

```
import pandas as pd
```

```
# Load your dataset
df = pd.read_csv("Narcolepsy_dataset.csv")
```

```
# Print the shape of the DataFrame
print(f"Rows: {df.shape[0]}")
print(f"Columns: {df.shape[1]}")
```

```
↗ Rows: 11268
Columns: 168
```

```
import pandas as pd
import numpy as np
import warnings
from sklearn.model_selection import StratifiedGroupKFold
from imblearn.over_sampling import SMOTE
from sklearn.preprocessing import MinMaxScaler
from xgboost import XGBClassifier
from lightgbm import LGBMClassifier, early_stopping
from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier, GradientBoostingClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.svm import SVC
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import classification_report, balanced_accuracy_score, ConfusionMatrixDisplay, roc_curve, auc
import matplotlib.pyplot as plt
import shap
from sklearn.base import clone
from imblearn.pipeline import Pipeline
import optuna
from optuna.samplers import TPESampler
from scipy.stats import ks_2samp
```

```
# Suppress warnings
warnings.filterwarnings("ignore")
```

```
# 1. Load and prepare data
print("Loading data...")
df = pd.read_csv("Narcolepsy_dataset.csv")
groups = df['subject_id']
y = df['label']
X = df.drop(['subject_id', 'label', 'epoch'], axis=1)
```

```
# 2. Group-aware train/test split
print("Splitting data...")
sgkf = StratifiedGroupKFold(n_splits=5, shuffle=True, random_state=42)
train_idx, test_idx = next(sgkf.split(X, y, groups=groups))
X_train_val, X_test = X.iloc[train_idx], X.iloc[test_idx]
y_train_val, y_test = y.iloc[train_idx], y.iloc[test_idx]
groups_train_val = groups.iloc[train_idx]
```

```
# 3. Define models and parameter spaces for Optuna
print("Initializing models...")
models = {
    'XGBoost': XGBClassifier(random_state=42, eval_metric='logloss', use_label_encoder=False),
    'LightGBM': LGBMClassifier(random_state=42),
    'RandomForest': RandomForestClassifier(random_state=42, n_jobs=-1),
    'AdaBoost': AdaBoostClassifier(random_state=42),
    'GradientBoosting': GradientBoostingClassifier(random_state=42),
    'SVM': SVC(probability=True, random_state=42),
    'LogisticRegression': LogisticRegression(max_iter=1000, random_state=42),
    'KNN': KNeighborsClassifier(),
    'GaussianNB': GaussianNB()
}
```

```
param_spaces = {
    'XGBoost': lambda trial: {
        'n_estimators': trial.suggest_int('n_estimators', 50, 200, step=50),
        'max_depth': trial.suggest_int('max_depth', 2, 10),
        'learning_rate': trial.suggest_float('learning_rate', 1e-3, 0.3, log=True),
        'subsample': trial.suggest_float('subsample', 0.5, 1.0),
        'colsample_bytree': trial.suggest_float('colsample_bytree', 0.5, 1.0),
        'reg_alpha': trial.suggest_float('reg_alpha', 1e-3, 10.0, log=True),
        'reg_lambda': trial.suggest_float('reg_lambda', 1e-3, 10.0, log=True),
    },

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        gamma : trial.suggest_float( gamma , 0.0, 0.5),
        'min_child_weight': trial.suggest_int('min_child_weight', 1, 10)
    },
    'LightGBM': lambda trial: {
        'n_estimators': trial.suggest_int('n_estimators', 50, 200),
        'max_depth': trial.suggest_int('max_depth', 2, 10),
        'learning_rate': trial.suggest_float('learning_rate', 1e-3, 0.3, log=True),
        'subsample': trial.suggest_float('subsample', 0.5, 1.0),
        'feature_fraction': trial.suggest_float('feature_fraction', 0.5, 1.0),
        'reg_alpha': trial.suggest_float('reg_alpha', 1e-3, 10.0, log=True),
        'reg_lambda': trial.suggest_float('reg_lambda', 1e-3, 10.0, log=True),
        'min_child_samples': trial.suggest_int('min_child_samples', 10, 50)
    },
    'RandomForest': lambda trial: {
        'n_estimators': trial.suggest_int('n_estimators', 50, 200),
        'max_depth': trial.suggest_int('max_depth', 2, 10),
        'min_samples_split': trial.suggest_int('min_samples_split', 2, 30),
        'min_samples_leaf': trial.suggest_int('min_samples_leaf', 1, 20),
        'max_features': trial.suggest_float('max_features', 0.3, 1.0)
    },
    'AdaBoost': lambda trial: {
        'n_estimators': trial.suggest_int('n_estimators', 50, 200),
        'learning_rate': trial.suggest_float('learning_rate', 0.01, 0.2, log=True)
    },
    'GradientBoosting': lambda trial: {
        'n_estimators': trial.suggest_int('n_estimators', 50, 200),
        'learning_rate': trial.suggest_float('learning_rate', 0.01, 0.2, log=True),
        'max_depth': trial.suggest_int('max_depth', 2, 5),
        'min_samples_split': trial.suggest_int('min_samples_split', 2, 30),
        'min_samples_leaf': trial.suggest_int('min_samples_leaf', 1, 20)
    },
    'SVM': lambda trial: {
        'C': trial.suggest_float('C', 0.01, 10, log=True),
        'kernel': trial.suggest_categorical('kernel', ['rbf', 'poly', 'sigmoid']),
        'gamma': trial.suggest_float('gamma', 0.01, 1, log=True)
    }
}

```

```

def optimize_model_params(model_name, X_train, y_train, groups, n_trials=50):
    if model_name not in param_spaces:
        return {}

    def objective(trial):
        params = param_spaces[model_name](trial)
        model = clone(models[model_name].set_params(**params))
        cv = StratifiedGroupKFold(n_splits=3, shuffle=True, random_state=42)
        scores = []

        for train_idx, val_idx in cv.split(X_train, y_train, groups=groups):
            X_tr, X_val = X_train.iloc[train_idx], X_train.iloc[val_idx]
            y_tr, y_val = y_train.iloc[train_idx], y_train.iloc[val_idx]

            pipe = Pipeline([
                ('scaler', MinMaxScaler()),
                ('smt', SMOTE(random_state=42))
            ])
            X_tr_res, y_tr_res = pipe.fit_resample(X_tr, y_tr)
            X_val_scaled = pipe.named_steps['scaler'].transform(X_val)

            model.fit(X_tr_res, y_tr_res)
            y_pred = model.predict(X_val_scaled)
            scores.append(balanced_accuracy_score(y_val, y_pred))

        return np.mean(scores)

    study = optuna.create_study(direction='maximize', sampler=TPESampler(seed=42))
    study.optimize(objective, n_trials=n_trials, show_progress_bar=True)
    print(f"\nBest params for {model_name}:", study.best_params)
    return study.best_params

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# 4. Optimize all models
print("\nOptimizing models...")
best_params = {}
for model_name in models:
    print(f"\nOptimizing {model_name}...")
    best_params[model_name] = optimize_model_params(model_name, X_train_val, y_train_val, groups_train_val)
    models[model_name].set_params(**best_params[model_name])

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# 5. Prepare final scaler and SMOTE for whole training set
print("\nPreprocessing data...")
scaler = MinMaxScaler()
X_train_val_scaled = scaler.fit_transform(X_train_val)
X_test_scaled = scaler.transform(X_test)
smt = SMOTE(random_state=42)
X_train_res, y_train_res = smt.fit_resample(X_train_val_scaled, y_train_val)

# 6. Enhanced evaluation function
def evaluate_models_with_metrics(X_train, y_train, X_test, y_test, feature_set_name=""):
    scores = {}
    gini_scores = {}
    ks_stats = {}
    auc_scores = {}

    # Create figure for ROC curves
    plt.figure(figsize=(12, 8))

    for name, model in models.items():
        print(f"\n{' '*60}\n{name} {feature_set_name}\n{' '*60}")
        model_clone = clone(model)

        # Special handling for LightGBM
        if name == 'LightGBM':
            model_clone.fit(X_train, y_train,
                           eval_set=[(X_test, y_test)],
                           eval_metric='binary_error',
                           callbacks=[early_stopping(stopping_rounds=20, verbose=False)])
        else:
            model_clone.fit(X_train, y_train)

        # Predictions
        y_pred_train = model_clone.predict(X_train)
        y_pred_test = model_clone.predict(X_test)

        # Classification reports
        print("\nTrain classification report:")
        print(classification_report(y_train, y_pred_train, digits=4))
        print("\nTest classification report:")
        print(classification_report(y_test, y_pred_test, digits=4))

        # Balanced accuracy
        test_score = balanced_accuracy_score(y_test, y_pred_test)
        scores[name] = test_score

        # Metrics for probabilistic models
        if hasattr(model_clone, "predict_proba"):
            y_proba_test = model_clone.predict_proba(X_test)[: , 1]

            # ROC and AUC
            fpr, tpr, _ = roc_curve(y_test, y_proba_test)
            roc_auc = auc(fpr, tpr)
            auc_scores[name] = roc_auc

            # Gini coefficient
            gini = 2 * roc_auc - 1
            gini_scores[name] = gini

            # KS statistic
            y_proba_healthy = y_proba_test[y_test == 0]
            y_proba_narco = y_proba_test[y_test == 1]
            ks_stat, _ = ks_2samp(y_proba_healthy, y_proba_narco)
            ks_stats[name] = ks_stat

            # Plot ROC
            plt.plot(fpr, tpr, lw=2,
                    label=f'{name} (AUC={roc_auc:.3f}, Gini={gini:.3f}, KS={ks_stat:.3f})')

    # Confusion matrix
    fig, ax = plt.subplots(figsize=(6, 6))
    ConfusionMatrixDisplay.from_estimator(model_clone, X_test, y_test,
                                          display_labels=["Healthy", "Narcolepsy"],
                                          cmap="Blues", normalize='true', ax=ax)
    ax.set_title(f'{name} Confusion Matrix\n{feature_set_name}')
    plt.tight_layout()
    plt.show()

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# Finalize ROC plot
plt.plot([0, 1], [0, 1], 'k--', lw=2)
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title(f'ROC Curves {feature_set_name}')
plt.legend(bbox_to_anchor=(1.05, 1), loc='upper left')
plt.grid(True)
plt.tight_layout()
plt.show()

# Create metrics dataframe
metrics_data = {
    'Balanced Accuracy': scores,
    'AUC': auc_scores,
    'Gini Coefficient': gini_scores,
    'KS Statistic': ks_stats
}

# Handle non-probabilistic models
for metric in ['AUC', 'Gini Coefficient', 'KS Statistic']:
    for model in models:
        if model not in metrics_data[metric]:
            metrics_data[metric][model] = np.nan

metrics_df = pd.DataFrame(metrics_data).sort_values('Balanced Accuracy', ascending=False)

print("\n" + "="*60)
print(f"Performance Metrics Summary ({feature_set_name})")
print("="*60)
print(metrics_df.to_string(float_format="%0.3f"))

# Decile analysis
def decile_analysis(metric_series, metric_name):
    valid_values = metric_series.dropna()
    if len(valid_values) == 0:
        print(f"\nNo valid {metric_name} values to analyze")
        return

    deciles = np.percentile(valid_values, np.linspace(0, 100, 11))
    print(f"\n{metric_name} Decile Analysis:")
    print("Deciles:", [f"{d:.3f}" for d in deciles])

    for model, value in metric_series.items():
        if pd.isna(value):
            print(f"{model}: Not applicable")
        else:
            decile = min(int(np.floor(np.interp(value, deciles, range(11)))), 9)
            print(f"{model}: {value:.3f} (Decile {decile})")

    for metric in ['AUC', 'Gini Coefficient', 'KS Statistic']:
        decile_analysis(metrics_df[metric], metric)

    return metrics_df

# 7. Evaluate all models with all features
print("\n" + "="*100)
print("EVALUATION WITH ALL FEATURES")
print("="*100)
all_metrics = evaluate_models_with_metrics(
    X_train_res, y_train_res, X_test_scaled, y_test,
    "(All Features)"
)

# 8. SHAP analysis and feature selection
print("\nPerforming SHAP analysis...")
explainer = shap.TreeExplainer(clone(models['XGBoost']).fit(X_train_res, y_train_res))
shap_values = explainer.shap_values(X_train_res)

plt.figure(figsize=(12, 8))
shap.summary_plot(shap_values, X_train_res, feature_names=X.columns, plot_type="bar", show=False)
plt.title("SHAP Feature Importance (XGBoost)")
plt.tight_layout()
plt.show()

if isinstance(shap_values, list):
    shap_values = np.abs(shap_values[1]).mean(axis=0)

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else:
    shap_values = np.abs(shap_values).mean(axis=0)

feature_importance_df = pd.DataFrame({'feature': X.columns, 'importance': shap_values}).sort_values('importance', ascending=True)
threshold = feature_importance_df['importance'].quantile(0.2)
least_important_features = feature_importance_df[feature_importance_df['importance'] < threshold]['feature'].tolist()

print("\nLeast important features (bottom 20%):")
print(least_important_features)

# 9. Remove least important features and re-evaluate
print("\nRemoving least important features...")
X_train_selected = X_train_val.drop(columns=least_important_features)
X_test_selected = X_test.drop(columns=least_important_features)

scaler_sel = MinMaxScaler()
X_train_sel_scaled = scaler_sel.fit_transform(X_train_selected)
X_test_sel_scaled = scaler_sel.transform(X_test_selected)
X_train_sel_res, y_train_sel_res = smt.fit_resample(X_train_sel_scaled, y_train_val)

# Re-optimize with selected features
print("\nRe-optimizing models with selected features...")
for model_name in models:
    print(f"\nRe-optimizing {model_name}...")
    best_params[model_name] = optimize_model_params(model_name, X_train_selected, y_train_val, groups_train_val)
    models[model_name].set_params(**best_params[model_name])

# 10. Evaluate with selected features
print("\n" + "="*100)
print("EVALUATION WITH SELECTED FEATURES")
print("="*100)
selected_metrics = evaluate_models_with_metrics(
    X_train_sel_res, y_train_sel_res, X_test_sel_scaled, y_test,
    "(Selected Features)"
)

# 11. Performance comparison
print("\n" + "="*100)
print("PERFORMANCE COMPARISON: ALL FEATURES vs SELECTED FEATURES")
print("="*100)

# Create comparison dataframe
comparison_df = pd.concat([
    all_metrics.add_suffix(' (All)'),
    selected_metrics.add_suffix(' (Selected)')
], axis=1)

# Reorder columns for better readability
comparison_df = comparison_df[[
    'Balanced Accuracy (All)', 'Balanced Accuracy (Selected)',
    'AUC (All)', 'AUC (Selected)',
    'Gini Coefficient (All)', 'Gini Coefficient (Selected)',
    'KS Statistic (All)', 'KS Statistic (Selected)'
]]

print(comparison_df.to_string(float_format="%.3f"))

# 12. Final best model analysis
best_model_name = selected_metrics['Balanced Accuracy'].idxmax()
print(f"\nBest model after feature selection: {best_model_name}")
best_model = clone(models[best_model_name])
best_model.fit(X_train_sel_res, y_train_sel_res)

# Final predictions
y_pred_test_best = best_model.predict(X_test_sel_scaled)
y_proba_test_best = best_model.predict_proba(X_test_sel_scaled)[:, 1] if hasattr(best_model, "predict_proba") else None

# Final classification report
print("\n" + "="*60)
print("FINAL CLASSIFICATION REPORT FOR BEST MODEL")
print("="*60)
print(classification_report(y_test, y_pred_test_best, digits=4))

# Final metrics
final_metrics = {
    'Balanced Accuracy': selected_metrics.loc[best_model_name, 'Balanced Accuracy']
}

```

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if y_proba_test_best is not None:
    # Calculate final metrics for probabilistic models
    fpr, tpr, _ = roc_curve(y_test, y_proba_test_best)
    roc_auc = auc(fpr, tpr)
    gini = 2 * roc_auc - 1
    y_proba_healthy = y_proba_test_best[y_test == 0]
    y_proba_narco = y_proba_test_best[y_test == 1]
    ks_stat, _ = ks_2samp(y_proba_healthy, y_proba_narco)

    final_metrics.update({
        'AUC': roc_auc,
        'Gini Coefficient': gini,
        'KS Statistic': ks_stat
    })

    # Plot final ROC curve
    plt.figure(figsize=(8, 6))
    plt.plot(fpr, tpr, color='darkorange', lw=2,
             label=f'ROC curve (AUC = {roc_auc:.3f}, Gini = {gini:.3f}, KS = {ks_stat:.3f})')
    plt.plot([0, 1], [0, 1], color='navy', lw=2, linestyle='--')
    plt.xlim([0.0, 1.0])
    plt.ylim([0.0, 1.05])
    plt.xlabel('False Positive Rate')
    plt.ylabel('True Positive Rate')
    plt.title(f'ROC Curve for {best_model_name} (Selected Features)')
    plt.legend(loc="lower right")
    plt.grid(True)

    plt.show()

# Print final metrics
print("\n" + "="*60)
print("FINAL PERFORMANCE METRICS")
print("="*60)
for metric, value in final_metrics.items():
    print(f"{metric}: {value:.4f}")

# Confusion matrix for best model
fig, ax = plt.subplots(figsize=(6, 6))
ConfusionMatrixDisplay.from_estimator(best_model, X_test_sel_scaled, y_test,
                                     display_labels=["Healthy", "Narcolepsy"],
                                     cmap="Blues", normalize='true', ax=ax)
ax.set_title(f"Best Model ({best_model_name}) Confusion Matrix\n(Selected Features)")
plt.tight_layout()
plt.show()

print("\nAnalysis complete!")

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50/50 [02:59<00:00, 3.77s/it]

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<https://colab.research.google.com/drive/1rIM9hrrNzcuUk8APZbpoSMBb5l37oJ-t#scrollTo=ocPPWbSOA73G&printMode=true>

You can set ``force col wise=true`` to remove the overhead.

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<https://pubmed.ncbi.nlm.nih.gov/pubmed/36087940>

You can set ``force col wise=true`` to remove the overhead.

<https://colab.research.google.com/drive/1rIM9hrrNzcuUk8APZbpoSMBb5l37oJ-t#scrollTo=ocPPWbSOA73G&printMode=true>

You can set ``force col wise=true`` to remove the overhead.

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```
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
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[illegible]

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[illegible]

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[illegible]

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[illegible]

[illegible]


```
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
```


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[illegible]

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[illegible]

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[illegible]

```
[LightGBM] [Warning] No further splits with positive gain. best gain: -inf
```


[illegible]

You can set ``force col wise=true`` to remove the overhead.

