



Google Earth Engine教学

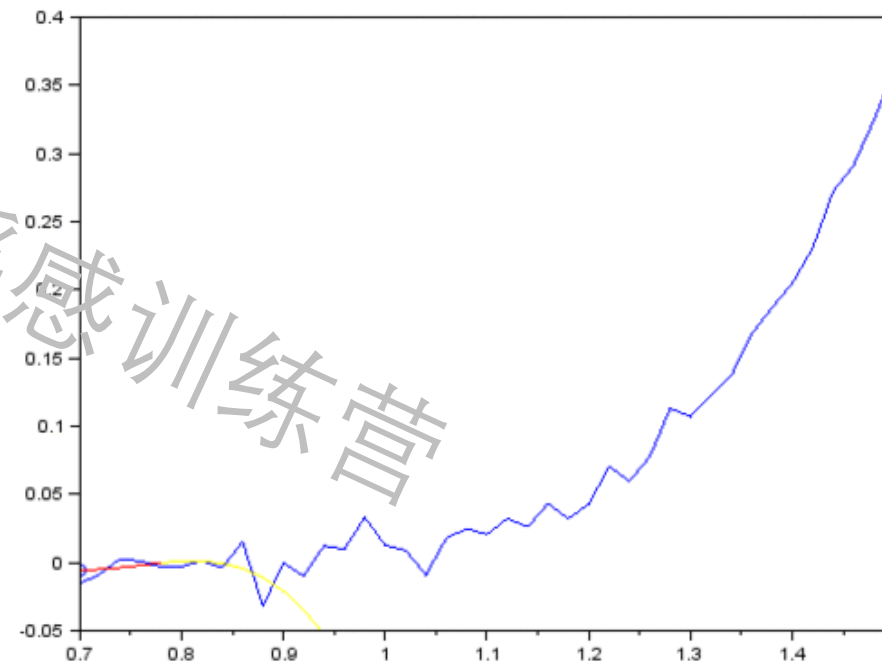
Day 7

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

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

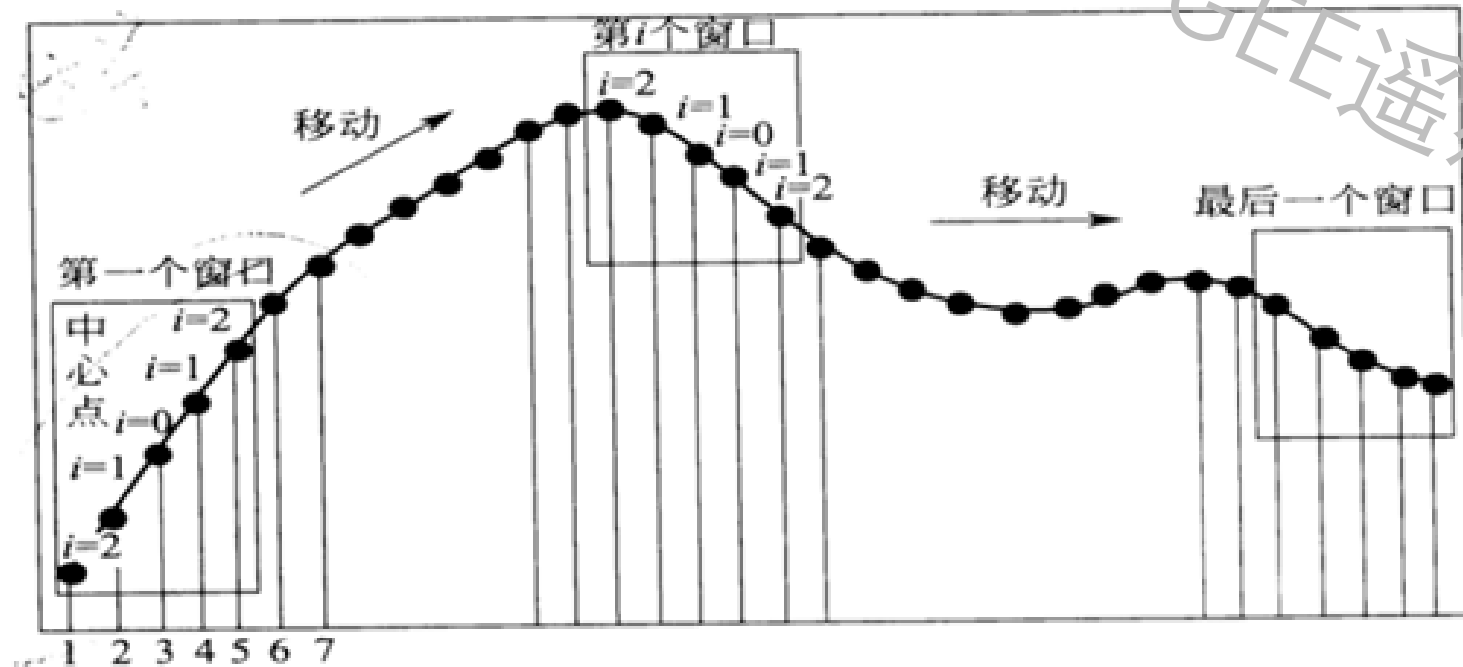


图 2-10 窗口移动平滑法示意图

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 $x = (-m, -m+1, 0, \dots, m-1, m)$ 采用 $k-1$ 次多项式对窗口内的数据点进行拟合

