

Seminar Work (KI/KPAR)

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Information

Date: 27. 03. 2022

Terms:

- The language for seminar work is English.
- Seminar work contains program part (codes in Python) and text part (document Word/pdf with details).
- Cooperation is allowed on program part.
- Text part is submitted individually.
- Text part contains:
 - i) topic description
 - ii) details including description of solutions, simplified code layout or workflow,
 - iii) results (Figures, tables etc.),
 - iv) Final report including literature

Deadline No later than 30.9.2023

No seminar work nor their corrections will be accepted after the deadline.

Calculation of Fourier transformation in CUDA using Numba package

Write the CUDA kernel for calculation of Discrete Fourier transformation (DFT), where DFT calculates the contribution of k-th frequency as follows

$$\bar{S}_k = \sum_{n=0}^{N-1} s_n e^{-i\frac{2\pi}{N}nk}$$

Evaluate the following matrix equation

$$\begin{pmatrix} \bar{S}_0 \\ \bar{S}_1 \\ \bar{S}_2 \\ \vdots \\ \bar{S}_{N-1} \end{pmatrix} = \begin{pmatrix} 1 & 1 & 1 & \dots & 1 \\ 1 & W^1 & W^1 & \dots & W^{N-1} \\ 1 & W^2 & W^3 & \dots & W^{N-2} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & W^{N-1} & W^{N-2} & \dots & W^1 \end{pmatrix} \begin{pmatrix} s_0 \\ s_1 \\ s_2 \\ \vdots \\ s_{N-1} \end{pmatrix}$$

where $W = e^{-i\frac{2\pi}{N}}$ using DFT and FFT variants.

- In case of DFT, implement any standard method for evaluation of matrix equation and construct the W matrix by yourself.
- In case of FFT, implement Cooley Tukey algorithm for fast evaluation of matrix equation.
- Compare the results with Numpy *fft* implementation or *cuFFT* CUDA function.

Deliver these graphical outputs:

- Original function and its spectra obtained from DFT, FFT and from Numpy *fft*.
- Comparison of scaling behaviour (Numpy, DFT, FFT) with increasing N .