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```
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] Stopped training because there are no more leaves that meet the split requirements
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] feature_fraction is set=0.9830750139842088, colsample_bytree=1.0 will be ignored. Current value: feature_fraction=0
[I 2025-06-30 06:15:11,548] Trial 49 finished with value: 0.8043140551324148 and parameters: {'n_estimators': 194, 'max_depth': 3, 'lear
```

Best params for LightGBM: {'n_estimators': 199, 'max_depth': 4, 'learning_rate': 0.11578459669741656, 'subsample': 0.9145947754307058, 'r

Optimizing RandomForest...

Best trial: 21. Best value: 0.838484: 100%

50/50 [50:11<00:00, 59.25s/it]

```
[I 2025-06-30 06:15:47,358] Trial 0 finished with value: 0.7992154436351564 and parameters: {'n_estimators': 106, 'max_depth': 10, 'min_s
[I 2025-06-30 06:16:15,303] Trial 1 finished with value: 0.8378703763975682 and parameters: {'n_estimators': 73, 'max_depth': 2, 'min_s
[I 2025-06-30 06:16:33,825] Trial 2 finished with value: 0.8234066688245667 and parameters: {'n_estimators': 53, 'max_depth': 10, 'min_s
[I 2025-06-30 06:17:01,815] Trial 3 finished with value: 0.8045031587271315 and parameters: {'n_estimators': 77, 'max_depth': 4, 'min_s
[I 2025-06-30 06:17:55,867] Trial 4 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 142, 'max_depth': 3, 'min_s
[I 2025-06-30 06:18:33,672] Trial 5 finished with value: 0.7961111124136941 and parameters: {'n_estimators': 168, 'max_depth': 3, 'min_s
[I 2025-06-30 06:19:51,957] Trial 6 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 141, 'max_depth': 3, 'min_s
[I 2025-06-30 06:21:03,953] Trial 7 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 172, 'max_depth': 4, 'min_s
[I 2025-06-30 06:21:29,085] Trial 8 finished with value: 0.7931601460229573 and parameters: {'n_estimators': 68, 'max_depth': 6, 'min_s
[I 2025-06-30 06:22:16,824] Trial 9 finished with value: 0.7935014813441953 and parameters: {'n_estimators': 150, 'max_depth': 4, 'min_s
[I 2025-06-30 06:24:22,825] Trial 10 finished with value: 0.8379902734563656 and parameters: {'n_estimators': 194, 'max_depth': 7, 'min_s
[I 2025-06-30 06:25:49,119] Trial 11 finished with value: 0.837665877420063 and parameters: {'n_estimators': 127, 'max_depth': 6, 'min_s
[I 2025-06-30 06:26:45,768] Trial 12 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 128, 'max_depth': 2, 'min_s
[I 2025-06-30 06:27:44,203] Trial 13 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 102, 'max_depth': 5, 'min_s
[I 2025-06-30 06:28:59,823] Trial 14 finished with value: 0.8374861013079964 and parameters: {'n_estimators': 148, 'max_depth': 8, 'min_s
[I 2025-06-30 06:29:55,265] Trial 15 finished with value: 0.8368022266847345 and parameters: {'n_estimators': 151, 'max_depth': 3, 'min_s
[I 2025-06-30 06:30:42,044] Trial 16 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 111, 'max_depth': 2, 'min_s
[I 2025-06-30 06:32:25,217] Trial 17 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 200, 'max_depth': 5, 'min_s
[I 2025-06-30 06:33:23,125] Trial 18 finished with value: 0.8332866305911507 and parameters: {'n_estimators': 172, 'max_depth': 3, 'min_s
[I 2025-06-30 06:34:43,210] Trial 19 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 136, 'max_depth': 5, 'min_s
[I 2025-06-30 06:35:26,684] Trial 20 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 90, 'max_depth': 8, 'min_s
[I 2025-06-30 06:36:40,224] Trial 21 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 174, 'max_depth': 4, 'min_s
[I 2025-06-30 06:37:48,853] Trial 22 finished with value: 0.8384045460256253 and parameters: {'n_estimators': 185, 'max_depth': 3, 'min_s
[I 2025-06-30 06:39:06,005] Trial 23 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 189, 'max_depth': 4, 'min_s
[I 2025-06-30 06:40:17,154] Trial 24 finished with value: 0.8382000470481201 and parameters: {'n_estimators': 182, 'max_depth': 3, 'min_s
[I 2025-06-30 06:41:02,573] Trial 25 finished with value: 0.8340799036357326 and parameters: {'n_estimators': 162, 'max_depth': 2, 'min_s
[I 2025-06-30 06:42:37,297] Trial 26 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 182, 'max_depth': 5, 'min_s
[I 2025-06-30 06:43:45,143] Trial 27 finished with value: 0.838210956180712 and parameters: {'n_estimators': 160, 'max_depth': 4, 'min_s
[I 2025-06-30 06:44:45,188] Trial 28 finished with value: 0.8332866305911507 and parameters: {'n_estimators': 180, 'max_depth': 3, 'min_s
[I 2025-06-30 06:45:15,581] Trial 29 finished with value: 0.796096708588038 and parameters: {'n_estimators': 115, 'max_depth': 9, 'min_s
[I 2025-06-30 06:45:56,103] Trial 30 finished with value: 0.7935691439779675 and parameters: {'n_estimators': 158, 'max_depth': 2, 'min_s
[I 2025-06-30 06:46:53,555] Trial 31 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 139, 'max_depth': 3, 'min_s
[I 2025-06-30 06:48:04,791] Trial 32 finished with value: 0.8382000470481201 and parameters: {'n_estimators': 139, 'max_depth': 4, 'min_s
[I 2025-06-30 06:48:39,772] Trial 33 finished with value: 0.8368022266847345 and parameters: {'n_estimators': 118, 'max_depth': 2, 'min_s
[I 2025-06-30 06:49:25,623] Trial 34 finished with value: 0.8378703763975682 and parameters: {'n_estimators': 101, 'max_depth': 3, 'min_s
[I 2025-06-30 06:50:08,421] Trial 35 finished with value: 0.7947481444122487 and parameters: {'n_estimators': 145, 'max_depth': 4, 'min_s
[I 2025-06-30 06:51:14,551] Trial 36 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 166, 'max_depth': 3, 'min_s
[I 2025-06-30 06:52:08,697] Trial 37 finished with value: 0.8376906002855016 and parameters: {'n_estimators': 168, 'max_depth': 2, 'min_s
[I 2025-06-30 06:53:16,669] Trial 38 finished with value: 0.7967847980556906 and parameters: {'n_estimators': 175, 'max_depth': 5, 'min_s
[I 2025-06-30 06:54:49,334] Trial 39 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 192, 'max_depth': 6, 'min_s
[I 2025-06-30 06:55:41,211] Trial 40 finished with value: 0.7935691439779675 and parameters: {'n_estimators': 159, 'max_depth': 4, 'min_s
[I 2025-06-30 06:56:22,795] Trial 41 finished with value: 0.7937059803217004 and parameters: {'n_estimators': 166, 'max_depth': 3, 'min_s
[I 2025-06-30 06:57:45,799] Trial 42 finished with value: 0.837665877420063 and parameters: {'n_estimators': 154, 'max_depth': 3, 'min_s
[I 2025-06-30 06:58:39,406] Trial 43 finished with value: 0.8368022266847345 and parameters: {'n_estimators': 186, 'max_depth': 2, 'min_s
[I 2025-06-30 06:59:47,575] Trial 44 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 134, 'max_depth': 4, 'min_s
[I 2025-06-30 07:01:10,898] Trial 45 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 200, 'max_depth': 3, 'min_s
[I 2025-06-30 07:02:54,791] Trial 46 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 175, 'max_depth': 4, 'min_s
[I 2025-06-30 07:03:49,014] Trial 47 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 144, 'max_depth': 3, 'min_s
[I 2025-06-30 07:04:38,101] Trial 48 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 124, 'max_depth': 2, 'min_s
[I 2025-06-30 07:05:23,529] A new study created in memory with name: no-name-5d3af20a-07b1-4828-84de-5c45cca969e8
[I 2025-06-30 07:05:23,523] Trial 49 finished with value: 0.7940732778759308 and parameters: {'n_estimators': 130, 'max_depth': 6, 'min_s
```

Best params for RandomForest: {'n_estimators': 174, 'max_depth': 4, 'min_samples_split': 3, 'min_samples_leaf': 14, 'max_features': 0.61

Optimizing AdaBoost...

Best trial: 0. Best value: 0.838484: 100%

50/50 [46:22<00:00, 62.75s/it]

```
[I 2025-06-30 07:06:15,663] Trial 0 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 106, 'learning_rate': 0.172
[I 2025-06-30 07:07:34,248] Trial 1 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 160, 'learning_rate': 0.066
[I 2025-06-30 07:08:09,851] Trial 2 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 73, 'learning_rate': 0.0159
[I 2025-06-30 07:08:39,009] Trial 3 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 58, 'learning_rate': 0.1339
[I 2025-06-30 07:09:47,288] Trial 4 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 140, 'learning_rate': 0.083
[I 2025-06-30 07:10:13,588] Trial 5 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 53, 'learning_rate': 0.1827
```

```
[I 2025-06-30 07:11:39,029] Trial 6 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 175, 'learning_rate': 0.018}
[I 2025-06-30 07:12:16,936] Trial 7 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 77, 'learning_rate': 0.0173}
[I 2025-06-30 07:13:03,732] Trial 8 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 95, 'learning_rate': 0.0481}
[I 2025-06-30 07:13:59,860] Trial 9 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 115, 'learning_rate': 0.023}
[I 2025-06-30 07:15:34,138] Trial 10 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 192, 'learning_rate': 0.10}
[I 2025-06-30 07:16:45,779] Trial 11 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 147, 'learning_rate': 0.05}
[I 2025-06-30 07:18:02,500] Trial 12 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 157, 'learning_rate': 0.03}
[I 2025-06-30 07:18:58,283] Trial 13 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 113, 'learning_rate': 0.06}
[I 2025-06-30 07:20:03,010] Trial 14 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 132, 'learning_rate': 0.01}
[I 2025-06-30 07:21:25,617] Trial 15 finished with value: 0.8382458914167089 and parameters: {'n_estimators': 168, 'learning_rate': 0.17}
[I 2025-06-30 07:22:13,184] Trial 16 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 97, 'learning_rate': 0.111}
[I 2025-06-30 07:23:46,394] Trial 17 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 191, 'learning_rate': 0.03}
[I 2025-06-30 07:24:42,069] Trial 18 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 114, 'learning_rate': 0.06}
[I 2025-06-30 07:26:00,810] Trial 19 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 161, 'learning_rate': 0.13}
[I 2025-06-30 07:27:02,613] Trial 20 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 127, 'learning_rate': 0.07}
[I 2025-06-30 07:27:41,682] Trial 21 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 80, 'learning_rate': 0.011}
[I 2025-06-30 07:28:24,878] Trial 22 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 89, 'learning_rate': 0.034}
[I 2025-06-30 07:28:58,054] Trial 23 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 67, 'learning_rate': 0.014}
[I 2025-06-30 07:29:48,799] Trial 24 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 104, 'learning_rate': 0.02}
[I 2025-06-30 07:30:25,243] Trial 25 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 74, 'learning_rate': 0.023}
[I 2025-06-30 07:31:36,312] Trial 26 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 146, 'learning_rate': 0.03}
[I 2025-06-30 07:33:03,755] Trial 27 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 180, 'learning_rate': 0.05}
[I 2025-06-30 07:33:36,438] Trial 28 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 67, 'learning_rate': 0.030}
[I 2025-06-30 07:34:07,372] Trial 29 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 62, 'learning_rate': 0.139}
[I 2025-06-30 07:34:51,127] Trial 30 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 90, 'learning_rate': 0.100}
[I 2025-06-30 07:35:18,591] Trial 31 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 54, 'learning_rate': 0.140}
[I 2025-06-30 07:35:46,647] Trial 32 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 57, 'learning_rate': 0.185}
[I 2025-06-30 07:36:53,030] Trial 33 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 137, 'learning_rate': 0.07}
[I 2025-06-30 07:37:18,336] Trial 34 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 51, 'learning_rate': 0.119}
[I 2025-06-30 07:37:55,746] Trial 35 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 76, 'learning_rate': 0.092}
[I 2025-06-30 07:38:37,021] Trial 36 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 83, 'learning_rate': 0.156}
[I 2025-06-30 07:39:29,281] Trial 37 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 107, 'learning_rate': 0.01}
[I 2025-06-30 07:40:29,558] Trial 38 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 123, 'learning_rate': 0.19}
[I 2025-06-30 07:41:03,281] Trial 39 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 69, 'learning_rate': 0.042}
[I 2025-06-30 07:41:53,680] Trial 40 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 102, 'learning_rate': 0.02}
[I 2025-06-30 07:43:03,338] Trial 41 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 143, 'learning_rate': 0.08}
[I 2025-06-30 07:44:17,473] Trial 42 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 152, 'learning_rate': 0.06}
[I 2025-06-30 07:45:44,090] Trial 43 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 173, 'learning_rate': 0.10}
[I 2025-06-30 07:47:00,937] Trial 44 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 158, 'learning_rate': 0.05}
[I 2025-06-30 07:47:59,207] Trial 45 finished with value: 0.838325218721167 and parameters: {'n_estimators': 119, 'learning_rate': 0.164}
[I 2025-06-30 07:49:05,336] Trial 46 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 136, 'learning_rate': 0.06}
[I 2025-06-30 07:49:34,882] Trial 47 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 59, 'learning_rate': 0.091}
[I 2025-06-30 07:50:16,807] Trial 48 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 86, 'learning_rate': 0.125}
[I 2025-06-30 07:51:46,070] A new study created in memory with name: no-name-a609e041-9e35-49e5-ba03-1ee6ca63dc09
[I 2025-06-30 07:51:46,061] Trial 49 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 184, 'learning_rate': 0.10}
```

Best params for AdaBoost: {'n_estimators': 106, 'learning_rate': 0.17254716573280354}

Optimizing GradientBoosting...

Best trial: 31. Best value: 0.854825: 100%

50/50 [2:22:31<00:00, 184.21s/it]

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[I 2025-06-30 07:54:51,331] Trial 0 finished with value: 0.8074668972869293 and parameters: {'n_estimators': 106, 'learning_rate': 0.172}
[I 2025-06-30 07:57:46,864] Trial 1 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 73, 'learning_rate': 0.0119}
[I 2025-06-30 07:59:48,163] Trial 2 finished with value: 0.8072623983094243 and parameters: {'n_estimators': 53, 'learning_rate': 0.1827}
[I 2025-06-30 08:02:24,684] Trial 3 finished with value: 0.8370630222383285 and parameters: {'n_estimators': 77, 'learning_rate': 0.0248}
[I 2025-06-30 08:06:08,897] Trial 4 finished with value: 0.8379955480706149 and parameters: {'n_estimators': 142, 'learning_rate': 0.015}
[I 2025-06-30 08:10:41,997] Trial 5 finished with value: 0.8371387946104756 and parameters: {'n_estimators': 168, 'learning_rate': 0.018}
[I 2025-06-30 08:13:19,509] Trial 6 finished with value: 0.8326471357360465 and parameters: {'n_estimators': 141, 'learning_rate': 0.016}
[I 2025-06-30 08:16:27,814] Trial 7 finished with value: 0.8324549981912606 and parameters: {'n_estimators': 172, 'learning_rate': 0.024}
[I 2025-06-30 08:17:43,605] Trial 8 finished with value: 0.8384045460256253 and parameters: {'n_estimators': 68, 'learning_rate': 0.0440}
[I 2025-06-30 08:22:37,096] Trial 9 finished with value: 0.8361163922452319 and parameters: {'n_estimators': 150, 'learning_rate': 0.025}
[I 2025-06-30 08:25:15,971] Trial 10 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 106, 'learning_rate': 0.08}
[I 2025-06-30 08:27:27,707] Trial 11 finished with value: 0.8324426367585414 and parameters: {'n_estimators': 55, 'learning_rate': 0.058}
[I 2025-06-30 08:29:03,392] Trial 12 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 83, 'learning_rate': 0.010}
[I 2025-06-30 08:30:46,493] Trial 13 finished with value: 0.8326471357360465 and parameters: {'n_estimators': 93, 'learning_rate': 0.046}
[I 2025-06-30 08:32:44,344] Trial 14 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 79, 'learning_rate': 0.106}
[I 2025-06-30 08:36:26,471] Trial 15 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 195, 'learning_rate': 0.01}
[I 2025-06-30 08:41:27,292] Trial 16 finished with value: 0.8072623983094243 and parameters: {'n_estimators': 200, 'learning_rate': 0.03}
[I 2025-06-30 08:44:18,980] Trial 17 finished with value: 0.8382458914167089 and parameters: {'n_estimators': 200, 'learning_rate': 0.11}
[I 2025-06-30 08:46:32,726] Trial 18 finished with value: 0.8323298265182139 and parameters: {'n_estimators': 122, 'learning_rate': 0.03}
[I 2025-06-30 08:50:59,225] Trial 19 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 179, 'learning_rate': 0.06}
[I 2025-06-30 08:53:15,293] Trial 20 finished with value: 0.8323756708868024 and parameters: {'n_estimators': 125, 'learning_rate': 0.04}
[I 2025-06-30 08:54:31,926] Trial 21 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 67, 'learning_rate': 0.010}
[I 2025-06-30 08:56:21,715] Trial 22 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 96, 'learning_rate': 0.012}
[I 2025-06-30 08:58:49,170] Trial 23 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 93, 'learning_rate': 0.018}
[I 2025-06-30 08:59:57,330] Trial 24 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 60, 'learning_rate': 0.010}
[I 2025-06-30 09:02:14,784] Trial 25 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 120, 'learning_rate': 0.01}
[I 2025-06-30 09:04:29,490] Trial 26 finished with value: 0.8374613784425579 and parameters: {'n_estimators': 84, 'learning_rate': 0.021}
[I 2025-06-30 09:06:31,182] Trial 27 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 110, 'learning_rate': 0.03}
[I 2025-06-30 09:08:10,023] Trial 28 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 62, 'learning_rate': 0.013}
[I 2025-06-30 09:11:00,876] Trial 29 finished with value: 0.8523661516102674 and parameters: {'n_estimators': 186, 'learning_rate': 0.13}
[I 2025-06-30 09:15:48,500] Trial 30 finished with value: 0.8074668972869293 and parameters: {'n_estimators': 193, 'learning_rate': 0.13}
[I 2025-06-30 09:19:04,747] Trial 31 finished with value: 0.8548252980484715 and parameters: {'n_estimators': 184, 'learning_rate': 0.08}
[I 2025-06-30 09:21:41,578] Trial 32 finished with value: 0.8521616526327623 and parameters: {'n_estimators': 182, 'learning_rate': 0.15}
[I 2025-06-30 09:24:24,868] Trial 33 finished with value: 0.8539526976994315 and parameters: {'n_estimators': 187, 'learning_rate': 0.14}
```

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[I 2025-06-30 09:27:03,422] Trial 34 finished with value: 0.8539526976994315 and parameters: {'n_estimators': 184, 'learning_rate': 0.15
[I 2025-06-30 09:29:18,758] Trial 35 finished with value: 0.8535436997444211 and parameters: {'n_estimators': 163, 'learning_rate': 0.19
[I 2025-06-30 09:32:25,736] Trial 36 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 160, 'learning_rate': 0.19
[I 2025-06-30 09:35:19,160] Trial 37 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 162, 'learning_rate': 0.08
[I 2025-06-30 09:38:46,952] Trial 38 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 175, 'learning_rate': 0.16
[I 2025-06-30 09:41:50,840] Trial 39 finished with value: 0.8539526976994315 and parameters: {'n_estimators': 188, 'learning_rate': 0.11
[I 2025-06-30 09:47:30,373] Trial 40 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 152, 'learning_rate': 0.11
[I 2025-06-30 09:50:22,401] Trial 41 finished with value: 0.8539526976994315 and parameters: {'n_estimators': 186, 'learning_rate': 0.13
[I 2025-06-30 09:53:44,375] Trial 42 finished with value: 0.8523661516102674 and parameters: {'n_estimators': 189, 'learning_rate': 0.09
[I 2025-06-30 09:56:30,635] Trial 43 finished with value: 0.8523661516102674 and parameters: {'n_estimators': 172, 'learning_rate': 0.13
[I 2025-06-30 09:59:11,383] Trial 44 finished with value: 0.8537481987219263 and parameters: {'n_estimators': 183, 'learning_rate': 0.15
[I 2025-06-30 10:01:39,510] Trial 45 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 138, 'learning_rate': 0.07
[I 2025-06-30 10:04:57,719] Trial 46 finished with value: 0.8523661516102674 and parameters: {'n_estimators': 191, 'learning_rate': 0.10
[I 2025-06-30 10:07:47,875] Trial 47 finished with value: 0.8523661516102674 and parameters: {'n_estimators': 168, 'learning_rate': 0.12
[I 2025-06-30 10:11:30,997] Trial 48 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 177, 'learning_rate': 0.16
[I 2025-06-30 10:14:17,990] A new study created in memory with name: no-name-7f026017-5ec3-4661-b2db-11b7ffeafa5e
[I 2025-06-30 10:14:17,983] Trial 49 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 154, 'learning_rate': 0.05
```

Best params for GradientBoosting: {'n_estimators': 184, 'learning_rate': 0.08776641793171308, 'max_depth': 2, 'min_samples_split': 17, 'min_samples_leaf': 17}

Optimizing SVM...

Best trial: 8. Best value: 0.833314: 100%

50/50 [36:12<00:00, 36.93s/it]

