

# Automatic Generation and Analysis of Algorithms

## Assignment #2

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# Linear algebra operations

## Operations:

$$y := \|A\|_1, \quad y := \|A\|_{\text{inf}}, \quad y := \|A\|_F, \quad A := A^T, \quad y := Ax, \quad y^T := x^T A$$

## Setup:

- Use the same operation as for the first assignment.
- Consider  $A \in \mathbb{R}^{8 \times 8}$ ;  $x$  and  $y$  are vectors of size  $n$ .
- First assume that the matrix is stored by columns, then repeat the exercise assuming storage by rows.

# What to do

- 1) Declare & initialize  $A$  (and  $x$  and  $y$ ) with single precision floating point numbers.
- 2) Implement two algorithms, or one algorithm in two different ways, —with explicit use of AVX intrinsics—. In total, you need to write 4 different implementations ( $A$  stored by cols/rows).
- 3) **Verify** that the algorithms are correct! Output “success” vs. “error”.
- 4) Generate the assembly code corresponding to each of implementations, and count separately the number of instructions relative to the **reading/writing** of the data (`mov`), to the **floating point operations** (`mul`, `add`, `div`, `sub`, `rcp`, `sqrt`), and the rest (`shuf`, `insert`, `extract`, `perm`, ...).
- 5) Use the cycle-accurate timer and time the algorithms.  
(both cold and warm data is fine)
- 6) Your objective is to perform better (in some metric) than traditional compilers. Compare with the best results you observed in HW1. Report all your results in a clear and visibly pleasant manner.
- 7) Describe carefully your algorithm!  
(Mathematically, with an example, with pseudocode, ...)

# Submission

- Individual assignment.
- Submission by email to `pauldj@aices.rwth-aachen.de`
- Email's subject: “AGAA-14 HW2 your\_last\_name”
- Submit your `*.c` files (and possibly the `*.s` too), together with a report (table, figure, discussion, ...). Submit your Makefile too.
- Use the following flags (for `icc`): `-O3`, `-xAVX`  
If you use other flags, indicate them.
- Make sure the files compile correctly.
- Archive them: `your_name.zip` or `your_name.tgz`
- Include your name inside each file.
- **Deadline: Tuesday, June 3rd, 5pm.**