

Temporal Convolutional Explorer Helps Understand 1D-CNN’s Learning Behavior in Time Series Classification from Frequency Domain

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1 Results of Regulatory Framework

We apply our regulatory framework on ResNet, InceptionTime, and FCN enabling them selectively to skip over the specified disturbing convolution. We choose ResNet, InceptionTime and FCN, and set their depth to five to alleviate their accuracy degradation problem. All models are trained on all UCR/UEA/UCI datasets (128 for the univariate cases and 31 for the multivariate cases) with three different random seeds, and the median results are reported. We conduct Wilcoxon signed-rank test following the process described in (Demšar 2006) with Holm’s α (5%) (Holm 1979), and all results including accuracy, parameters (Params) and floating point operations (FLOPs) are listed in Tab. 1.1, 1.2 and 1.3. We can see that the performances of ResNet, InceptionTime, and FCN with our regulatory framework get improved with fewer Params and FLOPs.

Notely, CNN-based methods equipped with our regulator have the better average rank in any case than the non-equipped counterpart. Although they do not show significant statistical differences in accuracy, we cost less consumption of memory and computation resources while maintaining comparable or even higher accuracy. Therefore, the successful application supports that TCE can provide hints for improving the performance of 1D-CNNs on TSC tasks.

Datasets	ResNet+Regulator	ResNet	IT+Regulator	IT	FCN+Regulator	FCN
ACSF1	92±1.73	87±4	92±2	92±1	90±0.58	82±3
Adiac	84.38±1.71	82.55±0.75	82.81±0.8	82.81±1.82	83.85±1.48	78.91±7.37
AllGestureWiimoteX	68.46±0.83	65.55±0.44	77.76±1.45	77.33±0.8	70.2±1.32	71.95±0.51
AllGestureWiimoteY	76.02±0.29	76.02±0.72	81.83±1.02	81.83±1.16	78.05±0.55	76.89±1.4
AllGestureWiimoteZ	71.95±1.03	66.42±3.97	77.47±0.5	73.69±1.46	71.95±1.02	73.26±0.22
ArrowHead	83.75±5.81	78.75±5.24	85±1.91	81.88±2.37	83.75±0.72	85.63±4.88
Beef	80±12.02	70±6.94	86.67±0	83.33±5.09	66.67±1.92	70±10.72
BeetleFly	80±2.89	90±7.64	85±0	85±7.64	85±2.89	70±0
BirdChicken	90±2.89	85±0	95±2.89	90±15.28	100±0	100±2.89
BME	100±0	100±0	100±0	100±0	71.33±14.64	100±0
Car	91.67±0.96	93.33±3.85	91.67±0.96	91.67±1.67	91.67±0.96	91.67±7.26
CBF	99.33±1.13	99.22±1.45	100±0	100±0	99.67±0.28	99.44±0.11
Chinatown	98.21±0	97.62±0.3	98.21±0.17	97.92±0.3	98.21±0.17	98.21±0
ChlorineConcentration	79.19±0.68	80.42±2.16	86.61±0.63	84.9±3.42	82.84±0.51	82.6±3.97
CinCECGTorso	83.28±0.98	82.56±2.19	86.99±1.78	90.41±5.31	80.6±1.24	83.72±2.62
Coffee	100±0	100±0	100±0	100±0	100±0	100±0
Computers	79.58±2.77	83.75±0.24	78.75±0.48	80±1.46	82.5±1.05	84.17±0.96
CricketX	80.00±3.14	71.61±0.78	85.16±0.69	83.85±2.1	78.91±0.4	77.86±0.15
CricketY	75.26±2.09	74.22±2.67	85.68±1.92	85.94±0.15	78.13±0.84	81.51±2.07
CricketZ	76.56±2.21	73.96±3.65	86.46±1.58	85.94±1.17	79.17±1.73	82.03±2.12
Crop	76.23±0.4	73.55±2.1	75.44±1.13	74.39±0.85	76.84±0.24	73.99±0.28
DiatomSizeReduction	49.34±14.05	30.26±15.1	58.55±36.19	29.93±17.98	29.61±2.92	28.29±16.07
DistalPhalanxOutlineAgeGroup	74.62±0.44	73.85±3.53	72.31±2.04	69.23±2.77	69.23±0.89	67.69±2.7
DistalPhalanxOutlineCorrect	76.1±1.27	76.47±0.74	74.63±2.33	75.37±1.39	75.74±1.06	76.84±1.89
DistalPhalanxTW	69.23±2.35	71.54±1.94	66.92±2.31	64.62±2.22	66.15±3.55	68.46±0.77
DodgerLoopDay	45±5.64	48.75±0.72	47.5±5.05	32.5±1.25	41.25±2.6	43.75±3.82
DodgerLoopGame	70±7.78	81.54±5.12	87.69±0.89	84.62±4.8	70±2.77	66.15±3.08
DodgerLoopWeekend	97.69±0.77	96.15±1.6	97.69±0.44	96.92±0.44	96.92±1.54	94.62±3.95
Earthquakes	74.62±0.44	73.85±0.89	73.08±1.78	73.85±2.31	72.31±1.6	73.85±1.6
ECG200	86±2.65	89±1	91±2.08	85±2.89	89±1.15	87±4.16
ECG5000	94.15±0.2	94.02±0.11	94.4±0.2	93.97±0.07	93.97±0.16	93.73±0.42
ECGFiveDays	98.7±2.92	99.76±4.5	100±0	100±0	98.58±0.3	95.17±1.13
ElectricDevices	71.15±0.42	70.48±1.72	70.04±1.58	70.43±2.34	71.57±0.42	70.97±1.92
EOGHorizontalSignal	61.93±0.91	54.26±6.58	64.77±1	63.35±3.6	65.34±0.59	59.94±5.75
EOGVerticalSignal	42.61±2.45	45.45±1.3	49.15±0.16	46.31±3.29	42.33±0.91	41.48±6.01
EthanolLevel	66.94±25.27	72.38±1.01	73.39±5.11	54.44±24.77	71.17±15.52	25.6±19.27
FaceAll	83.29±0.52	79.39±0.91	80.54±1.06	82.8±1.83	91.37±1.24	90±3.51
FaceFour	94.32±0.66	94.32±0	95.45±0	94.32±0.66	93.18±1.31	95.45±1.74
FacesUCR	95.07±0.13	95.17±1.1	96.58±0.17	96.58±0.88	95.21±0.24	95.07±0.16
FiftyWords	61.61±1.16	67.63±2.47	79.69±2.57	81.03±4.61	65.63±0.85	73.21±0.59
Fish	96.25±1.57	98.13±1.25	100±1.08	99.38±1.08	96.25±0.72	97.5±0.36
FordA	94.44±1.11	92.99±1.7	95.2±0.39	95.5±0.15	92.3±0.12	92.76±1.24
FordB	81.75±0.88	77.63±4.78	83.13±0.51	84.88±0.83	78±0.94	80.88±3.12
FreezerRegularTrain	99.72±0.14	99.75±0.36	99.72±0.04	99.61±0.12	99.68±0.02	99.58±0.07
FreezerSmallTrain	82.23±3.06	85.36±6.16	94.17±6.19	89.22±7.79	75.91±4.72	63.03±14.62
Fungi	6.25±4.73	14.2±12.87	12.5±15.47	4.55±2.69	2.27±4.41	2.27±2.05
GestureMidAirD1	68.46±0.44	73.08±3.47	75.38±1.18	71.54±0.44	72.31±1.18	69.23±1.6
GestureMidAirD2	55.38±1.6	57.69±2.35	59.23±1.94	56.92±0.44	63.08±0	54.62±7.05
GestureMidAirD3	35.38±6.54	30.77±1.6	36.92±2.22	34.62±4.7	42.31±0.77	36.92±1.6
GesturePebbleZ1	81.88±1.91	85.63±2.19	90±1.8	85±2.86	83.75±0.63	84.38±3.44
GesturePebbleZ2	76±4.73	79.33±3.42	83.33±2.14	82±2.04	73.33±0.67	79.33±3.36
GunPoint	100±0	98±2.34	100±0	99.33±0.77	99.33±0	97.33±0.77
GunPointAgeSpan	100±0.19	99.67±0.33	98.68±0.33	98.68±0.38	96.71±1.06	97.37±1.43
GunPointMaleVersusFemale	99.67±0.19	100±0.19	99.67±0	99.67±0.19	99.67±0.19	98.68±4.95
GunPointOldVersusYoung	100±0	100±0	100±0	100±0	100±0	100±0
Ham	72±3.51	75±4	72±1	73±3.51	69±1.73	69±2
HandOutlines	82.88±10.97	89.4±1.44	93.48±1.28	90.76±32.6	90.76±6.7	69.29±9.91
Haptics	52.96±1.81	52.3±1.87	50±2.19	52.63±1.16	49.01±0.5	52.63±1.55
Herring	61.67±4.19	60±4.19	50±10.14	60±1.92	65±6.01	60±2.89
HouseTwenty	97.27±0.91	97.27±0.52	97.27±0.52	96.36±1.82	92.73±2.1	94.55±2.78
InlineSkate	48.71±2.77	62.87±9.62	51.65±1.75	49.63±5.15	32.35±0.8	30.7±4.46
InsectEPGRegularTrain	100±0	100±8.18	100±0	100±0	100±0	100±0
InsectEPGSmallTrain	2.08±8.6	35.83±23.92	36.25±27.55	47.5±8.73	47.5±28.03	47.92±8.91

