Google Earth Engine

Google Earth Engine教学

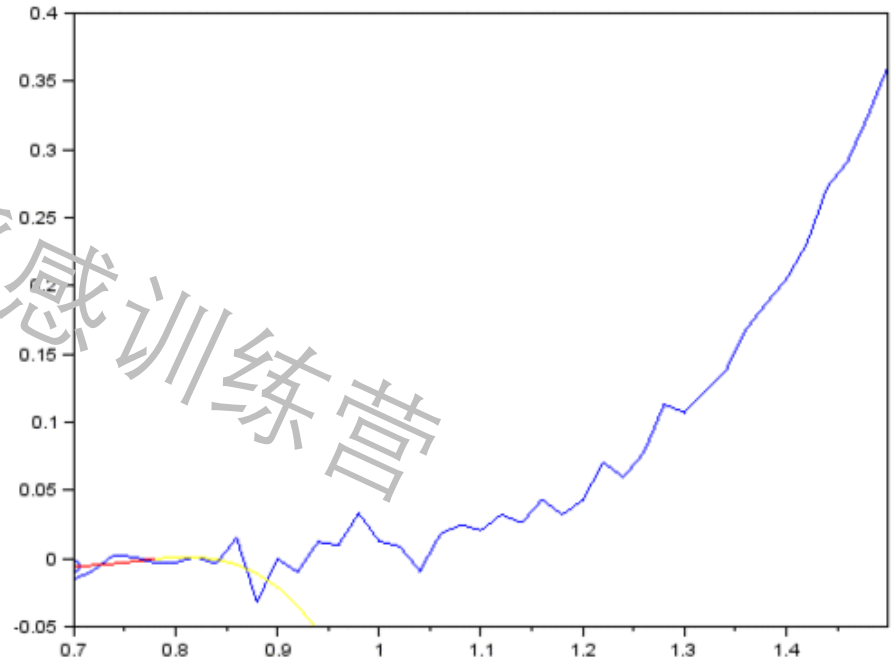
Day 7

基本内容

- ✓sg滤波

Sg的定义

- A Savitzky–Golay filter is a digital filter that can be applied **to a set of digital data points** for the purpose of smoothing the data, that is, to increase the precision of the data without distorting the signal tendency. **This is achieved, in a process known as convolution, by fitting successive sub-sets of adjacent data points with a low-degree polynomial by the method of linear least squares**.
- When the data points are equally spaced, an analytical solution to the least-squares equations can be found, in the form of a single set of "convolution coefficients" that can be applied to all data sub-sets, **to give estimates of the smoothed signal, (or derivatives of the smoothed signal) at the central point of each sub-set.**
- The method, based on established mathematical procedures, was popularized by **Abraham Savitzky and Marcel J. E. Golay**, who published tables of convolution coefficients for various polynomials and sub-set sizes in 1964.



