Similarity Measures

- Sum of Squared Differences (SSD):

$$SSD(R,T) := \frac{1}{1 + \frac{1}{N}\sum_{j=1}^{N}(R(j) - T(j))^2}$$

where N is the number of voxels (in ROI).

- Normalized Cross Correlation (NCC)

$$NCC(R,T) := \frac{(Cov(R,T))^2}{Var(R) \cdot Var(T)} = \frac{(\sum_{j=1}^{N}(R(j) - \bar{R})(T(j) - \bar{T}))^2}{\sum_{j=1}^{N}(R(j) - \bar{R})^2 \cdot \sum_{j=1}^{N}(T(j) - \bar{T})^2}$$

where Cov means Covariance and Var means Variance and N is the number of voxels (in ROI).

- Mutual Information (MI):

$$MI(R,T) := H(R) + H(T) - H(R,T) = \sum_{j,k=1}^{N} p_{RT}(j,k) \ \log \frac{p_{RT}(j,k)}{p_R(j)p_T(k)}$$

where H is the Shannon-Entropy and N is the number of pixels of each image and $p_R,\ p_T,\ p_{RT}$ are probability density functions. In more detail this looks like

$$H(R) := -\sum_{j=1}^{N} p_R(j) \ \log p_R(j)$$

$$H(T) := -\sum_{k=1}^{N} p_T(k) \ \log p_T(k)$$

$$H(R,T) := -\sum_{j=1}^{N}\sum_{k=1}^{N} p_{RT}(j,k) \ \log p_{RT}(j,k).$$

- Normalized Mutual Information (NMI):

$$NMI(R,T) := \frac{H(R) + H(T)}{2\ H(R,T)}$$

with the above mentioned entropies.

- Local Cross Correlation (LCC):

$$LCC(R,T) := \frac{1}{N}\sum_{j=1}^{N}\frac{[R,T]_j^2}{[R,R]_j[T,T]_j}$$

whereas

$$[AB]_j := \sum_{i\in n(j)}(A_i - \bar{A}_j)(B_i - \bar{B}_j)$$

with N is the number of local neighborhoods $n(j)$ of voxel j and $\bar{A}_j,\ \bar{B}_j$ are the mean values of the neighborhood i in image A and image B respectively.

- Normalized Gradient Field (NGF):

$$NGF(R,T) := \frac{1}{N}\sum_{j=1}^{N}\left(\mathbf{n}(R,j)^T\mathbf{n}(T,j)\right)^2$$

whereas N is the number of voxels and

$$\mathbf{n}(A,j) = \begin{cases} \frac{\nabla A(j)}{\|\nabla A(j)\|} & \text{in case } \|\nabla A(j)\| \neq 0, \\ 0 & \text{otherwise.} \end{cases}$$