

# HiGEC: Enhanced Hierarchical Classification with Optimized Exploitation for Improved Multi-Class Performance

This supplementary document contains additional figures that complement the main text of the paper titled: “*HiGEC: Improving Multi-Class Classification with Automated Hierarchy Generation and Extended Exploitation Schemes*”.

Each figure is labeled and referenced in the main text where appropriate.

## 1. EXTRA FIGURES AND TABLES

GNB, FC mean F1 score (in %): 44.99									
	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	
	41.70	44.66	41.77	44.18	43.12	43.03	44.02	42.85	43.76
CCM-HAC	41.20	44.43	40.50	44.29	41.74	41.73	44.10	41.92	42.77
CCM-HDC	41.46	44.57	41.42	43.75	42.75	42.43	44.01	43.21	43.74
JSD-HAC	40.79	44.45	39.00	42.63	38.73	38.88	43.08	39.82	42.35
JSD-HDC	41.00	44.60	39.75	43.68	41.13	41.05	43.49	41.72	42.38
CMD-HAC	41.43	44.58	40.25	42.96	40.65	40.67	43.64	40.70	42.61
CMD-HDC	41.16	45.01	41.48	44.59	43.41	43.32	44.28	43.37	43.95
TSD-HAC	41.15	44.33	39.89	43.13	40.57	40.63	43.45	40.77	41.88
TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+F	LCPN+F	LCL+	LCL+F

GNB, FC mean ACC score (in %): 63.84									
	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	
	59.57	63.04	61.69	63.30	62.75	62.75	63.27	62.21	62.40
CCM-HAC	59.62	63.09	61.23	64.05	62.26	62.33	63.59	61.62	62.38
CCM-HDC	60.19	63.40	62.33	63.60	62.74	62.64	63.27	62.58	62.81
JSD-HAC	59.20	63.29	60.17	62.56	59.70	59.72	63.16	59.91	61.70
JSD-HDC	59.50	63.27	60.72	62.96	61.10	61.16	62.54	61.71	62.04
CMD-HAC	59.65	63.12	62.20	62.66	62.07	62.11	62.86	61.85	62.41
CMD-HDC	59.84	63.70	62.21	64.10	63.28	63.28	63.60	62.69	62.89
TSD-HAC	59.53	62.89	60.98	63.44	61.28	61.30	62.77	60.93	61.52
TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+F	LCL+	LCL+F	

GNB, FC mean AUC score (in %): 81.96									
	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	
	79.98	80.93	80.84	81.18	70.12	80.57	79.52	80.58	80.86
CCM-HAC	79.95	80.91	80.51	80.74	69.97	80.82	79.56	80.66	80.93
CCM-HDC	80.29	81.21	80.71	80.70	69.97	81.11	80.25	81.29	81.02
JSD-HAC	80.18	81.12	80.10	80.09	68.27	80.43	79.58	80.69	81.33
JSD-HDC	80.72	81.51	81.28	81.75	69.24	80.56	80.83	81.23	81.43
CMD-HAC	80.09	81.11	80.47	80.49	69.38	81.05	80.02	81.32	81.28
CMD-HDC	80.23	81.06	80.12	80.33	70.65	81.13	79.75	81.13	80.95
TSD-HAC	79.84	80.78	79.84	79.82	69.23	80.46	79.11	80.49	80.80
TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+F	LCL+	LCL+F	

GNB, FC total runtime [sec] per dataset: 0.03									
	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	
	0.21	0.24	0.32	0.35	0.51	0.13	0.16	0.13	0.16
CCM-HAC	0.19	0.22	0.32	0.35	0.43	0.14	0.16	0.13	0.16
CCM-HDC	0.48	0.51	0.59	0.62	0.77	0.40	0.43	0.40	0.43
JSD-HAC	0.68	0.71	0.59	0.62	0.82	0.42	0.45	0.42	0.45
JSD-HDC	0.28	0.30	0.37	0.40	0.49	0.19	0.22	0.19	0.21
CMD-HAC	0.26	0.29	0.37	0.40	0.51	0.20	0.23	0.19	0.22
CMD-HDC	13.49	13.51	13.61	13.64	13.80	13.44	13.47	13.43	13.45
TSD-HAC	13.43	13.46	13.56	13.59	13.67	13.38	13.41	13.37	13.40
TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+F	LCL+	LCL+F	

**Fig. S1.** Mean F1, ACC, AUC, and runtime durations (HG, training, and inference) across the development set comparison of all HG and HE methods for GNB.

**Table S1.** Key abbreviations used

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<i>Abbreviations</i>	
ML	Machine Learning
FC	Flat Classification
OVA	One vs All
AVA	All vs All
HC	Hierarchical Classification
HG	Hierarchy Generation
HE	Hierarchy Exploitation
HiGEC	Hierarchy Generation and Extended Classification
CCM	Class Conditional Means
JSD	Jensen-Shannon Divergence
TSD	Task Similarity Distance
CMD	Confusion Matrix-based Distance
HAC	Hierarchical Agglomerative Clustering
HDC	Hierarchical Divisive Clustering
GC	Global Classification
LCN	Local Classifier per Node
LCPN	Local Classifier per Parent Node
LCL	Local Classifier per Level
LCN+	LCN with extended prediction phase
LCN+F	LCN extended with FC
LCPN+	LCPN with extended prediction phase
LCPN+F	LCPN extended with FC
LCL+	LCL with extended prediction phase
LCL+F	LCL extended with FC
MCCV	Monte Carlo Cross Validation
F1	F1 score
ACC	Accuracy
AUC	Area Under the receiver operating characteristic Curve
CDD	Critical Difference Diagram
MCM	Multiple Comparison Matrix
XGB	eXtreme Gradient Boosting
LGB	Light Gradient Boosting machine
CATB	CATBoost
RF	Random Forests
ETC	Extremely randomized Tree Classifier
CART	Classification and Regression Trees
LDA	Linear Discriminant Analysis
wpKNN	weighted probabilistic K-Nearest Neighbor
GNB	Gaussian Naive Bayes
FTT	Feature Tokenizer Transformer