```
[I 2025-06-30 10:15:00,306] Trial 0 finished with value: 0.8171502480250954 and parameters: {'C': 0.13292918943162169, 'kernel': 'rbf',
[I 2025-06-30 10:15:03,831] Trial 1 finished with value: 0.82319997963258968 and parameters: {'C': 0.029375384576328288, 'kernel': 'poly',
[I 2025-06-30 10:16:47,480] Trial 2 finished with value: 0.8243174356680129 and parameters: {'C': 0.011527987128232402, 'kernel': 'rbf',
[I 2025-06-30 10:17:14,476] Trial 3 finished with value: 0.8168114929530367 and parameters: {'C': 0.03549878832196503, 'kernel': 'poly',
[I 2025-06-30 10:18:47,875] Trial 4 finished with value: 0.7994415475763121 and parameters: {'C': 0.6847920095574779, 'kernel': 'sigmoid',
[I 2025-06-30 10:19:14,461] Trial 5 finished with value: 0.8256029104510355 and parameters: {'C': 2.267398652378039, 'kernel': 'sigmoid',
[I 2025-06-30 10:20:39,715] Trial 6 finished with value: 0.5125600090858001 and parameters: {'C': 0.6647135865318028, 'kernel': 'sigmoid',
[I 2025-06-30 10:21:28,268] Trial 7 finished with value: 0.7610119942416689 and parameters: {'C': 2.6619018884890564, 'kernel': 'sigmoid',
[I 2025-06-30 10:23:26,910] Trial 8 finished with value: 0.8333136042002341 and parameters: {'C': 0.023233503515390115, 'kernel': 'sigmc',
[I 2025-06-30 10:24:00,615] Trial 9 finished with value: 0.8197755225113189 and parameters: {'C': 0.9717775305059632, 'kernel': 'sigmoid',
[I 2025-06-30 10:24:23,303] Trial 10 finished with value: 0.8277153683437856 and parameters: {'C': 0.1329285254704278, 'kernel': 'rbf',
[I 2025-06-30 10:24:45,910] Trial 11 finished with value: 0.82714072639373 and parameters: {'C': 0.10978744399571558, 'kernel': 'rbf',
[I 2025-06-30 10:25:07,217] Trial 12 finished with value: 0.8281258773749842 and parameters: {'C': 0.12599201418393083, 'kernel': 'rbf',
[I 2025-06-30 10:25:40,779] Trial 13 finished with value: 0.817001124155112 and parameters: {'C': 0.04211091391382456, 'kernel': 'rbf',
[I 2025-06-30 10:26:09,756] Trial 14 finished with value: 0.8129918681313931 and parameters: {'C': 0.011381919023371847, 'kernel': 'poly',
[I 2025-06-30 10:28:27,657] Trial 15 finished with value: 0.5463875205254515 and parameters: {'C': 0.23791785519693218, 'kernel': 'sigmc',
[I 2025-06-30 10:28:55,169] Trial 16 finished with value: 0.8235858962311252 and parameters: {'C': 0.06143425542833049, 'kernel': 'rbf',
[I 2025-06-30 10:31:08,627] Trial 17 finished with value: 0.5607481347045775 and parameters: {'C': 0.020468026001232136, 'kernel': 'sigm',
[I 2025-06-30 10:31:32,849] Trial 18 finished with value: 0.8248656923315446 and parameters: {'C': 0.32143915874272255, 'kernel': 'rbf',
[I 2025-06-30 10:31:48,666] Trial 19 finished with value: 0.824336720944654 and parameters: {'C': 9.728583151931055, 'kernel': 'poly',
[I 2025-06-30 10:34:28,024] Trial 20 finished with value: 0.5406403940886699 and parameters: {'C': 0.07129857930334428, 'kernel': 'sigmc',
[I 2025-06-30 10:34:46,346] Trial 21 finished with value: 0.8254185369556755 and parameters: {'C': 0.23587749079216147, 'kernel': 'rbf',
[I 2025-06-30 10:35:10,295] Trial 22 finished with value: 0.8239655793160705 and parameters: {'C': 0.12006977637241491, 'kernel': 'rbf',
[I 2025-06-30 10:35:26,868] Trial 23 finished with value: 0.8269123370528323 and parameters: {'C': 0.3649571045984814, 'kernel': 'rbf',
[I 2025-06-30 10:36:24,425] Trial 24 finished with value: 0.8133044258094199 and parameters: {'C': 0.024365710257412562, 'kernel': 'rbf',
[I 2025-06-30 10:36:56,269] Trial 25 finished with value: 0.822218937606635 and parameters: {'C': 0.0541140891529234, 'kernel': 'rbf',
[I 2025-06-30 10:37:20,846] Trial 26 finished with value: 0.8294068855862252 and parameters: {'C': 0.14615444351755424, 'kernel': 'rbf',
[I 2025-06-30 10:38:25,656] Trial 27 finished with value: 0.815451616379571 and parameters: {'C': 0.01817391505693273, 'kernel': 'rbf',
[I 2025-06-30 10:38:49,559] Trial 28 finished with value: 0.8182452690772944 and parameters: {'C': 0.08073589786098685, 'kernel': 'poly',
[I 2025-06-30 10:40:59,191] Trial 29 finished with value: 0.5497400109469075 and parameters: {'C': 0.17294097147722898, 'kernel': 'sigmc',
[I 2025-06-30 10:41:13,265] Trial 30 finished with value: 0.8249389270767634 and parameters: {'C': 0.6121171504144455, 'kernel': 'rbf',
[I 2025-06-30 10:41:35,234] Trial 31 finished with value: 0.8289582771106607 and parameters: {'C': 0.14122210913686964, 'kernel': 'rbf',
[I 2025-06-30 10:41:52,298] Trial 32 finished with value: 0.8236032528530277 and parameters: {'C': 0.2042339091998678, 'kernel': 'rbf',
[I 2025-06-30 10:42:17,684] Trial 33 finished with value: 0.8272366178747775 and parameters: {'C': 0.09079055554255012, 'kernel': 'rbf',
[I 2025-06-30 10:42:33,433] Trial 34 finished with value: 0.8289755083440106 and parameters: {'C': 0.39238629786170415, 'kernel': 'rbf',
[I 2025-06-30 10:42:36,353] Trial 35 finished with value: 0.8231999763258968 and parameters: {'C': 1.6893806027344112, 'kernel': 'poly',
[I 2025-06-30 10:42:50,960] Trial 36 finished with value: 0.8278260477098428 and parameters: {'C': 0.44780391267347713, 'kernel': 'rbf',
[I 2025-06-30 10:43:23,271] Trial 37 finished with value: 0.8234729138236588 and parameters: {'C': 1.1077990501142667, 'kernel': 'sigmoid',
[I 2025-06-30 10:44:09,086] Trial 38 finished with value: 0.8176181056693267 and parameters: {'C': 0.0359837003811888, 'kernel': 'rbf',
[I 2025-06-30 10:46:20,380] Trial 39 finished with value: 0.6217097311882296 and parameters: {'C': 0.015350221822493496, 'kernel': 'sigm',
[I 2025-06-30 10:46:32,201] Trial 40 finished with value: 0.8223753573070853 and parameters: {'C': 0.5652217654200395, 'kernel': 'poly',
[I 2025-06-30 10:46:52,680] Trial 41 finished with value: 0.83000806857331 and parameters: {'C': 0.1719095921398995, 'kernel': 'rbf',
[I 2025-06-30 10:47:10,144] Trial 42 finished with value: 0.83008175750121 and parameters: {'C': 0.28670855346744045, 'kernel': 'rbf',
[I 2025-06-30 10:47:22,480] Trial 43 finished with value: 0.823869171388235 and parameters: {'C': 0.8956353377454194, 'kernel': 'rbf',
[I 2025-06-30 10:47:38,851] Trial 44 finished with value: 0.8286319064084898 and parameters: {'C': 0.4382763978240323, 'kernel': 'rbf',
[I 2025-06-30 10:47:57,133] Trial 45 finished with value: 0.8301509312111707 and parameters: {'C': 0.27636499696298694, 'kernel': 'rbf',
[I 2025-06-30 10:48:53,145] Trial 46 finished with value: 0.8277152809020661 and parameters: {'C': 0.24094195891266176, 'kernel': 'sigmc',
[I 2025-06-30 10:48:58,189] Trial 47 finished with value: 0.82429466707576 and parameters: {'C': 4.469125372345562, 'kernel': 'rbf', 'ga',
[I 2025-06-30 10:49:24,740] Trial 48 finished with value: 0.8243784465248526 and parameters: {'C': 0.16964138124260755, 'kernel': 'rbf',
[I 2025-06-30 10:50:30,247] Trial 49 finished with value: 0.8283687398906157 and parameters: {'C': 0.2696452990661463, 'kernel': 'sigmoid'}
```

Best params for SVM: {'C': 0.023233503515390115, 'kernel': 'sigmoid', 'gamma': 0.032927591344236166}

Optimizing LogisticRegression...

Optimizing KNN...

Optimizing GaussianNB...

Preprocessing data...

EVALUATION WITH ALL FEATURES
=====

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XGBoost (All Features)

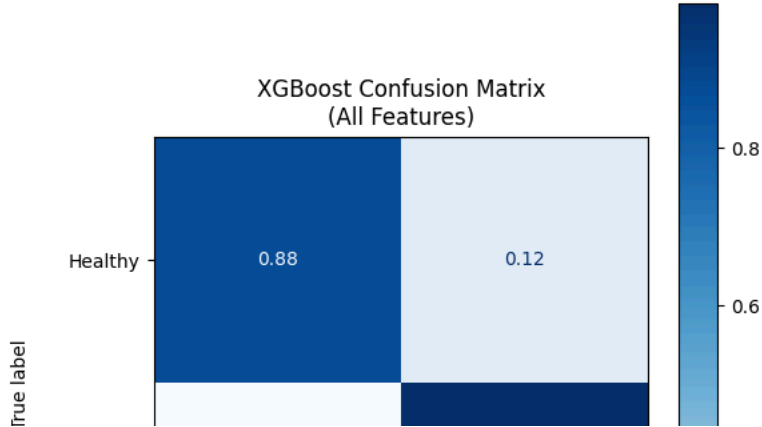
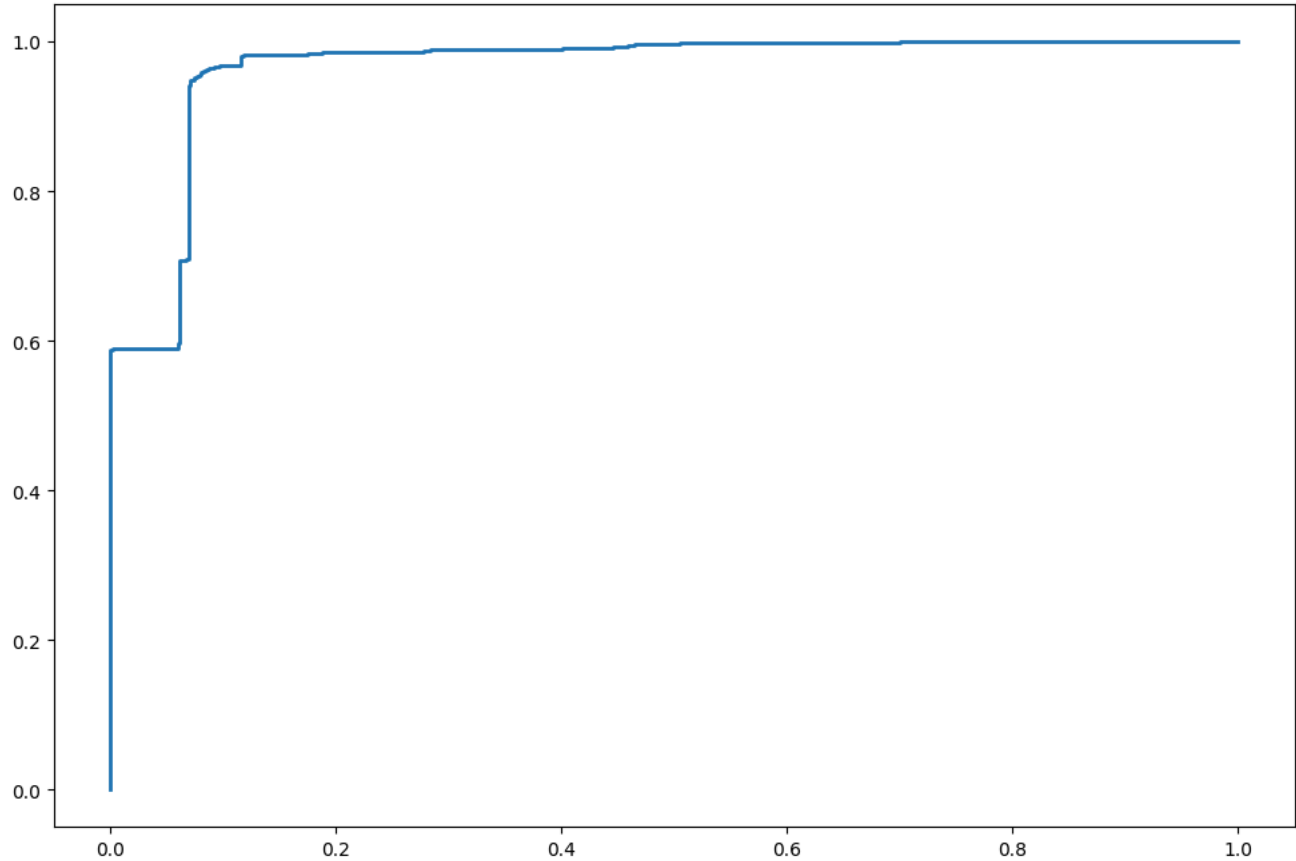
=====

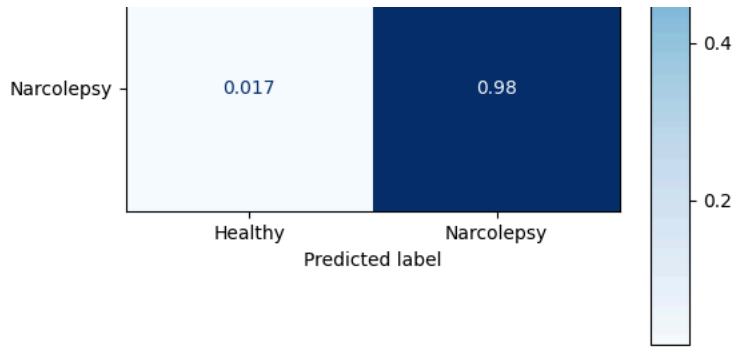
Train classification report:

	precision	recall	f1-score	support
0	0.9994	1.0000	0.9997	4785
1	1.0000	0.9994	0.9997	4785
accuracy			0.9997	9570
macro avg	0.9997	0.9997	0.9997	9570
weighted avg	0.9997	0.9997	0.9997	9570

Test classification report:

	precision	recall	f1-score	support
0	0.9783	0.8764	0.9246	979
1	0.9032	0.9834	0.9416	1148
accuracy			0.9342	2127
macro avg	0.9408	0.9299	0.9331	2127
weighted avg	0.9378	0.9342	0.9338	2127





LightGBM (All Features)

```
[LightGBM] [Warning] feature_fraction is set=0.8705765955899738, colsample_bytree=1.0 will be ignored. Current value: feature_fraction=0  
[LightGBM] [Warning] feature_fraction is set=0.8705765955899738, colsample_bytree=1.0 will be ignored. Current value: feature_fraction=0  
[LightGBM] [Info] Number of positive: 4785, number of negative: 4785  
[LightGBM] [Info] Auto-choosing col-wise multi-threading, the overhead of testing was 0.019216 seconds.  
You can set `force_col_wise=true` to remove the overhead.  
[LightGBM] [Info] Total Bins 42075  
[LightGBM] [Info] Number of data points in the train set: 9570, number of used features: 165  
[LightGBM] [Warning] feature_fraction is set=0.8705765955899738, colsample_bytree=1.0 will be ignored. Current value: feature_fraction=0  
[LightGBM] [Info] [binary:BoostFromScore]: pavg=0.500000 -> initscore=0.000000  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf  
[LightGBM] [Warning] feature_fraction is set=0.8705765955899738, colsample_bytree=1.0 will be ignored. Current value: feature_fraction=0  
[LightGBM] [Warning] feature_fraction is set=0.8705765955899738, colsample_bytree=1.0 will be ignored. Current value: feature_fraction=0
```

Train classification report:

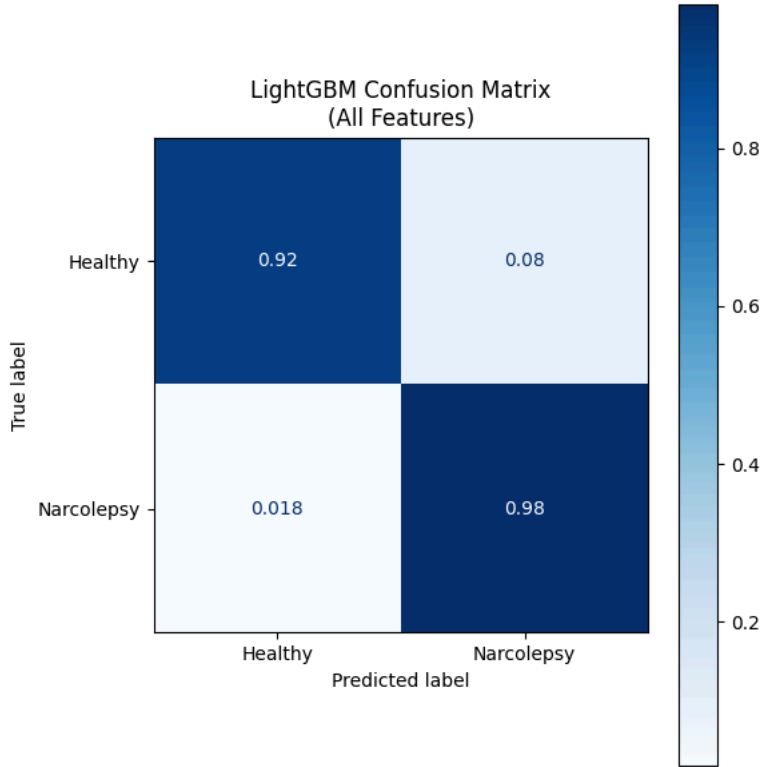
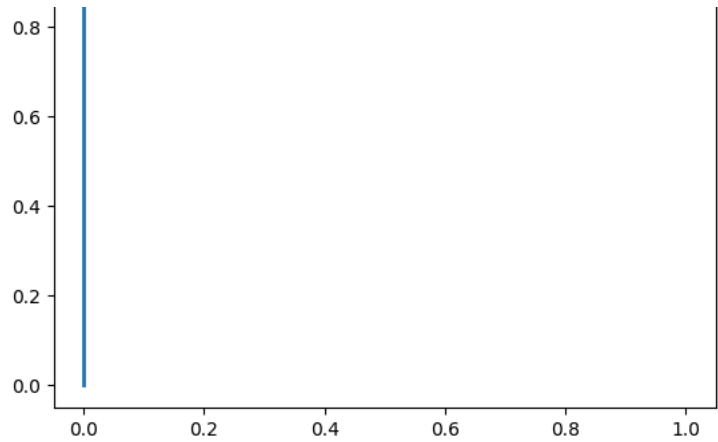
	precision	recall	f1-score	support
0	0.9977	0.9996	0.9986	4785
1	0.9996	0.9977	0.9986	4785
accuracy			0.9986	9570
macro avg	0.9986	0.9986	0.9986	9570
weighted avg	0.9986	0.9986	0.9986	9570

Test classification report:

	precision	recall	f1-score	support
0	0.9772	0.9203	0.9479	979
1	0.9353	0.9817	0.9579	1148
accuracy			0.9535	2127
macro avg	0.9562	0.9510	0.9529	2127
weighted avg	0.9546	0.9535	0.9533	2127

