

# Calculate the SNR after intergration

peter

July 31, 2017

## 1 Sigma changing

Assuming we have 2-D Gaussian Noise array, which we can create with Numpy:

```
import numpy as np
a = np.random.normal(loc = 0 , scale = 1 , size = (1024,1024))
```

In array a, the standard deviation is 1, mean is zero. That means in each part of a , the mean and standard deviation should be same or close to it. like we have array b = a[1:1000,1] , the  $\sigma \approx 1$ , mean  $\approx 0$ .

If we integration an array with shape (N,N) along one axis, the sigma will become:

$$\sigma_i = \sigma_2 \cdot \sqrt{N} \quad (1)$$

like c = a.sum(axis = 0). Array c has shape of (1024,) Then the  $\sigma$  of c is not 1 anymore, it should be 32.

## 2 Deduction

Definition of Standard Deviation:

$$\sigma = \sqrt{\frac{\sum_{i=1}^N (x_i - \bar{x})^2}{N - 1}} \quad (2)$$

For a 2-D array,

$$\sigma_2 = \sqrt{\frac{\sum_{i=1}^N \sum_{j=1}^N (x_{ij} - \bar{x})^2}{(N - 1) \cdot (N - 1)}} \quad (3)$$

If we integration along one axis,  $x_{ij} = \sum_{i=1}^N$ , then the equation above will becomes:

$$\sigma_i = \sqrt{\frac{\sum_{j=1}^N (\sum_{i=1}^N x_j - \bar{x})^2}{(N - 1)}} \quad (4)$$

As  $\bar{x}$  should keep zero, the uper itirms under square root should keep the same , denominator under square root is the only change. Then we get equation (1).