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XGB, FC mean F1 score (in %): 57.49															RF, FC mean F1 score (in %): 56.42																	
	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+F	LCL+	LCL+F	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+F	LCL+	LCL+F
CCM-HAC	55.34	57.96	58.64	57.65	56.18	56.85	58.40	57.78	58.22							55.38	56.54	56.46	55.86	54.64	56.58	57.55	56.20	56.62								
CCM-HDC	56.09	57.91	57.72	57.44	55.90	56.07	58.03	57.45	57.85							54.85	56.10	55.22	55.17	54.44	55.54	56.20	55.50	55.12								
JSD-HAC	55.13	57.55	57.28	56.87	55.30	55.58	57.45	56.98	57.44							54.52	55.78	54.85	54.67	54.48	55.97	56.03	55.37	55.03								
JSD-HDC	55.33	57.61	57.09	56.59	55.04	55.27	57.99	56.90	57.93							54.60	55.66	55.10	54.32	54.34	55.65	55.71	55.59	55.27								
CMD-HAC	55.79	57.96	57.90	57.04	55.42	55.63	57.67	57.27	57.86							54.41	55.87	55.13	54.58	54.50	55.95	56.40	55.50	55.76								
CMD-HDC	54.55	57.60	56.84	56.78	55.41	55.60	57.58	56.53	57.49							54.42	55.73	54.70	54.21	53.82	55.87	56.18	55.62	55.29								
TSD-HAC	56.30	58.10	58.09	57.72	55.84	56.29	58.13	57.90	58.20							54.65	56.32	55.41	55.08	55.24	56.19	56.20	55.64	55.28								
TSD-HDC	55.58	57.93	57.36	57.28	55.59	55.86	57.99	57.27	57.96							55.10	56.45	55.17	55.55	54.22	55.68	56.61	54.95	55.48								
ETC, FC mean F1 score (in %): 56.21															LGB, FC mean F1 score (in %): 54.13																	
CCM-HAC	55.43	56.44	56.04	55.32	54.64	56.17	57.11	55.39	56.12						CCM-HAC	46.54	52.02	56.10	53.97	51.93	52.03	54.33	53.65	54.31								
CCM-HDC	54.16	55.70	54.86	54.90	54.75	55.79	56.03	55.11	54.94						CCM-HDC	47.90	52.82	55.90	54.68	50.00	50.14	54.59	52.59	54.61								
JSD-HAC	53.40	55.36	54.49	54.21	54.52	56.08	55.68	55.19	54.58						JSD-HAC	45.77	52.50	54.96	54.23	48.86	49.37	54.00	52.08	53.95								
JSD-HDC	54.05	55.20	54.92	54.19	54.29	55.65	55.70	55.40	55.35						JSD-HDC	46.37	52.17	55.26	54.10	48.11	48.40	54.27	52.30	54.25								
CMD-HAC	53.67	55.69	55.10	55.00	54.41	55.75	56.27	55.35	55.61						CMD-HAC	46.67	52.53	55.54	54.33	48.76	48.70	54.34	52.61	54.22								
CMD-HDC	53.84	55.54	54.56	54.18	53.95	55.88	55.89	55.37	55.15						CMD-HDC	45.54	52.33	55.34	54.33	50.09	50.32	54.31	51.83	54.12								
TSD-HAC	53.87	55.34	54.81	54.83	55.17	55.95	55.70	55.15	54.77						TSD-HAC	48.61	52.59	55.91	54.25	49.17	49.44	54.41	54.10	54.45								
TSD-HDC	54.71	56.09	54.92	55.17	54.47	56.19	56.51	55.31	55.44						TSD-HDC	48.09	52.81	55.34	54.25	49.94	50.21	54.37	53.23	54.25								
CATB, FC mean F1 score (in %): 55.70															LDA, FC mean F1 score (in %): 47.22																	
CCM-HAC	48.26	55.57	54.91	54.13	53.63	54.74	55.76	52.54	54.17						CCM-HAC	46.69	47.58	44.35	45.85	45.88	46.22	47.23	46.68	46.77								
CCM-HDC	51.11	55.68	55.57	54.76	55.20	55.31	55.86	55.09	55.18						CCM-HDC	47.06	46.99	43.86	45.77	44.69	45.30	47.28	46.08	46.78								
JSD-HAC	53.33	55.43	55.40	54.57	54.55	55.23	55.63	55.29	55.00						JSD-HAC	45.49	46.81	42.88	45.13	43.29	43.88	46.50	44.74	45.95								
JSD-HDC	53.07	55.58	55.83	54.57	54.47	54.88	56.00	54.72	55.40						JSD-HDC	45.34	46.66	42.44	45.08	43.28	43.66	46.15	44.67	45.55								
CMD-HAC	53.22	55.63	56.41	54.91	55.68	55.87	55.71	55.71	55.62						CMD-HAC	46.52	47.22	44.01	46.02	45.12	45.25	46.92	46.17	46.59								
CMD-HDC	52.12	55.44	55.86	54.51	54.47	54.82	55.78	54.57	55.19						CMD-HDC	45.79	47.04	42.87	45.40	43.95	44.25	46.65	44.54	46.21								
TSD-HAC	53.87	55.75	56.33	55.33	55.68	56.06	56.12	55.52	55.53						TSD-HAC	46.64	47.10	44.03	45.75	44.98	45.30	47.20	46.08	46.77								
TSD-HDC	53.91	55.51	56.05	54.81	54.70	54.81	55.93	54.81	55.04						TSD-HDC	46.24	47.04	43.44	45.93	43.96	44.65	46.65	45.31	45.90								
CART, FC mean F1 score (in %): 54.04															wpKNN, FC mean F1 score (in %): 49.33																	
CCM-HAC	54.08	54.10	53.94	53.77	54.03	54.06	53.42	54.35	53.52						CCM-HAC	42.98	48.46	48.96	49.08	48.21	48.56	49.04	48.57	48.47								
CCM-HDC	53.48	53.96	53.44	53.75	52.74	52.81	52.97	53.38	53.45						CCM-HDC	44.58	48.79	49.07	49.33	48.01	48.24	49.08	48.62	48.91								
JSD-HAC	53.75	54.02	53.27	53.86	52.98	53.03	53.12	53.56	53.55						JSD-HAC	43.94	48.68	49.00	48.62	48.22	48.46	48.11	48.38	49.04								
JSD-HDC	52.60	53.85	52.17	52.67	52.43	52.37	52.88	52.93	53.24						JSD-HDC	43.91	48.48	48.91	48.40	47.83	48.10	48.31	48.37	48.70								
CMD-HAC	54.01	54.01	53.17	53.63	53.31	53.25	52.95	53.53	53.44						CMD-HAC	43.37	48.51	49.08	48.94	48.44	48.44	48.88	48.62	48.97								
CMD-HDC	53.46	53.83	53.14	53.39	53.05	53.07	53.19	53.04	53.19						CMD-HDC	42.35	48.53	49.63	49.28	48.59	48.89	49.49	48.50	48.62								
TSD-HAC	53.66	54.06	53.78	54.05	53.45	53.49	53.29	53.58	53.89						TSD-HAC	44.85	48.77	49.56	49.20	48.83	48.88	49.02	48.91	49.30								
TSD-HDC	53.97	53.83	53.24	53.38	53.08	53.12	53.03	53.18	53.19						TSD-HDC	43.76	48.79	49.52	49.30	48.42	48.76	49.26	48.90	49.00								

