

## 1. Feature selection

| ID | Datasets     | Datapoints | Dimensions | N_Boruta | N_mRMR | mRMR-Boruta |
|----|--------------|------------|------------|----------|--------|-------------|
| 1  | E-GEOD-20685 | 327        | 54627      | 1878     | 1878   | 520         |
| 2  | E-GEOD-20711 | 90         | 54675      | 701      | 701    | 86          |
| 3  | E-GEOD-21050 | 310        | 54613      | 3028     | 3028   | 84          |
| 4  | E-GEOD-21122 | 158        | 22283      | 856      | 856    | 193         |
| 5  | E-GEOD-29354 | 53         | 22215      | 237      | 237    | 29          |
| 6  | E-GEOD-30784 | 229        | 54675      | 732      | 732    | 135         |
| 7  | E-GEOD-31312 | 498        | 54630      | 3301     | 3301   | 214         |
| 8  | E-GEOD-31552 | 111        | 33297      | 592      | 592    | 79          |
| 9  | E-GEOD-32537 | 217        | 11950      | 1444     | 1444   | 76          |
| 10 | E-GEOD-33315 | 575        | 22283      | 3132     | 3132   | 547         |
| 11 | E-GEOD-36895 | 76         | 54675      | 768      | 768    | 49          |
| 12 | E-GEOD-37364 | 94         | 54675      | 514      | 514    | 76          |
| 13 | E-GEOD-39582 | 566        | 54675      | 4251     | 4251   | 772         |
| 14 | E-GEOD-39716 | 53         | 33297      | 311      | 311    | 66          |
| 15 | E-GEOD-44077 | 226        | 33252      | 210      | 210    | 139         |
| 16 | E-GEOD-47460 | 582        | 15261      | 3339     | 3339   | 181         |
| 17 | E-GEOD-63270 | 104        | 18989      | 879      | 879    | 94          |
| 18 | E-GEOD-63885 | 101        | 54675      | 916      | 916    | 49          |
| 19 | E-GEOD-65106 | 59         | 33297      | 328      | 328    | 17          |
| 20 | E-GEOD-6532  | 327        | 22645      | 1012     | 1012   | 82          |
| 21 | E-GEOD-66533 | 58         | 54675      | 156      | 156    | 54          |
| 22 | E-GEOD-68468 | 390        | 22283      | 1035     | 1035   | 215         |
| 23 | E-GEOD-68606 | 274        | 22283      | 651      | 651    | 544         |
| 24 | E-GEOD-7307  | 677        | 54675      | 4958     | 4958   | 6           |
| 25 | E-GEOD-73685 | 183        | 33297      | 1087     | 1087   | 334         |

## 2. Train with ML

### 1. mRMR -ML

| Dataset ID | Methods       | N_mRMR | Accuracy (%) | Precision (%) | Recall (%) | F1 Score (%) | Training times (s) |
|------------|---------------|--------|--------------|---------------|------------|--------------|--------------------|
| 1          | SVM           | 1878   | 96.35        | 97.49         | 96.46      | 96.68        | 0.53               |
|            | RandomForest  |        | 87.17        | 91.97         | 84.79      | 86.51        | 5.57               |
|            | XGBoost       |        | 90.24        | 93.62         | 88.88      | 89.65        | 15.59              |
|            | GradientBoost |        | 79.23        | 83.02         | 74.48      | 76.16        | 1634.88            |
| 2          | SVM           | 701    | 87.78        | 93.89         | 93.89      | 87.78        | 0.30               |
|            | RandomForest  |        | 85.56        | 92.78         | 92.78      | 85.56        | 19.09              |
|            | XGBoost       |        | 82.22        | 91.11         | 91.11      | 82.22        | 15.17              |
|            | GradientBoost |        | 84.44        | 92.22         | 92.22      | 84.44        | 1288.21            |
| 3          | SVM           | 3028   | 74.84        | 84.19         | 60.46      | 60.41        | 0.76               |
|            | RandomForest  |        | 73.23        | 89.44         | 57.75      | 57.17        | 5.15               |
|            | XGBoost       |        | 75.48        | 81.15         | 61.59      | 61.68        | 17.31              |
|            | GradientBoost |        | 70.97        | 78.45         | 57.06      | 56.76        | 1235.22            |
| 4          | SVM           | 856    | 89.87        | 94.94         | 94.94      | 89.87        | 1.24               |
|            | RandomForest  |        | 82.28        | 91.14         | 91.14      | 82.28        | 45.95              |
|            | XGBoost       |        | 86.71        | 93.35         | 93.35      | 86.71        | 58.13              |
|            | GradientBoost |        | 87.97        | 93.99         | 93.99      | 87.97        | 7055.70            |
|            | SVM           | 237    | 83.02        | 91.51         | 91.51      | 83.02        | 0.08               |
|            | RandomForest  |        | 81.13        | 90.57         | 90.57      | 81.13        | 8.62               |

