ONE View

How to generate and use reports with ONE View

Version 1.17

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MAQAO Tutorial series

www.maqao.org

1 Introduction

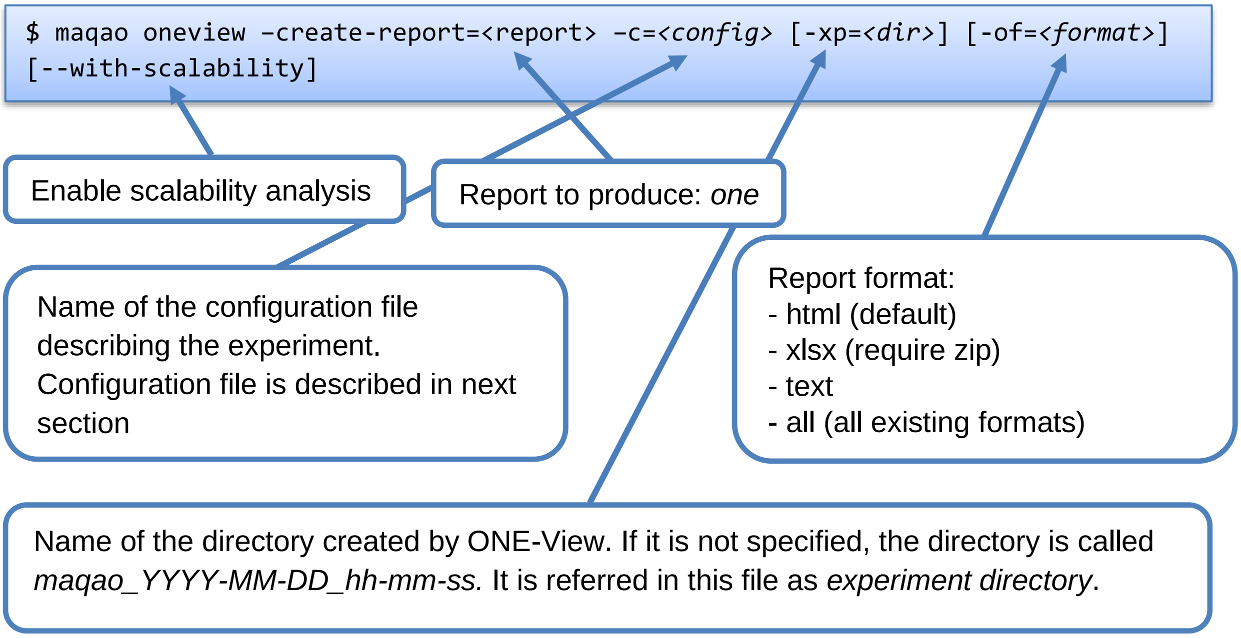
ONE View is the MAQAO module in charge of driving all other MAQAO modules in order to produce reports aggregating results from all these tools. It automatizes the execution of other MAQAO modules to generate reports in HTML pages, XLSX data sheets or text output.

ONE View offers several built-in reports combining both static and dynamic approaches to get an overview of the application performance. This document details reports ONE, which uses MAQAO modules LProf (a dynamic profiler) and CQA (a static code analyser).

2 Running ONE View

To generate a report using ONE View, the default command is:

```
$ maqao oneview –create-report=<report> –c=<config> [-xp=<dir>] [-of=<format>]
[--with-scalability]
```



It is also possible to provide the necessary parameters to ONE View from the command line.

It can be used when a small set of variables in the configuration file is needed. All existing parameters for the configuration of the experiment are available in sections 3.2 and 3.3.

To list all options for ONE View:

```
$ maqao oneview --help
```

The report *ONE* is the simplest and fastest report. It combines a profiling of the application using LProf module with CQA static analysis on loops and functions. The scalability analysis contains all data from the report *ONE* and additional data generated using several profilings of the application with different values for the number of processes and the number of threads.

The report *ONE* (and all other report levels) can be enhanced using one or more cumulative options that could run additional analyses and add more data into reports. These options are:

- *--with-scalability* (*-WS*): Run additional LPROF analyses and add several charts about application scalability.
- *--with-POP*: Generate several additional metrics that do not need additional runs.
- --with-FLOPS: Generate several additional metrics that do not need additional runs. Metrics are based on some hardware counters measured with LPROF.

More options will be added in future MAQAO versions.

3 Filling the Configuration File

3.1 Creating the configuration file

To generate a template of configuration file:

```
$ maqao oneview –create-config[=<file>]
```

Name of the generated configuration file. If it is not specified, the configuration file is called *config.json* and it is created in the current directory.

```
{
  "config": {
     …
  }
}
```

The template contains all available fields and it is fully documented. This document details all fields in the next subsections. The configuration file uses the JSON syntax and all elements must be in a main table named *config*, as shown in the following figure.

As JSON doesn't allow comments, the configuration file template uses two tricks to help its understanding:

- The key *"#"* is used to write a single line comment
- ONE-View keys never start with the "_" (underscore) character. If a key starts with it, it means the entry is commented, as ONE-View will ignore it.

3.2 Main fields

- *executable*: Path to the binary of the application to analyse
- *run_command*: A string detailing how the application must be run. In this string, the main executable is referred as *<executable>.* This substring is automatically replaced by the correct executable name when ONE View needs to run any version of the

binary.
If the application does not need any parameter, the field has "<*executable*>" as value. If the application needs two parameters, *-a=5* and *--b*, the field value must be "<*executable*> *-a=5 --b*".

- *mpi_command*: A string detailing the MPI command to use to run the application. If MPI should not be used, this string must be empty. If MPI is used, this field must contain the call to *mpirun* or *mpiexec* with all its parameters, except the application and its own parameters.

For example, if an application needs the following command to be run:

```
$ mpirun -n 4 ./my_app 250 -output=./log.out
```

```
{
  "content": {
    "executable": "./my_app",
    "run_command": "<executable> 250 -output=./log.out",
    "mpi_command": "mpirun -n 4",
  }
}
```

The corresponding configuration file contains:

- *number_processes:* Number of processes to use to run the application. Default is 1. Can be referred as <*number_processes*> in the *batch_script* or the *mpi_command* fields.
- *batch_command:* When the cluster uses a batch manager, this variable describes how to use it. If a script is needed, it must be referred as <*batch_script*>.
- *batch_script:* Path to a script used by a batch manager. The script must be adapted to ONE View by using the code <*run_command*> instead of the classic binary execution command. For example, a batch script adapted for ONE View for SLURM can be:

```
#! /bin/bash

#SBATCH SETTINGS
#SBATCH -J myJob
…

#APPLICATION SETTINGS
module load …
export MY_VAR …

#RUN THE APPLICATION
# mpiexec -n 16 ./my_app
<mpi_comamnd> <run_command>
```

- *environment_variables:* An optional table containing environment variables to be set before running the application. Each entry has for key the environment variable name and for value the environment variable value. Environment variables declaration can be done using the shortcut syntax *envv_<ENV_NAME>=<value>*. *environment_variables* can be used to set the environment variable OMP_NUM_THREADS used by OpenMP.
- *multiruns_params*: When scalability report is generated, describes all experiments to run. It is a table containing one entry per experiment, with following fields:
    - *number_processes* – Number of processes for the experiment. Default is 1. It substitutes *<number_processes>* in the *batch_script* or the *mpi_command* fields for scalability runs.
    - *number_nodes* – Number of nodes for the experiment. Default is 1. It substitutes *number_nodes* for scalability runs.
    - *number_processes_per_node* – Number of processes per node for the experiment. Default is 1. It substitutes *number_processes_per_node* for scalability runs.
    - *run_command* – Command to use to run the executable for the experiment. Default is the value specified in the *run_command* configuration field.
    - *mpi_command* – Command to use to run MPI for the experiment. Default is the value specified in the *mpi_command* configuration field.
    - *dataset* – Path to the dataset to use for the experiment. Default is the value specified in the *dataset* configuration field.
    - *run_directory* – Path to a directory where to run the binary for the experiment. Default is the value specified in the *run_directory* configuration field.
    - *script_variables* – A set of user defined variables substituted on a batch script. Default is the value specified in the *script_variables* configuration field.
    - *environment_variables* – An optional table containing environment variables to be set before running the application. Each entry has for key the environment variable name and for value the environment variable value. Environment variables declaration can be done using the shortcut syntax *envv_<ENV_NAME>=<value>*. *environment_variables* can be used to set the environment variable OMP_NUM_THREADS used by OpenMP. Environment variables set in the base run are preserved in additional runs. To unset an environment variable, its value must be set to *nil* or the field *unset_envv* can be used.
    - *unset_envv* – Can be a string with an environment variable name to unset for the run, or a string table with several environment variables names.
    - *name* – Name used to identify the run in reports. For readability reasons, it is not always used and can be replaced in some sections of the reports by the string “run <index>”, with index the position in multiruns_params, starting at 2 (index 1 represents the run described by main parameters)

3.3 Secondary fields

- *dataset*: Path to a directory containing the application dataset. If filled, this directory is copied or linked (depending on the value of the *dataset_handler* link) into the experiment directory. If *dataset_handler* is set to “copy”, the experiment directory must not be created in the dataset directory, and it is also advised to have the directory specified in *dataset* be as small as possible.

- *custom_categories*: A table describing additional categories used in application categorization reports. When *external_libraries* is used, one additional category is created for each library. If *custom_categories* is filled, only categories specified are used. Each category is a subtable with the following fields:
    - *type* - *"library"* (the custom category is a single library), *"all-external-libraries"* (shortcut to get one category for each entry in external-libraries as done by default), *"library_group"* to accumulate several libraries into a single category
    - *value* - *"<library name>"* when type is *"library"*, *nil* when type is *"all-external-libraries"*, *{"lib1.so", "lib2.so",…}* when type is *"library_group"*
    - *name* - Used only when type is "*library_group*", to specify the name of the catergory
- *experiment_name*: An optional string copied into report main page that can be used to distinguish various reports.
- *external_libraries*: An optional table describing dynamic libraries to analyse in addition of the executable. By default, linked libraries are not analysed since most of them are system libraries that are not the target of optimisation efforts. This option allows to analyse the loops in the specified libraries, for instance when the application code is in such a library. Each entry in the table is a string with the name of a library to analyse.
- *script_variables*: A table of user defined variables that are substituted in the script defined in *batch_script*. Each entry has for key the variable name and for value a string or a number that will replace the tag <*variable name*> in the script, as for ONE View built-in variables.
- *scalability_reference*: An optional string detailing which entry in the *multiruns_params* table must be used as reference when scalability metrics are computed. Available values are:
    - *main* – Main experiment defined in the configuration (default value)
    - *lowest-time* –The run with the shortest time
    - *highest-time* –The run with the highest time
    - *lowest-threads* –The run with the lowest number of threads
    - *highest-threads* –The run with the highest number of threads
    - *lowest-efficiency* –The run with the worst efficiency
    - *highest-efficiency* –The run with the best efficiency
    - *<number>* –The run at index <number> in the *multiruns_params* table
- *source_code_location*: An optional string detailing where the source code is located. It is needed to localize the source code of your application if it is not at the location defined in debug data (which is set when compiling the application).
- *run_directory*: A string detailing where the executable should be run. Default value is the local directory. Some applications must be run from a specific directory, most of the time related to the dataset directory. This field is used to specify this path. The substring "<*dataset*>" can be used to represent the path to the dataset directory located in the experiment directory and it is automatically substituted by the real path by ONE View during runs.
- *maximal_path_number*: A number indicating the maximal number of paths in the control flow graph a loop can have. Loops with a greater number of paths will not be analysed.