```
[LightGBM] [Warning] feature_fraction is set=0.8705765955899738, colsample_bytree=1.0 will be ignored. Current value: feature_fraction=0
[LightGBM] [Warning] feature_fraction is set=0.8705765955899738, colsample_bytree=1.0 will be ignored. Current value: feature_fraction=0
```





=====
RandomForest (All Features)
=====

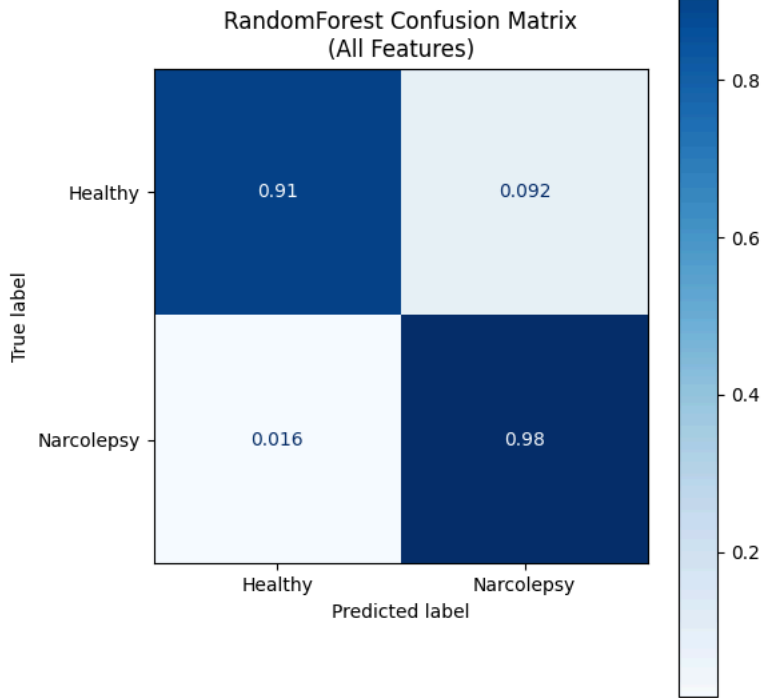
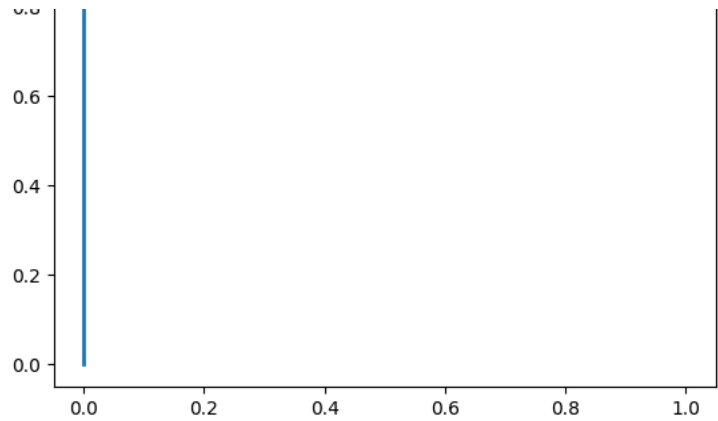
Train classification report:

	precision	recall	f1-score	support
0	0.9981	0.9996	0.9989	4785
1	0.9996	0.9981	0.9988	4785
accuracy			0.9989	9570
macro avg	0.9989	0.9989	0.9989	9570
weighted avg	0.9989	0.9989	0.9989	9570

Test classification report:

	precision	recall	f1-score	support
0	0.9802	0.9081	0.9427	979
1	0.9262	0.9843	0.9544	1148
accuracy			0.9492	2127
macro avg	0.9532	0.9462	0.9486	2127
weighted avg	0.9510	0.9492	0.9490	2127





=====
AdaBoost (All Features)
=====

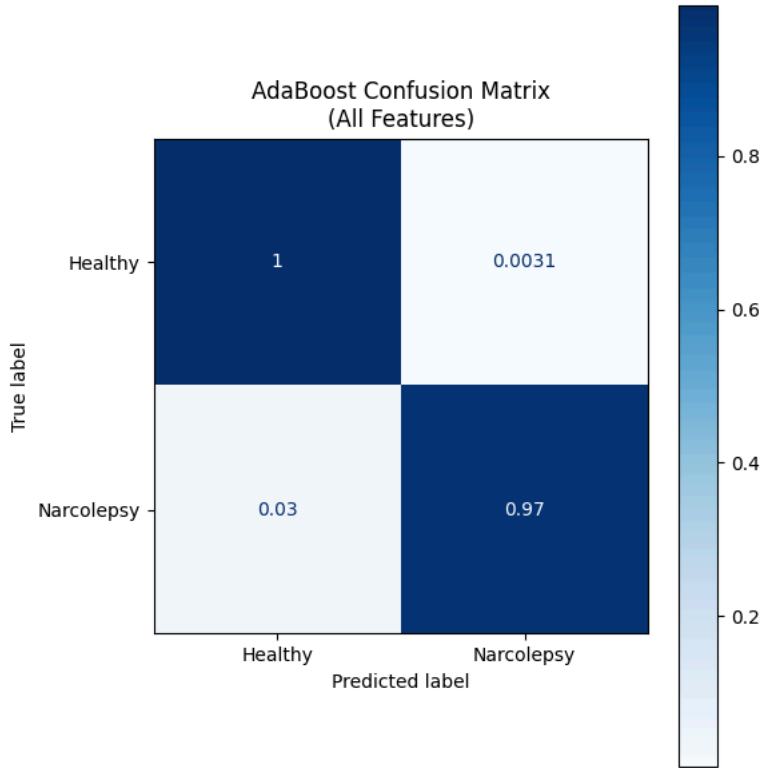
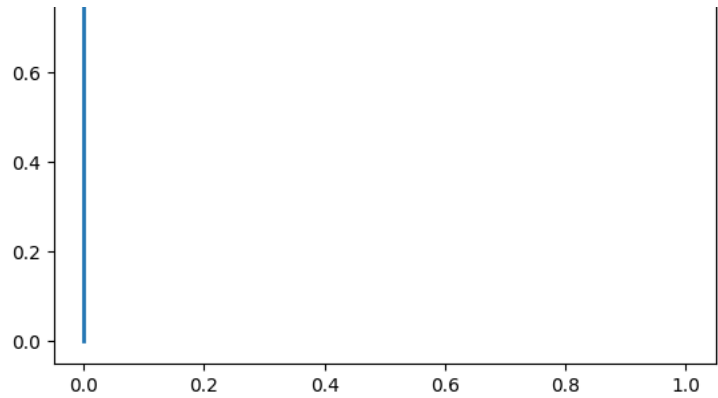
Train classification report:

	precision	recall	f1-score	support
0	0.9994	0.9996	0.9995	4785
1	0.9996	0.9994	0.9995	4785
accuracy			0.9995	9570
macro avg	0.9995	0.9995	0.9995	9570
weighted avg	0.9995	0.9995	0.9995	9570

Test classification report:

	precision	recall	f1-score	support
0	0.9663	0.9969	0.9814	979
1	0.9973	0.9704	0.9837	1148
accuracy			0.9826	2127
macro avg	0.9818	0.9837	0.9825	2127
weighted avg	0.9831	0.9826	0.9826	2127





=====
GradientBoosting (All Features)
=====

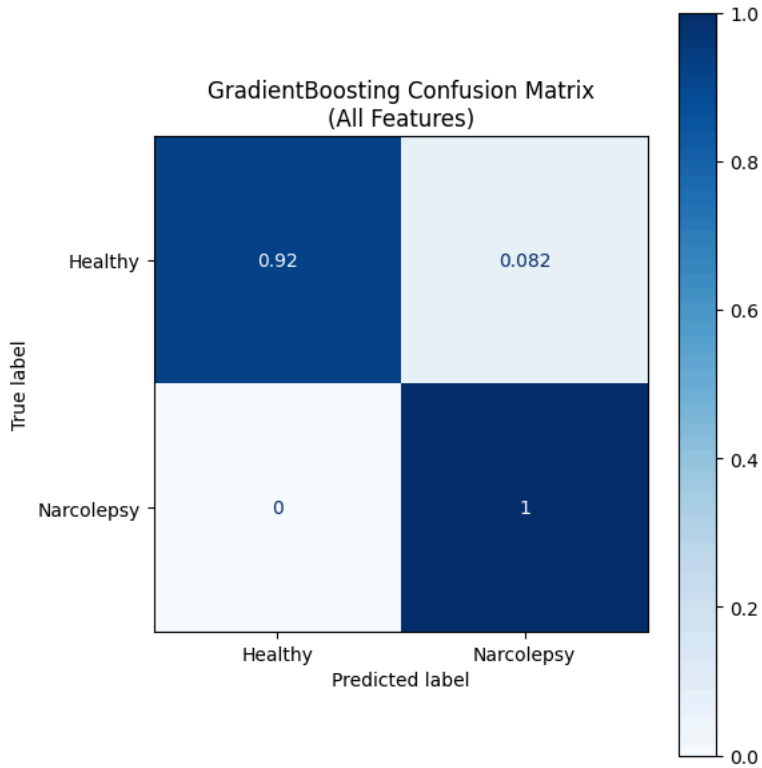
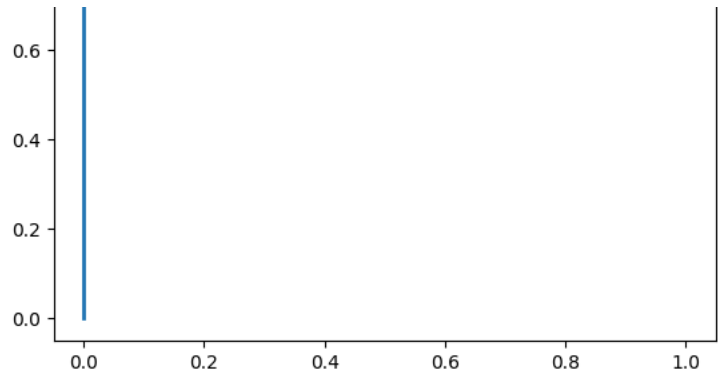
Train classification report:

	precision	recall	f1-score	support
0	1.0000	1.0000	1.0000	4785
1	1.0000	1.0000	1.0000	4785
accuracy			1.0000	9570
macro avg	1.0000	1.0000	1.0000	9570
weighted avg	1.0000	1.0000	1.0000	9570

Test classification report:

	precision	recall	f1-score	support
0	1.0000	0.9183	0.9574	979
1	0.9349	1.0000	0.9663	1148
accuracy			0.9624	2127
macro avg	0.9674	0.9591	0.9619	2127
weighted avg	0.9648	0.9624	0.9622	2127





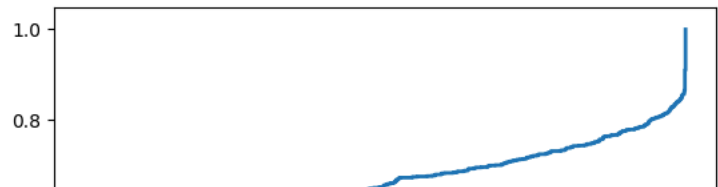
SVM (All Features)

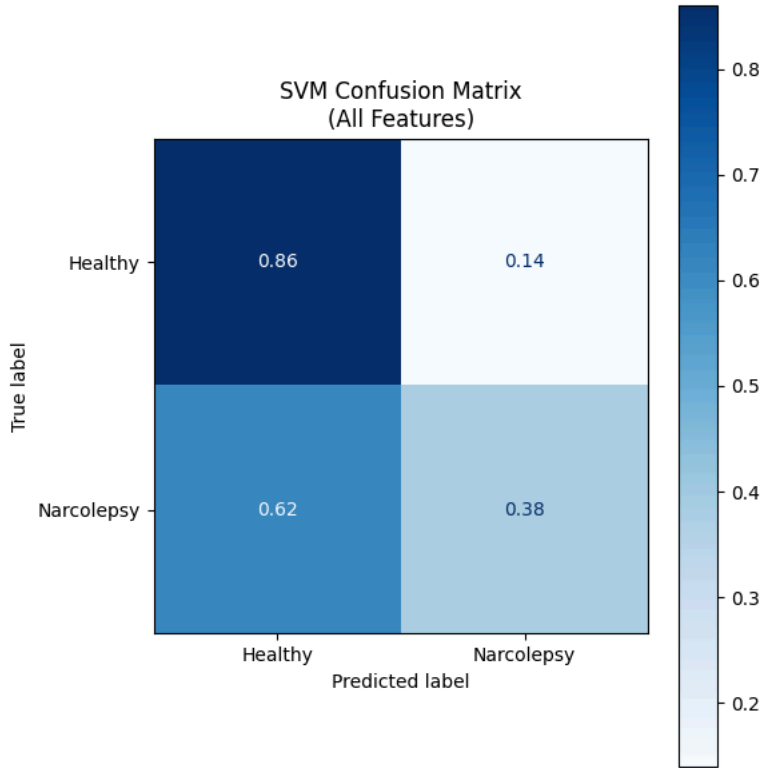
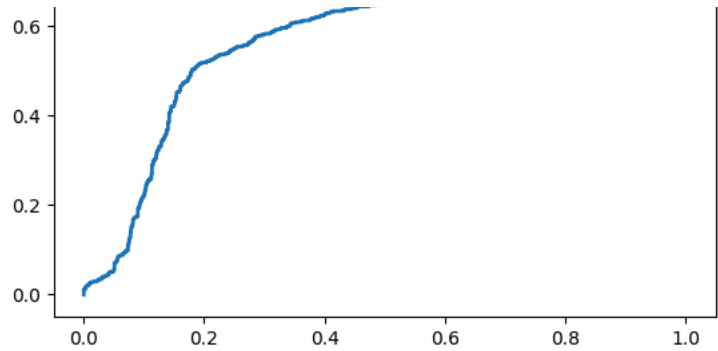
Train classification report:

	precision	recall	f1-score	support
0	0.7939	0.9638	0.8707	4785
1	0.9540	0.7498	0.8397	4785
accuracy			0.8568	9570
macro avg	0.8740	0.8568	0.8552	9570
weighted avg	0.8740	0.8568	0.8552	9570

Test classification report:

	precision	recall	f1-score	support
0	0.5418	0.8601	0.6648	979
1	0.7609	0.3798	0.5067	1148
accuracy			0.6008	2127
macro avg	0.6514	0.6199	0.5858	2127
weighted avg	0.6601	0.6008	0.5795	2127





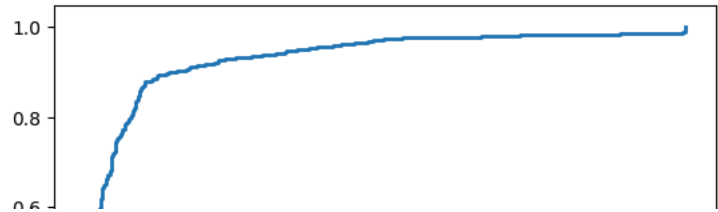
=====
LogisticRegression (All Features)
=====

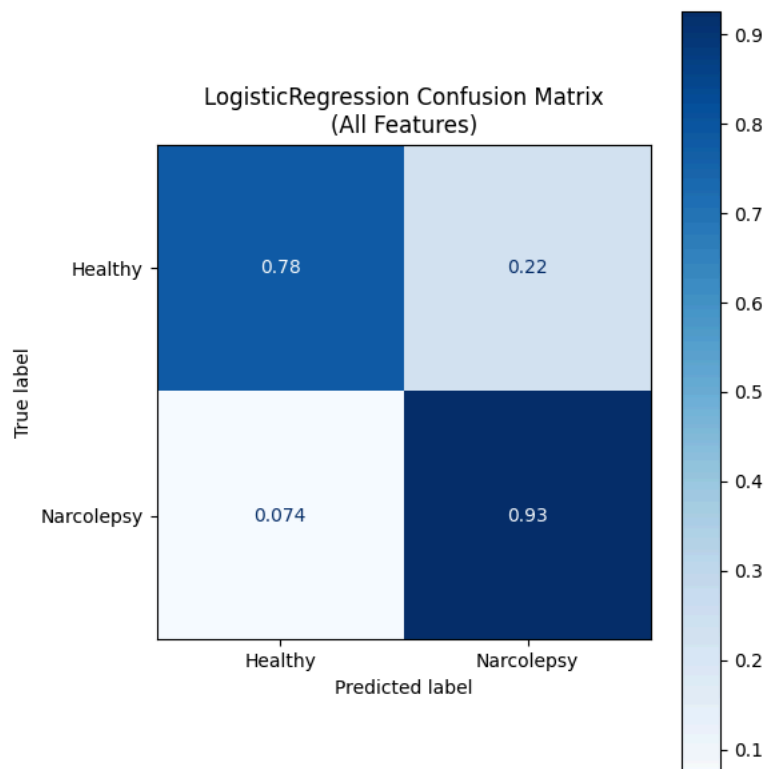
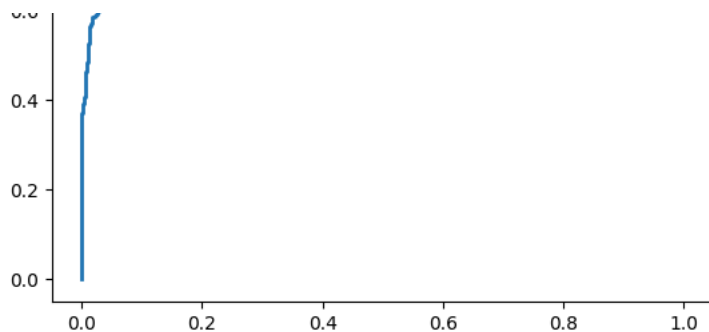
Train classification report:

	precision	recall	f1-score	support
0	0.9950	0.9964	0.9957	4785
1	0.9964	0.9950	0.9957	4785
accuracy			0.9957	9570
macro avg	0.9957	0.9957	0.9957	9570
weighted avg	0.9957	0.9957	0.9957	9570

Test classification report:

	precision	recall	f1-score	support
0	0.8994	0.7763	0.8333	979
1	0.8292	0.9260	0.8749	1148
accuracy			0.8571	2127
macro avg	0.8643	0.8511	0.8541	2127
weighted avg	0.8615	0.8571	0.8558	2127





=====

KNN (All Features)

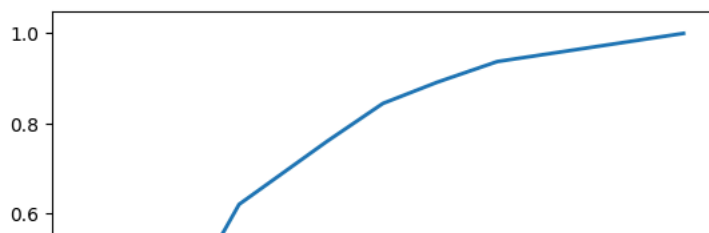
=====

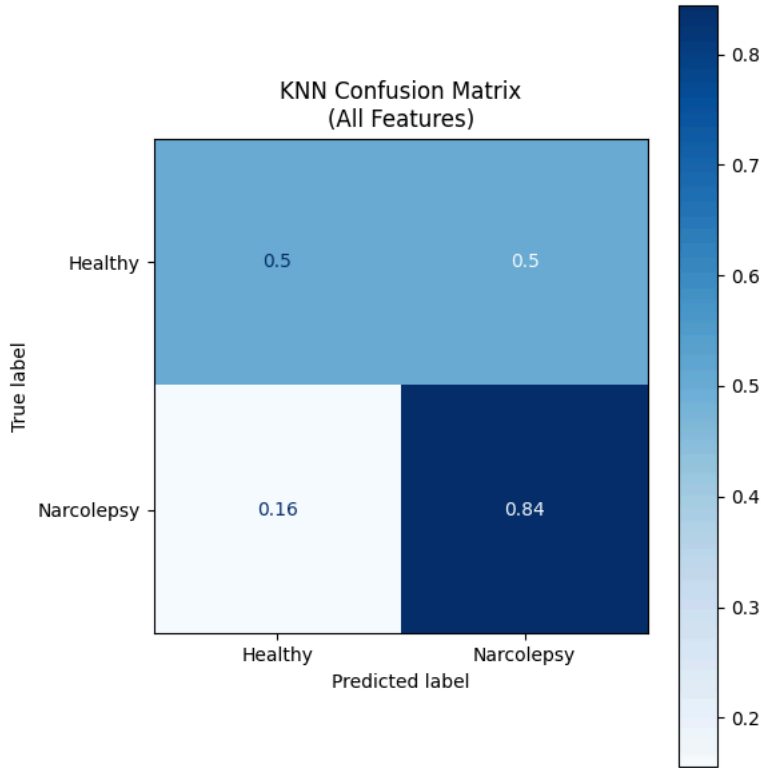
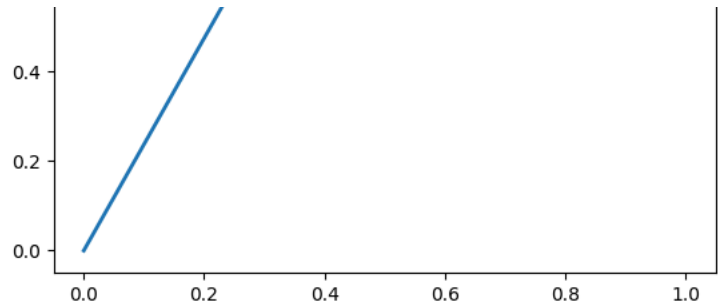
Train classification report:

	precision	recall	f1-score	support
0	0.9979	0.9937	0.9958	4785
1	0.9938	0.9979	0.9958	4785
accuracy			0.9958	9570
macro avg	0.9958	0.9958	0.9958	9570
weighted avg	0.9958	0.9958	0.9958	9570

Test classification report:

	precision	recall	f1-score	support
0	0.7320	0.4995	0.5938	979
1	0.6642	0.8441	0.7434	1148
accuracy			0.6855	2127
macro avg	0.6981	0.6718	0.6686	2127
weighted avg	0.6954	0.6855	0.6745	2127





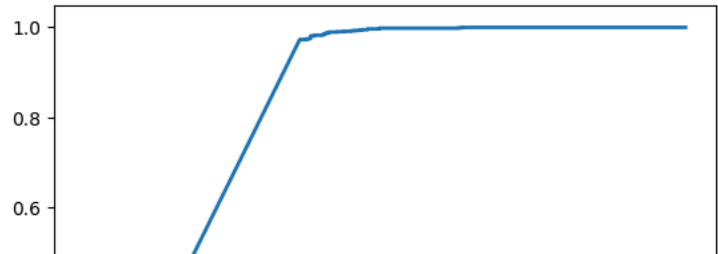
=====
GaussianNB (All Features)
=====

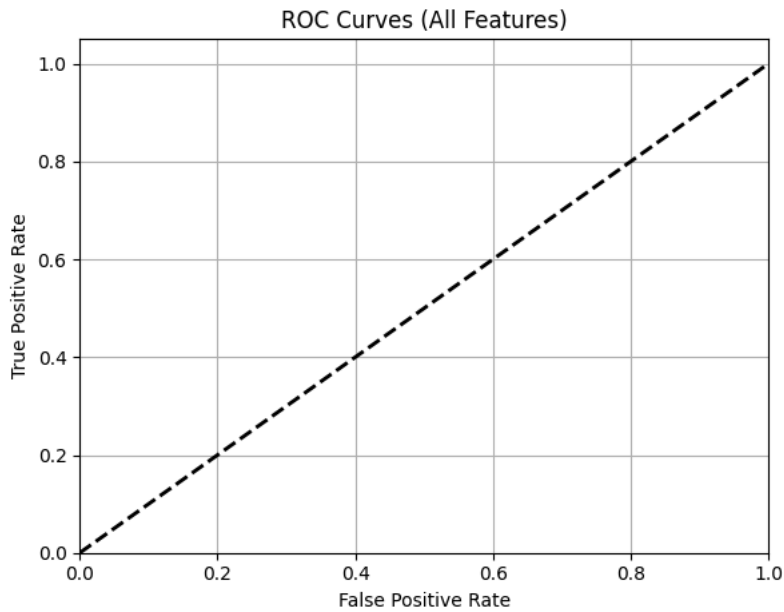
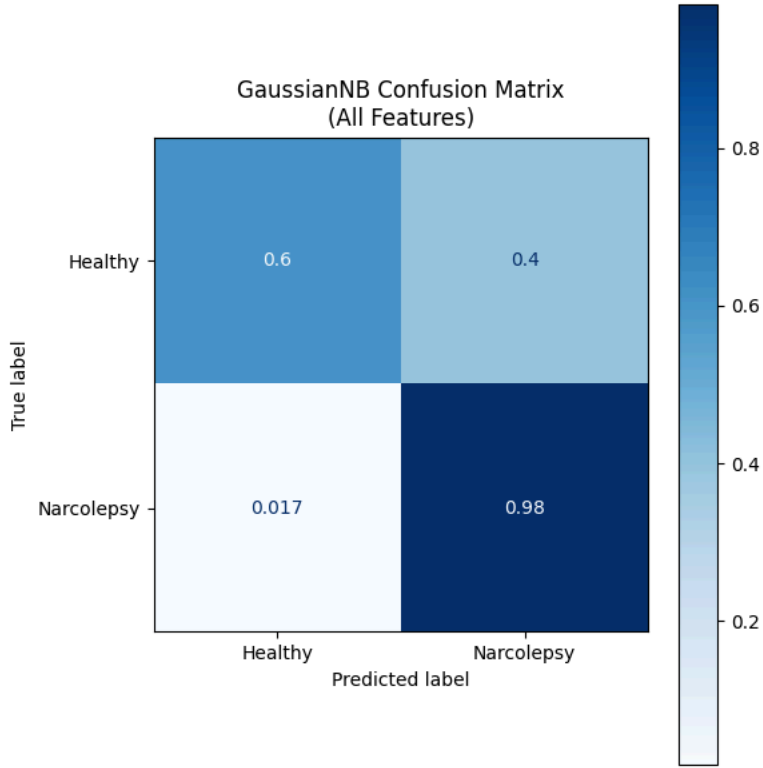
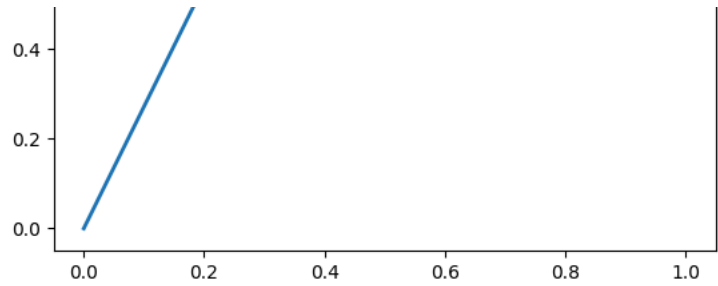
Train classification report:

	precision	recall	f1-score	support
0	0.8867	0.9156	0.9009	4785
1	0.9127	0.8830	0.8976	4785
accuracy			0.8993	9570
macro avg	0.8997	0.8993	0.8992	9570
weighted avg	0.8997	0.8993	0.8992	9570

Test classification report:

	precision	recall	f1-score	support
0	0.9672	0.6027	0.7426	979
1	0.7436	0.9826	0.8465	1148
accuracy			0.8077	2127
macro avg	0.8554	0.7926	0.7946	2127
weighted avg	0.8465	0.8077	0.7987	2127





Performance Metrics Summary ((All Features))					
	Balanced Accuracy	AUC	Gini Coefficient	KS Statistic	
AdaBoost	0.984	0.999	0.998	0.969	
GradientBoosting	0.959	0.999	0.999	0.989	
LightGBM	0.951	0.997	0.993	0.973	
RandomForest	0.946	0.994	0.989	0.945	
XGBoost	0.930	0.966	0.933	0.879	
LogisticRegression	0.851	0.934	0.868	0.776	

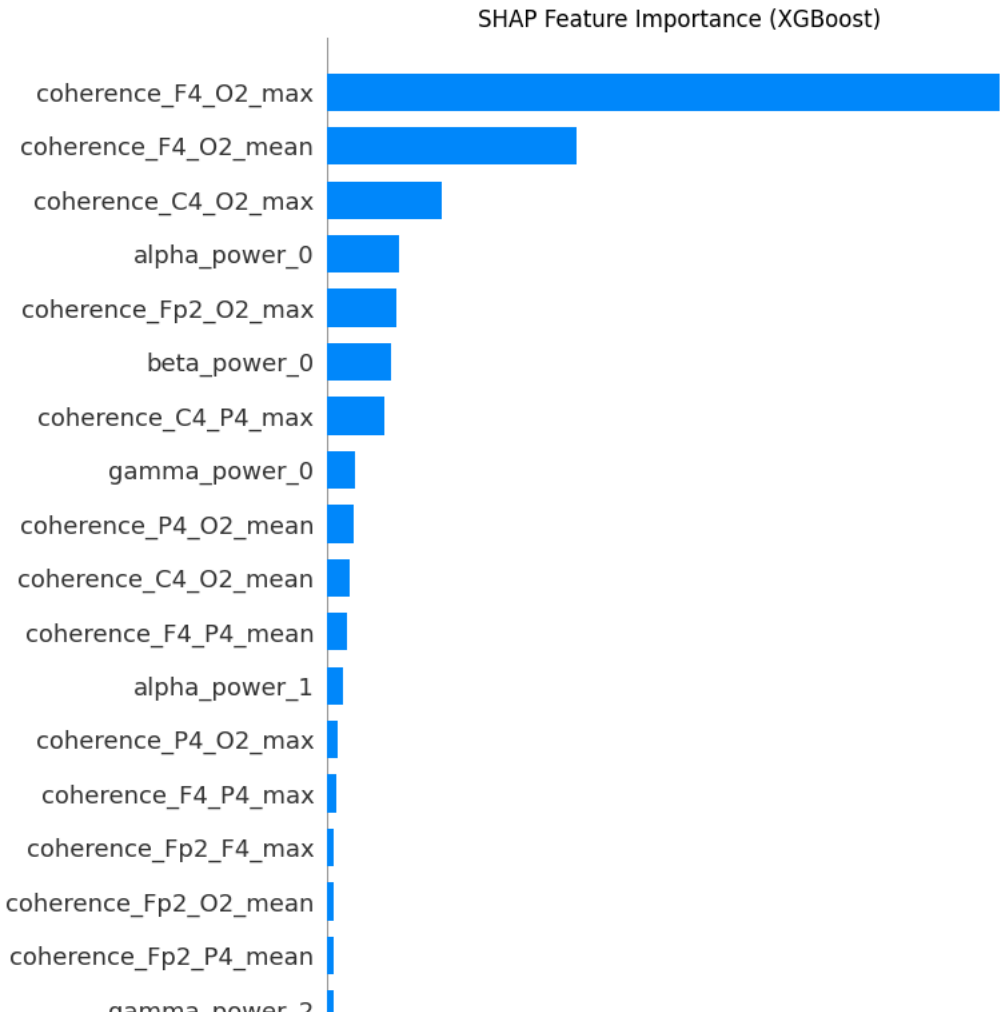
GaussianNB	0.793 0.814	0.628	0.614
KNN	0.672 0.726	0.451	0.358
SVM	0.620 0.591	0.182	0.323

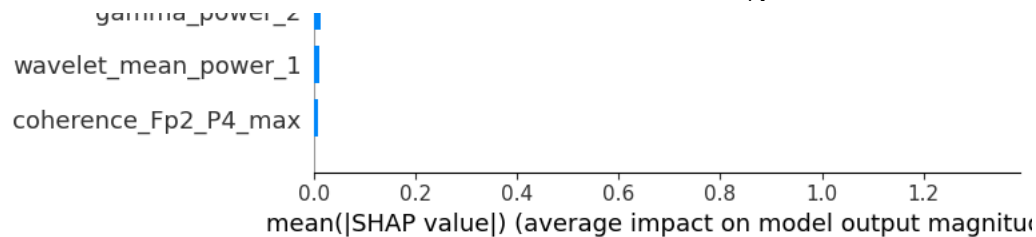
AUC Decile Analysis:
Deciles: ['0.591', '0.699', '0.779', '0.862', '0.941', '0.966', '0.989', '0.996', '0.998', '0.999', '0.999']
AdaBoost: 0.999 (Decile 8)
GradientBoosting: 0.999 (Decile 9)
LightGBM: 0.997 (Decile 7)
RandomForest: 0.994 (Decile 6)
XGBoost: 0.966 (Decile 5)
LogisticRegression: 0.934 (Decile 3)
GaussianNB: 0.814 (Decile 2)
KNN: 0.726 (Decile 1)
SVM: 0.591 (Decile 0)

Gini Coefficient Decile Analysis:
Deciles: ['0.182', '0.397', '0.557', '0.724', '0.881', '0.933', '0.977', '0.991', '0.995', '0.998', '0.999']
AdaBoost: 0.998 (Decile 8)
GradientBoosting: 0.999 (Decile 9)
LightGBM: 0.993 (Decile 7)
RandomForest: 0.989 (Decile 6)
XGBoost: 0.933 (Decile 5)
LogisticRegression: 0.868 (Decile 3)
GaussianNB: 0.628 (Decile 2)
KNN: 0.451 (Decile 1)
SVM: 0.182 (Decile 0)

KS Statistic Decile Analysis:
Deciles: ['0.323', '0.351', '0.511', '0.679', '0.797', '0.879', '0.932', '0.960', '0.971', '0.976', '0.989']
AdaBoost: 0.969 (Decile 7)
GradientBoosting: 0.989 (Decile 9)
LightGBM: 0.973 (Decile 8)
RandomForest: 0.945 (Decile 6)
XGBoost: 0.879 (Decile 5)
LogisticRegression: 0.776 (Decile 3)
GaussianNB: 0.614 (Decile 2)
KNN: 0.358 (Decile 1)
SVM: 0.323 (Decile 0)

Performing SHAP analysis...





Least important features (bottom 20%):

[]

Removing least important features...

[I 2025-06-30 10:55:45,755] A new study created in memory with name: no-name-425096d4-70e1-46de-807b-5d45baef31a2

Re-optimizing models with selected features...

Re-optimizing XGBoost...

Best trial: 39. Best value: 0.84998: 100%

50/50 [03:27<00:00, 4.13s/it]