Sg的定义

Savitzky-Golay卷积平滑算法是移动平滑算法的改进

$$x_{k,\text{smooth}} = \bar{x}_k = \frac{1}{2w+1}\sum_{i=-w}^{+w} x_{k+i}$$

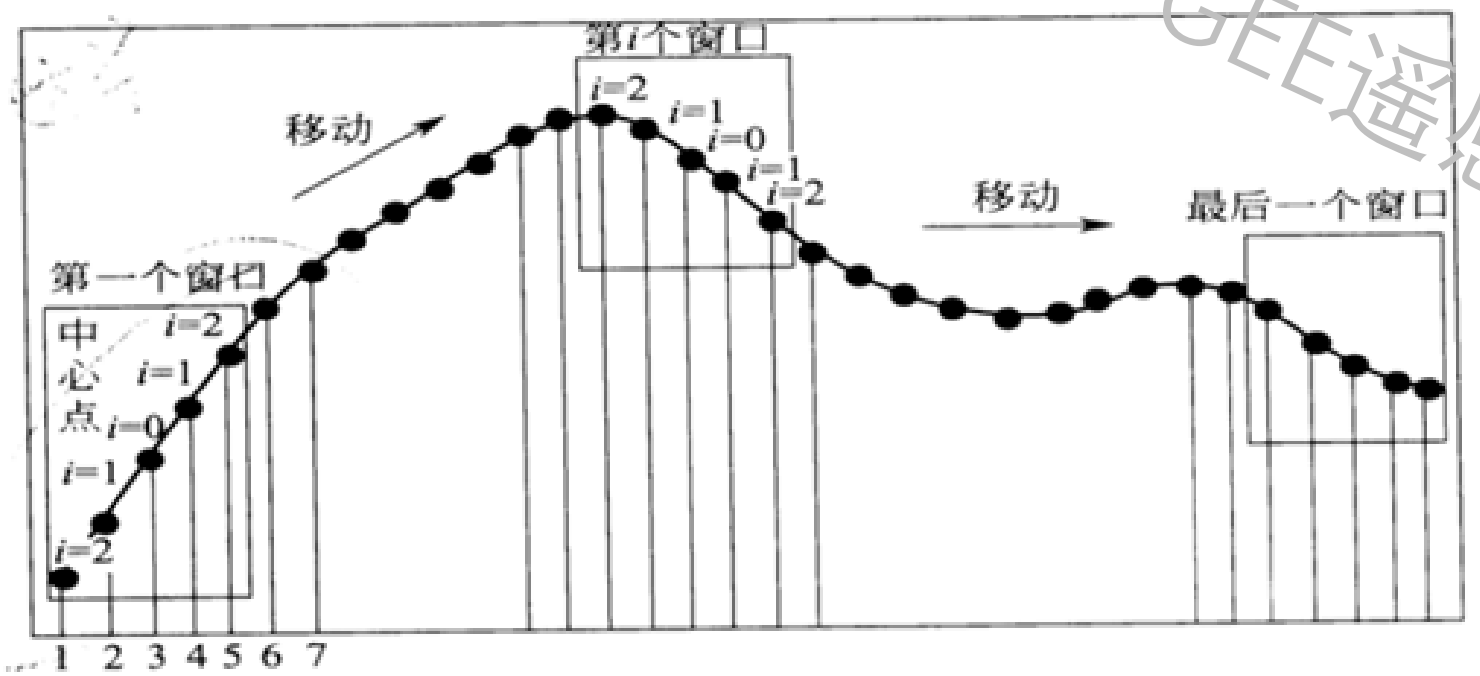


图 2-10　窗口移动平滑法示意图

Sg的定义

Savitzky-Golay卷积平滑关键在于矩阵算子的求解。

设滤波窗口的宽度为n=2m+1，各测量点为x=（-m,-m+1,0,,,,0,1,…m-1,m）采用k-1次多项式对窗口内的数据点进行拟合

$$y = a_o + a_1 x + a_2 x^2 + \ldots + a_{k-1} x^{k-1}$$

于是就有了n个这样的方程，扣成了k元线性方程组。要使方程组有解则n应大于等于k，一般选择n>k，通过最小二乘法拟合确定拟合参数A。由此得到

$$\begin{pmatrix} y_{-m} \\ y_{-m+1} \\ \vdots \\ y_m \end{pmatrix} = \begin{pmatrix} 1 & -m & \cdots & (-m)^{k-1} \\ 1 & -m+1 & \cdots & (-m+1)^{k-1} \\ \vdots & \vdots & \vdots & \vdots \\ 1 & m & \cdots & m^{k-1} \end{pmatrix} \begin{pmatrix} a_0 \\ a_1 \\ \vdots \\ a_{k-1} \end{pmatrix} + \begin{pmatrix} e_{-m} \\ e_{-m+1} \\ \vdots \\ e_m \end{pmatrix}$$

用矩阵表示为

$$Y_{(2m+1)\times 1} = X_{(2m+1)\times k} \cdot A_{K\times 1} + E_{(2m+1)\times 1}$$

