Religious Affiliation Prediction

DSAN 6600

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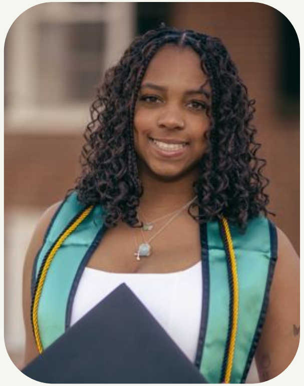


Religious Affiliation Prediction

Survey Data
Supervised Learning
Religion multi-class classification
Hypotheses

Data

Pew Research Center Religious Landscape Study

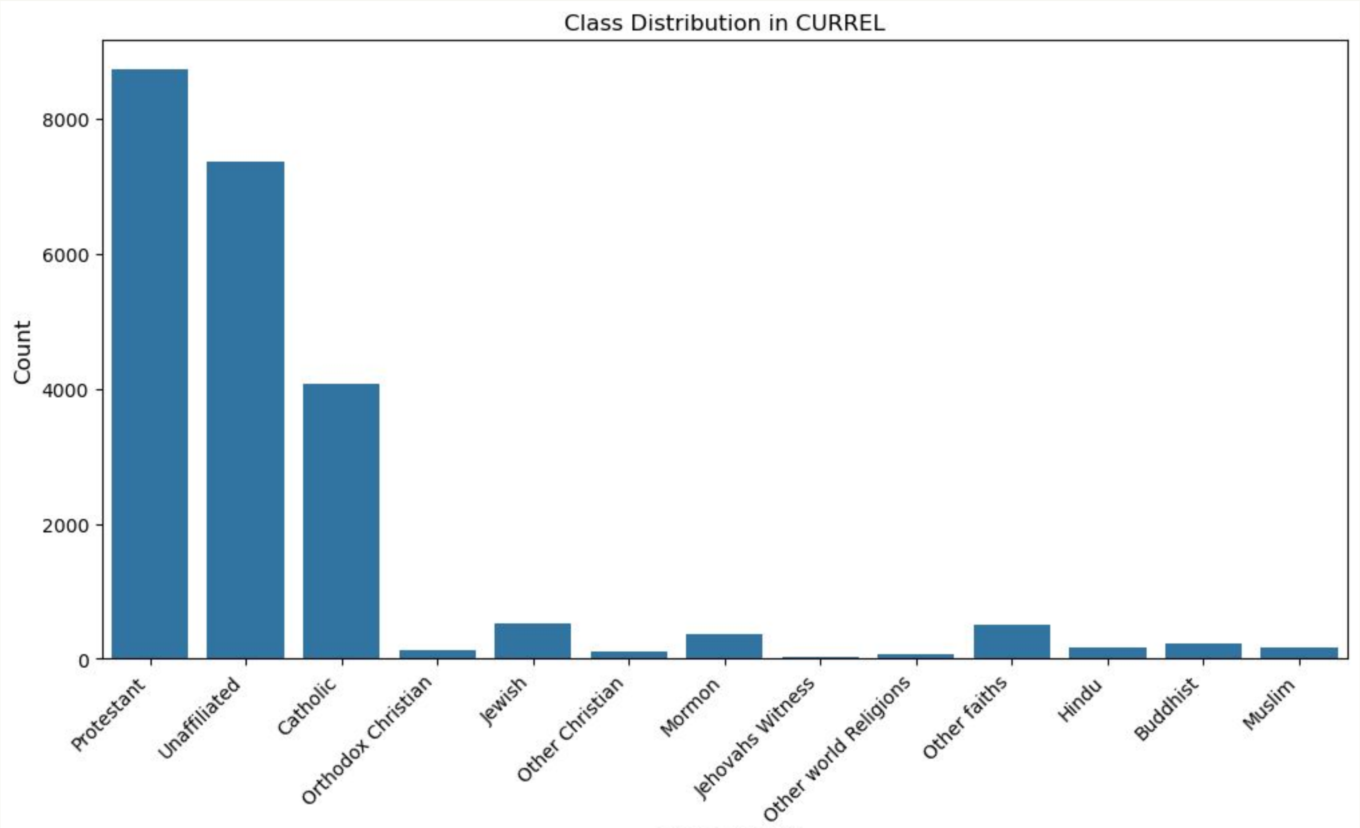
Surveyed in 2023-2024

Address Based Sampling (ABS)

