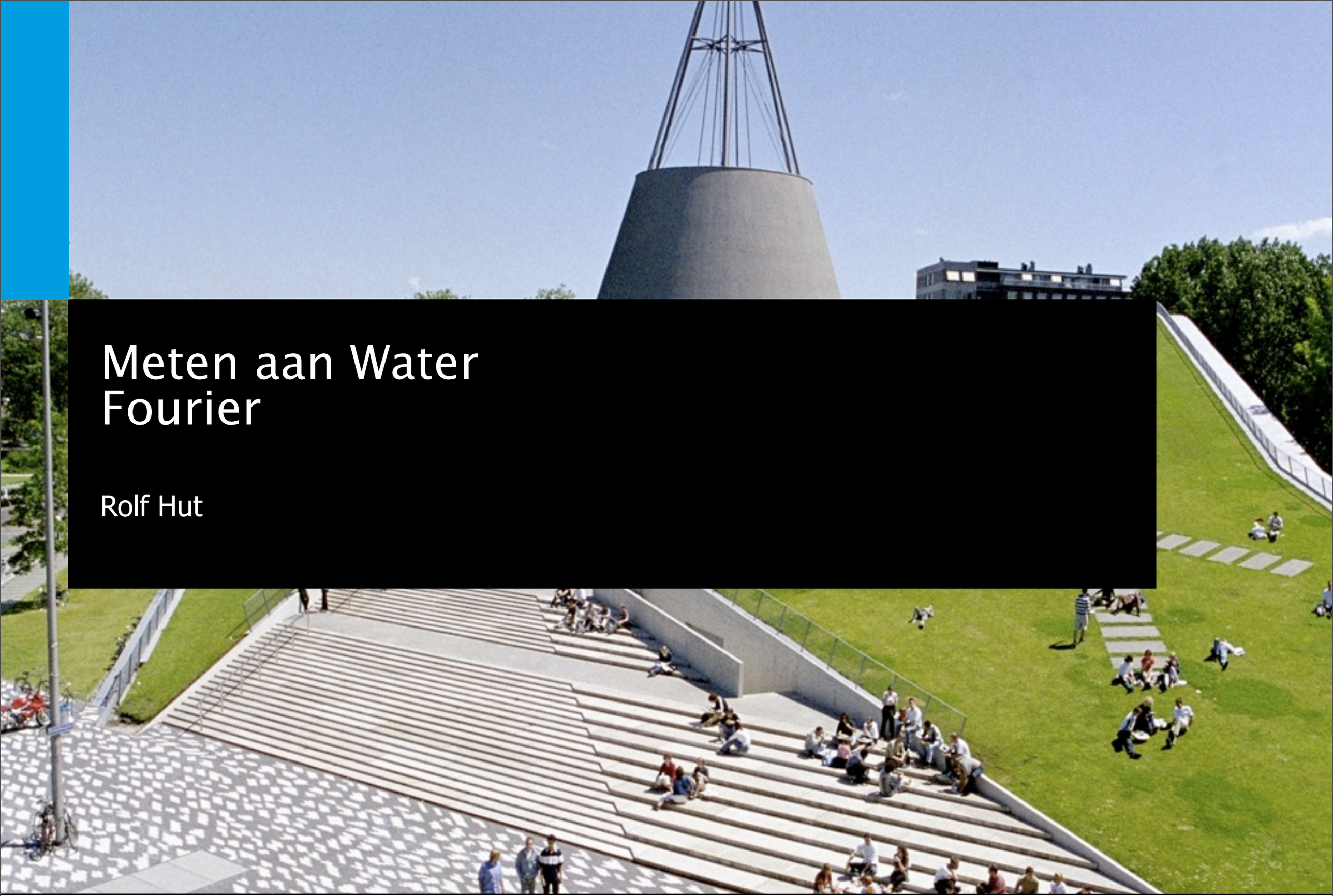
Measurements for water

Rolf Hut

Meten aan water: Fourier

Meten aan Water