- *number_nodes:* Number of nodes to use to run the application on the cluster. Can be referred as <*number_nodes*> in the *batch_script* or the *mpi_command* fields.
- *number_processes_per_node:* Number of processes per nodes to use to run the application. Can be referred as <*number_processes_per_node*> in the *batch_script* or the *mpi_command* field.
- *dataset_handler*: Specify how the dataset is handled in the experiment. Default value is *link* meaning that a link is created from the experiment directory to the dataset. *copy* can be used to copy the full dataset content into the experiment directory.
- *keep_executable_location*: Specify if the executable must be copied and run from the experiment directory (*false*, default value), or if it must be run from its original location (*true*).
- *lprof_params*: An optional string representing additional parameters passed to LPROF during the profiling step. Refer to the LProf documentation for the list of available options.
- *lprof_post_process_params*: An optional table representing additional parameters passed to LPROF during formatting step.

The following fields are not used by report ONE and reserved for future releases:

- *filter*
- *frequencies*
- *profile_start*
- *additional_hwc*
- *bucket_threshold*
- *decan_multi_variant*
- *decan_all_variants*
- *decan_params*
- *vprof_params*
- *is_sudo_available*
- *excluded_areas*
- *included_areas*

3.4 Simple configuration templates

```
$ maqao oneview --create-config-template[=<case>]
```

Some basic configuration file templates can be generated using the command

The command generates several simple configuration files that list basic options to use depending on the use case (sequential application, parallel application that uses either MPI or OpenMP, how to setup a scalability analysis).

The optional value <*case*> can be used to generate only one template, as all templates are generated if it is not defined. Available cases are *seq*, *lib*, *mpi*, *omp*, *scalability*, *script*.

4 Reading Reports

Reports are generated in *<experiment_directory>/REPORTS/* as *<executable>_<report>.<format>*, where *<executable>* is the analysed executable, *<report>* is the value of the parameter *–create-report* and *<format>* the value of the parameter *format*.

4.1 HTML Output

HTLM reports can be read using Mozilla Firefox, Google Chrome and Microsoft Edge web browsers. The main file is **index.html**, located in *<experiment_directory>/RESULTS/<report>_html/*. All tabs have a menu located at the top of the tab which can be used to navigate between tabs. All tabs are described in next subsections. On most on tabs, there are one or several symbols ? that display help when the cursor is over them.

4.1.1 Main Menu

Located on the top of each page, the main menu is used to navigate into the report.

Figure 1- HTML report main menu

The orange item is the current location. **Global** entry can be expanded by moving the cursor over it to display a sub menu. Additional entries can appear depending of the context.

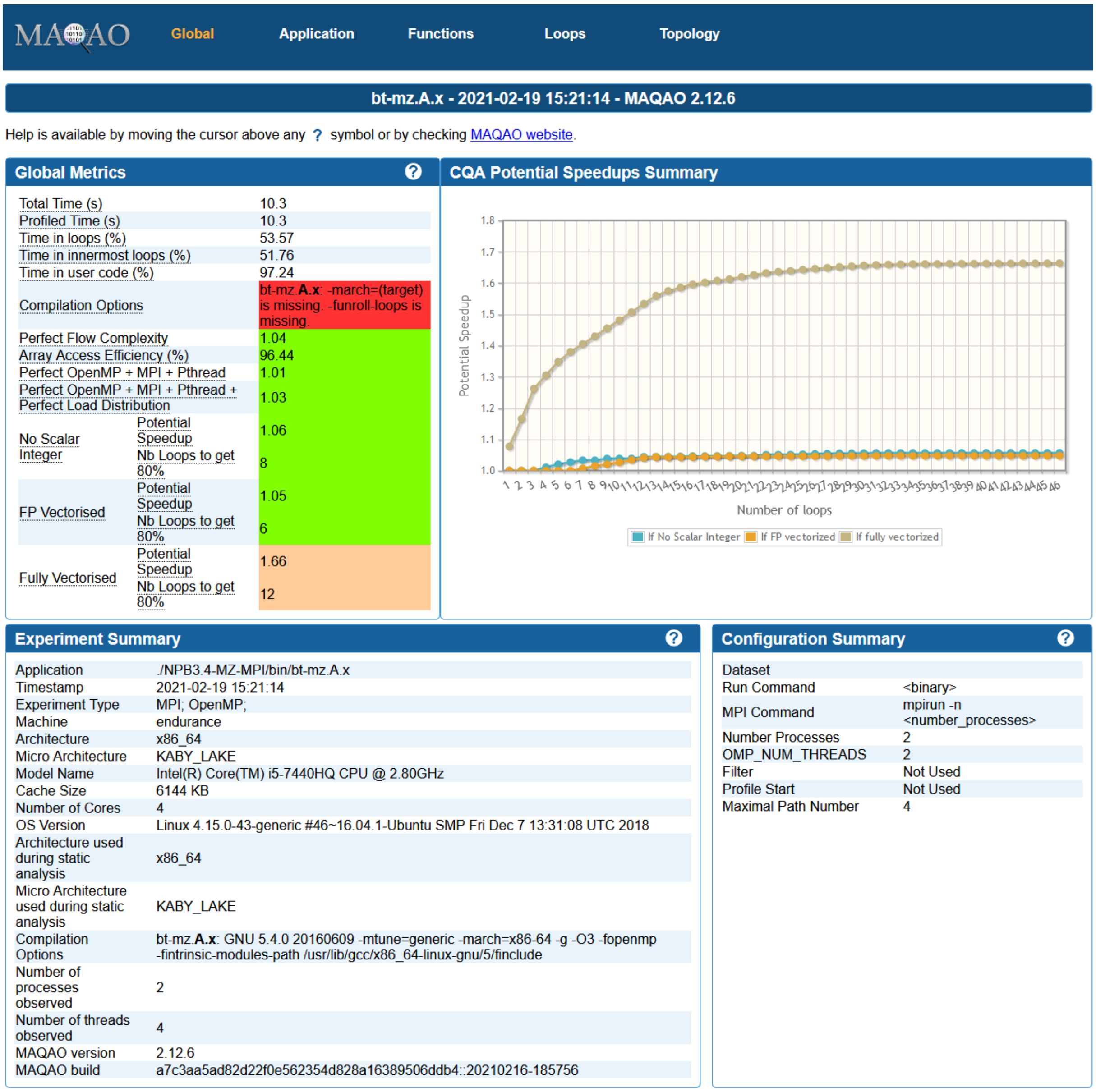
- **Global** is the report entry point and described some general data about the application and the experiment
  - **Configurations** contains all configuration parameters used to generate the experiment
  - **Environment Variables** lists all environment variables set during the application execution
  - **Outputs** is a copy of what is displayed on the standard output during the LPROF run
  - **Logs** is a copy of the log produced during the experiment
- **Application** contains additional charts about the application
- **Functions** is a profiling of the application at the function level
- **Loops** is a profiling of the application at the loop level
- **Topology** summarizes all nodes, processes and threads run by the application.
  - **lstopo** displays the ouput produced by the external tool lstopo-no-graphic in order to detail how processes were pinned during the run.
  - **lstopo_PU** uses lstopo-no-graphics and LPROF results to give a view based on material objects (node / core / processing unit) of processes execution time.
  - **lstopo_threads** uses lstopo-no-graphics and LPROF results to give a view based on logical objects (node / process / thread) of processing unit execution time.

4.1.2 Global

The file **index.html** is the report index and it presents several sections:

- **Global Metrics** on the top left, that presents several metrics the summarize the application performances, the application charactristics or potentiel speedup that can be achieved by performing some changes on the application. Some help about each metric is available by moving the cursor over the metric name.
- **Chart box**, located on the top right, is used to displayed charts relative to global metrics. Displayed charts can be changed by clicking on some global metrics identified by a blue bar on their left when the cursor is over. Clickable metrics will be detailled in a folowing subsection. When the symbol ⏎ appears in the box header right, it can be clicked to display the summary speedup chart.
- **Experiment Summary** on the page bottom left summarizes several parameters about the experiment
- **Configuration Summary** on the bottom right displays some of the configuration parameters set to run the experiment. The full configuration is available in the main menu entry **Configurations**

Disclaimer: All screenshots presented in this manual are extracted from the default report. When the scalability analysis is used, data from all runs are displayed in most of the pages and charts can be slightly different.



Global Metrics		
Total Time (s)		10.3
Profiled Time (s)		10.3
Time in loops (%)		53.57
Time in innermost loops (%)		51.76
Time in user code (%)		97.24
Compilation Options		bt-mz.A.x: -march=(target) is missing. -funroll-loops is missing.
Perfect Flow Complexity		1.04
Array Access Efficiency (%)		96.44
Perfect OpenMP + MPI + Pthread		1.01
Perfect OpenMP + MPI + Pthread + Perfect Load Distribution		1.03
No Scalar Integer	Potential Speedup	1.06
	Nb Loops to get 80%	8
FP Vectorised	Potential Speedup	1.05
	Nb Loops to get 80%	6
Fully Vectorised	Potential Speedup	1.66
	Nb Loops to get 80%	12

Experiment Summary	
Application	./NPB3.4-MZ-MPI/bin/bt-mz.A.x
Timestamp	2021-02-19 15:21:14
Experiment Type	MPI; OpenMP;
Machine	endurance
Architecture	x86_64
Micro Architecture	KABY_LAKE
Model Name	Intel(R) Core(TM) i5-7440HQ CPU @ 2.80GHz
Cache Size	6144 KB
Number of Cores	4
OS Version	Linux 4.15.0-43-generic #46~16.04.1-Ubuntu SMP Fri Dec 7 13:31:08 UTC 2018
Architecture used during static analysis	x86_64
Micro Architecture used during static analysis	KABY_LAKE
Compilation Options	bt-mz.A.x: GNU 5.4.0 20160609 -mtune=generic -march=x86-64 -g -O3 -fopenmp -fintrinsic-modules-path /usr/lib/gcc/x86_64-linux-gnu/5/finclude
Number of processes observed	2
Number of threads observed	4
MAQAO version	2.12.6
MAQAO build	a7c3aa5ad82d22f0e562354d828a16389506ddb4::20210216-185756

Configuration Summary	
Dataset	
Run Command	<binary>
MPI Command	mpirun -n <number_processes>
Number Processes	2
OMP_NUM_THREADS	2
Filter	Not Used
Profile Start	Not Used
Maximal Path Number	4

Figure 2- Global Report Without Scalability Analysis

4.1.2.1 Global Metrics

- **Total Time (s)** – Not clickable – Time spent during the application execution expressed in seconds
- **Max (Thread Active Time) (s)** – Not clickable, previously **Profiled Time (s)** – Time spent during the application profiling execution expressed in seconds. It can be lower than **Total Time (s)** when a part of the application is excluded from the profiling using option *profile_start* or when the application is passive-waiting (accounted only in total time).
- **Average Active Time (s)** – Not clickable – Sum of threads CPU time divided by threads count.
- **Activity Ration (%)** – Not clickable – Sum over all threads of their CPU time divided by the sum of their walltime.

