TableS1. The results of 10 repetitions of Hamming loss and top-*k* on ML-*k*NN, MLTSVM, NLSD-MLP, NLSD-XGB, NLSD-EXT, NLSD-RF, NLSD-SVM with 10×5-fold-cross-validation *in CV method* and the previous work.

TableS1.1 The results of 10 repetitions of Hamming loss and top-*k* on ML-*k*NN with 10×5-fold-cross-validation in CV method and the previous work.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ML-*k*NN (CV) | Hamming loss | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Valid\_1 |  |  |  |  |
| Valid\_2 |  |  |  |  |
| Valid\_3 |  |  |  |  |
| Valid\_4 |  |  |  |  |
| Valid\_5 |  |  |  |  |
| Valid\_6 |  |  |  |  |
| Valid\_7 |  |  |  |  |
| Valid\_8 |  |  |  |  |
| Valid\_9 |  |  |  |  |
| Valid\_10 |  |  |  |  |
| Average |  |  |  |  |
| 7-Class RF  (Previous Work) | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |

TableS1.2 The results of 10 repetitions of Hamming loss and top-*k* on MLTSVM with 10×5-fold-cross-validation in CV method and the previous work.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| MLTSVM (CV) | Hamming loss | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Valid\_1 |  | —— | —— | —— |
| Valid\_2 |  |
| Valid\_3 |  |
| Valid\_4 |  |
| Valid\_5 |  |
| Valid\_6 |  |
| Valid\_7 |  |
| Valid\_8 |  |
| Valid\_9 |  |
| Valid\_10 |  |
| Average |  |
| 7-Class RF  (Previous Work) | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |

TableS1.3 The results of 10 repetitions of Hamming loss and top-*k* on NLSD-MLP with 10×5-fold-cross-validation in CV method and the previous work.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NLSD-MLP (CV) | Hamming loss | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Valid\_1 |  |  |  |  |
| Valid\_2 |  |  |  |  |
| Valid\_3 |  |  |  |  |
| Valid\_4 |  |  |  |  |
| Valid\_5 |  |  |  |  |
| Valid\_6 |  |  |  |  |
| Valid\_7 |  |  |  |  |
| Valid\_8 |  |  |  |  |
| Valid\_9 |  |  |  |  |
| Valid\_10 |  |  |  |  |
| Average |  |  |  |  |
| 7-Class RF  (Previous Work) | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |

TableS1.4 The results of 10 repetitions of Hamming loss and top-*k* on NLSD-XGB with 10×5-fold-cross-validation in CV method and the previous work.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NLSD-XGB (CV) | Hamming loss | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Valid\_1 |  |  |  |  |
| Valid\_2 |  |  |  |  |
| Valid\_3 |  |  |  |  |
| Valid\_4 |  |  |  |  |
| Valid\_5 |  |  |  |  |
| Valid\_6 |  |  |  |  |
| Valid\_7 |  |  |  |  |
| Valid\_8 |  |  |  |  |
| Valid\_9 |  |  |  |  |
| Valid\_10 |  |  |  |  |
| Average |  |  |  |  |
| 7-Class RF  (Previous Work) | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |

TableS1.5 The results of 10 repetitions of Hamming loss and top-*k* on NLSD-EXT with 10×5-fold-cross-validation in CV method and the previous work.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NLSD-EXT (CV) | Hamming loss | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Valid\_1 |  |  |  |  |
| Valid\_2 |  |  |  |  |
| Valid\_3 |  |  |  |  |
| Valid\_4 |  |  |  |  |
| Valid\_5 |  |  |  |  |
| Valid\_6 |  |  |  |  |
| Valid\_7 |  |  |  |  |
| Valid\_8 |  |  |  |  |
| Valid\_9 |  |  |  |  |
| Valid\_10 |  |  |  |  |
| Average |  |  |  |  |
| 7-Class RF  (Previous Work) | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |

TableS1.6 The results of 10 repetitions of Hamming loss and top-*k* on NLSD-RF with 10×5-fold-cross-validation in CV method and the previous work.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NLSD-RF  (CV) | Hamming loss | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Valid\_1 |  |  |  |  |
| Valid\_2 |  |  |  |  |
| Valid\_3 |  |  |  |  |
| Valid\_4 |  |  |  |  |
| Valid\_5 |  |  |  |  |
| Valid\_6 |  |  |  |  |
| Valid\_7 |  |  |  |  |
| Valid\_8 |  |  |  |  |
| Valid\_9 |  |  |  |  |
| Valid\_10 |  |  |  |  |
| Average |  |  |  |  |
| 7-Class RF  (Previous Work) | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |

TableS1.7 The results of 10 repetitions of Hamming loss and top-*k* on NLSD-SVM with 10×5-fold-cross-validation in CV method and the previous work.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NLSD-SVM (CV) | Hamming loss | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Valid\_1 |  |  |  |  |
| Valid\_2 |  |  |  |  |
| Valid\_3 |  |  |  |  |
| Valid\_4 |  |  |  |  |
| Valid\_5 |  |  |  |  |
| Valid\_6 |  |  |  |  |
| Valid\_7 |  |  |  |  |
| Valid\_8 |  |  |  |  |
| Valid\_9 |  |  |  |  |
| Valid\_10 |  |  |  |  |
| Average |  |  |  |  |
| 7-Class RF  (Previous Work) | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |

TableS2. The results of 10 repetitions of Hamming loss and top-k on ML-kNN, MLTSVM, NLSD-MLP, NLSD-XGB, NLSD-EXT, NLSD-RF, NLSD-SVM with 10×5-fold-cross-validation *in HO method* and the previous work.