Fourier

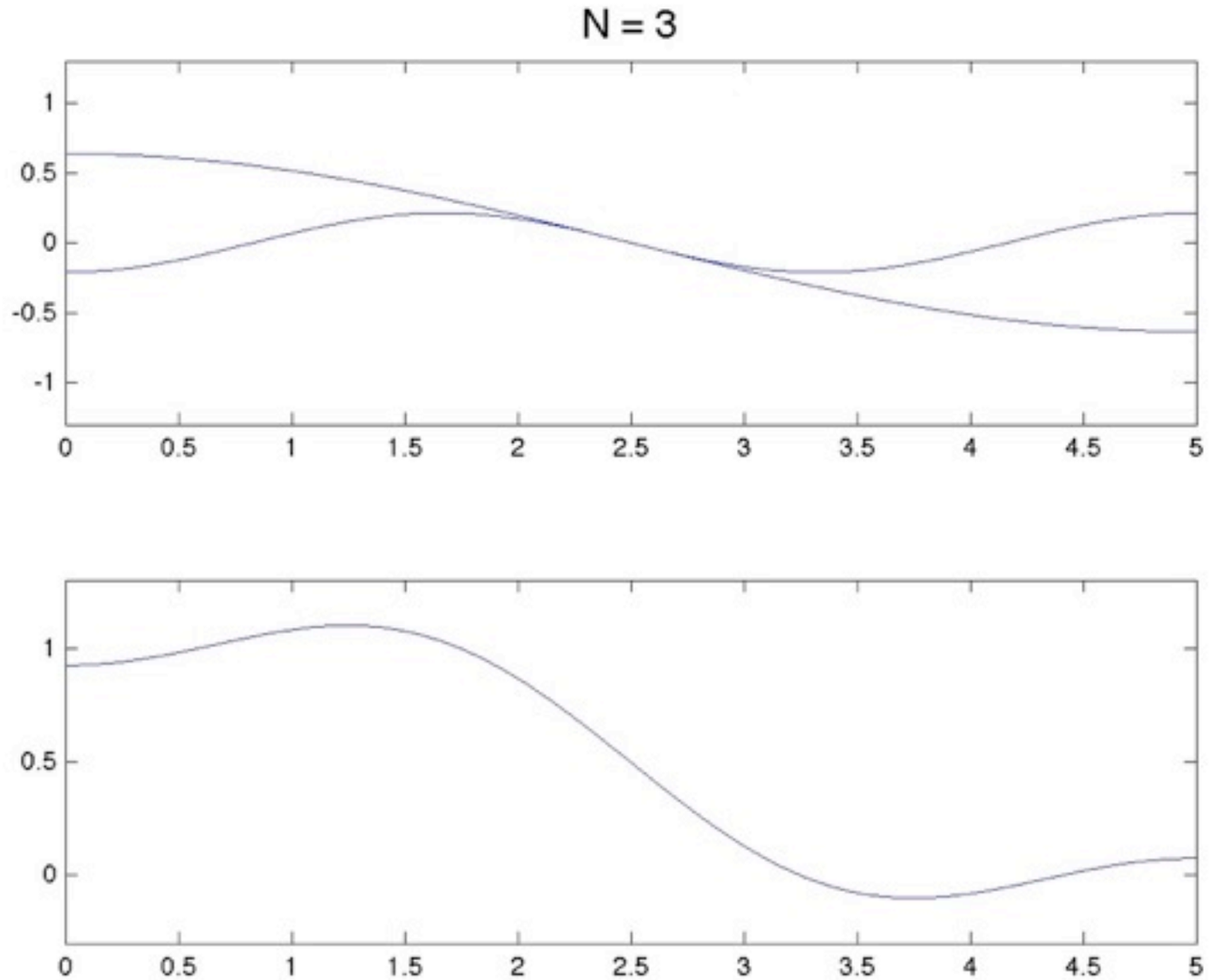
Rolf Hut



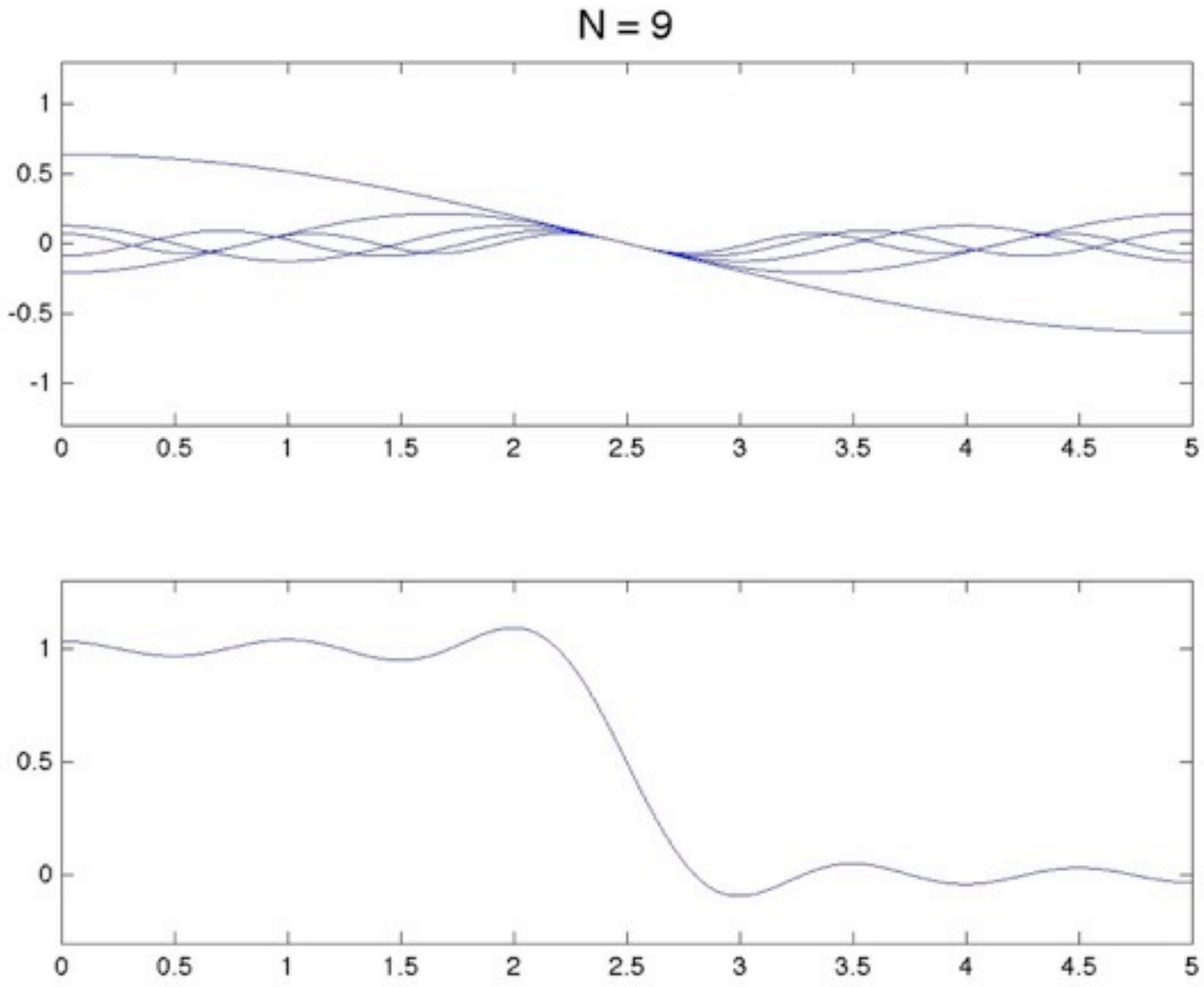
TU Delft
Delft
