

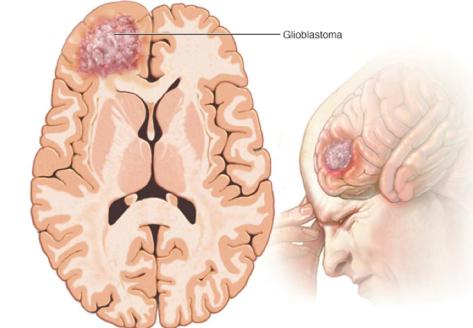
Glioblastoma Patient Outcome Prediction with Radiomics as Quantitative Imaging Biomarker

02740 Bioimage Informatics - Course Project

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Background

- **Glioblastoma:** aggressive cancer in the brain / spinal cord, originated from astrocytes that support nerve cells
- **Magnetic Resonance Imaging (MRI):** the major imaging approach to locate and characterize the tumor

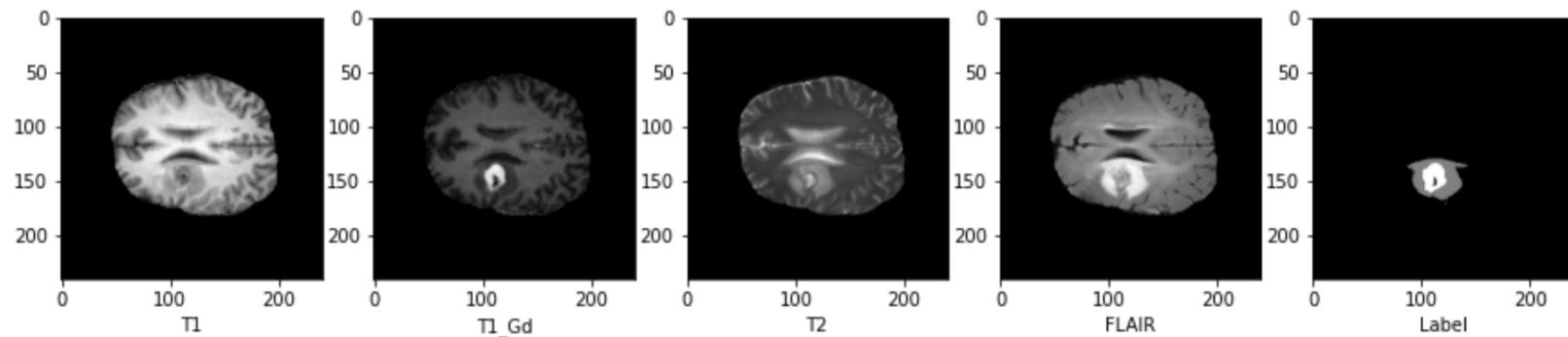


Different types of MRI

T1 weighted (T1)	High signal for fat, paramagnetic substances(eg. MRI contrast agents); Low signal for more water content
T2 weighted (T2)	High signal for more water content; Low for fat and paramagnetic substances
Fluid-attenuated inversion recovery (FLAIR)	High signal in lacunar infarction , multiple sclerosis (MS) plaques , subarachnoid haemorrhage and meningitis