**Fig. S2.** Mean F1 comparison of all HG and HE methods for base classifiers.

XGB, FC mean ACC score (in %): 78.06												RF, FC mean ACC score (in %): 78.42																				
	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+F	LCL+	LCL+F	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+F	LCL+	LCL+F
CCM-HAC	75.50	78.06	78.35	77.88	77.18	77.58	78.56	78.30	78.44							76.06	77.90	77.35	77.54	76.90	78.25	78.59	77.60	77.71								
CCM-HDC	76.46	78.14	78.10	77.93	76.96	77.23	78.35	78.07	78.15							76.27	77.74	76.54	77.14	76.58	77.73	77.95	77.32	76.82								
JSD-HAC	75.71	77.92	77.76	77.68	76.56	76.86	78.18	77.71	78.06							76.01	77.46	76.60	77.10	76.85	78.10	77.91	77.39	76.90								
JSD-HDC	75.71	77.71	77.42	77.08	76.56	76.74	78.21	77.75	78.09							75.70	76.99	76.13	76.34	76.70	77.82	77.27	77.70	76.84								
CMD-HAC	76.57	78.36	78.41	77.73	76.85	77.07	78.32	77.91	78.35							76.16	77.75	76.93	76.96	76.72	77.99	78.38	77.74	77.64								
CMD-HDC	75.37	77.93	77.59	77.43	76.42	76.78	78.07	77.27	77.92							75.42	77.34	75.89	76.47	75.97	77.88	77.57	77.26	76.82								
TSD-HAC	76.84	78.33	78.40	78.13	76.97	77.48	78.58	78.38	78.50							76.34	77.94	77.28	77.37	77.08	78.20	78.26	77.69	77.32								
TSD-HDC	75.83	77.95	77.67	77.85	76.76	77.02	78.24	78.00	78.12							76.09	77.87	76.32	77.46	76.64	77.80	78.11	77.07	77.01								
ETC, FC mean ACC score (in %): 77.74												LGB, FC mean ACC score (in %): 76.59																				
CCM-HAC	75.63	77.33	76.55	76.82	76.57	77.76	77.86	76.89	76.90							67.47	73.84	78.13	75.82	76.24	76.43	76.69	76.83	76.54								
CCM-HDC	75.14	76.97	75.86	76.47	76.40	77.54	77.28	76.77	76.22							68.90	75.03	78.13	76.53	74.94	75.32	77.02	76.08	76.83								
JSD-HAC	75.12	76.77	75.93	76.28	76.38	77.79	77.16	76.87	76.18							68.16	74.64	77.52	76.89	74.54	75.64	76.67	76.04	76.41								
JSD-HDC	74.83	76.22	75.59	75.68	76.34	77.48	76.71	77.19	76.32							66.80	74.22	77.49	76.01	73.97	74.31	76.62	75.93	76.45								
CMD-HAC	75.60	77.23	76.62	76.67	76.22	77.64	77.80	77.17	77.13							68.54	74.74	78.24	76.46	74.69	74.78	76.80	76.50	76.63								
CMD-HDC	74.52	76.61	75.51	75.96	75.77	77.58	77.05	76.88	76.35							68.13	74.57	77.72	76.92	74.09	75.08	76.75	75.62	76.57								
TSD-HAC	75.74	77.02	76.42	76.76	76.73	77.73	77.52	76.97	76.56							70.27	74.85	78.13	76.32	75.59	75.96	76.88	77.45	76.82								
TSD-HDC	75.19	77.03	75.65	76.71	76.34	77.81	77.56	76.95	76.31							68.74	74.40	77.67	76.28	74.75	75.19	76.76	76.46	76.52								
CATB, FC mean ACC score (in %): 77.75												LDA, FC mean ACC score (in %): 68.52																				
CCM-HAC	73.05	77.56	77.15	76.62	76.63	77.58	77.86	75.96	76.64							67.73	68.44	66.22	67.29	67.39	67.84	68.09	68.20	67.89								
CCM-HDC	74.96	77.47	77.19	76.80	76.91	77.15	77.55	77.16	76.97							68.51	68.27	66.83	67.31	67.02	67.75	68.34	68.16	68.33								
JSD-HAC	76.14	77.59	77.15	77.06	76.84	77.28	77.82	77.38	77.25							67.44	68.17	66.07	67.44	66.20	66.96	67.99	67.55	67.76								
JSD-HDC	75.75	77.33	76.87	76.29	76.66	76.95	77.60	77.06	77.17							67.59	67.93	66.16	66.99	66.71	67.01	67.65	67.45	67.45								
CMD-HAC	76.32	77.70	77.89	77.15	77.23	77.23	77.50	77.74	77.55							67.99	68.36	66.41	67.56	67.09	67.62	68.21	67.93	67.93								
CMD-HDC	75.11	77.31	77.23	76.49	76.42	76.78	77.47	76.65	76.98							67.18	68.31	65.94	66.90	66.29	66.84	68.13	66.98	67.87								
TSD-HAC	76.84	77.77	77.89	77.45	77.51	77.78	77.98	77.59	77.49							68.58	68.44	66.80	67.43	67.80	68.41	68.48	68.44	68.18								
TSD-HDC	76.61	77.42	77.45	77.08	76.79	76.96	77.76	77.11	76.98							67.99	68.29	66.72	67.94	66.55	67.24	68.09	67.46	67.59								
CART, FC mean ACC score (in %): 73.25												wpKNN, FC mean ACC score (in %): 71.62																				
CCM-HAC	72.92	73.26	73.70	73.37	72.85	72.90	73.04	73.37	73.11							62.38	70.09	71.16	71.21	71.05	71.38	71.04	71.07	70.99								
CCM-HDC	72.59	73.17	73.18	73.43	71.89	72.03	72.78	72.72	73.15							64.71	70.27	71.43	71.38	70.99	71.06	70.87	71.01	71.47								
JSD-HAC	72.79	73.22	73.47	73.55	72.31	72.32	72.79	73.13	73.28							63.81	70.17	71.09	71.25	70.96	71.27	70.87	70.91	71.10								
JSD-HDC	71.96	73.08	71.89	72.47	71.77	71.76	72.49	72.64	72.84							63.70	69.64	71.21	70.62	70.90	71.23	70.49	70.94	71.11								
CMD-HAC	72.93	73.16	73.09	73.27	72.49	72.46	72.71	72.74	73.05							63.05	70.07	71.38	71.49	71.17	71.24	71.31	71.29	71.28								
CMD-HDC	72.59	73.07	73.14	73.24	72.21	72.28	72.62	72.34	72.85							61.40	68.66	70.71	70.65	70.31	70.77	70.50	71.18	70.82								
TSD-HAC	72.86	73.29	73.68	73.58	72.72	72.77	72.95	73.22	73.36							65.57	71.13	72.31	72.35	72.14	72.23	71.95	72.00	72.09								
TSD-HDC	72.69	72.99	72.93	73.07	72.17	72.20	72.71	72.86	72.80							63.59	70.41	72.05	71.92	71.90	72.10	71.59	71.89	71.84								