InsectWingbeatSound	49.49±0.73	54.37±7.1	61.79±0.61	63.87±1.5	39.68±0.48	45.63±0.58
ItalyPowerDemand	96.58±0.15	95.51±0.3	96.97±0.31	96.58±0.1	96.48±0.35	96.68±0.7
LargeKitchenAppliances	89.4±0.42	90.76±0.68	89.67±1.1	90.76±0.68	89.67±0.16	89.67±1.81
Lightning2	73.33±0.96	76.67±1.92	81.67±1.67	81.67±0	75±1.67	75±3.47
Lightning7	72.86±2.97	81.43±2.97	78.57±0.82	81.43±0.82	84.29±2.18	80±1.65
Mallat	95.46±1.28	95.76±1.33	96.1±0.26	96.7±0.76	96.79±0.26	96.58±1.97
Meat	96.67±0.96	93.33±2.89	96.67±1.92	93.33±5.09	91.67±0	91.67±12.02
MedicalImages	74.47±0.87	75.4±1.61	74.07±0.5	76.06±0.87	77.79±0.94	76.46±1.01
MelbournePedestrian	96.5±0.63	96.13±0.51	96.59±0.18	96.79±0.31	96.88±1.13	96.18±0.5
MiddlePhalanxOutlineAgeGroup	55.33±0.67	54±3.42	50±2.04	52.67±3.71	56±3.08	55.33±1.02
MiddlePhalanxOutlineCorrect	77.78±1.4	74.31±5.06	79.51±0.6	78.47±0.92	79.51±0.4	80.21±1.22
MiddlePhalanxTW	49.33±0.38	52±0.67	49.33±2.04	52±1.92	52±3.91	52±3.67
MixedShapesRegularTrain	97.19±0.25	96.48±0.73	98.18±0.21	98.34±0.06	95.57±0.09	97.31±0.19
MixedShapesSmallTrain	92.8±0.41	92.34±1.78	93.54±0.64	91.97±0.66	88.33±0.79	87.91±1.54
MoteStrain	91.59±0.9	92.47±2.55	89.82±0.24	87.34±1.09	92.79±0.56	92.07±0.47
NonInvasiveFetalECGThorax1	94.77±0.44	93.6±0.46	96.41±0.39	91.65±1.38	95.49±0.25	93.65±3.36
NonInvasiveFetalECGThorax2	94.26±0.54	93.49±0.39	95.65±0.51	92.21±0.72	95.18±0.28	92.98±2.34
OliveOil	86.67±1.92	73.33±20.28	86.67±1.92	83.33±26.03	83.33±1.92	40±0
OSULeaf	99.17±0	98.33±1.82	98.75±0	98.33±1.58	97.5±0.24	97.08±1.34
PhalangesOutlinesCorrect	80.66±1.02	80.19±1.9	80.54±1.12	80.54±0.98	81.96±1.28	79.6±1.18
Phoneme	37.87±0.27	37.29±0.83	33±1.16	32.26±0.45	34±0.19	36.07±0.09
PickupGestureWiimoteZ	84±5.03	82±2.31	92±3.06	88±5.29	76±2	82±0
PigAirwayPressure	93.27±3.92	85.58±9.3	86.06±6.4	90.38±7.7	31.73±8.09	16.35±3.82
PigArtPressure	100±0	100±0	100±0.28	99.52±0.28	99.04±0	100±17.76
PigCVP	16.35±2.22	25.96±14.27	53.37±21.24	90.38±6.73	9.62±7.39	21.15±7.93
PLAID	10.8±4.01	13.07±2.71	8.33±4.62	14.77±8.24	22.92±4.48	7.95±9.32
Plane	100±0	100±0	100±0	100±0	100±0	100±0
PowerCons	87.5±0.66	88.07±2.15	98.3±1.18	98.86±1.43	88.07±1.7	89.2±0.87
ProximalPhalanxOutlineAgeGroup	85.94±1.38	85.42±0.6	85.42±2.87	84.9±1.67	81.77±1.2	83.85±3.35
ProximalPhalanxOutlineCorrect	91.32±2.28	89.93±1.22	89.93±2.65	91.32±1.45	89.58±0.72	90.28±0.53
ProximalPhalanxTW	77.08±0.9	80.73±2.9	76.56±1.38	78.13±1.56	75±1.31	78.65±0.52
RefrigerationDevices	55.98±1.85	53.8±0.83	49.46±1.44	51.9±3.15	51.63±1.7	48.91±2.28
Rock	54±9.45	42±6.43	34±26.56	48±9.02	40±5.29	26±10.39
ScreenType	64.95±1.39	64.95±1.1	55.98±0.68	60.6±2.52	61.96±2.45	61.14±0.98
SemgHandGenderCh2	78.55±1.38	79.39±1.85	81.25±0.94	81.08±2.39	79.05±1.86	77.03±3.48
SemgHandMovementCh2	40.18±1.31	30.8±8.55	45.98±0.85	35.49±6.51	43.75±0.68	39.29±3.49
SemgHandSubjectCh2	52.01±1.92	51.79±1.69	56.03±3.74	57.81±6.88	52.23±3.67	51.34±2.49
ShakeGestureWiimoteZ	90±3.06	88±3.46	94±3.06	94±3.06	96±0	96±2
ShapeletSim	67.61±6.98	82.95±7.76	87.5±8.55	80.68±15.91	84.66±7.71	92.61±14.21
ShapesAll	89.02±0.51	88.51±0.2	93.07±0.54	93.58±1.28	89.36±0.51	90.54±0.59
SmallKitchenAppliances	79.35±0.98	78.8±0.68	76.36±0.63	76.63±2.12	77.72±0.83	74.18±2.47
SmoothSubspace	99.33±0.38	100±1.54	98.67±0.67	98.67±0.38	100±0	99.33±1.76
SonyAIBORobotSurface1	98.82±0.68	97.8±0.52	99.32±0.1	98.65±0.35	98.14±0.35	97.8±3.38
SonyAIBORobotSurface2	96.82±0.69	96.4±1.6	96.4±0.5	93.01±1.35	97.14±0.74	97.35±0.22
StarLightCurves	97.7±0.15	97.85±0.13	97.88±0.19	97.96±0.12	96.64±0.29	97.35±1.42
Strawberry	97.28±0.42	97.55±0.98	98.1±0.16	97.83±0.57	97.28±0.16	95.92±0.57
SwedishLeaf	97.28±0.4	96.47±1.03	96.96±0.94	96.79±0.33	96.96±0.09	97.12±0.28
Symbols	92.44±2.51	88.1±5.25	97.88±0.23	97.38±0.73	94.86±1.9	93.75±0.57
SyntheticControl	100±0.6	99.65±0.2	99.65±0.2	99.65±0.53	99.65±0.35	98.96±0.4
ToeSegmentation1	95.54±0.93	95.09±0.68	97.77±0.26	95.98±1.03	95.54±0.45	95.54±0.26
ToeSegmentation2	87.69±2.7	88.46±2.47	92.31±0.44	92.31±1.54	92.31±0.44	88.46±5.04
Trace	100±0	100±0	100±0	100±0	100±0	100±0
TwoLeadECG	100±0.15	99.91±0.05	99.91±0	99.91±0	100±0	99.91±0.13
TwoPatterns	98.82±4.7	98.57±2.95	100±0	100±0	87.75±2.23	94.85±0.3
UMD	99.29±0.41	99.29±0	99.29±0	99.29±0.41	98.57±17.53	99.29±0.82
UWaveGestureLibraryAll	77.21±1.23	74.47±1.33	92.88±2.74	94.28±3.05	83.02±0.32	82.46±0.68
UWaveGestureLibraryX	75±0.99	74.05±0.83	81.47±0.53	82.4±0.99	77.02±0.32	76.71±0.69
UWaveGestureLibraryY	67.12±1.54	61.72±1.85	74.66±0.84	74.94±0.4	66.17±1.24	63.85±1.08
UWaveGestureLibraryZ	72.62±0.65	69.06±0.23	75.9±1.12	76.4±0.93	73.54±0.22	74.36±0.76
Wafer	99.92±0.09	99.84±0.04	99.77±0.04	99.72±0.14	99.72±0.06	99.66±0.02
Wine	80±7.21	70±15.87	80±3.06	56±13.61	70±8	50±2
WordSynonyms	52.72±1.56	56.73±2.37	72.28±0.91	72.92±1.55	54.65±1.24	60.42±0.91
Worms	74.03±2.25	76.62±2.6	81.82±0.75	83.12±2.25	77.92±2.6	77.92±0
WormsTwoClass	80.52±2.6	77.92±0	76.62±1.98	75.32±0	74.03±2.7	77.92±1.5