- **Average Number of Active Threads** – Clickable – Sum over all threads of their active time divided by the application walltime. When clicked, it displays a chart presenting the metric evolution across the time.
- **Affinity Stability (%)** – Not clickable – Sum over all threads of the max time spent on the same CPU divided by the sum over all threads of the thread walltime.
- **Time in analysed loops (%)** – Clickable – Percentage of time spent in application loops, based on the **Profiled Time (s)** value. When clicked, it displays a chart presenting a loop-based profiling.
- **Time in analysed innermost loops (%)** – Clickable - Percentage of time spent in application innermost loops, based on the **Profiled Time (s)** value. When clicked, it displays a chart presenting an innermost loop-based profiling.
- **Time in user code (%)** – Clickable – Percentage of the time spent in the user code, based on the **Profiled Time (s)** value. User code corresponds to the functions located in the application main binary and libraries listed in *external_libraries*. When clicked, it displays a categorization of the application.
- **Compilation Options Score (%)** – Clickable - An analyse of compilation options used to produce the application binary. Several compilation options are checked for each source file found in debug data, and a global score is produced. When clicked, it displays a table detailing for each source file compilation options that are missing to either improved the report accuracy or to obtain good performances with the compiler.
- **Array Access Efficiency (%)** – Not clickable – Indicates if data layout is adapted to processor capabilities or not
- **Perfect Flow Complexity** – Clickable – Optimistic speedup of the application if the number of paths is reduced. When clicked, it displays a categorization of loops based on their path count.
- **Perfect OpenMP + MPI + Pthread** – Not clickable – Optimistic speedup of the application if time spent in OpenMP, MPI and Pthread runtimes is null.
- **Perfect OpenMP + MPI + Pthread + Perfect Load Distribution** – Not clickable – Optimistic speedup of the application if time spent in OpenMP, MPI and Pthread runtimes is null and if all threads are perfectly balanced.
- **No Scalar Integer** – Clickable – Optimistic speedup obtainable if all instructions performing scalar integer computation and address computation are removed from the innermost loops. When clicked, it displays a chart detailing the evolution of the speedup based on which loops are optimized
- **FP Vectorised** – Clickable – Optimistic speedup that can be achieved if all floating-point instructions are vectorised in the innermost loops. When clicked, it displays a chart detailing the evolution of the speedup based on which loops are optimized
- **Fully Vectorised** – Clickable – Optimistic speedup that can be achieved if all instructions are vectorised in the innermost loops. When clicked, it displays a chart detailing the evolution of the speedup based on which loops are optimized
- **FP Arithmetic Only** – Clickable – Optimistic speedup that can be achieved by keeping only arithmetic floating-point instructions. When clicked, it displays a chart detailing the evolution of the speedup based on which loops are optimized

Some additional global metrics are not available in report ONE.

4.1.2.2 Charts

This section details all charts that can be displayed in the chart box.

- **CQA Potential Speedups Summary** – Default chart displayed on the page, it summarizes various speedups (**No Scalar Integer, FP Vectorised, Fully Vectorised**) and their evolution according to the number of optimized loops. The x-axis corresponds to the number of optimized loops. Loops are ordered by their coverage. The y-axis corresponds to an optimistic speedup on the total application time that can be achieved.

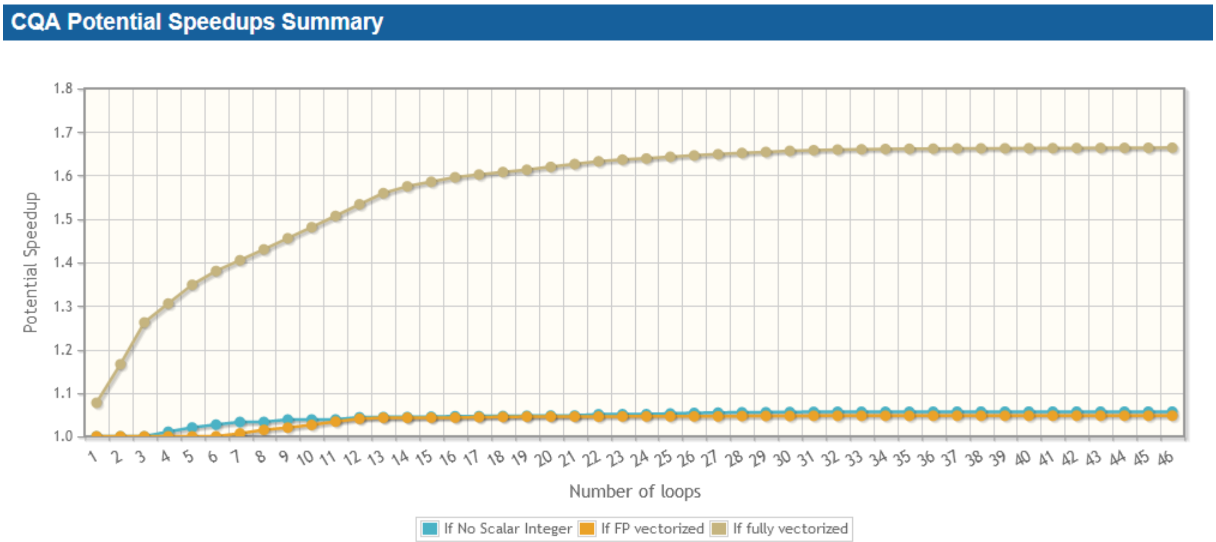


Figure 3- CQA Potential Speedups Summary Chart

- **Average Active Threads Count** – Available through the global metric **Average Number of Active Threads**, the chart displays the number of active threads across the application execution time. The time is split in 100 slices. Bars color varying from blue to red depending on the value (blue means few threads are active, red means all threads are active).

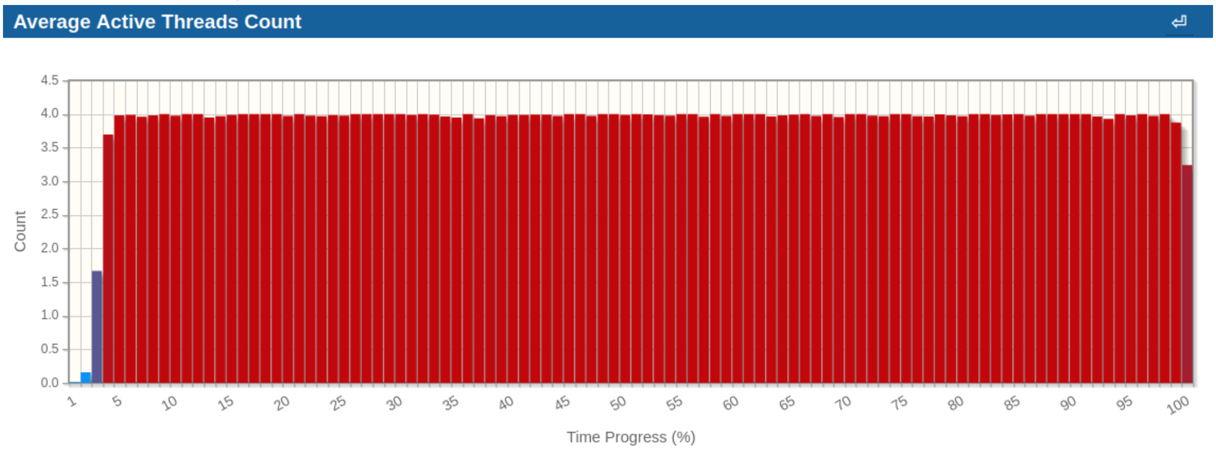


Figure 4 - Average Active Threads Count Chart

- **Loop Based Profile** – Available through the global metric **Time in loops (%)**, the chart displays a profiling of the application at the loop level. Loops are grouped based on their coverage into buckets. Loops are divided into three categories: **Innermost/Single** are loops that don't contain any other loop, **InBetween** loops are loops that contain a least one other loop and are contained in a loop, and **Outermost** loops contains others loops, but are not contained in a loop. For each bucket and each loop category, the chart displays the number of loops and the coverage they represent. In addition, the cumulated coverage across buckets in displayed.

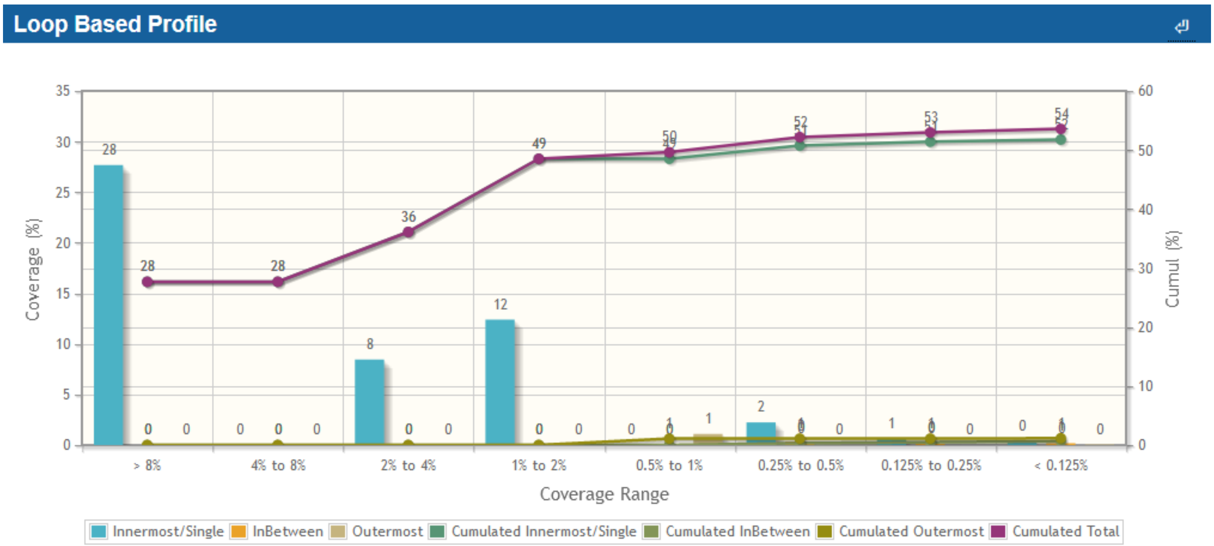


Figure 5- Loop Based Profile Chart

- **Innermost Loop Based Profile** – Available through the global metric **Time in innermost loops (%)**, the chart is similar to **Loop Based Profile**, but it focuses on **Innermost/Single** loops only.

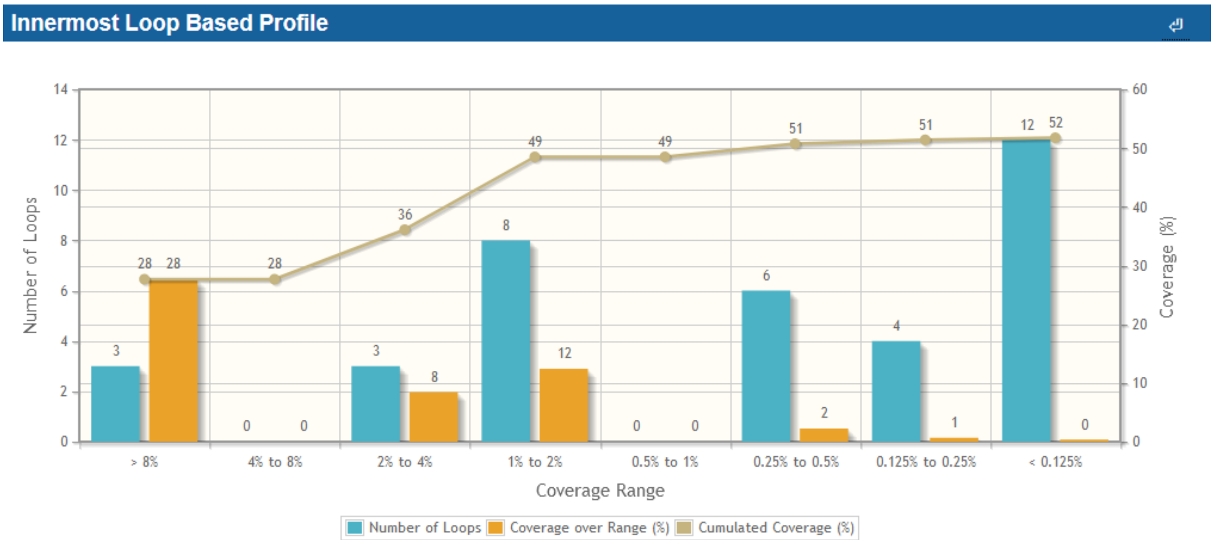


Figure 6 - Innermost Loop Based Profile Chart

- **Application Categorization** - Available through the global metric **Time in user code (%)**, the chart details the percentage of the application spent in various categories.

