temci Documentation

Release 0.7.0

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Contents

An advanced benchmarking tool written in python3 that supports binary randomization and the generation of visually appealing reports.

It runs on sufficiently new linux systems and (rudimentary) on Apple's OS X systems.

The development started as part of my bachelor thesis in october 2015. The bachelor thesis (written in german) can be found here.

CHAPTER 1

Why should you use temci?

temci allows you to easily measure the execution time (and other things) of programs and compare them against each other resulting in a pretty HTML5 based report. Furthermore it set's up the environment to ensure benchmarking results with a low variance and use some kind of assembly randomisation to reduce the effect of caching.

CHAPTER 2

Installation

Installing temci on linux systems should be possible by just installing it via `pip3`:

```
pip3 install temci
```

If this results in any problems or you're on an Apple system, visit the Installation page. Open an issue in the issue tracker if you experience any weird errors.

To simplify using temci, enable tab completion for your favorite shell (bash and zsh are supported) by adding the following line to your bash or zsh configuration file

```
source `temci_completion [bash|zsh]`
```

If you can't install temci via *pip3*, using it to benchmark programs is possible by using *temci/scripts/run* instead of temci (execute this file with your favorite python3 interpreter directly if this interpreter isn't located at */usr/bin/python3*).

CHAPTER 3

Usage

Side note: This tool needs root privileges for some benchmarking features. If you're not root, it will not fail, but it will warn you and disable the features.

There are currently two good ways to explore the features of temci: 1. Play around with temci using the provided tab completion for zsh (preferred) and bash 2. Look into the annotated settings file (it can be generated via `temci init settings`).

A user guide is planned. Until it's finished consider reading the code documentation.

A documentation of all command line commands and options is given in the documentation for the cli module.

A documentation for all available run drivers, runners and run driver plugins is given in the documentation for the run module

The status of the documentation is given in the section *Status of the documentation*.

CHAPTER 4

Geting started with simple benchmarking

Or: How to benchmarking a simple program called ls (a program is every valid shell code that is executable by /bin/sh)

There are two ways to benchmark a program: A short and a long one.

The short one first: Just type:

```
temci short exec -wd "ls" --runs 100 --out out.yaml
```

Explanation:

- `short` is the category of small helper subprograms that allow to use some temci features without config files
- `-wd` is the short option for `--without_description` an tells temci to use the program as its own description
- `ls` is the executed program
- `--runs 100` is short for `--min_runs 100 --max_runs 100`
- `--min_runs 100` tells temci to benchmark `ls` at least 100 times (the default value is currently 20)
- `--max_runs 100` tells temci to benchmark `ls` at most 100 times (the default value is currently 100)
- setting min and max runs non equal makes only sense when comparing two or more programs via temci
- `--out out.yaml` tells temci to store the YAML result file as `out.yaml` (default is `result.yaml`)

The long one now: Just type

```
temci init run_config
```

This let's you create a temci run config file by using a textual interface (if you don't want to create it entirely by hand). To actually run the configuration type:

```
temci exec [file you stored the run config in] --out out.yaml
```

Explanation:

- `exec` is the sub program that takes a run config an benchmarks all the included program blocks
- `--out out.yaml` tells temci where to store the YAML file containing the benchmarking results
- the measured `__ov-time` property is just a time information used by temci internally

Now you have a YAML result file that has the following structure:

```
- attributes:
    description: ls
  data:
```

```
    ...
    task-clock:
       - [first measurement for property task-clock]
       - ...
    ...
```

You can either create a report by parsing the YAML file yourself or by using the temci report tool. To use the latter type:

```
temci report out.yaml --reporter html2 --html2_out ls_report
```

Explanation:

- `out.yaml` is the previously generated benchmarking result file
- `--reporter html2` tells temci to use the HTML2Reporter. This reporter creates a fancy HTML5 based report in the folder `ls_report`. The main HTML file is named `report.html`. Other possible reporters are `html` and `console`. The default reporter is `html2`
- `--html2_out` tells the HTML2Reporter the folder in which to place the report.

Now you have a report on the performance of `ls`.