**Fig. S3.** Mean ACC comparison of all HG and HE methods for base classifiers.

XGB, FC mean AUC score (in %): 87.45												RF, FC mean AUC score (in %): 87.34																					
	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+F	LCL+	LCL+F	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+F	LCL+	LCL+F	
CCM-HAC	85.24	86.53	87.43	86.20	76.01	87.24	87.57	87.23	87.52								84.61	86.59	87.01	85.97	74.99	87.32	87.35	87.23	87.24								
CCM-HDC	84.87	85.98	87.34	86.18	75.92	87.15	87.49	87.25	87.39								84.43	86.34	86.94	85.75	74.62	87.20	87.31	87.07	87.20								
JSD-HAC	84.85	86.22	87.30	85.87	75.75	86.95	87.45	87.07	87.36								84.34	86.38	87.02	85.71	75.25	87.33	87.40	87.15	87.31								
JSD-HDC	84.15	85.55	87.04	85.35	75.35	87.06	87.39	87.18	87.30								83.82	85.91	86.77	85.23	74.46	87.24	87.19	87.18	87.11								
CMD-HAC	85.82	86.91	87.37	86.54	76.12	87.16	87.54	87.32	87.46								85.06	86.79	87.03	86.30	75.12	87.33	87.34	87.23	87.26								
CMD-HDC	84.51	85.72	87.03	85.71	75.60	86.92	87.38	86.98	87.27								84.27	86.17	86.84	85.64	74.27	87.28	87.23	87.06	87.14								
TSD-HAC	85.57	86.53	87.47	86.38	75.99	87.14	87.63	87.29	87.55								84.86	86.69	87.15	86.05	75.33	87.34	87.38	87.38	87.32								
TSD-HDC	84.29	85.76	87.09	85.48	75.62	87.02	87.42	87.05	87.26								83.85	86.12	86.87	85.35	74.42	87.23	87.28	87.00	87.18								
ETC, FC mean AUC score (in %): 87.06												LGB, FC mean AUC score (in %): 85.76																					
CCM-HAC	84.91	86.59	86.78	85.73	74.60	87.06	86.99	86.96	86.92								82.25	84.28	86.97	85.44	75.02	86.52	85.85	86.13	85.85								
CCM-HDC	84.45	86.22	86.68	85.38	74.38	86.95	86.97	86.76	86.86								82.98	83.88	87.05	85.68	73.98	85.97	85.97	85.45	85.90								
JSD-HAC	84.60	86.35	86.82	85.48	74.71	86.98	87.04	86.92	86.95								82.46	84.01	87.01	85.21	74.47	86.10	85.85	85.52	85.81								
JSD-HDC	83.96	85.71	86.58	84.84	74.15	86.98	86.92	86.88	86.88								82.03	83.55	86.90	84.21	73.17	85.64	85.85	85.55	85.84								
CMD-HAC	85.18	86.65	86.71	85.89	74.61	86.96	86.96	86.81	86.88								82.30	84.68	87.00	85.99	74.12	85.90	85.86	86.12	85.79								
CMD-HDC	84.40	86.19	86.66	85.36	74.07	86.96	86.96	86.80	86.89								82.13	83.50	86.82	85.09	73.99	85.89	85.84	85.83	85.76								
TSD-HAC	85.12	86.55	86.90	85.72	74.94	87.01	87.02	86.92	86.95								83.28	84.52	87.16	85.80	74.72	86.39	85.94	86.38	85.87								
TSD-HDC	84.04	86.00	86.73	84.94	74.08	87.05	87.02	86.87	86.93								83.13	83.43	86.82	84.84	73.79	85.89	85.75	85.67	85.70								
CATB, FC mean AUC score (in %): 88.34												LDA, FC mean AUC score (in %): 83.26																					
CCM-HAC	86.15	87.92	88.14	87.07	74.76	88.38	88.45	88.12	88.31								81.56	82.34	81.49	81.91	71.17	82.69	82.90	82.77	82.92								
CCM-HDC	85.53	87.41	88.26	86.81	75.25	88.24	88.40	88.16	88.27								81.36	82.26	81.45	82.06	70.76	82.60	83.01	82.78	83.12								
JSD-HAC	86.55	87.57	88.11	86.86	75.25	88.31	88.37	88.19	88.22								80.78	82.16	80.87	81.80	69.92	81.70	82.42	81.97	82.49								
JSD-HDC	85.55	87.15	87.80	86.40	74.70	88.22	88.30	88.06	88.16								80.67	81.77	80.25	81.09	70.16	81.73	82.68	82.19	82.78								
CMD-HAC	86.75	87.81	88.14	87.21	75.72	88.38	88.40	88.17	88.27								81.45	82.36	81.43	82.05	71.27	82.58	82.92	82.60	82.91								
CMD-HDC	85.83	87.19	87.96	86.47	74.72	88.11	88.21	87.93	88.01								80.21	81.80	80.49	81.38	70.46	81.94	82.72	81.95	82.68								
TSD-HAC	86.85	87.83	88.37	87.30	75.69	88.45	88.50	88.23	88.35								81.75	82.64	81.88	82.35	71.15	82.72	83.21	82.75	83.13								
TSD-HDC	85.88	87.27	88.02	86.32	74.88	88.16	88.23	88.05	88.06								80.83	81.97	80.60	81.25	70.38	82.19	82.73	82.29	82.73								
CART, FC mean AUC score (in %): 75.98												wpKNN, FC mean AUC score (in %): 76.93																					
CCM-HAC	77.18	78.96	80.79	78.51	74.96	75.72	78.83	78.09	78.78								72.21	76.35	76.64	76.58	69.65	77.08	76.66	76.67	76.54								
CCM-HDC	76.38	78.25	80.26	78.70	74.33	75.19	78.36	78.23	78.28								73.12	76.29	76.33	76.46	69.50	77.08	76.70	76.76	76.30								
JSD-HAC	76.72	78.71	80.20	78.19	74.53	75.35	78.66	78.03	78.58								72.84	76.25	76.37	76.37	69.86	77.10	76.65	76.62	76.32								
JSD-HDC	75.14	77.29	79.31	77.88	74.08	74.87	77.49	77.51	77.34								71.86	75.73	75.76	75.93	69.34	76.95	76.54	76.58	75.76								
CMD-HAC	77.03	79.10	80.81	79.14	74.72	75.49	79.26	78.61	79.28								72.56	76.34	76.58	76.62	69.92	77.13	76.71	76.62	76.53								
CMD-HDC	75.89	77.77	79.93	78.52	74.56	75.36	78.00	77.99	77.92								72.27	76.40	76.37	76.51	69.84	77.57	77.20	76.68	75.92								
TSD-HAC	77.28	79.25	80.75	79.01	74.85	75.68	79.25	78.53	79.23								72.93	76.44	76.64	76.60	70.00	77.09	76.76	76.62	76.47								
TSD-HDC	75.67	77.66	79.52	77.98	74.44	75.27	77.80	77.45	77.57								72.20	75.87	75.71	75.85	69.60	76.86	76.61	76.58	75.65								

**Fig. S4.** Mean AUC comparison of all HG and HE methods for base classifiers.

XGB, FC total runtime [sec]: 3.69

	XGB, FC total runtime [sec]: 3.69										RF, FC total runtime [sec]: 0.80																									
	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+	LCPN+F	LCL+	LCL+F	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+	LCPN+F	LCL+	LCL+F		
CCM-HAC	28.86	32.56	3.19	6.88	2.01	0.91	4.60	2.21	5.90									5.27	6.07	1.91	2.71	13.53	0.89	1.69	0.90	1.70										
CCM-HDC	26.83	30.53	3.19	6.88	1.87	0.95	4.65	2.68	6.37									4.94	5.73	1.89	2.69	11.21	0.95	1.75	0.97	1.77										
JSD-HAC	26.83	30.52	3.53	7.23	2.44	1.38	5.07	2.91	6.60									4.82	5.61	2.24	3.04	13.39	1.21	2.01	1.21	2.01										
JSD-HDC	48.15	51.84	3.65	7.35	2.68	1.47	5.17	2.64	6.33									6.95	7.74	2.28	3.08	13.46	1.36	2.16	1.39	2.19										
CMD-HAC	33.09	36.79	5.23	8.92	4.00	3.02	6.71	4.64	8.34									5.75	6.55	2.56	3.36	12.83	1.57	2.37	1.60	2.40										
CMD-HDC	33.76	37.45	5.28	8.97	4.11	3.02	6.72	4.27	7.96									6.15	6.95	2.62	3.42	13.56	1.66	2.45	1.68	2.48										
TSD-HAC	38.41	42.11	15.62	19.32	14.45	13.40	17.10	15.24	18.93									17.79	18.59	14.62	15.42	26.36	13.60	14.40	13.61	14.41										
TSD-HDC	39.34	43.04	15.84	19.54	14.52	13.59	17.29	15.10	18.80									17.70	18.50	14.60	15.40	24.55	13.61	14.41	13.63	14.43										
GC																																				
GC+F																																				
LCN+																																				
LCN+F																																				
LCPN																																				
LCPN+																																				
LCPN+F																																				
LCL+																																				
LCL+F																																				