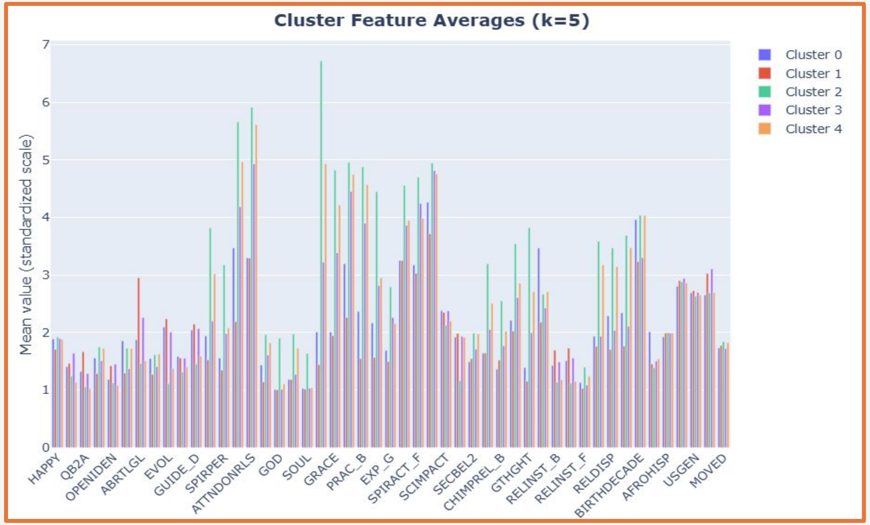
36,908 people responded

130 questions asked

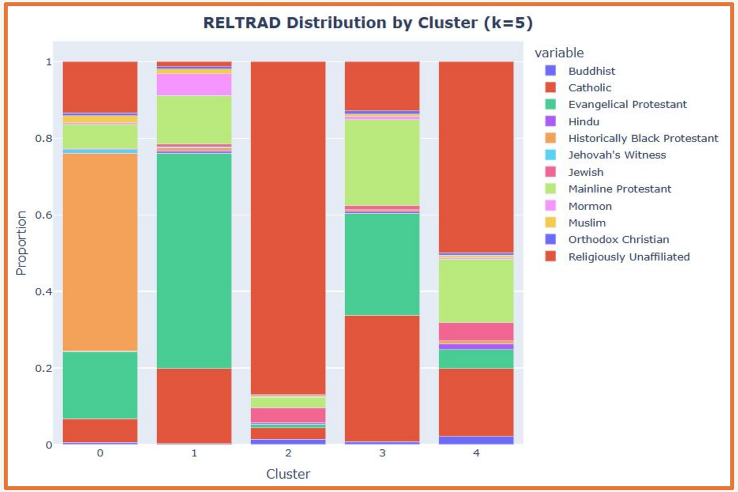
Current Religion (Currel): Protestant | Unaffiliated | Catholic | Jewish | Mormon | Buddhist | Muslim | Hindu | Orthodox Christian | Jehovah's Witness | Other Christian | Other world religions | Other faiths