Yoga	87±0.46	85.43±2.38	93.11±0.99	90.81±0.57	84.59±0.51	84.36±1.16
ArticulatoryWordRecognition	98.26±0.4	98.26±0.53	98.96±0	98.96±0.35	98.96±0.2	98.61±0.53
AtrialFibrillation	46.67±3.85	33.33±11.55	33.33±6.67	33.33±20.37	40±3.85	33.33±0
BasicMotions	100±0	100±0	100±0	100±0	100±0	100±0
CharacterTrajectories	99.23±0.2	99.09±0.27	99.65±0.11	99.51±0.04	99.44±0.19	98.88±0.53
Cricket	97.14±0	98.57±0.82	98.57±0.82	100±0.82	98.57±0.82	98.57±0
DuckDuckGeese	62±1.15	64±5.03	58±7.21	54±2	58±3.06	58±0
EigenWorms	45±12.76	20±20.97	19.17±3	24.17±4.41	18.33±6.74	20.83±21.9
Epilepsy	97.69±1.33	99.23±0.77	98.46±1.18	98.46±0.89	99.23±0.89	98.46±1.18
ERing	87.41±2.26	86.3±4.06	90±0.98	91.48±0.93	89.26±1.5	87.04±1.13
EthanolConcentration	21.88±2.56	21.09±3.18	29.3±2.6	23.05±2.83	22.27±1.37	25±1.76
FaceDetection	54.97±0.45	54.23±1.16	65.63±0.06	65.03±1.13	54.18±2.04	50.14±2.78
FingerMovements	52.08±2.17	54.17±1.8	51.04±2.41	50±2.41	57.29±4.54	53.13±3.66
HandMovementDirection	39.06±6.31	29.69±1.56	39.06±0.9	39.06±8.7	40.63±3.25	31.25±0.9
Handwriting	52.62±0.96	58.21±1.87	65.12±1.89	67.62±5.57	55.95±1.31	53.21±2.07
Heartbeat	71.88±6.26	64.06±6.7	53.65±11.22	61.98±16.9	68.75±3.14	71.35±2.08
InsectWingbeat	65.03±1.05	64.41±1.7	68.53±0.54	63.00±1.45	63.68±3.25	63.23±1.01
JapaneseVowels	98.37±0.47	98.1±0.78	98.37±0.72	98.1±0.27	98.91±0.16	99.46±0.31
Libras	94.89±1.14	95.45±0.57	92.05±1.74	92.61±1.5	97.16±0.57	97.73±0.33
LSST	55.24±3.24	38.64±11.36	27.64±14.38	56.66±18.55	55.28±1.7	33.04±15.94
MotorImagery	52.08±3.94	51.04±0.6	52.08±2.76	51.04±2.08	53.13±2.62	53.13±3.66
NATOPS	97.16±0.87	96.02±1.14	98.3±0.66	96.59±2.3	98.3±0.33	97.16±1.5
PEMS-SF	80±0.95	80±0.36	80.63±0.36	83.13±5.56	78.13±0.63	73.75±3.82
PenDigits	97.74±0.55	98.05±0.56	98.54±0.34	98.68±0.23	98.71±0.18	98.05±0.25
PhonemeSpectra	28.53±1.01	27.30±1.01	30.56±2.15	27.84±0.24	30.56±2.16	27.99±0.85
RacketSports	86±2.69	90.67±2.04	89.33±7.71	90±0.77	88.67±1.02	89.33±1.54
SelfRegulationSCP1	81.25±1.59	73.62±1.93	75±16.05	79.86±1.04	77.08±0.6	78.82±2.99
SelfRegulationSCP2	48.3±3.99	49.43±2.05	46.02±31.22	48.86±4.3	48.3±1.7	49.43±3.33
SpokenArabicDigits	99.45±0.09	99.27±0.27	99.73±38.37	99.59±0.07	99.68±0.24	99.64±0.15
StandWalkJump	26.67±10.18	33.33±0	40±36.27	26.67±10.18	33.33±3.85	26.67±3.85
UWaveGestureLibrary	87.18±1.58	76.6±1.40	92.15±1.59	90.71±1.40	84.29±3.09	88.78±3.46
HAR	93.33±1.52	92.26±2.51	93.21±2.39	91.95±1.25	94.77±1.05	90.01±1.87
Avg. Rank	3.53	3.88	2.76	3.15	3.61	4.07
Wilcoxon Test p-value	-	0.07	-	0.06	-	0.02