|    |               |      |       |       |       |       |          |
|----|---------------|------|-------|-------|-------|-------|----------|
| 5  | XGBoost       |      | 86.79 | 93.40 | 93.40 | 86.79 | 2.41     |
|    | GradientBoost |      | 77.36 | 88.68 | 88.68 | 77.36 | 92.67    |
|    | SVM           | 732  | 95.63 | 97.82 | 97.82 | 95.63 | 1.35     |
|    | RandomForest  |      | 92.58 | 96.29 | 96.29 | 92.58 | 77.53    |
| 6  | XGBoost       |      | 94.32 | 97.16 | 97.16 | 94.32 | 54.52    |
|    | GradientBoost |      | 93.89 | 96.94 | 96.94 | 93.89 | 5603.66  |
|    | SVM           | 3301 | 88.56 | 92.73 | 66.30 | 64.30 | 1.97     |
|    | RandomForest  |      | 87.76 | 92.04 | 64.61 | 61.44 | 9.64     |
| 7  | XGBoost       |      | 86.95 | 88.21 | 64.54 | 61.93 | 31.97    |
|    | GradientBoost |      | 86.14 | 90.88 | 63.95 | 61.32 | 2241.09  |
|    | SVM           | 592  | 90.99 | 95.50 | 95.50 | 90.99 | 0.34     |
|    | RandomForest  |      | 89.19 | 94.59 | 94.59 | 89.19 | 24.14    |
| 8  | XGBoost       |      | 90.99 | 95.50 | 95.50 | 90.99 | 13.47    |
|    | GradientBoost |      | 86.49 | 93.24 | 93.24 | 86.49 | 984.96   |
|    | SVM           | 1444 | 78.34 | 89.17 | 89.17 | 78.34 | 5.03     |
|    | RandomForest  |      | 77.42 | 88.71 | 88.71 | 77.42 | 88.98    |
| 9  | XGBoost       |      | 80.18 | 90.09 | 90.09 | 80.18 | 188.91   |
|    | GradientBoost |      | 78.80 | 89.40 | 89.40 | 78.80 | 23124.69 |
|    | SVM           | 3132 | 86.45 | 94.70 | 75.45 | 77.18 | 3.02     |
|    | RandomForest  |      | 74.10 | 91.40 | 47.45 | 45.97 | 11.52    |
| 10 | XGBoost       |      | 89.25 | 94.72 | 78.85 | 78.60 | 69.65    |
|    | GradientBoost |      | 84.88 | 92.24 | 72.11 | 72.40 | 8221.51  |
|    | SVM           | 768  | 72.37 | 86.18 | 86.18 | 72.37 | 0.39     |
|    | RandomForest  |      | 73.68 | 86.84 | 86.84 | 73.68 | 14.92    |
| 11 | XGBoost       |      | 89.47 | 94.74 | 94.74 | 89.47 | 18.64    |
|    | GradientBoost |      | 76.32 | 88.16 | 88.16 | 76.32 | 2182.91  |
|    | SVM           | 514  | 84.04 | 92.02 | 92.02 | 84.04 | 0.25     |
|    | RandomForest  |      | 89.36 | 94.68 | 94.68 | 89.36 | 18.83    |
| 12 | XGBoost       |      | 86.17 | 93.09 | 93.09 | 86.17 | 10.04    |
|    | GradientBoost |      | 90.43 | 95.21 | 95.21 | 90.43 | 769.23   |
|    | SVM           | 4251 | 87.79 | 90.61 | 86.50 | 87.43 | 3.73     |
|    | RandomForest  |      | 77.57 | 85.18 | 74.47 | 76.56 | 12.88    |
| 13 | XGBoost       |      | 85.14 | 86.86 | 84.11 | 84.50 | 79.36    |
|    | GradientBoost |      | 80.92 | 85.27 | 79.84 | 80.63 | 6799.47  |
|    | SVM           | 311  | 94.34 | 97.17 | 97.17 | 94.34 | 0.08     |
|    | RandomForest  |      | 96.23 | 98.11 | 98.11 | 96.23 | 8.46     |
| 14 | XGBoost       |      | 98.11 | 99.06 | 99.06 | 98.11 | 2.61     |
|    | GradientBoost |      | 92.45 | 96.23 | 96.23 | 92.45 | 105.81   |
|    | SVM           | 210  | 99.56 | 99.78 | 99.78 | 99.56 | 0.69     |
|    | RandomForest  |      | 99.56 | 99.78 | 99.78 | 99.56 | 50.66    |
| 15 | XGBoost       |      | 98.67 | 99.34 | 99.34 | 98.67 | 20.30    |
|    | GradientBoost |      | 97.79 | 98.89 | 98.89 | 97.79 | 1740.48  |
|    | SVM           | 3339 | 81.62 | 93.42 | 27.01 | 25.79 | 3.79     |
|    | RandomForest  |      | 78.70 | 94.49 | 22.90 | 21.00 | 12.09    |
| 16 | XGBoost       |      | 80.93 | 88.89 | 29.14 | 26.93 | 79.57    |
|    | GradientBoost |      | 79.55 | 83.21 | 32.86 | 30.43 | 9155.01  |
|    | SVM           | 879  | 68.27 | 84.13 | 84.13 | 68.27 | 0.55     |
|    | RandomForest  |      | 70.19 | 85.10 | 85.10 | 70.19 | 25.01    |
| 17 | XGBoost       |      | 68.27 | 84.13 | 84.13 | 68.27 | 30.91    |
|    | GradientBoost |      | 58.65 | 79.33 | 79.33 | 58.65 | 3906.01  |
|    | SVM           | 916  | 75.25 | 87.62 | 87.62 | 75.25 | 0.37     |
|    | RandomForest  |      | 65.35 | 82.67 | 82.67 | 65.35 | 23.65    |
| 18 | XGBoost       |      | 73.27 | 86.63 | 86.63 | 73.27 | 19.44    |
|    | GradientBoost |      | 74.26 | 87.13 | 87.13 | 74.26 | 1701.31  |
|    | SVM           | 328  | 91.53 | 95.76 | 95.76 | 91.53 | 0.10     |

