	Fold 5	Fold 4	Fold 3	Fold 2	Fold 1
VGG19	Test 0.9828571677207947 Val0.9892857074737549 AUc_roc	Test 0.9878571629524231 Val 0.9821428656578064 AUc_roc	Test 0.9907143115997314 Val 0.9857142567634583 AUc_roc	Test 0.9850000143051147 Val0.9946428537368774] AUc_roc	Test 0.9907143115997314 Val 0.9883928298950195 AUc_roc
DenseNet121	Test 0.9878571629524231 Val0.9910714030265808 AUc_roc	Test 0.9907143115997314 Val 0.9830357432365417 AUc_roc	Test 0.9885714054107666 Val0.9857142567634583 AUc_roc	Test 0.9907143115997314 Val 0.9937499761581421 AUc_roc	Test 0.9864285588264465 Val 0.9839285612106323 AUc_roc
ResNet50	Test 0.9864285588264465 Val0.9866071343421936 AUc_roc	Test 0.9892857074737549 Val0.9937499761581421 AUc_roc	Test 0.9885714054107666 Val0.9919642806053162 AUc_roc	Test0.9878571629524231 Val0.9910714030265808] AUc_roc	Test 0.9871428608894348 Val 0.9848214387893677 AUc_roc

By using val accuracy as weights sugeno	0.991428	0.9935714285714285	0.9936	0.9910	0.9910
Weighted average using val accuracies					
Average ensembling	0.9864285714285714				
Majority voting	0.9935714285714285				

Fold1

Average ensembling

```
0.9857142857142858
[[700   0]
 [ 20 680]]
              precision    recall  f1-score   support

           0       0.97      1.00      0.99       700
           1       1.00      0.97      0.99       700

    accuracy                           0.99      1400
   macro avg       0.99      0.99      0.99      1400
weighted avg       0.99      0.99      0.99      1400
```

Weighted average with val accuracy ensembling

```
0.9914285714285714
              precision    recall  f1-score   support

           0       0.99      0.99      0.99       700
           1       0.99      0.99      0.99       700

    accuracy                           0.99      1400
   macro avg       0.99      0.99      0.99      1400
```

```
weighted avg       0.99      0.99      0.99      1400
```

```
[[694   6]
 [  6 694]]
```

Majority voting

```
0.9921428571428571
              precision    recall  f1-score   support

           0       0.99      0.99      0.99       700
           1       0.99      0.99      0.99       700

    accuracy                           0.99      1400
   macro avg       0.99      0.99      0.99      1400
weighted avg       0.99      0.99      0.99      1400
```

```
[[694   6]
 [  5 695]]
```

FOLD 2

Average ensembling

```
0.99
[[696   4]
 [ 10 690]]
              precision    recall  f1-score   support

           0       0.99      0.99      0.99       700
           1       0.99      0.99      0.99       700

    accuracy                           0.99      1400
   macro avg       0.99      0.99      0.99      1400
weighted avg       0.99      0.99      0.99      1400
```

Weighted average with val accuracy ensembling

```
0.9921428571428571
              precision    recall  f1-score   support

           0       1.00      0.99      0.99       700
           1       0.99      1.00      0.99       700

    accuracy                           0.99      1400
   macro avg       0.99      0.99      0.99      1400
weighted avg       0.99      0.99      0.99      1400
```

```
[[691   9]
 [  2 698]]
```

Majority voting

```
0.9935714285714285
              precision    recall  f1-score   support

           0       1.00      0.99      0.99       700
           1       0.99      1.00      0.99       700

    accuracy                           0.99      1400
   macro avg       0.99      0.99      0.99      1400
weighted avg       0.99      0.99      0.99      1400

[[693   7]
 [  2 698]]
```

FOLD 3

Average ensembling

```
0.9828571428571429
[[699   1]
 [ 23 677]]
              precision    recall  f1-score   support

           0       0.97      1.00      0.98       700
           1       1.00      0.97      0.98       700

    accuracy                           0.98      1400
   macro avg       0.98      0.98      0.98      1400
weighted avg       0.98      0.98      0.98      1400
```