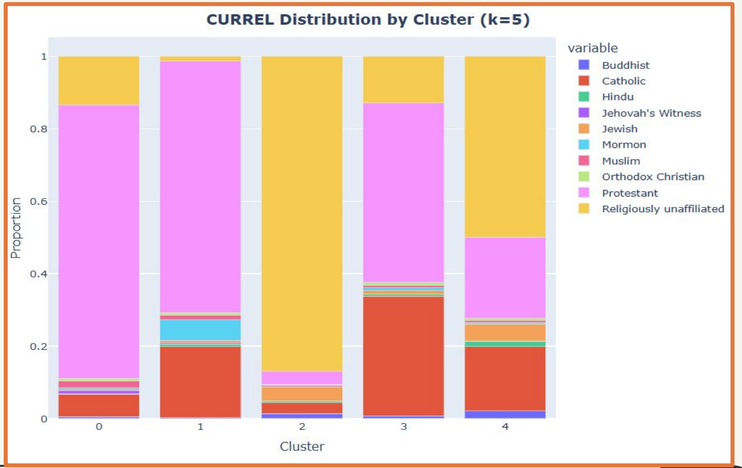

Class Distribution in CURREL
Count
8000
6000
4000
2000
0
Protestant
Unaffiliated
Catholic
Orthodox Christian
Jewish
Other Christian
Mormon
Jehovahs Witness
Other world Religions
Other faiths
Hindu
Buddhist
Muslim

Clustering EDA

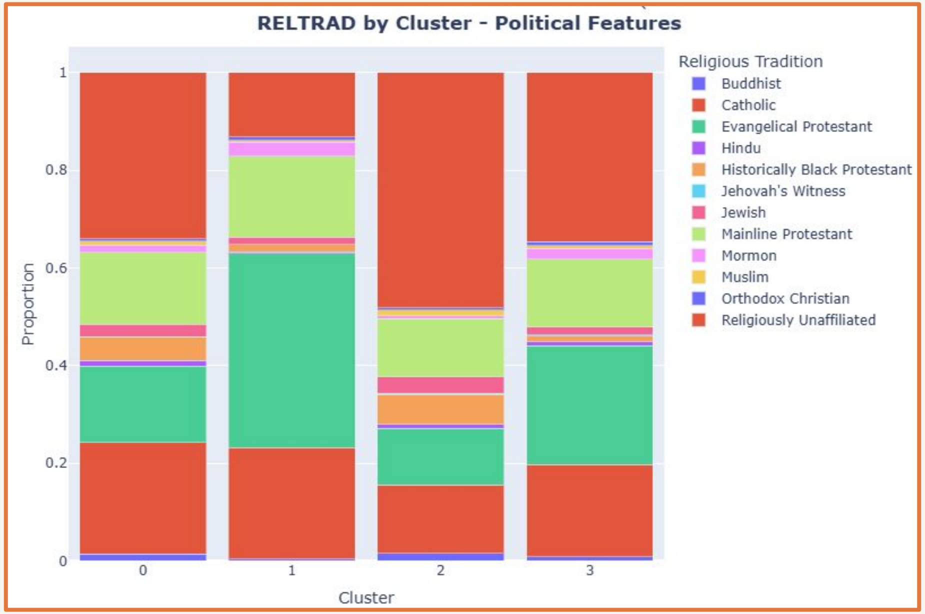


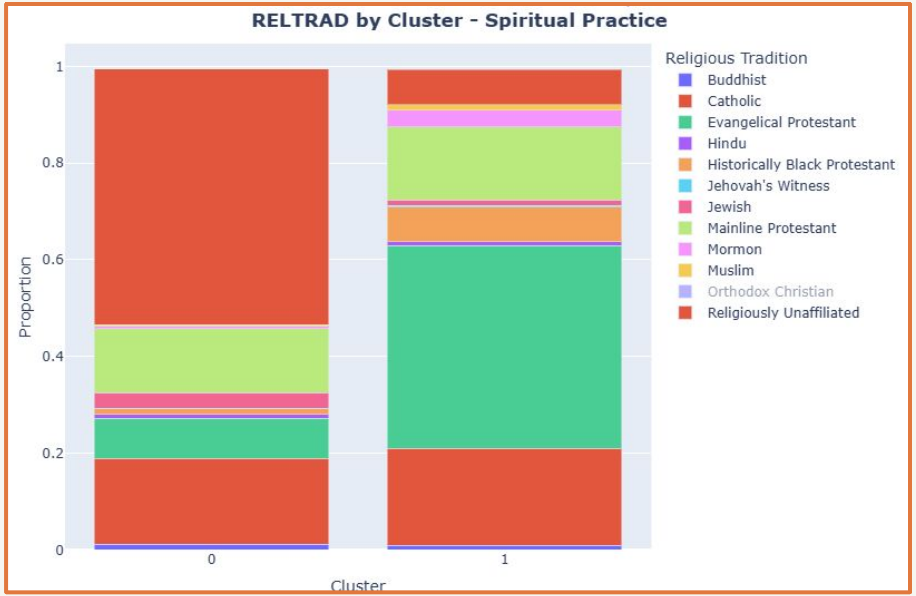
- **Clusters reflect distinct socio cultural profiles** — not just religion but values, practice, and belief.
- **RELTRAD shows richer variation** within Protestant subgroups; **CURREL oversimplifies** into Protestant vs. unaffiliated.
- **Religious identity ≠ worldview** — high religiosity spans multiple clusters, and some unaffiliated groups show strong spiritual engagement.