|    |               |      |        |        |        |        |          |
|----|---------------|------|--------|--------|--------|--------|----------|
| 19 | RandomForest  | 1012 | 84.75  | 92.37  | 92.37  | 84.75  | 10.12    |
|    | XGBoost       |      | 96.61  | 98.31  | 98.31  | 96.61  | 3.38     |
|    | GradientBoost |      | 88.14  | 94.07  | 94.07  | 88.14  | 148.30   |
|    | SVM           |      | 92.71  | 95.04  | 70.45  | 69.08  | 0.10     |
| 20 | RandomForest  | 156  | 91.45  | 93.97  | 63.75  | 61.72  | 3.58     |
|    | XGBoost       |      | 91.76  | 94.13  | 67.08  | 65.16  | 4.31     |
|    | GradientBoost |      | 90.84  | 90.39  | 63.19  | 61.34  | 426.52   |
|    | SVM           |      | 98.28  | 99.14  | 99.14  | 98.28  | 0.09     |
| 21 | RandomForest  | 1035 | 96.55  | 98.28  | 98.28  | 96.55  | 9.04     |
|    | XGBoost       |      | 94.83  | 97.41  | 97.41  | 94.83  | 2.25     |
|    | GradientBoost |      | 91.38  | 95.69  | 95.69  | 91.38  | 53.79    |
|    | SVM           |      | 92.82  | 96.73  | 82.38  | 84.63  | 0.43     |
| 22 | RandomForest  | 651  | 85.90  | 94.91  | 65.82  | 69.09  | 5.17     |
|    | XGBoost       |      | 96.67  | 98.31  | 90.72  | 91.95  | 8.73     |
|    | GradientBoost |      | 95.64  | 98.25  | 86.90  | 89.50  | 1064.73  |
|    | SVM           |      | 100.00 | 100.00 | 100.00 | 100.00 | 3.91     |
| 23 | RandomForest  | 4958 | 87.59  | 93.80  | 93.80  | 87.59  | 91.73    |
|    | XGBoost       |      | 100.00 | 100.00 | 100.00 | 100.00 | 148.29   |
|    | GradientBoost |      | 100.00 | 100.00 | 100.00 | 100.00 | 23068.88 |
|    | SVM           |      | 82.87  | 98.09  | 11.19  | 10.15  | 17.71    |
| 24 | RandomForest  | 1087 | 82.87  | 98.09  | 11.19  | 10.15  | 17.58    |
|    | XGBoost       |      | 82.87  | 98.09  | 11.19  | 10.15  | 158.94   |
|    | GradientBoost |      | 81.84  | 84.99  | 15.48  | 9.60   | 19806.93 |
|    | SVM           |      | 86.89  | 93.44  | 93.44  | 86.89  | 2.29     |
| 25 | RandomForest  |      | 81.42  | 90.71  | 90.71  | 81.42  | 60.58    |
|    | XGBoost       |      | 86.34  | 93.17  | 93.17  | 86.34  | 101.93   |
|    | GradientBoost |      | 79.23  | 89.62  | 89.62  | 79.23  | 14004.84 |

## 2. Boruta -ML

| Dataset ID | Methods       | N_Boruta | Accuracy (%) | Precision (%) | Recall (%) | F1 Score (%) | Training times (s) |
|------------|---------------|----------|--------------|---------------|------------|--------------|--------------------|
| 1          | SVM           | 545      | 95.11        | 96.11         | 95.63      | 95.55        | 0.12               |
|            | RandomForest  |          | 92.38        | 94.37         | 92.19      | 92.70        | 5.95               |
|            | XGBoost       |          | 83.79        | 88.10         | 83.44      | 83.82        | 41.82              |
|            | GradientBoost |          | 86.88        | 89.92         | 85.56      | 86.27        | 257.57             |
| 2          | SVM           | 111      | 84.44        | 92.22         | 92.22      | 84.44        | 0.20               |
|            | RandomForest  |          | 82.22        | 91.11         | 91.11      | 82.22        | 18.43              |
|            | XGBoost       |          | 75.56        | 87.78         | 87.78      | 75.56        | 25.51              |
|            | GradientBoost |          | 77.78        | 88.89         | 88.89      | 77.78        | 132.28             |
| 3          | SVM           | 72       | 67.42        | 63.22         | 59.70      | 60.20        | 0.10               |
|            | RandomForest  |          | 75.48        | 75.87         | 62.48      | 62.59        | 3.44               |
|            | XGBoost       |          | 72.58        | 72.44         | 60.78      | 61.23        | 3.00               |
|            | GradientBoost |          | 75.48        | 73.40         | 64.95      | 65.56        | 18.93              |
| 4          | SVM           | 271      | 91.77        | 95.89         | 95.89      | 91.77        | 0.66               |
|            | RandomForest  |          | 91.77        | 95.89         | 95.89      | 91.77        | 47.50              |
|            | XGBoost       |          | 82.91        | 91.46         | 91.46      | 82.91        | 179.79             |
|            | GradientBoost |          | 82.91        | 91.46         | 91.46      | 82.91        | 1267.80            |
| 5          | SVM           | 28       | 84.91        | 92.45         | 92.45      | 84.91        | 0.09               |
|            | RandomForest  |          | 86.79        | 93.40         | 93.40      | 86.79        | 9.08               |
|            | XGBoost       |          | 79.25        | 89.62         | 89.62      | 79.25        | 4.34               |
|            | GradientBoost |          | 75.47        | 87.74         | 87.74      | 75.47        | 13.31              |
| 6          | SVM           | 171      | 95.63        | 97.82         | 97.82      | 95.63        | 0.65               |
|            | RandomForest  |          | 93.45        | 96.72         | 96.72      | 93.45        | 70.87              |
|            | XGBoost       |          | 93.45        | 96.72         | 96.72      | 93.45        | 120.62             |
|            | GradientBoost |          | 92.58        | 96.29         | 96.29      | 92.58        | 746.43             |
|            | SVM           | 213      | 88.56        | 77.87         | 70.91      | 71.14        | 0.13               |