ETC, FC total runtime [sec]: 0.99

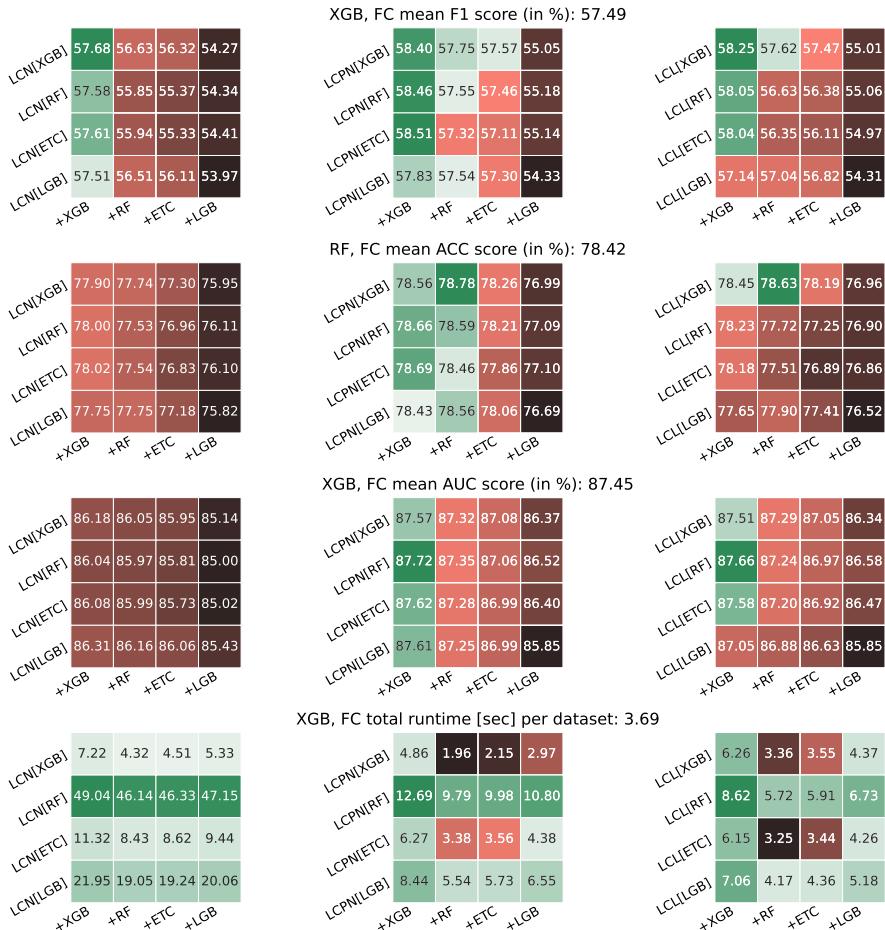
	ETC, FC total runtime [sec]: 0.99										LGB, FC total runtime [sec]: 1.81																									
	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+	LCPN+F	LCL+	LCL+F	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+	LCPN+F	LCL+	LCL+F		
CCM-HAC	8.44	9.43	4.98	5.97	26.73	1.43	2.42	1.63	2.61									8.97	10.78	4.39	6.20	4.20	1.47	3.28	2.26	4.06										
CCM-HDC	8.20	9.19	5.11	6.10	22.00	1.47	2.46	1.67	2.66									10.12	11.93	4.36	6.16	3.61	1.39	3.19	2.27	4.08										
JSD-HAC	7.46	8.44	6.20	7.19	27.09	2.47	3.46	2.57	3.56									9.25	11.06	5.63	7.43	5.08	2.43	4.24	3.31	5.12										
JSD-HDC	14.84	15.83	6.44	7.43	27.08	2.80	3.79	2.98	3.97									9.63	11.44	5.70	7.50	5.78	2.91	4.72	3.59	5.39										
CMD-HAC	9.97	10.95	6.26	7.25	23.33	2.61	3.59	2.74	3.73									9.39	11.20	5.67	7.47	5.03	2.75	4.56	3.67	5.48										
CMD-HDC	10.70	11.69	6.42	7.40	26.73	2.69	3.68	2.92	3.91									10.61	12.42	5.68	7.49	5.26	2.87	4.68	3.59	5.39										
TSD-HAC	21.88	22.87	18.77	19.76	40.01	15.07	16.05	15.25	16.24									20.38	22.19	17.62	19.42	17.29	14.67	16.48	15.68	17.49										
TSD-HDC	22.46	23.45	19.27	20.26	36.60	15.32	16.31	15.52	16.51									23.52	25.33	17.66	19.46	17.03	14.79	16.60	15.66	17.47										
GC																																				
GC+F																																				
LCN+																																				
LCN+F																																				
LCPN																																				
LCPN+																																				
LCPN+F																																				
LCL+																																				
LCL+F																																				

CATB, FC total runtime [sec]: 6.35

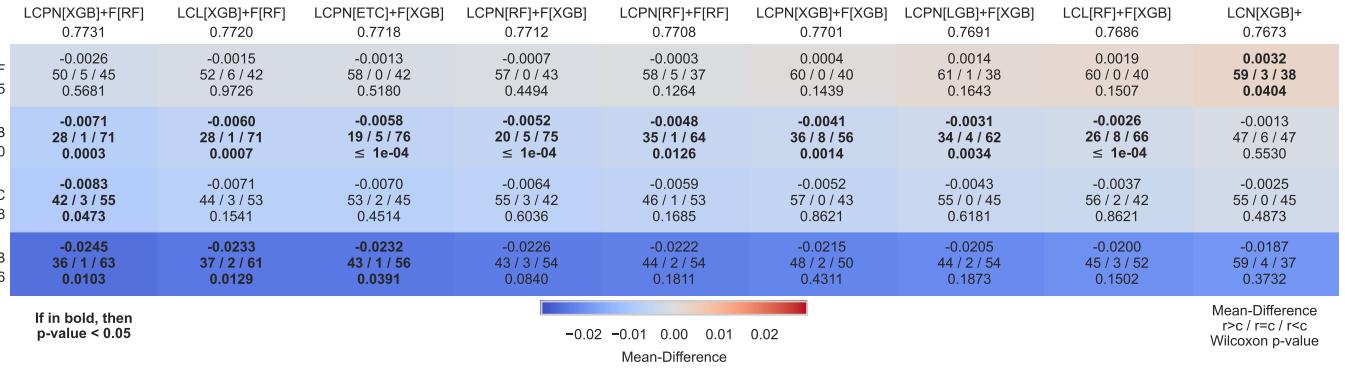
	CATB, FC total runtime [sec]: 6.35										LDA, FC total runtime [sec]: 0.12																									
	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+	LCPN+F	LCL+	LCL+F	CCM-HAC	CCM-HDC	JSD-HAC	JSD-HDC	CMD-HAC	CMD-HDC	TSD-HAC	TSD-HDC	GC	GC+F	LCN+	LCN+F	LCPN	LCPN+	LCPN+F	LCL+	LCL+F		
CCM-HAC	21.92	28.27	30.13	36.48	14.30	11.56	17.91	13.27	19.62									5.32	5.45	3.73	3.85	0.75	0.46	0.58	0.49	0.61										
CCM-HDC	10.44	15.37	32.33	37.26	14.19	12.08	17.00	9.81	14.74									3.20	3.33	3.50	3.62	0.59	0.38	0.50	0.38	0.51										
JSD-HAC	9.82	16.17	33.83	40.18	14.97	12.32	18.67	9.96	16.31									5.24	5.36	4.70	4.82	1.81	1.55	1.67	1.57	1.69										
JSD-HDC	10.95	17.30	32.56	38.91	17.84	13.57	19.92	12.85	19.20									9.53	9.65	4.76	4.88	2.17	1.93	2.05	1.95	2.07										
CMD-HAC	14.95	21.30	37.37	43.72	20.71	17.91	24.26	16.54	22.89									4.39	4.51	3.60	3.72	0.69	0.49	0.61												

**Table S2.** Key notations used

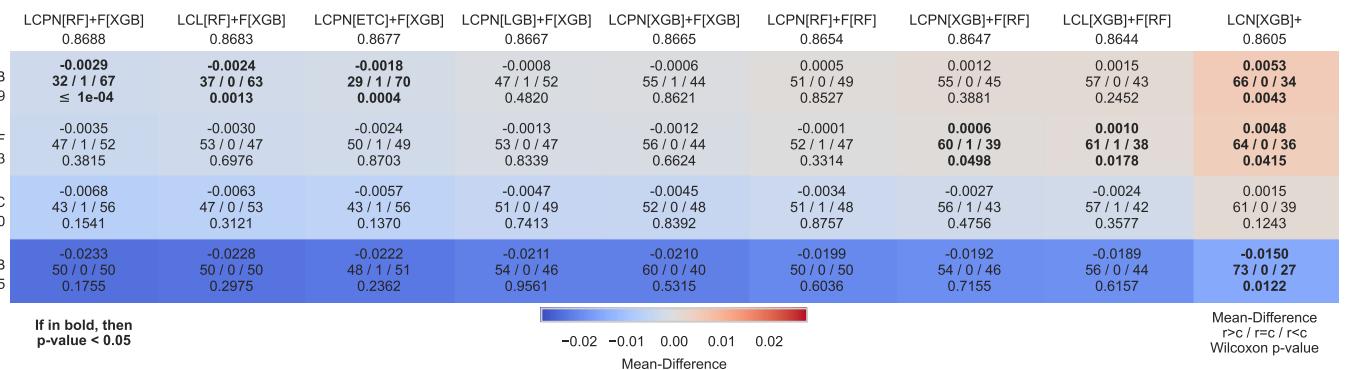
Notations	
$k$	Number of flat classes
$\eta$	Number of hierarchical classes
$m$	Number of examples
$n$	Number of features
$\ell_{u,a}^{v,d}$	Node label
$u$	Node index
$a$	Index of parent (ancestor) node
$v$	Level index
$d$	Indicator of being left (0) or right (1) child (descendant)
$f$	FC model
$h^G$	GC model
$h_u^N$	LCN model working at node with index $u$
$h_u^P$	LCPN model working at parent node with index $u$
$h_v^L$	LCL model working at level $v$



**Fig. S6.** Hybrid HE+F mean F1, ACC, AUC, and runtime (HG, training, and inference) scores using XGB, RF, ETC, and LGB base classifiers.



