Skoltech

Skolkovo Institute of Science and Technology

# “Experimental Data Processing”

Assignment 4
Determining and removing drawbacks of exponential and running mean. Task 2

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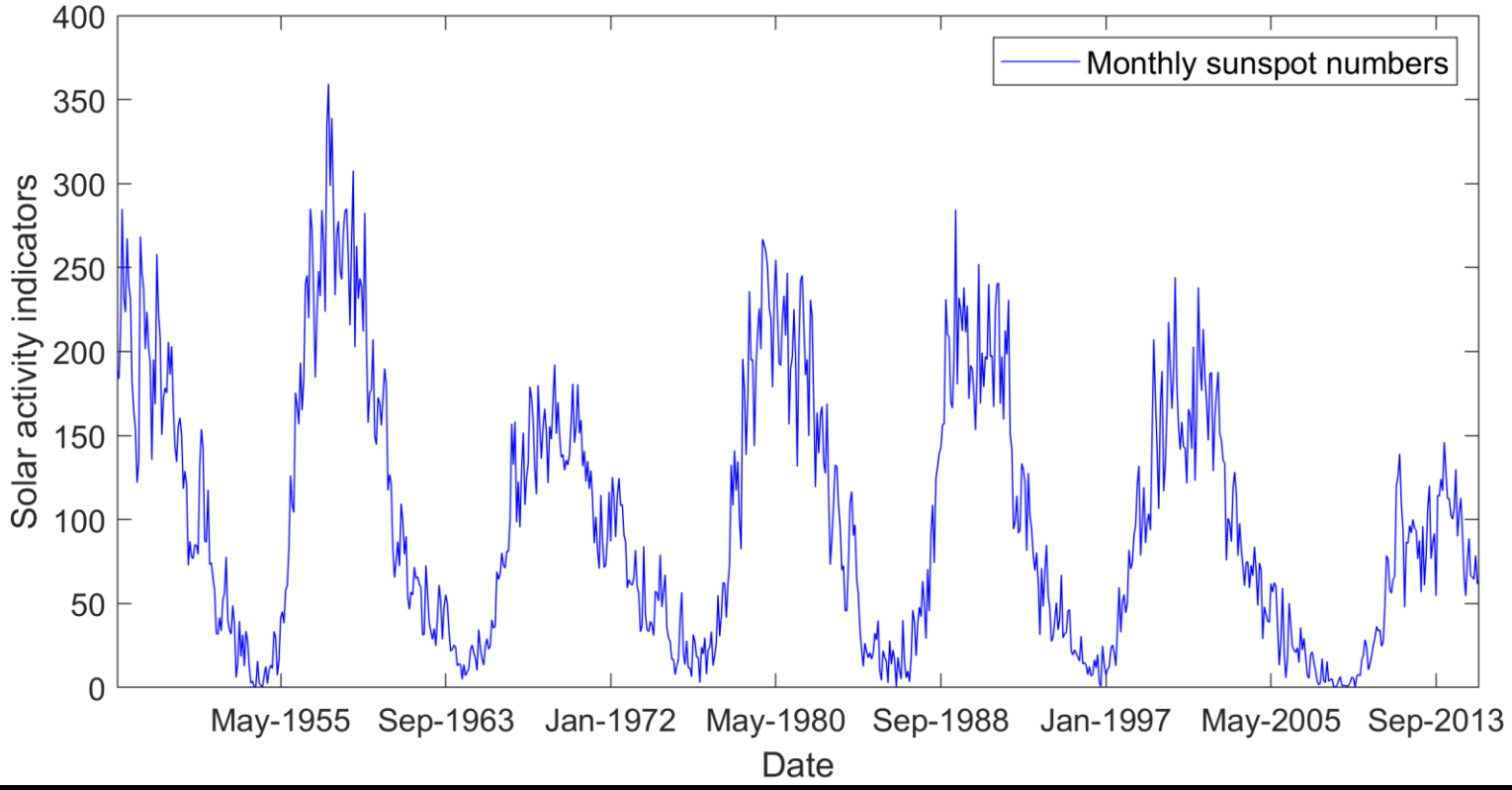
# Part 1. Main indicator of solar activity