```
[I 2025-06-30 10:55:48,936] Trial 0 finished with value: 0.8206088456656202 and parameters: {'n_estimators': 100, 'max_depth': 10, 'learn
[I 2025-06-30 10:55:51,188] Trial 1 finished with value: 0.8204648074090591 and parameters: {'n_estimators': 150, 'max_depth': 2, 'learn
[I 2025-06-30 10:55:56,363] Trial 2 finished with value: 0.7910645066392891 and parameters: {'n_estimators': 100, 'max_depth': 4, 'learn
[I 2025-06-30 10:56:00,952] Trial 3 finished with value: 0.8158832781072253 and parameters: {'n_estimators': 150, 'max_depth': 7, 'learn
[I 2025-06-30 10:56:03,627] Trial 4 finished with value: 0.8236467897163348 and parameters: {'n_estimators': 100, 'max_depth': 2, 'learn
[I 2025-06-30 10:56:09,991] Trial 5 finished with value: 0.7858185746223678 and parameters: {'n_estimators': 150, 'max_depth': 4, 'learn
[I 2025-06-30 10:56:14,981] Trial 6 finished with value: 0.822719689974002 and parameters: {'n_estimators': 150, 'max_depth': 10, 'learn
[I 2025-06-30 10:56:20,260] Trial 7 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 100, 'max_depth': 4, 'learn
[I 2025-06-30 10:56:22,870] Trial 8 finished with value: 0.8471174303223682 and parameters: {'n_estimators': 50, 'max_depth': 9, 'learn
[I 2025-06-30 10:56:27,604] Trial 9 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 150, 'max_depth': 4, 'learn
[I 2025-06-30 10:56:31,645] Trial 10 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 50, 'max_depth': 8, 'learn
[I 2025-06-30 10:56:34,023] Trial 11 finished with value: 0.7966651855435782 and parameters: {'n_estimators': 50, 'max_depth': 6, 'learn
[I 2025-06-30 10:56:36,454] Trial 12 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 50, 'max_depth': 6, 'learn
[I 2025-06-30 10:56:45,104] Trial 13 finished with value: 0.8465039333898527 and parameters: {'n_estimators': 200, 'max_depth': 8, 'lear
[I 2025-06-30 10:56:51,844] Trial 14 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 200, 'max_depth': 8, 'lear
[I 2025-06-30 10:57:00,441] Trial 15 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 200, 'max_depth': 9, 'lear
[I 2025-06-30 10:57:04,012] Trial 16 finished with value: 0.7866411937609536 and parameters: {'n_estimators': 200, 'max_depth': 8, 'lear
[I 2025-06-30 10:57:08,238] Trial 17 finished with value: 0.843231949749771 and parameters: {'n_estimators': 50, 'max_depth': 9, 'learn
[I 2025-06-30 10:57:14,658] Trial 18 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 200, 'max_depth': 7, 'lear
[I 2025-06-30 10:57:19,934] Trial 19 finished with value: 0.8497759170299345 and parameters: {'n_estimators': 100, 'max_depth': 9, 'lear
[I 2025-06-30 10:57:22,324] Trial 20 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 50, 'max_depth': 10, 'lear
[I 2025-06-30 10:57:25,029] Trial 21 finished with value: 0.7870501017159639 and parameters: {'n_estimators': 100, 'max_depth': 9, 'lear
[I 2025-06-30 10:57:30,638] Trial 22 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 100, 'max_depth': 7, 'lear
[I 2025-06-30 10:57:33,505] Trial 23 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 50, 'max_depth': 9, 'learn
[I 2025-06-30 10:57:36,659] Trial 24 finished with value: 0.8175117866279106 and parameters: {'n_estimators': 100, 'max_depth': 8, 'lear
[I 2025-06-30 10:57:43,282] Trial 25 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 150, 'max_depth': 10, 'lea
[I 2025-06-30 10:57:45,831] Trial 26 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 50, 'max_depth': 9, 'learn
[I 2025-06-30 10:57:50,702] Trial 27 finished with value: 0.7870501017159639 and parameters: {'n_estimators': 200, 'max_depth': 7, 'lear
[I 2025-06-30 10:57:54,712] Trial 28 finished with value: 0.7842233509309553 and parameters: {'n_estimators': 100, 'max_depth': 5, 'lear
[I 2025-06-30 10:57:57,346] Trial 29 finished with value: 0.8465039333898527 and parameters: {'n_estimators': 50, 'max_depth': 10, 'lear
[I 2025-06-30 10:58:00,261] Trial 30 finished with value: 0.7870501017159639 and parameters: {'n_estimators': 100, 'max_depth': 8, 'lear
[I 2025-06-30 10:58:02,895] Trial 31 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 50, 'max_depth': 10, 'lear
[I 2025-06-30 10:58:07,281] Trial 32 finished with value: 0.8475264282773783 and parameters: {'n_estimators': 50, 'max_depth': 9, 'learn
[I 2025-06-30 10:58:09,937] Trial 33 finished with value: 0.7829555889372962 and parameters: {'n_estimators': 50, 'max_depth': 9, 'learn
[I 2025-06-30 10:58:14,129] Trial 34 finished with value: 0.8462994344123477 and parameters: {'n_estimators': 100, 'max_depth': 8, 'lear
[I 2025-06-30 10:58:21,195] Trial 35 finished with value: 0.7845961139859026 and parameters: {'n_estimators': 150, 'max_depth': 9, 'lear
[I 2025-06-30 10:58:23,311] Trial 36 finished with value: 0.8133074394916262 and parameters: {'n_estimators': 100, 'max_depth': 7, 'lear
[I 2025-06-30 10:58:25,707] Trial 37 finished with value: 0.7858185746223678 and parameters: {'n_estimators': 50, 'max_depth': 10, 'lear
[I 2025-06-30 10:58:31,167] Trial 38 finished with value: 0.8481399252098937 and parameters: {'n_estimators': 100, 'max_depth': 9, 'lear
[I 2025-06-30 10:58:35,021] Trial 39 finished with value: 0.8499804160074397 and parameters: {'n_estimators': 100, 'max_depth': 9, 'lear
[I 2025-06-30 10:58:38,220] Trial 40 finished with value: 0.8477309272548835 and parameters: {'n_estimators': 100, 'max_depth': 3, 'lear
[I 2025-06-30 10:58:41,568] Trial 41 finished with value: 0.8497759170299345 and parameters: {'n_estimators': 100, 'max_depth': 2, 'lear
[I 2025-06-30 10:58:45,322] Trial 42 finished with value: 0.8367900800982965 and parameters: {'n_estimators': 100, 'max_depth': 2, 'lear
[I 2025-06-30 10:58:48,660] Trial 43 finished with value: 0.8495714180524295 and parameters: {'n_estimators': 100, 'max_depth': 3, 'lear
[I 2025-06-30 10:58:51,505] Trial 44 finished with value: 0.7859554109661007 and parameters: {'n_estimators': 100, 'max_depth': 2, 'lear
[I 2025-06-30 10:58:56,360] Trial 45 finished with value: 0.8261961725915888 and parameters: {'n_estimators': 100, 'max_depth': 3, 'lear
[I 2025-06-30 10:59:00,254] Trial 46 finished with value: 0.821795461068653 and parameters: {'n_estimators': 150, 'max_depth': 3, 'learn
[I 2025-06-30 10:59:03,711] Trial 47 finished with value: 0.8499804160074397 and parameters: {'n_estimators': 100, 'max_depth': 5, 'lear
[I 2025-06-30 10:59:09,665] Trial 48 finished with value: 0.7858185746223678 and parameters: {'n_estimators': 150, 'max_depth': 5, 'lear
[I 2025-06-30 10:59:13,197] A new study created in memory with name: no-name-247b6eba-7ef3-4550-939d-b158cef2e534
[I 2025-06-30 10:59:13,190] Trial 49 finished with value: 0.8471174303223682 and parameters: {'n_estimators': 100, 'max_depth': 5, 'lear
```

Best params for XGBoost: {'n_estimators': 100, 'max_depth': 9, 'learning_rate': 0.02056215904645569, 'subsample': 0.9140421188354219, 'c

Re-optimizing LightGBM...

Best trial: 15. Best value: 0.833918: 100%

50/50 [03:06<00:00, 4.09s/it]

Streaming output truncated to the last 5000 lines.

```
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
```

```
[lightGRM] [Warning] No further splits with positive gain, best gain: -inf
```

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<https://colab.research.google.com/drive/1rIM9hrrNzcuUk8APZbpoSMBb5l37oJ-t#scrollTo=ocPPWbSOA73G&printMode=true>

<https://colab.research.google.com/drive/1rIM9hrrNzcuUk8APZbpoSMBb5l37oJ-#scrollTo=ocPPWbSOA73G&printMode=true>

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<https://colab.research.google.com/drive/1rIM9hrrNzcuUk8APZbpoSMBb5l37oJ-t#scrollTo=ocPPWbSOA73G&printMode=true>

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[illegible]

<https://colab.research.google.com/drive/1rIM9hrrNzcuUk8APZbpoSMBb5l37oJ-t#scrollTo=ocPPWbSOA73G&printMode=true>

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You can set ``force col wise=true`` to remove the overhead.

[illegible]

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[illegible]

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<https://colab.research.google.com/drive/1rIM9hrrNzcuUk8APZbpoSMBb5l37oJ-t#scrollTo=ocPPWbSOA73G&printMode=true>

[illegible]

[illegible]

You can set `force col wise=true` to remove the overhead.

<https://colab.research.google.com/drive/1rIM9hrrNzcuUk8APZbpoSMBb5l37oJ-t#scrollTo=ocPPWbSOA73G&printMode=true>

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lab research google.com/drive/1rIM9hrrNzcuIjK8AP7bnpSMBb5l37oL-1/#scrollTo=ocPPWhSOA73G&printMode=tr

<https://colab.research.google.com/drive/1rIM9hrrNzcuUk8APZbpoSMBb5l37oJ-t#scrollTo=ocPPWbSOA73G&printMode=true>

2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
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You can set ``force col wise=true`` to remove the overhead.

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[illegible]

lab research google.com/drive/1rIM9hrrNzcuIlk8AP7hpcSMBb5I37oI-#scrollTo=

You can set ``force col wise=true`` to remove the overhead.

[illegible]

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[illegible]

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```
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
```


[illegible]

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lab research google.com/drive/1rIM9hrrNzcuIlk8AP7hnpSMBb5l37oL-#scrollTo=

2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962	1961	1960	1959	1958	1957	1956	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946	1945	1944	1943	1942	1941	1940	1939	1938	1937	1936	1935	1934	1933	1932	1931	1930	1929	1928	1927	1926	1925	1924	1923	1922	1921	1920	1919	1918	1917	1916	1915	1914	1913	1912	1911	1910	1909	1908	1907	1906	1905	1904	1903	1902	1901	1900	1899	1898	1897	1896	1895	1894	1893	1892	1891	1890	1889	1888	1887	1886	1885	1884	1883	1882	1881	1880	1879	1878	1877	1876	1875	1874	1873	1872	1871	1870	1869	1868	1867	1866	1865	1864	1863	1862	1861	1860	1859	1858	1857	1856	1855	1854	1853	1852	1851	1850	1849	1848	1847	1846	1845	1844	1843	1842	1841	1840	1839	1838	1837	1836	1835	1834	1833	1832	1831	1830	1829	1828	1827	1826	1825	1824	1823	1822	1821	1820	1819	1818	1817	1816	1815	1814	1813	1812	1811	1810	1809	1808	1807	1806	1805	1804	1803	1802	1801	1800	1799	1798	1797	1796	1795	1794	1793	1792	1791	1790	1789	1788	1787	1786	1785	1784	1783	1782	1781	1780	1779	1778	1777	1776	1775	1774	1773	1772	1771	1770	1769	1768	1767	1766	1765	1764	1763	1762	1761	1760	1759	1758	1757	1756	1755	1754	1753	1752	1751	1750	1749	1748	1747	1746	1745	1744	1743	1742	1741	1740	1739	1738	1737	1736	1735	1734	1733	1732	1731	1730	1729	1728	1727	1726	1725	1724	1723	1722	1721	1720	1719	1718	1717	1716	1715	1714	1713	1712	1711	1710	1709	1708	1707	1706	1705	1704	1703	1702	1701	1700	1699	1698	1697	1696	1695	1694	1693	1692	1691	1690	1689	1688	1687	1686	1685	1684	1683	1682	1681	1680	1679	1678	1677	1676	1675	1674	1673	1672	1671	1670	1669	1668	1667	1666	1665	1664	1663	1662	1661	1660	1659	1658	1657	1656	1655	1654	1653	1652	1651	1650	1649	1648	1647	1646	1645	1644	1643	1642	1641	1640	1639	1638	1637	1636	1635	1634	1633	1632	1631	1630	1629	1628	1627	1626	1625	1624	1623	1622	1621	1620	1619	1618	1617	1616	1615	1614	1613	1612	1611	1610	1609</
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```
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
```


100	5	1	100	100	0	100	100	0	100	0	0	0	0	0	0	0	100
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[illegible]

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1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5197314/>

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```
[LightGBM] [Warning] Stopped training because there are no more leaves that meet the split requirements
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] No further splits with positive gain, best gain: -inf
[LightGBM] [Warning] feature_fraction is set=0.9830750139842088, colsample_bytree=1.0 will be ignored. Current value: feature_fraction=0
[I 2025-06-30 11:02:19,414] Trial 49 finished with value: 0.8043140551324148 and parameters: {'n_estimators': 194, 'max_depth': 3, 'lear
```

Best params for LightGBM: {'n_estimators': 199, 'max_depth': 4, 'learning_rate': 0.11578459669741656, 'subsample': 0.9145947754307058, 'l

Re-optimizing RandomForest...