University of
Technology

Challenge the future

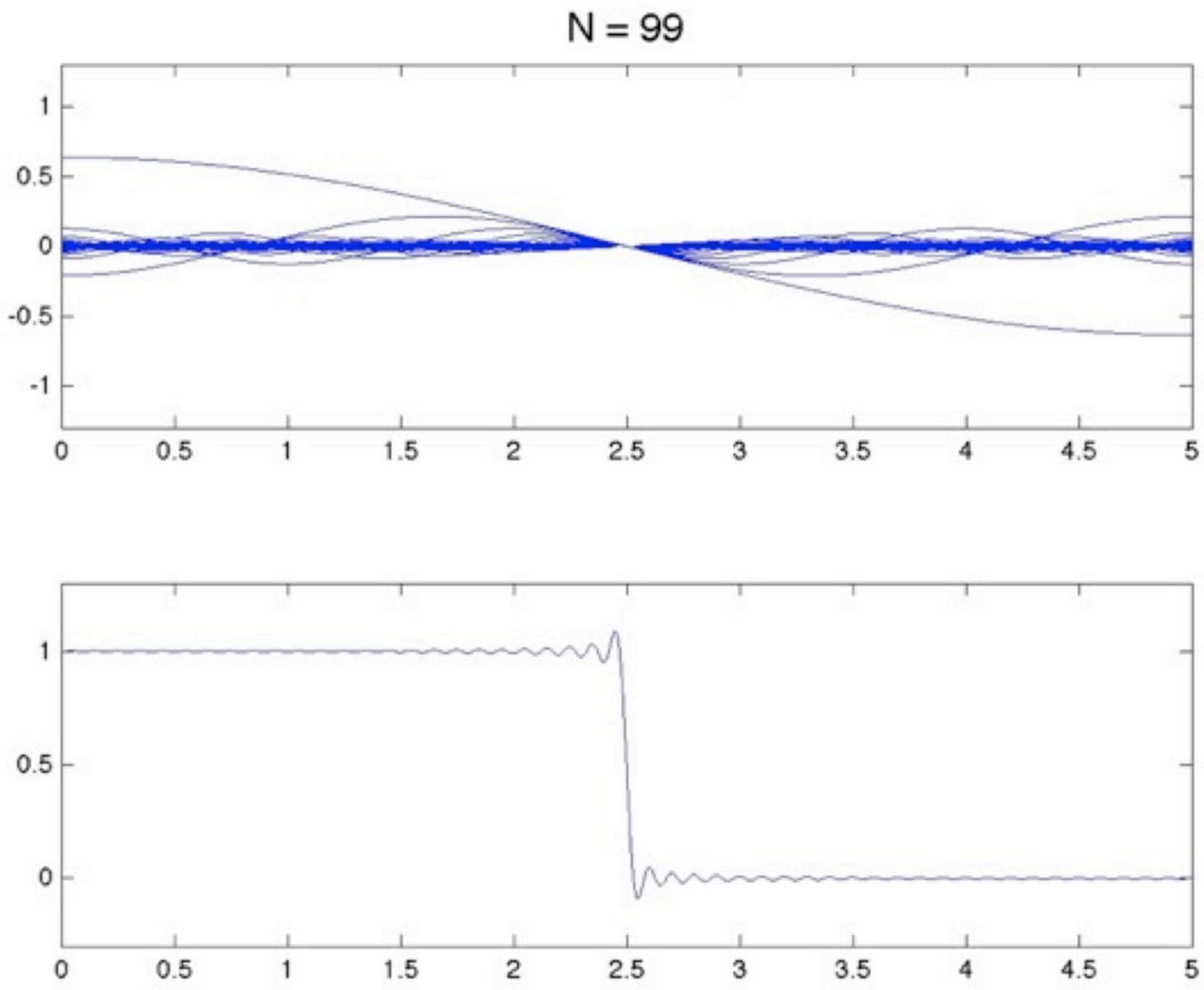
Fourier



Fourier



Fourier



Fourier

- Fourier series

$$f(t) = \sum_{k=-\infty}^{\infty} a_k e^{i\omega_0 k t}$$

- for periodic signals!!!

