# Estimating Time since Death with Artificial Intelligence

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Introduction

Accurately determining the time since death, or **postmortem interval (PMI)**, can facilitate the identification of an unknown individual and help to reconstruct the events around the time of death in medicolegal death investigations.
We use the unique data resource afforded by the **geoFOR app** to build and test models for estimating PMI.
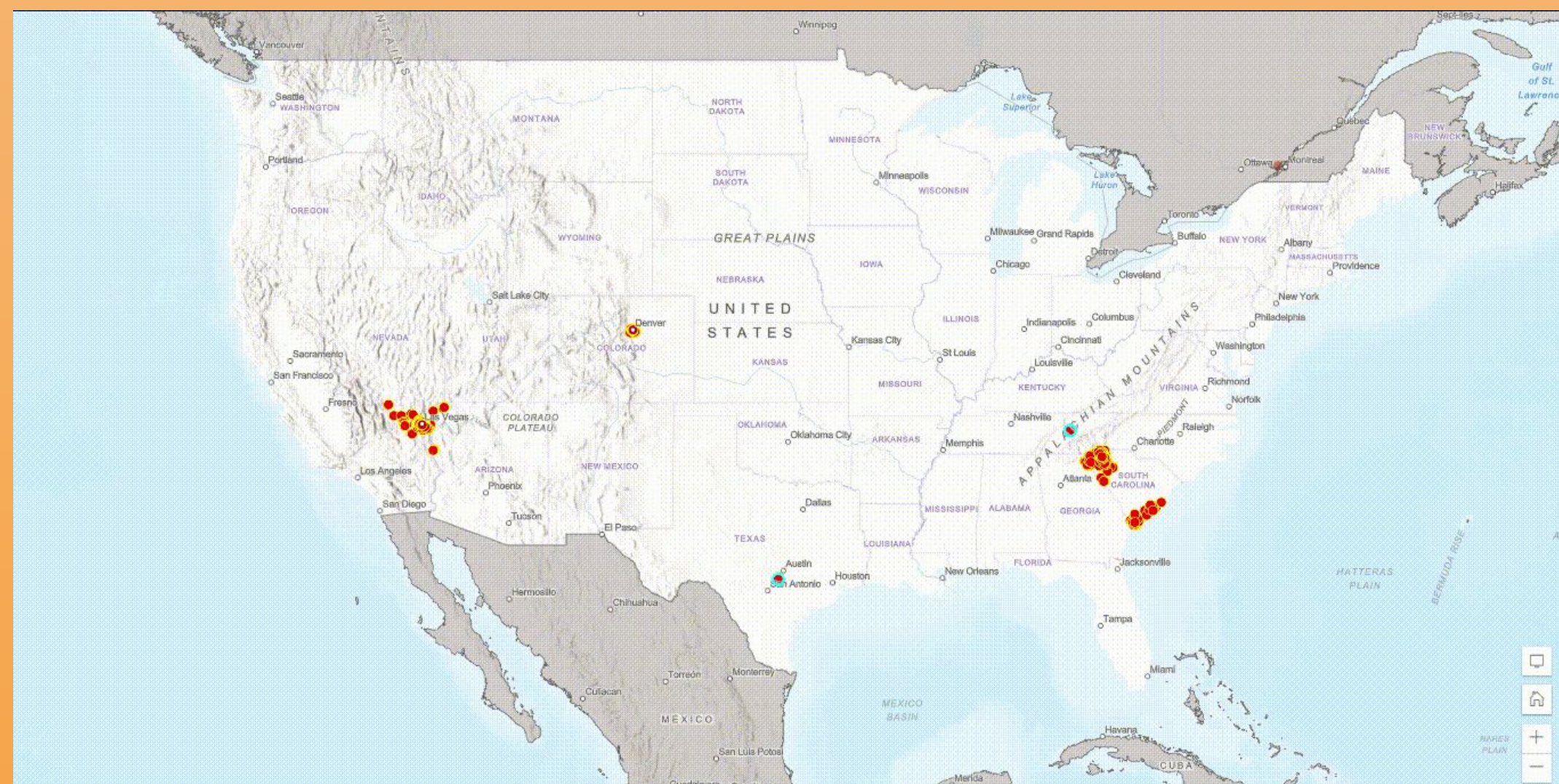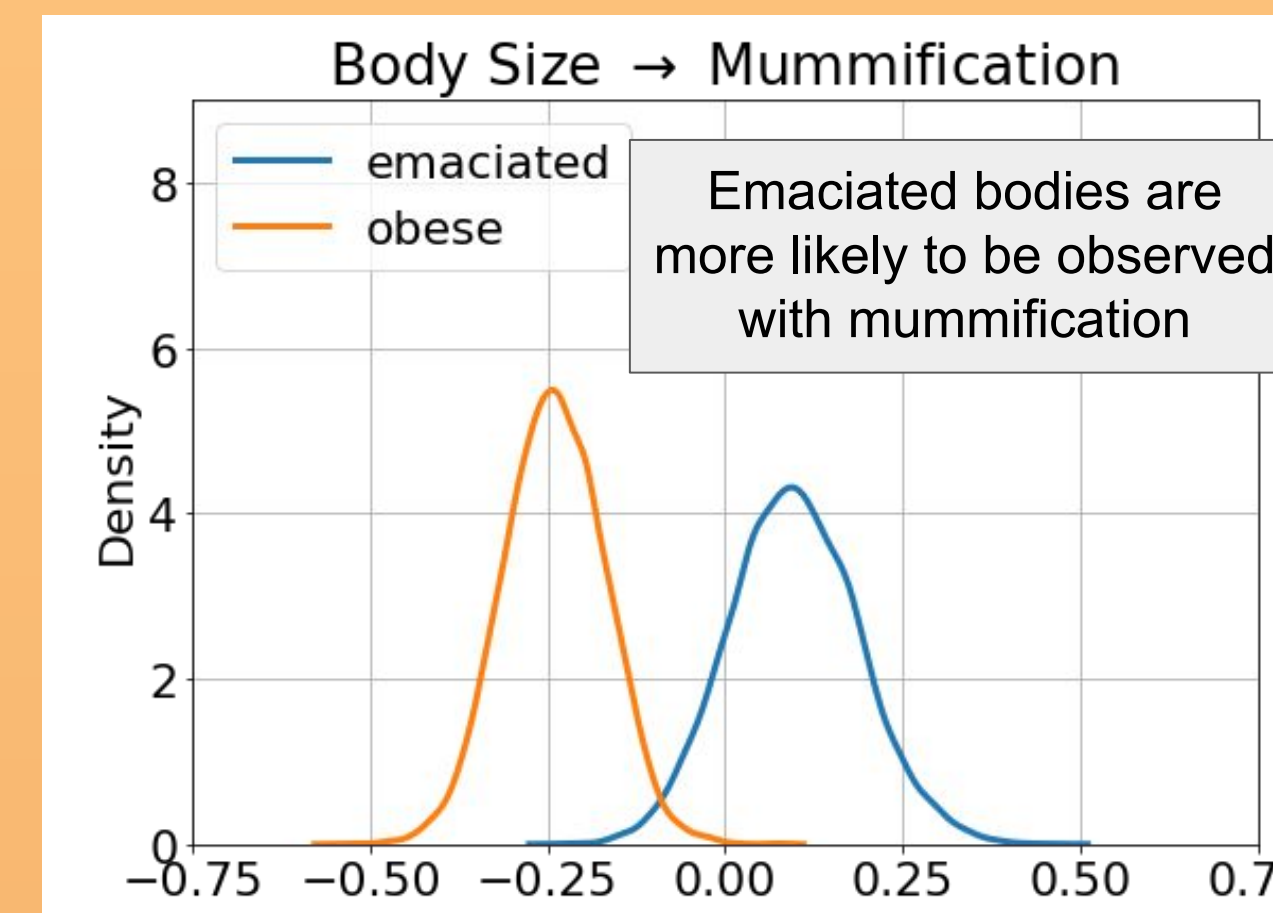

