Interactive Performance Profiling and Debugging

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Profiling today

- `gprof`
  - compile-time instrumentation of function calls
  - whole execution
- `perf stat`
  - OS hooks for hardware counters
  - whole execution or attach/detach
- `papi`
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  - manual code instrumentation
- trace-based post-mortem analyzers
  - runtime library instrumentation

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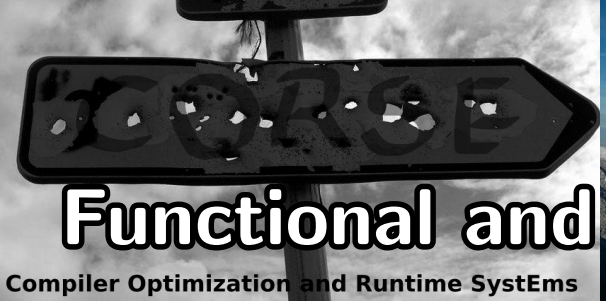
Let's combine them into an interactive profiling tool![a]

[a] only sequential executions / at language-level for now.



Functional and Performance Source-level Debugging

Compiler Optimization and Runtime SystEms

Functional Interactive debugging

- Navigate in the application execution
- Study its current memory state and execution paths
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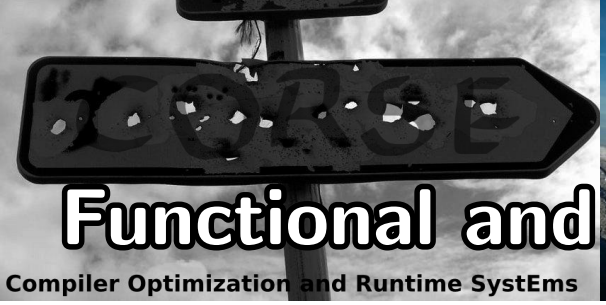

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Experimentation prototype developed as a GDB Python extension

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- Outside of the normal execution:
  - we'll discuss it a bit later

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What is measured?

- `/proc/PID/...` values (*mem usage*, *context switches*, ...)
- `perf stat` counters
  - `LD_PRELOAD` patch to support on-demand counter dump
  - *task-clock*, *context-switches*, *cpu-migrations*, *page-faults*, *cycles*, *instructions*, *branches*, ...
- `gprof` counters
  - preliminary and on-going (inspection of `glibc` profiling counters)
  - call-graph, time per function, ...
- function/address execution count (breakpoints involved)

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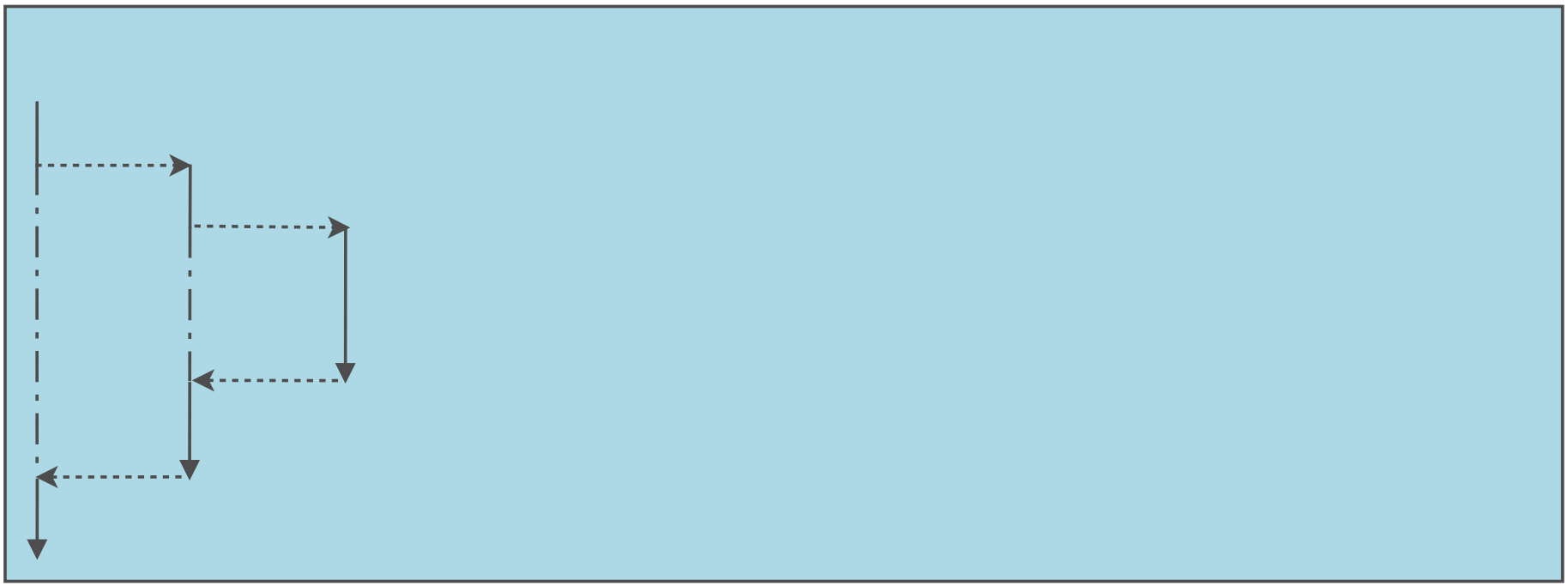