Best trial: 21. Best value: 0.838484: 100%

50/50 [49:28<00:00, 58.87s/it]

```
[I 2025-06-30 11:02:53,664] Trial 0 finished with value: 0.7992154436351564 and parameters: {'n_estimators': 106, 'max_depth': 10, 'min_
[I 2025-06-30 11:03:22,254] Trial 1 finished with value: 0.8378703763975682 and parameters: {'n_estimators': 73, 'max_depth': 2, 'min_sa
[I 2025-06-30 11:03:40,739] Trial 2 finished with value: 0.8234066688245667 and parameters: {'n_estimators': 53, 'max_depth': 10, 'min_s
[I 2025-06-30 11:04:08,483] Trial 3 finished with value: 0.8045031587271315 and parameters: {'n_estimators': 77, 'max_depth': 4, 'min_sa
[I 2025-06-30 11:05:02,013] Trial 4 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 142, 'max_depth': 3, 'min_s
[I 2025-06-30 11:05:39,818] Trial 5 finished with value: 0.7961111124136941 and parameters: {'n_estimators': 168, 'max_depth': 3, 'min_s
[I 2025-06-30 11:06:57,324] Trial 6 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 141, 'max_depth': 3, 'min_s
[I 2025-06-30 11:08:09,013] Trial 7 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 172, 'max_depth': 4, 'min_s
[I 2025-06-30 11:08:34,176] Trial 8 finished with value: 0.7931601460229573 and parameters: {'n_estimators': 68, 'max_depth': 6, 'min_sa
[I 2025-06-30 11:09:20,213] Trial 9 finished with value: 0.7935014813441953 and parameters: {'n_estimators': 150, 'max_depth': 4, 'min_s
[I 2025-06-30 11:11:12,133] Trial 10 finished with value: 0.8379902734563656 and parameters: {'n_estimators': 194, 'max_depth': 7, 'min_
[I 2025-06-30 11:12:34,507] Trial 11 finished with value: 0.837665877420063 and parameters: {'n_estimators': 127, 'max_depth': 6, 'min_s
[I 2025-06-30 11:13:30,837] Trial 12 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 128, 'max_depth': 2, 'min_
[I 2025-06-30 11:14:29,473] Trial 13 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 102, 'max_depth': 5, 'min_
[I 2025-06-30 11:15:44,770] Trial 14 finished with value: 0.8374861013079964 and parameters: {'n_estimators': 148, 'max_depth': 8, 'min_
[I 2025-06-30 11:16:39,379] Trial 15 finished with value: 0.8368022266847345 and parameters: {'n_estimators': 151, 'max_depth': 3, 'min_
[I 2025-06-30 11:17:24,777] Trial 16 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 111, 'max_depth': 2, 'min_
[I 2025-06-30 11:19:07,370] Trial 17 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 200, 'max_depth': 5, 'min_
[I 2025-06-30 11:20:06,006] Trial 18 finished with value: 0.8332866305911507 and parameters: {'n_estimators': 172, 'max_depth': 3, 'min_
[I 2025-06-30 11:21:25,443] Trial 19 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 136, 'max_depth': 5, 'min_
[I 2025-06-30 11:22:08,310] Trial 20 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 90, 'max_depth': 8, 'min_s
[I 2025-06-30 11:23:21,426] Trial 21 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 174, 'max_depth': 4, 'min_
[I 2025-06-30 11:24:27,984] Trial 22 finished with value: 0.8384045460256253 and parameters: {'n_estimators': 185, 'max_depth': 3, 'min_
[I 2025-06-30 11:25:43,999] Trial 23 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 189, 'max_depth': 4, 'min_
[I 2025-06-30 11:26:53,789] Trial 24 finished with value: 0.8382000470481201 and parameters: {'n_estimators': 182, 'max_depth': 3, 'min_
[I 2025-06-30 11:27:38,016] Trial 25 finished with value: 0.8340799036357326 and parameters: {'n_estimators': 162, 'max_depth': 2, 'min_
[I 2025-06-30 11:29:12,070] Trial 26 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 182, 'max_depth': 5, 'min_
[I 2025-06-30 11:30:19,763] Trial 27 finished with value: 0.838210956180712 and parameters: {'n_estimators': 160, 'max_depth': 4, 'min_s
[I 2025-06-30 11:31:20,614] Trial 28 finished with value: 0.8332866305911507 and parameters: {'n_estimators': 180, 'max_depth': 3, 'min_
[I 2025-06-30 11:31:49,785] Trial 29 finished with value: 0.796096708588038 and parameters: {'n_estimators': 115, 'max_depth': 9, 'min_s
[I 2025-06-30 11:32:29,916] Trial 30 finished with value: 0.7935691439779675 and parameters: {'n_estimators': 158, 'max_depth': 2, 'min_
[I 2025-06-30 11:33:26,760] Trial 31 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 139, 'max_depth': 3, 'min_
[I 2025-06-30 11:34:37,985] Trial 32 finished with value: 0.8382000470481201 and parameters: {'n_estimators': 139, 'max_depth': 4, 'min_
[I 2025-06-30 11:35:11,454] Trial 33 finished with value: 0.8368022266847345 and parameters: {'n_estimators': 118, 'max_depth': 2, 'min_
[I 2025-06-30 11:35:58,064] Trial 34 finished with value: 0.8378703763975682 and parameters: {'n_estimators': 101, 'max_depth': 3, 'min_
[I 2025-06-30 11:36:39,389] Trial 35 finished with value: 0.7947481444122487 and parameters: {'n_estimators': 145, 'max_depth': 4, 'min_
[I 2025-06-30 11:37:45,267] Trial 36 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 166, 'max_depth': 3, 'min_
[I 2025-06-30 11:38:39,509] Trial 37 finished with value: 0.8376906002855016 and parameters: {'n_estimators': 168, 'max_depth': 2, 'min_
[I 2025-06-30 11:39:47,791] Trial 38 finished with value: 0.7967847980556906 and parameters: {'n_estimators': 175, 'max_depth': 5, 'min_
[I 2025-06-30 11:41:18,821] Trial 39 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 192, 'max_depth': 6, 'min_
[I 2025-06-30 11:42:09,764] Trial 40 finished with value: 0.7935691439779675 and parameters: {'n_estimators': 159, 'max_depth': 4, 'min_
[I 2025-06-30 11:42:50,431] Trial 41 finished with value: 0.7937059803217004 and parameters: {'n_estimators': 166, 'max_depth': 3, 'min_
[I 2025-06-30 11:44:12,410] Trial 42 finished with value: 0.837665877420063 and parameters: {'n_estimators': 154, 'max_depth': 3, 'min_s
[I 2025-06-30 11:45:05,480] Trial 43 finished with value: 0.8368022266847345 and parameters: {'n_estimators': 186, 'max_depth': 2, 'min_
[I 2025-06-30 11:46:13,273] Trial 44 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 134, 'max_depth': 4, 'min_
[I 2025-06-30 11:47:37,776] Trial 45 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 200, 'max_depth': 3, 'min_
[I 2025-06-30 11:49:21,171] Trial 46 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 175, 'max_depth': 4, 'min_
[I 2025-06-30 11:50:14,818] Trial 47 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 144, 'max_depth': 3, 'min_
[I 2025-06-30 11:51:03,200] Trial 48 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 124, 'max_depth': 2, 'min_
[I 2025-06-30 11:51:48,354] A new study created in memory with name: no-name-4e2b784a-db16-4600-95d2-86b87d5480f6
[I 2025-06-30 11:51:48,346] Trial 49 finished with value: 0.7940732778759308 and parameters: {'n_estimators': 130, 'max_depth': 6, 'min_
```

Best params for RandomForest: {'n_estimators': 174, 'max_depth': 4, 'min_samples_split': 3, 'min_samples_leaf': 14, 'max_features': 0.61

Re-optimizing AdaBoost...

Best trial: 0. Best value: 0.838484: 100%

50/50 [46:24<00:00, 62.78s/it]

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[I 2025-06-30 11:52:40,324] Trial 0 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 106, 'learning_rate': 0.172
[I 2025-06-30 11:53:58,642] Trial 1 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 160, 'learning_rate': 0.060
[I 2025-06-30 11:54:34,440] Trial 2 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 73, 'learning_rate': 0.0159
[I 2025-06-30 11:55:03,112] Trial 3 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 58, 'learning_rate': 0.1339
[I 2025-06-30 11:56:11,007] Trial 4 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 140, 'learning_rate': 0.083
[I 2025-06-30 11:56:37,410] Trial 5 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 53, 'learning_rate': 0.1827
[I 2025-06-30 11:58:02,426] Trial 6 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 175, 'learning_rate': 0.018
[I 2025-06-30 11:58:40,183] Trial 7 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 77, 'learning_rate': 0.0173
[I 2025-06-30 11:59:26,942] Trial 8 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 95, 'learning_rate': 0.0481
[I 2025-06-30 12:00:33,663] Trial 9 finished with value: 0.838516273135556 and parameters: {'n_estimators': 115, 'learning_rate': 0.022
```

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[I 2025-06-30 12:00:23,070] Trial 9 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 113, 'learning_rate': 0.02}
[I 2025-06-30 12:01:58,585] Trial 10 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 192, 'learning_rate': 0.10}
[I 2025-06-30 12:03:10,996] Trial 11 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 147, 'learning_rate': 0.05}
[I 2025-06-30 12:04:27,668] Trial 12 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 157, 'learning_rate': 0.03}
[I 2025-06-30 12:05:23,347] Trial 13 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 113, 'learning_rate': 0.06}
[I 2025-06-30 12:06:27,891] Trial 14 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 132, 'learning_rate': 0.01}
[I 2025-06-30 12:07:50,295] Trial 15 finished with value: 0.8382458914167089 and parameters: {'n_estimators': 168, 'learning_rate': 0.17}
[I 2025-06-30 12:08:38,377] Trial 16 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 97, 'learning_rate': 0.111}
[I 2025-06-30 12:10:11,477] Trial 17 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 191, 'learning_rate': 0.03}
[I 2025-06-30 12:11:07,705] Trial 18 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 114, 'learning_rate': 0.06}
[I 2025-06-30 12:12:26,323] Trial 19 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 161, 'learning_rate': 0.13}
[I 2025-06-30 12:13:28,524] Trial 20 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 127, 'learning_rate': 0.07}
[I 2025-06-30 12:14:07,932] Trial 21 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 80, 'learning_rate': 0.011}
[I 2025-06-30 12:14:51,937] Trial 22 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 89, 'learning_rate': 0.034}
[I 2025-06-30 12:15:24,812] Trial 23 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 67, 'learning_rate': 0.014}
[I 2025-06-30 12:16:16,311] Trial 24 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 104, 'learning_rate': 0.02}
[I 2025-06-30 12:16:52,616] Trial 25 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 74, 'learning_rate': 0.023}
[I 2025-06-30 12:18:03,854] Trial 26 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 146, 'learning_rate': 0.03}
[I 2025-06-30 12:19:31,337] Trial 27 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 180, 'learning_rate': 0.05}
[I 2025-06-30 12:20:04,570] Trial 28 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 67, 'learning_rate': 0.030}
[I 2025-06-30 12:20:35,177] Trial 29 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 62, 'learning_rate': 0.139}
[I 2025-06-30 12:21:19,562] Trial 30 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 90, 'learning_rate': 0.100}
[I 2025-06-30 12:21:46,299] Trial 31 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 54, 'learning_rate': 0.140}
[I 2025-06-30 12:22:14,812] Trial 32 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 57, 'learning_rate': 0.185}
[I 2025-06-30 12:23:21,874] Trial 33 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 137, 'learning_rate': 0.07}
[I 2025-06-30 12:23:47,215] Trial 34 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 51, 'learning_rate': 0.119}
[I 2025-06-30 12:24:24,631] Trial 35 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 76, 'learning_rate': 0.092}
[I 2025-06-30 12:25:05,233] Trial 36 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 83, 'learning_rate': 0.156}
[I 2025-06-30 12:25:57,864] Trial 37 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 107, 'learning_rate': 0.01}
[I 2025-06-30 12:26:57,750] Trial 38 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 123, 'learning_rate': 0.19}
[I 2025-06-30 12:27:32,005] Trial 39 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 69, 'learning_rate': 0.042}
[I 2025-06-30 12:28:21,945] Trial 40 finished with value: 0.8328516347135516 and parameters: {'n_estimators': 102, 'learning_rate': 0.02}
[I 2025-06-30 12:29:31,733] Trial 41 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 143, 'learning_rate': 0.08}
[I 2025-06-30 12:30:45,733] Trial 42 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 152, 'learning_rate': 0.06}
[I 2025-06-30 12:32:10,305] Trial 43 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 173, 'learning_rate': 0.10}
[I 2025-06-30 12:33:27,214] Trial 44 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 158, 'learning_rate': 0.05}
[I 2025-06-30 12:34:24,958] Trial 45 finished with value: 0.83825218721167 and parameters: {'n_estimators': 119, 'learning_rate': 0.164}
[I 2025-06-30 12:35:31,568] Trial 46 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 136, 'learning_rate': 0.06}
[I 2025-06-30 12:36:00,544] Trial 47 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 59, 'learning_rate': 0.091}
[I 2025-06-30 12:36:43,143] Trial 48 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 86, 'learning_rate': 0.125}
[I 2025-06-30 12:38:12,516] A new study created in memory with name: no-name-05d6acb7-1593-499e-921c-a027620416e5
[I 2025-06-30 12:38:12,510] Trial 49 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 184, 'learning_rate': 0.10}

```

Best params for AdaBoost: {'n_estimators': 106, 'learning_rate': 0.17254716573280354}

Re-optimizing GradientBoosting...

Best trial: 31. Best value: 0.854825: 100%

50/50 [2:23:07<00:00, 184.70s/it]

```

[I 2025-06-30 12:41:18,529] Trial 0 finished with value: 0.8074668972869293 and parameters: {'n_estimators': 106, 'learning_rate': 0.172}
[I 2025-06-30 12:44:14,522] Trial 1 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 73, 'learning_rate': 0.0119}
[I 2025-06-30 12:46:16,361] Trial 2 finished with value: 0.8072623983094243 and parameters: {'n_estimators': 53, 'learning_rate': 0.1827}
[I 2025-06-30 12:48:53,474] Trial 3 finished with value: 0.8370630222383285 and parameters: {'n_estimators': 77, 'learning_rate': 0.0248}
[I 2025-06-30 12:52:38,495] Trial 4 finished with value: 0.83799554800706149 and parameters: {'n_estimators': 142, 'learning_rate': 0.015}
[I 2025-06-30 12:57:12,250] Trial 5 finished with value: 0.8371387946104756 and parameters: {'n_estimators': 168, 'learning_rate': 0.018}
[I 2025-06-30 12:59:50,246] Trial 6 finished with value: 0.8326471357360465 and parameters: {'n_estimators': 141, 'learning_rate': 0.016}
[I 2025-06-30 13:02:58,939] Trial 7 finished with value: 0.8324549981912606 and parameters: {'n_estimators': 172, 'learning_rate': 0.024}
[I 2025-06-30 13:04:15,313] Trial 8 finished with value: 0.8384045460256523 and parameters: {'n_estimators': 68, 'learning_rate': 0.0440}
[I 2025-06-30 13:09:09,178] Trial 9 finished with value: 0.8361163922452319 and parameters: {'n_estimators': 150, 'learning_rate': 0.025}
[I 2025-06-30 13:11:47,627] Trial 10 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 106, 'learning_rate': 0.08}
[I 2025-06-30 13:13:59,142] Trial 11 finished with value: 0.8324426367585414 and parameters: {'n_estimators': 55, 'learning_rate': 0.058}
[I 2025-06-30 13:15:34,873] Trial 12 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 83, 'learning_rate': 0.010}
[I 2025-06-30 13:17:17,770] Trial 13 finished with value: 0.8326471357360465 and parameters: {'n_estimators': 93, 'learning_rate': 0.046}
[I 2025-06-30 13:19:15,392] Trial 14 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 79, 'learning_rate': 0.106}
[I 2025-06-30 13:22:56,773] Trial 15 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 195, 'learning_rate': 0.01}
[I 2025-06-30 13:27:56,570] Trial 16 finished with value: 0.8072623983094243 and parameters: {'n_estimators': 200, 'learning_rate': 0.03}
[I 2025-06-30 13:30:47,879] Trial 17 finished with value: 0.8382458914167089 and parameters: {'n_estimators': 200, 'learning_rate': 0.11}
[I 2025-06-30 13:33:01,734] Trial 18 finished with value: 0.8323298265182139 and parameters: {'n_estimators': 122, 'learning_rate': 0.03}
[I 2025-06-30 13:37:28,222] Trial 19 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 179, 'learning_rate': 0.06}
[I 2025-06-30 13:39:44,458] Trial 20 finished with value: 0.8323756708868024 and parameters: {'n_estimators': 125, 'learning_rate': 0.04}
[I 2025-06-30 13:41:01,272] Trial 21 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 67, 'learning_rate': 0.010}
[I 2025-06-30 13:42:51,024] Trial 22 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 96, 'learning_rate': 0.012}
[I 2025-06-30 13:45:18,548] Trial 23 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 93, 'learning_rate': 0.018}
[I 2025-06-30 13:46:26,845] Trial 24 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 60, 'learning_rate': 0.010}
[I 2025-06-30 13:48:44,356] Trial 25 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 120, 'learning_rate': 0.01}
[I 2025-06-30 13:51:00,263] Trial 26 finished with value: 0.8374613784425579 and parameters: {'n_estimators': 84, 'learning_rate': 0.021}
[I 2025-06-30 13:53:04,949] Trial 27 finished with value: 0.8382793743525783 and parameters: {'n_estimators': 110, 'learning_rate': 0.03}
[I 2025-06-30 13:54:45,765] Trial 28 finished with value: 0.8380748753750732 and parameters: {'n_estimators': 62, 'learning_rate': 0.013}
[I 2025-06-30 13:57:38,929] Trial 29 finished with value: 0.8523661516102674 and parameters: {'n_estimators': 186, 'learning_rate': 0.13}
[I 2025-06-30 14:02:31,708] Trial 30 finished with value: 0.8074668972869293 and parameters: {'n_estimators': 193, 'learning_rate': 0.13}
[I 2025-06-30 14:05:49,457] Trial 31 finished with value: 0.8548252980484715 and parameters: {'n_estimators': 184, 'learning_rate': 0.08}
[I 2025-06-30 14:08:27,392] Trial 32 finished with value: 0.8521616526327623 and parameters: {'n_estimators': 182, 'learning_rate': 0.15}
[I 2025-06-30 14:11:11,176] Trial 33 finished with value: 0.8539526976994315 and parameters: {'n_estimators': 187, 'learning_rate': 0.14}
[I 2025-06-30 14:13:51,051] Trial 34 finished with value: 0.8539526976994315 and parameters: {'n_estimators': 184, 'learning_rate': 0.15}
[I 2025-06-30 14:16:06,912] Trial 35 finished with value: 0.8535436997444211 and parameters: {'n_estimators': 163, 'learning_rate': 0.19}
[I 2025-06-30 14:19:15,218] Trial 36 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 160, 'learning_rate': 0.19}