geoFOR

A major weakness with the current state of forensic research is the lack of a **large and representative reference data set**.

geoFOR is an app designed for use by researchers and investigators which creates a **crowdsourced database** that can be used to create, test, and refine models of decomposition rates in order to improve methods for estimating PMI.

Generative model

With a Bayesian approach, we model the decomposition process to not only get better predictions but **better understand the relationships that drive the model to predict higher or lower PMI estimates.**

Body Size → Mummification

Emaciated bodies are more likely to be observed with mummification
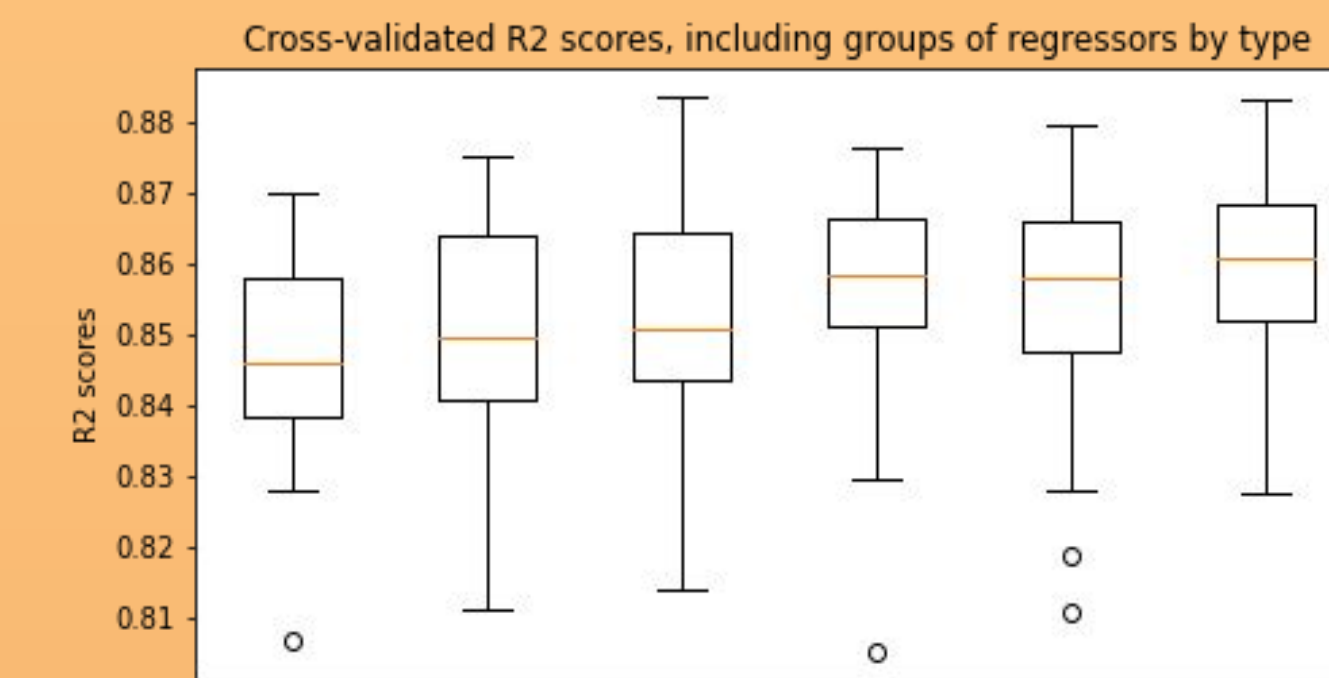
Data validation

Investigation into interobserver agreement scoring of decomposition characteristics for **Reviewers A, B, and C** using Fleiss' kappa, Cohen's kappa, and percent agreement.

A, B, C Fleiss' kappa:	**0.76**
A and C Cohen's kappa:	**0.87**
B and C Cohen's kappa:	**0.71**
B and A Cohen's kappa:	**0.71**
Percent Agreement	**0.86**