Custom categories can be created using configuration parameter *custom_categories*.

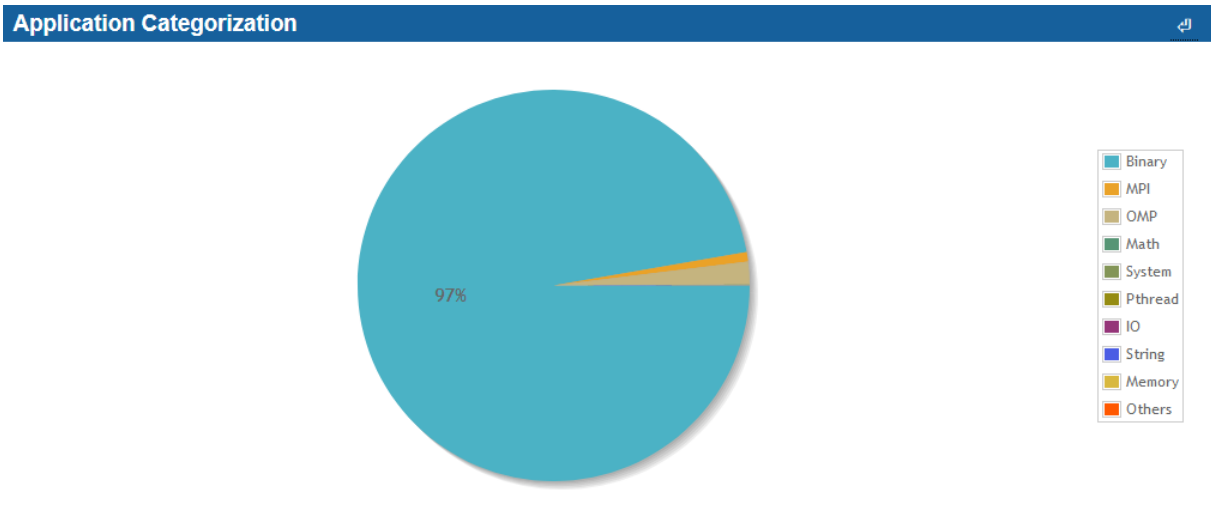


Figure 7- Application Categorization Chart

- **Loop Path Count Profile** – Available through the global metric **Perfect Flow Complexity**, the chart categorizes innermost loops into buckets according to their number of paths. For each bucket, the chart displays the number of loops it contains and how much coverage it represents. In addition, the cumulated coverage across buckets is displayed. The chart allows to detect if the application has potential performances issues because of loops with multiple number of paths.

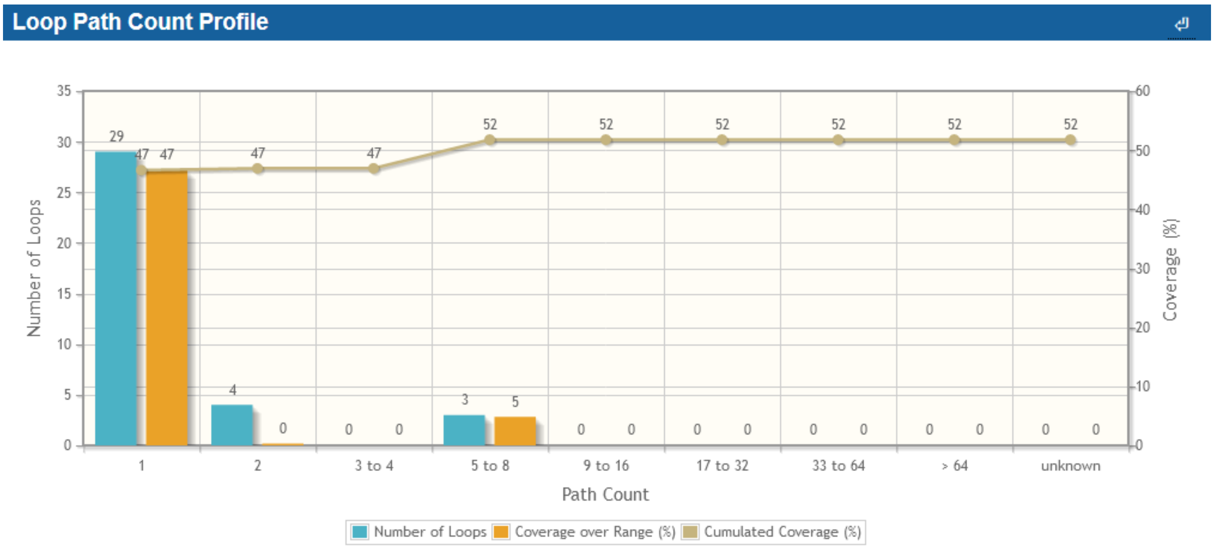


Figure 8 - Loop Path Count Profile Chart

- **Cumulated Speedup If …** - Available through global metrics **No Scalar Integer**, **FP Vectorised** and **Fully Vectorised**, the chart details one specific speedup shown in **CQA Potential Speedups Summary** based on the clicked global metric. The x-axis corresponds to loops sorted by the higher global speedup.

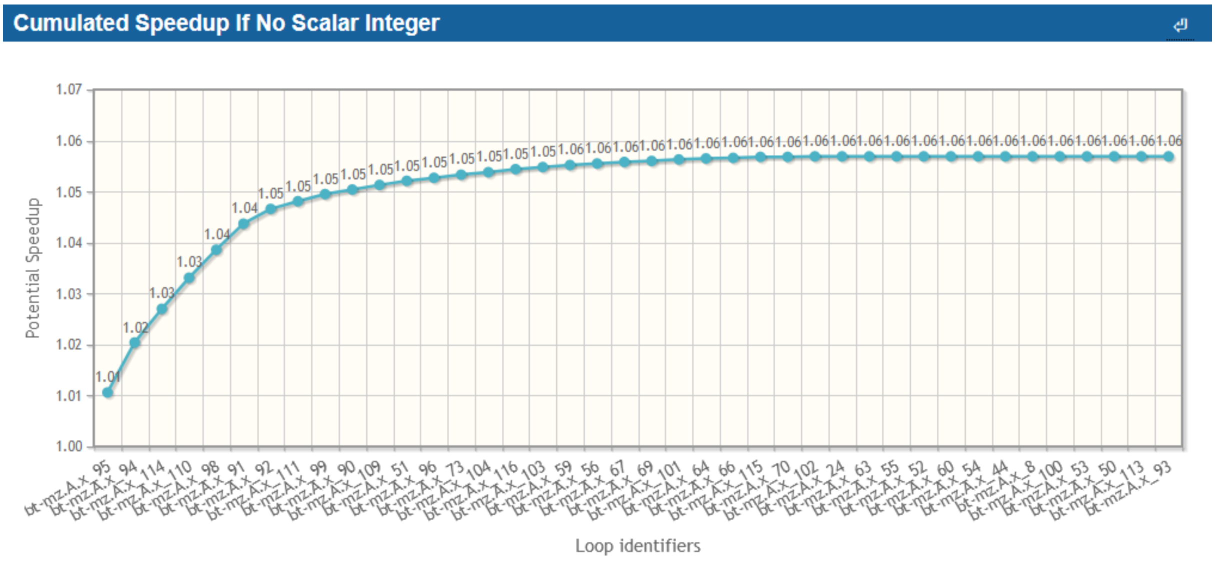


Figure 9 - Cumulated Speedup if … Chart

4.1.3 Summary

The **Summary** tab shows various analysis at the application level and at loop level. It is split in three sections:

4.1.3.1 Stylizer

A basic analysis at application level that checks if the ONE-View run is relevant or if it must be redo after some changes. Each analysis has a score based on the importance of the issue (higher means more important) and a color based on that score (green means everything is good, red means there is an issue that should be fixed in most of time, orange means there is a minor issue).

4.1.3.2 Strategizer

An analysis at application level that checks basic performance metrics. As for Stylizer, each analysis has a score based on the importance of the issue (higher means more important) and a color based on that score (green means everything is good, red means there is an issue that should be fixed in most of time, orange means there is a minor issue).

4.1.3.3 Optimizer

An analysis at loop level that checks performance issues of hotter innermost loops, based on 4 axes:

- **Loop Computation Issues** – Issues related to how numerical computation is done.
- **Control Flow Issues** – Issues related to the loop control flow that could cause performance issues.
- **Data Access Issues** – Issues related to how data is accessed in the loop.
- **Vectorization Roadblocks** – Issues that prevent efficient vectorization.

Each analysis as a score related to the estimated difficulty to fix it. The same analysis can appear several times as it can be related to various analysis axes.

Loops can be clicked to open their own report detailed in section 4.1.8.

4.1.4 Application

The **Application** tab shows several charts available by clicking on the corresponding menu entry on the left. Menu entries whose name started by *Scalability* are only available in *scalability* reports. Other entries are available on all reports.

4.1.4.1 Application Categorization

Similar to the graph of the same name presented in section 4.1.2.2, it details the percentage of the application spent in various categories. The section **Detailed Application Categorization** can be expanded to reveal a table with all data for each thread, process and node. An example is available with Figure 10 - Application Categorization. In this example, there is about 20% of the application time spent in MPI runtime (not MPI parallel sections), 70% in the application code (including parallel regions) and 10% in two other categories.

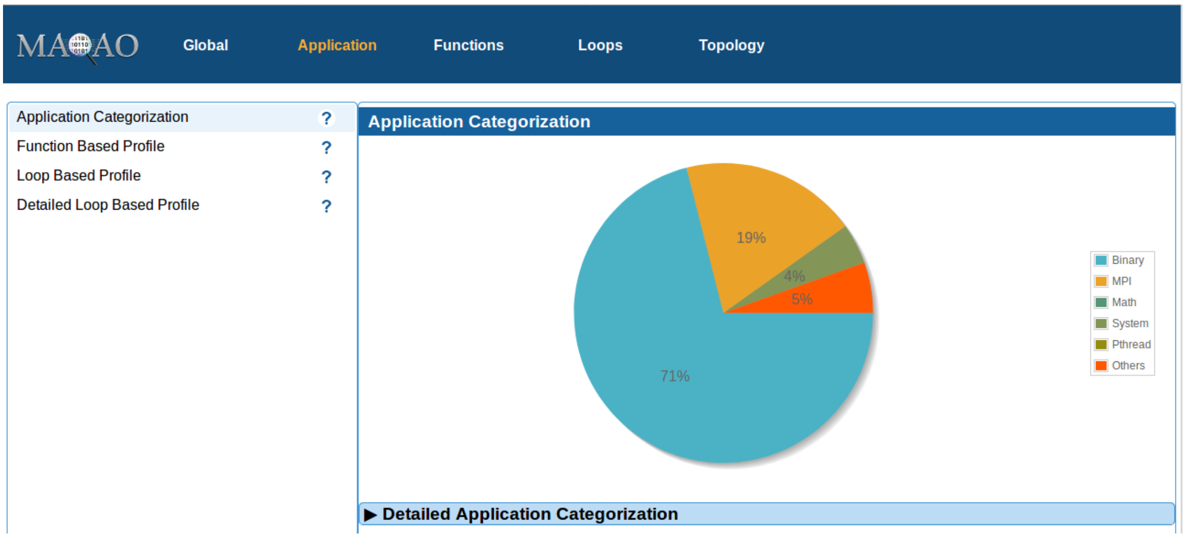


Figure 10 - Application Categorization

4.1.4.2 Function Based Profile

It presents a profiling of the application at the function level. Functions are grouped by coverage in buckets and for each bucket, three metrics are available:

- The number of functions in the bucket,
- The total coverage of the bucket,
- The cumulated coverage with all previous buckets

An example is available with Figure 11 - Function Based Profile. The example presents an application containing five functions with a coverage greater than 8%, which represents 54% of the total time.