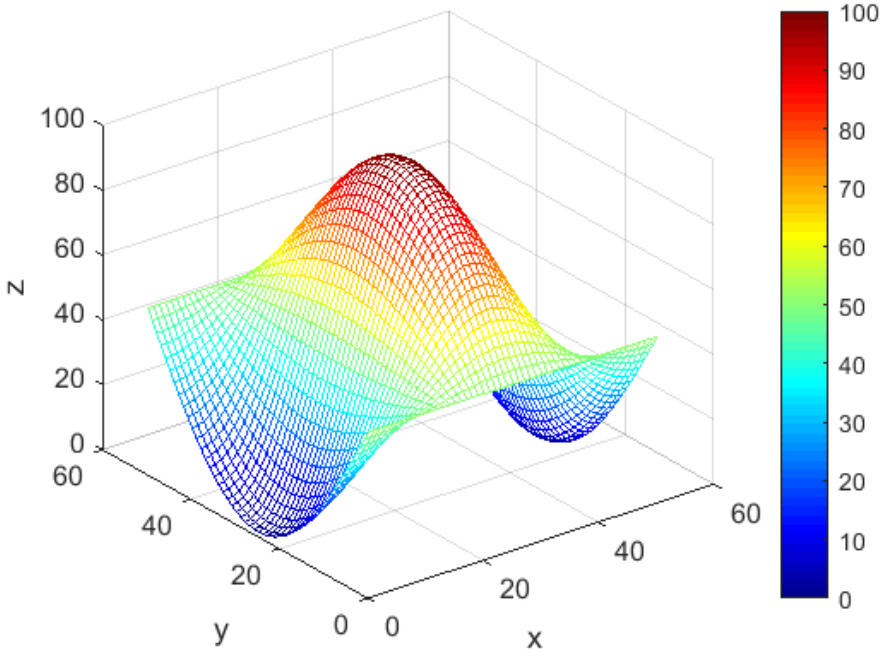



**Which method provides better approximation of 11-year solar cycle?**

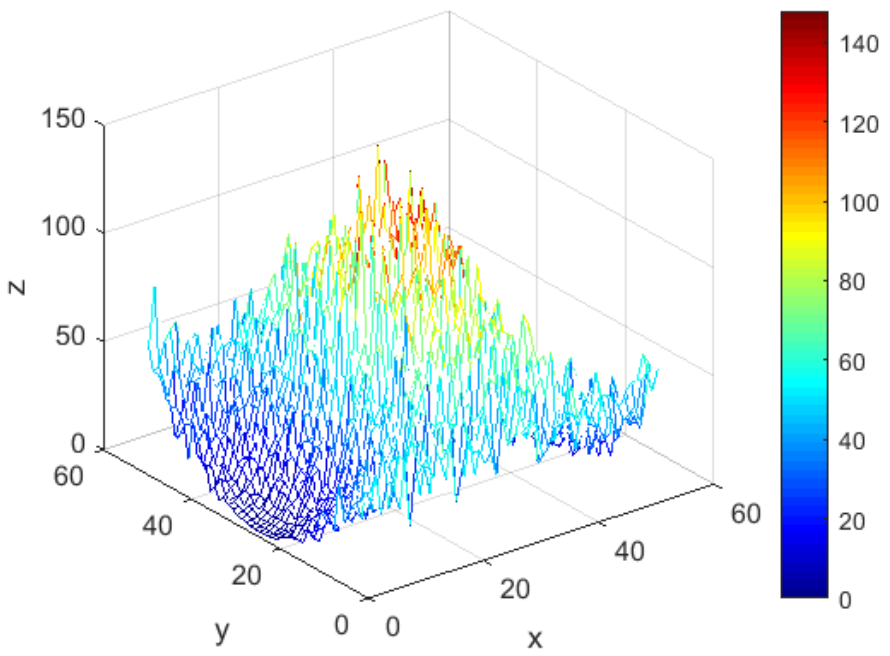
- **13-month running mean**
- **Forward-backward smoothing**

# Part 2. How to recover true surface having only noise surface?

## True surface




## Noisy surface



# 2-D forward-backward exponential smoothing

Surface is presented by 2-d matrix

$$\begin{vmatrix} a_{11} & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} \\ a_{21} & a_{22} & a_{23} & a_{24} & a_{25} & a_{26} \\ a_{31} & a_{32} & a_{33} & a_{34} & a_{35} & a_{36} \\ a_{41} & a_{41} & a_{42} & a_{44} & a_{45} & a_{46} \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & a_{56} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} \end{vmatrix}$$