4.1 How to go further from here

- Benchmark two programs against each other either by adding a `-wd [other program]` to the command line or appending the run config file (also possible via `temci init run_config`)
- If using `temci short exec`
  - add a better description for the benchmarked program by using `-d [DESCRIPTION] [PROGRAM]` instead `-wd`. `-d` is short for `--with_description`
- If using `temci init run_config`:
  - Choose another set of measured properties (e.g. to measure the LL1 cache misses)
  - Change the used runner. The default runner is `time` and uses `time` (gnu time, not shell builtin) to actually measure the program. Other possible runners are for example `perf_stat`, `rusage` and `spec`:
    - The `perf_stat` runner that uses the `perf` tool (especially `perf stat`) to measure the performance and read performance counters.
    - The `rusage` runner uses a small C wrapper around the `getrusage(2)` system call to measure things like the maximum resource usage (it's comparable to `time`)
    - The `spec` runner gets its measurements by parsing a SPEC benchmark like result file. This allows using the SPEC benchmark with temci.
- Append `--send_mail [your email adress]` to get a mail after the benchmarking finished. This mail has the benchmarking result file in it's appendix
- Try to benchmark a failing program (e.g. "lsabc"). temci will create a new run config file (with the ending ".erroneous.yaml" that contains all failing run program blocks. Try to append the benchmarking result via "–append" to the original benchmarking result file.

CHAPTER 5

Why is temci called temci?

The problem in naming programs is that most good program names are already taken. A good program or project name has (in my opinion) the following properties: - it shouldn't be used on the relevant platforms (in this case: github and pypi) - it should be short (no one want's to type long program names) - it should be pronounceable - it should have at least something to do with the program temci is such a name. It's lojban for time (i.e. the time duration between to moments or events).

CHAPTER 6

Contributing

Bug reports and code contributions are highly appreciated.

CHAPTER 7

Status of the documentation

README/this page	Work in progress
Installation	Finished
Resources	Finished

CHAPTER 8

Contents of this documentation

8.1 Installation

8.1.1 System Requirements

- Linux (although Apples OS X works to a certain degree), a kernel version >= 2.6.31 is recommended
- Processor with an x86 or AMD64 architecture (although most features should work on ARM too)
- python with a version >= 3.3

8.1.2 Required packages

temci depends on the existence of some packages that aren't installible via *pip*. The following commands install the normally needed packages.

On **Ubuntu** or **Debian** (or a similar distribution) execute the following command with super user privileges:

```
apt-get install python3-pandas python3-cffi python3-cairo python3-cairocffi python3-matplotlib pytho
```

On **Fedora** (or similar distribution using the *dnf* or *yum* package manager) execute the following command with super user privileges:

```
dnf install python3-pandas python3-cffi python3-cairo python3-cairocffi python3-matplotlib python3-nu
```

or:

```
yum install python3-pandas python3-cffi python3-cairo python3-cairocffi python3-matplotlib python3-nu
```

On **Apples OS X** install at least the gnu-time package with homebrew.

8.1.3 Optional Requirements

Requirements that aren't normally needed.

- kernel-devel packages (for compiling the kernel module to disable caches)
- (pdf)latex (for pdf report generation)

8.1.4 Installation via pip3

Just run (with super user privileges):

```
pip3 install temci
```

8.1.5 Installation from the Git repository

Just clone temci and install it via:

```
git clone https://github.com/parttimenerd/temci
cd temci
./install_packages.sh # runs the install package commands from above
sudo pip3 install .
```

8.1.6 Post installation

Run the following command after the installation to compile some binaries needed e.g. for *temci build*:

```
temci setup
```

8.1.7 Tab completion for zsh or bash

To enable zsh or bash tab completion support for temci add:

```
source `temci_completion [bash|zsh]`
```

to your shell's configuration file.

To regenerate the tab completions run:

```
temci completion [bash|zsh]
```

8.2 temci build

Some random notes about using `temci build` that should later be transformed in an actual description.

8.2.1 Haskell support for assembly randomisation.

To build haskell projects randomized (or any other compiled language that is not directly supported by gcc) you'll to tell the compiler to use the gcc or the gnu as tool. This is e.g. possible with ghc's "-pgmc" option.

8.3 temci run

8.3.1 Fancy Plugins

DisableCaches

Build it via "temci setup". Needs the kernel develop packet of you're distribitution. It's called `kernel-devel` on fedora.

