TABLE 7. Performance Comparison (Execution Time, Memory Usage and CPU Usage) of Imbalanced vs. Balanced Sampling Methods. The base performance for each model is reported on imbalanced data (IB), with the values in square brackets indicating the difference when applying balanced-oversampling (BDO), balanced-undersampling (BDU), and balanced-hybridsampling (BDH).

Method	Execution Time (s) IB [BDO, BDU, BDH]	Memory Usage (GB) IB [BDO, BDU, BDH]	CPU Usage (%) IB [BDO, BDU, BDH]
Without hyper-parameter Tuning (WHT)			
Autoencoder	32866 [-2959, -3271, -2316]	15.62 [+0.47, -7.36, -0.19]	20.07 [+3.09, **-14.01**, +15.53]
Decision Trees	3105 [-996, **-2594**, +821]	7.97 [-3.48, -3.54, -3.50]	14.38 [+1.12, -7.95, +8.63]
Gaussian Naive Bayes	2725 [-1414, -1953, -624]	1.15 [**-0.05**, 0.00, **-0.05**]	9.44 [-2.04, -2.34, -1.44]
Isolation Forest	1982 [+118, -1102, +2040]	2.60 [-0.35, -1.10, -0.56]	7.22 [+1.78, -0.42, -0.21]
KNN	4550 [-1095, -3330, -2650]	9.40 [-2.60, -4.25, -2.80]	11.10 [+0.10, -2.70, -2.00]
LightGBM	6123 [-1633, -4473, -2973]	3.50 [-0.30, +0.30, +0.30]	12.50 [+0.90, -2.30, +1.70]
Random Forest	7100 [-980, -2661, -1980]	4.31 [-0.06, -0.11, -0.01]	18.80 [-1.80, -5.70, -2.10]
Robust Covariance	1432 [+548, -292, +8]	1.94 [-0.22, -0.29, +0.05]	6.55 [+0.70, -0.44, +0.95]
XGBoost	5450 [-2262, -3063, -2120]	2.90 [-0.25, +1.32, -0.40]	23.20 [-3.30, -3.49, -2.50]
ADMXGB	755 [-223, **-632**, +3016]	3.34 [-0.54, **-1.03**, -0.30]	60.20 [+18.30, **-41.90**, +0.60]
With hyper-parameter Tuning (HT) - Grid Search			
Autoencoder	49705 [+4004, -4675, +6341]	13.39 [+8.90, -3.36, +9.24]	9.62 [+3.45, +0.05, +1.46]
Decision Trees	22133 [+31958, -16923, +7634984]	9.02 [+0.30, -4.29, -3.25]	6.14 [+1.87, +1.74, +0.97]
Gaussian Naive Bayes	3341 [-786, **-2161**, -740]	1.20 [**-0.05**, -0.04, -0.02]	8.35 [-0.80, -1.15, -0.80]
Isolation Forest	3120 [+101, -1730, +1440]	2.70 [-0.20, -0.90, -0.40]	7.60 [+1.90, -0.80, +0.20]
KNN	4160 [+418, -2650, -1290]	6.20 [+0.90, -0.70, +0.90]	8.10 [+2.10, +0.60, +1.40]
LightGBM	7542 [-652, -5431, -3543]	3.85 [-0.15, +0.15, +0.25]	14.45 [+0.15, -3.65, +0.05]
Random Forest	9100 [-1980, -5078, -3485]	4.80 [-0.30, -0.65, -0.42]	17.30 [-0.50, -4.80, -1.20]
Robust Covariance	2288 [-44, -1044, -738]	2.10 [-0.32, -0.40, -0.05]	6.90 [+0.40, **-0.65**, +0.80]
XGBoost	6811 [-3421, -3961, -3291]	2.70 [+0.02, +0.40, 0.00]	98.70 [-0.05, -0.15, +0.85]
ADMXGB	4578 [+271, **-1088**, +243]	2.55 [+0.93, **-1.48**, +0.94]	**71.30** [+24.10, +20.40, +13.30]
With hyper-parameter Tuning (HT) - Random Search			
Autoencoder	33452 [-5129, -3070, +42847]	26.74 [+36.75, -12.76, +21.39]	7.34 [+6.20, -3.63, -0.29]
Decision Trees	18364 [+1394, -12286, +6328]	9.02 [+2.90, -6.42, -2.36]	4.69 [+3.61, **-1.67**, -0.17]
Gaussian Naive Bayes	4781 [-2580, **-3621**, -2091]	1.25 [0.00, **-0.12**, -0.05]	7.90 [0.00, -0.90, -0.30]
Isolation Forest	4012 [-1022, -2432, +865]	2.80 [-0.25, -0.95, -0.40]	7.22 [+1.88, -0.62, +0.68]
KNN	2988 [+2034, -1198, +122]	6.40 [+0.80, -0.68, +0.80]	7.80 [+3.00, +1.10, +2.00]
LightGBM	6225 [-437, -3980, -2105]	3.60 [0.00, +0.50, +0.65]	12.00 [+1.90, -1.10, +2.80]
Random Forest	8144 [-1169, -3989, -2254]	4.65 [-0.10, -0.45, -0.25]	16.90 [-0.50, -4.10, -0.40]
Robust Covariance	2109 [+221, -810, -499]	2.00 [-0.18, -0.27, +0.08]	6.25 [+1.30, +0.10, +1.55]
XGBoost	5493 [-2053, -2498, -1883]	2.80 [-0.05, +0.40, -0.05]	48.00 [+0.51, -0.29, +0.91]
ADMXGB	3225 [+888, **-3161**, +5425]	2.41 [+3.45, **-1.35**, +1.63]	48.10 [+38.00, **-35.50**, +2.30]
With hyper-parameter Tuning (HT) - HyperOPT			
Autoencoder	15551 [+4336, -12321, +33004]	15.30 [+23.40, -3.80, +23.10]	6.80 [+5.30, -2.70, +0.00]
Decision Trees	17549 [+5231, -12269, +5537]	9.00 [+3.15, -6.30, -2.05]	4.55 [+4.65, **-1.30**, +0.65]
Gaussian Naive Bayes	5200 [-2745, **-4102**, -2405]	1.30 [+0.00, **-0.16**, -0.05]	7.33 [+0.47, -0.23, +0.37]
Isolation Forest	2881 [+630, -1260, +2241]	2.90 [-0.30, -1.06, -0.40]	7.10 [+2.40, -0.20, +1.00]
KNN	3555 [+2456, -1715, -145]	6.10 [+1.40, -0.32, +1.20]	8.40 [+2.80, +0.40, +1.50]
LightGBM	4922 [+1433, -2272, -392]	3.55 [+0.15, +0.60, +0.83]	11.45 [+2.75, -0.55, +3.75]
Random Forest	6741 [+1147, -2761, -719]	4.62 [+0.08, -0.37, -0.12]	16.50 [+0.75, -4.00, +0.30]
Robust Covariance	1399 [+1051, -44, +326]	2.05 [-0.17, -0.28, +0.05]	6.20 [+1.45, +0.30, +1.65]
XGBoost	4288 [-698, -1408, -538]	2.10 [+0.75, +1.05, +0.70]	63.10 [-0.08, -0.78, +0.07]
ADMXGB	1484 [+399, **-1387**, +414]	11.56 [-5.88, **-10.49**, -4.32]	65.40 [+20.70, **-23.00**, +13.00]