Category-Specific Clustering





Clustering reveals behavioral patterns that religious labels miss. Identity and practice often diverge — especially in spiritual domains — creating intra-group variation (noise) that complicates classification. This could help explain why we weren't able to achieve a perfect model accuracy–there's no clean mapping between belief, behavior, and affiliation.

Multi-Layer Perceptron

Feature Selection

Normalization: StandardScaler applied to input features

Label Encoding: Religious groups mapped to integers for model training.

Stepwise Feature Selection: Random Forest Classifier

- Selected 50 features via 3-fold stratified CV
- Accuracy after selection: 65.4%

Model

Input Layer: 50 features (after scaling and selection)

Hidden Layers:

- 2 Dense hidden layers (64 units each)
- Activation functions and regularization tuned via grid search

Output Layer: 12 neurons with Softmax activation

Loss Function: Sparse categorical cross-entropy

Training Settings:

- Early Stopping: Patience = 10 epochs
- Batch Size: 16
- Max Epochs: 80 (early stop if no improvement)

Hyperparameters Tuning

Grid Search
Optimizers: rmsprop, sgd, adam
Activations: relu, tanh, leaky_relu
Regularization: None, L1, L2
Regularization Strengths: 0.001, 0.01, 0.1
Dropout: 0, 0.2, 0.5

Best Configuration (Validation):

SGD Optimizer + Tanh Act. Function, L1(0.001), No Dropout

- Validation Accuracy: 67.7%
- Precision: 65.2%
- Recall: 46.1%
- F1: 48.8%

Performance

Test Set Performance

- **Accuracy:** 68%
- **Macro F1 Score:** 0.44
- **Weighted F1 Score:** 0.66

Conclusion:

- Strong prediction of dominant classes (Protestant, Religiously unaffiliated).
- Poor recall for rare classes (Orthodox Christian, Jehovah's Witness, Buddhist).
- **Class imbalance** likely affecting minority class predictions.

Quadratic Discriminant Analysis

Model 1) Full Currel

Model 2) Christian
Non-Christian
Unaffiliated

Model 3) Protestant
Unaffiliated
Catholic
Jewish
Mormon
Other
Jehovah's Witness

All Predictor Variables

&

50 Feature Selected Variables (SF)

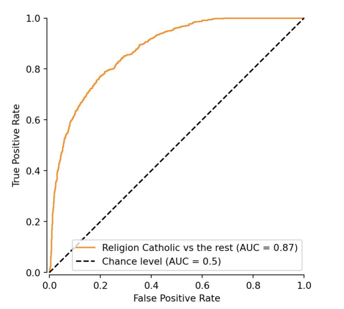
Standard Scaler

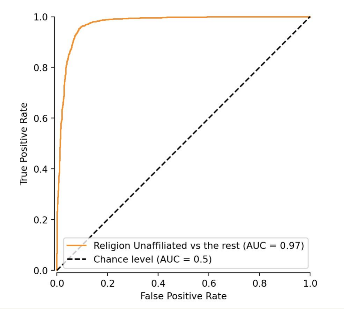
SMOTE

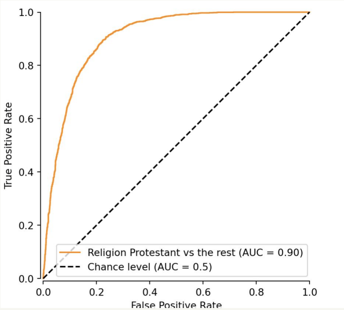
Hyperparameter Tuning (reg_param)