TableS2.1. The results of 10 repetitions of Hamming loss and top-*k* on ML-*k*NN with 10×5-fold-cross-validation in HO method and the previous work.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ML-*k*NN (HO) | Hamming loss  on training set | Hamming loss  on test set | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Test\_1 | 0.2624 | 0.2642 | 82.2 | 94.5 | 100 |
| Test\_2 | 0.2708 | 0.2309 | 80.1 | 90.4 | 95.9 |
| Test\_3 | 0.2628 | 0.2935 | 84.9 | 90.4 | 95.9 |
| Test\_4 | 0.2635 | 0.2896 | 83.6 | 93.2 | 95.9 |
| Test\_5 | 0.2673 | 0.2642 | 74.0 | 90.4 | 95.9 |
| Test\_6 | 0.2770 | 0.2250 | 91.8 | 95.9 | 100 |
| Test\_7 | 0.2614 | 0.2838 | 71.2 | 84.9 | 94.5 |
| Test\_8 | 0.2530 | 0.2838 | 78.1 | 94.5 | 97.3 |
| Test\_9 | 0.2673 | 0.2466 | 79.5 | 91.8 | 97.3 |
| Test\_10 | 0.2673 | 0.2466 | 78.1 | 91.8 | 97.1 |
| Average | 0.2647 ± 0.0061 | 0.2648 ± 0.0229 | 80.4 ± 5.5 | 91.8 ± 2.9 | 97.1 ± 1.7 |
| 7-Class RF-CV  (Previous Work) | —— | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |

TableS2.2. The results of 10 repetitions of Hamming loss and top-*k* on MLTSVM with 10×5-fold-cross-validation in HO method and the previous work.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| MLTSVM (HO) | Hamming loss  on training set | Hamming loss  on test set | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Test\_1 | 0.2899 | 0.3346 | —— | —— | —— |
| Test\_2 | 0.3135 | 0.2564 |
| Test\_3 | 0.2812 | 0.2779 |
| Test\_4 | 0.2840 | 0.3542 |
| Test\_5 | 0.2979 | 0.2935 |
| Test\_6 | 0.3111 | 0.2975 |
| Test\_7 | 0.2878 | 0.2955 |
| Test\_8 | 0.2687 | 0.2740 |
| Test\_9 | 0.3156 | 0.3249 |
| Test\_10 | 0.3003 | 0.2818 |
| Average | 0.2950 ± 0.0146 | 0.2990 ± 0.0287 |
| 7-Class RF-CV  (Previous Work) | —— | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |

TableS2.3. The results of 10 repetitions of Hamming loss and top-*k* on NLSD-MLP with 10×5-fold-cross-validation in HO method and the previous work.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NLSD-MLP (HO) | Hamming loss  on training set | Hamming loss  on test set | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Test\_1 |  | 0.2544 | 83.6 | 94.5 | 95.9 |
| Test\_2 |  | 0.2192 | 86.3 | 97.3 | 1 |
| Test\_3 |  | 0.2662 | 87.7 | 97.3 | 98.6 |
| Test\_4 |  | 0.3014 | 93.2 | 97.3 | 98.6 |
| Test\_5 |  | 0.2583 | 82.2 | 91.8 | 97.3 |
| Test\_6 |  | 0.2153 | 91.8 | 97.3 | 1 |
| Test\_7 |  | 0.2505 | 87.7 | 95.9 | 1 |
| Test\_8 |  | 0.2622 | 83.6 | 93.2 | 95.9 |
| Test\_9 |  | 0.2446 | 89.0 | 97.3 | 1 |
| Test\_10 |  | 0.2172 | 80.8 | 93.2 | 97.3 |
| Average |  | 0.2489 ± 0.0253 | 86.6 ± 3.9 | 95.5 ± 2.0 | 98.4 ± 1.6 |
| 7-Class RF-CV  (Previous Work) | —— | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |

TableS2.4. The results of 10 repetitions of Hamming loss and top-*k* on NLSD-XGB with 10×5-fold-cross-validation in HO method and the previous work.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NLSD-XGB (HO) | Hamming loss  on training set | Hamming loss  on test set | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Test\_1 |  | 0.2192 | 94.5 | 95.9 | 98.6 |
| Test\_2 |  | 0.1996 | 93.2 | 97.3 | 98.6 |
| Test\_3 |  | 0.2270 | 93.2 | 100 | 100 |
| Test\_4 |  | 0.2387 | 93.2 | 97.3 | 97.3 |
| Test\_5 |  | 0.2133 | 91.8 | 98.6 | 98.6 |
| Test\_6 |  | 0.2133 | 89.0 | 91.8 | 97.3 |
| Test\_7 |  | 0.2133 | 89.0 | 95.9 | 98.6 |
| Test\_8 |  | 0.2505 | 89.0 | 95.9 | 98.6 |
| Test\_9 |  | 0.2133 | 89.0 | 95.9 | 95.9 |
| Test\_10 |  | 0.2329 | 89.0 | 93.2 | 98.6 |
| Average |  | 0.2221 ± 0.0143 | 91.1 ± 2.1 | 96.2 ± 2.3 | 98.2 ± 1.1 |
| 7-Class RF-CV  (Previous Work) | —— | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |

TableS2.5. The results of 10 repetitions of Hamming loss and top-*k* on NLSD-EXT with 10×5-fold-cross-validation in HO method and the previous work.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NLSD-EXT  (HO) | Hamming loss  on training set | Hamming loss  on test set | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Test\_1 |  | 0.2153 | 94.5 | 97.3 | 98.6 |
| Test\_2 |  | 0.2055 | 93.2 | 97.3 | 98.6 |
| Test\_3 |  | 0.2466 | 86.3 | 97.3 | 98.6 |
| Test\_4 |  | 0.2564 | 90.4 | 95.9 | 95.9 |
| Test\_5 |  | 0.1996 | 87.7 | 94.5 | 98.6 |
| Test\_6 |  | 0.1781 | 94.5 | 97.3 | 98.6 |
| Test\_7 |  | 0.2094 | 89.0 | 95.9 | 98.6 |
| Test\_8 |  | 0.2427 | 87.7 | 94.5 | 95.9 |
| Test\_9 |  | 0.1742 | 89.0 | 97.3 | 97.3 |
| Test\_10 |  | 0.2153 | 89.0 | 95.9 | 97.3 |
| Average |  | 0.2143 ± 0.0262 | 90.1 ± 2.8 | 96.2 ± 1.0 | 97.8 ± 1.1 |
| 7-Class RF-CV  (Previous Work) | —— | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |

TableS2.6. The results of 10 repetitions of Hamming loss and top-*k* on NLSD-RF with 10×5-fold-cross-validation in HO method and the previous work.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NLSD-RF  (HO) | Hamming loss  on training set | Hamming loss  on test set | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Test\_1 |  | 0.2133 | 94.5 | 98.6 | 100 |
| Test\_2 |  | 0.1937 | 91.8 | 97.3 | 98.6 |
| Test\_3 |  | 0.2524 | 87.7 | 94.5 | 98.6 |
| Test\_4 |  | 0.2603 | 90.4 | 95.9 | 97.3 |
| Test\_5 |  | 0.2114 | 90.4 | 94.5 | 97.3 |
| Test\_6 |  | 0.2114 | 87.7 | 94.5 | 97.3 |
| Test\_7 |  | 0.2114 | 86.3 | 94.5 | 97.3 |
| Test\_8 |  | 0.2348 | 86.3 | 95.9 | 97.3 |
| Test\_9 |  | 0.1879 | 91.8 | 97.3 | 97.3 |
| Test\_10 |  | 0.2192 | 87.7 | 94.5 | 97.3 |
| Average |  | 0.2196 ± 0.0221 | 89.5 ± 2.6 | 95.8 ± 1.4 | 97.8 ± 0.9 |
| 7-Class RF-CV  (Previous Work) | —— | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |

TableS2.7. The results of 10 repetitions of Hamming loss and top-*k* on NLSD-SVM with 10×5-fold-cross-validation in HO method and the previous work.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NLSD-SVM  (HO) | Hamming loss  on training set | Hamming loss  on test set | Top-*k* | | |
| Top-1% | Top-2% | Top-3% |
| Test\_1 |  | 0.2759 | 86.3 | 94.5 | 98.6 |
| Test\_2 |  | 0.2016 | 90.4 | 98.6 | 98.6 |
| Test\_3 |  | 0.2681 | 82.2 | 95.9 | 100 |
| Test\_4 |  | 0.3033 | 90.4 | 94.5 | 98.6 |
| Test\_5 |  | 0.2446 | 84.9 | 95.9 | 100 |
| Test\_6 |  | 0.2094 | 89.0 | 95.9 | 97.3 |
| Test\_7 |  | 0.2368 | 91.8 | 97.3 | 100 |
| Test\_8 |  | 0.2564 | 89.0 | 95.9 | 98.6 |
| Test\_9 |  | 0.2153 | 90.4 | 94.5 | 97.3 |
| Test\_10 |  | 0.2192 | 84.9 | 97.3 | 98.6 |
| Average |  | 0.2431 ± 0.0312 | 87.9 ± 3.0 | 96.0 ± 1.3 | 98.8 ± 1.0 |
| 7-Class RF-CV  (Previous Work) | —— | —— | 76.3 ± 5.4 | 88.4 ± 4.9 | 93.3 ± 3.4 |