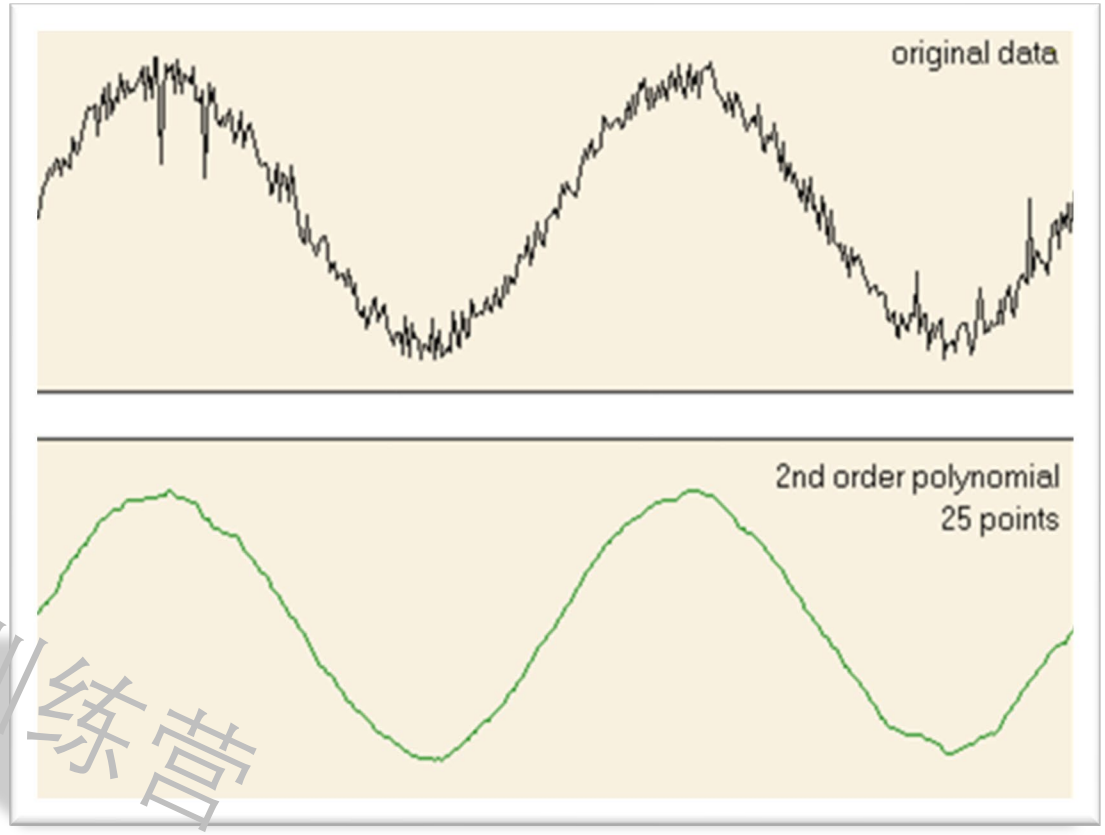
A 的最小二乘解 $\hat{A}$ 为

$$\hat{A} = (X^{\mathrm{T}} \cdot X)^{-1} \cdot X^{\mathrm{T}} \cdot Y$$

Y 的模型预测值或滤波值 $\hat{Y}$ 为

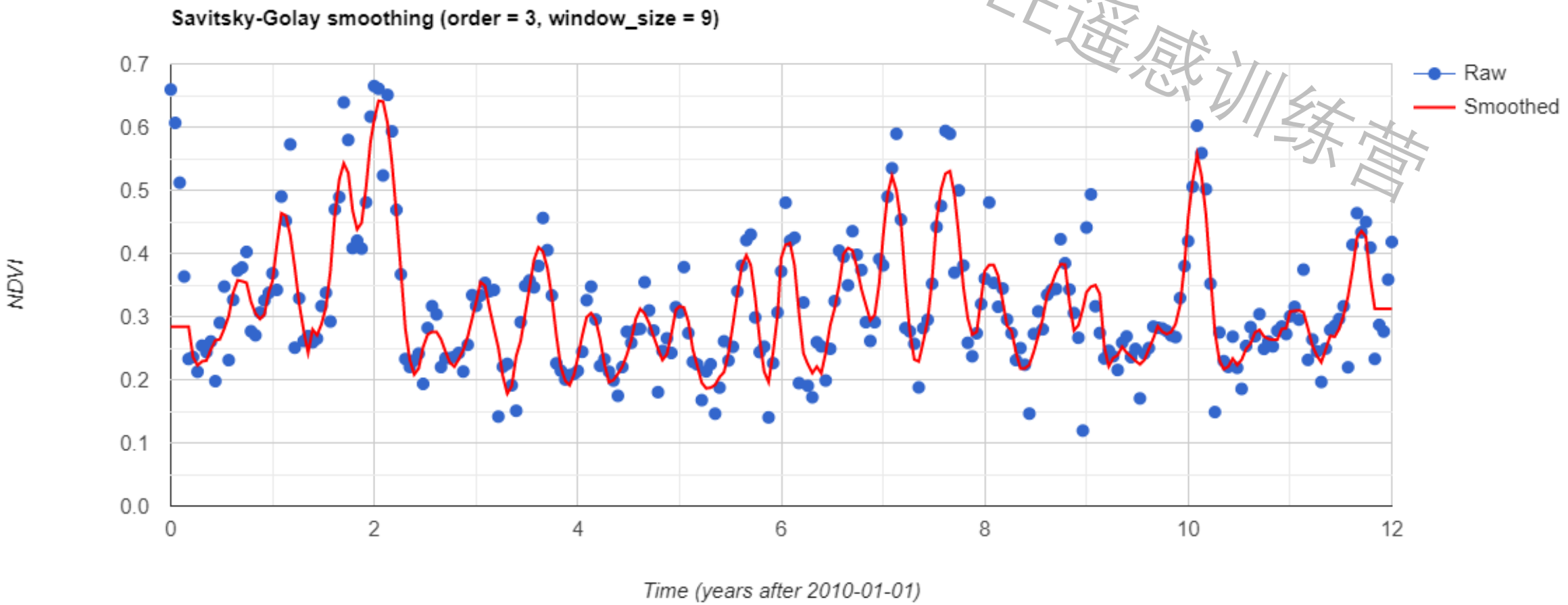
$$\hat{Y} = X \cdot A = X \cdot (X^{\mathrm{T}} \cdot X)^{-1} \cdot X^{\mathrm{T}} \cdot Y = B \cdot Y$$

