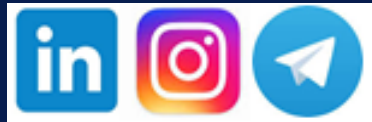# Image Processing 9

Radiomics (Theory)

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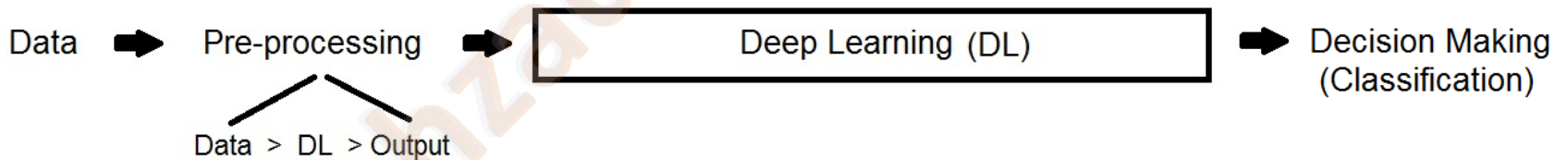
Machine Learning

Classic (Shallow / Conventional Learning)
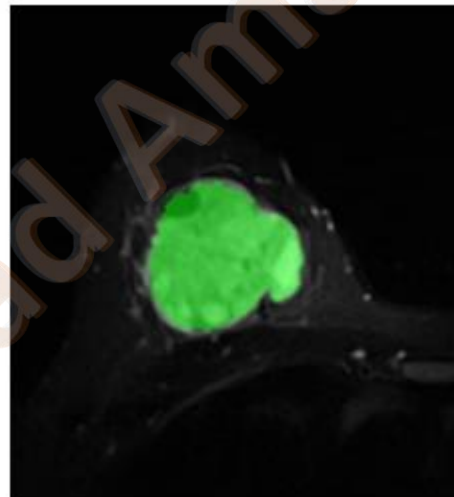
Data ➡ Pre-processing ➡ | Feature Extraction ➡ Feature Selection | ➡ Decision Making (Classification)

Deep Learning

Data ➡ Pre-processing ➡ | Deep Learning (DL) | ➡ Decision Making (Classification)

Data > DL > Output

Radiomics

- **A method for extracting features from medical images**

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3

Morphological Features (Shape-based Features)

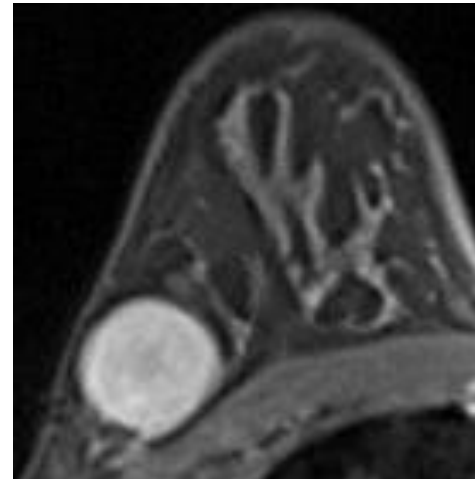- _MajorAxisLength
- _MaximumDiameter
- _MeshSurface
- _MinorAxisLength
- _Perimeter
- _PerimeterSurfaceRatio
- _PixelSurface
- _Sphericity
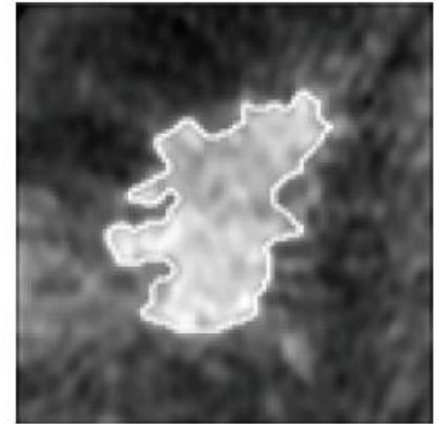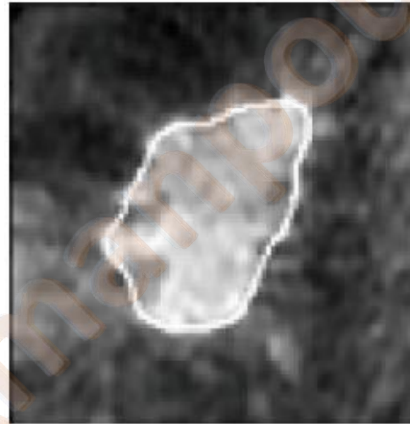
Texture Features
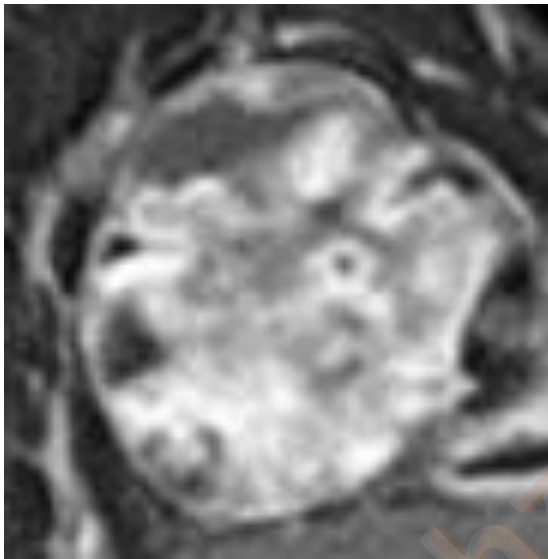
Texture Features