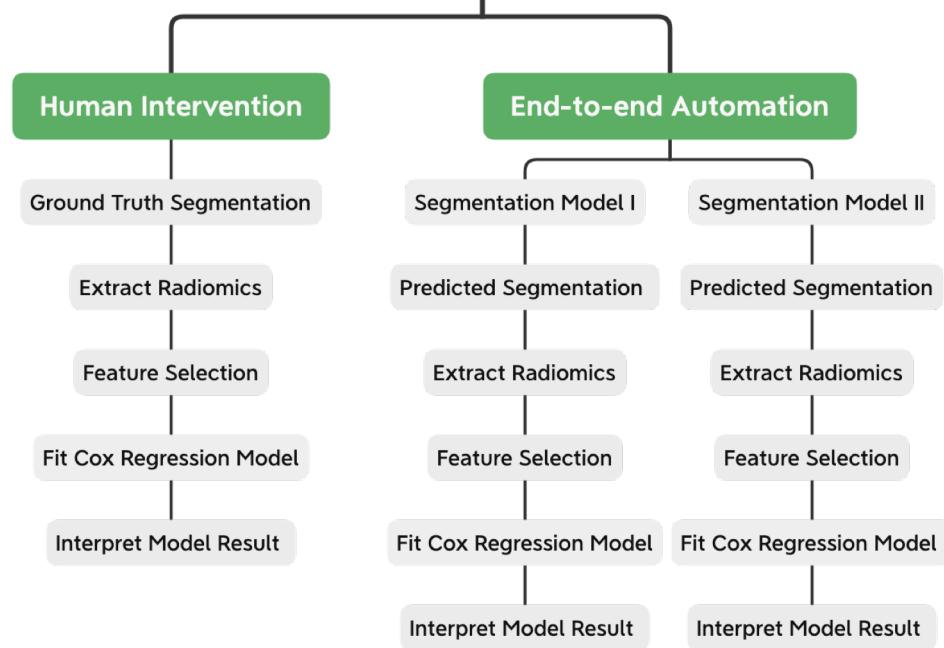
Data

- 102 patients from TCGA GBM
- 4 modalities (T1, T1_Gd, T2, and Flair)
- Image dimension: 240*240*155
- 5 patients do not have ground truth segmentation references, the final number of samples is 97.



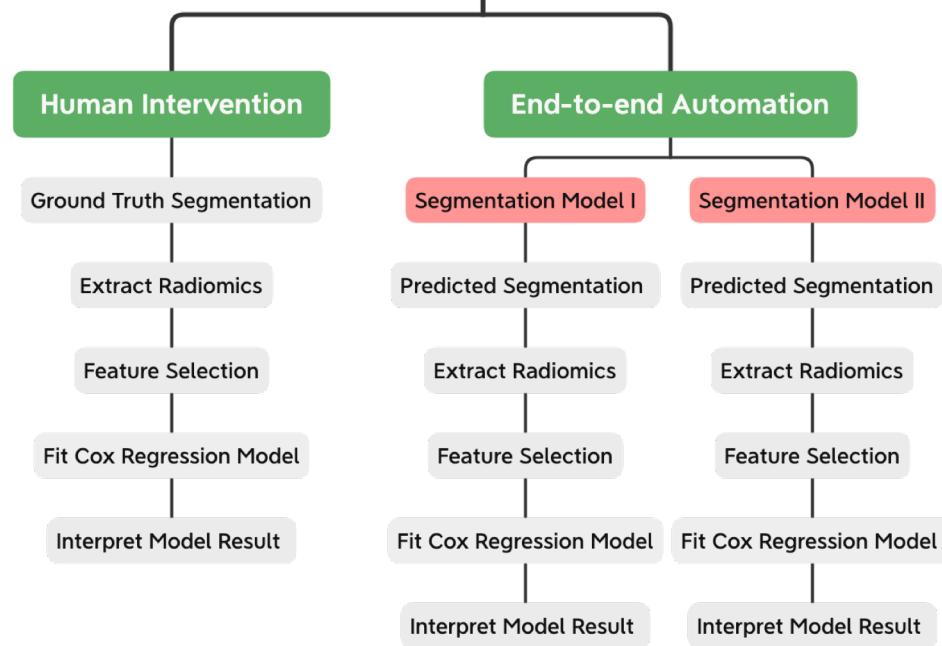
Clinical Outcome Prediction with Radiomics Workflow