```

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[I 2025-06-30 14:22:10,654] Trial 37 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 162, 'learning_rate': 0.08}
[I 2025-06-30 14:25:39,630] Trial 38 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 175, 'learning_rate': 0.16}
[I 2025-06-30 14:28:43,800] Trial 39 finished with value: 0.8539526976994315 and parameters: {'n_estimators': 188, 'learning_rate': 0.11}
[I 2025-06-30 14:34:24,754] Trial 40 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 152, 'learning_rate': 0.11}
[I 2025-06-30 14:37:19,214] Trial 41 finished with value: 0.8539526976994315 and parameters: {'n_estimators': 186, 'learning_rate': 0.13}
[I 2025-06-30 14:40:42,449] Trial 42 finished with value: 0.8523661516102674 and parameters: {'n_estimators': 189, 'learning_rate': 0.09}
[I 2025-06-30 14:43:30,144] Trial 43 finished with value: 0.8523661516102674 and parameters: {'n_estimators': 172, 'learning_rate': 0.13}
[I 2025-06-30 14:46:11,761] Trial 44 finished with value: 0.8537481987219263 and parameters: {'n_estimators': 183, 'learning_rate': 0.15}
[I 2025-06-30 14:48:40,061] Trial 45 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 138, 'learning_rate': 0.07}
[I 2025-06-30 14:51:58,611] Trial 46 finished with value: 0.8523661516102674 and parameters: {'n_estimators': 191, 'learning_rate': 0.10}
[I 2025-06-30 14:54:49,478] Trial 47 finished with value: 0.8523661516102674 and parameters: {'n_estimators': 168, 'learning_rate': 0.12}
[I 2025-06-30 14:58:32,711] Trial 48 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 177, 'learning_rate': 0.16}
[I 2025-06-30 15:01:20,058] A new study created in memory with name: no-name-6e5f72a5-8752-497c-bf6e-5024da784492
[I 2025-06-30 15:01:20,051] Trial 49 finished with value: 0.8384838733300835 and parameters: {'n_estimators': 154, 'learning_rate': 0.05}
```

Best params for GradientBoosting: {'n_estimators': 184, 'learning_rate': 0.08776641793171308, 'max_depth': 2, 'min_samples_split': 17, 'min_samples_leaf': 17}

Re-optimizing SVM...

Best trial: 8. Best value: 0.833314: 100%

50/50 [32:53<00:00, 33.24s/it]

