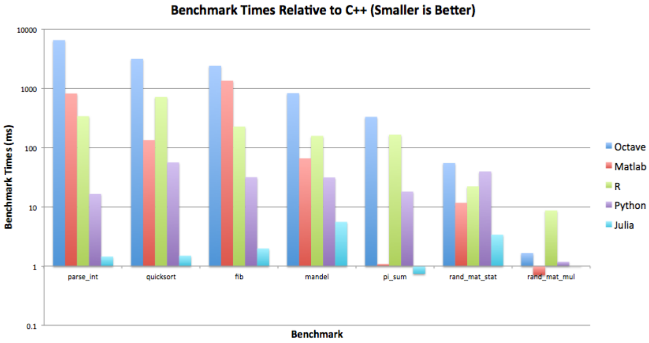
Julia

- Julia was developed to bridge the gap between interpreted and compiled scientific computing
- streamlining parallelization techniques has been a priority

Julia



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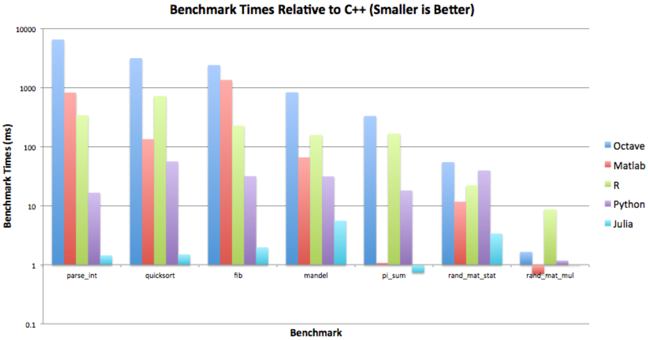

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Question: is there room for overlap between the PetaBricks and Julia approaches?

Approach

Options for Implementation

Julia in PetaBricks

- can utilize PetaBricks autotuner and compiler
- PetaBricks compiler needs to interpret Julia

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Julia + OpenTuner

- apply PetaBricks framework to Julia
- utilize OpenTuner to optimize Julia

Approach Used Here

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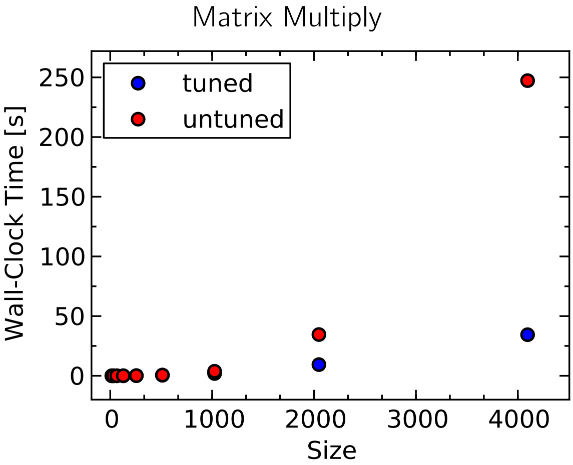
→ lower bound of performance improvement

→ is there proof of benefit?