|    |               |     |       |       |       |       |        |
|----|---------------|-----|-------|-------|-------|-------|--------|
| 7  | RandomForest  | 79  | 88.36 | 92.33 | 65.05 | 61.84 | 6.47   |
|    | XGBoost       |     | 84.13 | 81.75 | 63.01 | 61.08 | 9.65   |
|    | GradientBoost |     | 86.35 | 66.69 | 65.90 | 64.77 | 80.37  |
|    | SVM           |     | 90.09 | 95.05 | 95.05 | 90.09 | 0.20   |
| 8  | RandomForest  | 96  | 90.99 | 95.50 | 95.50 | 90.99 | 22.48  |
|    | XGBoost       |     | 90.99 | 95.50 | 95.50 | 90.99 | 18.14  |
|    | GradientBoost |     | 87.39 | 93.69 | 93.69 | 87.39 | 89.22  |
|    | SVM           |     | 81.11 | 90.55 | 90.55 | 81.11 | 0.86   |
| 9  | RandomForest  | 483 | 78.34 | 89.17 | 89.17 | 78.34 | 67.34  |
|    | XGBoost       |     | 77.88 | 88.94 | 88.94 | 77.88 | 131.99 |
|    | GradientBoost |     | 74.65 | 87.33 | 87.33 | 74.65 | 918.15 |
|    | SVM           |     | 88.36 | 93.09 | 81.08 | 82.03 | 0.36   |
| 10 | RandomForest  | 39  | 86.11 | 94.01 | 75.29 | 75.57 | 12.33  |
|    | XGBoost       |     | 86.47 | 93.10 | 76.25 | 75.34 | 53.30  |
|    | GradientBoost |     | 84.17 | 87.60 | 71.19 | 71.11 | 696.12 |
|    | SVM           |     | 75.00 | 87.50 | 87.50 | 75.00 | 0.17   |
| 11 | RandomForest  | 59  | 77.63 | 88.82 | 88.82 | 77.63 | 13.40  |
|    | XGBoost       |     | 73.68 | 86.84 | 86.84 | 73.68 | 19.19  |
|    | GradientBoost |     | 71.05 | 85.53 | 85.53 | 71.05 | 100.75 |
|    | SVM           |     | 79.79 | 89.89 | 89.89 | 79.79 | 0.16   |
| 12 | RandomForest  | 640 | 87.23 | 93.62 | 93.62 | 87.23 | 17.42  |
|    | XGBoost       |     | 88.30 | 94.15 | 94.15 | 88.30 | 13.15  |
|    | GradientBoost |     | 82.98 | 91.49 | 91.49 | 82.98 | 69.00  |
|    | SVM           |     | 86.74 | 89.49 | 86.49 | 87.12 | 0.30   |
| 13 | RandomForest  | 124 | 84.28 | 87.07 | 83.63 | 84.31 | 12.32  |
|    | XGBoost       |     | 77.37 | 78.96 | 75.98 | 75.62 | 52.37  |
|    | GradientBoost |     | 83.38 | 86.57 | 82.10 | 82.51 | 547.70 |
|    | SVM           |     | 94.34 | 97.17 | 97.17 | 94.34 | 0.07   |
| 14 | RandomForest  | 227 | 94.34 | 97.17 | 97.17 | 94.34 | 9.21   |
|    | XGBoost       |     | 90.57 | 95.28 | 95.28 | 90.57 | 6.42   |
|    | GradientBoost |     | 88.68 | 94.34 | 94.34 | 88.68 | 27.50  |
|    | SVM           |     | 99.56 | 99.78 | 99.78 | 99.56 | 0.55   |
| 15 | RandomForest  | 135 | 99.56 | 99.78 | 99.78 | 99.56 | 58.07  |
|    | XGBoost       |     | 97.35 | 98.67 | 98.67 | 97.35 | 149.74 |
|    | GradientBoost |     | 96.46 | 98.23 | 98.23 | 96.46 | 943.80 |
|    | SVM           |     | 80.76 | 70.92 | 31.08 | 29.44 | 0.22   |
| 16 | RandomForest  | 80  | 80.08 | 90.13 | 27.32 | 24.79 | 8.14   |
|    | XGBoost       |     | 79.56 | 82.44 | 27.79 | 24.62 | 16.09  |
|    | GradientBoost |     | 78.18 | 70.58 | 32.00 | 25.73 | 201.91 |
|    | SVM           |     | 71.15 | 85.58 | 85.58 | 71.15 | 0.28   |
| 17 | RandomForest  | 38  | 79.81 | 89.90 | 89.90 | 79.81 | 21.93  |
|    | XGBoost       |     | 73.08 | 86.54 | 86.54 | 73.08 | 35.63  |
|    | GradientBoost |     | 76.92 | 88.46 | 88.46 | 76.92 | 239.80 |
|    | SVM           |     | 81.19 | 90.59 | 90.59 | 81.19 | 0.21   |
| 18 | RandomForest  | 3   | 73.27 | 86.63 | 86.63 | 73.27 | 20.56  |
|    | XGBoost       |     | 71.29 | 85.64 | 85.64 | 71.29 | 14.43  |
|    | GradientBoost |     | 65.35 | 82.67 | 82.67 | 65.35 | 59.80  |
|    | SVM           |     | 76.27 | 88.14 | 88.14 | 76.27 | 0.10   |
| 19 | RandomForest  | 87  | 79.66 | 89.83 | 89.83 | 79.66 | 9.71   |
|    | XGBoost       |     | 81.36 | 90.68 | 90.68 | 81.36 | 3.56   |
|    | GradientBoost |     | 81.36 | 90.68 | 90.68 | 81.36 | 9.19   |
|    | SVM           |     | 89.33 | 80.78 | 67.60 | 67.26 | 0.03   |
| 20 | RandomForest  |     | 91.15 | 92.25 | 66.52 | 63.69 | 2.95   |
|    | XGBoost       |     | 91.75 | 90.98 | 66.98 | 65.27 | 3.29   |
|    | GradientBoost |     | 90.54 | 82.25 | 65.87 | 63.48 | 21.70  |