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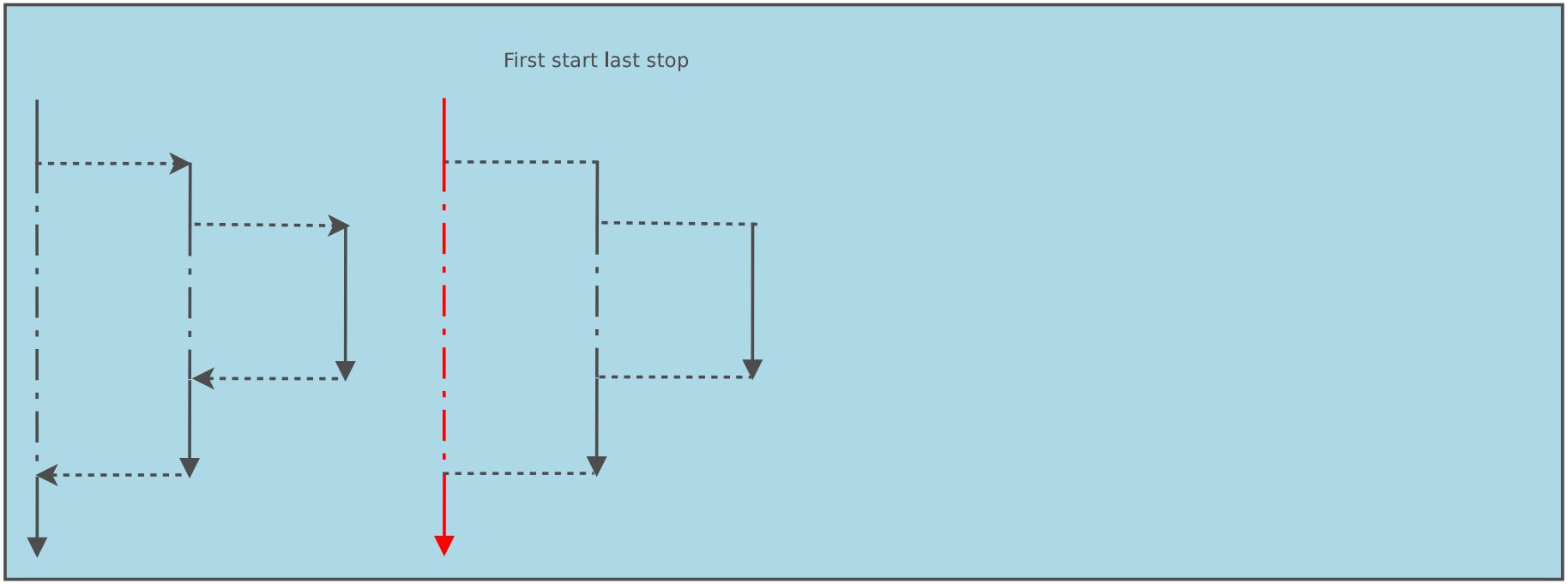