Weighted average using val Accracies

```
0.9935714285714285
              precision    recall  f1-score   support

           0       0.99      0.99      0.99       700
           1       0.99      0.99      0.99       700

    accuracy                           0.99      1400
   macro avg       0.99      0.99      0.99      1400
weighted avg       0.99      0.99      0.99      1400

[[696   4]
```

```
 [  5 695]]
Majority voting
0.9942857142857143
              precision    recall  f1-score   support

           0       0.99      1.00      0.99       700
           1       1.00      0.99      0.99       700

    accuracy                           0.99      1400
   macro avg       0.99      0.99      0.99      1400
weighted avg       0.99      0.99      0.99      1400

[[697   3]
 [  5 695]]


FOLD 4
Average ensembling
0.9964285714285714
[[700   0]
 [  5 695]]
              precision    recall  f1-score   support

           0       0.99      1.00      1.00       700
           1       1.00      0.99      1.00       700

    accuracy                           1.00      1400
   macro avg       1.00      1.00      1.00      1400
weighted avg       1.00      1.00      1.00      1400

Weighted Average ensembling val accuracies
0.9964285714285714
              precision    recall  f1-score   support

           0       0.99      1.00      1.00       700
           1       1.00      0.99      1.00       700

    accuracy                           1.00      1400
   macro avg       1.00      1.00      1.00      1400
weighted avg       1.00      1.00      1.00      1400

[[700   0]
 [  5 695]]
Majority voting ensembling
0.9971428571428571
```

	precision	recall	f1-score	support
0	0.99	1.00	1.00	700
1	1.00	0.99	1.00	700
accuracy			1.00	1400
macro avg	1.00	1.00	1.00	1400
weighted avg	1.00	1.00	1.00	1400

```
[[700   0]
 [  4 696]]
```

FOLD 5

Average ensembling

0.9914285714285714

```
[[698   2]
 [ 10 690]]
```

	precision	recall	f1-score	support
0	0.99	1.00	0.99	700
1	1.00	0.99	0.99	700
accuracy			0.99	1400
macro avg	0.99	0.99	0.99	1400
weighted avg	0.99	0.99	0.99	1400

Weighted Average ensembling val accuracies

0.9914285714285714

	precision	recall	f1-score	support
0	0.99	1.00	0.99	700
1	1.00	0.99	0.99	700
accuracy			0.99	1400
macro avg	0.99	0.99	0.99	1400
weighted avg	0.99	0.99	0.99	1400

```
[[698   2]
 [ 10 690]]
```

Majority voting ensembling

0.9914285714285714

```
              precision    recall  f1-score   support

           0       0.99      1.00      0.99       700
           1       1.00      0.99      0.99       700

    accuracy                           0.99      1400
   macro avg       0.99      0.99      0.99      1400
weighted avg       0.99      0.99      0.99      1400

[[698   2]
 [ 10 690]]
```