XMind
Trial Mode



Clinical Outcome Prediction with Radiomics Workflow

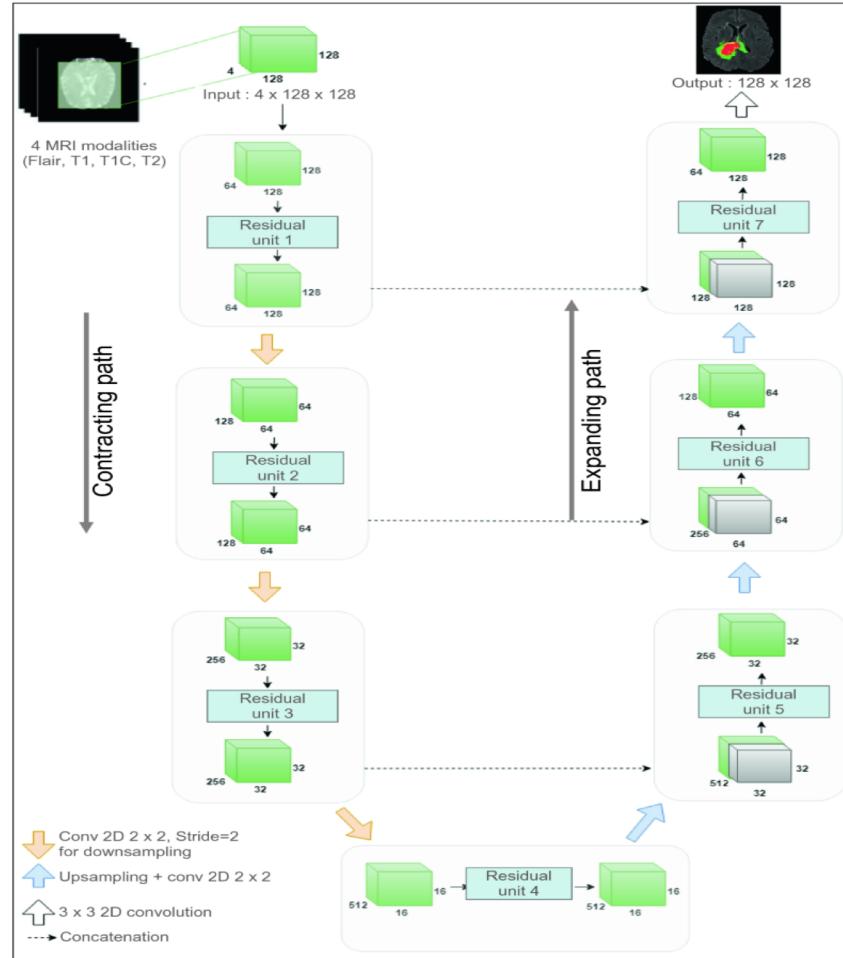
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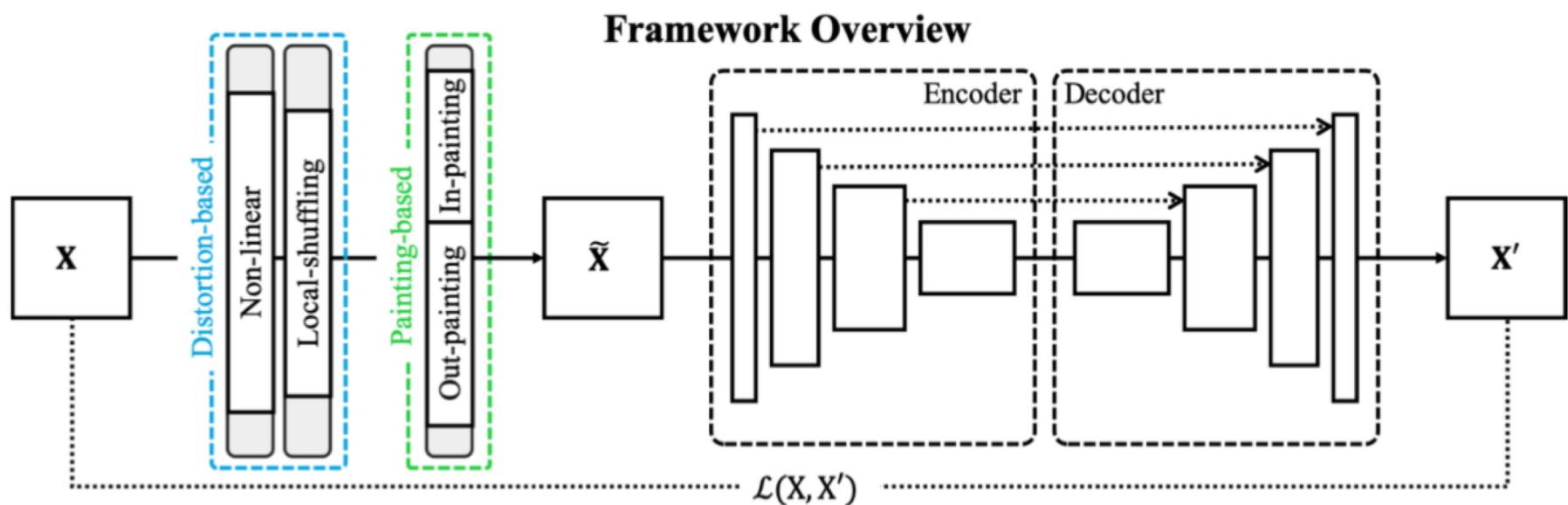
Segmentation I:

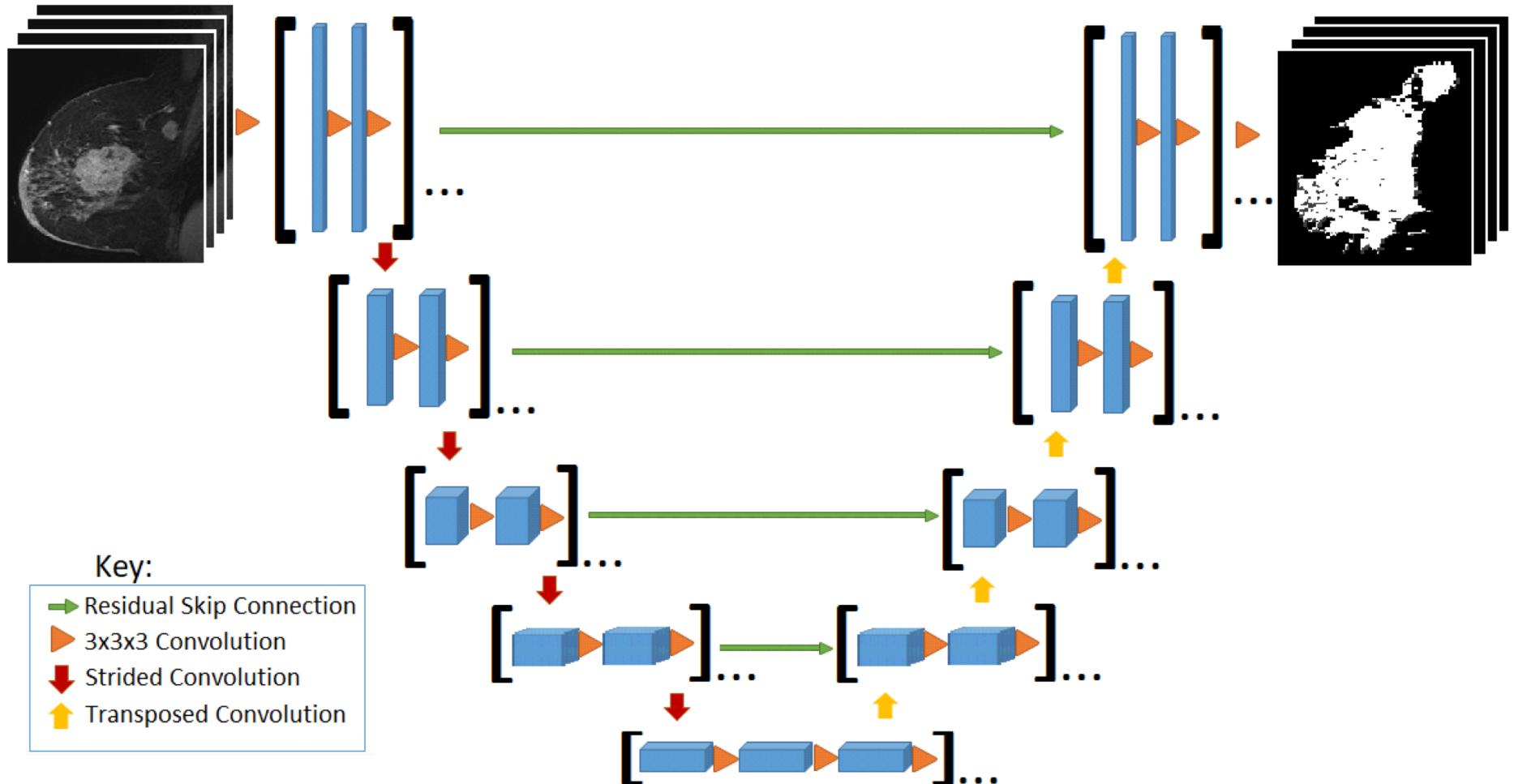
The proposed network model is modified from U-net architecture

- 7 residual blocks
- Each block:
 - 2 convolution units
 - (each of them has a Batch Normalization (BN) layer, an activation function, called Parametric Rectified Linear Unit (PReLU))
- 10,159,748 parameters to optimize.