QuadraticDiscriminantAnalysis (sklearn)

QDA	Baseline Model		With Selected Features	
	Accuracy	Weighted F-1	Accuracy	Weighted F-1
Model 1	0.67	0.70	0.60	0.66
Model 2	0.89	0.90	0.91	0.91
Model 3	0.68	0.71	0.65	0.69







Transformer

Model 1

10 classes

Test Accuracy: 75.47%

Model 2

13 classes

Test Accuracy: 94.77%

No decoder

Decoders predict the next token in a sequence - not applicable to multi-class classification

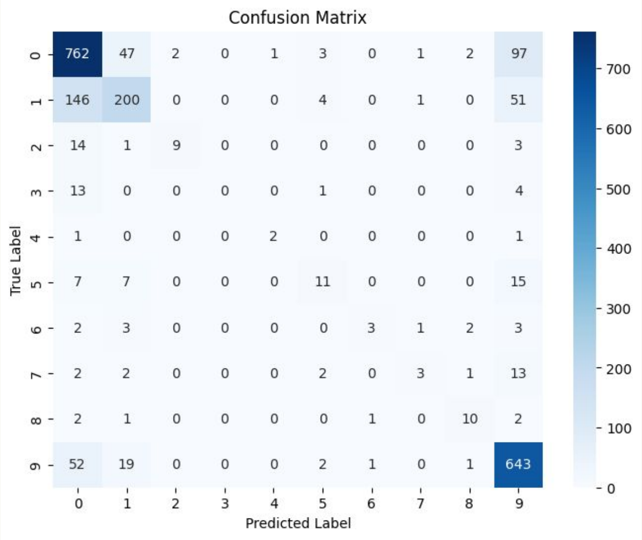
Embeddings

Embeddings created by the encoder are the main reason why the transformer outperforms MLP

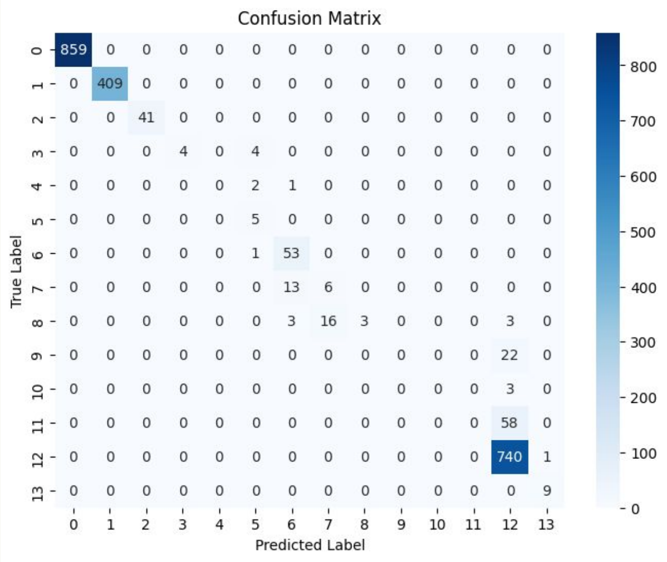
Hyperparameter Tuning

- Embedding Dimension
- Feedforward Dimension
- Number of Attention Heads
- Number of encoding layers
- Dropout regularization
- Learning Rate

10 Classes:



13 Classes:



Conclusion

Best Model:

- Transformer Model 2 (13 classes)
- Test Accuracy: **94.77%**

Why it performed best:

- Captured nuanced patterns via embeddings and attention
- Outperformed MLP and QDA across all metrics

Model Limitations:

- Poor recall for minority classes (e.g., Jehovah's Witnesses)
- Religious identity ≠ behavior → intra-group noise
- Class imbalance affected performance across all models

Future Work:

- Implement class rebalancing (oversampling, weights)
- Explore multi-label or probabilistic affiliation models
- Integrate open-text responses for richer context
- Use interpretability tools (e.g., SHAP, attention maps)

Thank You