FOLD5 sugeno ----optimizer DE--- fuzzy scores--validation----test

RUN 1 `[0.32367648 0.86816962 0.20469143] 0.9946428571428572 0.9957142857142857`

RUN 2 `[0.60652904 0.60761822 0.28470913] 0.9946428571428572 0.9957142857142857`

RUN 3 `[0.53859704 0.02854854 0.01747606] 0.9946428571428572 0.995`

RUN 4 `[0.12402031 0.70712827 0.93044628] 0.9946428571428572 0.995`

RUN 5 [0.48351541 0.89492229 0.11041567] 0.9946428571428572
0.9957142857142857

RUN 6 [0.21426744 0.64287213 0.96920865] 0.9946428571428572
0.995

RUN 7 [0.21426744 0.64287213 0.96920865] 0.9946428571428572
0.995

RUN 8 [0.49020662 0.98550642 0.23468598] 0.9946428571428572
0.9957142857142857

RUN 9 [0.98869597 0.86393334 0.03321119] 0.9946428571428572
0.9957142857142857

RUN 10 [0.89227778 0.88044519 0.3703405]0.9946428571428572

0.9957142857142857

FOLD5 sugeno ----optimizer WOA --- fuzzy scores--validation----test

RUN 1 [0.95107526 0.01569268 0.99534048] 0.9973214285714286
0.9942857142857143

RUN 2 [0.4030942 0.05527412 0.99934763] 0.9973214285714286
0.9942857142857143

RUN 3 [0.55045494 0.12633032 1.   ] 0.9973214285714286
0.9942857142857143

RUN 4[0.03295115 0.52011902 0.9882743] 0.9973214285714286

0.9942857142857143

RUN 5[0.95630219 0.96240663 0.99438256] 0.9973214285714286
0.9942857142857143

RUN 6 [0.71605918 0.64315495 0.98328924] 0.9973214285714286
0.9942857142857143

RUN 7[0.97075886 0.08883613 0.98166732] 0.9973214285714286
0.9942857142857143

RUN 8 [0.7131003 0.21776361 0.99082152] same

RUN 9

RUN 10

FOLD5 sugeno ----optimizer ALO--- fuzzy scores--validation----test

RUN 1[0.16034194 0.64391513 0.96743945] 0.9964285714285714
0.9978571428571429

RUN 2[0.71420228 0.95804941 0.974537] same
0.9971428571428571

RUN 3 [0.38510331 0.49781735 0.97157027] 0.9964285714285714
0.9971428571428571

RUN 4[0.10642452 0.47588309 0.95424527] 0.9964285714285714
0.9978571428571429

RUN 5

RUN 6

RUN 7

RUN 8

RUN 9

RUN 10

FOLD5 sugeno ----optimizer PSO--- fuzzy scores--validation----test

RUN 1 `[0.9887952  0.86306685 0.99098409]  0.9982142857142857 0.9964285714285714`

RUN 2`[0.82893763 0.73091089 0.99750404] same`

RUN 3 `[0.85499011 0.29127636 0.99738482]`

RUN 4`[0.84924308 0.64260424 0.99246983]`

RUN 5`[0.9696713  0.22708502 0.99756281]`

RUN 6

RUN 7

RUN 8

RUN 9

RUN 10

FOLD5 sugeno ----optimizer GWO --- fuzzy scores--validation----test

RUN 1 `[0.42783132 0.8140165  0.97441626]0.9964285714285714 0.9971428571428571`

RUN 2 `[0.00935139 0.28698666 0.97634145]` same

RUN 3 `[0.09425729 0.63118508 0.99609892]  0.9964285714285714 0.9964285714285714`

RUN 4 `.9964285714285714 [0.27187688 0.31442534 0.99187676]] 0.9964285714285714`

RUN 5 `[0.50801472 0.54122559 0.98656387]`

RUN 6 `[0.22249514 0.4618045  0.99682539]`

RUN 7

RUN 8

RUN 9

RUN 10

FOLD 2

FOLD4 sugeno ----optimizer PSO --- fuzzy scores--validation----test

RUN 1 [0.14155013 0.32144721 0.98666431] 0.9973214285714286 0.9978571428571429

RUN 2 [0.37226613 0.97258267 0.79357793] 0.9973214285714286 0.9957142857142857

RUN 3 [0.14779894 0.21197872 0.99251287] 0.9973214285714286 0.9978571428571429

