Adaptive MNN graph built using local scaling (k\_selector=5).

Found 50 isolated samples (with 0 MNNs).

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Starting comprehensive sample analysis...

Sample Analysis Complete:

-> Identified 79 'SAFE' samples.

-> Identified 40 'BOUNDARY' samples.

-> Identified 17 'OUTLIER' samples.

-> Identified 50 'ISOLATED' samples.

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Calculating density factor (rho) for dynamic parameter tuning...

Density factor calculation complete.

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Applied DYNAMIC weight suppression to 67 outlier/isolated samples based on their density.

Assigned DYNAMIC flipping gain (range [0.7, 0.9]) to 24 majority boundary samples.

Assigned DYNAMIC flipping gain (range [0.05, 0.15]) to 77 majority safe samples.

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--- Starting AdaBoost Training with Dynamic Parameters (V3.1) ---

Iteration 1/50: G-Mean=0.396, Flipped=0 samples

-> Generating visualization for iteration 1...

Iteration 2/50: G-Mean=0.396, Flipped=7 samples

Iteration 3/50: G-Mean=0.754, Flipped=15 samples

Iteration 4/50: G-Mean=0.707, Flipped=17 samples

Iteration 5/50: G-Mean=0.776, Flipped=16 samples

Iteration 6/50: G-Mean=0.729, Flipped=15 samples

Iteration 7/50: G-Mean=0.748, Flipped=15 samples

Iteration 8/50: G-Mean=0.694, Flipped=14 samples

Iteration 9/50: G-Mean=0.790, Flipped=15 samples

Iteration 10/50: G-Mean=0.705, Flipped=14 samples

-> Generating visualization for iteration 10...

Iteration 11/50: G-Mean=0.800, Flipped=11 samples

Iteration 12/50: G-Mean=0.733, Flipped=11 samples

Iteration 13/50: G-Mean=0.787, Flipped=17 samples

Iteration 14/50: G-Mean=0.810, Flipped=14 samples

Iteration 15/50: G-Mean=0.793, Flipped=12 samples

Iteration 16/50: G-Mean=0.793, Flipped=13 samples

Iteration 17/50: G-Mean=0.754, Flipped=18 samples

Iteration 18/50: G-Mean=0.765, Flipped=10 samples

Iteration 19/50: G-Mean=0.813, Flipped=13 samples

Iteration 20/50: G-Mean=0.810, Flipped=11 samples

-> Generating visualization for iteration 20...

Iteration 21/50: G-Mean=0.813, Flipped=12 samples

Iteration 22/50: G-Mean=0.813, Flipped=13 samples

Iteration 23/50: G-Mean=0.813, Flipped=14 samples

Iteration 24/50: G-Mean=0.790, Flipped=14 samples

Iteration 25/50: G-Mean=0.770, Flipped=11 samples

Iteration 26/50: G-Mean=0.773, Flipped=13 samples

Iteration 27/50: G-Mean=0.806, Flipped=11 samples

Iteration 28/50: G-Mean=0.800, Flipped=15 samples

Iteration 29/50: G-Mean=0.803, Flipped=13 samples

Iteration 30/50: G-Mean=0.810, Flipped=14 samples

-> Generating visualization for iteration 30...

Iteration 31/50: G-Mean=0.783, Flipped=17 samples

Iteration 32/50: G-Mean=0.803, Flipped=14 samples

Iteration 33/50: G-Mean=0.813, Flipped=13 samples

Iteration 34/50: G-Mean=0.816, Flipped=14 samples

Iteration 35/50: G-Mean=0.797, Flipped=12 samples

Iteration 36/50: G-Mean=0.819, Flipped=13 samples

Iteration 37/50: G-Mean=0.816, Flipped=15 samples

Iteration 38/50: G-Mean=0.812, Flipped=15 samples

Iteration 39/50: G-Mean=0.816, Flipped=12 samples

Iteration 40/50: G-Mean=0.816, Flipped=14 samples

-> Generating visualization for iteration 40...

Iteration 41/50: G-Mean=0.793, Flipped=16 samples

Iteration 42/50: G-Mean=0.812, Flipped=12 samples

Iteration 43/50: G-Mean=0.790, Flipped=14 samples

Iteration 44/50: G-Mean=0.809, Flipped=13 samples

Iteration 45/50: G-Mean=0.812, Flipped=14 samples

Iteration 46/50: G-Mean=0.821, Flipped=13 samples

Iteration 47/50: G-Mean=0.829, Flipped=15 samples

Iteration 48/50: G-Mean=0.829, Flipped=15 samples

Iteration 49/50: G-Mean=0.812, Flipped=12 samples

Iteration 50/50: G-Mean=0.832, Flipped=12 samples

-> Generating visualization for iteration 50...

--- Performance Metrics on Test Set ---

Accuracy: 0.840

Precision: 0.871

Recall: 0.840

F1-Score: 0.849

G-Mean: 0.834

AUC: 0.897