```
[I 2025-06-30 15:01:59,849] Trial 0 finished with value: 0.8171502480250954 and parameters: {'C': 0.13292918943162169, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:02:03,884] Trial 1 finished with value: 0.8231999763258968 and parameters: {'C': 0.029375384576328288, 'kernel': 'poly', 'gamma': 0.001}
[I 2025-06-30 15:03:36,310] Trial 2 finished with value: 0.8243174356680129 and parameters: {'C': 0.011527987128232402, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:04:00,748] Trial 3 finished with value: 0.8168114929530367 and parameters: {'C': 0.03549878832196503, 'kernel': 'poly', 'gamma': 0.001}
[I 2025-06-30 15:05:24,347] Trial 4 finished with value: 0.7994415475763121 and parameters: {'C': 0.6847920095574779, 'kernel': 'sigmoid', 'gamma': 0.001}
[I 2025-06-30 15:05:50,202] Trial 5 finished with value: 0.8256029104510355 and parameters: {'C': 2.267398652378039, 'kernel': 'sigmoid', 'gamma': 0.001}
[I 2025-06-30 15:07:07,547] Trial 6 finished with value: 0.5125600090858001 and parameters: {'C': 0.6647135865318028, 'kernel': 'sigmoid', 'gamma': 0.001}
[I 2025-06-30 15:07:56,667] Trial 7 finished with value: 0.7610119942416689 and parameters: {'C': 2.6619018884890564, 'kernel': 'sigmoid', 'gamma': 0.001}
[I 2025-06-30 15:09:50,503] Trial 8 finished with value: 0.8333136042002341 and parameters: {'C': 0.023233503515390115, 'kernel': 'sigmc', 'gamma': 0.001}
[I 2025-06-30 15:10:23,694] Trial 9 finished with value: 0.81977552525113189 and parameters: {'C': 0.9717775305059632, 'kernel': 'sigmoid', 'gamma': 0.001}
[I 2025-06-30 15:10:44,643] Trial 10 finished with value: 0.8277153683437856 and parameters: {'C': 0.1329285254704278, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:11:06,889] Trial 11 finished with value: 0.82714072639373 and parameters: {'C': 0.10978744399571558, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:11:27,660] Trial 12 finished with value: 0.8281258773749842 and parameters: {'C': 0.12599201418393083, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:11:59,964] Trial 13 finished with value: 0.817001124155112 and parameters: {'C': 0.04211091391382456, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:12:28,914] Trial 14 finished with value: 0.8129918681313931 and parameters: {'C': 0.011381919023371847, 'kernel': 'poly', 'gamma': 0.001}
[I 2025-06-30 15:14:34,499] Trial 15 finished with value: 0.546387520254515 and parameters: {'C': 0.23791785519693218, 'kernel': 'sigmc', 'gamma': 0.001}
[I 2025-06-30 15:15:01,054] Trial 16 finished with value: 0.8235858962311252 and parameters: {'C': 0.06143425542833049, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:17:01,495] Trial 17 finished with value: 0.5607481347045775 and parameters: {'C': 0.020468026001232136, 'kernel': 'sigmoid', 'gamma': 0.001}
[I 2025-06-30 15:17:23,607] Trial 18 finished with value: 0.8248656923315446 and parameters: {'C': 0.32143915874272255, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:17:38,380] Trial 19 finished with value: 0.824336720944654 and parameters: {'C': 9.728583151931055, 'kernel': 'poly', 'gamma': 0.001}
[I 2025-06-30 15:19:38,575] Trial 20 finished with value: 0.5406403940886699 and parameters: {'C': 0.07129857930334428, 'kernel': 'sigmc', 'gamma': 0.001}
[I 2025-06-30 15:19:54,740] Trial 21 finished with value: 0.8254185369556755 and parameters: {'C': 0.23587749079216147, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:20:15,021] Trial 22 finished with value: 0.8239655793160705 and parameters: {'C': 0.12006977637241491, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:20:29,458] Trial 23 finished with value: 0.8269123370528323 and parameters: {'C': 0.3649571045984814, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:21:14,351] Trial 24 finished with value: 0.8133044258094199 and parameters: {'C': 0.024365710257412562, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:21:41,879] Trial 25 finished with value: 0.822218937606635 and parameters: {'C': 0.0541140891529234, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:22:04,358] Trial 26 finished with value: 0.8294068855862252 and parameters: {'C': 0.14615444351755424, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:22:58,176] Trial 27 finished with value: 0.815451616379571 and parameters: {'C': 0.0187391505693273, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:23:20,211] Trial 28 finished with value: 0.8182452690772944 and parameters: {'C': 0.08073589786098685, 'kernel': 'poly', 'gamma': 0.001}
[I 2025-06-30 15:25:19,376] Trial 29 finished with value: 0.5497400109469075 and parameters: {'C': 0.17294097147722898, 'kernel': 'sigmc', 'gamma': 0.001}
[I 2025-06-30 15:25:32,844] Trial 30 finished with value: 0.8249389270767634 and parameters: {'C': 0.6121171504144455, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:25:53,558] Trial 31 finished with value: 0.8289582771106607 and parameters: {'C': 0.14122210913686964, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:26:09,265] Trial 32 finished with value: 0.8236032528530277 and parameters: {'C': 0.2042339091998678, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:26:33,518] Trial 33 finished with value: 0.8272366178747775 and parameters: {'C': 0.09079055554255012, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:26:48,456] Trial 34 finished with value: 0.8289755083440106 and parameters: {'C': 0.39238629786170415, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:26:51,331] Trial 35 finished with value: 0.8231999763258968 and parameters: {'C': 1.6893806027344112, 'kernel': 'poly', 'gamma': 0.001}
[I 2025-06-30 15:27:05,566] Trial 36 finished with value: 0.8278260477098428 and parameters: {'C': 0.44780391267347713, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:27:36,751] Trial 37 finished with value: 0.8234729138236588 and parameters: {'C': 1.1077990501142667, 'kernel': 'sigmoid', 'gamma': 0.001}
[I 2025-06-30 15:28:15,557] Trial 38 finished with value: 0.8176181056693267 and parameters: {'C': 0.0359837003811888, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:30:19,447] Trial 39 finished with value: 0.6217097311882296 and parameters: {'C': 0.015350221822493496, 'kernel': 'sigmoid', 'gamma': 0.001}
[I 2025-06-30 15:30:31,434] Trial 40 finished with value: 0.8223753573070853 and parameters: {'C': 0.5652217654200395, 'kernel': 'poly', 'gamma': 0.001}
[I 2025-06-30 15:30:51,667] Trial 41 finished with value: 0.83008086857331 and parameters: {'C': 0.17190959213989995, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:31:09,675] Trial 42 finished with value: 0.83008175750121 and parameters: {'C': 0.28670855346744045, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:31:22,152] Trial 43 finished with value: 0.823869171388235 and parameters: {'C': 0.8956353377454194, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:31:38,535] Trial 44 finished with value: 0.8286319064084898 and parameters: {'C': 0.4382763978240323, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:31:56,810] Trial 45 finished with value: 0.8301509312111707 and parameters: {'C': 0.27636499696298694, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:32:46,966] Trial 46 finished with value: 0.8277152809020661 and parameters: {'C': 0.24094195891266176, 'kernel': 'sigmc', 'gamma': 0.001}
[I 2025-06-30 15:32:52,550] Trial 47 finished with value: 0.82429466707576 and parameters: {'C': 4.469125372345562, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:33:17,618] Trial 48 finished with value: 0.8243784465248526 and parameters: {'C': 0.16964138124260755, 'kernel': 'rbf', 'gamma': 0.001}
[I 2025-06-30 15:34:13,950] Trial 49 finished with value: 0.8283687398906157 and parameters: {'C': 0.2696452990661463, 'kernel': 'sigmoid', 'gamma': 0.001}
```

Best params for SVM: {'C': 0.023233503515390115, 'kernel': 'sigmoid', 'gamma': 0.032927591344236166}

Re-optimizing LogisticRegression...

Re-optimizing KNN...

Re-optimizing GaussianNB...

=====

EVALUATION WITH SELECTED FEATURES

=====

=====

XGBoost (Selected Features)

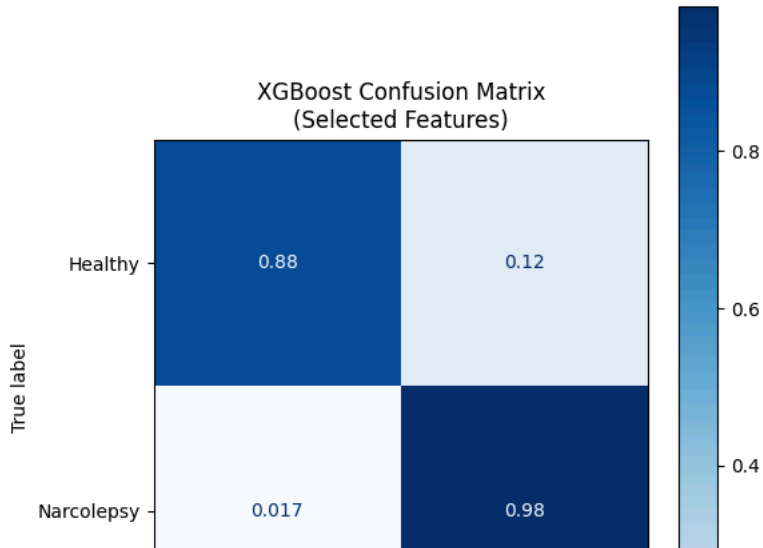
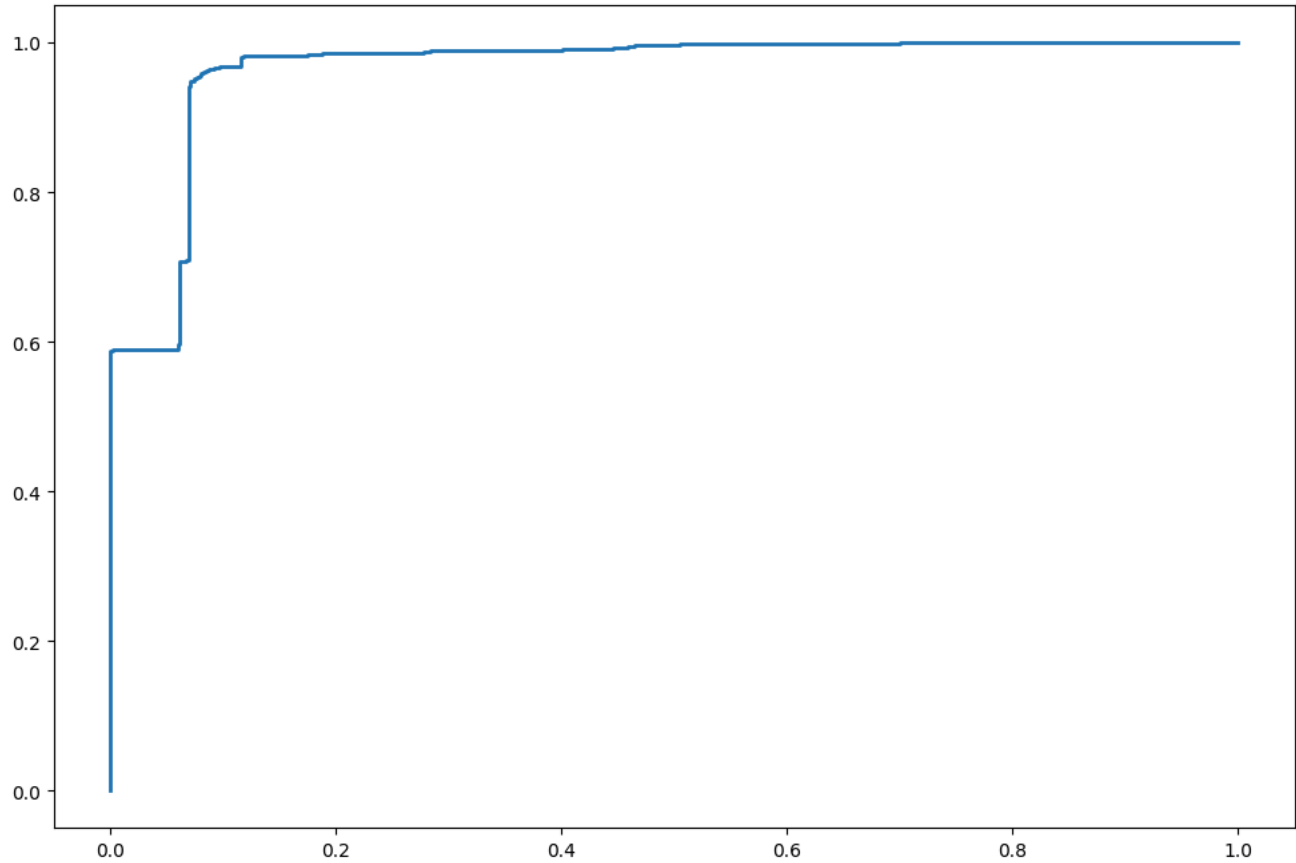
=====

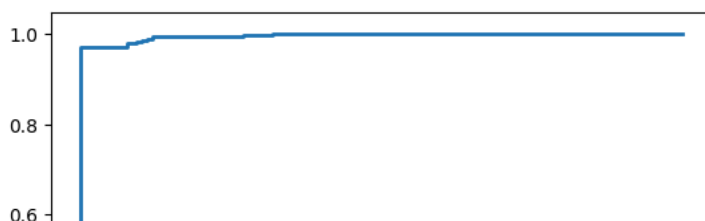
Train classification report:

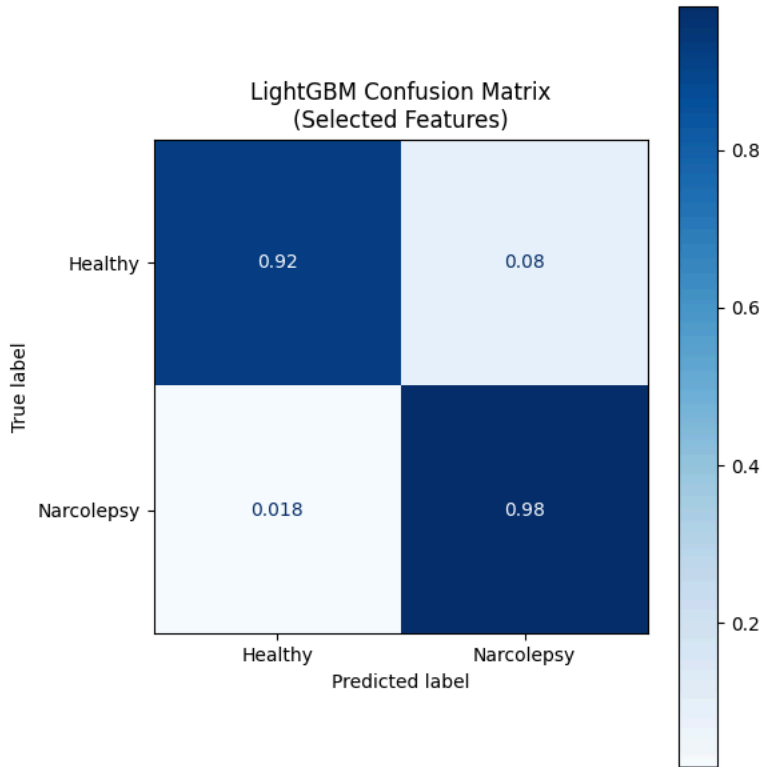
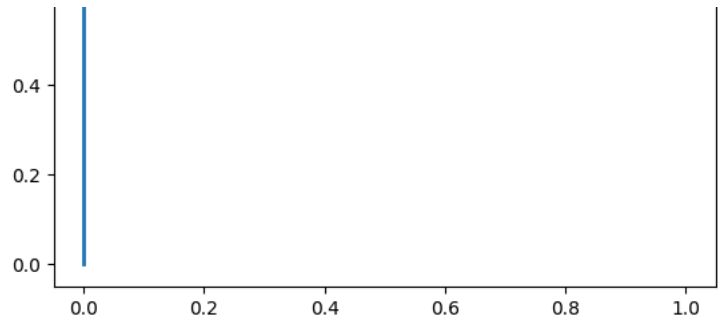
	precision	recall	f1-score	support
0	0.9994	1.0000	0.9997	4785
1	1.0000	0.9994	0.9997	4785
accuracy			0.9997	9570
macro avg	0.9997	0.9997	0.9997	9570
weighted avg	0.9997	0.9997	0.9997	9570

Test classification report:

	precision	recall	f1-score	support
0	0.9783	0.8764	0.9246	979
1	0.9032	0.9834	0.9416	1148
accuracy			0.9342	2127
macro avg	0.9408	0.9299	0.9331	2127
weighted avg	0.9378	0.9342	0.9338	2127







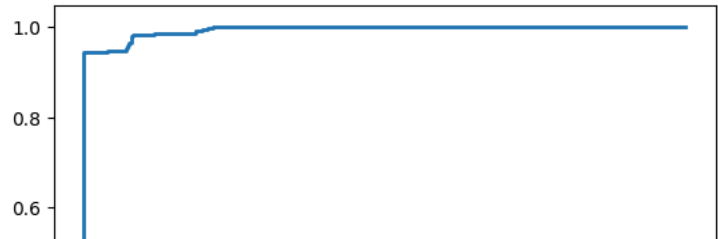
=====
RandomForest (Selected Features)
=====

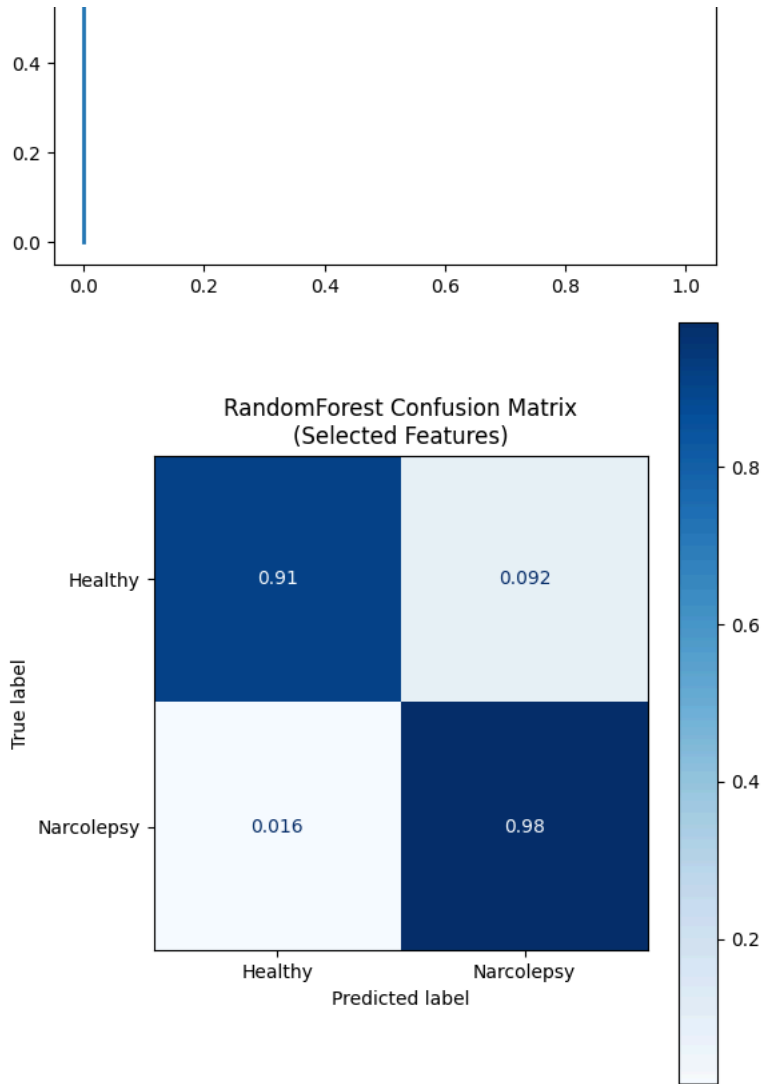
Train classification report:

	precision	recall	f1-score	support
0	0.9981	0.9996	0.9989	4785
1	0.9996	0.9981	0.9988	4785
accuracy			0.9989	9570
macro avg	0.9989	0.9989	0.9989	9570
weighted avg	0.9989	0.9989	0.9989	9570

Test classification report:

	precision	recall	f1-score	support
0	0.9802	0.9081	0.9427	979
1	0.9262	0.9843	0.9544	1148
accuracy			0.9492	2127
macro avg	0.9532	0.9462	0.9486	2127
weighted avg	0.9510	0.9492	0.9490	2127





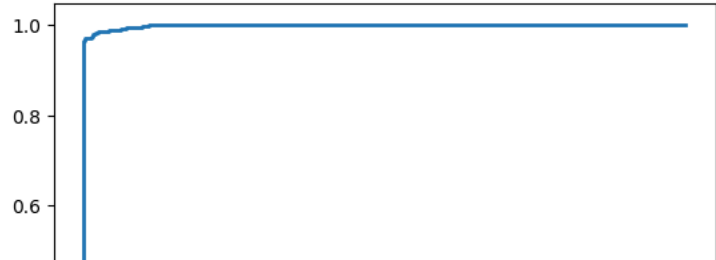
=====
AdaBoost (Selected Features)
=====

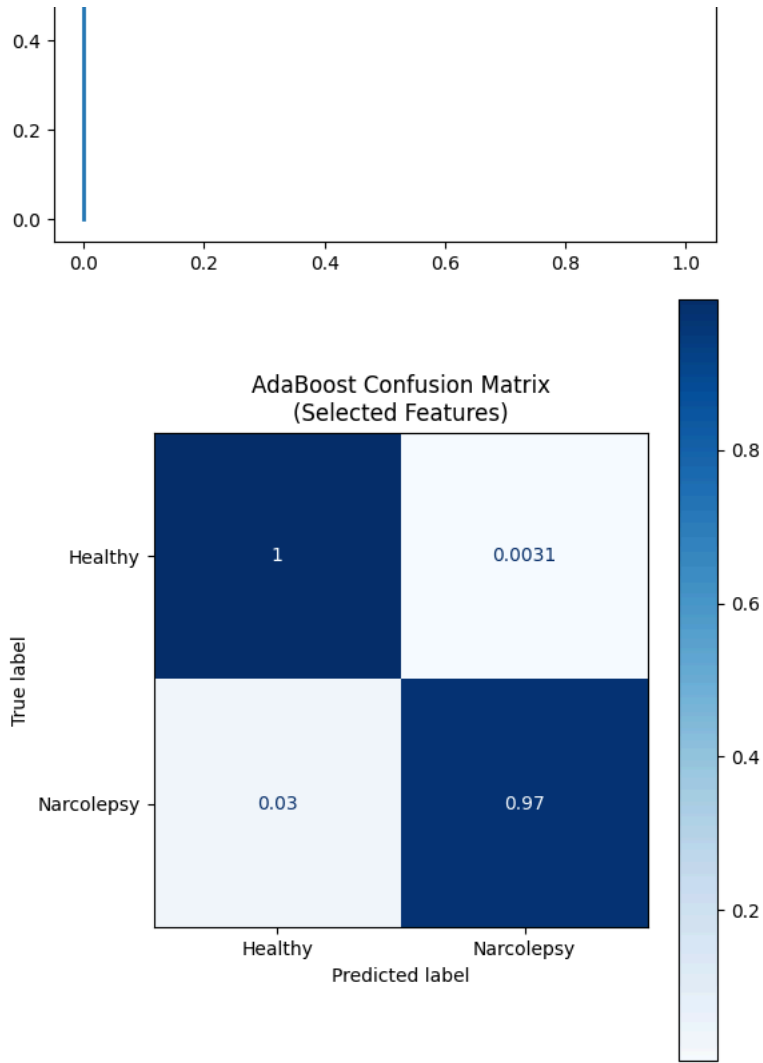
Train classification report:

	precision	recall	f1-score	support
0	0.9994	0.9996	0.9995	4785
1	0.9996	0.9994	0.9995	4785
accuracy			0.9995	9570
macro avg	0.9995	0.9995	0.9995	9570
weighted avg	0.9995	0.9995	0.9995	9570

Test classification report:

	precision	recall	f1-score	support
0	0.9663	0.9969	0.9814	979
1	0.9973	0.9704	0.9837	1148
accuracy			0.9826	2127
macro avg	0.9818	0.9837	0.9825	2127
weighted avg	0.9831	0.9826	0.9826	2127





=====
GradientBoosting (Selected Features)
=====

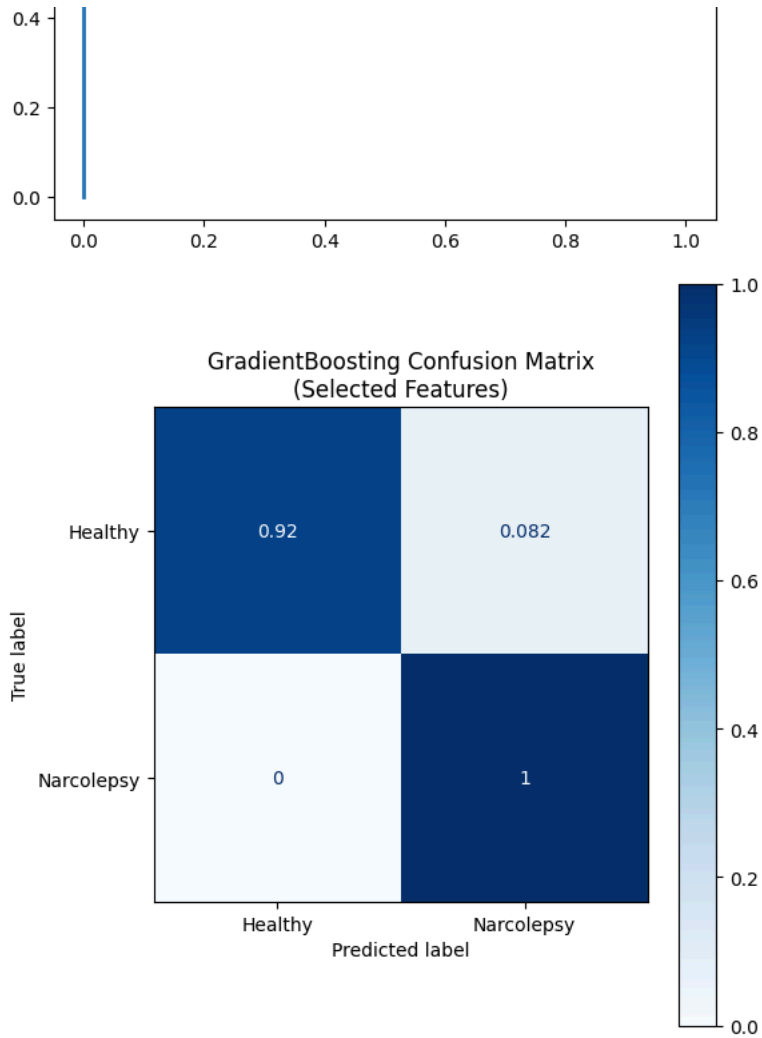
Train classification report:

	precision	recall	f1-score	support
0	1.0000	1.0000	1.0000	4785
1	1.0000	1.0000	1.0000	4785
accuracy			1.0000	9570
macro avg	1.0000	1.0000	1.0000	9570
weighted avg	1.0000	1.0000	1.0000	9570

Test classification report:

	precision	recall	f1-score	support
0	1.0000	0.9183	0.9574	979
1	0.9349	1.0000	0.9663	1148
accuracy			0.9624	2127
macro avg	0.9674	0.9591	0.9619	2127
weighted avg	0.9648	0.9624	0.9622	2127





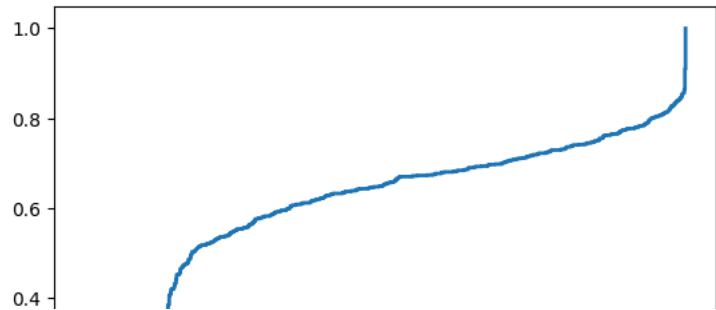
=====
SVM (Selected Features)
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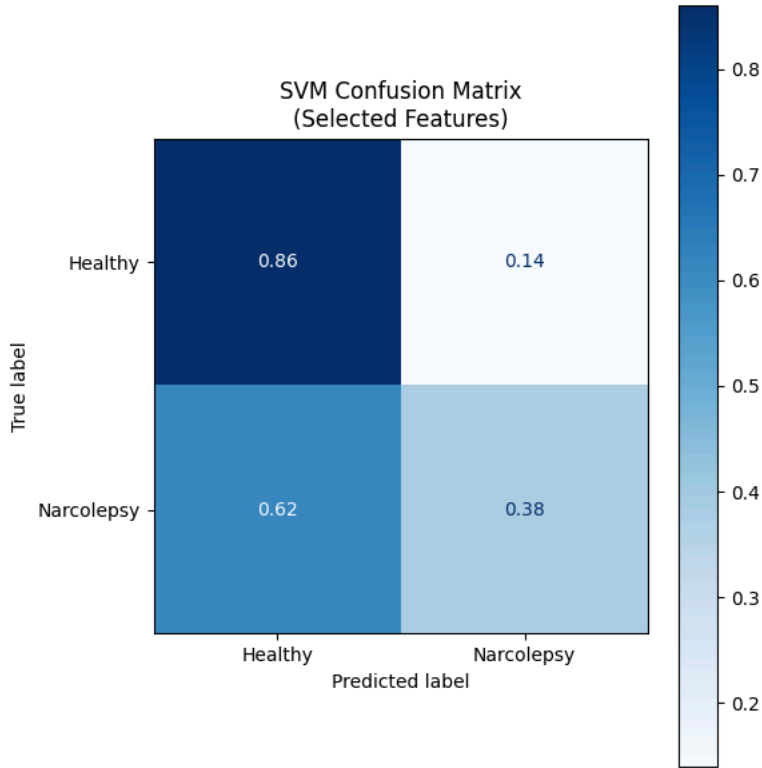
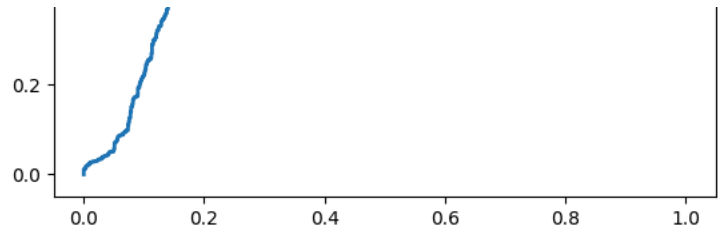
Train classification report:

	precision	recall	f1-score	support
0	0.7939	0.9638	0.8707	4785
1	0.9540	0.7498	0.8397	4785
accuracy			0.8568	9570
macro avg	0.8740	0.8568	0.8552	9570
weighted avg	0.8740	0.8568	0.8552	9570

Test classification report:

	precision	recall	f1-score	support
0	0.5418	0.8601	0.6648	979
1	0.7609	0.3798	0.5067	1148
accuracy			0.6008	2127
macro avg	0.6514	0.6199	0.5858	2127
weighted avg	0.6601	0.6008	0.5795	2127





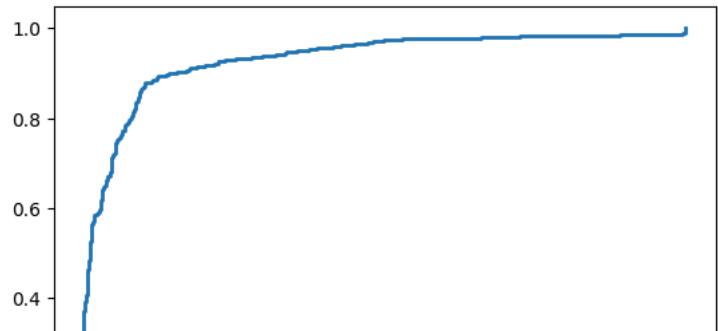
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LogisticRegression (Selected Features)
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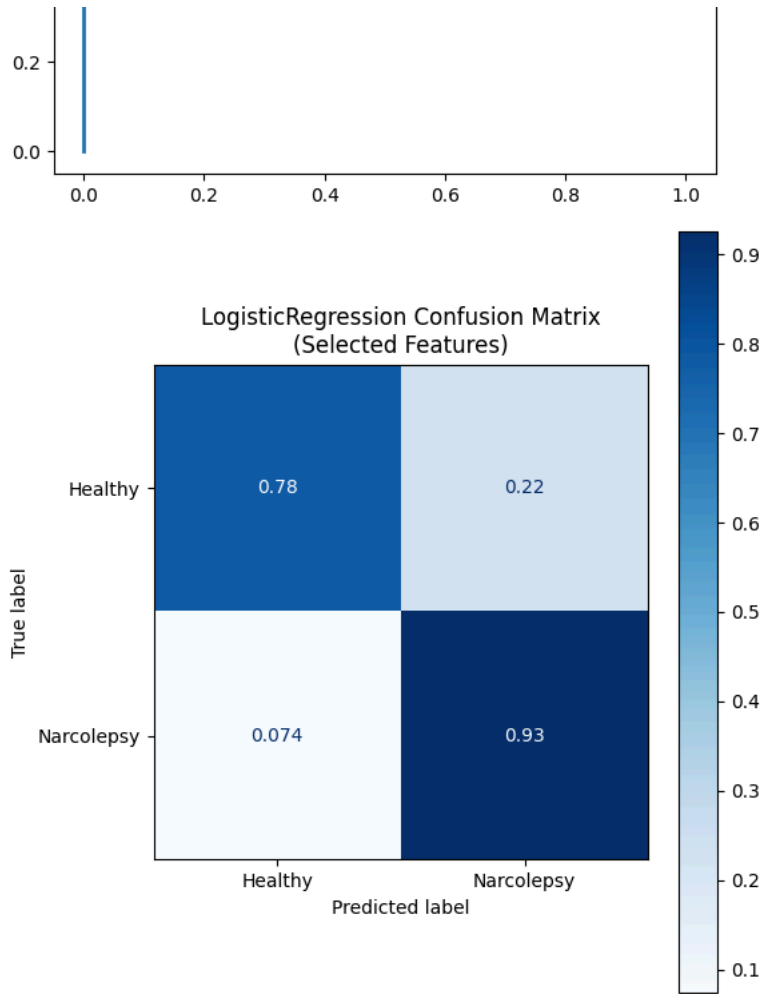
Train classification report:

	precision	recall	f1-score	support
0	0.9950	0.9964	0.9957	4785
1	0.9964	0.9950	0.9957	4785
accuracy			0.9957	9570
macro avg	0.9957	0.9957	0.9957	9570
weighted avg	0.9957	0.9957	0.9957	9570

Test classification report:

	precision	recall	f1-score	support
0	0.8994	0.7763	0.8333	979
1	0.8292	0.9260	0.8749	1148
accuracy			0.8571	2127
macro avg	0.8643	0.8511	0.8541	2127
weighted avg	0.8615	0.8571	0.8558	2127





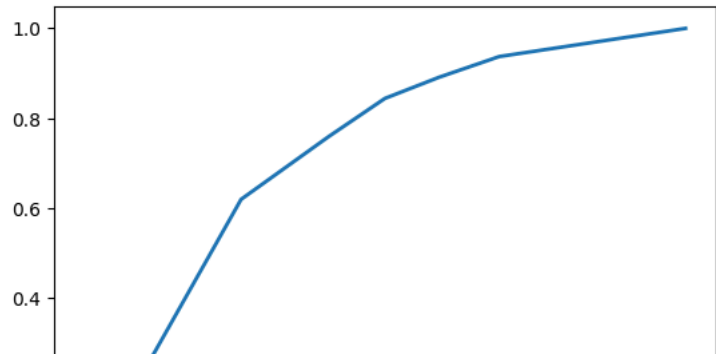
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KNN (Selected Features)
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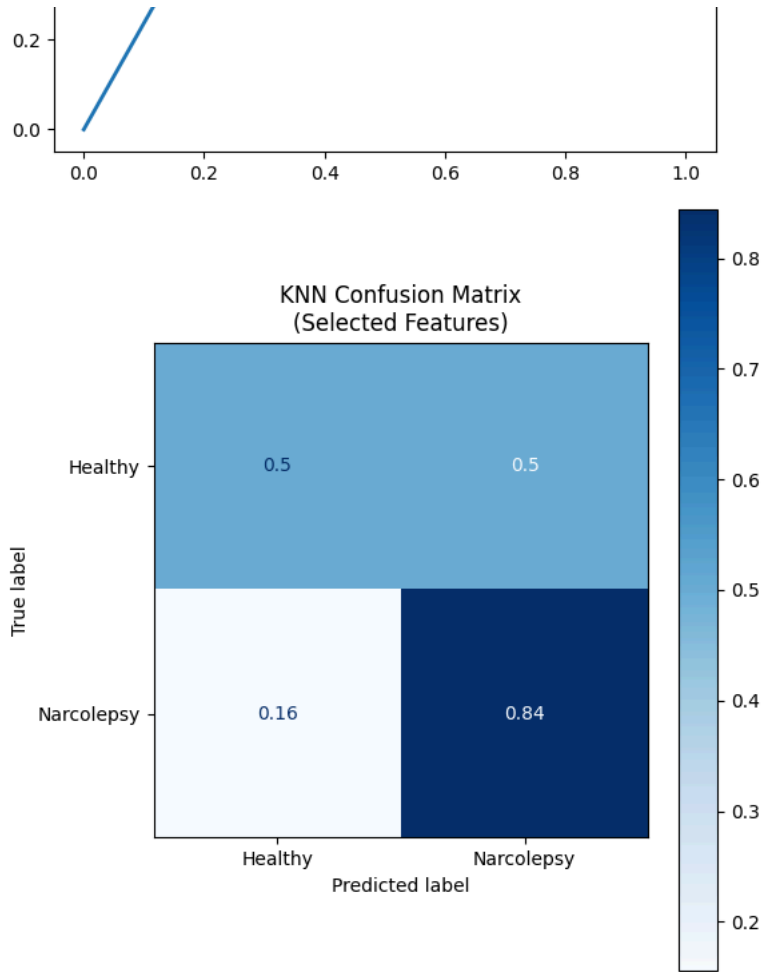
Train classification report:

	precision	recall	f1-score	support
0	0.9979	0.9937	0.9958	4785
1	0.9938	0.9979	0.9958	4785
accuracy			0.9958	9570
macro avg	0.9958	0.9958	0.9958	9570
weighted avg	0.9958	0.9958	0.9958	9570

Test classification report:

	precision	recall	f1-score	support
0	0.7320	0.4995	0.5938	979
1	0.6642	0.8441	0.7434	1148
accuracy			0.6855	2127
macro avg	0.6981	0.6718	0.6686	2127
weighted avg	0.6954	0.6855	0.6745	2127





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GaussianNB (Selected Features)
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Train classification report:

	precision	recall	f1-score	support
0	0.8867	0.9156	0.9009	4785
1	0.9127	0.8830	0.8976	4785
accuracy			0.8993	9570
macro avg	0.8997	0.8993	0.8992	9570
weighted avg	0.8997	0.8993	0.8992	9570

Test classification report:

	precision	recall	f1-score	support
0	0.9672	0.6027	0.7426	979
1	0.7436	0.9826	0.8465	1148
accuracy			0.8077	2127
macro avg	0.8554	0.7926	0.7946	2127
weighted avg	0.8465	0.8077	0.7987	2127

