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Lab: Discrete Fourier Transform and

<u>Course</u> > <u>Unit 1: Fourier Series</u> > <u>Signal Processing</u>

> 4. Fast Fourier Transform

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4. Fast Fourier Transform

The **Fast Fourier Transform (FFT)** is an algorithm originated by Cooley and Tukey in 1965 for computing the FDFT very efficiently.

Note that if ${f A}$ is an N imes N matrix, and y is N imes 1, to compute ${f A} y$ requires N^2 scalar multiplications in general.

We reduce this by taking advantage of the symmetries in \mathbf{F}_N .

Suppose that $N=2^j$ for j a positive integer.

FFT is a divide and conquer algorithm, which exploits the fact that

$$\mathbf{F}_N y = egin{pmatrix} \mathbf{I}_{N/2} & \mathbf{D}_{N/2} \ \mathbf{I}_{N/2} & -\mathbf{D}_{N/2} \end{pmatrix} egin{pmatrix} \mathbf{F}_{N/2} & 0 \ 0 & \mathbf{F}_{N/2} \end{pmatrix} egin{pmatrix} y_1 \ y_3 \ dots \ y_{N/2-1} \ y_2 \ dots \ y_N/2 \end{pmatrix},$$

where ${f I}_{N/2}$ is the N/2 imes N/2 identity matrix, and ${f D}_{N/2}$ is the diagonal matrix

We continue to apply the same rule to the two ${f F}_{N/2}$ matrices to get a formula for ${f F}_N$ involving four ${f F}_{N/4}$ matrix multiplications instead.

Continue.

Result We can compute $\mathbf{F}_N y$ with only $rac{1}{2} N j = rac{1}{2} N \log N$ multiplications!

4. Fast Fourier Transform

Topic: Unit 1: Fourier Series / 4. Fast Fourier Transform

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Please, can you show us at least the rule for FN/4?	2	
Motivation? While I'm familiar with the DFT and FFT, and this is a nice review, I'm not sure I'm following how this is relating to the goal of learning to solve PDEs using FS? I suspect you are	2	
☑ [staff] possible errors: Fast Fourier Transform for the reordered y column vector on the right, perhaps the index N/2 in the middle should be N-2 and the index N/2-1 at the end of the list should be N-1. Also, for the D N/2	8	
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