|    |               |     |        |        |        |        |          |
|----|---------------|-----|--------|--------|--------|--------|----------|
| 21 | SVM           | 130 | 96.55  | 98.28  | 98.28  | 96.55  | 0.09     |
|    | RandomForest  |     | 96.55  | 98.28  | 98.28  | 96.55  | 10.30    |
|    | XGBoost       |     | 79.31  | 89.66  | 89.66  | 79.31  | 6.86     |
|    | GradientBoost |     | 86.21  | 93.10  | 93.10  | 86.21  | 29.55    |
| 22 | SVM           | 278 | 97.18  | 97.51  | 93.09  | 93.01  | 0.09     |
|    | RandomForest  |     | 96.15  | 97.74  | 90.87  | 91.89  | 5.63     |
|    | XGBoost       |     | 96.15  | 97.24  | 91.70  | 92.10  | 16.80    |
|    | GradientBoost |     | 96.67  | 96.21  | 92.54  | 90.99  | 150.77   |
| 23 | SVM           | 700 | 100.00 | 100.00 | 100.00 | 100.00 | 3.17     |
|    | RandomForest  |     | 100.00 | 100.00 | 100.00 | 100.00 | 153.45   |
|    | XGBoost       |     | 100.00 | 100.00 | 100.00 | 100.00 | 1445.26  |
|    | GradientBoost |     | 100.00 | 100.00 | 100.00 | 100.00 | 10859.63 |
| 24 | SVM           | 3   | 54.96  | 23.34  | 29.32  | 11.54  | 4.72     |
|    | RandomForest  |     | 82.58  | 88.79  | 13.71  | 13.12  | 2.72     |
|    | XGBoost       |     | 82.43  | 93.10  | 11.67  | 10.70  | 2.74     |
|    | GradientBoost |     | 77.42  | 58.39  | 18.70  | 11.95  | 12.87    |
| 25 | SVM           | 343 | 85.79  | 92.90  | 92.90  | 85.79  | 0.84     |
|    | RandomForest  |     | 83.06  | 91.53  | 91.53  | 83.06  | 66.67    |
|    | XGBoost       |     | 82.51  | 91.26  | 91.26  | 82.51  | 372.10   |
|    | GradientBoost |     | 77.60  | 88.80  | 88.80  | 77.60  | 2429.28  |

### 3. MRMR-Boruta -ML

| Dataset ID | Methods       | mRMR-Boruta | Accuracy (%) | Precision (%) | Recall (%) | F1 Score (%) | Training times (s) |
|------------|---------------|-------------|--------------|---------------|------------|--------------|--------------------|
| 1          | SVM           | 520         | 95.72        | 96.64         | 96.47      | 96.28        | 0.13               |
|            | RandomForest  |             | 90.83        | 93.56         | 91.25      | 91.46        | 2.93               |
|            | XGBoost       |             | 84.40        | 87.27         | 84.56      | 84.37        | 11.75              |
|            | GradientBoost |             | 86.59        | 88.80         | 84.56      | 85.10        | 245.66             |
| 2          | SVM           | 86          | 85.56        | 92.78         | 92.78      | 85.56        | 0.18               |
|            | RandomForest  |             | 85.56        | 92.78         | 92.78      | 85.56        | 9.49               |
|            | XGBoost       |             | 78.89        | 89.44         | 89.44      | 78.89        | 9.61               |
|            | GradientBoost |             | 77.78        | 88.89         | 88.89      | 77.78        | 99.90              |
| 3          | SVM           | 84          | 70.00        | 67.38         | 64.86      | 64.77        | 0.06               |
|            | RandomForest  |             | 78.06        | 80.70         | 65.86      | 66.51        | 1.77               |
|            | XGBoost       |             | 74.84        | 76.81         | 66.52      | 67.15        | 2.50               |
|            | GradientBoost |             | 75.16        | 77.12         | 65.22      | 65.97        | 19.95              |
| 4          | SVM           | 193         | 93.67        | 96.84         | 96.84      | 93.67        | 0.66               |
|            | RandomForest  |             | 91.77        | 95.89         | 95.89      | 91.77        | 22.58              |
|            | XGBoost       |             | 86.71        | 93.35         | 93.35      | 86.71        | 45.36              |
|            | GradientBoost |             | 86.71        | 93.35         | 93.35      | 86.71        | 873.44             |
| 5          | SVM           | 29          | 98.11        | 99.06         | 99.06      | 98.11        | 0.07               |
|            | RandomForest  |             | 90.57        | 95.28         | 95.28      | 90.57        | 4.84               |
|            | XGBoost       |             | 84.91        | 92.45         | 92.45      | 84.91        | 2.35               |
|            | GradientBoost |             | 79.25        | 89.62         | 89.62      | 79.25        | 11.43              |
| 6          | SVM           | 135         | 96.51        | 98.25         | 98.25      | 96.51        | 0.60               |
|            | RandomForest  |             | 93.45        | 96.72         | 96.72      | 93.45        | 33.41              |
|            | XGBoost       |             | 92.58        | 96.29         | 96.29      | 92.58        | 34.59              |
|            | GradientBoost |             | 92.58        | 96.29         | 96.29      | 92.58        | 578.44             |
| 7          | SVM           | 214         | 89.96        | 83.25         | 73.97      | 74.76        | 0.13               |
|            | RandomForest  |             | 87.56        | 88.77         | 64.45      | 61.40        | 3.18               |
|            | XGBoost       |             | 80.10        | 65.64         | 61.69      | 61.30        | 7.12               |
|            | GradientBoost |             | 88.16        | 83.18         | 69.43      | 69.53        | 78.35              |
| 8          | SVM           | 79          | 88.29        | 94.14         | 94.14      | 88.29        | 0.18               |
|            | RandomForest  |             | 92.79        | 96.40         | 96.40      | 92.79        | 11.47              |
|            | XGBoost       |             | 90.99        | 95.50         | 95.50      | 90.99        | 8.49               |
|            | GradientBoost |             | 90.09        | 95.05         | 95.05      | 90.09        | 83.25              |