RUN 4 [0.71962655 0.77936295 0.71997678] 0.9973214285714286 0.9957142857142857

RUN 5 [0.58125047 0.1984576 0.11294338] same

RUN 6 [0.39677429 0.21975963 0.98240565] 0.9973214285714286 0.9971428571428571

RUN 7[0.95383385 0.80555998 0.76330186] 0.9973214285714286
0.9957142857142857

RUN 8[0.35415377 0.9957061 0.92434237]0.9971428571428571

0.9971428571428571

RUN 9[0.60651334,0.84745409,0.75516298] 0.9973214285714286
0.9957142857142857

RUN 10[0.43649999 0.73570982 0.71163253] 0.9973214285714286
0.9957142857142857

FOLD4 sugeno ----optimizer GWO --- fuzzy scores--validation----test

RUN 1[0.54916156 0.54747232 0.986694]0.9991071428571429
0.9935714285714285

RUN 2[0.20283891 0.42523595 0.98387087] 0.9991071428571429
0.9935714285714285

RUN 3[0.43586674 0.85960831 0.99834852] same

RUN 4[0.84167826 0.51502948 0.99992421] same

RUN 5[0.05183547,0.38720729,0.97058141] 0.9991071428571429
0.9928571428571429

RUN 6[0.10833086,0.06187462,0.97764078]0.9991071428571429
0.9935714285714285

RUN 70.31269386,0.28442986,0.98914188 0.9991071428571429
0.9935714285714285

RUN 8[0.82761983 1.06492615 1.26400566] 0.9991071428571429
0.9935714285714285

RUN 9 [0.30087103,0.98757259,0.97310368]0.9991071428571429
0.9935714285714285

RUN 10[0.3577549 0.35712534 0.96718982] 0.9991071428571429
0.9921428571428571

FOLD4 sugeno ----optimizer ALO --- fuzzy scores--validation----test

RUN 1 [0.55114518 0.07689115 0.99727619] 0.9973214285714286
0.9964285714285714

RUN 2[0.59181738 0.46832587 0.9858279]0.9973214285714286
0.9964285714285714

RUN 3[0.09407955 0.82602469 0.99612685]0.9973214285714286
0.9964285714285714

RUN 4[0.99287342 0.36528908 0.99866987] 0.9973214285714286
0.9964285714285714

RUN 5[0.23828821 0.06097293 0.99059046] 0.9973214285714286
0.9964285714285714

RUN 6 [0.33267819 0.34316128 0.25682687] 0.9973214285714286
0.9942857142857143

RUN 7[0.65948258 0.49997896 0.99819299] 0.9973214285714286 0.9964285714285714

RUN 8 [0.24653161,0.36117223,0.06183366]0.9973214285714286 0.9942857142857143

RUN 9[0.58610074 0.46991475 0.9847972] same

RUN 10

FOLD4 sugeno ----optimizer WOA --- fuzzy scores--validation----test

RUN 1[0.51403814 0.79114404 0.5401044]0.9973214285714286 0.9957142857142857

RUN 2[0.42227517 0.30660857 1.   ] same

RUN 3[0.9985825 0.5044867 0.47879358] same

RUN 4[0.16833095 0.84029941 0.34012531] same

RUN 5[0.06814429 0.03419037 0.02664247] 0.9982142857142857 0.9942857142857143

RUN 6[0.97394334 0.91085943 0.58298614]0.9973214285714286 0.9964285714285714

RUN 7[0.68644784 0.50619104 0.00652304] same as 1

RUN 8`[0.97464665 0.85698423 0.58567816] 0.997321428571428 0.9964285714285714`

RUN 9

RUN 10

FOLD4 sugeno ----optimizer DE --- fuzzy scores--validation----test

RUN 1`[0.45659043 0.30609338 0.14092198] 0.9964285714285714 0.9914285714285714`

RUN 2`[0.48471267 0.32832092 0.05943991]0.9964285714285714 0.9914285714285714`

RUN 3`[0.72463714 0.95817371 0.65798384]0.9964285714285714 0.9914285714285714`

RUN 4`[0.2933437  0.75977213 0.6570942 ]0.9964285714285714 0.9914285714285714`

RUN 5`[0.75583145 0.73851759 0.65880123] same`

RUN 6`[0.49789128 0.29476193 0.19614892] same`

