Table 1

JSD stability score - Individual vs proposed Ensemble Filter Method

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Methods | Threshold = 17 | Threshold = 23 | Threshold = 28 | Threshold = 33 |
| Chi - Square | 0.9100385770180721 | 0.8936632185486372 | 0.8705575031729956 | 0.8296027061303517 |
| Relief | 0.9152386402625874 | 0.8842702508570819 | 0.8599382679636445 | 0.8322924566602141 |
| Mutual info | 0.9025361515424769 | 0.8889531950687359 | 0.8803753892836893 | 0.8257441826735306 |
| Pearson | 0.9190543881758789 | 0.9190543881758789 | 0.9190543881758789 | 0.9190543881758789 |
| Proposed(Ensemble) | **0.9220638594100095** | **0.897737967459395** | **0.8762279915707437** | **0.8154402631653704** |

Table 2

Accuracies obtained with and without hybridization of filter and wrapper-based approaches

Friedman test statistic: 7.2667

p-value: 0.0639

|  |  |  |  |
| --- | --- | --- | --- |
| Methods | Accuracy | Friedman mean rank | Rank |
| Ensemble filter+BEEO(RL)+BMFK(proposed) | 0.8559 | 1.6500 | 1.0 |
| Without ensemble filter  &  with BEO-RL | 0.8261 | 2.5500 | 2.0 |
| without filter &  wrapper(all 44 features to BMFK  classifier) | 0.8151 | 2.7500 | 4.0 |
| With ensemble filter  &  with BEO alone (NO RL) | 0.8113 | 3.0500 | 5.0 |
| With ensemble filter + BMFK | 0.8233 | 2.6000 | 3.0 |

Table 3

Best fitness and Mean fitness values using the proposed approach and other heuristic algorithms

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Methods | Best Fitness | Mean Fitness | Accuracy | Friedman mean rank |
| Ensemble filter+BEEO(RL)+BMFK(proposed) | 0.925926 | 0.835354 | 0.925926 | 1.00 |
| GA- BMFK | 0.851852 | 0.805912 | 0.851852 | 2.33 |
| PSO- BMFK | 0.842593 | 0.802209 | 0.842593 | 3.33 |
| GWO- BMFK | 0.833333 | 0.811485 | 0.833333 | 3.33 |

Table 4

Best Parameters for bmfk : {'n\_neighbors': 9, 'm': 1.5, 'p': 3, 'q': 3}

Number of features selected using the proposed approach and other heuristic algorithms

|  |  |  |
| --- | --- | --- |
| Methods | No.of features selected | Friedman mean rank |
| Ensemble filter+BEEO(RL)+BMFK(proposed) | 13 | 1.00 |
| GA- BMFK | 18 | 1.50 |
| PSO- BMFK | 21 | 2.50 |
| GWO- BMFK | 24 | 3.50 |

Graph - Convergence behavior of the proposed (Ensemble filter+BEE+RL+ BMFK) approach

1. Number of iterations vs fitness value
2. Number of iterations vs mean fitness (if possible)

Table 5

Classification performance analysis of individual ML classifier without feature selection

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Methods | Accuracy | Precision | Recall | F1 Score | AUC Score |
| KNN | 0.78 | 0.75 | 0.72 | 0.73 | 0.85 |
| Random Forest | 0.85 | 0.84 | 0.82 | 0.83 | 0.86 |
| Decision Tree | 0.76 | 0.74 | 0.70 | 0.72 | 0.80 |
| Naïve Bayes | 0.72 | 0.71 | 0.68 | 0.69 | 0.81 |
| SVM | 0.84 | 0.83 | 0.81 | 0.82 | 0.87 |
| AdaBoost | 0.80 | 0.79 | 0.77 | 0.78 | 0.84 |
|  |  |  |  |  |  |

ROC Plot - individual ML classifier without feature selection

Table 6

Classification performance analysis of individual ML classifier with proposed feature selection

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Methods | Accuracy | Precision | Recall | F1 Score | AUC Score |
| KNN | 0.90 | 0.88 | 0.85 | 0.86 | 0.91 |
| Random Forest | 0.93 | 0.92 | 0.91 | 0.91 | 0.94 |
| Decision Tree | 0.87 | 0.86 | 0.84 | 0.85 | 0.89 |
| Naïve Bayes | 0.84 | 0.82 | 0.80 | 0.81 | 0.90 |
| SVM | 0.91 | 0.90 | 0.89 | 0.89 | 0.93 |
| AdaBoost | 0.88 | 0.87 | 0.85 | 0.86 | 0.92 |
|  |  |  |  |  |  |

ROC Plot - of individual ML classifier with proposed feature selection

Parameter settings

**Algorithm Parameter Settings**

|  |  |
| --- | --- |
| Algorithms | Parameter Values |
| Common Parameter Settings | - Population Size (N): 10 - Maximum Number of Iterations: GA: 10, PSO: 10, GWO: 5 - Value of k in KNN and BMFK: 5 - Fuzzy Strength Parameter in BMFK (m): 2 |
| Genetic Algorithm (GA) | - Mutation Rate: 0.1 - Crossover Rate: Implemented via cross point and offspring generation (not explicitly defined) |
| Particle Swarm Optimization (PSO) | - Inertia Weight (w): 0.9 - Acceleration Constants (c1 & c2): 0.5 each - Velocity Maximum (v\_max): 0.1 |
| Grey Wolf Optimization (GWO) | - Convergence Parameter (a): Decreases non-linearly from 2 to 0 over iterations |
| Proposed [EF(Ensemble Filter) + BEE(RL) + BMFK] | - BMFK Parameters:  - n\_neighbors: 5  - m: 2  - p: 2  - q: 2 |