Table 1.1: Accuracy (%) performances. The Wilcoxon signed-rank test is performed between each pair of the network over the 128 UCR datasets, 30 UEA datasets and one UCI dataset. Compared CNN-based method equipped with our regulatory framework with non-equipped counterpart, the better rank is highlighted, and then Holm’s method is used to reject the null hypothesis that the rank between these two networks is the same.

Datasets	ResNet+Regulator	ResNet	IT+Regulator	IT	FCN+Regulator	FCN
ACSF1	1.03±0	1.03	0.16±0.05	0.32	0.99±0	0.99
Adiac	0.57±0	1.03	0.25±0	0.33	0.47±0	0.99
AllGestureWiimoteX	0.5±0	1.03	0.16±0	0.32	0.37±0.3	0.99
AllGestureWiimoteY	0.5±0	1.03	0.16±0	0.32	0.37±0.3	0.99
AllGestureWiimoteZ	0.5±0	1.03	0.16±0	0.32	0.37±0.3	0.99
ArrowHead	0.57±0.14	1.03	0.24±0.05	0.32	0.46±0.19	0.99
Beef	0.57±0.14	1.03	0.16±0.05	0.32	0.36±0.06	0.99
BeetleFly	0.5±0.3	1.03	0.24±0	0.32	0.69±0.06	0.99
BirdChicken	0.5±0.15	1.03	0.24±0	0.32	0.89±0.28	0.99
BME	0.77±0.14	1.03	0.24±0.05	0.32	0.26±0.23	0.99
Car	0.83±0	1.03	0.24±0	0.32	0.26±0	0.99
CBF	0.77±0.15	1.03	0.24±0	0.32	0.46±0.33	0.99
Chinatown	0.77±0.26	1.03	0.24±0	0.32	0.86±0.1	0.99
ChlorineConcentration	0.5±0	1.03	0.24±0.08	0.32	0.69±0.19	0.99
CinCECGTorso	0.5±0	1.03	0.16±0	0.32	0.36±0	0.99
Coffee	0.57±0	1.03	0.24±0	0.32	0.89±0	0.99
Computers	0.57±0.14	1.03	0.16±0.05	0.32	0.36±0	0.99
CricketX	0.5±0	1.03	0.24±0	0.32	0.37±0	0.99
CricketY	0.5±0	1.03	0.24±0	0.32	0.37±0	0.99
CricketZ	0.5±0	1.03	0.24±0	0.32	0.37±0.19	0.99
Crop	0.51±0.15	1.03	0.17±0.09	0.33	0.76±0.04	0.99
DiatomSizeReduction	0.5±0.15	1.03	0.32±0.09	0.32	0.99±0.11	0.99
DistalPhalanxOutlineAgeGroup	0.57±0.04	1.03	0.24±0	0.32	0.36±0.3	0.99
DistalPhalanxOutlineCorrect	0.5±0.15	1.03	0.16±0.05	0.32	0.26±0	0.99
DistalPhalanxTW	0.77±0.15	1.03	0.24±0	0.32	0.46±0.06	0.99
DodgerLoopDay	1.03±0	1.03	0.24±0	0.32	0.86±0	0.99
DodgerLoopGame	0.5±0.15	1.03	0.24±0.08	0.32	0.99±0.06	0.99
DodgerLoopWeekend	0.77±0.17	1.03	0.24±0.05	0.32	0.99±0.08	0.99
Earthquakes	0.5±0.15	1.03	0.24±0.05	0.32	0.36±0.3	0.99
ECG200	0.77±0.14	1.03	0.24±0	0.32	0.79±0.1	0.99
ECG5000	0.5±0	1.03	0.24±0.05	0.32	0.36±0.19	0.99
ECGFiveDays	0.57±0.04	1.03	0.24±0	0.32	0.36±0.06	0.99
ElectricDevices	1.03±0.15	1.03	0.16±0	0.32	0.66±0.02	0.99
EOGHorizontalSignal	0.57±0.04	1.03	0.16±0	0.32	0.69±0.27	0.99
EOGVerticalSignal	0.57±0	1.03	0.16±0	0.32	0.89±0	0.99
EthanolLevel	0.77±0.26	1.03	0.16±0	0.32	0.69±0	0.99
FaceAll	0.5±0.04	1.03	0.25±0	0.33	0.27±0	0.99
FaceFour	0.57±0.15	1.03	0.24±0	0.32	0.26±0.3	0.99
FacesUCR	0.83±0.15	1.03	0.25±0	0.33	0.79±0	0.99
FiftyWords	0.58±0.04	1.04	0.17±0	0.33	0.38±0.06	0.99
Fish	0.57±0.11	1.03	0.24±0	0.32	0.27±0	0.99
FordA	0.77±0.11	1.03	0.32±0.09	0.32	0.66±0.06	0.99
FordB	0.5±0.15	1.03	0.16±0.05	0.32	0.66±0	0.99
FreezerRegularTrain	0.57±0	1.03	0.24±0	0.32	0.89±0.39	0.99
FreezerSmallTrain	0.5±0	1.03	0.24±0.05	0.32	0.86±0.1	0.99
Fungi	0.51±0.04	1.03	0.17±0	0.33	0.37±0.06	0.99
GestureMidAirD1	0.57±0	1.03	0.17±0	0.33	0.37±0.3	0.99
GestureMidAirD2	0.57±0	1.03	0.17±0	0.33	0.37±0	0.99
GestureMidAirD3	0.51±0.04	1.03	0.17±0	0.33	0.37±0	0.99
GesturePebbleZ1	0.57±0.15	1.03	0.24±0.05	0.32	0.69±0.25	0.99
GesturePebbleZ2	0.57±0.04	1.03	0.24±0.05	0.32	0.36±0.19	0.99
GunPoint	0.57±0	1.03	0.16±0	0.32	0.89±0	0.99
GunPointAgeSpan	0.57±0.14	1.03	0.16±0	0.32	0.69±0.27	0.99
GunPointMaleVersusFemale	0.57±0.04	1.03	0.24±0	0.32	0.69±0.04	0.99
GunPointOldVersusYoung	0.77±0.15	1.03	0.16±0.09	0.32	0.69±0.13	0.99
Ham	0.57±0.15	1.03	0.16±0	0.32	0.36±0.22	0.99
HandOutlines	1.03±0.15	1.03	0.16±0	0.32	0.76±0.08	0.99
Haptics	0.57±0.04	1.03	0.16±0	0.32	0.26±0	0.99
Herring	0.5±0	1.03	0.24±0.05	0.32	0.36±0.3	0.99
HouseTwenty	0.5±0.04	1.03	0.24±0.05	0.32	0.46±0.27	0.99
InlineSkate	0.5±0	1.03	0.16±0.05	0.32	0.36±0.06	0.99
InsectEPGRegularTrain	0.5±0.04	1.03	0.16±0	0.32	0.46±0.21	0.99
InsectEPGSmallTrain	0.57±0.11	1.03	0.24±0.05	0.32	0.86±0.09	0.99

