Introduction to profiling

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Overview

- Profiling basics
- Simple profiling
- Open source profiling tools
- Intel development tools
  - Advisor XE
  - Inspector XE
  - VTune Amplifier XE
  - Trace Analyzer and Collector
- Interpreted languages profiling
- https://www.surveymonkey.com/r/7PFVFCY

Why to profile

- Evaluate performance

- Find the performance bottlenecks
  - inefficient programming
  - memory I/O bottlenecks
  - parallel scaling

Tools categories

- Hardware counters
  - count events from CPU perspective (# of flops, memory loads, etc)
  - usually need Linux kernel module installed
- Statistical profilers (sampling)
  - interrupt program at given intervals to find what routine/line the program is in
- Event based profilers (tracing)
  - collect information on each function call

Simple profiling

- Time program runtime
  - get an idea on time to run and parallel scaling
- Serial profiling
  - discover inefficient programming
  - computer architecture slowdowns
  - compiler optimizations evaluation
  - gprof
    - Trick how to get gprof to work in parallel: http://shwina.github.io/2014/11/profiling-parallel

Open source tools

- Vendor based
  - AMD CodeAnalyst
- Community based
  - perf
    - hardware counter collection, part of Linux
  - oprofile
    - profiler
  - drawback – harder to analyze the profiling results

HPC OS tools

- HPC Toolkit
  - A few years old, did not find it as straightforward to use
- TAU
  - Lots of features, which makes the learning curve slow
- Scalasca
  - Developed by European consortium, did not try yet

Intel software development products

- We have a 2 concurrent users license
- Tools for all stages of development
  - Compilers and libraries
  - Verification tools
  - Profilers
- More info

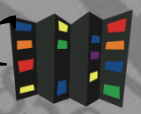
`https://software.intel.com/en-us/intel-parallel-studio-xe`

`https://www.chpc.utah.edu/documentation/software/intel-parallelXE.php`

Intel tools

- Intel Parallel Studio XE 2018 Cluster Edition
  - Compilers (C/C++, Fortran)
  - Distribution for Python
  - Math library (MKL)
  - Data Analytics Acceleration Library (DAAL)
  - Threading library (TBB)
  - Vectorization or thread design and prototype (Advisor)
  - Memory and thread debugging (Inspector)
  - Profiler (VTune Amplifier)
  - MPI library (Intel MPI)
  - MPI analyzer and profiler (ITAC)

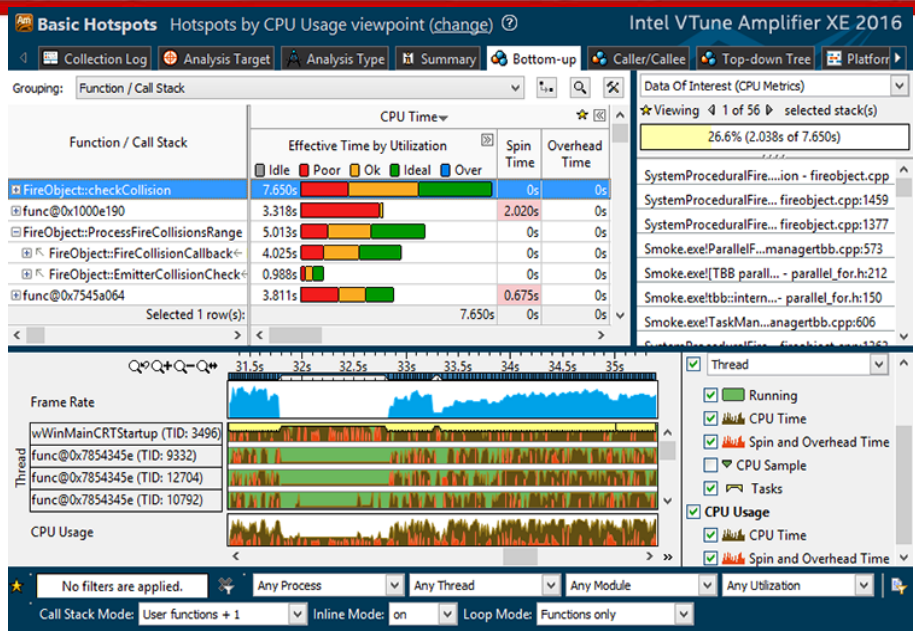
Intel VTune Amplifier



- Serial and parallel profiler
  - multicore support for OpenMP and OpenCL on CPUs, GPUs and Xeon Phi
- Quick identification of performance bottlenecks
  - various analyses and points of view in the GUI
- GUI and command line use
- More info

`https://software.intel.com/en-us/intel-vtune-amplifier-xe`

Intel VTune Amplifier



- Source the environment

  `module load vtune`

- Run VTune

  `amplxe-gui` – graphical user interface

  `amplxe-cl` – command line (best to get from the GUI)

