A primal perspective for indefinite kernel SVM problem

Hui XUE, Hai-Ming XU, Xiao-Hong CHEN, Yun-Yun WANG

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Problems & Ideas

- Problems of Indefinite Kernel Support Vector Machines (IKSVM)
  - IKSVM is a **non-convex** and **NP-hard** problem
  - Most of the existing methods either **change the spectrum of indefinite kernel matrix directly** but risking **losing some valuable information**, or solve the **dual form of IKSVM** whereas suffering from **a dual gap problem**

- Ideas: A primal perspective method & IKSVM-DC algorithm
  - Propose a novel algorithm named IKSVM-DC to solve the primal form of IKSVM
  - Theoretical analysis is presented to validate that IKSVM-DC algorithm can converge to a local minimum
  - Construct a multi-class IKSVM model which can classify multiple classes in a unified form

Main Contributions

- **Classification accuracy of compared algorithms on binary datasets**

	Clip	Flip	Shift	SMO-IKSVM	TDCASVM	IKSVM-CA	ESVM	1-norm IKSVM	IKSVM-DC
Ion.	73.72%±0.104•	75.92%±0.086•	67.72%±0.055•	73.11%±0.108•	74.93%±0.047•	86.56%±0.057•	88.68%±0.020•	91.93%±0.016•	**93.64%±0.011**
Son.	67.63%±0.062•	68.93%±0.017•	65.83%±0.047•	64.94%±0.068•	63.86%±0.072•	75.86%±0.030•	73.44%±0.027•	79.23%±0.030•	**84.83%±0.023**
Tit.	73.62%±0.068•	77.40%±0.009•	71.78%±0.071•	74.3%4±0.051•	73.60%±0.043•	78.84%±0.005	78.82%±0.005	78.76%±0.005•	**79.18%±0.004**
Bre.	73.11%±0.022•	73.69%±0.023•	71.34%±0.007•	72.79%±0.020•	74.16%±0.022•	37.50%±0.395•	73.47%±0.027•	73.85%±0.026•	**78.33%±0.015**
Thy.	89.94%±0.039•	92.16%±0.036•	75.78%±0.074•	87.22%±0.041•	87.78%±0.057•	94.05%±0.025•	92.76%±0.051•	94.17%±0.034•	**97.73%±0.019**
Fla.	60.46%±0.052•	58.91%±0.050•	55.37%±0.000•	58.81%±0.049•	56.97%±0.026•	66.42%±0.039	63.27%±0.055•	62.35%±0.059•	**68.16%±0.013**
Bal.	47.87%±0.055•	47.16%±0.031•	48.28%±0.053•	49.98%±0.035•	55.84%±0.016•	51.31%±0.040•	53.68%±0.029•	54.69%±0.044•	**57.08%±0.031**
Pro.	67.90%±0.000•	67.97%±0.000•	67.91%±0.000•	67.93%±0.000•	68.98%±0.029•	95.81%±0.063•	99.07%±0.010	85.98%±0.070•	**99.91%±0.003**

- **Classification accuracy of compared algorithms on multi-class datasets**

	Strategy: One vs. One								Unified Form
	Clip	Flip	Shift	SMO-IKSVM	TDCASVM	IKSVM-CA	ESVM	1-norm IKSVM	IKSVM-DC
Der.	96.34%±0.066	94.12%±0.136	93.36%±0.148	62.08%±0.025•	95.32%±0.017•	98.63%±0.006	95.61%±0.087	97.15%±0.009•	**98.46%±0.006**
Eco.	72.34%±0.187•	71.11%±0.169•	67.18%±0.195•	63.63%±0.103•	66.67%±0.108•	89.13%±0.029	83.96%±0.096	88.01%±0.021•	**90.14%±0.021**
New.	90.65%±0.043•	92.24%±0.027•	83.86%±0.064•	70.14%±0.000•	86.46%±0.043•	96.67%±0.015•	97.13%±0.015•	97.85%±0.012•	**99.37%±0.011**
Gla.	53.05%±0.059•	55.33%±0.068•	53.26%±0.067•	47.84%±0.038•	50.01%±0.021•	61.35%±0.089•	68.73%±0.064	67.95%±0.052•	**72.42%±0.032**
Coi.	13.56%±0.034•	13.53%±0.033•	16.96%±0.028•	21.72%±0.078•	25.85%±0.026•	31.03%±0.017•	62.25%±0.032•	40.45%±0.035•	**67.37%±0.037**
Zon.	00.00%±0.000•	00.10%±0.001•	00.00%±0.000•	00.00%±0.000•	00.40%±0.002•	37.33%±0.021•	91.35%±0.007•	28.14%±0.029•	**92.54%±0.009**
C5.	26.55%±0.000•	26.56%±0.000•	26.52%±0.000•	26.56%±0.000•	24.93%±0.023•	28.45%±0.010•	76.17%±0.040•	64.85%±0.026•	**81.06%±0.033**
C10.	26.56%±0.000•	26.58%±0.000•	26.53%±0.000•	26.56%±0.000•	24.47%±0.044•	27.81%±0.009•	84.25%±0.024•	63.03%±0.023•	**89.46%±0.021**
C20.	26.55%±0.000•	26.56%±0.000•	26.54%±0.000•	26.54%±0.000•	20.67%±0.026•	27.13%±0.006•	87.17%±0.023•	59.56%±0.035•	**92.15%±0.028**
C30.	26.55%±0.000•	26.56%±0.000•	26.52%±0.000•	26.57%±0.000•	17.96%±0.031•	27.26%±0.007•	89.33%±0.019•	52.46%±0.028•	**92.48%±0.018**
C40.	26.57%±0.000•	26.56%±0.000•	26.57%±0.000•	26.53%±0.000•	18.47%±0.048•	26.84%±0.004•	86.57%±0.027•	50.64%±0.036•	**90.26%±0.022**
	Strategy: One vs. Rest								Unified Form
	Clip	Flip	Shift	SMO-IKSVM	TDCASVM	IKSVM-CA	ESVM	1-norm IKSVM	IKSVM-DC
Der.	94.85%±0.052•	94.26%±0.065	77.01%±0.195•	96.86%±0.007•	86.24%±0.023•	97.11%±0.007•	95.54%±0.060	95.36%±0.009•	**98.46%±0.006**
Eco.	68.65%±0.126•	67.87%±0.109•	50.11%±0.084•	69.84%±0.131•	66.16%±0.089•	79.93%±0.031•	77.47%±0.107•	83.46%±0.031•	**90.14%±0.021**
New.	76.57%±0.050•	79.49%±0.038•	73.63%±0.035•	74.98%±0.049•	79.38%±0.047•	80.83%±0.044•	93.57%±0.023•	87.93%±0.024•	**99.37%±0.011**
Gla.	44.24%±0.038•	47.22%±0.034•	41.45%±0.035•	43.18%±0.030•	47.84%±0.025•	47.42%±0.035•	65.06%±0.056•	60.97%±0.045•	**72.42%±0.032**
Coi.	25.15%±0.004•	25.02%±0.000•	26.27%±0.015•	26.33%±0.018•	25.92%±0.019•	25.05%±0.000•	55.41%±0.039•	27.07%±0.016•	**67.37%±0.037**
Zon.	10.01%±0.000•	10.00%±0.000•	10.02%±0.000•	10.01%±0.000•	10.01%±0.000•	10.00%±0.000•	61.74%±0.060•	44.67%±0.019•	**92.54%±0.009**
C5.	17.00%±0.000•	17.01%±0.000•	17.00%±0.000•	17.53%±0.010•	18.75%±0.021•	17.00%±0.000•	52.22%±0.048•	48.34%±0.042•	**81.06%±0.033**
C10.	17.04%±0.000•	17.05%±0.000•	17.02%±0.000•	17.03%±0.000•	20.86%±0.020•	17.01%±0.000•	55.75%±0.092•	50.65%±0.033•	**89.46%±0.021**
C20.	17.01%±0.000•	17.04%±0.000•	17.02%±0.000•	17.03%±0.000•	21.51%±0.000•	17.03%±0.000•	72.21%±0.035•	46.64%±0.022•	**92.15%±0.028**
C30.	17.04%±0.000•	17.03%±0.000•	17.00%±0.000•	17.52%±0.000•	21.52%±0.000•	17.25%±0.004•	80.46%±0.069•	46.92%±0.031•	**92.48%±0.018**
C40.	17.04%±0.000•	17.00%±0.000•	17.02%±0.000•	17.01%±0.000•	20.66%±0.018•	18.31%±0.011•	82.25%±0.056•	47.11%±0.024•	**90.26%±0.022**