RUN 7`[0.45000301 0.32216819 0.30685871] same`

RUN 8`[0.04447573 0.96921612 0.67935611]`

RUN 9

RUN 10

FOLD3 sugeno ----optimizer DE --- fuzzy scores--validation----test

RUN 1`[0.95291643 0.68760189 0.23775024]0.9928571428571429 0.9942857142857143`

RUN 2`[0.64534065 0.83612972 0.37243044] same`

RUN 3`[0.19016951 0.53245741 0.96448515] same`

RUN 4`[0.37588195 0.50732407 0.97862504] 0.9928571428571429 0.9935714285714285`

RUN 5`[0.3865866  0.64041578 0.14318348] 0.9928571428571429 0.9942857142857143`

RUN 6`[0.58311317 0.5694053  0.47768654] same`

RUN 7`[0.51542778 0.80223316 0.43155849] same`

RUN 8`[0.43813565 0.98855613 0.09554704] same`

RUN 9

RUN 10

FOLD3 sugeno ----optimizer WOA --- fuzzy scores--validation----test

RUN 1`[0.6661014  0.71419372 0.9951954 ]0.9964285714285714 0.995`

RUN 2 [0.88412288 0.50571824 0.96855298] same

RUN 3[0.21511165 0.45711345 0.97290462] same

RUN 4[0.75433796 0.71535087 0.97406214] same

RUN 5[0.66562529 0.8454333 0.96281489] same

RUN 6[0.24303385 0.99076327 0.97516233] same

RUN 7[0.98171638 0.35450974 0.96394943] same

RUN 8

RUN 9

RUN 10

FOLD3 sugeno ----optimizer GWO --- fuzzy scores--validation----test

RUN 1[0.8906473 0.21203105 0.96030243]0.9955357142857143
0.9921428571428571

RUN 2 [0.83767202 0.81775268 0.97841593] same

RUN 3[0.8234936 0.69098918 0.9603121] same

RUN 4[0.79389166 0.59120473 0.9891765] same

RUN 5[0.73184076 0.17931993 0.97685524] same

RUN 6[0.53141431 0.66685336 0.98828145] same

RUN 7[0.75063435 0.60796509 0.97322134] same

RUN 8[0.33532328 0.62529027 0.99736683] same

RUN 9

RUN 10

FOLD3 sugeno ----optimizer ALO--- fuzzy scores--validation----test

RUN 1[0.23221016 0.55226281 0.98078322]0.9973214285714286
0.995

RUN 2 [0.25969356 0.40303068 0.99556857] same

RUN 3[0.97790846 0.75607143 0.99801341] same

RUN 4[0.71531283 0.47220497 0.99454996] same

RUN 5[0.6906226 0.16690156 0.03511354] same

RUN 6[0.61792607 0.71534006 0.98103746] same

RUN 7[0.60512745 0.35452553 0.98609182] same

RUN 8[0.19737677 0.98914516 0.88131033] 0.9973214285714286 0.9942857142857143

RUN 9[0.4772072 0.0886186 0.02184508] 0.9973214285714286 0.9942857142857143

RUN 10

FOLD3 sugeno ----optimizer PSO--- fuzzy scores--validation----test

RUN 1[0.84768304 0.060102   0.11944881] 0.9955357142857143 0.9928571428571429

RUN 2 [0.63325841 0.1541166 0.90051535] same

RUN 3[0.45860375 0.11513266 0.0646037] same

RUN 4[0.39393967 0.19615532 0.9651587]0.9955357142857143 0.9935714285714285

RUN 5[0.02359912 0.33140774 0.99697598] 0.9955357142857143 0.9942857142857143

RUN 6 [0.14774844 0.18158404 0.85006725]0.9955357142857143 0.9914285714285714

RUN 7 [0.16884088 0.61049824 0.94177371] 0.9955357142857143 0.9935714285714285

RUN 8 [0.26365628 0.803419   0.96299274] same

RUN 9 [0.90952352 0.17145009 0.11424764] 0.9955357142857143 0.9942857142857143

FOLD2 Sugeno ----optimizer PSO--- fuzzy scores--validation----test

RUN 1 [0.61896258 0.27925586 0.97964067]0.9964285714285714 0.995

RUN 2 [0.36932036 0.65039436 0.36783057] 0.9964285714285714 0.9957142857142857

RUN 3 [0.01347748 0.99493361 0.1875466] same