InsectWingbeatSound	0.57±0	1.03	0.16±0	0.32	0.27±0	0.99
ItalyPowerDemand	1.03±0	1.03	0.24±0	0.32	0.86±0	0.99
LargeKitchenAppliances	0.5±0	1.03	0.16±0	0.32	0.36±0	0.99
Lightning2	0.5±0	1.03	0.16±0	0.32	0.36±0.06	0.99
Lightning7	0.57±0.04	1.03	0.16±0.05	0.32	0.36±0	0.99
Mallat	0.57±0	1.03	0.24±0	0.32	0.27±0.06	0.99
Meat	0.57±0	1.03	0.16±0	0.32	0.36±0.06	0.99
MedicalImages	0.5±0	1.03	0.16±0	0.32	0.37±0	0.99
MelbournePedestrian	0.5±0.04	1.03	0.16±0	0.32	0.69±0.04	0.99
MiddlePhalanxOutlineAgeGroup	0.77±0.23	1.03	0.24±0	0.32	0.46±0.28	0.99
MiddlePhalanxOutlineCorrect	0.77±0.15	1.03	0.24±0.08	0.32	0.69±0.19	0.99
MiddlePhalanxTW	0.57±0.27	1.03	0.24±0.05	0.32	0.99±0	0.99
MixedShapesRegularTrain	0.5±0.04	1.03	0.24±0	0.32	0.36±0	0.99
MixedShapesSmallTrain	0.57±0.15	1.03	0.24±0	0.32	0.46±0.06	0.99
MoteStrain	0.57±0.14	1.03	0.24±0.05	0.32	0.36±0.39	0.99
NonInvasiveFetalECGThorax1	0.57±0.27	1.03	0.17±0	0.33	0.27±0	0.99
NonInvasiveFetalECGThorax2	0.57±0.27	1.03	0.17±0	0.33	0.27±0	0.99
OliveOil	0.5±0.04	1.03	0.16±0.05	0.32	0.86±0.1	0.99
OSULeaf	0.83±0	1.03	0.24±0	0.32	0.26±0	0.99
PhalangesOutlinesCorrect	0.83±0.23	1.03	0.16±0.05	0.32	0.66±0.27	0.99
Phoneme	0.77±0.15	1.03	0.25±0	0.33	0.9±0	0.99
PickupGestureWiimoteZ	0.5±0	1.03	0.16±0	0.32	0.37±0	0.99
PigAirwayPressure	0.58±0	1.04	0.25±0	0.33	0.99±0	0.99
PigArtPressure	0.84±0	1.04	0.17±0.05	0.33	0.27±0	0.99
PigCVP	0.77±0.15	1.04	0.17±0.05	0.33	0.66±0.08	0.99
PLAID	0.5±0.04	1.03	0.16±0	0.32	0.37±0	0.99
Plane	1.03±0	1.03	0.24±0	0.32	0.79±0	0.99
PowerCons	0.83±0.27	1.03	0.24±0.05	0.32	0.66±0.19	0.99
ProximalPhalanxOutlineAgeGroup	0.5±0.15	1.03	0.24±0	0.32	0.89±0	0.99
ProximalPhalanxOutlineCorrect	0.5±0	1.03	0.24±0	0.32	0.36±0.1	0.99
ProximalPhalanxTW	0.5±0	1.03	0.24±0	0.32	0.46±0.19	0.99
RefrigerationDevices	0.57±0.14	1.03	0.16±0.05	0.32	0.36±0	0.99
Rock	0.57±0.04	1.03	0.16±0.05	0.32	0.66±0.24	0.99
ScreenType	0.57±0	1.03	0.16±0	0.32	0.36±0.06	0.99
SemgHandGenderCh2	0.57±0.11	1.03	0.16±0	0.32	0.79±0.15	0.99
SemgHandMovementCh2	0.5±0	1.03	0.16±0	0.32	0.69±0.19	0.99
SemgHandSubjectCh2	0.5±0.15	1.03	0.16±0	0.32	0.69±0.11	0.99
ShakeGestureWiimoteZ	0.5±0	1.03	0.16±0.05	0.32	0.79±0.06	0.99
ShapeletSim	0.5±0.04	1.03	0.16±0.05	0.32	0.99±0.06	0.99
ShapesAll	0.58±0	1.04	0.25±0	0.33	0.27±0.06	0.99
SmallKitchenAppliances	0.5±0	1.03	0.16±0	0.32	0.36±0	0.99
SmoothSubspace	1.03±0	1.03	0.16±0.05	0.32	0.86±0.08	0.99
SonyAIBORobotSurface1	0.57±0.27	1.03	0.24±0	0.32	0.99±0	0.99
SonyAIBORobotSurface2	0.57±0.11	1.03	0.24±0.05	0.32	0.99±0	0.99
StarLightCurves	1.03±0	1.03	0.16±0	0.32	0.69±0.27	0.99
Strawberry	0.5±0.15	1.03	0.24±0.05	0.32	0.36±0.19	0.99
SwedishLeaf	0.5±0.04	1.03	0.25±0	0.33	0.46±0	0.99
Symbols	0.57±0.29	1.03	0.24±0	0.32	0.46±0	0.99
SyntheticControl	0.77±0.15	1.03	0.24±0	0.32	0.99±0	0.99
ToeSegmentation1	0.57±0.17	1.03	0.24±0.05	0.32	0.79±0.08	0.99
ToeSegmentation2	0.5±0.04	1.03	0.24±0.05	0.32	0.89±0.3	0.99
Trace	0.83±0.11	1.03	0.16±0.05	0.32	0.99±0.11	0.99
TwoLeadECG	0.5±0.19	1.03	0.24±0.05	0.32	0.89±0.28	0.99
TwoPatterns	1.03±0.27	1.03	0.32±0.05	0.32	0.26±0.25	0.99
UMD	0.77±0.23	1.03	0.24±0.05	0.32	0.33±0.25	0.99
UWaveGestureLibraryAll	0.5±0	1.03	0.24±0.05	0.32	0.69±0	0.99
UWaveGestureLibraryX	0.5±0	1.03	0.16±0.05	0.32	0.69±0	0.99
UWaveGestureLibraryY	0.5±0	1.03	0.24±0	0.32	0.69±0.19	0.99
UWaveGestureLibraryZ	0.5±0	1.03	0.24±0.05	0.32	0.69±0	0.99
Wafer	0.57±0.11	1.03	0.24±0.05	0.32	0.33±0.27	0.99
Wine	0.5±0.04	1.03	0.16±0	0.32	0.89±0.15	0.99
WordSynonyms	0.57±0	1.03	0.17±0.05	0.33	0.27±0	0.99
Worms	0.83±0.11	1.03	0.24±0	0.32	0.46±0.32	0.99
WormsTwoClass	0.57±0.15	1.03	0.24±0	0.32	0.89±0.1	0.99