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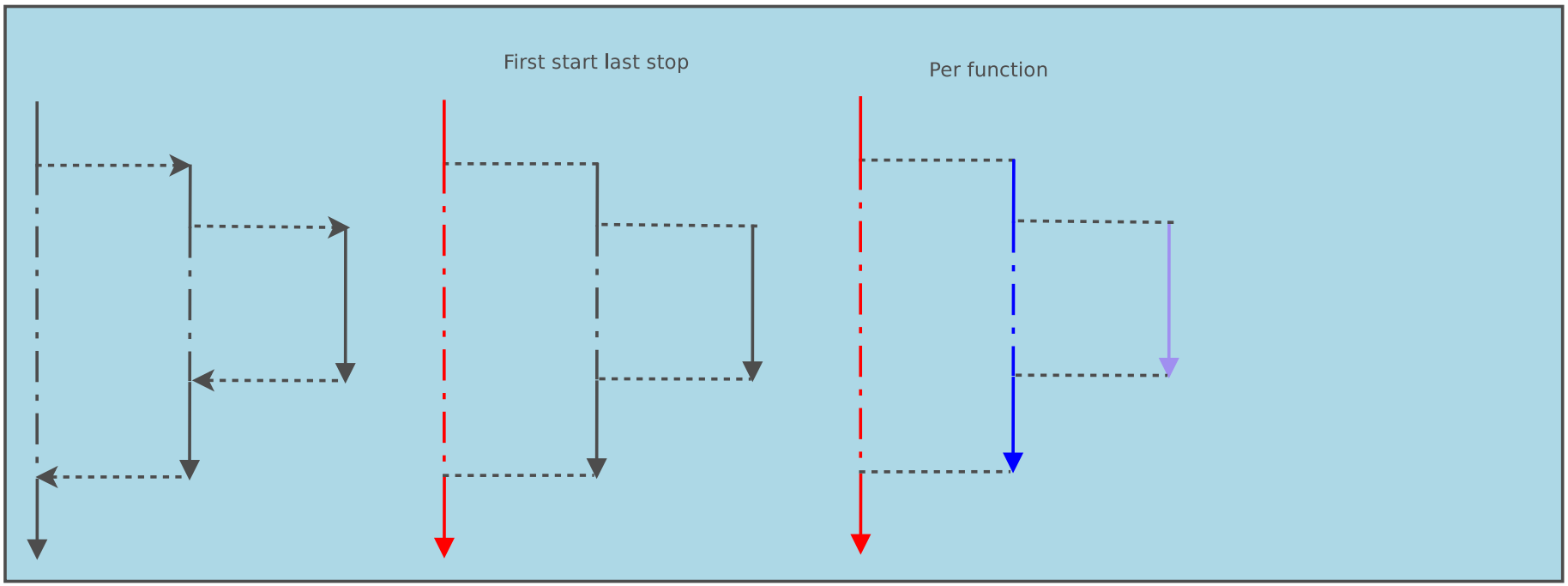