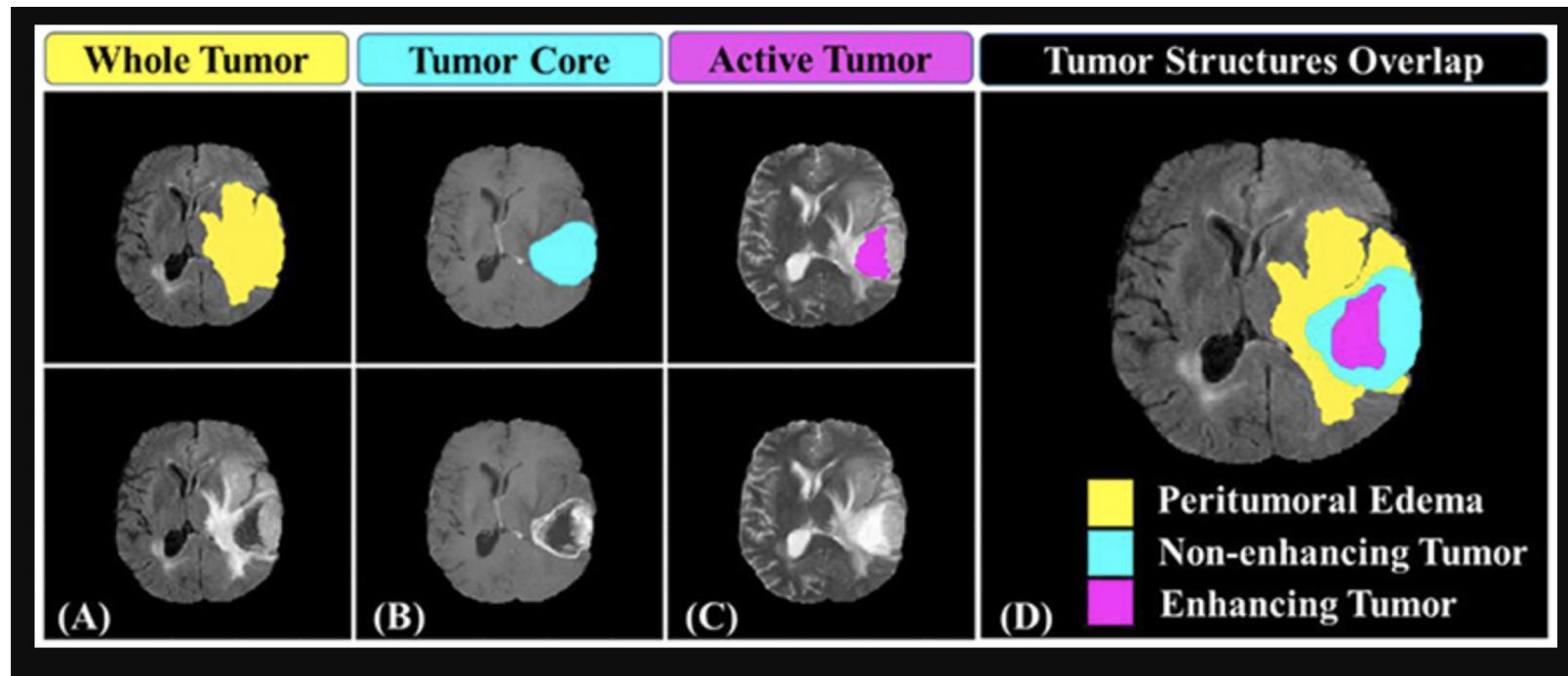


Segmentation -- Model II

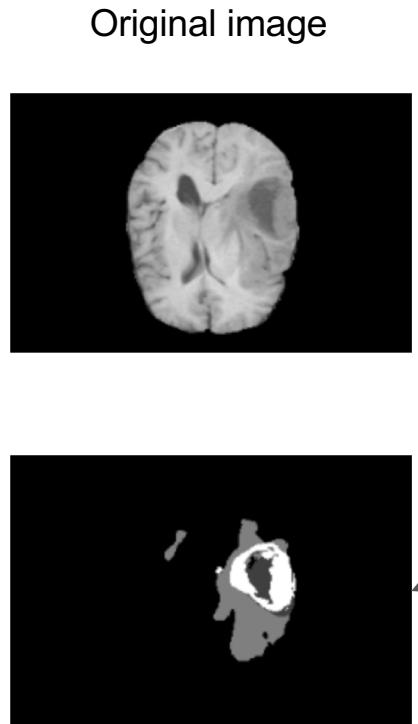




Label Interpretation



Segmentation Results -- Model I



Ground Truth

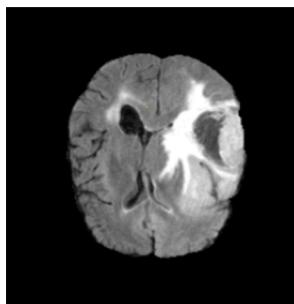


Evaluation Metrics for all 97 patients

Metrics	Mean Value
Whole tumor dice score	0.75561333
Tumor core dice score	0.65999171
Active tumor dice score	0.66140959