  Can be used also for remote profiling (e.g. on Xeon Phi)

- Tuning guides for specific architectures

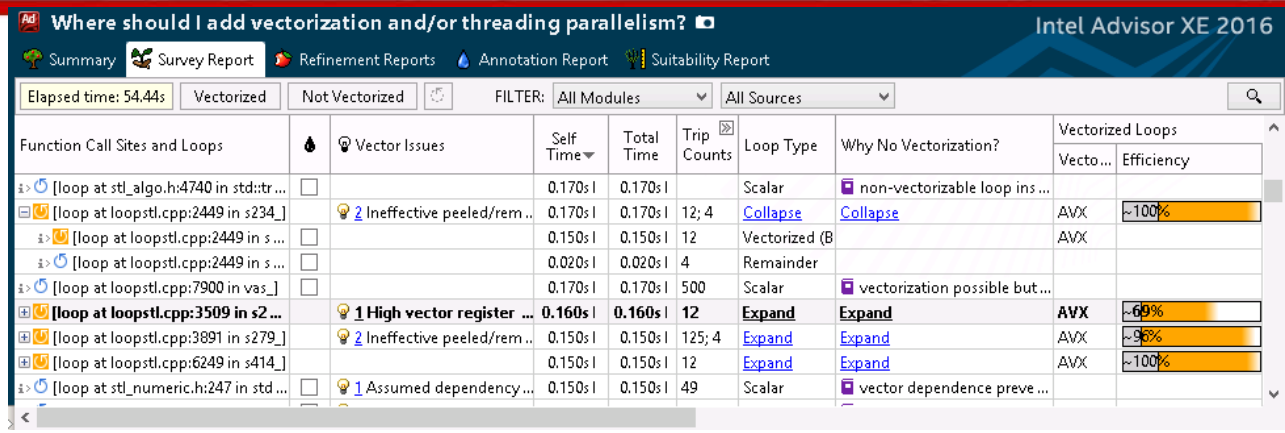
`https://software.intel.com/en-us/articles/processor-specific-performance-analysis-papers`

Intel Advisor

- Vectorization advisor
  - Identify loops that benefit from vectorization, what is blocking efficient vectorization and explore benefit of data reorganization
- Thread design and prototyping
  - Analyze, design, tune and check threading design without disrupting normal development
- More info

`http://software.intel.com/en-us/intel-advisor-xe/`

Intel Advisor



- Source the environment

  `module load advisorxe`

- Run Advisor

  `advixe-gui` – graphical user interface

  `advixe-cl` – command line (best to get from the GUI)

- Create project and choose appropriate modeling
- Getting started guide

`https://software.intel.com/en-us/get-started-with-advisor`

Intel Trace Analyzer and Collector

- MPI profiler
  - traces MPI code
  - identifies communication inefficiencies
- Collector collects the data and Analyzer visualizes them
- More info

`https://software.intel.com/en-us/intel-trace-analyzer`

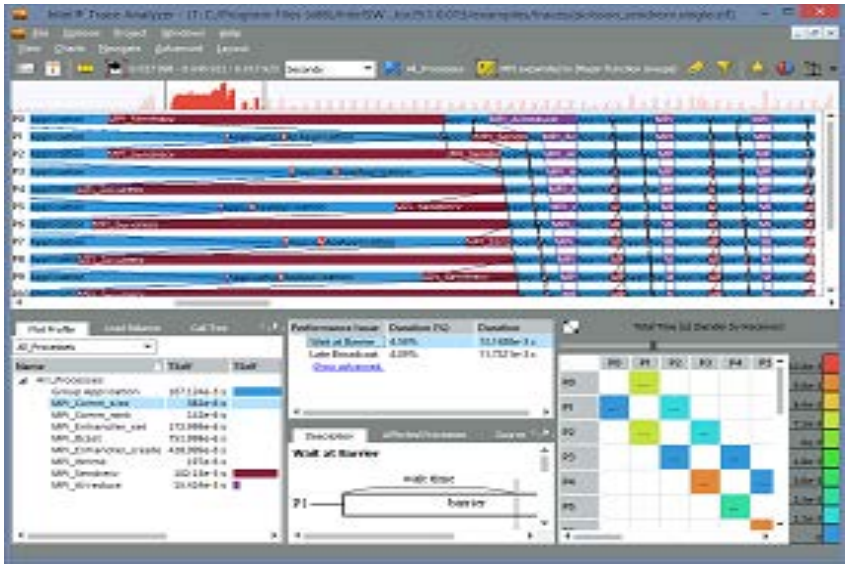
Intel TAC

- Source the environment

```
module load itac
```

- Using Intel compilers, can compile with `-trace`

```
mpiifort -openmp –trace trap.f
```