Results

PetaBricks- Tuning Improvements

performance improvement— tuned and untuned PetaBricks



Comparing PetaBricks with Julia - Apples to Apples

PetaBricks

→ functions read in ASCII files and output same

→ determines parallelization during autotuning

→ autotuning can take days

Julia

→ JIT for each independent execution

→ can addprocs(n), but may not parallelize

→ can be used interactively

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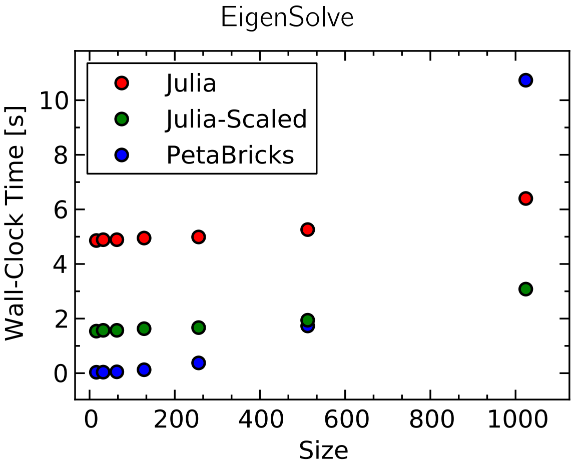
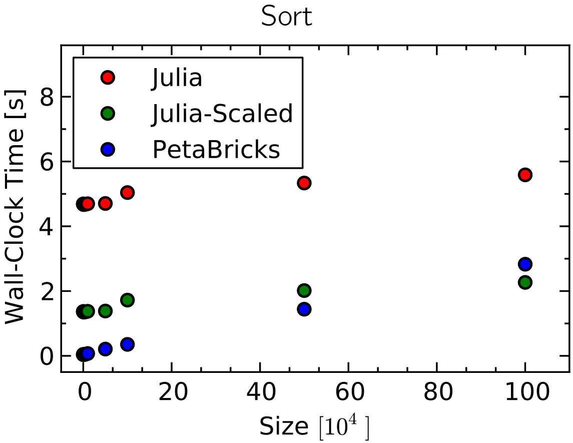
- → make both programs do i/o
- → run both programs from shell
- → try addprocs(n) in Julia, with no other instructions
- → subtract 'hello world' start-up time from Julia wall-clock

Comparing PetaBricks to Julia - EigenSolve



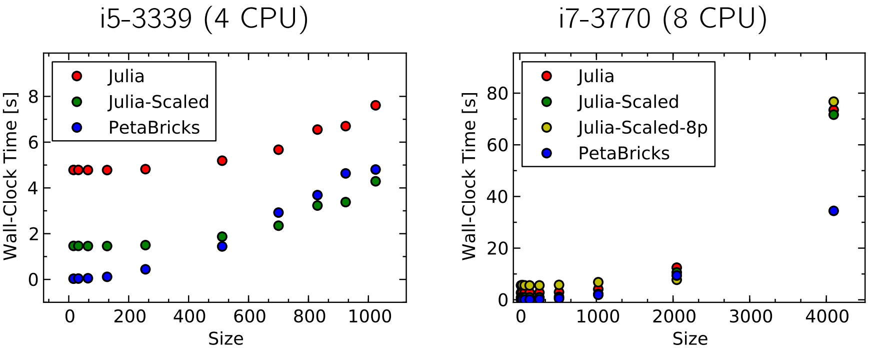
- → Julia seems to do the best for large matrices
- → however, the results were not comparable
- → this test was not a good apples-to-apples performance test

Comparing PetaBricks with Julia - Sort



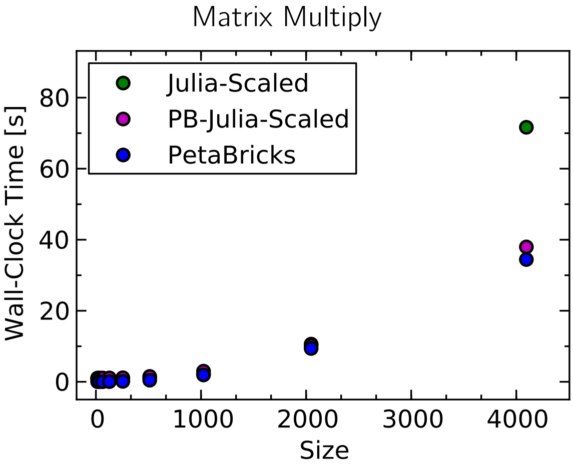
- → Julia and PetBricks converge for large vectors
- → PetaBricks is better with shorter vectors
- → effect of i/o not considered wrt performance

Comparing PetaBricks with Julia Matrix Multiply



- → Julia and PetBricks converge moderate matrix sizes on fewer cores
- → PetaBricks is better with smaller lists and larger matrices
- → using addprocs(n) with no other instruction does not utilize parallel functionality in Julia