|    |               |     |        |        |        |        |        |
|----|---------------|-----|--------|--------|--------|--------|--------|
| 9  | SVM           | 76  | 80.65  | 90.32  | 90.32  | 80.65  | 0.87   |
|    | RandomForest  |     | 78.80  | 89.40  | 89.40  | 78.80  | 33.28  |
|    | XGBoost       |     | 80.18  | 90.09  | 90.09  | 80.18  | 51.72  |
|    | GradientBoost |     | 74.65  | 87.33  | 87.33  | 74.65  | 703.48 |
| 10 | SVM           | 547 | 89.77  | 95.71  | 81.78  | 83.00  | 0.47   |
|    | RandomForest  |     | 86.11  | 93.88  | 71.80  | 71.51  | 6.06   |
|    | XGBoost       |     | 84.89  | 84.31  | 76.32  | 75.94  | 37.58  |
|    | GradientBoost |     | 85.40  | 85.25  | 72.52  | 71.79  | 748.95 |
| 11 | SVM           | 49  | 76.32  | 88.16  | 88.16  | 76.32  | 0.16   |
|    | RandomForest  |     | 78.95  | 89.47  | 89.47  | 78.95  | 7.36   |
|    | XGBoost       |     | 85.53  | 92.76  | 92.76  | 85.53  | 11.56  |
|    | GradientBoost |     | 78.95  | 89.47  | 89.47  | 78.95  | 99.93  |
| 12 | SVM           | 76  | 84.04  | 92.02  | 92.02  | 84.04  | 0.16   |
|    | RandomForest  |     | 89.36  | 94.68  | 94.68  | 89.36  | 9.44   |
|    | XGBoost       |     | 81.91  | 90.96  | 90.96  | 81.91  | 7.33   |
|    | GradientBoost |     | 80.85  | 90.43  | 90.43  | 80.85  | 73.04  |
| 13 | SVM           | 772 | 88.15  | 90.65  | 88.48  | 88.62  | 0.40   |
|    | RandomForest  |     | 85.33  | 88.65  | 84.60  | 85.57  | 6.39   |
|    | XGBoost       |     | 77.40  | 80.43  | 77.41  | 77.26  | 37.86  |
|    | GradientBoost |     | 83.38  | 86.59  | 81.89  | 82.55  | 648.04 |
| 14 | SVM           | 66  | 96.23  | 98.11  | 98.11  | 96.23  | 0.07   |
|    | RandomForest  |     | 94.34  | 97.17  | 97.17  | 94.34  | 4.84   |
|    | XGBoost       |     | 94.34  | 97.17  | 97.17  | 94.34  | 2.63   |
|    | GradientBoost |     | 84.91  | 92.45  | 92.45  | 84.91  | 17.45  |
| 15 | SVM           | 139 | 99.56  | 99.78  | 99.78  | 99.56  | 0.54   |
|    | RandomForest  |     | 99.56  | 99.78  | 99.78  | 99.56  | 27.76  |
|    | XGBoost       |     | 97.35  | 98.67  | 98.67  | 97.35  | 30.11  |
|    | GradientBoost |     | 97.35  | 98.67  | 98.67  | 97.35  | 602.41 |
| 16 | SVM           | 181 | 80.92  | 75.71  | 31.41  | 30.05  | 0.27   |
|    | RandomForest  |     | 80.07  | 91.59  | 26.13  | 24.28  | 4.55   |
|    | XGBoost       |     | 79.39  | 70.00  | 31.10  | 28.54  | 19.79  |
|    | GradientBoost |     | 79.73  | 72.79  | 35.86  | 30.39  | 265.45 |
| 17 | SVM           | 94  | 77.88  | 88.94  | 88.94  | 77.88  | 0.28   |
|    | RandomForest  |     | 86.54  | 93.27  | 93.27  | 86.54  | 11.85  |
|    | XGBoost       |     | 74.04  | 87.02  | 87.02  | 74.04  | 17.58  |
|    | GradientBoost |     | 71.15  | 85.58  | 85.58  | 71.15  | 260.17 |
| 18 | SVM           | 49  | 85.15  | 92.57  | 92.57  | 85.15  | 0.20   |
|    | RandomForest  |     | 80.20  | 90.10  | 90.10  | 80.20  | 10.88  |
|    | XGBoost       |     | 76.24  | 88.12  | 88.12  | 76.24  | 9.80   |
|    | GradientBoost |     | 76.24  | 88.12  | 88.12  | 76.24  | 66.02  |
| 19 | SVM           | 17  | 98.31  | 99.15  | 99.15  | 98.31  | 0.07   |
|    | RandomForest  |     | 100.00 | 100.00 | 100.00 | 100.00 | 5.28   |
|    | XGBoost       |     | 91.53  | 95.76  | 95.76  | 91.53  | 2.94   |
|    | GradientBoost |     | 84.75  | 92.37  | 92.37  | 84.75  | 10.47  |
| 20 | SVM           | 82  | 92.67  | 87.50  | 76.34  | 74.82  | 0.03   |
|    | RandomForest  |     | 91.75  | 94.19  | 63.91  | 61.93  | 1.44   |
|    | XGBoost       |     | 92.05  | 91.30  | 63.75  | 62.24  | 1.61   |
|    | GradientBoost |     | 91.75  | 91.02  | 66.87  | 65.26  | 20.39  |
| 21 | SVM           | 54  | 98.28  | 99.14  | 99.14  | 98.28  | 0.08   |
|    | RandomForest  |     | 96.55  | 98.28  | 98.28  | 96.55  | 5.21   |
|    | XGBoost       |     | 94.83  | 97.41  | 97.41  | 94.83  | 2.56   |
|    | GradientBoost |     | 87.93  | 93.97  | 93.97  | 87.93  | 13.72  |
|    | SVM           | 215 | 97.69  | 98.49  | 93.70  | 93.89  | 0.10   |
|    | RandomForest  |     | 96.92  | 98.37  | 91.88  | 92.73  | 2.51   |
|    | XGBoost       |     | 96.41  | 97.65  | 91.86  | 92.39  | 4.49   |

|    |               |     |        |        |        |        |         |
|----|---------------|-----|--------|--------|--------|--------|---------|
| 22 | GradientBoost |     | 96.15  | 93.76  | 91.32  | 88.15  | 113.85  |
|    | SVM           |     | 100.00 | 100.00 | 100.00 | 100.00 | 3.16    |
|    | RandomForest  | 544 | 100.00 | 100.00 | 100.00 | 100.00 | 69.47   |
|    | XGBoost       |     | 98.54  | 99.27  | 99.27  | 98.54  | 283.98  |
| 23 | GradientBoost |     | 100.00 | 100.00 | 100.00 | 100.00 | 8106.03 |
|    | SVM           |     | 66.91  | 36.19  | 20.95  | 9.30   | 1.08    |
|    | RandomForest  | 6   | 82.28  | 84.68  | 12.04  | 11.55  | 1.95    |
|    | XGBoost       |     | 81.53  | 80.41  | 11.54  | 10.91  | 3.76    |
| 24 | GradientBoost |     | 78.58  | 59.54  | 19.86  | 10.57  | 18.16   |
|    | SVM           |     | 84.15  | 92.08  | 92.08  | 84.15  | 0.96    |
|    | RandomForest  | 334 | 87.43  | 93.72  | 93.72  | 87.43  | 33.74   |
|    | XGBoost       |     | 84.70  | 92.35  | 92.35  | 84.70  | 91.69   |
| 25 | GradientBoost |     | 82.51  | 91.26  | 91.26  | 82.51  | 2273.34 |