RUN 4 [0.8265352 0.87483032 0.95134771]0.9964285714285714 0.9978571428571429

RUN 5 [0.3861172 0.85959773 0.05674748] same

RUN 6 [0.53549968 0.36320583 0.9489723]0.9964285714285714 0.9978571428571429

RUN 7 `[0.2442322  0.87358098 0.32682205] same`

RUN 8 `[0.34232382 0.56038747 0.19163023] 0.9964285714285714 0.9957142857142857`

RUN 9 `[0.84844584 0.91338307 0.49267925] same`

RUN 10 `[0.9725345  0.78056705 0.34576289] same`

FOLD2 Sugeno ----optimizer ALO--- fuzzy scores--validation----test

RUN 1 `[0.59285402 0.88126816 0.16236548] 100 0.995`

RUN 2 `[0.27203565 0.96960714 0.26990905] same`

RUN 3 `[0.55458221 0.99988759 0.01018874] 100 0.9942857142857143`

RUN 4 `[0.59606435 0.67656373 0.11867482] same`

RUN 5 `[0.94814881 0.41743606 0.23799292] same`

RUN 6 `[0.35221801 0.43437616 0.00418428] same`

RUN 7 `[0.97375227 0.78645045 0.13906679] same`

RUN 8 `[0.92755109 0.98974709 0.00403643] same`

RUN 9 `[0.83906944 0.56418522 0.24122818] same`

RUN 10

FOLD2 Sugeno ----optimizer GWO--- fuzzy scores--validation----test

RUN 1[0.95937016 0.06107289 0.22524846]0.9973214285714286
0.9914285714285714

RUN 2[0.40597012 0.08047403 0.21000856] same

RUN 3[0.86784909 0.8240462 0.81933056] same

RUN 4[0.9746276 0.40313778 0.80476679] same

RUN 5[0.88085761 0.69131435 0.9884216]0.9973214285714286
0.9928571428571429

RUN 6[0.67210375 0.1275915 0.75152838]0.9973214285714286
0.9921428571428571

RUN 7[0.73301329 0.06543913 0.79292718]0.9973214285714286
0.9914285714285714

RUN 8[0.01   0.14036211 0.87492271] same

RUN 9

RUN 10

FOLD2 Sugeno ----optimizer WOA--- fuzzy scores--validation----test

RUN 1[0.36476755 0.55630272 0.44590543] 0.9973214285714286
0.9935714285714285

RUN 2[0.56714438 0.60226998 0.31570037] 0.9973214285714286
0.9935714285714285

RUN 3[0.94598419 0.82196735 0.96889117]0.9973214285714286
0.992

RUN 4[0.34343811 0.99155628 0.8896771] 0.9973214285714286
0.9935714285714285

RUN 5[0.39728414 0.99234576 0.1468329] same

RUN 6[0.70999624 0.6361078 0.35637642] same

RUN 7[0.74305934 0.98357217 0.03938321] same

RUN 8[0.16065645 0.99115229 0.56586762] same
0.995

RUN 9

RUN 10

FOLD2 Sugeno ----optimizer WOA--- fuzzy scores--validation----test

RUN 1[0.94094327 0.87347986 0.98327261]0.9982142857142857
0.9921428571428571

RUN 2[1.   0.74613463 1.   ] same

RUN 3[0.28887654 0.85883144 1.   ] same

RUN 4[0.27214674 0.96939177 0.98288514] same

RUN 5[0.14929495 0.31505005 0.98889598] same

RUN 6[0.41178108 0.24329232 1.   ] same

RUN 7[0.33801701 0.01773359 0.00914726] same

RUN 8[0.59426056 0.43689297 0.98676035] same

RUN 9[0.91713888 0.92483576 0.98250301] same

RUN 10

FOLD1 Sugeno ----optimizer GWO--- fuzzy scores--validation----test

RUN 1[0.28869815 0.91688598 0.94985095]0.9955357142857143
0.9928571428571429

RUN 2[0.90062777 0.34869173 0.99402625] 0.9955357142857143

0.9957142857142857

RUN 3[0.61855764 0.98223426 0.99990116] 0.9955357142857143
0.9957142857142857

RUN 4[0.99446649 0.01297396 0.97012457]0.9955357142857143
0.9942857142857143

RUN 5[0.90779453 0.83136756 0.98369072] 0.9955357142857143
0.995

RUN 6 [0.12792811 0.44524962 0.99874868]0.9955357142857143
0.9957142857142857

RUN 7[0.84216752 0.62032512 0.97322323]0.9955357142857143
0.9942857142857143

RUN 8[0.07036999 0.31841592 0.96040562] 0.9955357142857143
0.9935714285714285

RUN 9[0.379241   0.42921905 0.95544338] same

RUN 10[0.74688951 0.80643511 0.95303554] 0.9955357142857143
0.9928571428571429

FOLD1 Sugeno ----optimizer PSO--- fuzzy scores--validation----test

RUN 1[0.86227389 0.50764036 0.96954106]0.9955357142857143
0.9935714285714285

RUN 2[0.68622802 0.30138139 0.99510591]0.9955357142857143
0.9942857142857143

RUN 3[0.96832933 0.79032821 0.98267022] 0.9955357142857143
0.9935714285714285

RUN 4[0.87119681 0.3567471 0.98993024] same

RUN 5[0.70245874 0.31690481 0.95837536] same

RUN 6 [0.49414405 0.84194098 0.98836498] 0.9955357142857143
0.9935714285714285

RUN 7[0.69947631 0.74043635 0.97580122] same

RUN 8[0.65534153 0.45528812 0.98565047] same

RUN 9

RUN 10

FOLD1 Sugeno ----optimizer WOA--- fuzzy scores--validation----test

RUN 1[0.87488587 0.26436502 0.98443277]0.9964285714285714
0.9935714285714285

RUN 2[0.48199326 0.76301789 0.97594032] 0.9964285714285714
0.9928571428571429

RUN 3[0.00635625 0.62682461 0.98082298] 0.9964285714285714
0.9935714285714285

RUN 4[0.71813836 0.73898868 0.96978682] 0.9964285714285714
0.9921428571428571

RUN 5[0.33044881 0.86048895 0.98024745] 0.9964285714285714
0.9935714285714285

RUN 6[0.17797772 0.45535583 0.97491381] 0.9964285714285714
0.9928571428571429

RUN 7[0.52525098 0.62323728 0.98945885] 0.9964285714285714
0.9935714285714285

RUN 8[0.40918803 0.27254635 0.97002079] same

RUN 9

RUN 10

FOLD1 Sugeno ----optimizer ALO--- fuzzy scores--validation----test

RUN 1[0.69304202 0.9819941 0.90601665] 0.9982142857142857 0.9957142857142857

RUN 2[0.723968   0.84999397 0.80611018] same

RUN 3[0.58680348 0.19906347 0.10325644] 0.9982142857142857 0.995

RUN 4[0.38373267 0.07933815 0.04862205] 0.9982142857142857 0.9957142857142857

RUN 5[0.84721371 0.2077642 0.08222739] 0.9982142857142857 0.995

RUN 6[0.37504518 0.20166127 0.13455769] 0.9982142857142857 0.995

RUN 7[0.56472544 0.23015448 0.92547217] same

RUN 8[0.69415197 0.90141054 0.80896715] 0.9982142857142857 0.9957142857142857

RUN 9

RUN 10

FOLD1 Sugeno ----optimizer DE--- fuzzy scores--validation----test

RUN 1 `[0.88427288 0.83184164 0.80180382] 0.9964285714285714 0.9935714285714285`

RUN 2 `[0.78084663 0.19636901 0.16058511] same`

RUN 3 `[0.51388341 0.02098168 0.80578112] 0.9964285714285714 0.9921428571428571`

RUN 4 `[0.66441778 1.         0.80465709] 0.9964285714285714 0.9935714285714285`

RUN 5 `[0.72602726 0.70471073 0.80518306] 0.9964285714285714 0.9921428571428571`

RUN 6 `[1.         0.78955294 0.80292817]same`

RUN 7 `[0.57596535 0.79921947 0.80488511] same`

RUN 8 `[0.75523624 0.52702442 0.80056234] same`

RUN 9

RUN 10

\begin{figure*}[]
\includegraphics[width=\textwidth]{fold2_cv.png}
\centering
\caption{Represents the mean accuracies of our proposed method using various optimization algorithms along with the accuracies achieved by other ensembling methods in the case of cross-validation Fold 2.}