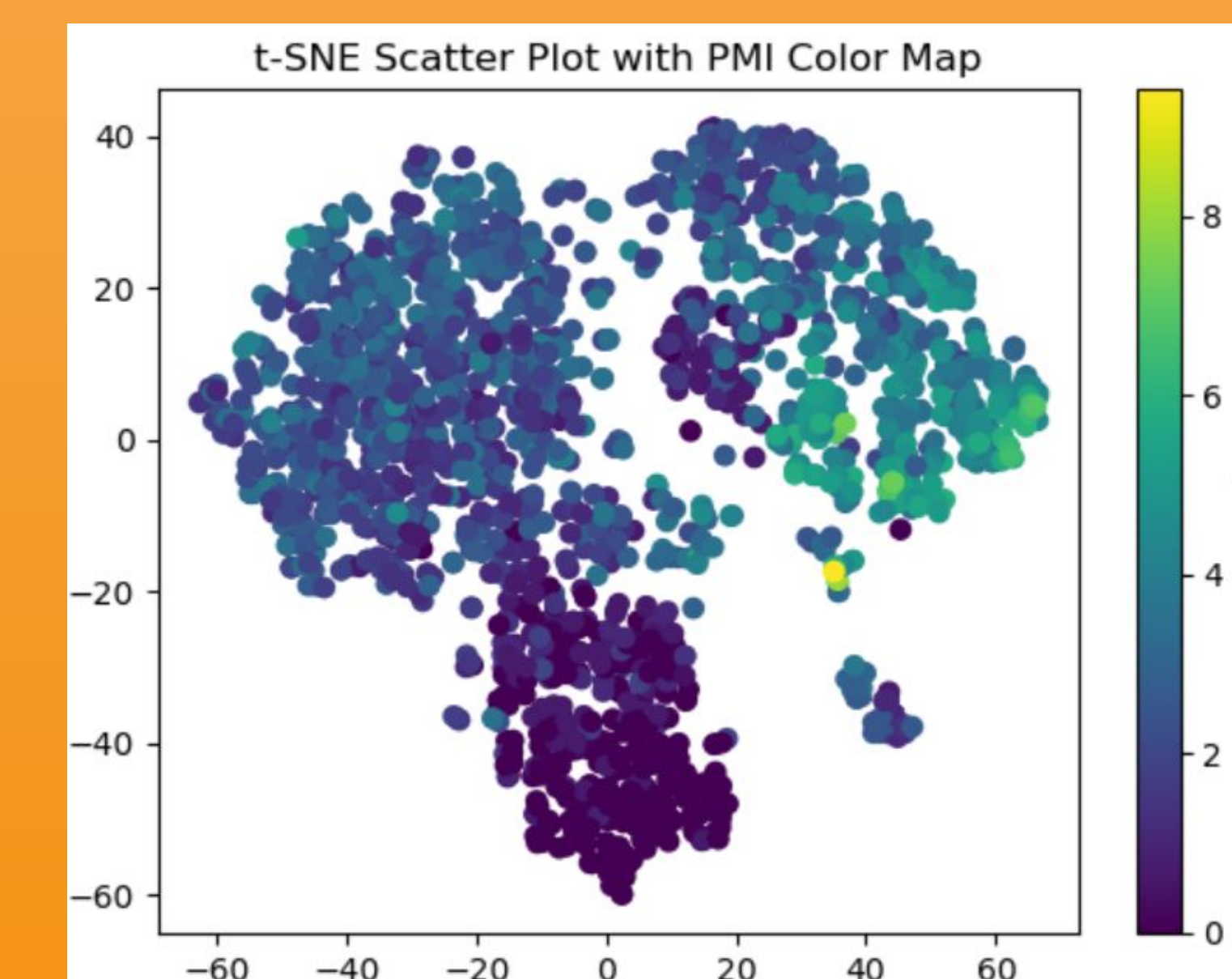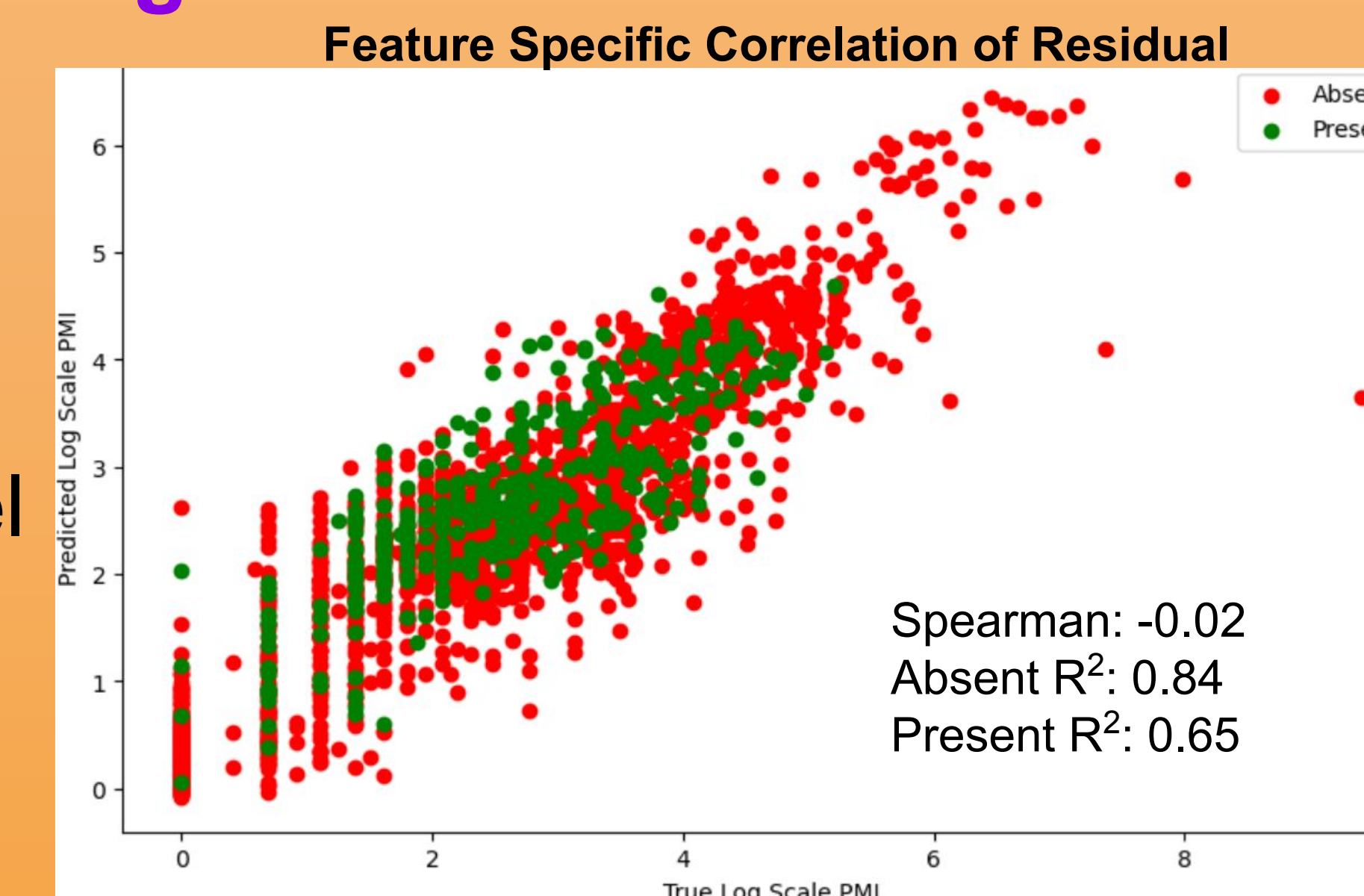| Decomposition Characteristics	Fleiss' kappa	% agree
Embalmed	NaN	1.00
Mummification	1.00	1.00
Burned	NaN	1.00
Weathered bone	NaN	1.00
Dry bone	NaN	1.00
Exposed bone, dry tissue	NaN	1.00
Adipocere	NaN	1.00
Rigor mortis full	1.00	1.00
Livor mortis absent	-0.01	0.96
Livor mortis unfixed	-0.01	0.96
Skin slippage	0.93	0.96
Rigor mortis absent	-0.01	0.96
Exposed bone, moist tissue	-0.01	0.96
Bone with grease	-0.01	0.96
Abdominal caving	0.31	0.92
Liquid decomp	0.72	0.92
Rigor mortis partial	-0.03	0.92
Skin discoloration	0.72	0.88
Drying of fingers, lips, nose	0.58	0.80
Marbling	0.69	0.80
Bloat	0.65	0.80
Greening abdomen	0.58	0.76
Purging	0.58	0.72
Rigor mortis passed	0.30	0.60

Discriminative model

- **Simultaneous model selection and model calibration** to optimize cross-validated performance
- CV'd R^2, 95% confidence interval: [0.80, 0.83]
- Ablation analysis to study model performance using different sets of regressors

Cross-validated R2 scores, including groups of regressors by type

Discriminative model investigation

- Spearman correlation coefficient and R^2 score to validate model performance on subcategories of data
- Clustering to examine model performance within clusters and for outlier detection
- Dimension reduction using t-SNE algorithm used to show 72 feature data in 2 dimensions

Feature Specific Correlation of Residual

Spearman: -0.02
Absent R^2: 0.84
Present R^2: 0.65

t-SNE Scatter Plot with PMI Color Map

K-Means Clustering

Cluster 0 (Yellow) R^2: 0.73
Cluster 1 (Purple) R^2: 0.82

Cluster	Ants	Beetles	Bloat	Marbling	Dry bone	Rigor mortis full	Desiccation	Skin discoloration
0	0.06	0.22	0.14	0.15	0.10	0.03	0.44	0.38
1	0.02	0.01	0.37	0.44	0.00	0.18	0.23	0.64

Sources

https://www.geoforapp.info/about
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7578167/