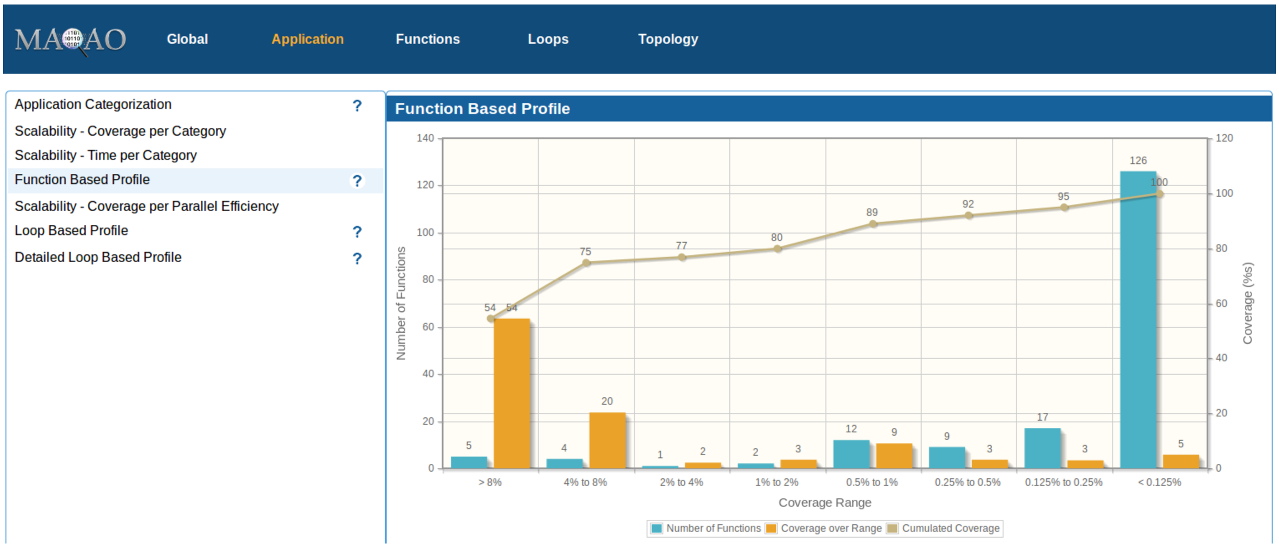


Figure 11 - Function Based Profile

4.1.4.3 Scalability - Coverage Per Category

This view is only available for reports executed with scalability mode enabled. It presents the same data than section 4.1.4.1, but there is one bar per configuration in the scalability parameters. Configurations are formatted as *<nb_processes>-<nb_threads>* It allows to see the impact of the number of processes and threads on the different categories. An example is shown by Figure 12 - Scalability: Coverage Per Category. In the example, we can see the time spent in MPI library increase with the number of processes.

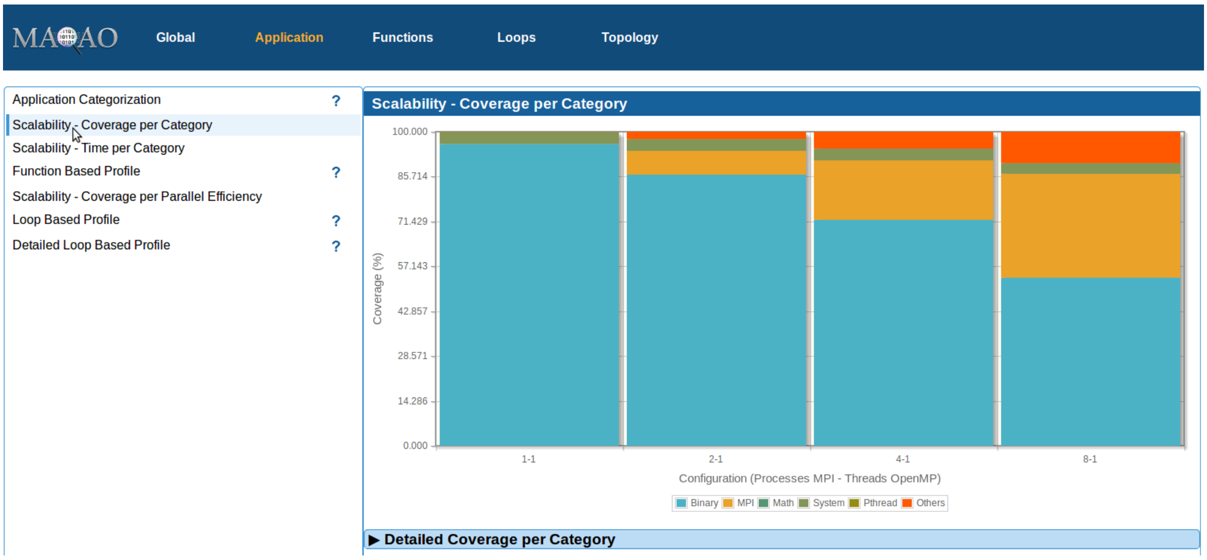


Figure 12 - Scalability: Coverage Per Category

4.1.4.4 Scalability - Time Per Category

This view is only available for reports executed with scalability mode enabled. It presents data similar than section 4.1.4.3, but now displays time (in seconds) instead of coverage. It allows to see the impact of the parallelism over the application time and categories. An example is presented by Figure 13 - Scalability: Time Per Category.

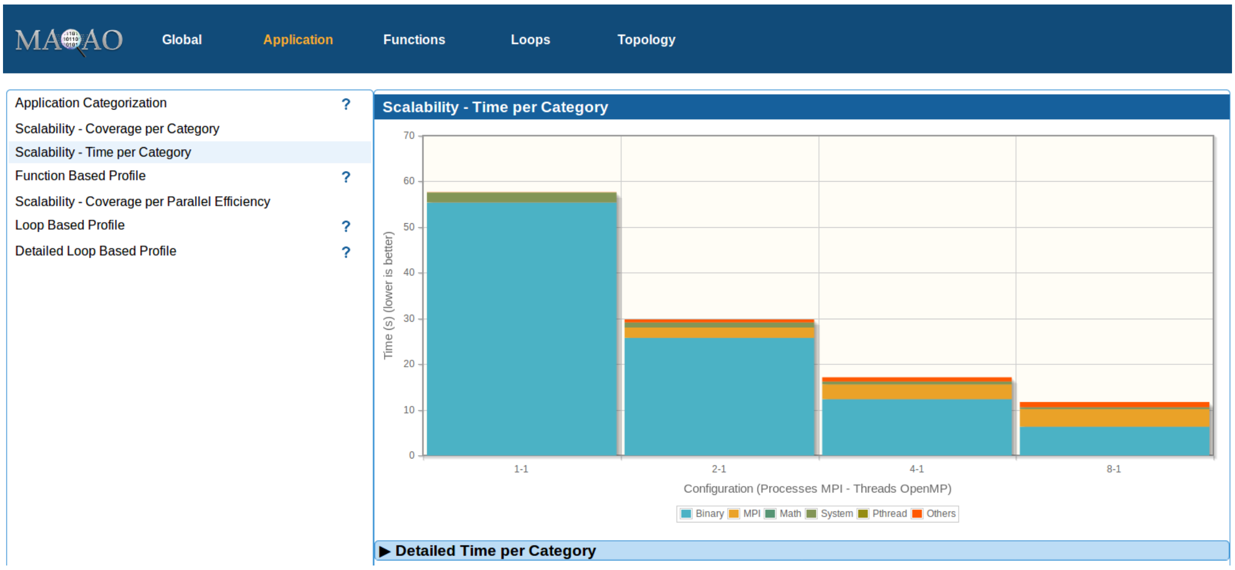


Figure 13 - Scalability: Time Per Category

4.1.4.5 Scalability - Coverage Per Parallel Efficiency

This chart is only available for reports executed with scalability mode enabled. It presents the efficiency of functions across runs of the scalability analysis. The efficiency is based on the first run described in parameters so the first bar is always in the grey color. Grey elements are functions that where not found during the first profiling. Colours varies from green for efficient functions to red for not efficient functions. An example is displayed by Figure 14 - Scalability: Coverage per Parallel Efficiency.

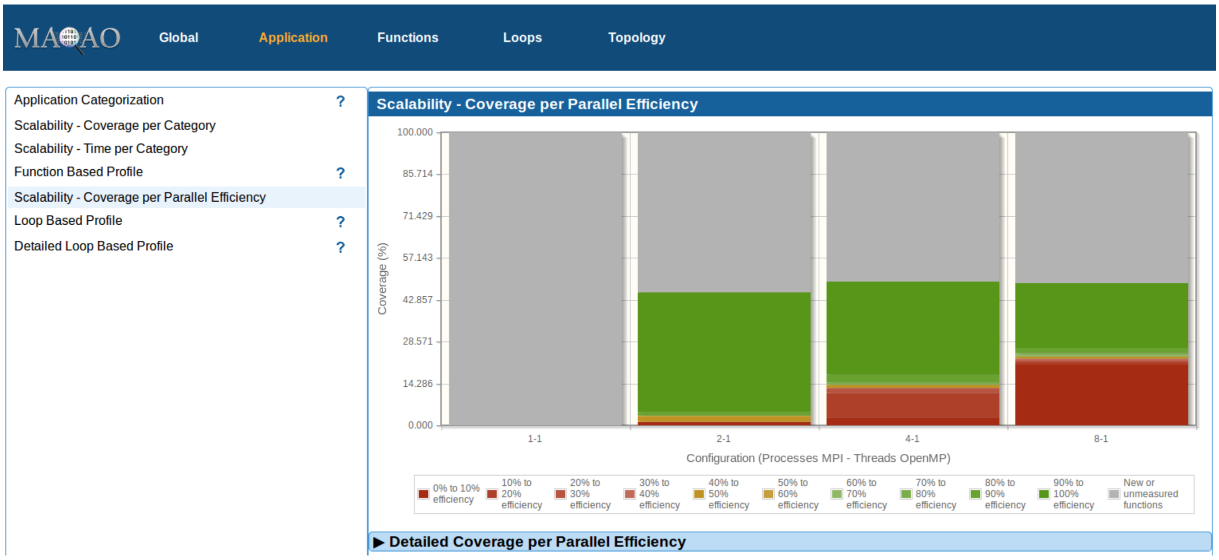


Figure 14 - Scalability: Coverage per Parallel Efficiency

4.1.5 Functions

The **Functions** tab presents a profiling of the application at the function level, listing all detected functions with their coverage. By clicking on the arrow on the left of any function, the box can be opened to reveal all profiled loops belonging to the function represented as a tree. Loops can also be opened by clicking on the left arrow. If a loop has a circle instead of an arrow, it means it is an innermost loop. All coverages are global to the application. A row can be fully expanded by clicking on the symbol + appearing on the right of the current row.