Segmentation Results -- Model II

Original image



Ground Truth



Segmentation result
of Model II

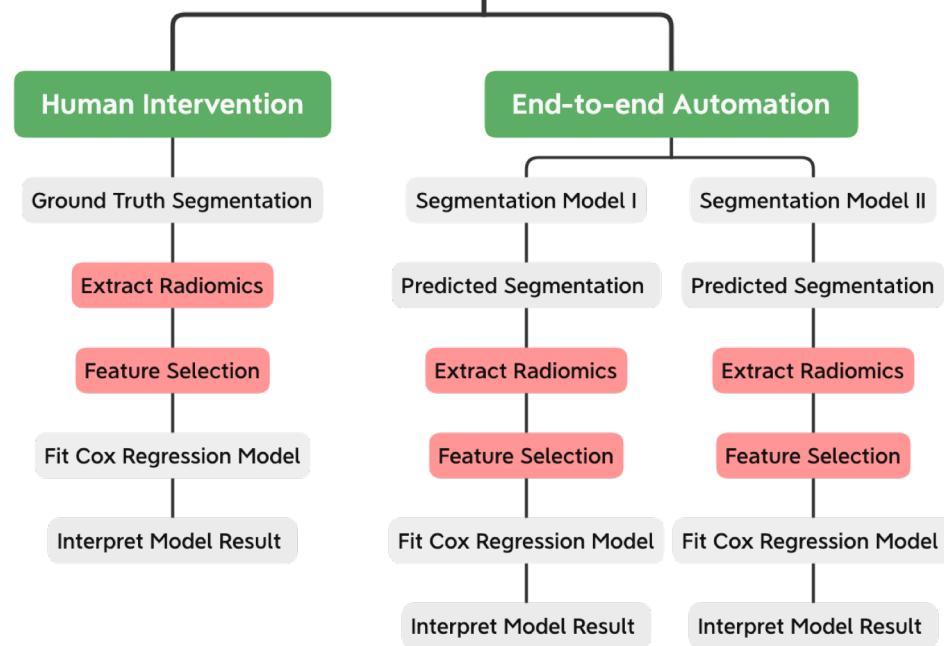
Patient ID:TCGA-02-0047

Evaluation Metrics for all 97 patients

Metrics	Mean Value
Whole tumor dice score	0.59028011
Tumor core dice score	0.80493862
Active tumor dice score	0.77413045

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Radiomics Features

- First Order Statistics (19 features)
- Shape-based (3D) (16 features)
- Shape-based (2D) (10 features)
- Gray Level Coccurrence Matrix (24 features)
- Gray Level Run Length Matrix (16 features)
- Gray Level Size Zone Matrix (16 features)
- Neighbouring Gray Tone Difference Matrix (5 features)
- Gray Level Dependence Matrix (14 features)