$$y = a_0 + a_1x + a_2x^2 + \dots + a_{k-1}x^{k-1}$$

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

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

用矩阵表示为

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

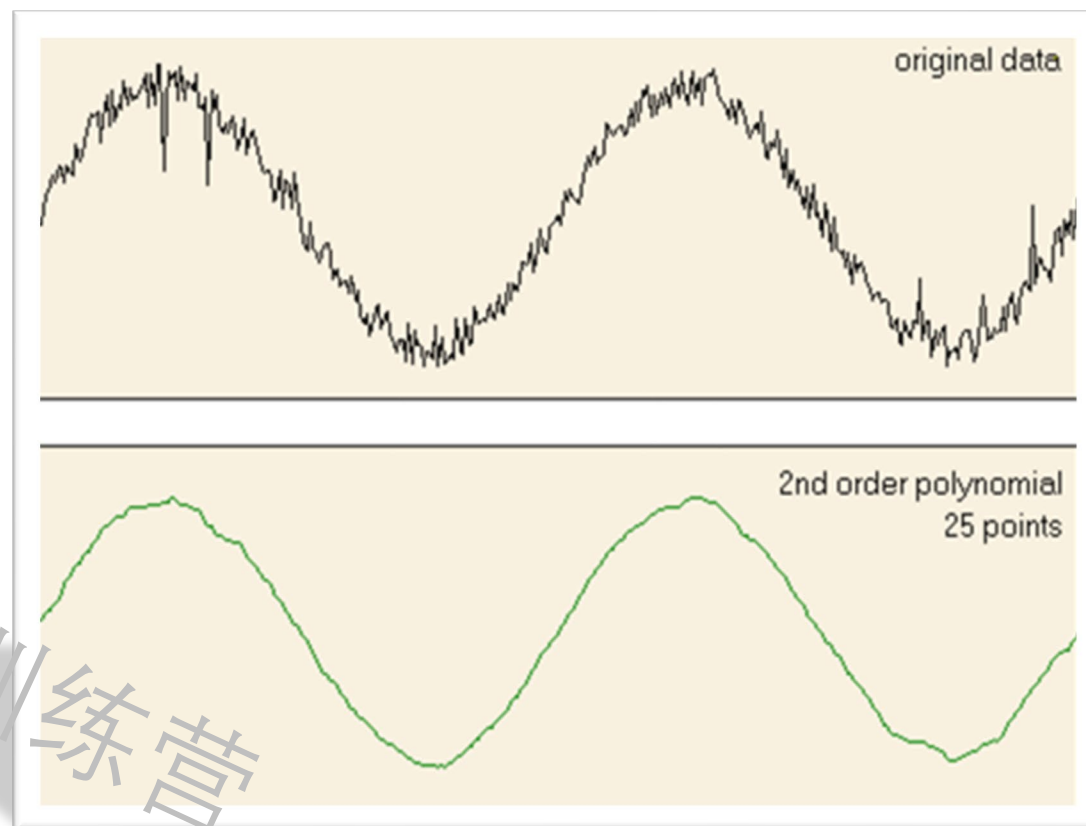
A 的最小二乘解 \hat{A} 为

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

Y 的模型预测值或滤波值 \hat{Y} 为

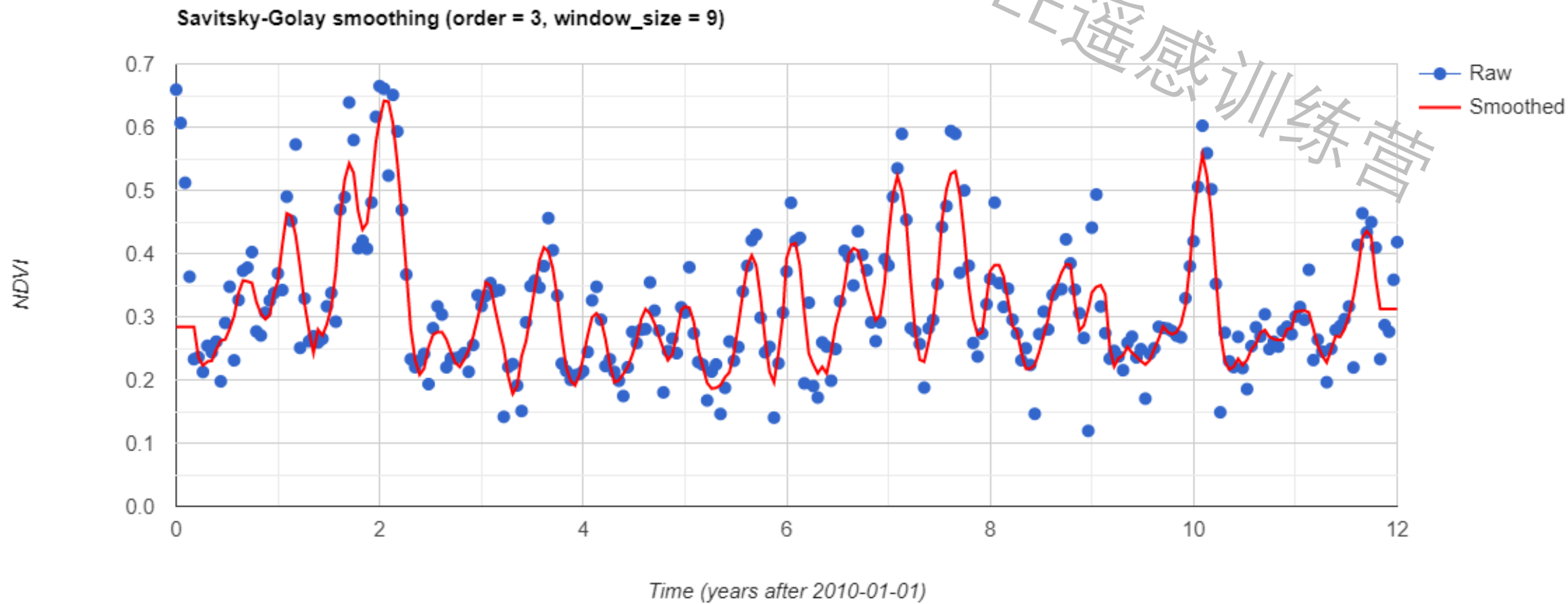
$$\hat{Y} = X \cdot A = X \cdot (X^T \cdot X)^{-1} \cdot X^T \cdot Y = B \cdot Y$$

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




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

结果展示



▶ Algorithms
▶ Element
▶ Export
▶ FeatureCollection
▶ Filter
▶ Image
▼ ImageCollection
OtsuThreshold
SavatskyGolayFilter
enhancingCollection
fromSingleImage
movingWindow

▶ data

 How to contribute

 About

```
ee.ImageCollection.SavatskyGolayFilter(collection, filter, distanceFunction, degree, bandOfInterest, estimationCollection)
```

SavatskyGolayTimeFilter. Pass a Savatsky-Golay filter along the image collection

Arguments:

- **collection*** `ee.ImageCollection` The image collection on which to perform the filtering
- **filter*** `ee.Filter` The moving windows filter
- **distanceFunction*** `function` A lambda function that specifies how to compute distance between two images that return an `ee.Image` (or an `ee.Number` to add);
`function(ee.Image(infromedImage), ee.Image(estimationImage))`
- **degree*** `integer` (*Default: 3*). Polynomial degree, odd number > 2
- **bandOfInterest*** `ee.List|object` (*Default: **). Band selectors, by default all of them
- **EstimationCollection** `ee.Collection` Specify the collection where to do the estimations (by default use the main collection)

If you like it, or the third-party material has any contribution or inspiration to you, please send a simple but encouraging email to the authors to express your gratitude.

<https://code.earthengine.google.com/d08fc376d9e216b4d03c9551cb1d3b40>

<https://www.open-geocomputing.org/OpenEarthEngineLibrary/#.ImageCollection.SavatskyGolayFilter>



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