Foundation Features for Non-Small Cell Lung Cancer Recurrence Prediction

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ABSTRACT

Purpose:
- Foundation models excel in language and vision tasks, but limited application in patient outcome prediction
- Aim: explore use of features extracted by foundation models for predicting two-year lung cancer recurrence type compared to radiomic and clinical features

Methods:
- Dataset: > 300 patients with non-small cell lung cancer (NSCLC) across five cancer centers
- Selected and visualized radiomic, foundation, and clinical features
- Trained models to predict recurrence type based on feature category
- Evaluated model performance against test and external validation datasets

Results:
- Moderate correlations between some foundation and radiomic features
- No clear classification clusters
- Model performance similar when trained on only foundation *or* clinical features, but lower when trained on both

Conclusion:
- Foundation features not highly predictive of NSCLC recurrence
- Future work to evaluate consistency of multi-institutional foundation features

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INTRODUCTION

- Foundation models: deep learning models trained on large datasets and adapted for downstream tasks (e.g. feature extraction)[1]
- Applying foundation models to patient outcome prediction relatively unexplored[2]
- **Aim: to investigate utility of so-called "foundation features" for predicting two-year lung cancer recurrence type compared to conventional features**

METHODS

- Dataset: 357 patients with newly diagnosed early-stage NSCLC treated with stereotactic ablative radiotherapy across 5 centers
- 3 feature categories:
  - **Radiomic** features from computed tomography scans using Imaging Biomarker Explorer software[3]
  - **Foundation** features from foundation model for cancer imaging biomarkers[4]
  - **Clinical** features from patient charts
- Features selected using Spearman, and visualized using t-SNE
- Multi-class XGBoost models to predict two-year recurrence type:
  - No recurrence
  - Locoregional recurrence
  - Metastatic recurrence
  - New primary
- Model performance evaluated against test and external validation datasets

RESULTS: Patient Demographics

- Patients most prevalently did not experience recurrence (Table 1)

Statistic		Train/Test	External
# of patients		357	27
Mean age		76	76
Sex	Female	194 *(54.3%)*	16 *(59.3%)*
	Male	163 *(45.7%)*	11 *(40.7%)*
Recurrence status	Recurrence	153 *(42.9%)*	15 *(55.6%)*
	Biopsy-confirmed	19 *(12.4%)*	2 *(7.4%)*
Recurrence type	None	204 *(57.1%)*	12 *(44.4%)*
	Locoregional	52 *(14.6%)*	6 *(22.2%)*
	Metastatic	72 *(20.2%)*	9 *(33.3%)*
	New primary	29 *(8.1%)*	0 *(0%)*

Table 1. Demographics of the patient cohort.

RESULTS: Feature Correlations

- Moderately strong Spearman rank correlation coefficients (Fig. 1) between foundation and some radiomic features
- Selected 24 out of 4096 foundation features and 6 out of 27 radiomic features with thresholds:
  - > 0.2 with recurrence outcome
  - < 0.7

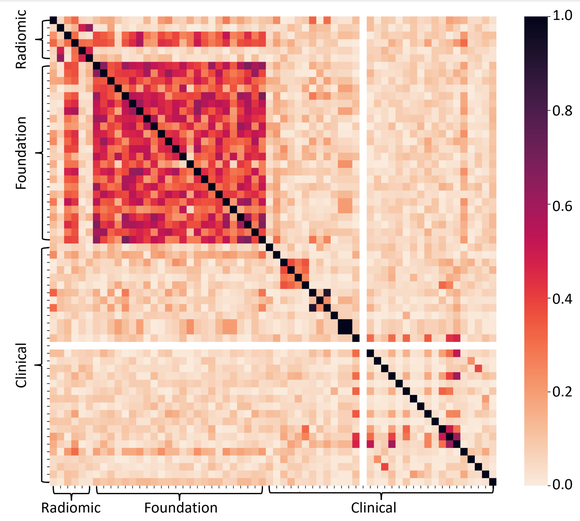

Figure 1 (right). Spearman rank correlation coefficients between feature groups.