- Run MPI code

```
mpirun –trace –n 4 ./a.out
```

- Run visualizer

```
traceanalyzer a.out.stf &
```

- CHPC site

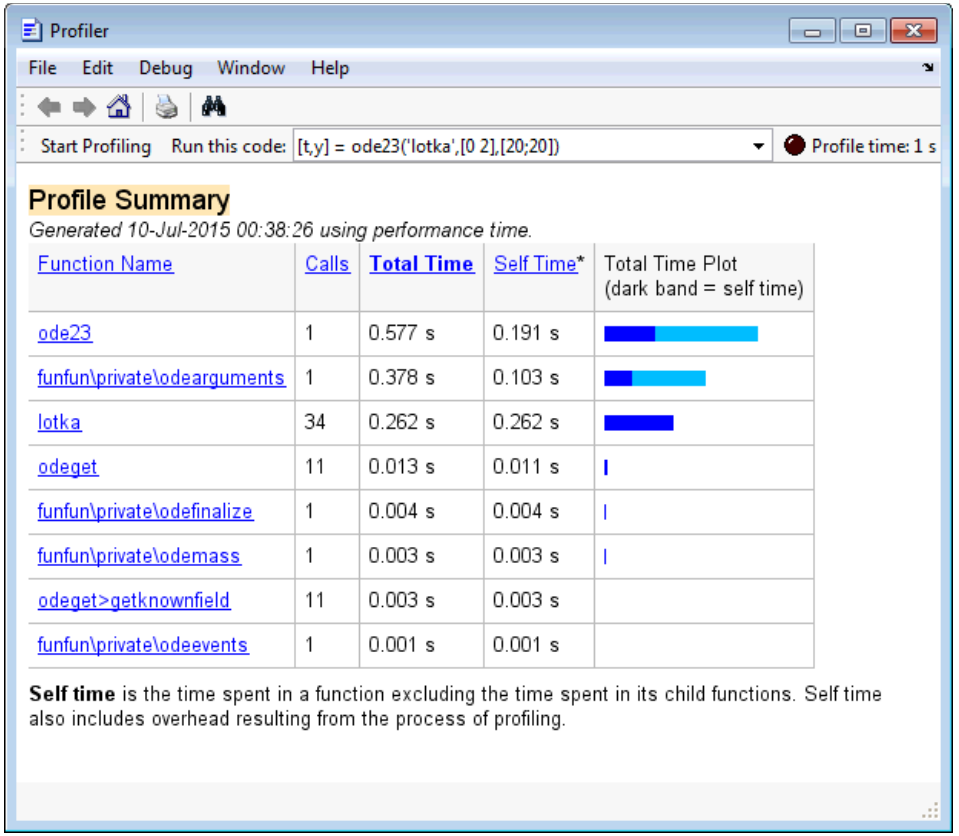
```
https://software.intel.com/en-us/get-started-with-itac-
   for-linux
```

Interpreted languages profiling

- With increased use of interpreted languages, their performance is becoming important
- Matlab
  - Profiling ecosystem in the IDE
- Python
  - Python modules or IDEs
- R
  - Profiling libraries or RStudio

Matlab

- `profile` command turns on/off profiling
- Profile is then displayed in the IDE
- Click on each function to show line-by-line profile

