ANALYSIS OF DNA STRUCTURE AS A 2D WALK BY COMPLEX WAVELET TRANSFORM

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Wavelet transform with the Morlet wavelet

Algorithm based on PDE

This CWT admits the following equation (M. Haase, 2000):

\[ w(a,b) = \frac{1}{a} \int_{-\infty}^{\infty} f(t)e^{i\omega_0 t + \frac{\omega_0}{a} \int_{-\infty}^{\infty} f(t)e^{i\omega_0 t + \frac{\omega_0}{a} t}} dt \]

\[ \text{modulus of its wavelet transform} \]

The Cauchy problem for real and imaginary parts

\[ w(a,b) = u(a,b) + i v(a,b) \]

\[ \begin{align*}
u(0,b) &= \text{Re(f(b),} \\
v(0,b) &= \text{Im(f(b).) }
\end{align*} \]

Numerical implementation

Advantages of PDE-based method over FFT-based algorithm for the evaluation of the wavelet transform:

* robust algorithms for the numerical solving of the diffusion-type PDE;
* there are almost no restrictions on the small scale-steps;
* boundary effects can be eliminated by the choice of suitable boundary conditions for finite samples (it eliminates errors of periodization in FFT algorithms);
* PDE-based algorithm is faster than FFT-based for large samples.

\[ o(N_a N_b), \text{ vs. } o(N_a N_b \log N_a) \]

For the grid \( N_a \times N_b \):

\[ N_a \text{, times to solve the matrix system by the Thomas method (} \times \text{operations).} \]

See some additional mathematical details: