Supplementary Material for Paper
Extreme Value Theory-Driven Robust Feature Selection with Application to Operator Stiffness Estimation

Chan Xu, Silu Chen, *Senior Member, IEEE*, Dehao Wang, Xiangjie Kong,
Chi Zhang, *Senior Member, IEEE*, Guilin Yang, *Member, IEEE*,
Chenguang Yang, *Fellow, IEEE*, and Zaojun Fang

S1. Supplementary Tables

Tables S1 – S4 provide the supplementary results corresponding to Section IV-C, reporting the classification accuracies with standard deviations, where the best results are highlighted in bold. The "Win" and "Loss" indicators denote the number of datasets on which NF-MRMR outperforms or underperforms the competing methods, respectively. The "Rank" represents the average ranking based on classification accuracies across the 15 datasets.

TABLE S1
Comparison of Classification Accuracy (Mean±Std %) for Ten Feature Selection Methods Using DT Classifier.

Dataset	mRMR	MNFR-MR	MRMSR	ANMVFS	C-FSAE	TAGA	BMFS	InfFS	CNAFS	NF-MRMR
Chia	51.62±0.82	77.57±0.41	73.68±0.48	51.54±0.56	67.30±0.49	74.61±0.54	44.50±0.76	64.16±0.63	59.69±0.68	**78.82±0.60**
Chri	86.00±0.30	99.56±0.04	96.73±0.18	94.86±0.15	97.86±0.13	**99.77±0.05**	93.10±0.22	97.04±0.07	94.06±0.21	99.53±0.05
Coil	56.25±0.10	**61.70±0.17**	53.46±0.15	52.36±0.18	18.57±0.06	58.60±0.12	50.46±0.19	51.02±0.20	57.87±0.22	59.73±0.18
Fash	53.54±0.03	58.15±0.05	36.37±0.06	49.98±0.04	12.68±0.02	51.11±0.04	37.33±0.03	45.62±0.05	18.16±0.02	**61.05±0.05**
Glio	63.23±0.72	61.67±0.77	**68.64±0.73**	45.98±0.96	45.80±0.36	54.77±1.02	40.16±0.93	41.75±0.64	40.13±0.83	67.60±0.75
Lung	78.39±0.29	88.04±0.44	83.60±0.34	76.36±0.27	79.23±0.39	80.06±0.32	79.24±0.36	79.87±0.40	71.75±0.49	**88.53±0.42**
Orl	30.53±0.23	29.62±0.35	**31.33±0.21**	25.39±0.19	20.78±0.21	24.86±0.17	17.84±0.26	18.63±0.34	23.40±0.22	29.46±0.24
Orlr	71.52±0.43	73.02±0.33	73.00±0.78	57.98±0.85	48.60±0.60	74.01±0.59	55.98±0.44	48.57±0.40	56.60±0.41	**77.45±0.52**
Pixr	95.76±0.10	95.42±0.19	91.11±0.15	91.88±0.17	77.82±0.45	95.56±0.15	80.82±0.42	72.76±0.39	75.64±0.57	**97.19±0.17**
Smkc	56.49±0.75	**66.90±0.80**	60.81±0.68	54.66±0.36	62.26±0.39	65.04±0.65	66.51±0.56	55.83±0.78	54.76±0.69	66.57±0.57
Subr	55.26±0.91	80.10±1.14	65.76±1.11	54.24±0.67	64.83±0.77	**82.16±0.94**	79.92±0.72	50.20±0.95	54.88±1.06	77.86±0.89
Waar	55.36±0.51	51.15±0.63	61.83±0.53	34.56±0.65	33.40±0.61	64.04±0.53	38.97±0.54	33.21±0.50	24.58±0.59	**67.83±0.63**
Wpie	64.72±0.58	68.39±0.51	70.67±0.46	57.55±0.42	50.02±0.46	62.73±0.45	60.27±0.36	55.95±0.39	46.21±0.38	**70.98±0.29**
Yale	40.32±0.56	39.24±0.44	46.03±0.55	38.69±0.47	31.50±0.48	48.29±0.58	21.23±0.57	25.41±0.58	35.41±0.45	**49.19±0.47**
Yeoh	35.45±0.43	83.97±0.24	81.22±0.34	38.71±0.33	74.57±0.35	40.82±0.44	64.61±0.35	64.70±0.38	71.78±0.26	**84.72±0.25**
Accuracy	59.63±0.45	68.97±0.43	66.28±0.45	54.98±0.42	52.35±0.38	65.10±0.44	55.40±0.45	53.65±0.45	52.33±0.47	**71.77±0.41**
Win/Loss	15 / 0	13 / 2	13 / 2	15 / 0	15 / 0	13 / 2	15 / 0	15 / 0	15 / 0	-
Rank	5.47	2.73	4.07	7.13	7.20	3.53	7.33	7.80	8.00	1.73

TABLE S2
COMPARISON OF CLASSIFICATION ACCURACY (MEAN±STD %) FOR TEN FEATURE SELECTION METHODS USING KNN CLASSIFIER.

Dataset	mRMR	MNFR-MR	MRMSR	ANMVFS	C-FSAE	TAGA	BMFS	InfFS	CNAFS	NF-MRMR
Chia	57.45±0.42	**87.04±0.28**	74.42±0.35	55.94±0.32	69.98±0.21	81.37±0.24	51.55±0.39	71.32±0.49	66.84±0.31	85.82±0.31
Chri	84.66±0.19	99.64±0.03	98.69±0.05	94.51±0.17	98.06±0.05	**99.80±0.01**	96.55±0.11	96.28±0.06	94.69±0.12	99.65±0.03
Coil	79.36±0.09	81.07±0.07	69.12±0.13	70.77±0.04	17.42±0.05	80.53±0.07	64.65±0.12	65.24±0.06	75.48±0.09	**84.19±0.09**
Fash	55.42±0.06	64.47±0.04	43.20±0.07	56.20±0.09	13.30±0.02	56.28±0.04	40.65±0.03	52.13±0.04	19.98±0.05	**68.49±0.04**
Glio	54.18±0.63	75.51±0.62	62.32±0.56	51.40±0.76	37.07±0.48	67.12±0.59	33.56±0.85	40.74±0.83	47.16±0.59	**80.26±0.61**
Lung	82.87±0.15	92.59±0.07	88.55±0.12	80.92±0.17	83.82±0.18	82.04±0.13	84.56±0.17	84.77±0.23	76.99±0.15	**94.77±0.09**
Orl	43.50±0.21	42.72±0.28	49.27±0.19	45.27±0.24	31.98±0.24	43.13±0.18	18.37±0.16	22.97±0.19	44.70±0.22	**58.92±0.21**
Orlr	58.11±0.44	57.96±0.39	72.30±0.35	47.78±0.44	54.06±0.40	78.21±0.54	45.92±0.37	39.97±0.61	46.61±0.44	**79.90±0.25**
Pixr	81.04±0.26	81.32±0.24	72.26±0.15	83.20±0.16	63.72±0.29	93.70±0.09	76.96±0.24	48.53±0.35	57.57±0.35	**95.26±0.11**
Smkc	61.00±0.53	74.99±0.35	68.02±0.46	60.36±0.50	68.60±0.31	73.41±0.27	69.70±0.25	60.07±0.54	56.56±0.44	**76.69±0.23**
Subr	67.14±0.59	81.48±0.38	73.99±0.64	64.34±0.51	66.61±0.49	89.46±0.33	**91.15±0.30**	64.73±0.53	65.00±0.56	81.70±0.43
Waar	48.39±0.32	45.24±0.32	55.75±0.34	24.19±0.38	31.70±0.38	61.04±0.45	36.39±0.44	28.99±0.43	19.55±0.32	**66.77±0.36**
Wpie	66.74±0.41	72.43±0.23	77.70±0.26	63.13±0.32	43.12±0.36	64.41±0.41	62.60±0.36	37.16±0.30	52.57±0.50	**81.55±0.34**
Yale	35.35±0.35	35.58±0.38	48.39±0.28	39.16±0.33	24.07±0.26	48.48±0.36	24.56±0.46	24.69±0.42	28.35±0.23	**56.16±0.35**
Yeoh	37.38±0.33	90.27±0.15	88.84±0.12	44.04±0.33	79.97±0.22	42.19±0.36	72.98±0.26	65.86±0.27	78.14±0.17	**91.36±0.10**
Accuracy	60.84±0.33	72.15±0.26	69.52±0.27	58.75±0.32	52.23±0.26	70.74±0.27	58.01±0.30	53.56±0.36	55.35±0.30	**80.10±0.24**
Win/Loss	15 / 0	14 / 1	15 / 0	15 / 0	15 / 0	14 / 1	14 / 1	15 / 0	15 / 0	-
Rank	6.00	3.27	4.20	6.73	7.33	3.60	7.07	7.87	7.67	1.27

TABLE S3
COMPARISON OF CLASSIFICATION ACCURACY (MEAN±STD %) FOR TEN FEATURE SELECTION METHODS USING NN CLASSIFIER.

Dataset	mRMR	MNFR-MR	MRMSR	ANMVFS	C-FSAE	TAGA	BMFS	InfFS	CNAFS	NF-MRMR
Chia	51.38±0.76	**83.45±0.45**	73.34±0.57	48.18±0.71	69.19±0.61	78.32±0.44	41.91±0.64	67.65±0.66	62.91±0.47	82.28±0.47
Chri	86.58±0.21	99.61±0.04	99.13±0.09	95.27±0.17	98.51±0.09	**99.84±0.04**	96.28±0.10	97.24±0.13	95.99±0.20	99.58±0.04
Coil	81.10±0.20	82.57±0.20	75.13±0.26	71.59±0.06	18.13±0.07	80.42±0.19	67.49±0.25	65.85±0.14	77.89±0.19	**83.55±0.20**
Fash	58.53±0.04	64.63±0.07	42.44±0.07	57.33±0.20	13.34±0.01	58.09±0.06	39.04±0.07	52.72±0.07	20.85±0.02	**69.05±0.06**
Glio	52.83±0.99	69.64±0.61	62.74±1.18	50.96±1.01	46.73±0.90	63.36±0.89	39.02±1.16	36.65±1.18	43.82±0.80	**83.06±0.97**
Lung	78.58±0.32	91.29±0.23	87.66±0.29	78.21±0.39	81.06±0.47	78.29±0.29	82.54±0.36	82.51±0.21	72.90±0.41	**92.29±0.24**
Orl	45.69±0.38	45.29±0.39	46.99±0.42	38.56±0.42	28.10±0.33	37.95±0.36	19.28±0.35	25.37±0.25	38.52±0.43	**50.26±0.53**
Orlr	69.88±0.88	70.74±0.79	78.27±0.50	59.59±0.58	52.54±0.96	79.67±0.52	58.42±0.95	50.43±0.66	50.96±0.63	**86.26±0.48**
Pixr	91.92±0.45	92.41±0.50	88.00±0.42	88.52±0.61	68.82±0.68	92.43±0.67	79.06±0.60	66.21±0.69	71.16±0.61	**94.00±0.50**
Smkc	57.72±0.50	72.40±0.39	61.78±0.50	57.36±0.77	66.17±0.55	65.72±0.54	65.83±0.44	56.36±0.56	56.03±0.53	**72.53±0.40**
Subr	60.86±1.12	84.04±0.52	71.23±1.02	57.68±0.90	59.83±0.96	83.66±0.75	**86.68±0.62**	56.69±0.93	52.63±1.10	84.41±0.83
Waar	53.79±0.57	52.29±0.59	66.48±0.75	38.85±0.54	35.25±0.70	66.81±0.54	39.66±0.44	36.70±0.71	26.41±0.61	**70.77±0.73**
Wpie	77.34±0.63	78.05±0.40	79.07±0.46	76.54±0.45	57.75±0.57	78.32±0.54	70.76±0.48	56.53±0.23	68.73±0.39	**83.70±0.43**
Yale	33.89±0.41	32.87±0.53	43.39±0.76	35.24±0.40	24.34±0.29	47.96±0.29	18.68±0.33	19.68±0.36	29.35±0.66	**51.00±0.59**
Yeoh	34.16±0.54	89.20±0.23	87.33±0.20	40.04±0.28	79.17±0.29	38.72±0.42	69.21±0.29	66.22±0.39	77.68±0.29	**90.87±0.25**
Accuracy	62.28±0.53	73.9±0.40	70.87±0.50	59.59±0.50	53.26±0.50	69.97±0.44	58.26±0.47	55.79±0.48	56.39±0.49	**79.57±0.45**
Win/Loss	15 / 0	14 / 1	15 / 0	15 / 0	15 / 0	14 / 1	14 / 1	15 / 0	15 / 0	-
Rank	5.67	2.93	4.07	6.80	7.20	3.93	6.93	8.20	8.00	1.27

TABLE S4
COMPARISON OF CLASSIFICATION ACCURACY (MEAN±STD %) FOR TEN FEATURE SELECTION METHODS USING SVM CLASSIFIER.

Dataset	mRMR	MNFR-MR	MRMSR	ANMVFS	C-FSAE	TAGA	BMFS	InfFS	CNAFS	NF-MRMR
Chia	56.10±0.60	**86.15±0.41**	75.34±0.42	51.50±0.50	71.77±0.48	77.48±0.49	44.28±0.57	69.98±0.32	67.76±0.47	85.20±0.38
Chri	87.47±0.16	99.39±0.13	99.24±0.03	94.93±0.15	98.84±0.06	**99.47±0.17**	96.45±0.21	96.38±0.14	96.22±0.14	99.43±0.14
Coil	85.19±0.14	89.76±0.11	85.34±0.10	81.93±0.18	15.86±0.10	88.17±0.11	77.09±0.07	67.56±0.16	85.22±0.14	**91.16±0.04**
Fash	44.44±0.23	61.10±0.20	38.86±0.25	54.29±0.17	10.82±0.10	55.06±0.20	25.38±0.32	48.33±0.12	10.73±0.11	**66.64±0.15**
Glio	54.33±0.69	71.76±0.75	66.13±0.95	54.32±0.81	43.61±0.50	66.22±0.75	40.05±0.66	38.92±0.60	49.07±1.00	**84.62±0.57**
Lung	72.82±0.69	92.31±0.35	90.02±0.26	81.01±0.62	83.30±0.27	82.82±0.33	84.82±0.35	86.02±0.26	79.34±0.25	**93.27±0.24**
Orl	68.08±0.27	66.89±0.20	66.69±0.22	60.21±0.28	43.88±0.21	60.71±0.22	31.09±0.27	41.08±0.28	63.56±0.22	**73.45±0.15**
Orlr	76.67±0.42	77.02±0.35	88.31±0.21	72.43±0.43	65.79±0.40	90.66±0.28	67.46±0.29	55.15±0.65	61.83±0.55	**93.47±0.25**
Pixr	96.54±0.17	96.39±0.10	91.97±0.24	90.84±0.16	77.95±0.48	95.68±0.14	82.11±0.34	72.35±0.46	84.51±0.32	**97.25±0.18**
Smkc	58.44±0.34	73.55±0.39	64.54±0.58	58.22±0.47	63.93±0.43	64.13±0.57	65.67±0.43	56.87±0.42	55.10±0.49	**74.01±0.51**
Subr	61.60±0.95	**87.93±0.42**	76.34±0.74	59.14±0.61	63.62±0.77	85.86±0.55	88.34±0.43	58.97±0.73	56.72±0.95	87.29±0.60
Waar	61.46±0.29	60.74±0.57	70.78±0.35	46.88±0.45	41.82±0.50	75.08±0.42	48.32±0.32	39.21±0.53	32.82±0.45	**81.64±0.38**
Wpie	84.63±0.22	84.36±0.20	86.30±0.15	75.22±0.30	66.58±0.33	86.80±0.19	78.72±0.29	66.00±0.49	79.01±0.42	**90.18±0.18**
Yale	44.69±0.40	44.45±0.37	52.29±0.36	45.75±0.46	34.60±0.42	55.89±0.38	26.19±0.38	31.04±0.29	42.53±0.25	**62.03±0.27**
Yeoh	38.89±0.26	91.09±0.14	89.87±0.16	45.58±0.43	82.42±0.30	43.39±0.41	72.28±0.26	70.28±0.19	82.25±0.29	**92.22±0.17**
Accuracy	66.09±0.39	78.86±0.31	76.13±0.33	64.82±0.40	57.65±0.36	75.16±0.35	61.88±0.35	59.88±0.38	63.11±0.40	**84.79±0.28**
Win/Loss	15 / 0	13 / 2	15 / 0	15 / 0	15 / 0	14 / 1	15 / 0	15 / 0	15 / 0	-
Rank	6.07	2.93	3.93	7.00	7.27	3.73	6.93	8.20	7.67	1.27