$a_{ij}$ → Element of a matrix, for example intensity of a pixel

# 2-D forward-backward exponential smoothing

Surface is presented by 2-d matrix

$$\begin{vmatrix} a_{11} & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} \\ a_{21} & a_{22} & a_{23} & a_{24} & a_{25} & a_{26} \\ a_{31} & a_{32} & a_{33} & a_{34} & a_{35} & a_{36} \\ a_{41} & a_{41} & a_{42} & a_{44} & a_{45} & a_{46} \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & a_{56} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} \end{vmatrix}$$

$a_{ij}$ → Element of a matrix, for example intensity of a pixel

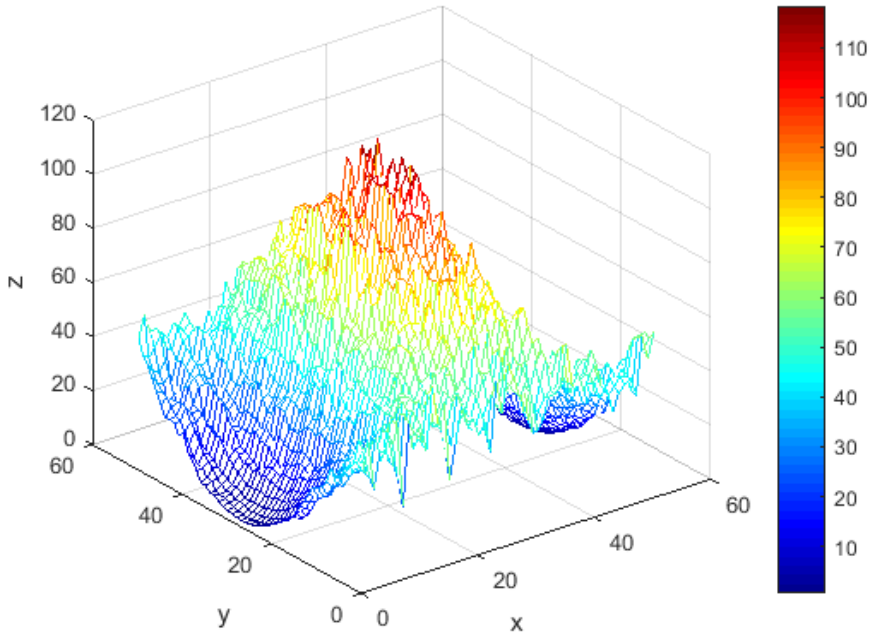
Smoothing of rows

$$X_i^f = X_{i-1}^f + \alpha\left(a_i - X_{i-1}^f\right), i = 2, \dots, N$$

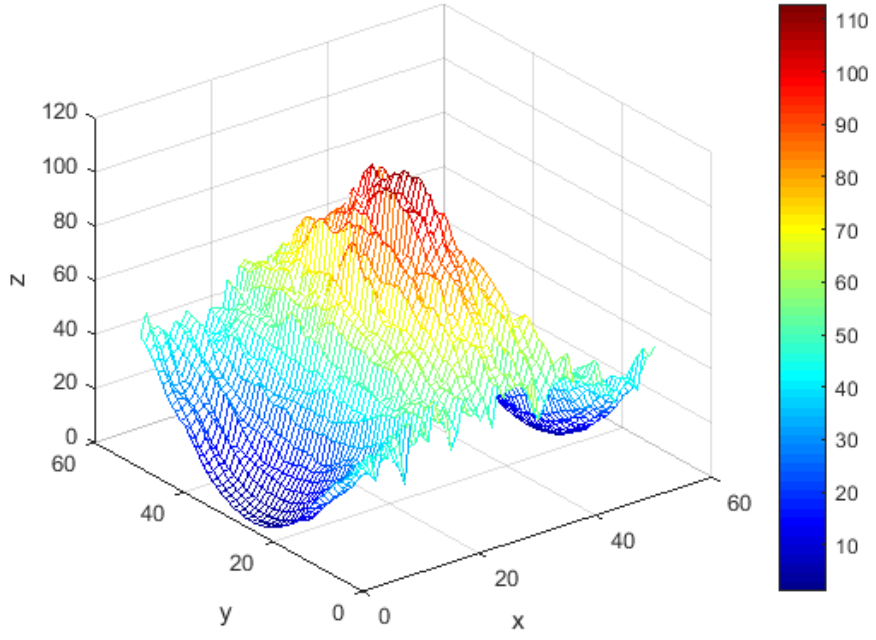
$$X_i^b = X_{i+1}^b + \alpha\left(X_i^f - X_{i+1}^b\right), i = N-1, \dots, 1$$