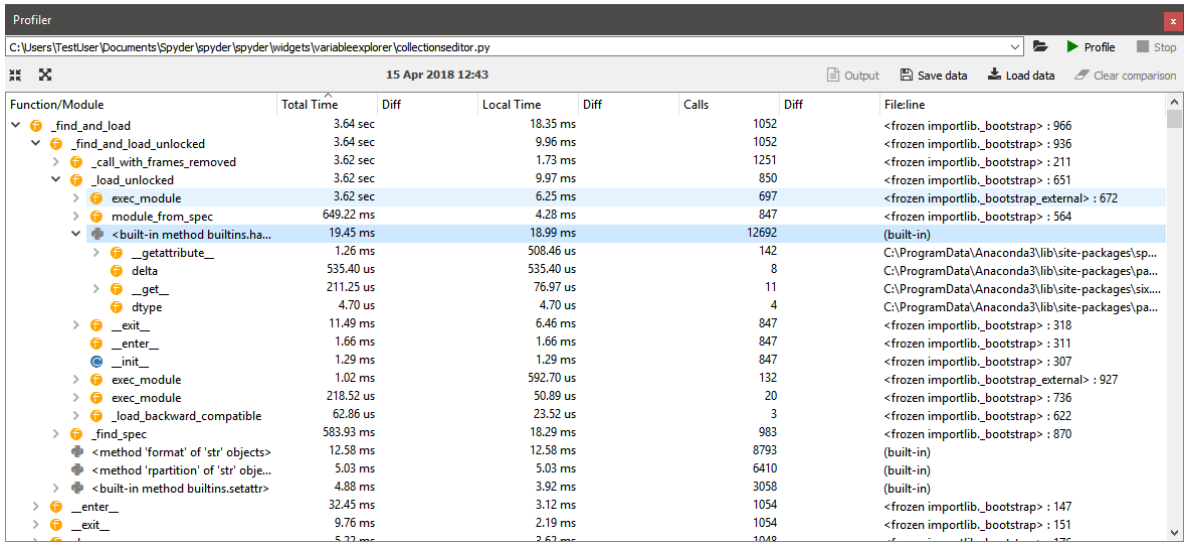


- Performance improvement strategies

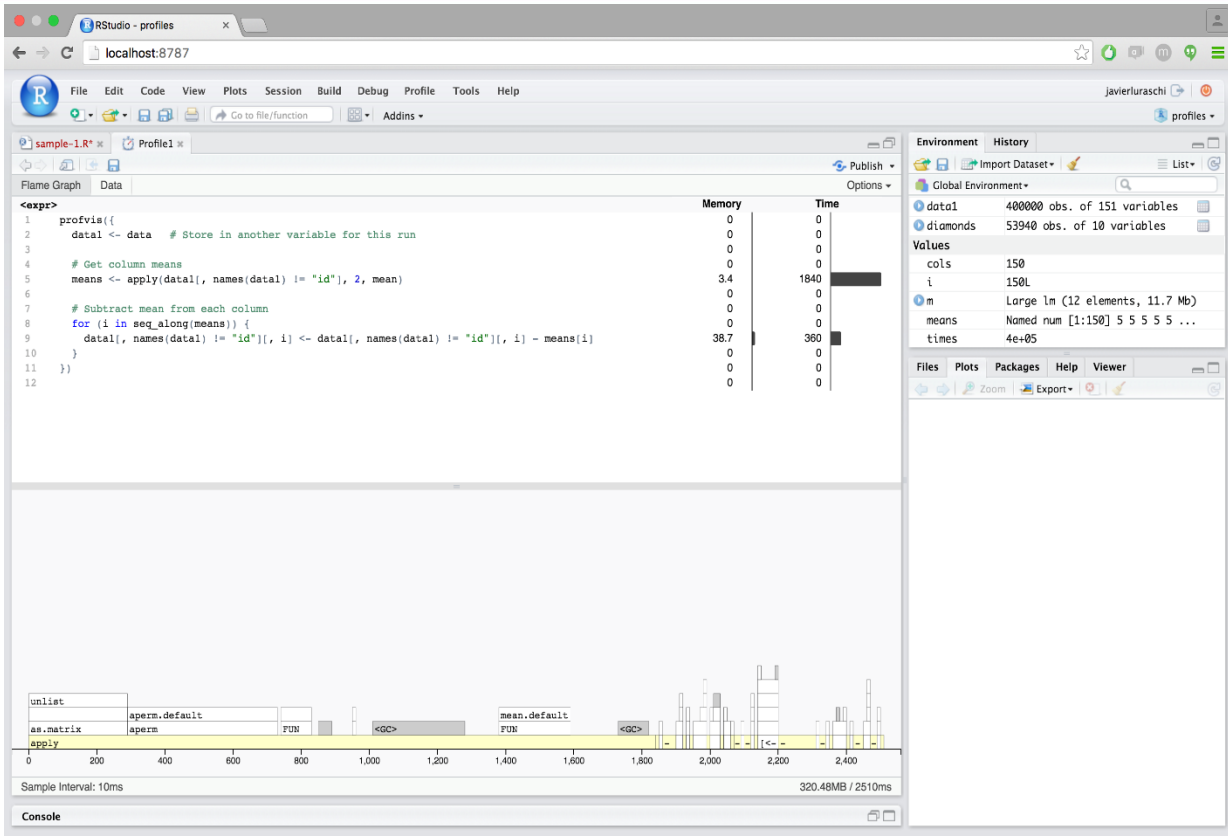
https://www.mathworks.com/help/matlab/matlab_prog/techniques-for-improving-performance.html

Python

- `profile` and `cProfile` modules
  - Text based output, optional format with `pstats` , analysis with `Stats`
- Plethora of other tools
  - E.g. line profiling with line_profiler
- Some IDEs display profiles
  - Spyder



- `Rprof` function to profile
- `summaryRprof` to display
- RStudio has a profile interface called profviz



- Performance improvement strategies

http://adv-r.had.co.nz/Profiling.html

Summary

- Serial profilers
  - gprof, perf
- Intel tools
  - VTune, AdvisorXE, ITAC
- Interpreted languages profiling
  - Matlab profile
  - Python profile, Cprofile
  - R Rprof, profviz
- https://www.surveymonkey.com/r/7PFVFCY

Survey

- https://www.surveymonkey.com/r/7PFVFCY