$$f(t + nT) = \sum_{k=-\infty}^{\infty} a_k e^{i\frac{2\pi}{T} k t}$$

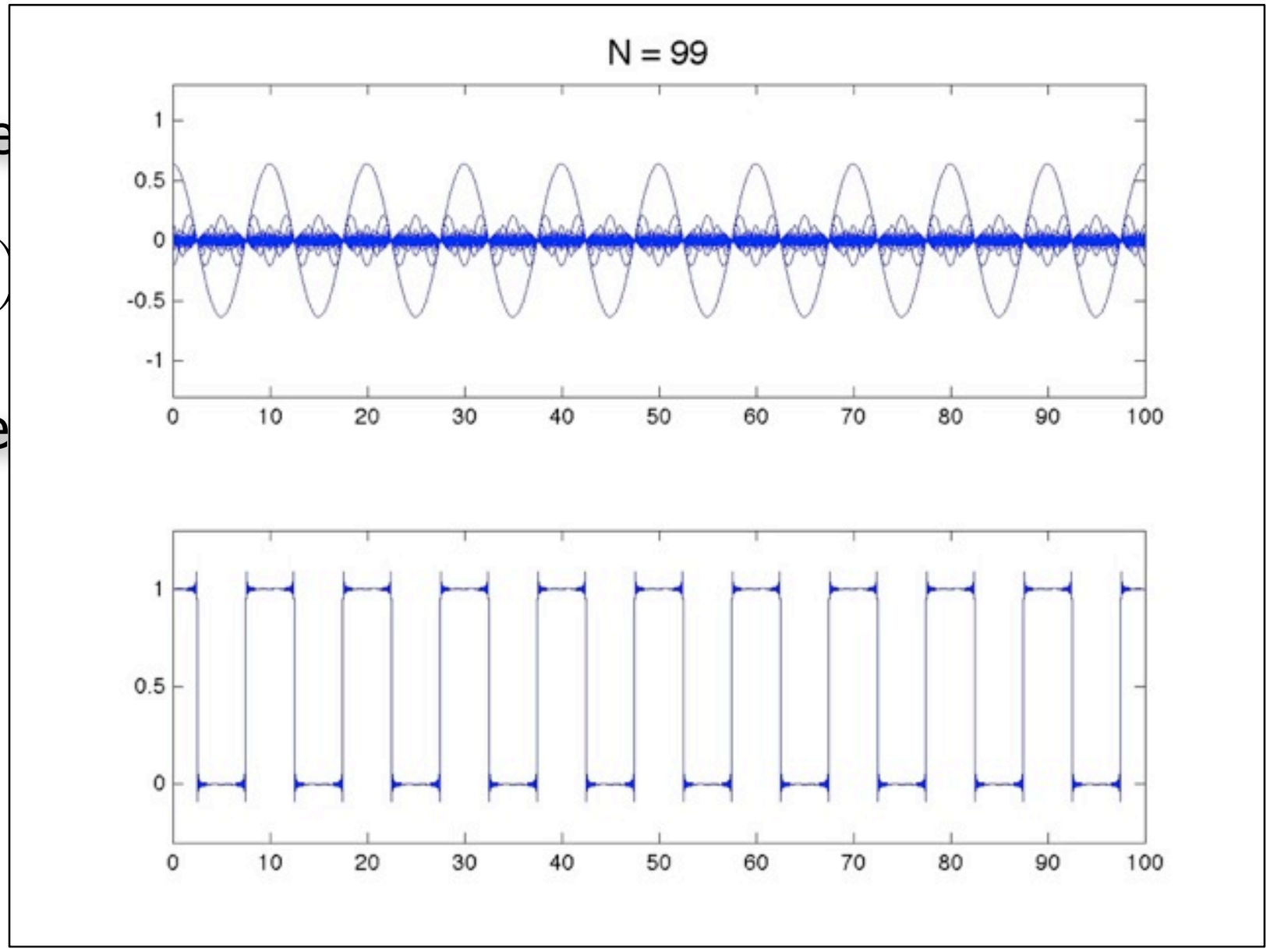
Fourier

- Fourie

$$f\left(t\right)$$

- for pe

$$f\left(t\right.$$



Fourier

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Fourier

- Fourier coefficients

$$f(t) = \sum_{k=-\infty}^{\infty} a_k e^{i\omega_0 k t}$$

$$a_k = \frac{1}{T} \int_T f(t)\, e^{-i\omega_0 k t} dt$$

Fourier

- Fourier transformation

$$f(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} F(i\omega)\, e^{i\omega t} d\omega$$

$$F(i\omega) = \int_{-\infty}^{\infty} f(t)\, e^{-i\omega t} dt$$

Fourier Transformatie

- Linear

$$g(t) = f_1(t) + f_2(t) \leftrightarrow G(i\omega) = F_1(i\omega) + F_2(i\omega)$$

- Time Shift

$$f(t - t_0) \leftrightarrow e^{-i\omega t_o} F(i\omega)$$

- Convolution

$$g(t) = \int_{-\infty}^{\infty} f(\tau)\, h(t - \tau)\, d\tau \leftrightarrow G(i\omega) = F(i\omega)\, H(i\omega)$$

Fourier Transformatie

- duality!

$$g(t) = f(t)\,h(t) \leftrightarrow G(\omega) = \frac{1}{2\pi}\int_{-\infty}^{\infty} F(\theta)\,H(\omega-\theta)\,d\theta$$

- terug naar sampling:

$$f_p(t) = \sum_{-\infty}^{\infty} f(nT)\,\delta(t-nT)$$

Nyquist criteria

- Sampling Theorem

$$\omega_s > 2\omega_m$$

- sample frequentie moet 2 keer zo hoog zijn als de hoogste frequentie in het signaal
- anders: aliasing