Yoga	0.5±0	1.03	0.24±0	0.32	0.36±0	0.99
ArticulatoryWordRecognition	0.3±0	0.3	0.32±0.05	0.4	0.15±0.01	0.16
AtrialFibrillation	0.17±0	0.3	0.31±0.05	0.39	0.51±0.21	0.72
BasicMotions	0.24±0	0.3	0.31±0.08	0.39	0.1±0.01	0.11
CharacterTrajectories	0.17±0	0.3	0.24±0.09	0.4	0.16±0	0.2
Cricket	0.3±0	0.3	0.32±0.05	0.4	1.24±0.12	1.35
DuckDuckGeese	0.94±0	1.07	0.57±0.05	0.65	0.87±0.09	1.05
EigenWorms	0.3±0	0.3	0.31±0.08	0.39	14.43±6.25	20.34
Epilepsy	0.23±0.04	0.3	0.31±0.05	0.39	0.16±0.03	0.23
ERing	0.3±0.04	0.3	0.31±0.08	0.39	0.07±0.01	0.07
EthanolConcentration	0.17±0	0.3	0.31±0.08	0.39	1.8±0.49	1.97
FaceDetection	0.25±0.04	0.38	0.26±0.09	0.42	0.06±0.02	0.09
FingerMovements	0.25±0.07	0.31	0.32±0.05	0.4	0.03±0.01	0.06
HandMovementDirection	0.3±0	0.3	0.32±0.05	0.4	0.46±0.05	0.46
Handwriting	0.23±0.04	0.3	0.32±0.05	0.4	0.16±0.04	0.17
Heartbeat	0.27±0.04	0.33	0.24±0.09	0.4	0.33±0.11	0.5
InsectWingbeat	0.28±0	0.41	0.43±0	0.43	1.19±0	1.32
JapaneseVowels	0.3±0.04	0.3	0.32±0.05	0.4	0.02±0	0.03
Libras	0.23±0.07	0.3	0.31±0.08	0.4	0.03±0.01	0.05
LSST	0.24±0.04	0.3	0.24±0.09	0.4	0.02±0.01	0.04
MotorImagery	0.2±0.04	0.33	0.41±0.09	0.41	2.76±0.84	3.75
NATOPS	0.31±0	0.31	0.32±0.05	0.4	0.06±0.01	0.06
PEMS-SF	0.85±0	0.85	0.5±0.05	0.58	0.38±0.02	0.45
PenDigits	0.23±0	0.3	0.39±0.05	0.39	0.01±0	0.01
PhonemeSpectra	0.17±0	0.31	0.24±0	0.4	0.91±0	1.13
RacketSports	0.3±0.04	0.3	0.24±0.09	0.4	0.03±0	0.03
SelfRegulationSCP1	0.17±0	0.3	0.23±0.09	0.39	0.54±0.09	1.01
SelfRegulationSCP2	0.17±0	0.3	0.23±0.09	0.39	1.04±0.25	1.31
SpokenArabicDigits	0.17±0	0.31	0.4±0.09	0.4	0.09±0.01	0.11
StandWalkJump	0.17±0	0.3	0.31±0.05	0.39	0.68±0.47	2.82
UWaveGestureLibrary	0.23±0	0.3	0.31±0.05	0.39	0.32±0.03	0.35
HAR	0.17±0	0.3	0.32±0	0.40	0.90±0	1.13
Avg. Rank	3.25	5.25	1.33	2.47	3.61	5.09
Wilcoxon Test p-value	-	0.00	-	0.00	-	0.00

Table 1.2: Params (M) performances. The Wilcoxon signed-rank test is performed between each pair of the network over the 128 UCR datasets, 30 UEA datasets and one UCI dataset. Compared CNN-based method equipped with our regulatory framework with non-equipped counterpart, the better rank is highlighted, and then Holm’s method is used to reject the null hypothesis that the rank between these two networks is the same.