RESULTS: Feature Clusters

- T-SNE visualization of features in training set (Fig. 2) did not clearly cluster by recurrence type
  - Suggests features do not capture a detectable nonlinear classification signal

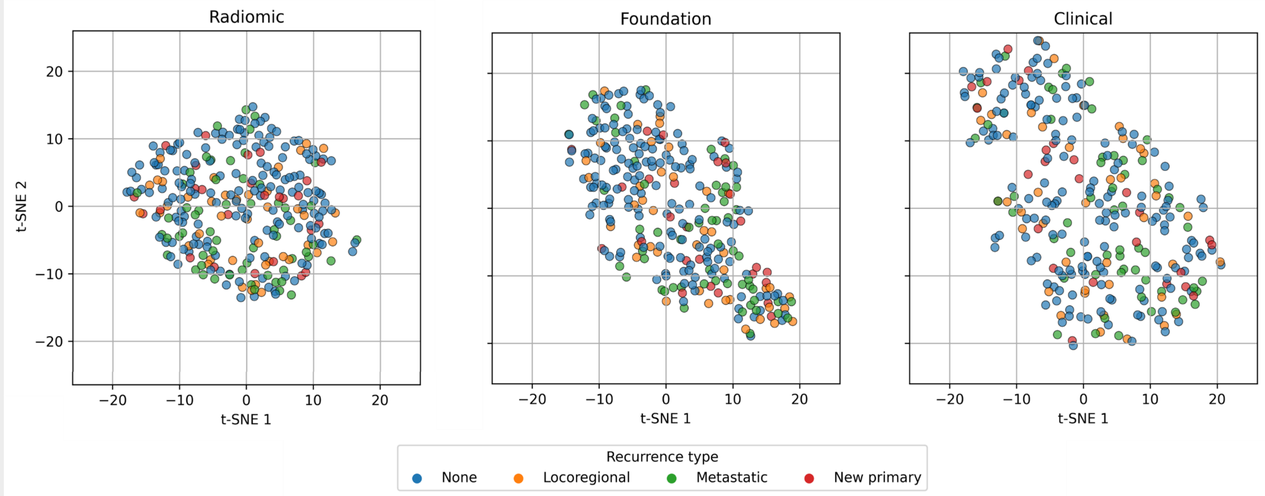

Figure 2 (above). Visualization of radiomic, foundation, and clinical features by t-SNE.

RESULTS: Model Performance Comparison

- Foundation features not as predictive of recurrence on withheld test (Fig. 3) and external validation sets

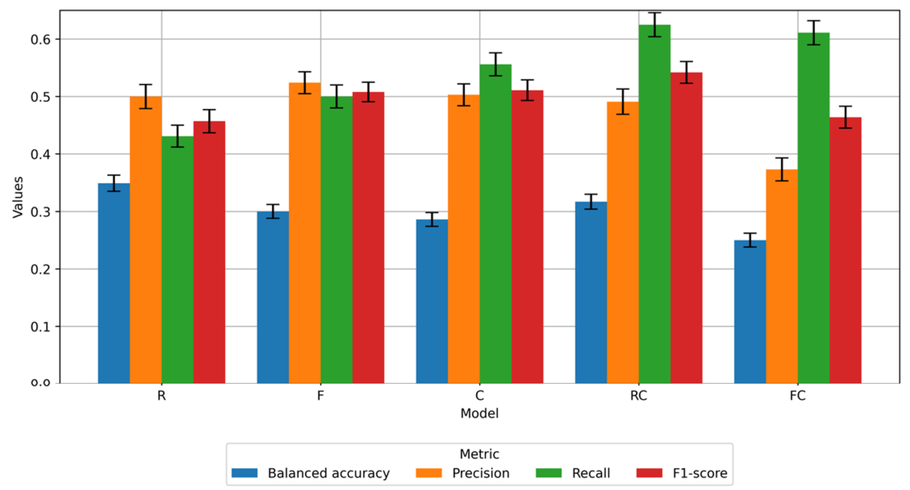

Figure 3 (right). Performance metrics of models trained on combinations of radiomic (R), foundation (F), and clinical (C) features on the test set.

CONCLUSIONS

- Foundation features may provide more comprehensive data for modelling, but not improved NSCLC recurrence prediction
- Future work will evaluate consistency of multi-institutional foundation features

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