#### 0. Seletion feature with RF

| ID | Methods       | n_ RF | Accuracy (%) | Precision (%) | Recall (%) | F1 Score (%) | Training times (s) |
|----|---------------|-------|--------------|---------------|------------|--------------|--------------------|
|    | SVM           |       | 93.29        | 94.91         | 93.85      | 93.94        | 0.50               |
|    | RandomForest  | 1878  | 92.05        | 94.61         | 91.41      | 92.33        | 4.43               |
|    | XGBoost       |       | 79.24        | 83.29         | 77.78      | 78.42        | 35.47              |
| 1  | GradientBoost |       | 82.28        | 85.68         | 79.91      | 80.35        | 809.29             |
|    | SVM           |       | 83.33        | 91.67         | 91.67      | 83.33        | 0.29               |
|    | RandomForest  | 701   | 76.67        | 88.33         | 88.33      | 76.67        | 12.02              |
|    | XGBoost       |       | 81.11        | 90.56         | 90.56      | 81.11        | 27.45              |
| 2  | GradientBoost |       | 62.22        | 81.11         | 81.11      | 62.22        | 637.84             |
|    | SVM           |       | 73.23        | 80.70         | 59.90      | 60.23        | 0.76               |
|    | RandomForest  | 3028  | 74.84        | 87.36         | 59.39      | 58.66        | 5.39               |
|    | XGBoost       |       | 66.77        | 68.26         | 56.48      | 56.65        | 41.10              |
| 3  | GradientBoost |       | 71.29        | 75.88         | 60.69      | 61.52        | 589.09             |
|    | SVM           |       | 89.87        | 94.94         | 94.94      | 89.87        | 1.20               |
|    | RandomForest  | 856   | 89.24        | 94.62         | 94.62      | 89.24        | 30.56              |
|    | XGBoost       |       | 77.22        | 88.61         | 88.61      | 77.22        | 113.36             |
| 4  | GradientBoost |       | 82.28        | 91.14         | 91.14      | 82.28        | 3391.88            |
|    | SVM           |       | 81.13        | 90.57         | 90.57      | 81.13        | 0.08               |
|    | RandomForest  | 237   | 79.25        | 89.62         | 89.62      | 79.25        | 4.96               |
|    | XGBoost       |       | 73.58        | 86.79         | 86.79      | 73.58        | 3.72               |
| 5  | GradientBoost |       | 66.04        | 83.02         | 83.02      | 66.04        | 47.37              |
|    | SVM           |       | 91.70        | 95.85         | 95.85      | 91.70        | 1.31               |
|    | RandomForest  | 732   | 92.14        | 96.07         | 96.07      | 92.14        | 51.88              |
|    | XGBoost       |       | 89.52        | 94.76         | 94.76      | 89.52        | 131.53             |
| 6  | GradientBoost |       | 92.58        | 96.29         | 96.29      | 92.58        | 2848.49            |
|    | SVM           |       | 87.34        | 91.73         | 64.19      | 61.10        | 1.95               |
|    | RandomForest  | 3301  | 86.55        | 91.12         | 63.70      | 60.57        | 9.72               |
|    | XGBoost       |       | 78.88        | 71.54         | 60.97      | 59.86        | 82.84              |
| 7  | GradientBoost |       | 83.33        | 71.76         | 61.87      | 59.69        | 1150.59            |
|    | SVM           |       | 90.09        | 95.05         | 95.05      | 90.09        | 0.30               |
|    | RandomForest  | 592   | 90.99        | 95.50         | 95.50      | 90.99        | 14.86              |
|    | XGBoost       |       | 88.29        | 94.14         | 94.14      | 88.29        | 27.78              |
| 8  | GradientBoost |       | 86.49        | 93.24         | 93.24      | 86.49        | 495.06             |
|    | SVM           |       | 77.42        | 88.71         | 88.71      | 77.42        | 4.41               |
|    | RandomForest  | 1444  | 77.88        | 88.94         | 88.94      | 77.88        | 75.35              |
|    | XGBoost       |       | 80.65        | 90.32         | 90.32      | 80.65        | 437.11             |
| 9  | GradientBoost |       | 74.65        | 87.33         | 87.33      | 74.65        | 11837.68           |
|    | SVM           |       | 86.62        | 94.65         | 76.14      | 77.73        | 3.03               |
|    | RandomForest  | 3132  | 83.34        | 93.20         | 68.17      | 67.70        | 13.03              |
|    | XGBoost       |       | 83.86        | 87.26         | 77.52      | 76.51        | 151.82             |

