Graduate Certificate in Application of AI in Radiation Oncology

Deep Learning in Radiation Oncology

Artificial Intelligence (AI)
AI refers to the simulation of human intelligence processes by machines, especially computer systems. These processes include learning (the acquisition of information and rules for using the information), reasoning (using rules to reach approximate or definite conclusions), and self-correction.

Big Data
Big data refers to extremely large data sets that may be analyzed computationally to reveal patterns, trends, and associations, especially relating to human behavior and interactions.

Convolutional Neural Network (CNN)
A Convolutional Neural Network (CNN) is a class of artificial neural networks, most commonly applied to analyzing visual imagery. CNNs use a variation of multilayer perceptrons designed to require minimal preprocessing.

Data Augmentation
Data augmentation is a technique used to increase the amount of data available for training models by creating slightly modified copies of the original data. This technique is commonly used to prevent overfitting and improve model performance.

Deep Learning
Deep learning is a subset of machine learning that uses artificial neural networks with multiple layers to model and extract representations from complex data. In the context of radiation oncology, deep learning is being increasingly used to improve treatment planning, image segmentation, and outcome prediction.

Feature Engineering
Feature engineering is the process of selecting, extracting, and transforming features in data to improve model performance. This process involves domain knowledge and creativity to identify relevant features for a particular problem.

Gradient Descent
Gradient descent is an optimization algorithm used to minimize the error of a model by adjusting its parameters iteratively. It calculates the gradient of the loss function with respect to the model's parameters and updates them in the opposite direction of the gradient.

Image Segmentation
Image segmentation is the process of partitioning an image into multiple segments to simplify its representation or make it more meaningful for analysis. In radiation oncology, image segmentation is

crucial for target delineation and treatment planning.

Machine Learning
Machine learning is a subset of artificial intelligence that provides systems the ability to learn and improve from experience without being explicitly programmed. Machine learning algorithms build a mathematical model based on sample data, known as "training data," to make predictions or decisions without being explicitly programmed to perform the task.

Model Evaluation
Model evaluation is the process of assessing the performance of a machine learning model on unseen data. Common evaluation metrics include accuracy, precision, recall, F1 score, and area under the receiver operating characteristic curve (AUC-ROC).

Overfitting
Overfitting occurs when a machine learning model learns the details and noise in the training data to the extent that it negatively impacts the model's performance on unseen data. Overfitting can be mitigated by techniques such as regularization, cross-validation, and data augmentation.

Precision Medicine
Precision medicine is an approach to patient care that considers individual variability in genes, environment, and lifestyle for each person. In the context of radiation oncology, precision medicine aims to tailor treatment plans to the unique characteristics of each patient to maximize therapeutic outcomes and minimize side effects.

Radiomics
Radiomics is a field of study that extracts a large number of quantitative features from medical images using advanced image processing techniques. These features can be used to characterize tumor phenotypes, predict treatment outcomes, and guide personalized treatment strategies.

Recurrent Neural Network (RNN)
A Recurrent Neural Network (RNN) is a class of artificial neural networks where connections between nodes form a directed cycle. RNNs are particularly effective in processing sequences of data and are commonly used in natural language processing, speech recognition, and time series analysis.

Supervised Learning
Supervised learning is a machine learning paradigm where models are trained on labeled data, meaning each example in the training set is associated with a target label. The goal of supervised learning is to learn a mapping from input features to the correct output labels.

Target Delineation
Target delineation is the process of outlining the tumor volume and organs at risk in medical imaging to guide radiation therapy planning. Accurate target delineation is essential for delivering precise and effective

radiation treatment while minimizing damage to surrounding healthy tissues.

Transfer Learning
Transfer learning is a machine learning technique where a model trained on one task is re-purposed on a second related task. By leveraging knowledge learned from one domain to another, transfer learning can accelerate model development and improve performance on tasks with limited training data.

Unsupervised Learning
Unsupervised learning is a machine learning paradigm where models learn patterns in data without explicit supervision or labeled examples. Unsupervised learning algorithms aim to discover the inherent structure in the data, such as clustering similar data points or dimensionality reduction.

Validation Set
A validation set is a portion of the dataset used to assess the performance of a machine learning model during training. The validation set is used to tune hyperparameters, evaluate model performance, and prevent overfitting on the training data.

Volume of Interest (VOI)
The volume of interest (VOI) refers to a region or volume within a medical image that is of particular interest for analysis or treatment planning. VOIs are commonly defined based on anatomical structures, pathology, or treatment targets in radiation oncology.