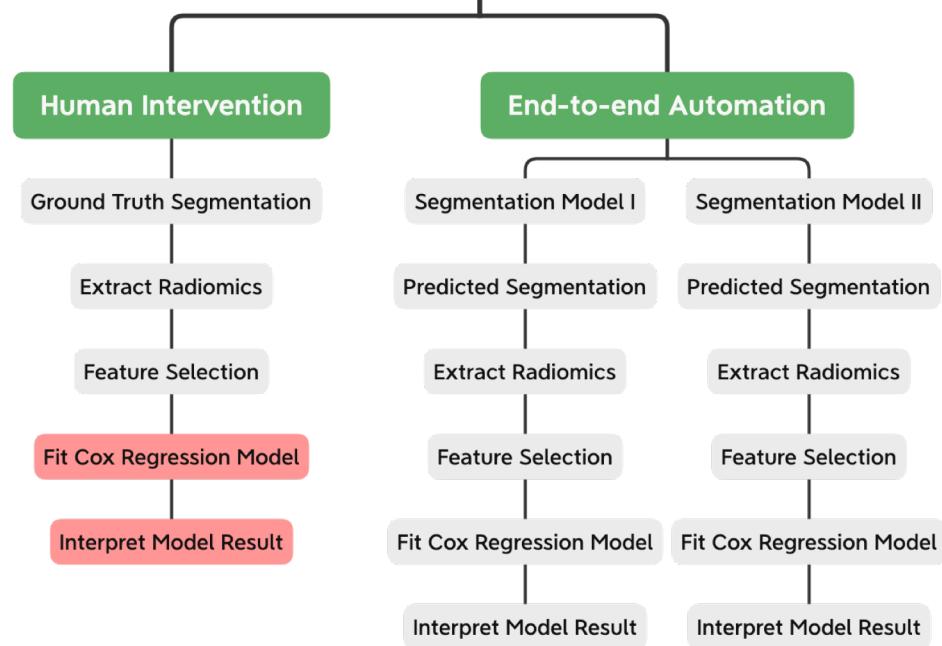
<https://pyradiomics.readthedocs.io/en/latest/features.html#radiomics.firstorder.RadiomicsFirstOrder>

Feature Selection

- Recursive Feature Elimination
- Remove Low Variance
- Drop High Collinearity
- Regularization
 - Elastic Net (Combining L1 and L2 Regularization)
- Backward Selection
 - Modify model using univariant predictive value

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Trial Mode



Experiment 1 Result Interpretation

Texture Related
Tumor Size/Shape Related
1: T1 Gd
2: T2
3: FLAIR

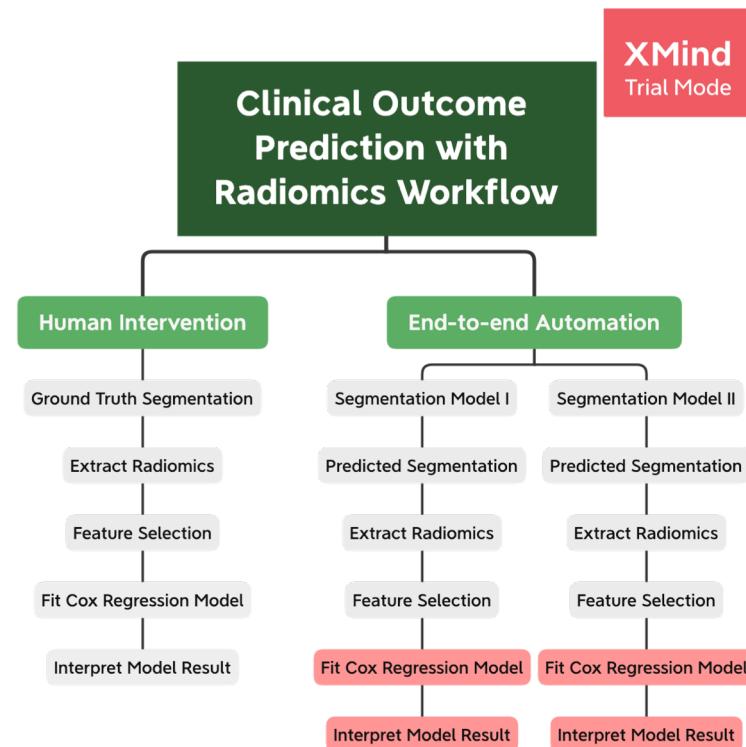
Selected Features	Coefficient	p-value
Major Axis Length_3	0.47	0.06
Minor Axis Length_3	-0.16	0.45
First Order Entropy_2	0.43	0.07
Sum Entropy_3	-0.14	0.54
DependenceNonUniformityNormalized_1	-0.21	0.15
SmallDependenceHighGrayLevelEmphasis_1	0.42	<0.005
GrayLevelNonUniformityNormalized_1 (GLNN) GLNN	0.32	0.04
Maximum2DDiameterRow_3	-0.50	0.06

Concordance = 0.6

Log Likelihood: 16.5

Log Likelihood P-value: 0.0356

Wrapping Up...



References

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- Park, Ji Eun, and Ho Sung Kim. "Radiomics as a quantitative imaging biomarker: practical considerations and the current standpoint in neuro-oncologic studies." *Nuclear medicine and molecular imaging* 52.2 (2018): 99-108.
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