By clicking on a column header, the table is sorted according to this column.

By right-clicking on a row (either loop or function), a menu appears and allows to display several charts:

- Load Distribution: The distribution of the function / loop coverage across threads.
- Sorted Load Distribution: The distribution of the function / loop coverage descending sorted across threads.
- Load Distribution All Threads: The distribution of the function / loop coverage across threads, including 0 values for threads that do not execute the function / loop.
- Scalability Report: Only available in the scalability analysis, it presents the efficiency and the speedup of the functions / loop across all experiments of the scalability analysis.
- Load Callchains: A table displaying call chains of the selected function or loop.
- Go to reports …: Open the detailed report of the selected function or loop in the current tab.

The topmost tab **Filter** allows to filter the functions according to the library where they are defined.

By double-clicking on a function or a loop, a new tab presenting all results for the loop is opened in the browser. Details about loop tabs are described in the subsection **Loop** and details about function tabs are described in the subsection **Function**.

In the scalability report, optional columns can be displayed by clicking on boxes in the list above the table to display efficiency and speedups from the scalability analysis.

4.1.6 Function

The **Function** tab is not accessible from the menu, but only from tabs **Functions** and **Loops**. This tab is split in two panels with a width that can be adjusted by moving the vertical blue bar on the left or on the right. Each panel content can be changed by selecting a report in the select box. Current reports are:

- The source code if available.
- The call chains table.
- The load distributions charts.
- The CQA report. More details about CQA are available in the CQA tutorial available at http://maqao.org/release/MAQAO.Tutorial.CQA.intel64.pdf. Current path can be

changed using arrows in the path selection header or by selecting a path identifier in the text box then clicking on the *OK* button.
- The function loop hierarchy with links to all its loops report.
- In the scalability report, the function scalability report.

The symbol can be clicked to open the current panel in a new browser tab. The same report cannot be opened in both panels.

4.1.7 Loops

The **Loops** tab presents a profiling of the application at the loop level, listing all analysed loops. For each loop, there is the MAQAO identifier, data about the location in the source code and the coverage with a colour associated to it. The colour is red when the loop is hot (high coverage) and it goes to blue when the loop is cold (low coverage).

Additional columns can be displayed by checking to corresponding box just above the table.

By clicking on a column header, the table is sorted according to this column.

By right-clicking on a row, a menu appears and allows to display several charts:

- Load Distribution: The distribution of the loop coverage across threads.
- Sorted Load Distribution: The distribution of the loop coverage descending sorted across threads.
- Load Distribution All Threads: The distribution of the loop coverage across threads, including 0 values for threads that do not execute the loop.
- Scalability Report: Only available in the scalability analysis, it presents the efficiency and the speedup of the loop across all experiments of the scalability analysis.

The topmost tab **Filter** allows to filter the loops according to the library where they are defined.

By double clicking on a loop, a new tab presenting all results for the loop is opened in the browser. Details about this tab are described in the subsection **Loop**.

4.1.8 Loop

The tab **Loop** is not accessible from the menu, but only from tabs **Functions** and **Loops**. This tab contains all available data about a specific loop and is similar than **Function** tab described in section 4.1.6. Its reports are:

- The source code if available,
- The assembly code with a memory group analysis that can be displayed by clicking on the corresponding button. A memory group is a set of assembly instructions that access to a same memory region. Most of the time, it corresponds to a same source data structure.
- The call chains table.
- The load distributions charts
- The CQA report. More details about CQA are available in the CQA tutorial available at http://maqao.org/release/MAQAO.Tutorial.CQA.intel64.pdf. Current path can be changed using arrows in the path selection header or by selecting a path identifier in the text box then clicking on the *OK* button.

- A table with more advanced CQA metrics
- In the scalability report, the function scalability report.

The symbol can be clicked to open the current panel in a new browser tab. The same report cannot be opened in both panels.

4.1.9 Topology

The tab **Topology** presents the topology of the run, meaning how threads, processes and nodes used during the run are organised. The table can be expanded by clicking on the left arrow, or fully expanded by clicking on the + symbol appearing on the right of the current row.

By double-clicking on a thread row, a new tab with the thread profiling at the function level is opened and by right-clicking on it, a contextual menu appears, allowing to open the thread profiling using button **Profile**, or to display a chart describing thread usage across time using button **Usage**.

In the scalability report, additional tables are available for each experiment.

4.2 Text Output

The text report is displayed on the terminal. It can be customized using several options:

- *--text-global [=on/off]*: Display *Global* section if parameter is *on* (default), else do not display it if *off.*
- *--text-summary [=on/off]*: Display *Summary* section if parameter is *on* (default), else do not display it if *off.*
- *--text-application [=on/off]*: Display *Application* section if parameter is *on* (default), else do not display it if *off.*
- *--text-functions [=on/off]*: Display *Functions* section if parameter is *on* (default), else do not display it if *off.*
- *--text-functions-full [=on/off]*: Display all data for *Function* section if parameter is *on* (default), else do not display it if *off.*
- *--text-loops [=on/off]*: Display *Loops* section if parameter is *on* (default), else do not display it if *off.*
- *--text-loops-full [=on/off]*: Display all data for *Loops* section if parameter is *on* (default), else do not display it if *off.*
- *--text-cqa [=on/off/[module:]id1, [module:]id2]*: Display *CQA* section if parameter is *on* (default), else do not display it if *off.* Analysed loops can be filtered by giving for each loop its module (*binary* (default) or an entry in *external_libraries*) and its MAQAO identifier.
- *--text-cqa-full [=on/off/[module:]id1, [module:]id2]* Display all data for *CQA* section if parameter is *on* (default), else do not display it if *off.* Analysed loops can be filtered by giving for each loop its module (*binary* (default) or an entry in *external_libraries*) and its MAQAO identifier.

Default output display sections *Global*, *Summary*, *Application*, *Functions*, *Loops* and *CQA*.

Text report sections are similar to corresponding HTML sections. CQA section is CQA reports of selected loops.

There is no special output for scalability in text output, it will be added in a future update.

4.3 XLSX Output

Available using option *--output-format=xlsx* in the command line, XLSX files can be read by several softwares: Microsoft Office Excel, LibreOffice, OpenOffice. The file contains several tabs with a content presented in HTML section (section 4.1). To generate XLSX reports, the command ‘zip’ must be available.

5 Comparing Reports

During the optimization process, applications are often analysed several times to get results of various changes. As it can be time consuming to compare manually several reports, ONE-View offers a way to generate an HTML report that compare existing ONE-View reports.

```
$ maqao oneview --compare-reports --inputs=<xp1>,<xp2>…
```

There are no restrictions on what can be compared using this option. It handles various applications, architectures, compilations options, source code …

It produces a directory containing an HTML report. **index.html** is the main file and is very similar to what is presented in section 4.1.2, excepted charts compare given runs instead of focusing on a single one. It is shown in Figure 15 - Comparison Index.

To improve the readability of the section **Experiment Summary**, values across runs are compared. However, the comparison of compilation options can fail as source files used for the comparison are selected using their coverages which can change between runs.

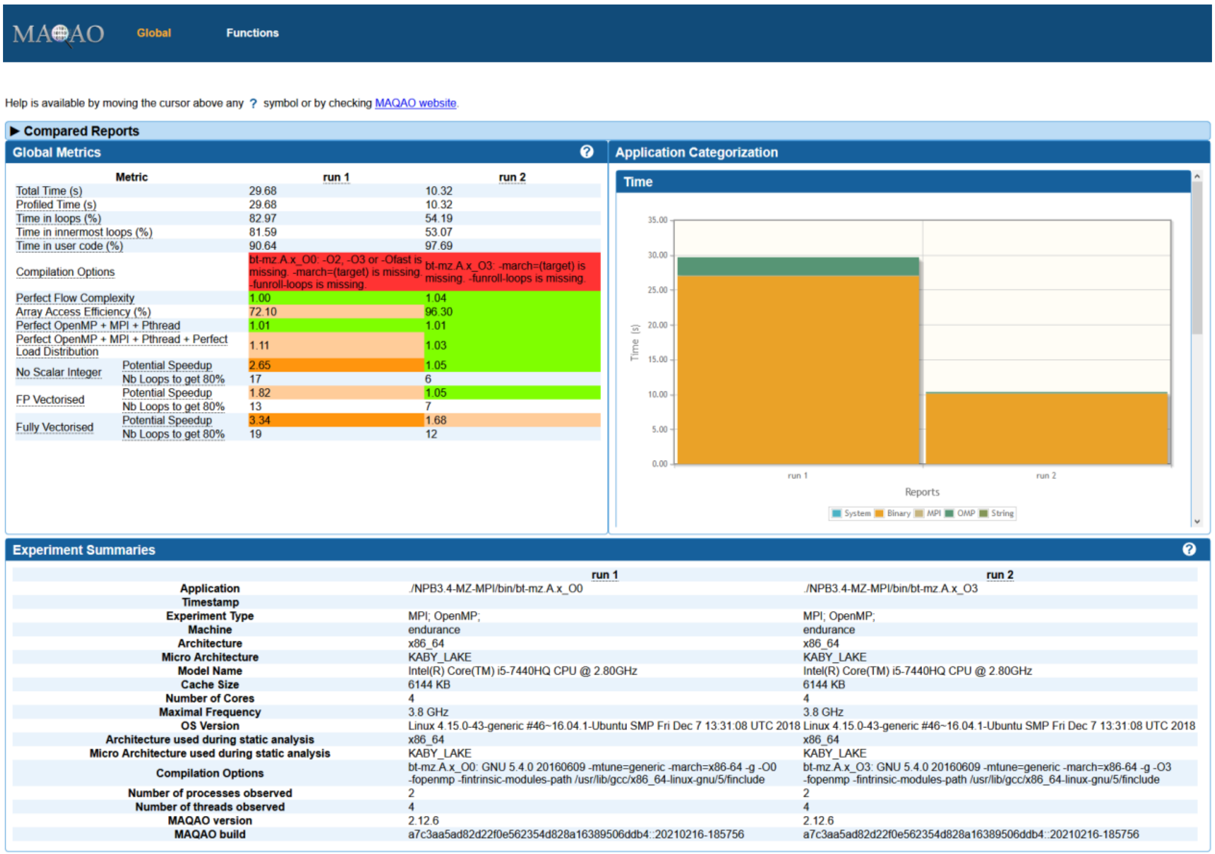


Figure 15 - Comparison Index

summary.html presents a comparison of all **Summary** reports. Sections **Stylizer** and **Strategizer** are similar to what is presented for classic ONE-View report as described in sections 4.1.3.1 and 4.1.3.2. Section **Optimizer** reuses categories described in section 4.1.3.3 to details how many times each issue appears in analysed runs. An example is shown by Figure 16 - Summary Comparison.