Attention: Everything takes very very long. It might require a restart of you're system. Example for the slow down: A silly haskell program (just printing `"sdf"`): the measured task-clock went from just 1.4 seconds to 875,2 seconds. The speed up with caches is 62084%.

StopStart

This plugin tries to stop most other processes on the system, that aren't really needed. By default most processes that are children (or children's children, ...) of a process which ends with "dm" are stopped. This is a simple heuristic to stop all processes that are not vital (e.i. created by some sort of display manager). SSH and X11 are stopped too.

The advantages of this plugin (which is used via the command line flag `--stop_start`): - No one can start other programs on the system (via ssh or the user interface) => less other processes interfere with the benchmarking - Processes like firefox don't interfere with the benchmarking as they are stopped - It reduces the variance of benchmarks significantly

Disadvantages: - You can't interact with the system (therefore use the send_mail option to get mails after the benchmarking finished) - Not all processes that could be safely stopped are stopped as this decision is hard to make - You can't stop the benchmarking as all keyboard interaction is disabled (by stopping X11)

Stopping a process here means to send a process a SIGSTOP signal and resume it by sending a SIGCONT signal later.

8.4 temci report

8.5 Resources

This a collection of additional resources that are related to temci.

Bachelor thesis The development of temci started as part of this bachelor thesis at the Karlsruhe Institute of Technology. It's written in german.

Talks at conferences like the GPN in Karlsruhe are planned.

8.6 Changelog

8.7 Development

8.8 License

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8.9 Documentation of the temci module

8.9.1 Subpackages

temci.build package

Submodules

temci.build.assembly module

temci.build.build_processor module

temci.build.builder module

temci.build.linker module

Enables the randomization of the link order during the building of programs. It’s used to create a wrapper for *ld* (@see ../scripts/ld).

An implementation of this wrapper in C++ is given in the ../scripts/linker directory. This python implementation is only the fall back solution if the C++ version isn’t available.

The link order randomization only works for compilers that use the *ld* tool.

`temci.build.linker.`**`link`**(*argv: typing.List[str], randomize: bool = True, ld_tool: str = '/usr/bin/ld'*)

Function that gets all argument the *ld* wrapper gets passed, randomized their order and executes the original *ld*.

Parameters

- **`argv`** – *ld* arguments

- **randomize** – actually randomize the order of the arguments?
- **ld_tool** – used *ld* tool

temci.build.linker.**process_linker**(*call: typing.List[str]*)

Uses the passed *ld* arguments to randomize the link order during linking. It's configured by environment variables.

Parameters **call** – arguments for *ld*

Module contents

This module contains the build part of temci (usable from the command line with *temci build*).

It's separated into four parts with the following purposes:

- build_processor.py: fassade for the the builders
- builder.py: Build programs with possible randomizations.
- assembly.py: randomize the assembler and provide some sort of a wrapper for *as*. It's called by ../scripts/as
- linker.py: randomize the link order and provide some sort of a wrapper for *ld*. It's called by ../scripts/ld and reimplemented in c++ in ../scripts/linker.

temci.misc package

Submodules

temci.misc.game module

temci.misc.meta_analysis module

Just some code to create the plots for the mata analysis of publications in my bachelor thesis.

temci.misc.meta_analysis.**combine_chairs**(*chairs: typing.Iterable[typing.Dict[str, typing.List[int]]]*) → typing.Dict[str, typing.List[int]]

temci.misc.meta_analysis.**has_both**(*chair: typing.Dict[str, typing.List[int]]*) → bool

temci.misc.meta_analysis.**latex_standalone**(*tex: str*, *standalone: bool = True*, *file: str = None*) → str

temci.misc.meta_analysis.**max_for_a_year**(*chair: typing.Dict[str, typing.List[int]]*) → int

temci.misc.meta_analysis.**max_years**(*chair: typing.Dict[str, typing.List[int]]*) → int

temci.misc.meta_analysis.**normalize_chair**(*chair: typing.Dict[str, typing.List[int]]*) → typing.Dict[str, typing.List[int]]

temci.misc.meta_analysis.**plot_chair_in_latex**(*chair: typing.Dict[str, typing.List[int]]*) → str

temci.misc.meta_analysis.**plot_chairs_sum_in_latex**(*chairs: typing.List[typing.Dict[str, typing.List[int]]], labels: typing.List[str]*) → str

temci.misc.meta_analysis.**sum_up_chair**(*chair: typing.Dict[str, typing.List[int]]*) → typing.Dict[str, int]

temci.misc.meta_analysis.**year_dict**(*chair: typing.Dict[str, typing.List[int]], year: int*) → typing.Dict[str, int]