|    |               |      |        |        |        |        |         |
|----|---------------|------|--------|--------|--------|--------|---------|
| 10 | GradientBoost | 768  | 85.93  | 89.54  | 76.82  | 76.09  | 4327.07 |
|    | SVM           |      | 75.00  | 87.50  | 87.50  | 75.00  | 0.39    |
|    | RandomForest  |      | 75.00  | 87.50  | 87.50  | 75.00  | 9.45    |
|    | XGBoost       |      | 71.05  | 85.53  | 85.53  | 71.05  | 35.58   |
| 11 | GradientBoost | 514  | 63.16  | 81.58  | 81.58  | 63.16  | 1105.45 |
|    | SVM           |      | 79.79  | 89.89  | 89.89  | 79.79  | 0.26    |
|    | RandomForest  |      | 84.04  | 92.02  | 92.02  | 84.04  | 11.48   |
|    | XGBoost       |      | 72.34  | 86.17  | 86.17  | 72.34  | 21.81   |
| 12 | GradientBoost | 4251 | 71.28  | 85.64  | 85.64  | 71.28  | 440.73  |
|    | SVM           |      | 85.14  | 89.01  | 83.95  | 84.99  | 3.81    |
|    | RandomForest  |      | 81.62  | 86.54  | 80.93  | 82.55  | 13.71   |
|    | XGBoost       |      | 70.65  | 71.20  | 70.64  | 69.59  | 188.68  |
| 13 | GradientBoost | 311  | 79.67  | 82.20  | 77.90  | 78.60  | 3627.00 |
|    | SVM           |      | 88.68  | 94.34  | 94.34  | 88.68  | 0.08    |
|    | RandomForest  |      | 90.57  | 95.28  | 95.28  | 90.57  | 5.04    |
|    | XGBoost       |      | 86.79  | 93.40  | 93.40  | 86.79  | 3.85    |
| 14 | GradientBoost | 210  | 88.68  | 94.34  | 94.34  | 88.68  | 54.04   |
|    | SVM           |      | 99.56  | 99.78  | 99.78  | 99.56  | 0.52    |
|    | RandomForest  |      | 99.12  | 99.56  | 99.56  | 99.12  | 29.10   |
|    | XGBoost       |      | 96.90  | 98.45  | 98.45  | 96.90  | 36.54   |
| 15 | GradientBoost | 3339 | 97.35  | 98.67  | 98.67  | 97.35  | 928.84  |
|    | SVM           |      | 80.59  | 92.54  | 28.22  | 26.80  | 3.65    |
|    | RandomForest  |      | 78.70  | 92.70  | 24.75  | 23.55  | 16.60   |
|    | XGBoost       |      | 78.87  | 75.59  | 27.83  | 26.09  | 192.21  |
| 16 | GradientBoost | 879  | 78.53  | 70.79  | 30.63  | 28.48  | 4761.71 |
|    | SVM           |      | 63.46  | 81.73  | 81.73  | 63.46  | 0.55    |
|    | RandomForest  |      | 69.23  | 84.62  | 84.62  | 69.23  | 16.75   |
|    | XGBoost       |      | 64.42  | 82.21  | 82.21  | 64.42  | 61.50   |
| 17 | GradientBoost | 916  | 65.38  | 82.69  | 82.69  | 65.38  | 1872.67 |
|    | SVM           |      | 71.29  | 85.64  | 85.64  | 71.29  | 0.38    |
|    | RandomForest  |      | 66.34  | 83.17  | 83.17  | 66.34  | 16.34   |
|    | XGBoost       |      | 61.39  | 80.69  | 80.69  | 61.39  | 44.85   |
| 18 | GradientBoost | 328  | 69.31  | 84.65  | 84.65  | 69.31  | 893.66  |
|    | SVM           |      | 83.05  | 91.53  | 91.53  | 83.05  | 0.09    |
|    | RandomForest  |      | 83.05  | 91.53  | 91.53  | 83.05  | 6.02    |
|    | XGBoost       |      | 79.66  | 89.83  | 89.83  | 79.66  | 5.71    |
| 19 | GradientBoost | 1012 | 77.97  | 88.98  | 88.98  | 77.97  | 78.34   |
|    | SVM           |      | 89.02  | 79.76  | 61.42  | 60.20  | 0.11    |
|    | RandomForest  |      | 91.15  | 93.74  | 63.47  | 61.50  | 2.83    |
|    | XGBoost       |      | 90.22  | 86.93  | 62.63  | 61.09  | 12.03   |
| 20 | GradientBoost | 156  | 91.45  | 90.77  | 63.75  | 61.82  | 228.45  |
|    | SVM           |      | 96.55  | 98.28  | 98.28  | 96.55  | 0.08    |
|    | RandomForest  |      | 93.10  | 96.55  | 96.55  | 93.10  | 5.15    |
|    | XGBoost       |      | 93.10  | 96.55  | 96.55  | 93.10  | 3.00    |
| 21 | GradientBoost | 1035 | 86.21  | 93.10  | 93.10  | 86.21  | 28.77   |
|    | SVM           |      | 95.38  | 97.86  | 88.80  | 90.43  | 0.37    |
|    | RandomForest  |      | 95.90  | 97.64  | 89.62  | 91.01  | 4.64    |
|    | XGBoost       |      | 95.13  | 96.42  | 90.73  | 91.05  | 17.46   |
| 22 | GradientBoost | 651  | 96.15  | 94.48  | 92.11  | 89.21  | 535.88  |
|    | SVM           |      | 100.00 | 100.00 | 100.00 | 100.00 | 3.80    |
|    | RandomForest  |      | 100.00 | 100.00 | 100.00 | 100.00 | 70.47   |
|    | XGBoost       |      | 97.81  | 98.91  | 98.91  | 97.81  | 290.01  |
| 23 | GradientBoost | 1050 | 100.00 | 100.00 | 100.00 | 100.00 | 9510.73 |
|    | SVM           |      | 82.87  | 98.09  | 11.19  | 10.15  | 15.40   |
|    | RandomForest  |      | 82.87  | 94.77  | 11.19  | 10.17  | 74.56   |



|    |               |      |       |       |       |       |         |
|----|---------------|------|-------|-------|-------|-------|---------|
|    | XGBoost       | 4998 | 82.72 | 92.77 | 11.71 | 10.90 | 385.61  |
| 24 | GradientBoost |      | 78.29 | 62.47 | 20.01 | 9.93  | 9914.35 |
|    | SVM           |      | 86.89 | 93.44 | 93.44 | 86.89 | 2.11    |
|    | RandomForest  | 1087 | 83.61 | 91.80 | 91.80 | 83.61 | 42.49   |
|    | XGBoost       |      | 72.68 | 86.34 | 86.34 | 72.68 | 228.70  |
| 25 | GradientBoost |      | 78.14 | 89.07 | 89.07 | 78.14 | 7062.85 |





























