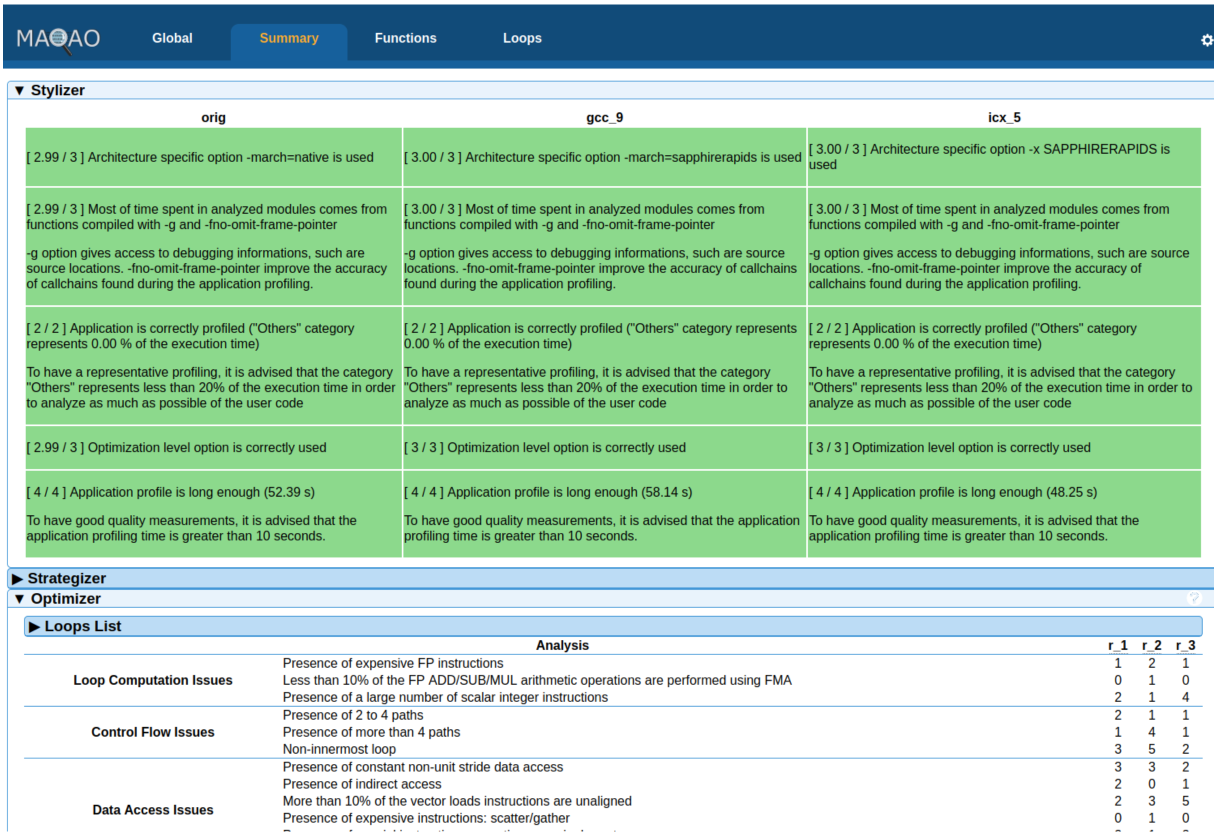


Figure 16 - Summary Comparison

functions.html presents a function-based profile of all the given reports. Results are displayed using two layouts:

- First layout uses source locations to group assembly functions into a virtual source function. Each box contains one source function. This layout can be used when the compiler generated several assembly versions of the same source loop, or when the assembly function renaming is different from a compiler to another one.
- Second layout (named **Old Layout** in the report) uses assembly files and function names to group assembly functions. As there may have a lot of differences between compared experiments, some functions may not appear in all runs and their corresponding values are nil. Rows can be sorted by clicking on any column header.

Both layouts are shown by Figure 17 - Functions Comparison.

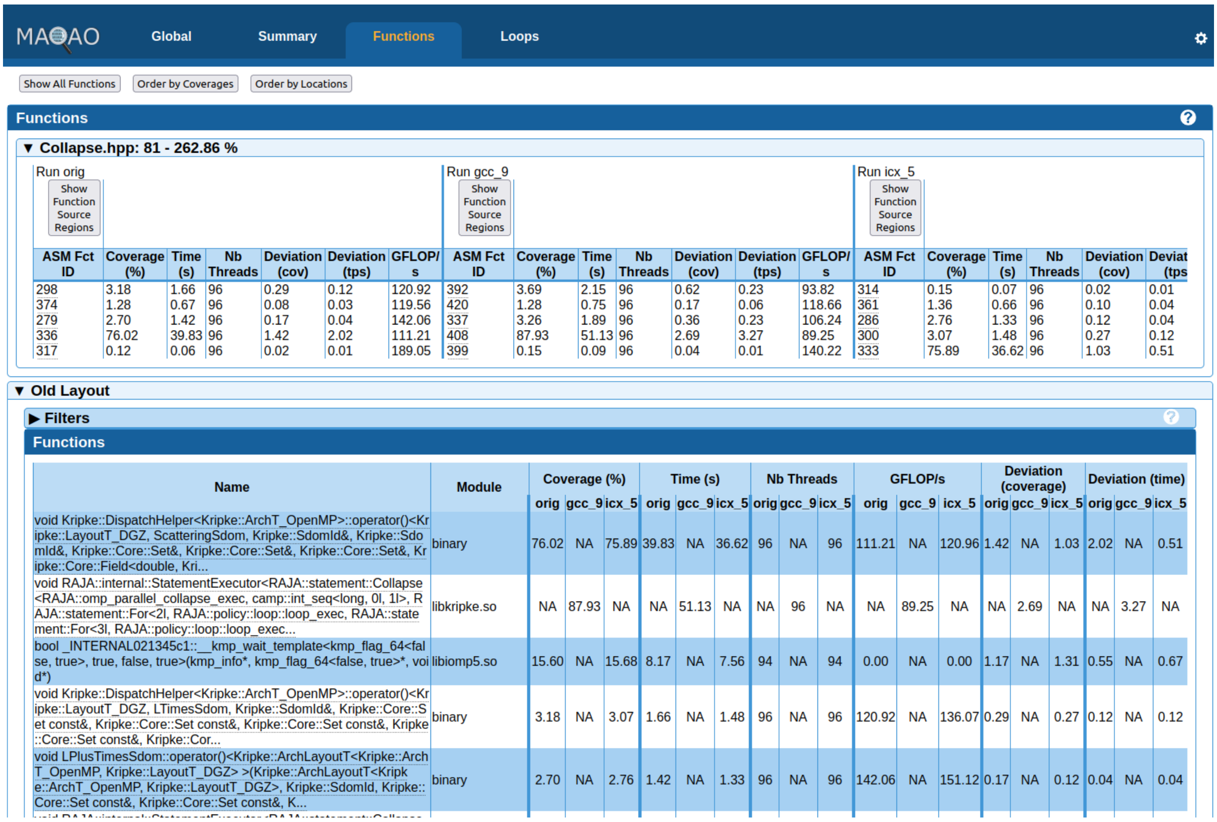
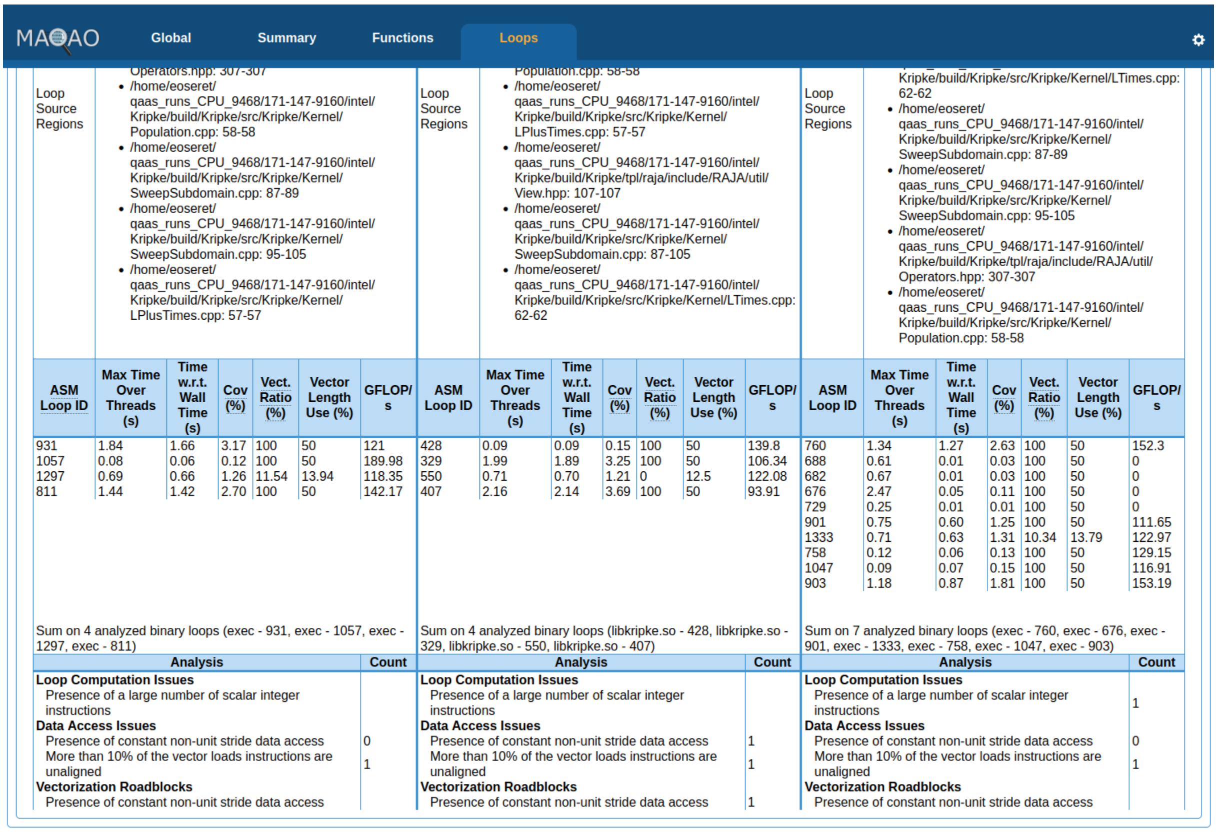


Figure 17 - Functions Comparison

loops.html presents a source loop-based comparison, that is computed by gathering assembly loops that share a common start source location.

Each source loop is a block that can be expanded to display all the matching source regions and some metrics about assembly loops for each run. The coverage associated to the source loop is the sum across all runs of all assembly loop coverages that have been attached to it.

Source loops can be ordered by global coverage (default order) or by source location using buttons on the top of the page. By default, only source functions whose at least one assembly loop has been found in each run are displayed. The button “Show All Loops” can be used to display all found source loops. An example is shown by Figure 18 - Loops Comparison.



