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Automatic Feature Extraction of Modulation Maps and Monitor Unit Profiles: A Machine Learning Approach for Virtual Specific-Plan Verification

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PURPOSE / OBJECTIVES

Machine Learning models predicting gamma passing rates are mainly based on dose distribution data and manually extracted features such as modulation complexity metrics. We have implemented automatic feature-extraction models based on two linac parameters linked to each individual plan: the modulation map or leaf trajectories map (LTM) (2D array) and the delivered monitor units per control points profile (MU_cp) (1D array).

MATERIAL & METHODS

- 1233 prostate plans, portal dosimetry measurements
- 3 models = Model_1:MU_cp, Model_2: LTM, Model_3: MU_cp + LTM
- 5-fold cross-validation, training-validation-testing split: 70%/20%/10%
- Evaluation metrics: The area under the ROC curve (ROC-AUC)

INPUT FEATURES

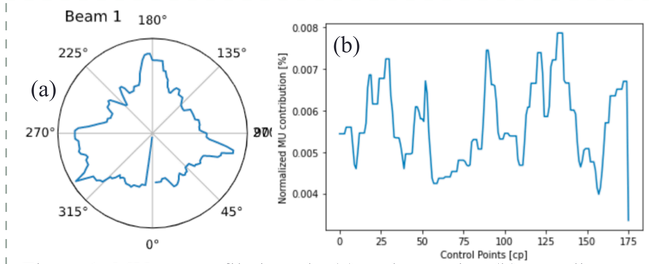

Figure 1. MU_cp profile in polar(a) and cartesian (b) coordinates

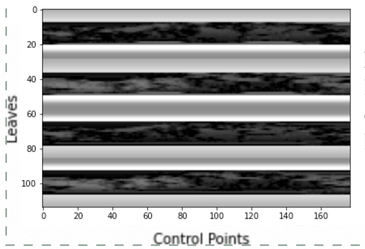

Figure 2. Modulation map or leaf trajectory map (LTM) for one Halcyon treatment (dual-layer MLC)

RESULTS

	Model_1	Model_2	Model_3 Hybrid
ROC-AUC	0.66 ± 0.03	0.81 ± 0.04	0.88 ± 0.02
Accuracy	0.57 ± 0.08	0.78 ± 0.05	0.81 ± 0.03

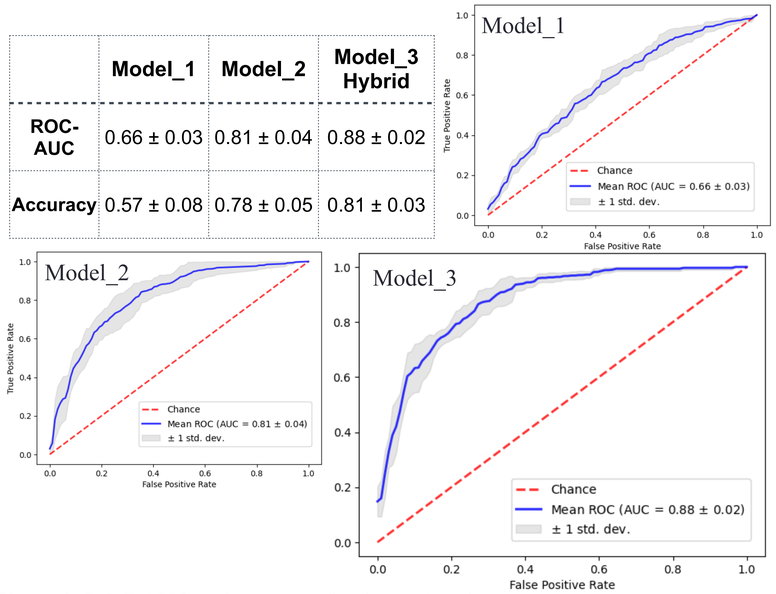

Figure 3. ROC-AUC and accuracy for the testing dataset

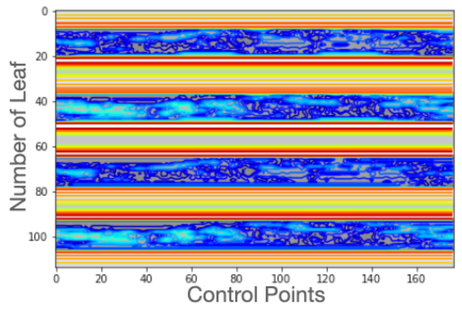

Figure 4. Activation (Saliency) map from Model_2 over the modulation map to identify physical aspects within the MLC trajectories during the treatment

MU profiles and Modulation maps are suitable features to predict dose deliverability

Hybrid models present higher prediction performance

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