Research Project

Acceleration of non-rigid image registration with Tensor Cores

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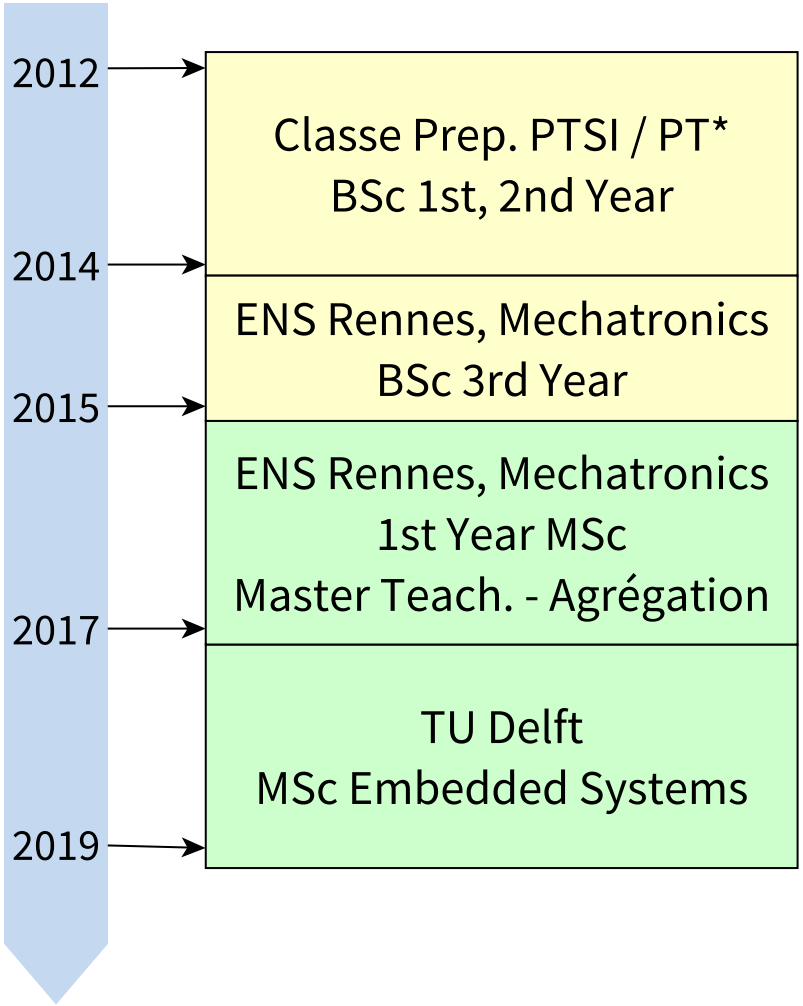
Cursus

About me:

- Jonathan LEVY
- MSc student in Embedded Systems, TU Delft (Netherlands)
- Multiple majors & countries



Current work

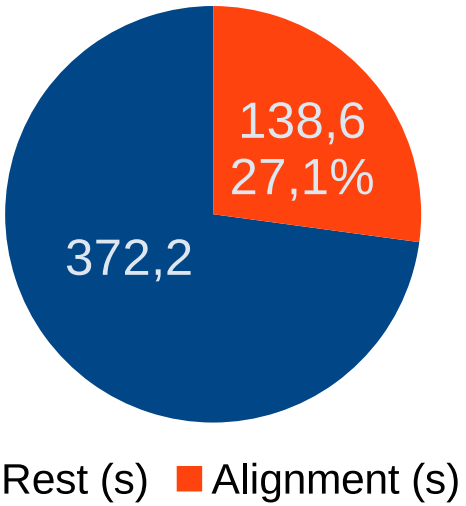
GASAL2 : GPU-accelerated library for DNA alignment

Languages C/C++ and CUDA

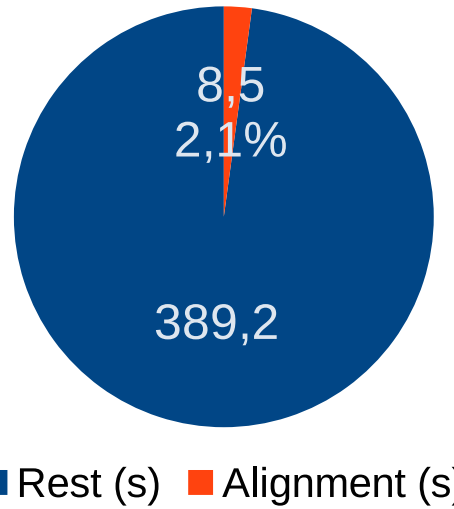
Algorithm Smith-Waterman

Goal Speed-up the *Burrough-Wheeler Aligner, "BWA"* by 1.33x

Fraction of time for alignment in BWA (12 threads)