- **First Order Statistics (19 features)**

- **GLCM (24):** Grey Level Co-occurrence Matrix

- **GLRLM (16):** Grey Level Run Length Matrix

- **GLSZM (16):** Grey Level Size Zone Matrix

- **NGTDM (5):** Neighbouring Grey Tone Difference Matrix

- **GLDM (14):** Grey Level Dependence Matrix

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First Order Statistics

- $\mathbf{X}$ be a set of N_p voxels included in the ROI

$$\min(\mathbf{X}) \qquad \max(\mathbf{X}) \qquad mean = \frac{1}{N_p} \sum_{i=1}^{N_p} \mathbf{X}(i)$$

$$energy = \sum_{i=1}^{N_p} (\mathbf{X}(i) + c)^2 \qquad entropy = - \sum_{i=1}^{N_g} p(i) \log_2 (p(i) + \epsilon)$$

$$skewness = \frac{\mu_3}{\sigma^3} = \frac{\frac{1}{N_p} \sum_{i=1}^{N_p} (\mathbf{X}(i) - \bar{X})^3}{\left(\sqrt{\frac{1}{N_p} \sum_{i=1}^{N_p} (\mathbf{X}(i) - \bar{X})^2} \right)^3}$$

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Gray Level Co-occurrence Matrix (GLCM)

$$
I = \begin{bmatrix} 1 & 2 & 5 & 2 & 3 \\ 3 & 2 & 1 & 3 & 1 \\ 1 & 3 & 5 & 5 & 2 \\ 1 & 1 & 1 & 1 & 2 \\ 1 & 2 & 4 & 3 & 5 \end{bmatrix}
$$

$$
P = \begin{bmatrix} 6 & 4 & 3 & 0 & 0 \\ 4 & 0 & 2 & 1 & 3 \\ 3 & 2 & 0 & 1 & 2 \\ 0 & 1 & 1 & 0 & 0 \\ 0 & 3 & 2 & 0 & 2 \end{bmatrix}
$$

glcm_Autocorrelation
glcm_ClusterProminence
glcm_ClusterShade
glcm_ClusterTendency
glcm_Contrast
glcm_Correlation
glcm_DifferenceAverage
glcm_DifferenceEntropy
glcm_DifferenceVariance
glcm_Id
glcm_Idm

glcm_Idn
glcm_Imc1
glcm_Imc2
glcm_InverseVariance
glcm_JointAverage
glcm_JointEnergy
glcm_JointEntropy
glcm_MaximumProbability
glcm_MCC
glcm_SumAverage
glcm_SumEntropy
glcm_SumSquares

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