# Exponential smoothing of rows

## Forward smoothing




## Backward smoothing



# 2-D forward-backward exponential smoothing

Surface is presented by 2-d matrix

$$\begin{vmatrix} a_{11} & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} \\ a_{21} & a_{22} & a_{23} & a_{24} & a_{25} & a_{26} \\ a_{31} & a_{32} & a_{33} & a_{34} & a_{35} & a_{36} \\ a_{41} & a_{41} & a_{42} & a_{44} & a_{45} & a_{46} \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & a_{56} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} \end{vmatrix}$$

$a_{ij}$ → Element of a matrix, for example intensity of a pixel

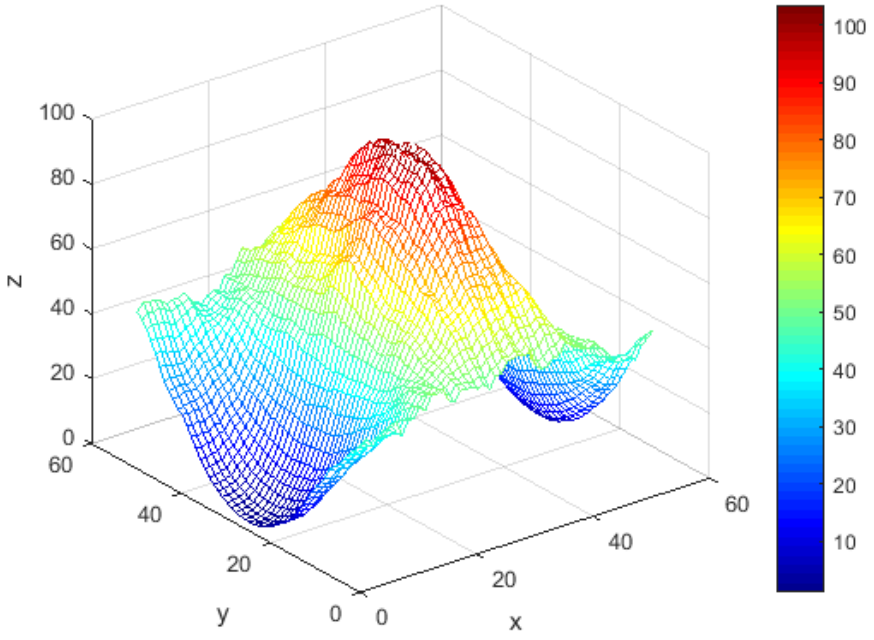
Smoothing of columns

$$X_j^f = X_{j-1}^f + \alpha\left(a_j - X_{j-1}^f\right), j = 2, \dots, N$$

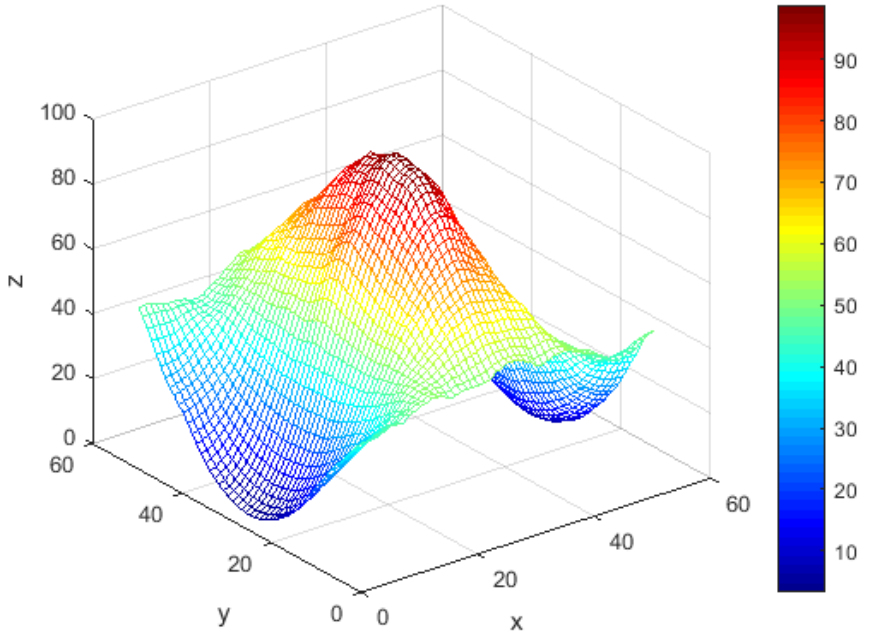
$$X_j^b = X_{j+1}^b + \alpha\left(X_j^f - X_{j+1}^b\right), \mathrm{j} = N-1, \dots, 1$$

# Exponential smoothing of columns

## Forward smoothing

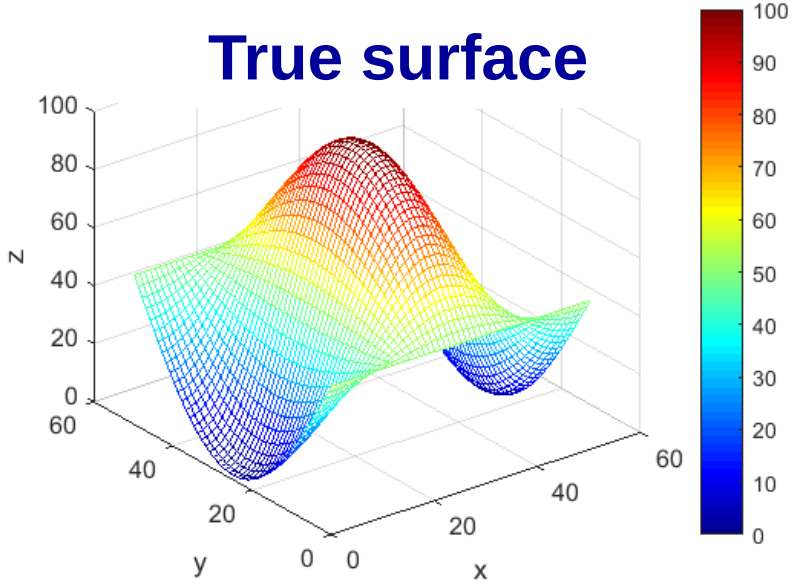



## Backward smoothing

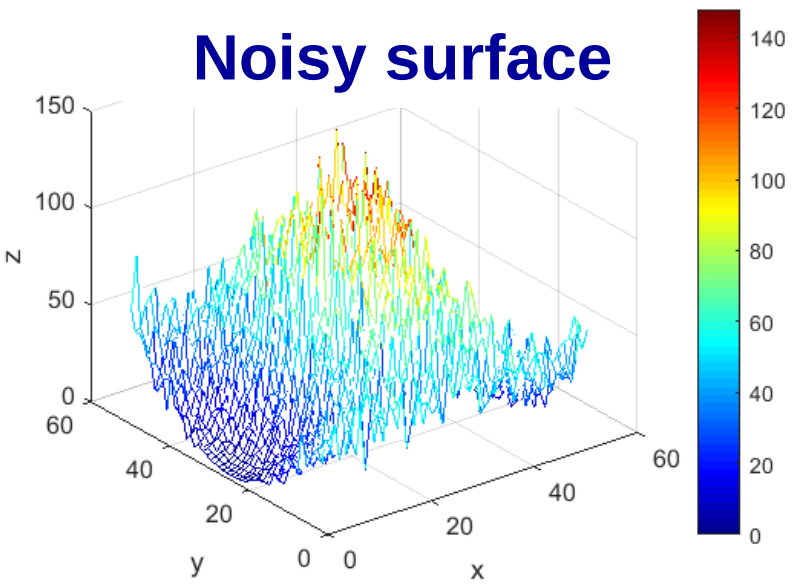


# Surface reconstruction

## True surface




## Noisy surface




## Reconstructed surface