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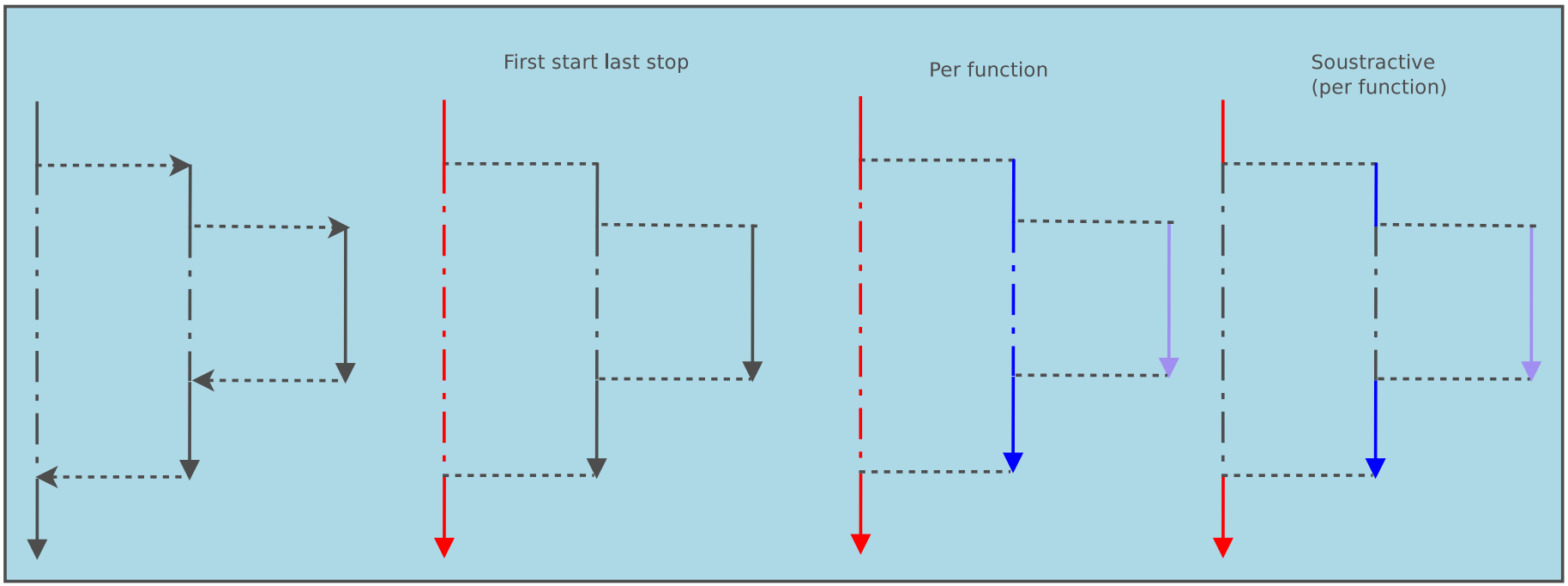

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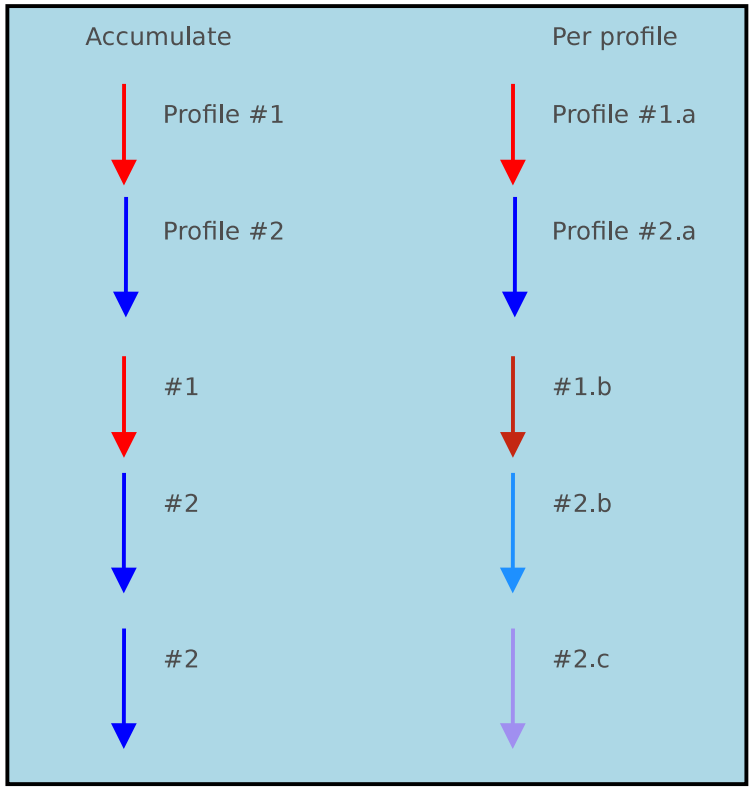