**Fig. S7.** MCM comparing the mean ACC of selected HiGEC schemes and top FC including XGB, RF, ETC, and LGB base classifiers.



**Fig. S8.** MCM comparing the mean AUC of selected HiGEC schemes and top FC including XGB, RF, ETC, and LGB base classifiers.

**Table S3.** MCCV mean F1 scores and std values for selected FC and HiGEC schemes. Best mean score for each dataset is highlighted.

name	RF	XGB	ETC	LGB	LCN[XGB]+	LCPN[ETC]+F[XGB]	LCPN[RF]+F[XGB]	LCPN[XGB]+F[XGB]
air-quality-and-pollution	<b>0.9291±0.0089</b>	0.9284±0.0116	0.9247±0.0110	0.9290±0.0105	0.9271±0.0119	0.9291±0.0114	0.9289±0.0112	0.9290±0.0101
alizadeh-2000-v2	0.9485±0.0630	0.8594±0.1081	<b>0.9743±0.0515</b>	0.9440±0.0668	0.8841±0.1039	0.8809±0.1219	0.8681±0.1153	0.9357±0.0643
amazon-commerce-reviews	0.6670±0.0281	0.7090±0.0253	<b>0.7273±0.0098</b>	0.7077±0.0294	0.5945±0.0203	<b>0.7402±0.0221</b>	0.7257±0.0262	0.5890±0.0157
analcatdata-halloffame	0.6588±0.0652	0.6516±0.0563	<b>0.6663±0.0507</b>	0.6490±0.0648	0.6565±0.0733	0.6530±0.0621	0.6532±0.0624	0.6474±0.0738
analcatdata-happiness	0.3204±0.1043	0.3990±0.0990	0.2605±0.1078	0.5259±0.1394	<b>0.5285±0.0643</b>	0.4019±0.1092	0.4019±0.1092	0.3601±0.0962
anneal	0.7733±0.0739	0.7976±0.0746	0.7814±0.0627	0.7722±0.0749	0.7690±0.0866	0.7995±0.0811	<b>0.8021±0.0887</b>	0.7871±0.0717
arrythmia	0.5761±0.0438	0.5924±0.0744	0.5257±0.0488	0.5946±0.0609	<b>0.6397±0.0380</b>	0.6305±0.0654	0.6281±0.0664	0.6267±0.0755
artificial-characters	0.9102±0.0058	0.8998±0.0078	0.9095±0.0065	0.9119±0.0081	0.8917±0.0055	<b>0.9199±0.0060</b>	0.9139±0.0067	0.9102±0.0069
auto-ml-selector	0.3392±0.0961	0.3710±0.1210	0.2765±0.0984	0.3560±0.1240	0.3635±0.1234	0.3682±0.1178	0.3782±0.1265	<b>0.3922±0.1208</b>
auto-univ-aud-2500	0.4071±0.0133	0.4562±0.0118	0.3850±0.0127	0.4627±0.0145	0.4670±0.0118	0.4560±0.0119	0.4560±0.0119	0.4071±0.0133
auto-univ-au7-1100	0.3775±0.0307	0.3680±0.0245	0.3614±0.0357	0.3701±0.0338	0.3813±0.0320	0.3785±0.0342	0.3772±0.0261	0.3598±0.0346
bach	0.5470±0.0379	0.5756±0.0389	0.5575±0.0381	0.0231±0.0127	<b>0.5916±0.0295</b>	0.5876±0.0374	0.5823±0.0395	0.5447±0.0353
baseball	0.6634±0.0590	0.6516±0.0563	<b>0.6663±0.0507</b>	0.6490±0.0648	0.6565±0.0733	0.6530±0.0621	0.6532±0.0624	0.6439±0.0713
bridges	<b>0.5828±0.1390</b>	0.5335±0.0787	0.5567±0.0822	0.4521±0.1287	0.5701±0.0998	0.5448±0.0780	0.5582±0.1020	0.5771±0.1267
calendar-dow	0.5704±0.0303	0.5569±0.0385	<b>0.5794±0.0415</b>	0.5620±0.0320	0.5655±0.0320	0.5669±0.0278	0.5651±0.0304	0.5730±0.0283
cars	0.7804±0.0451	0.7802±0.0356	<b>0.7710±0.0384</b>	0.7790±0.0671	0.7782±0.0398	0.7797±0.0415	0.7824±0.0436	<b>0.7863±0.0533</b>
cervical-cancer-risk	0.2480±0.0224	0.2315±0.0283	<b>0.2510±0.0198</b>	0.2082±0.0202	0.2234±0.0243	0.2328±0.0281	0.2304±0.0287	0.2454±0.0207
cleveland-nominal	0.2638±0.0286	0.2663±0.0453	0.2825±0.0412	0.2605±0.0307	0.2519±0.0434	0.2669±0.0565	0.2604±0.0490	0.2601±0.0439
cnae-9	0.9304±0.0055	0.9194±0.0154	<b>0.9405±0.0139</b>	0.8423±0.0145	0.8958±0.0143	0.9255±0.0152	0.9242±0.0165	0.9291±0.0104
collins	0.2055±0.0232	0.2030±0.0180	0.2057±0.0199	0.1932±0.0213	0.1868±0.0181	<b>0.2164±0.0183</b>	0.2088±0.0141	0.2033±0.0224
deng-reads	0.9339±0.0218	0.9430±0.0197	0.9368±0.0126	0.9540±0.0563	<b>0.9750±0.0244</b>	0.9623±0.0154	0.9623±0.0154	0.9382±0.0211
dgf	0.6104±0.0533	0.6355±0.0690	0.6394±0.0533	0.6333±0.0725	0.6352±0.0960	<b>0.6506±0.0920</b>	0.6347±0.0676	0.6151±0.0719
diabetes-130-us	0.3920±0.0024	<b>0.4066±0.0031</b>	0.3906±0.0023	0.3999±0.0033	0.3963±0.0028	0.3481±0.0023	0.3505±0.0022	0.3426±0.0027