$$B = X \cdot (X^T \cdot X)^{-1} \cdot X^T$$

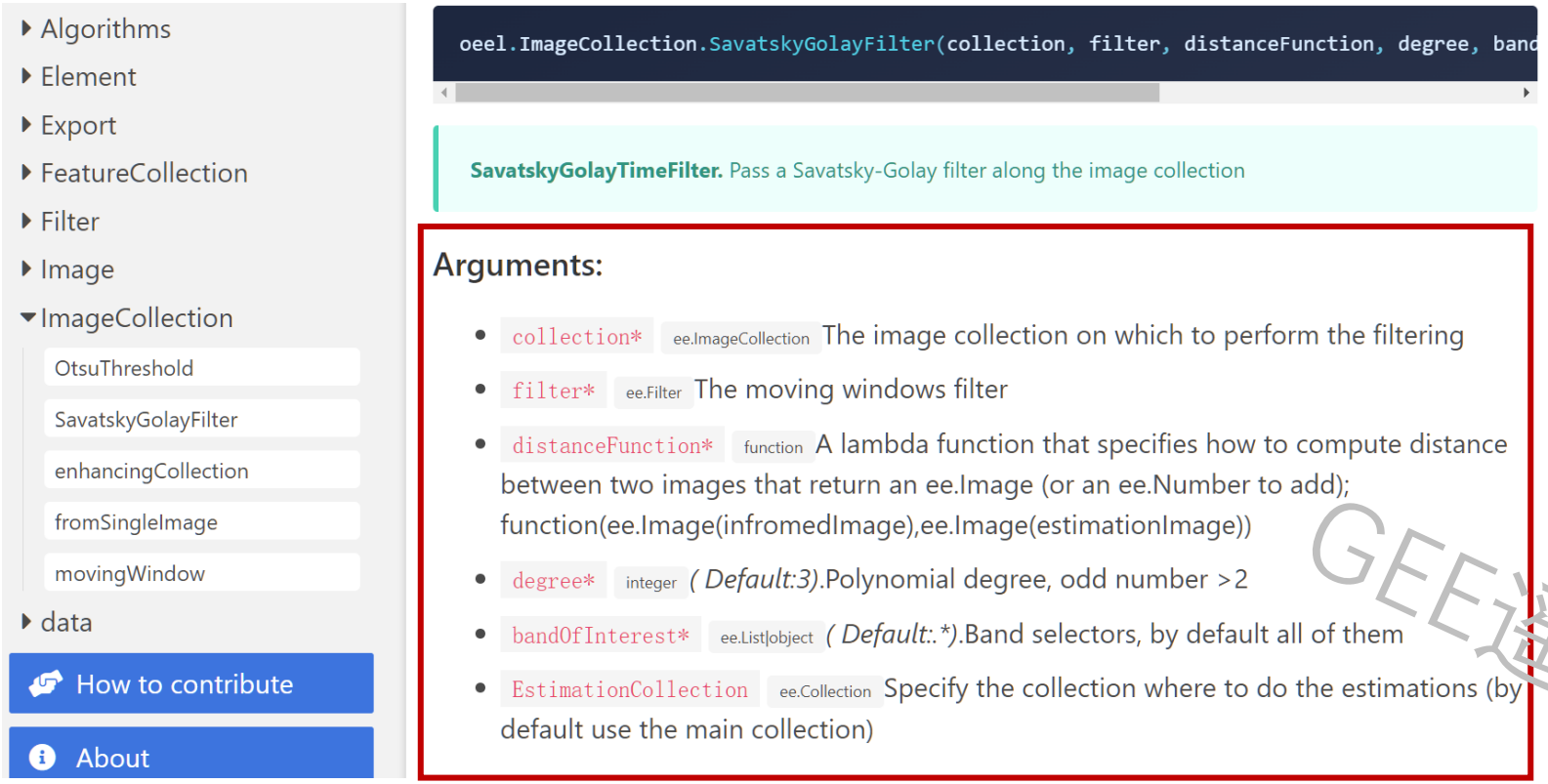


https://code.earthengine.google.com/ce3c669b273b137d411a5c251370b6d2

结果展示



Sg封装版



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https://code.earthengine.google.com/d08fc376d9e216b4d03c9551cb1d3b40
https://www.open-geocomputing.org/OpenEarthEngineLibrary/#.ImageCollection.SavatskyGolayFilter

Google Earth Engine

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