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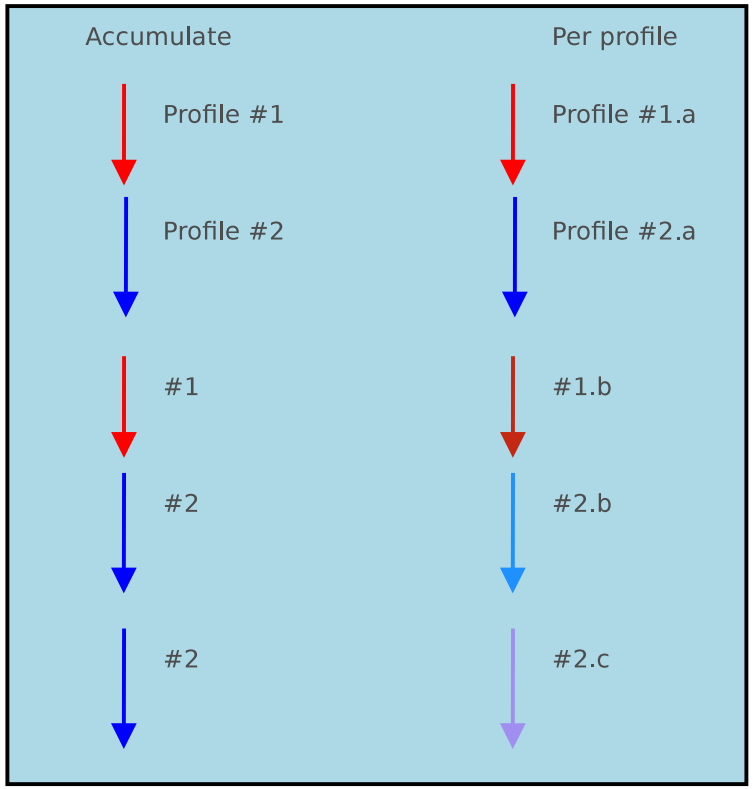
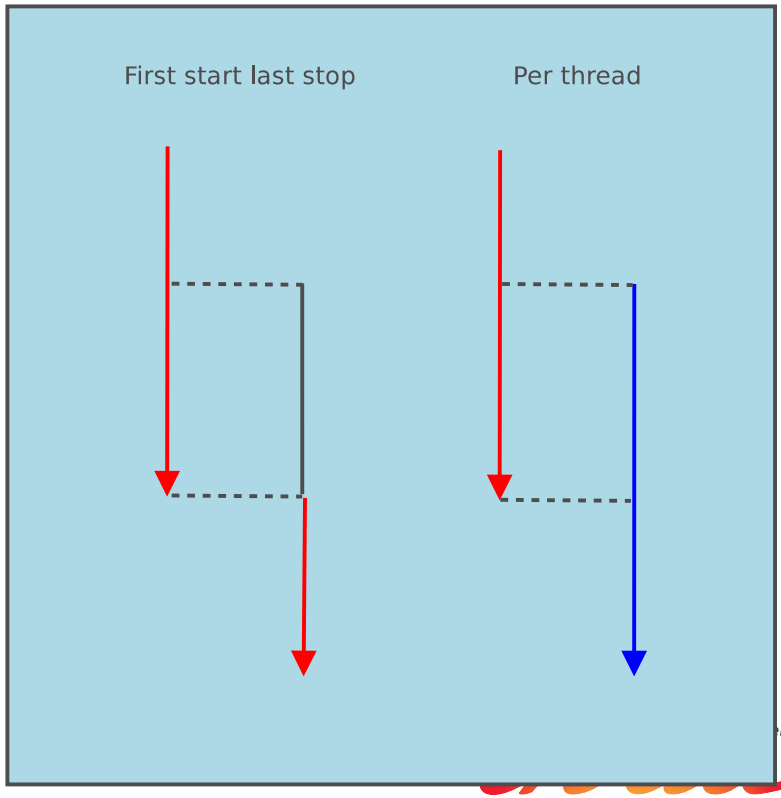


... and concurrent hits ?