diggle-table-a2	0.9585±0.0304	0.9628±0.0144	0.9747±0.0186	<b>0.9791±0.0113</b>	0.9690±0.0175	0.9644±0.0143	0.9643±0.0143	0.9731±0.0168
eda-mortgage-ny	<b>0.5001±0.0036</b>	0.4850±0.0031	0.4927±0.0031	0.4824±0.0038	0.4681±0.0051	0.4861±0.0036	0.4823±0.0022	0.4845±0.0042
energy-efficiency	0.6951±0.0253	0.6972±0.0373	0.6870±0.0363	0.6857±0.0261	0.6951±0.0388	<b>0.7036±0.0372</b>	0.6946±0.0417	0.6948±0.0309
financial-risk-assessment	0.2796±0.0039	0.3045±0.0065	0.2999±0.0117	0.2686±0.0032	<b>0.3098±0.0115</b>	0.3081±0.0184	0.3076±0.0192	0.2942±0.0216
flags	0.5562±0.0746	0.5597±0.0591	0.5161±0.0586	0.5663±0.1027	0.5712±0.0675	0.5833±0.0612	0.5741±0.0580	<b>0.5922±0.0808</b>
flare	0.6143±0.0239	0.6207±0.0187	0.6050±0.0166	0.6126±0.0280	0.6127±0.0248	<b>0.6235±0.0212</b>	0.6212±0.0202	0.6152±0.0255
football-player-position	0.8476±0.0134	0.8456±0.0152	0.8466±0.0184	0.8484±0.0124	0.8491±0.0128	0.8495±0.0133	0.8479±0.0132	<b>0.8507±0.0113</b>
golub-1999-v2	0.8575±0.1599	0.9233±0.0789	0.8984±0.1400	0.9164±0.1282	0.9065±0.0629	0.9250±0.0675	<b>0.9301±0.0671</b>	0.8371±0.1300
hayes-roth	0.8212±0.0303	0.7848±0.0417	<b>0.8247±0.0573</b>	0.8224±0.0793	0.8020±0.0528	0.8160±0.0474	0.8177±0.0452	0.8212±0.0303
heart-h	0.3579±0.0385	0.3402±0.0646	0.3581±0.0673	0.3054±0.0637	0.2958±0.0667	<b>0.3602±0.0564</b>	0.3579±0.0562	0.3459±0.0475
heart-switzerland	0.2571±0.0463	0.2760±0.0837	0.2455±0.0646	0.2354±0.0555	0.2420±0.0773	0.2883±0.0886	0.2878±0.0842	0.2742±0.0510
helena	0.2037±0.0044	0.2124±0.0047	0.2053±0.0051	0.0197±0.0083	0.1903±0.0052	0.2169±0.0033	0.2152±0.0039	0.2102±0.0032
hepatitis-c	0.5256±0.0714	0.5570±0.0762	0.5596±0.0546	0.5880±0.0833	<b>0.6150±0.0925</b>	0.5922±0.0498	0.5922±0.0498	0.5773±0.0623
hypothyroid	0.3608±0.0188	0.3575±0.0236	0.3622±0.0201	0.3544±0.0225	0.3513±0.0207	0.3599±0.0197	<b>0.3626±0.0230</b>	0.3595±0.0179
internet-firewall	0.8427±0.0375	0.8234±0.0531	0.8291±0.0413	0.8115±0.0950	0.8310±0.0492	0.8234±0.0531	0.8234±0.0531	<b>0.8431±0.0376</b>
ipums-la-98-small	0.4097±0.0138	0.4079±0.0171	<b>0.4157±0.0185</b>	0.4071±0.0194	0.4057±0.0207	0.4108±0.0160	0.4105±0.0196	0.4105±0.0142
ipums-la-99-small	0.4437±0.0088	<b>0.4454±0.0145</b>	0.4264±0.0146	0.4435±0.0145	0.4388±0.0126	0.4405±0.0164	0.4439±0.0148	0.4401±0.0135
khan-2001	0.9981±0.0357	0.9699±0.0331	<b>0.9945±0.0165</b>	0.9782±0.0348	0.9740±0.0263	0.9845±0.0239	0.9845±0.0239	0.9875±0.0376
kropt	0.8306±0.0083	0.8622±0.0115	0.8003±0.0122	0.5748±0.0984	0.8466±0.0101	0.8632±0.0062	<b>0.8636±0.0091</b>	0.8458±0.0118
led24	<b>0.7198±0.0114</b>	0.6880±0.0185	0.7182±0.0130	0.6972±0.0196	0.6946±0.0184	0.6968±0.0155	0.6969±0.0149	0.7105±0.0122
led-7-digit	0.6838±0.0302	0.6875±0.0399	0.6842±0.0377	0.6917±0.0420	0.6995±0.0331	0.6866±0.0457	0.6858±0.0352	<b>0.7006±0.0449</b>
leukemia	0.7361±0.1254	0.8904±0.1465	0.8661±0.0404	<b>0.9422±0.0632</b>	0.8894±0.1482	0.9156±0.1121	0.9395±0.0634	0.8799±0.1330
lung	0.7055±0.0890	0.7351±0.1063	0.7230±0.0884	<b>0.8637±0.1030</b>	0.8545±0.0653	0.7760±0.1018	0.7532±0.1029	0.7181±0.0490
lymphoma-burkitt	0.7961±0.0830	0.8254±0.0677	0.7631±0.0627	0.7967±0.0499	0.7636±0.0822	<b>0.8255±0.0705</b>	0.8255±0.0705	0.7995±0.0957
mabbob-ela-as-2d	0.3216±0.0474	0.3783±0.0332	0.3099±0.0553	0.3652±0.0377	0.3770±0.0306	0.3717±0.0275	<b>0.3841±0.0305</b>	0.3291±0.0511
mental-health-detection	0.4143±0.0427	0.4162±0.0467	0.4135±0.0449	0.4136±0.0520	0.4261±0.0453	0.4255±0.0456	0.4269±0.0434	<b>0.4281±0.0458</b>
meta-all	0.4832±0.1442	0.4996±0.1652	0.4828±0.1230	0.3979±0.1432	0.4590±0.1504	<b>0.5044±0.1712</b>	0.5044±0.1712	0.4859±0.1372