Datasets	ResNet+Regulator	ResNet	IT+Regulator	IT	FCN+Regulator	FCN
ACSF1	1.51±0	1.51	0.24±0.07	0.47	1.45±0	1.45
Adiac	0.1±0	0.18	0.04±0	0.06	0.08±0	0.17
AllGestureWiimoteX	0.19±0	0.40	0.06±0	0.13	0.14±0.12	0.38
AllGestureWiimoteY	0.19±0	0.40	0.06±0	0.13	0.14±0.12	0.38
AllGestureWiimoteZ	0.19±0	0.40	0.06±0	0.13	0.14±0.12	0.38
ArrowHead	0.14±0.03	0.26	0.06±0.01	0.08	0.12±0.05	0.25
Beef	0.27±0.06	0.49	0.08±0.02	0.15	0.17±0.03	0.47
BeetleFly	0.26±0.16	0.53	0.13±0	0.17	0.36±0.03	0.51
BirdChicken	0.26±0.08	0.53	0.13±0	0.17	0.46±0.14	0.51
BME	0.1±0.02	0.13	0.03±0.01	0.04	0.03±0.03	0.13
Car	0.48±0	0.60	0.14±0	0.19	0.15±0	0.57
CBF	0.1±0.02	0.13	0.03±0	0.04	0.06±0.04	0.13
Chinatown	0.02±0.01	0.02	0.01±0	0.01	0.02±0	0.02
ChlorineConcentration	0.08±0	0.17	0.04±0.01	0.05	0.12±0.03	0.16
CinCECGTorso	0.83±0	1.70	0.27±0	0.53	0.6±0	1.62
Coffee	0.16±0	0.30	0.07±0	0.09	0.25±0	0.28
Computers	0.41±0.1	0.74	0.12±0.03	0.23	0.26±0	0.71
CricketX	0.15±0	0.31	0.07±0	0.10	0.11±0	0.3
CricketY	0.15±0	0.31	0.07±0	0.10	0.11±0	0.3
CricketZ	0.15±0	0.31	0.07±0	0.10	0.11±0.06	0.3
Crop	0.02±0.01	0.05	0.01±0	0.01	0.03±0	0.05
DiatomSizeReduction	0.17±0.05	0.36	0.11±0.03	0.11	0.34±0.04	0.34
DistalPhalanxOutlineAgeGroup	0.05±0	0.08	0.02±0	0.03	0.03±0.02	0.08
DistalPhalanxOutlineCorrect	0.04±0.01	0.08	0.01±0	0.03	0.02±0	0.08
DistalPhalanxTW	0.06±0.01	0.08	0.02±0	0.03	0.04±0	0.08
DodgerLoopDay	0.3±0	0.30	0.07±0	0.09	0.25±0	0.29
DodgerLoopGame	0.15±0.04	0.30	0.07±0.02	0.09	0.29±0.02	0.29
DodgerLoopWeekend	0.22±0.05	0.30	0.07±0.01	0.09	0.29±0.02	0.29
Earthquakes	0.26±0.08	0.53	0.13±0.02	0.17	0.19±0.16	0.51
ECG200	0.07±0.01	0.10	0.02±0	0.03	0.08±0.01	0.1
ECG5000	0.07±0	0.14	0.03±0.01	0.05	0.05±0.03	0.14
ECGFiveDays	0.08±0.01	0.14	0.03±0	0.04	0.05±0.01	0.13
ElectricDevices	0.1±0.01	0.10	0.02±0	0.03	0.06±0	0.1
EOGHorizontalSignal	0.72±0.05	1.29	0.21±0	0.41	0.87±0.33	1.24
EOGVerticalSignal	0.72±0	1.29	0.21±0	0.41	1.11±0	1.24
EthanolLevel	1.35±0.46	1.81	0.29±0	0.57	1.21±0	1.73
FaceAll	0.07±0	0.14	0.03±0	0.04	0.03±0	0.13
FaceFour	0.2±0.05	0.36	0.09±0	0.11	0.09±0.11	0.35
FacesUCR	0.11±0.02	0.14	0.03±0	0.04	0.1±0	0.13
FiftyWords	0.15±0.01	0.28	0.04±0	0.09	0.1±0.02	0.27
Fish	0.27±0.05	0.48	0.11±0	0.15	0.12±0	0.46
FordA	0.39±0.06	0.52	0.16±0.05	0.16	0.33±0.03	0.49
FordB	0.25±0.08	0.52	0.08±0.02	0.16	0.33±0	0.49
FreezerRegularTrain	0.17±0	0.31	0.07±0	0.10	0.27±0.12	0.3
FreezerSmallTrain	0.15±0	0.31	0.07±0.01	0.10	0.26±0.03	0.3
Fungi	0.1±0.01	0.21	0.03±0	0.07	0.07±0.01	0.2
GestureMidAirD1	0.21±0	0.37	0.06±0	0.12	0.13±0.11	0.36
GestureMidAirD2	0.21±0	0.37	0.06±0	0.12	0.13±0	0.36
GestureMidAirD3	0.18±0.01	0.37	0.06±0	0.12	0.13±0	0.36
GesturePebbleZ1	0.26±0.07	0.47	0.11±0.02	0.15	0.32±0.11	0.45
GesturePebbleZ2	0.26±0.02	0.47	0.11±0.02	0.15	0.17±0.09	0.45
GunPoint	0.09±0	0.16	0.02±0	0.05	0.13±0	0.15
GunPointAgeSpan	0.09±0.02	0.16	0.02±0	0.05	0.1±0.04	0.15
GunPointMaleVersusFemale	0.09±0.01	0.16	0.04±0	0.05	0.1±0.01	0.15
GunPointOldVersusYoung	0.12±0.02	0.16	0.02±0.01	0.05	0.1±0.02	0.15
Ham	0.25±0.07	0.45	0.07±0	0.14	0.16±0.1	0.43
HandOutlines	2.8±0.41	2.80	0.45±0	0.88	2.06±0.23	2.68
Haptics	0.63±0.04	1.13	0.18±0	0.35	0.29±0	1.08
Herring	0.26±0	0.53	0.13±0.02	0.17	0.19±0.16	0.51
HouseTwenty	1.01±0.08	2.07	0.49±0.09	0.65	0.93±0.55	1.98
InlineSkate	0.95±0	1.95	0.31±0.09	0.61	0.69±0.11	1.86
InsectEPGRegularTrain	0.3±0.02	0.62	0.1±0	0.20	0.28±0.13	0.59
InsectEPGSmallTrain	0.34±0.07	0.62	0.15±0.03	0.20	0.52±0.06	0.59