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- `(gdb) profile interactive`
  - `-repeat:10`
  - `-code: fct(param1, param2, ...)`

$\Longrightarrow$ generates:

```
/* start profiling */
for(int i = 0; i < 10; i++) fct(param1, param2, ...);
/* stop profiling */
```

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- "side-effect" free code only
  - at least no dependency on overwritten values

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```
| function profile[compute_forces_crust_mantle_dev]
| ================================================
| min_flt:                                    13
| cycles:                            113,705,103
| branch-misses                          110,791
| task-clock:                             39.381
| branches:                           10,622,409
| instructions:                      188,404,850
| stalled-cycles-frontend:            50,032,346
| stalled-cycles-backend:             15,004,422
| ...
|
```

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```
| cycles                          avg:  11553677
|                                 min:     13549
|                                 max: 218766806
| -------------------------------
| stalled-cycles-backend          avg:  1517803
|                                 min:  1178455
|                                 max: 26184303
| -------------------------------
| instructions                    avg:  19149774
|                                 min:     18745
|                                 max: 367804777
| ...
```

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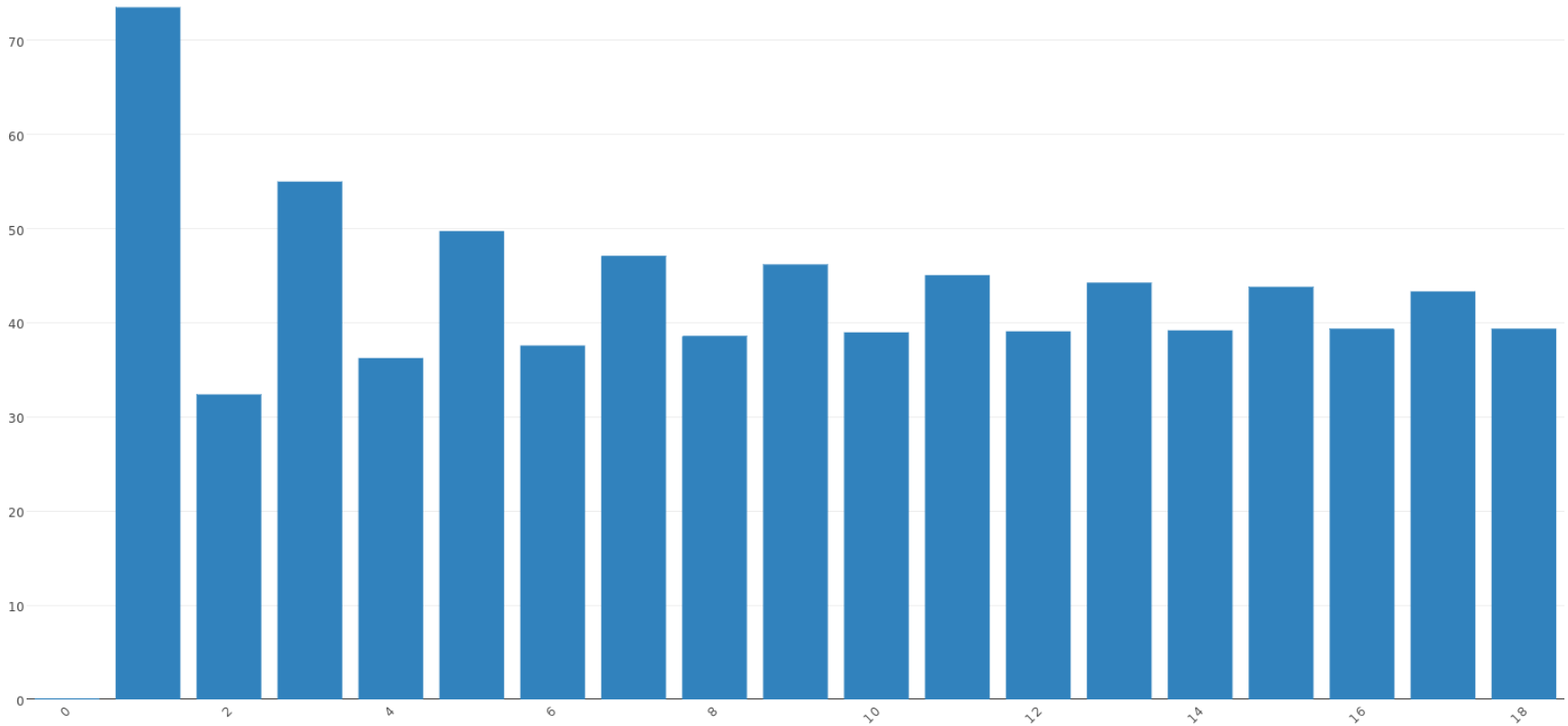