Running PetaBricks from Julia



→ Can get PetaBricks improvement by incorporating PetaBricks executable in Julia

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Recommendations

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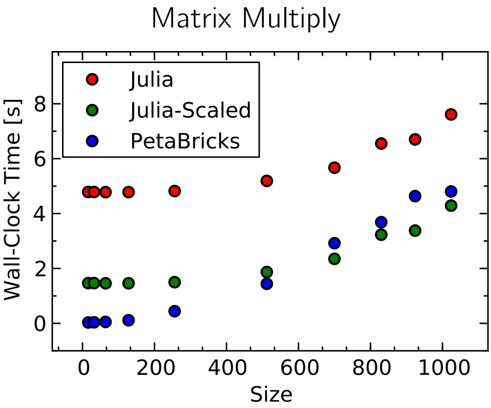

→ under many circumstances, Julia performs as well as PetaBricks without days of compilation

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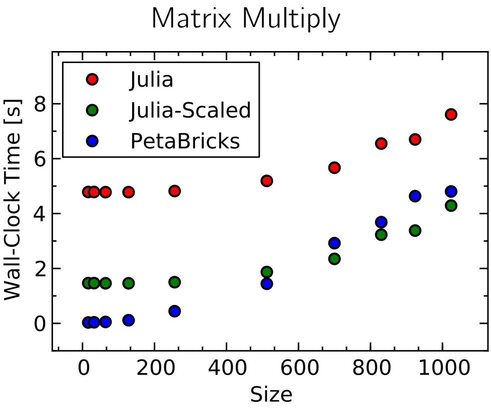

→ there is room for improvement on the start-up time for Julia

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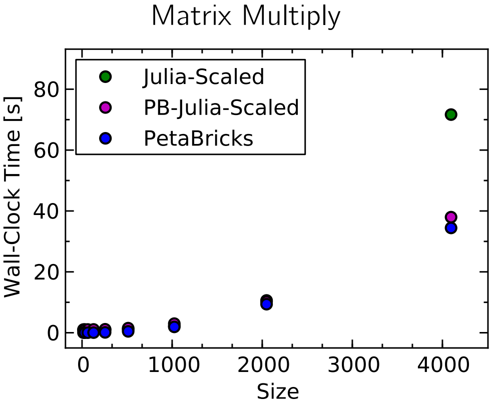

→ PetaBricks performance can be achieved by using a shell command in Julia

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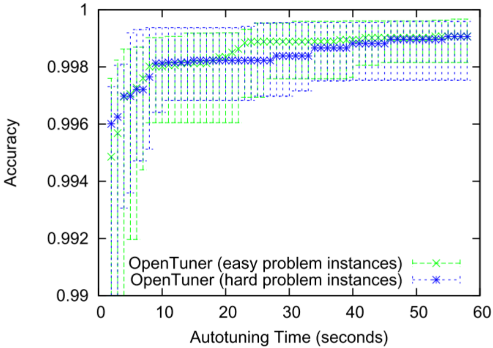

Ansel, et. al. MIT CSAIL Technical Report MIT-CSAIL-TR-2013-026 (2013).

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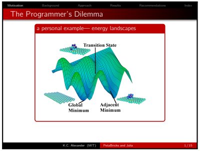

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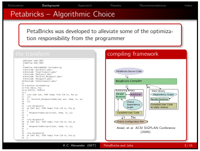

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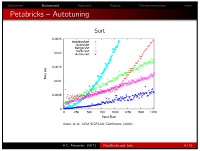

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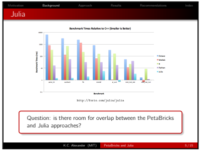

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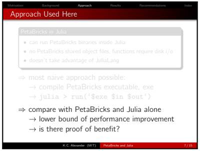

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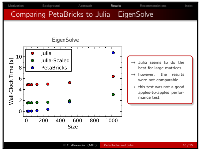

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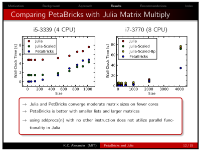

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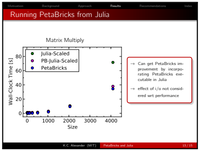

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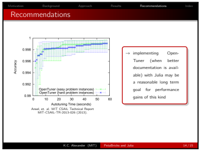

Recommendations

Accuracy
OpenTuner (easy problem instances)
OpenTuner (hard problem instances)
Autotuning Time (seconds)

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