A Novel Active Learning Method for Multi-class Imbalanced Data Streams with Concept Drift

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TABLE IV

Results MAUC (%) and Results Labels (%) of Comparative Experiments

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Algorithms** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| FU-LB | 97.5 | 97.8 | 97.3 | 98.3 | 97.9 | 97.4 | 96.7 | 74.8 | 96.5 | 69.4 | 97.7 | 76 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20 | 19.8 | 20 | 21.3 |
| VU-LB | 97.8 | 98.3 | 97.2 | 98.3 | 98.6 | 97.8 | 97.2 | 74.9 | 97.4 | 75.4 | 97.8 | 74.7 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| RVU-LB | 97.5 | 97.8 | 97.7 | 98.3 | 98 | 97.4 | 97.1 | 74.6 | 97.5 | 76.2 | 98 | 75.2 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| SelS-LB | 97.5 | 98.1 | 97.8 | 98.3 | 98.3 | 97.3 | 97.4 | 74.6 | 97.5 | 76.2 | 98.1 | 75.1 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| FU-BOLE | 92.9 | 96.1 | 94.4 | 96.7 | 95.8 | 95.4 | 94.7 | 69.9 | 97.6 | 55 | 97.5 | 65.9 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 19.4 | 20.1 | 9.9 | 20 | 21.3 |
| VU-BOLE | 91 | 93.5 | 89.8 | 94.2 | 92.5 | 94.8 | 93.8 | 68.2 | 97.7 | 75 | 97.4 | 66 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 20.9 |
| RVU-BOLE | 92.8 | 95.7 | 91.8 | 96.4 | 95.4 | 95.8 | 94.8 | 70.2 | 97.8 | 75.8 | 98.1 | 66.1 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| SelS-BOLE | 93.3 | 96.1 | 92.9 | 96.4 | 95.8 | 95.7 | 95 | 70.3 | 97.7 | 76.5 | 98.1 | 70.3 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| FU-ADACC | 67.6 | 75.7 | 67 | 76.8 | 78.3 | 78.4 | 77.4 | 63.9 | 55.9 | 50.7 | 83.6 | 49.8 |
|  | 20.3 | 20.4 | 19.8 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 0.6 | 0.2 | 17.5 | 1.8 |
| VU-ADACC | 69.7 | 77.5 | 69.2 | 77.9 | 79.5 | 79.4 | 79.1 | 62.7 | 89.9 | 67.2 | 92.1 | 51.2 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| RVU-ADACC | 68.2 | 76.4 | 68.2 | 76.6 | 79.6 | 79 | 78.2 | 63.8 | 89.9 | 68.1 | 91.7 | 51.9 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| SelS-ADACC | 67.9 | 76.3 | 68.2 | 76.6 | 79.4 | 78.8 | 78 | 63.6 | 88.6 | 67.5 | 92 | 51.9 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| FU-ARF | 96.6 | 96.8 | 96.4 | 97 | 94.9 | 96.5 | 94.8 | 71.3 | 96.5 | 76.6 | 98.4 | 69.9 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| VU-ARF | 97.2 | 97.5 | 96.8 | 97.4 | 96 | 97.1 | 96 | 70 | 96.5 | 77.1 | 98.6 | 69.3 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| RVU-ARF | 96.7 | 96.9 | 96.6 | 97.1 | 95 | 96.7 | 95.2 | 70.9 | 96.6 | 76.6 | 98.4 | 69.5 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| SelS-ARF | 96.7 | 97 | 96.6 | 97.1 | 95.1 | 96.6 | 95.3 | 70.9 | 96.6 | 76.6 | 98.4 | 69.5 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| FU-MOOB | 95.5 | 96.1 | 95.3 | 94.5 | 96.1 | 91 | 93.3 | 70.3 | 92.2 | 68.1 | 93.5 | 74.9 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| VU-MOOB | 95.1 | 95.4 | 94.5 | 94.9 | 96.5 | 91.2 | 94.3 | 71.5 | 95.7 | 79.9 | 89.9 | 74.7 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| RVU-MOOB | 95.4 | 96 | 94.9 | 95.7 | 96.3 | 91.1 | 94.2 | 70.5 | 95.8 | 81.1 | 91.1 | 74.8 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| SelS-MOOB | 95.4 | 95.9 | 95 | 95.7 | 96.3 | 91.3 | 94.3 | 70.3 | 95.7 | 80.2 | 92.9 | 74.8 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| FU-MUOB | 87.7 | 91.6 | 86.1 | 92.3 | 93.1 | 81.9 | 88.8 | 51.3 | 59.9 | 0 | 0 | 74.5 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 2.7 | 8.1 | 20 | 20 | 21.3 |
| VU-MUOB | 87.3 | 90.9 | 85.2 | 90.6 | 90.4 | 87.6 | 85.2 | 62.4 | 69.8 | 0 | 0 | 71.4 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| RVU-MUOB | 89.6 | 92.4 | 86.1 | 93.3 | 93.5 | 83.1 | 90.5 | 63.3 | 76.1 | 0 | 0 | 71.3 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| SelS-MUOB | 89.5 | 92.1 | 86.6 | 93 | 93.4 | 83.3 | 90.5 | 62.8 | 78.6 | 0 | 0 | 71.4 |
|  | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.4 | 20.1 | 20 | 20 | 21.3 |
| OAL-DI | 84.3 | 88.2 | 84 | 89 | 85.5 | 86.5 | 87 | 73.2 | 93.4 | 80.6 | 88.2 | 74.8 |
|  | 32.6 | 32.1 | 32.3 | 32.1 | 30.8 | 30.9 | 30.2 | 44.7 | 23.1 | 25.1 | 24.4 | 32.7 |
| OALE | 95.9 | 97.2 | 96 | 97.2 | 96.7 | 95.3 | 96.9 | 78.6 | 97.6 | 83.6 | 98.3 | 76.4 |
|  | 32 | 31.5 | 31.3 | 30.8 | 31 | 33.1 | 31.4 | 43.6 | 25.7 | 28 | 23.3 | 38.6 |
| CALF-MID | 98.8 | 99.1 | 98.7 | 98.9 | 99.4 | 99 | 98.8 | 79.2 | 97.9 | 82.7 | 98.7 | 75.5 |
|  | 18.6 | 18.2 | 18.9 | 18.5 | 17.6 | 18.6 | 19 | 20 | 19.7 | 19.8 | 20 | 20 |