Fraction of time for alignment in BWA-GASAL2 (with hidden time, 12 threads)



https://github.com/j-levy/GASAL2

https://github.com/j-levy/bwa-gasal2 ← private repository

Weekly logs → https://jlevy.weblog.tudelft.nl

Research Proposal

Acceleration of non-rigid image registration with Tensor Cores

- Image registration: aligning 2 images
- *Non-rigid*: various deformations allowed
- Use next-gen GPUs for acceleration
- **Goal: get closer to real-time (currently: seconds) for surgery**

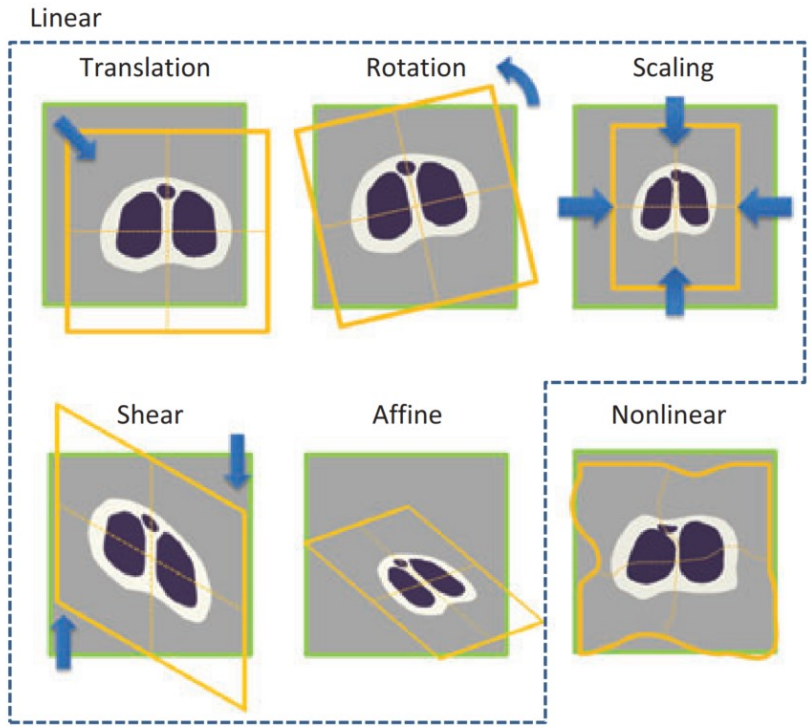


Figure 1: Different types of deformation.

Acceleration with Tensor Cores

Recent NVIDIA GPUs
(Volta Architecture)

- Refined scheduler
- New memory scheme
- Tensor Cores

Tensor Cores:

WHAT Matrix-matrix multiplication

HOW Mixed precision (precision loss)

WHY Originally, deep learning

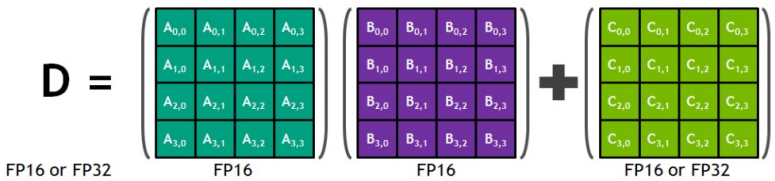


Figure 2: Operation done by a Tensor Core

Could be used to calculate:

- B-Splines (image deformation, quantify smoothness)
- Entropy (quantify similarity)

And other various modern optimizations

Work proposal

Provide a library for accelerated calculation:

1. Accelerate entropy (NMI) with tensor cores
2. Accelerated B-Splines using tensor cores too
3. Quantify precision loss
4. Send results for rendering (visual output)

   $\Longrightarrow$ Generic functions

   $\Longrightarrow$ Reusable

Challenges:

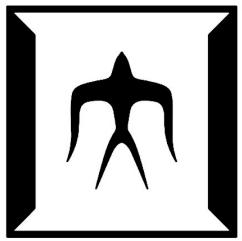
Sufficient speedup? Integration in another software? Precision loss?

Why Japan?

ENS Rennes: French state school teachers and researchers
Yet: *few incentives to go abroad!!*

- Entice younger students to go abroad
- Foster global research, in the EU and outside
- Personal interest ↗

Contacted 2 laboratories:



Tokyo Tech

Pr. Rio YOKOTA

Pr. Fumihiko INO

OSAKA UNIVERSITY

Helped defining the project.