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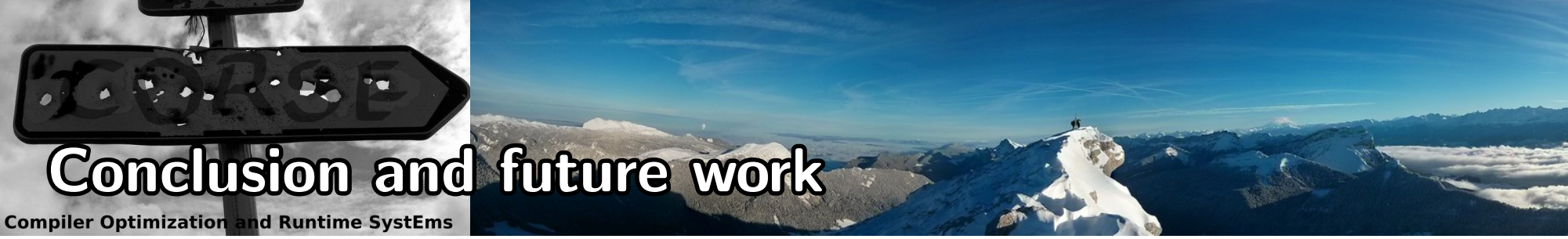

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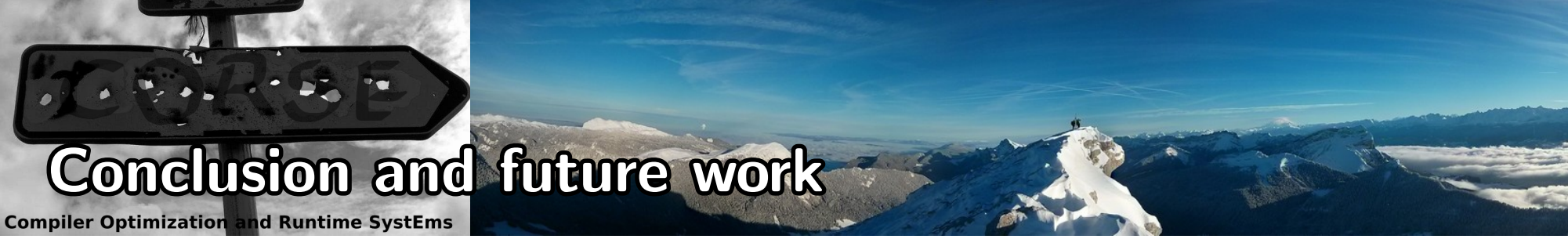

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- Profile real-world applications to demonstrate usability
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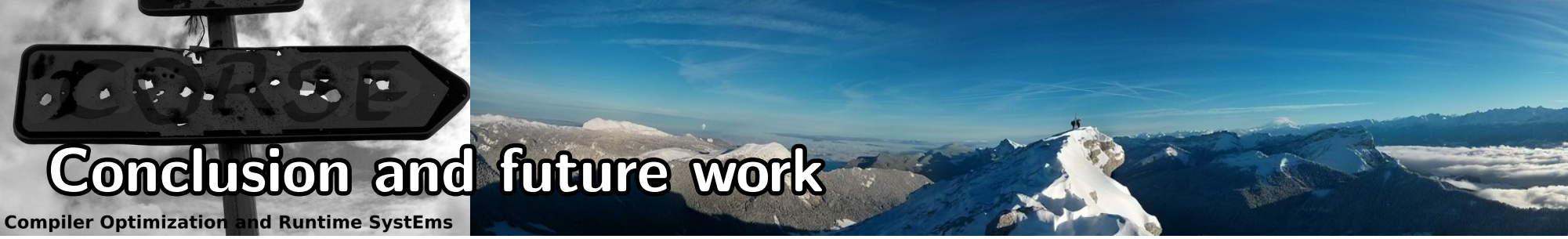

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- Extend to multithreaded environments
- Integrate with mcGDB and its programming models (OpenMP)
  - focus on task/task-graph execution ?

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