InsectWingbeatSound	0.15±0	0.26	0.04±0	0.08	0.07±0	0.25
ItalyPowerDemand	0.02±0	0.02	0.01±0	0.01	0.02±0	0.02
LargeKitchenAppliances	0.36±0	0.74	0.12±0	0.23	0.26±0	0.71
Lightning2	0.32±0	0.66	0.1±0	0.21	0.23±0.04	0.63
Lightning7	0.18±0.01	0.33	0.05±0.01	0.10	0.12±0	0.32
Mallat	0.59±0	1.06	0.25±0	0.33	0.27±0.06	1.01
Meat	0.26±0	0.46	0.07±0	0.15	0.16±0.03	0.44
MedicalImages	0.05±0	0.10	0.02±0	0.03	0.04±0	0.1
MelbournePedestrian	0.01±0	0.02	0±0	0.01	0.02±0	0.02
MiddlePhalanxOutlineAgeGroup	0.06±0.02	0.08	0.02±0	0.03	0.04±0.02	0.08
MiddlePhalanxOutlineCorrect	0.06±0.01	0.08	0.02±0.01	0.03	0.06±0.02	0.08
MiddlePhalanxTW	0.05±0.02	0.08	0.02±0	0.03	0.08±0	0.08
MixedShapesRegularTrain	0.52±0.04	1.06	0.25±0	0.33	0.37±0	1.01
MixedShapesSmallTrain	0.59±0.16	1.06	0.25±0	0.33	0.48±0.06	1.01
MoteStrain	0.05±0.01	0.09	0.02±0	0.03	0.03±0.03	0.08
NonInvasiveFetalECGThorax1	0.43±0.2	0.78	0.12±0	0.24	0.2±0	0.74
NonInvasiveFetalECGThorax2	0.43±0.2	0.78	0.12±0	0.24	0.2±0	0.74
OliveOil	0.29±0.02	0.59	0.09±0.03	0.19	0.49±0.06	0.56
OSULeaf	0.36±0	0.44	0.1±0	0.14	0.11±0	0.42
PhalangesOutlinesCorrect	0.07±0.02	0.08	0.01±0	0.03	0.05±0.02	0.08
Phoneme	0.79±0.16	1.06	0.25±0	0.33	0.91±0	1.01
PickupGestureWiimoteZ	0.18±0	0.37	0.06±0	0.12	0.13±0	0.36
PigAirwayPressure	1.14±0	2.07	0.49±0	0.65	1.98±0	1.98
PigArtPressure	1.67±0	2.07	0.33±0.09	0.65	0.53±0	1.98
PigCVP	1.54±0.31	2.07	0.33±0.09	0.65	1.32±0.15	1.98
PLAID	0.68±0.05	1.39	0.22±0	0.44	0.49±0	1.33
Plane	0.15±0	0.15	0.04±0	0.05	0.11±0	0.14
PowerCons	0.12±0.04	0.15	0.04±0.01	0.05	0.1±0.03	0.14
ProximalPhalanxOutlineAgeGroup	0.04±0.01	0.08	0.02±0	0.03	0.07±0	0.08
ProximalPhalanxOutlineCorrect	0.04±0	0.08	0.02±0	0.03	0.03±0.01	0.08
ProximalPhalanxTW	0.04±0	0.08	0.02±0	0.03	0.04±0.02	0.08
RefrigerationDevices	0.41±0.1	0.74	0.12±0.03	0.23	0.26±0	0.71
Rock	1.63±0.11	2.94	0.47±0.13	0.92	1.88±0.68	2.82
ScreenType	0.41±0	0.74	0.12±0	0.23	0.26±0.04	0.71
SemgHandGenderCh2	0.86±0.17	1.55	0.25±0	0.49	1.19±0.23	1.48
SemgHandMovementCh2	0.76±0	1.55	0.25±0	0.49	1.04±0.28	1.48
SemgHandSubjectCh2	0.76±0.23	1.55	0.25±0	0.49	1.04±0.17	1.48
ShakeGestureWiimoteZ	0.19±0	0.40	0.06±0.02	0.13	0.3±0.02	0.38
ShapeletSim	0.25±0.02	0.52	0.08±0.02	0.16	0.49±0.03	0.49
ShapesAll	0.29±0	0.53	0.13±0	0.17	0.14±0.03	0.51
SmallKitchenAppliances	0.36±0	0.74	0.12±0	0.23	0.26±0	0.71
SmoothSubspace	0.02±0	0.02	0±0	0.00	0.01±0	0.01
SonyAIBORobotSurface1	0.04±0.02	0.07	0.02±0	0.02	0.07±0	0.07
SonyAIBORobotSurface2	0.04±0.01	0.07	0.02±0	0.02	0.06±0	0.06
StarLightCurves	1.06±0	1.06	0.17±0	0.33	0.71±0.27	1.01
Strawberry	0.12±0.04	0.24	0.06±0.01	0.08	0.09±0.04	0.23
SwedishLeaf	0.06±0	0.13	0.03±0	0.04	0.06±0	0.13
Symbols	0.23±0.11	0.41	0.1±0	0.13	0.18±0	0.39
SyntheticControl	0.05±0.01	0.06	0.01±0	0.02	0.06±0	0.06
ToeSegmentation1	0.16±0.05	0.29	0.07±0.01	0.09	0.22±0.02	0.27
ToeSegmentation2	0.17±0.01	0.35	0.08±0.02	0.11	0.31±0.1	0.34
Trace	0.23±0.03	0.28	0.05±0.01	0.09	0.27±0.03	0.27
TwoLeadECG	0.04±0.02	0.08	0.02±0	0.03	0.07±0.02	0.08
TwoPatterns	0.13±0.03	0.13	0.04±0.01	0.04	0.03±0.03	0.13
UMD	0.12±0.03	0.16	0.04±0.01	0.05	0.05±0.04	0.15
UWaveGestureLibraryAll	0.48±0	0.98	0.23±0.04	0.31	0.66±0	0.94
UWaveGestureLibraryX	0.16±0	0.33	0.05±0.01	0.10	0.22±0	0.31
UWaveGestureLibraryY	0.16±0	0.33	0.08±0	0.10	0.22±0.06	0.31
UWaveGestureLibraryZ	0.16±0	0.33	0.08±0.01	0.10	0.22±0	0.31
Wafer	0.09±0.02	0.16	0.04±0.01	0.05	0.05±0.04	0.15
Wine	0.12±0.01	0.24	0.04±0	0.08	0.21±0.04	0.23
WordSynonyms	0.15±0	0.28	0.04±0.01	0.09	0.07±0	0.27
Worms	0.75±0.1	0.93	0.22±0	0.29	0.42±0.29	0.89
WormsTwoClass	0.52±0.14	0.93	0.22±0	0.29	0.8±0.09	0.89

Yoga	0.22±0	0.44	0.1±0	0.14	0.16±0	0.42
ArticularyWordRecognition	0.04±0	0.04	0.05±0	0.06	1.03±0.06	1.13
AtrialFibrillation	0.11±0	0.19	0.2±0	0.25	0.79±0.33	1.12
BasicMotions	0.02±0	0.03	0.03±0	0.04	1.02±0.1	1.12
CharacterTrajectories	0.03±0	0.05	0.04±0	0.07	0.89±0.02	1.12
Cricket	0.37±0	0.37	0.38±0	0.47	1.03±0.1	1.12
DuckDuckGeese	0.44±0	0.48	0.15±0	0.18	1.84±0.32	2.49
EigenWorms	5.52±0	5.52	4.22±0.83	7.11	0.79±0.35	1.12
Epilepsy	0.05±0.01	0.06	0.06±0	0.08	0.79±0.17	1.12
ERing	0.02±0	0.02	0.02±0	0.03	1.12±0.11	1.12
EthanolConcentration	0.3±0	0.53	0.55±0.08	0.69	1.02±0.28	1.12
FaceDetection	0.02±0	0.03	0.02±0	0.03	0.84±0.27	1.26
FingerMovements	0.01±0	0.02	0.02±0	0.02	0.49±0.25	1.15
HandMovementDirection	0.12±0	0.12	0.13±0	0.16	1.13±0.11	1.13
Handwriting	0.04±0.01	0.05	0.05±0	0.06	1.03±0.25	1.12
Heartbeat	0.12±0.02	0.15	0.1±0	0.16	0.75±0.28	1.18
InsectWingbeat	0.01±0	0.01	0.01±0	0.01	0.03±0	0.03
JapaneseVowels	0.01±0	0.01	0.01±0	0.01	0.8±0.17	1.13
Libras	0.01±0	0.01	0.01±0	0.02	0.6±0.27	1.12
LSST	0.01±0	0.01	0.01±0	0.01	0.66±0.17	1.12
MotorImagery	0.7±0.12	1.1	1.22±0.28	1.22	0.85±0.28	1.18
NATOPS	0.02±0	0.02	0.02±0	0.02	1.14±0.19	1.14
PEMS-SF	0.19±0	0.19	0.07±0	0.08	1.68±0.13	2.1
PenDigits	0±0	0	0±0	0	0.89±0.36	1.12
PhonemeSpectra	0.04±0	0.07	0.05±0	0.09	0.2±0	1.12
RacketSports	0.01±0	0.01	0.01±0.03	0.09	1.12±0.11	1.12
SelfRegulationSCP1	0.16±0	0.27	0.21±0	0.35	0.6±0.1	1.12
SelfRegulationSCP2	0.2±0	0.35	0.27±0	0.46	0.89±0.21	1.12
SpokenArabicDigits	0.02±0	0.03	0.02±0.01	0.04	1±0.09	1.13
StandWalkJump	0.43±0	0.76	0.79±0	0.99	0.27±0.19	1.12
UWaveGestureLibrary	0.07±0	0.1	0.1±0	0.12	1.02±0.1	1.12
HAR	0.02±0	0.04	0.04±0	0.05	0.12±0	0.15
Avg. Rank	3.31	5.30	1.26	2.45	3.59	5.08
Wilcoxon Test p-value	-	0.00	-	0.00	-	0.00

Table 1.3: FLOPs (G) performances. The Wilcoxon signed-rank test is performed between each pair of the network over the 128 UCR datasets, 30 UEA datasets and one UCI dataset. Compared CNN-based method equipped with our regulatory framework with non-equipped counterpart, the better rank is highlighted, and then Holm’s method is used to reject the null hypothesis that the rank between these two networks is the same.

References

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