Calculate the SNR after intergration

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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:

$$\sigma_i = \sigma_2 \cdot \sqrt{N} \tag{1}$$

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

2 Deduction

Definition of Standard Deviation:

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

For a 2-D array,

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

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

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

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