Module contents

The stuff in this folder doesn't really belong to the temci tool but builds on top of it some cool applications, like a benchmarksgame inspired comparison of different implementations of several languages. The tools may depend on other code or packages than the temci tool itself.

temci.package package

Submodules

temci.package.action module

temci.package.dsl module

temci.package.util module

Module contents

This module contains the package part of temci that allows to package a benchmarking setup.

temci.run package

Submodules

temci.run.cpuset module

temci.run.run_driver module

temci.run.run_driver_plugin module

temci.run.run_processor module

temci.run.run_worker_pool module

Module contents

This module contains code to make the actual benchmarks.

temci.scripts package

Submodules

temci.scripts.cli module

temci.scripts.init module

temci.scripts.temci_completion module

Just a more performant version of *temci completion* that rebuilds the completion files only if the temci version changed. The advantage over using *temci completion* directly is, that it's normally significantly faster.

Usage:

``` temci_completion [zsh|bash]

``` This returns the location of the completion file.

`temci.scripts.temci_completion.`**`cli`**`()`
Process the command line arguments and call `temci completion` if needed.

`temci.scripts.temci_completion.`**`completion_dir`**`()` → str
Get the name of the completion directory

`temci.scripts.temci_completion.`**`completion_file_name`**`(`*shell: str*`)` → str
Get the completion file name for the passed shell and the current temci version

`temci.scripts.temci_completion.`**`create_completion_dir`**`()` → str
Create the directory for the completion files if it doesn't already exist.

`temci.scripts.temci_completion.`**`print_help`**`()`

### temci.scripts.version module

Contains the current version of temci. The first number gives the major version and the second the minor version. Versions with uneven minor version number are considered beta.

`temci.scripts.version.`**`version`** **= '0.7.2'**
The current version of temci

### Module contents

This directory contains the command line interface and tab completion code and also the several wrapper scripts and the projects C++ code in sub directories.

## temci.setup package

### Submodules

### temci.setup.setup module

This module helps to build the C and C++ code in the scripts directory.

**exception** temci.setup.setup.**ExecError**(*cmd: str*, *out: str*, *err: str*)
Bases: BaseException

Error raised if a command failed.

**cmd = None**
Failed command

**err = None**
Error output of the command

**out = None**
Output of the command

temci.setup.setup.**exec**(*dir: str*, *cmd: str*)
Run the passed command in the passed directory

**Parameters**

- **dir** – passed directory
- **cmd** – passed command

**Raises** **ExecError** – if the executed program has a > 0 error code

temci.setup.setup.**make_scripts**()
Builds the C and C++ code inside the scripts directory.

temci.setup.setup.**script_relative**(*file: str*) → str
Returns the absolute version of the passed file name. :param file: passed file name relative to the scripts directory

#### Module contents

### temci.report package

#### Submodules

#### temci.report.report module

#### temci.report.report_processor module

#### temci.report.rundata module

#### temci.report.stats module

#### temci.report.testers module

#### Module contents

This module is about generating meaningful reports an working with the resulting measurements of serveral benchmarks.

#### temci.utils package

##### Submodules

##### temci.utils.click_helper module

##### temci.utils.mail module

Utilities to send mails.

`temci.utils.mail.`**`hostname`**`()` → str
Returns the hostname of the current machine

`temci.utils.mail.`**`send_mail`**(*recipient: str*, *subject: str*, *content: str*, *attached_files: typing.List[str] = None*)
Sends a mail to the recipient with the passed subject, content and attached files.

**Parameters**

- **`recipient`** – recipient of the mail, i.e. a mail address
- **`subject`** – subject of the mail
- **`content`** – content of the mail
- **`attached_files`** – optional list of names of files that are attached to the mail

##### temci.utils.registry module

##### temci.utils.settings module

##### temci.utils.typecheck module

##### temci.utils.util module

##### temci.utils.vcs module

##### Module contents

Package with utility modules.

### 8.9.2 Module contents

- modindex
- search

## t

## C



## E



## H



## L



## M



## N



## O



## P



## S



## T



## V



## Y