Loop Source Regions:
- Operators.hpp: 307-307
- /home/eoseret/qaas_runs_CPU_9468/171-147-9160/intel/Kripke/build/Kripke/src/Kripke/Kernel/Population.cpp: 58-58
- /home/eoseret/qaas_runs_CPU_9468/171-147-9160/intel/Kripke/build/Kripke/src/Kripke/Kernel/SweepSubdomain.cpp: 87-89
- /home/eoseret/qaas_runs_CPU_9468/171-147-9160/intel/Kripke/build/Kripke/src/Kripke/Kernel/SweepSubdomain.cpp: 95-105
- /home/eoseret/qaas_runs_CPU_9468/171-147-9160/intel/Kripke/build/Kripke/src/Kripke/Kernel/LPlusTimes.cpp: 57-57

ASM Loop ID	Max Time Over Threads (s)	Time w.r.t. Wall Time (s)	Cov (%)	Vect. Ratio (%)	Vector Length Use (%)	GFLOP/s
931	1.84	1.66	3.17	100	50	121
1057	0.08	0.06	0.12	100	50	189.98
1297	0.69	0.66	1.26	11.54	13.94	118.35
811	1.44	1.42	2.70	100	50	142.17

Sum on 4 analyzed binary loops (exec - 931, exec - 1057, exec - 1297, exec - 811)

Analysis	Count
Loop Computation Issues	
Presence of a large number of scalar integer instructions	
Data Access Issues	
Presence of constant non-unit stride data access	0
More than 10% of the vector loads instructions are unaligned	1
Vectorization Roadblocks	
Presence of constant non-unit stride data access	

Loop Source Regions:
- Population.cpp: 58-58
- /home/eoseret/qaas_runs_CPU_9468/171-147-9160/intel/Kripke/build/Kripke/src/Kripke/Kernel/LPlusTimes.cpp: 57-57
- /home/eoseret/qaas_runs_CPU_9468/171-147-9160/intel/Kripke/build/Kripke/tpl/raja/include/RAJA/util/View.hpp: 107-107
- /home/eoseret/qaas_runs_CPU_9468/171-147-9160/intel/Kripke/build/Kripke/src/Kripke/Kernel/SweepSubdomain.cpp: 87-105
- /home/eoseret/qaas_runs_CPU_9468/171-147-9160/intel/Kripke/build/Kripke/src/Kripke/Kernel/LTimes.cpp: 62-62

ASM Loop ID	Max Time Over Threads (s)	Time w.r.t. Wall Time (s)	Cov (%)	Vect. Ratio (%)	Vector Length Use (%)	GFLOP/s
428	0.09	0.09	0.15	100	50	139.8
329	1.99	1.89	3.25	100	50	106.34
550	0.71	0.70	1.21	0	12.5	122.08
407	2.16	2.14	3.69	100	50	93.91

Sum on 4 analyzed binary loops (libkripke.so - 428, libkripke.so - 329, libkripke.so - 550, libkripke.so - 407)

Analysis	Count
Loop Computation Issues	
Presence of a large number of scalar integer instructions	
Data Access Issues	
Presence of constant non-unit stride data access	1
More than 10% of the vector loads instructions are unaligned	1
Vectorization Roadblocks	
Presence of constant non-unit stride data access	1

Loop Source Regions:
- Kripke/build/Kripke/src/Kripke/Kernel/LTimes.cpp: 62-62
- /home/eoseret/qaas_runs_CPU_9468/171-147-9160/intel/Kripke/build/Kripke/src/Kripke/Kernel/SweepSubdomain.cpp: 87-89
- /home/eoseret/qaas_runs_CPU_9468/171-147-9160/intel/Kripke/build/Kripke/src/Kripke/Kernel/SweepSubdomain.cpp: 95-105
- /home/eoseret/qaas_runs_CPU_9468/171-147-9160/intel/Kripke/build/Kripke/tpl/raja/include/RAJA/util/Operators.hpp: 307-307
- /home/eoseret/qaas_runs_CPU_9468/171-147-9160/intel/Kripke/build/Kripke/src/Kripke/Kernel/Population.cpp: 58-58

ASM Loop ID	Max Time Over Threads (s)	Time w.r.t. Wall Time (s)	Cov (%)	Vect. Ratio (%)	Vector Length Use (%)	GFLOP/s
760	1.34	1.27	2.63	100	50	152.3
688	0.61	0.01	0.03	100	50	0
682	0.67	0.01	0.03	100	50	0
676	2.47	0.05	0.11	100	50	0
729	0.25	0.01	0.01	100	50	0
901	0.75	0.60	1.25	100	50	111.65
1333	0.71	0.63	1.31	10.34	13.79	122.97
758	0.12	0.06	0.13	100	50	129.15
1047	0.09	0.07	0.15	100	50	116.91
903	1.18	0.87	1.81	100	50	153.19

Sum on 7 analyzed binary loops (exec - 760, exec - 676, exec - 901, exec - 1333, exec - 758, exec - 1047, exec - 903)

Analysis	Count
Loop Computation Issues	
Presence of a large number of scalar integer instructions	1
Data Access Issues	
Presence of constant non-unit stride data access	0
More than 10% of the vector loads instructions are unaligned	1
Vectorization Roadblocks	
Presence of constant non-unit stride data access	

Figure 18 - Loops Comparison

6 Stability Report

```
$ maqao oneview --analyze-stability -c=<config> […]
```

ONE-View can be used to analyze an application or system stability by running and measuring the application several times and then computes statistics across runs.

Several specific options can be used to customize the analysis:

- *-rep / --repetitions* – Select how many times the application must be run. Default value is 31.
- *--delay* – Define a delay in second between two consecutive runs. Default value is 0.
- *--ranges-count* – Define the number of ranges used in statistics computation. Default is 20.
- *--outliers-count* – Define how many outliers runs must be removed during statistics computation. Default is 0.

Other options detailed in sections 3.2 and 3.3 can also be used to customize or configure a run to generate stability reports.

6.1 Global

As presented in section 4.1.2 and shown by Figure 19 - Stability Index, the file **index.html** is the report index and it presents several sections. Only the content of the chart section, shown by Figure 20 - Stability Charts will be detailed.

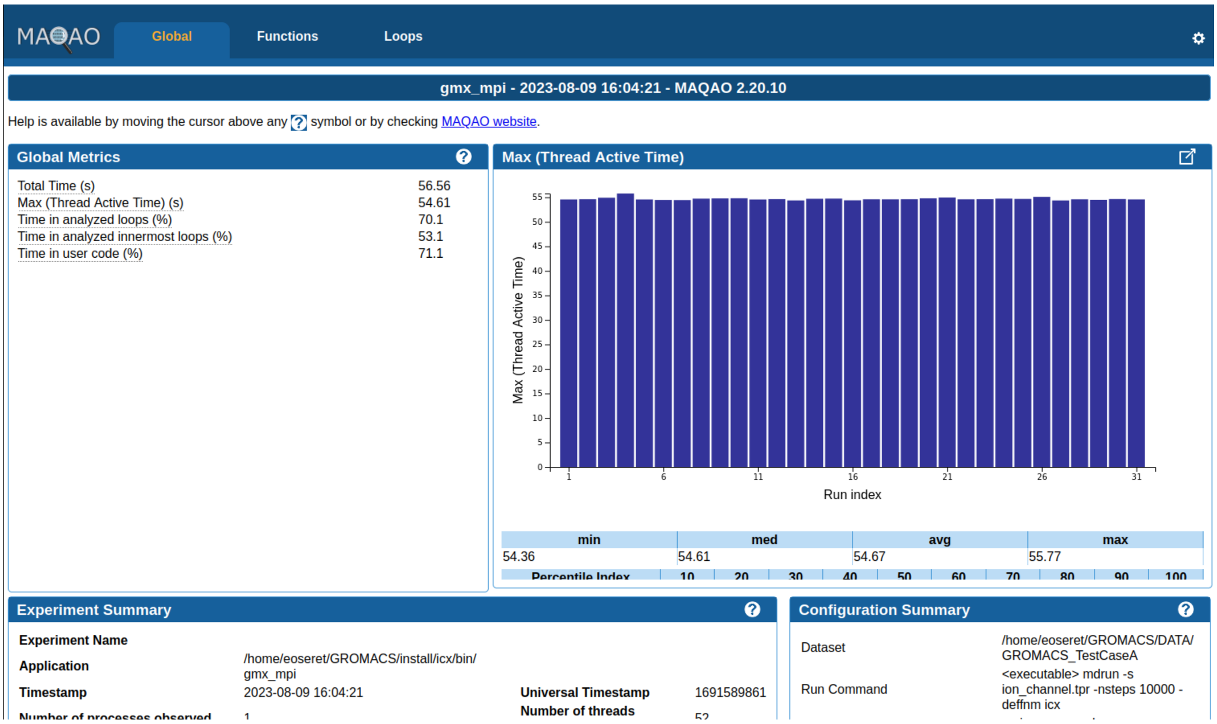
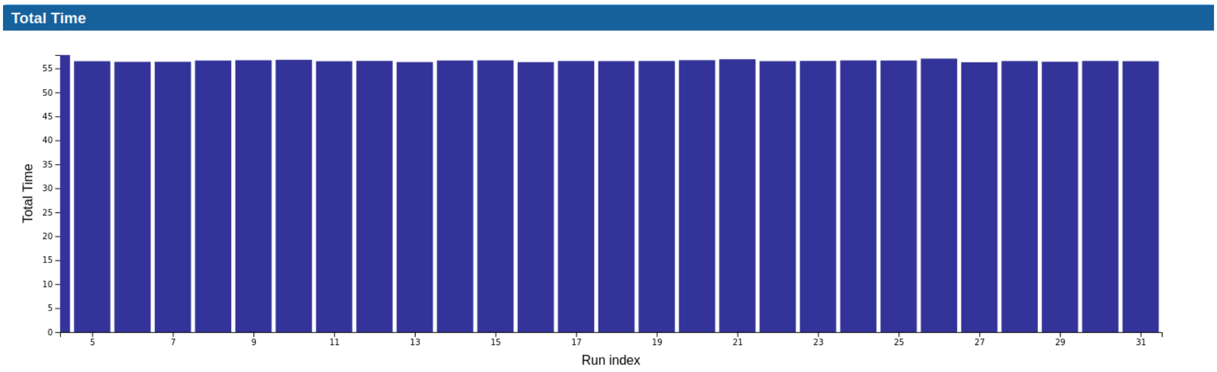


Figure 19 - Stability Index

Chart section contains:

- A first bar chart presenting the selected metric value across all runs,
- Some basic statistics computed on these values (minimum, median, average and maximum),
- A percentile repartition,
- A second bar chart presenting the distribution of values into ranges. Ranges are determined by splitting the interval between the minimum and the maximum into several sub intervals that have the same size.



min	med	avg	max
56.28	56.56	56.62	57.79

Percentile Index	10	20	30	40	50	60	70	80	90	100
Value	56.32	56.40	56.51	56.53	56.55	56.57	56.65	56.68	56.79	57.79

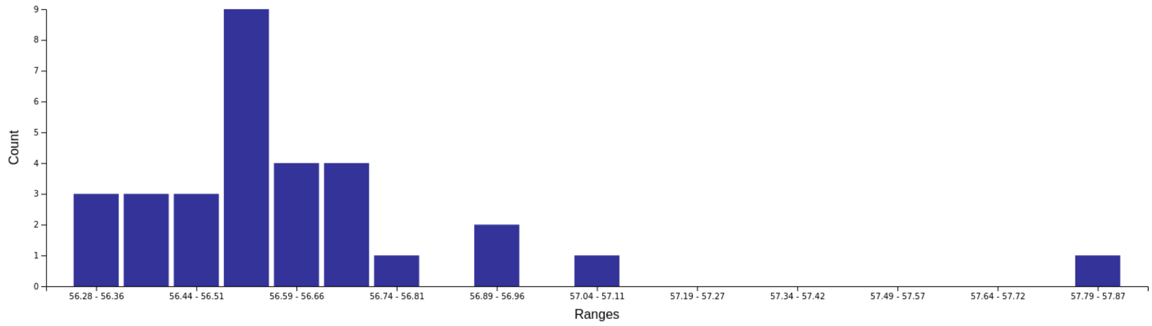


Figure 20 - Stability Charts

6.2 Functions

functions.html reuses what is presented in Section 4.1.5 with metrics specific to stability reports. Each function / loop can be double clicked to open the corresponding object report in a new page.

6.3 Loops

loops.html presents a listing of innermost loops, sorted by their coverage. Data can be sorted by clicking on any column header, columns can be displayed / hidden using checkboxes in the section Columns Filter, and each metric can be clicked to display charts and data presented in the chart section from section 6.1. Loop IDs can be clicked to display the corresponding loop report

6.4 Loop / Function

Each function and loop has its own report that contains two sections:

- On the left side, the object source code
- On the right side, data and charts presented in Section 6.1. The displayed metric can be selected using the top scrolling list.