**Table S4.** Continuation of Table S3

name	RF	XGB	ETC	LGB	LCN[XGB]+	LCPN[ETC]+F[XGB]	LCPN[RF]+F[XGB]	LCPN[XGB]+F[XGB]
meta-batchincremental	0.4146±0.1038	0.4267±0.0925	0.3972±0.0885	<b>0.4364±0.0920</b>	0.4099±0.1321	0.4203±0.1083	0.4057±0.1145	0.3694±0.1160
meta-instanceincremental	0.7530±0.2114	0.7503±0.2203	<b>0.7989±0.2383</b>	0.7919±0.1432	0.7227±0.2235	0.7556±0.2188	0.7430±0.2078	0.6866±0.2031
mfeat-fourier	0.8175±0.0191	0.8244±0.0229	<b>0.8281±0.0158</b>	<b>0.8320±0.0238</b>	0.8301±0.0164	0.8274±0.0196	0.8258±0.0214	0.8107±0.0194
mfeat-zernike	0.7705±0.0132	0.7815±0.0098	0.7854±0.0123	0.7851±0.0071	0.7804±0.0102	<b>0.7859±0.0123</b>	0.7827±0.0106	0.7624±0.0190
mobile-price	0.8783±0.0176	0.9135±0.0176	0.8675±0.0235	0.9153±0.0184	<b>0.9188±0.0153</b>	0.9127±0.0162	0.9129±0.0156	0.8976±0.0278
ocupid-stem	0.5083±0.0094	0.5353±0.0048	0.4972±0.0040	0.5236±0.0043	0.5398±0.0049	0.5457±0.0046	<b>0.5473±0.0043</b>	0.5282±0.0080
olindda-outliers	<b>0.8176±0.1141</b>	0.7654±0.1223	0.7711±0.0943	0.7653±0.1178	0.6950±0.1318	0.7762±0.1073	0.7705±0.1095	0.7674±0.0873
ovarian-tumour	0.4959±0.0563	0.5570±0.0762	0.5596±0.0546	0.5880±0.0833	<b>0.6150±0.0925</b>	0.5922±0.0498	0.5922±0.0498	0.5909±0.0429
page-blocks	0.8501±0.0292	0.8478±0.0177	0.8407±0.0313	0.8355±0.0386	0.8505±0.0220	<b>0.8517±0.0170</b>	0.8488±0.0170	0.8470±0.0243
pasture	0.7743±0.1629	0.7680±0.1571	0.7597±0.1476	0.1333±0.0000	0.7437±0.1556	0.7747±0.1409	<b>0.7894±0.1441</b>	0.7810±0.1471
prnn-cushings	0.6637±0.2039	0.6102±0.2736	0.5935±0.2601	0.2500±0.0000	<b>0.7055±0.02219</b>	0.6519±0.2689	0.6519±0.2689	0.6943±0.1571
re1-wc	0.6428±0.0276	0.7936±0.0322	0.6763±0.0271	0.7206±0.0353	0.7692±0.0346	<b>0.8012±0.0334</b>	0.7962±0.0350	0.7240±0.0352
rmltsa-sleepdata	<b>0.4082±0.0355</b>	0.4038±0.0232	0.4082±0.0299	0.4033±0.0219	0.3966±0.0277	0.3968±0.0259	0.4008±0.0267	0.3951±0.0346
robot-failures-lp1	0.8252±0.0686	0.7260±0.0831	<b>0.8581±0.0817</b>	0.7593±0.0927	0.7404±0.1184	0.7488±0.0855	0.7439±0.0854	0.8478±0.0580
robot-failures-lp2	0.4347±0.1626	0.5732±0.2123	0.4764±0.1562	0.1143±0.0000	<b>0.6282±0.1726</b>	0.6049±0.1697	0.5934±0.1739	0.5849±0.1405
rscct2010-1	0.3545±0.0558	0.6528±0.0728	0.3277±0.0797	0.6175±0.1618	0.6697±0.0859	0.6528±0.0728	0.6528±0.0728	0.5937±0.1710
rscct2010-2	0.4025±0.0869	0.6528±0.0728	0.3277±0.0797	0.6175±0.1616	0.6697±0.0859	0.6528±0.0728	0.6528±0.0728	0.6420±0.1395
rscct2010-3	0.7376±0.0429	0.7973±0.1133	0.7345±0.0352	0.7722±0.1038	0.8447±0.1081	0.8193±0.1145	0.8193±0.1145	0.7196±0.0471
rscct2010-4	0.2790±0.0568	0.3354±0.0975	0.2868±0.0815	0.3124±0.0761	0.3420±0.0461	0.3399±0.0642	0.3336±0.0547	0.3002±0.0818
rscct2010-6	0.4207±0.1091	0.4339±0.1159	0.4063±0.0929	0.5013±0.1151	<b>0.5292±0.1012</b>	0.4630±0.1194	0.4631±0.1174	0.4574±0.1516
sdss17	0.9738±0.0011	0.9713±0.0012	0.9678±0.0012	<b>0.9740±0.0013</b>	0.9714±0.0014	0.9712±0.0013	0.9721±0.0011	0.9725±0.0012
segment	0.9792±0.0038	0.9846±0.0055	0.9810±0.0056	0.9843±0.0053	0.9840±0.0065	<b>0.9853±0.0057</b>	0.9848±0.0056	0.9796±0.0070
shuttle	0.9410±0.0550	0.9676±0.0464	0.9665±0.0285	0.5356±0.0830	0.9826±0.0247	0.9783±0.0254	0.9783±0.0255	0.9824±0.0241
soybean	0.2282±0.0251	0.2167±0.0168	0.2263±0.0188	0.2302±0.0227	<b>0.2380±0.0254</b>	0.2345±0.0148	0.2330±0.0190	0.2288±0.0233
spectrometer	<b>0.5191±0.0334</b>	0.4581±0.0483	0.5154±0.0538	0.4771±0.0481	0.4618±0.0427	0.4779±0.0436	0.4709±0.0451	0.5045±0.0303
students-academic-success	0.6828±0.0168	0.6887±0.0172	0.6860±0.0167	<b>0.6927±0.0140</b>	0.6799±0.0179	0.6865±0.0145	0.6824±0.0155	0.6634±0.0139
thyroid-allbp	0.4749±0.0253	0.4580±0.0203	0.4703±0.0352	<b>0.4498±0.0283</b>	0.4650±0.0259	0.4730±0.0280	0.4706±0.0250	<b>0.4820±0.0210</b>
thyroid-allhyper	<b>0.4776±0.0214</b>	0.4580±0.0203	0.4703±0.0352	<b>0.4498±0.0283</b>	0.4650±0.0259	0.4730±0.0280	0.4706±0.0250	0.4749±0.0173
thyroid-allhypoth	<b>0.4763±0.0254</b>	0.4580±0.0203	0.4703±0.0352	<b>0.4498±0.0283</b>	0.4650±0.0259	0.4730±0.0280	0.4706±0.0250	0.4730±0.0219
thyroid-allrep	0.4750±0.0261	0.4580±0.0203	0.4703±0.0352	<b>0.4498±0.0283</b>	0.4650±0.0259	0.4730±0.0280	0.4706±0.0250	<b>0.4768±0.0194</b>
thyroid-dis	0.4768±0.0221	0.4580±0.0203	0.4703±0.0352	<b>0.4498±0.0283</b>	0.4650±0.0259	0.4730±0.0280	0.4706±0.0250	<b>0.4837±0.0254</b>
tumors-11	0.7975±0.0862	0.8118±0.0698	0.8248±0.0667	<b>0.8652±0.0674</b>	0.8215±0.0881	0.8163±0.0779	0.8188±0.0836	0.8404±0.0453
visualizing-livestock	0.3427±0.0622	0.3527±0.0537	0.2073±0.0560	0.3501±0.0448	<b>0.3598±0.0659</b>	0.3459±0.0621	0.3479±0.0500	0.3414±0.0705
volcanoes-a2	<b>0.3673±0.0496</b>	0.3520±0.0837	0.3401±0.0532	0.3557±0.0629	0.3439±0.0766	0.3516±0.0755	0.3543±0.0718	0.3636±0.0541
volcanoes-a3	0.3084±0.0339	0.3032±0.0366	<b>0.3219±0.0577</b>	0.3051±0.0599	0.2956±0.0353	0.3011±0.0449	0.3178±0.0392	0.2860±0.0358
volcanoes-b1	0.2883±0.0156	0.3033±0.0283	0.2804±0.0188	<b>0.3071±0.0190</b>	0.3034±0.0260	0.3005±0.0258	0.3048±0.0292	0.2949±0.0221
volcanoes-b3	0.2853±0.0223	<b>0.3174±0.0364</b>	0.2607±0.0213	0.2877±0.0252	0.3069±0.0302	0.2985±0.0457	0.3068±0.0419	0.2841±0.0248
volcanoes-b4	0.2801±0.0185	0.2990±0.0217	0.2689±0.0191	0.2885±0.0209	0.2913±0.0252	0.2911±0.0306	0.2970±0.0271	<b>0.2991±0.0310</b>
volcanoes-b6	0.2897±0.0206	0.2955±0.0237	0.2754±0.0212	0.2874±0.0194	<b>0.2991±0.0261</b>	0.2874±0.0263	0.2904±0.0249	0.2957±0.0233
volcanoes-d1	0.2371±0.0250	0.2404±0.0224	0.2259±0.0198	0.2323±0.0146	0.2500±0.0285	0.2414±0.0320	0.2491±0.0313	0.2490±0.0350
volcanoes-d2	0.2367±0.0259	0.2290±0.0213	0.2325±0.0262	0.2264±0.0170	0.2591±0.0196	0.2464±0.0330	0.2443±0.0270	0.2538±0.0172
volcanoes-d3	0.2428±0.0191	0.2404±0.0276	0.2283±0.0211	0.2482±0.0290	<b>0.2638±0.0394</b>	0.2559±0.0354	0.2549±0.0317	0.2578±0.0296
volcanoes-d4	0.2490±0.0206	0.2549±0.0249	0.2312±0.0230	0.2512±0.0271	0.2654±0.0245	0.2573±0.0205	0.2589±0.0232	<b>0.2666±0.0235</b>
volcanoes-e1	0.2759±0.0735	0.2875±0.0548	0.2675±0.0613	0.2807±0.0503	0.2599±0.0554	0.2823±0.0501	<b>0.2902±0.0517</b>	0.2700±0.0748
volcanoes-e3	0.2902±0.0742	0.2882±0.0607	0.2750±0.0577	<b>0.3025±0.0754</b>	0.2833±0.0579	0.2891±0.0676	0.2894±0.0676	0.2809±0.0685
volcanoes-e5	0.2576±0.0310	0.2814±0.0487	0.2462±0.0335	0.2635±0.0455	0.2771±0.0474	<b>0.2835±0.0422</b>	0.2715±0.0353	0.2770±0.0625
walking-activity	0.6142±0.0035	0.6038±0.0026	0.6170±0.0028	0.5418±0.0541	0.5909±0.0031	<b>0.6195±0.0027</b>	0.6174±0.0027	0.6166±0.0043
wine-quality-red	0.3878±0.0369	0.3853±0.0381	0.3823±0.0358	<b>0.3887±0.0382</b>	0.3749±0.0411	0.3809±0.0347	0.3808±0.0349	0.3777±0.0403
wine-quality-white	0.4211±0.0116	0.4246±0.0224	0.4237±0.0166	0.4157±0.0204	0.4062±0.0148	<b>0.4266±0.0214</b>	0.4229±0.0197	0.4137±0.0124
zoo	0.9032±0.1331	0.8927±0.1416	<b>0.9402±0.0918</b>	0.9141±0.1082	0.8383±0.1755	0.9210±0.0968	0.9233±0.0941	0.9032±0.1331