\label{fig:cvfold2}
\end{figure*}

\begin{figure*}[]
\includegraphics[width=\textwidth]{fold3_cv.png}
\centering
\caption{Represents the mean accuracies of our proposed method using various optimization algorithms along with the accuracies achieved by other ensembling methods in the case of cross-validation Fold 3.}
\label{fig:cvfold3}
\end{figure*}

\begin{figure*}[]
\includegraphics[width=\textwidth]{fold4_cv.png}
\centering
\caption{Represents the mean accuracies of our proposed method using various optimization algorithms along with the accuracies achieved by other ensembling methods in the case of cross-validation Fold 4.}
\label{fig:cvfold4}
\end{figure*}

\begin{figure*}[]
\includegraphics[width=\textwidth]{fold5_cv.png}
\centering
\caption{Represents the mean accuracies of our proposed method using various optimization algorithms along with the accuracies achieved by other ensembling methods in the case of cross-validation Fold 5.}
\label{fig:cvfold5}
\end{figure*}

\begin{figure*}[]
\includegraphics[width=\textwidth]{fold5_cv.png}
\centering
\caption{Represents the average of the performances of our proposed method using various optimization algorithms along with the performances by other ensembling methods for all the cross-validation folds.}
\label{fig:cvfold5}
\end{figure*}
Here the working of the Sugeno integral method as a classifier combination is shown in the form of an example.
Let us consider a case where we have a classifier set
$X = \{x_1, x_2, x_3\}$ such that the confidence scores for TB class and Normal class are defined as $r(x_1) = 0.2$, $r(x_2) = 0.3$ and $r(x_3) = 0.5$. The fuzzy measures are defined as $\mu(x_1) = 0.2, \mu(x_2) = 0.4$ and $\mu(x_3) = 0.5$ then,

We calculate the Sugeno λ fuzzy-measure as,
$$1+\lambda = \Pi_{i=1}^{n} (\mu(\{x_i\}) \lambda + 1)$$

The characteristic equation,
$$4\lambda^3+38\lambda^2+10\lambda = 0$$
By solving the above characteristic equation the values of λ we get are,
$\lambda = 0$, $\lambda = -0.27$ and $\lambda = -9.23$.

For $\lambda = -0.27$, using the equation below,
$$\mu(x_2,x_3) = \mu(x_2)+\mu(x_3)+\lambda \mu(x_2)\mu(x_3)$$
we get $\mu(x_2,x_3) = 0.846$ and using $\mu(x_2,x_3)$ and $\mu(x_3)$,
$$\mu(x_1,x_2,x_3) = \mu(x_2,x_3)+\mu(x_1)+\lambda \mu(x_2,x_3)\mu(x_3)$$
the value of $\mu(x_1,x_2,x_3)$ is calculated to be 1.00031 or 1.00(approx).
Also by adding all the fuzzy measures we get,

$$\mu(x_1)+\mu(x_2)+\mu(x_3) = 1.1$$
which is more than the value of $\mu(x_1,x_2,x_3)$. Therefore, the value of λ is considered as -0.27.
With this value of λ we calculate the other fuzzy measures i.e, $\mu(x_1,x_2) = 0.578$ and $\mu(x_1,x_3) = 0.673$.

Therefore all the fuzzy-measures are,
- $\mu(\phi) = 0$
- $\mu(x_1) = 0.2$
- $\mu(x_2) = 0.4$
- $\mu(x_3) = 0.5$
- $\mu(x_1,x_2) = 0.578$
- $\mu(x_2,x_3) = 0.846$
- $\mu(x_1,x_3) = 0.673$
- $\mu(x_1,x_2,x_3) = 1.00$

%which is greater than 1 or $\mu(x_1,x_2,x_3)$. Therefore, we consider the λ to be -0.27.

Hence the Sugeno integral is given by,

$$\int_{n=1}^{3} r(x) d\mu = max(min(r(x_1), \mu(x_1, x_2, x_3)), min(r(x_2), \mu(x_2, x_3)),min(r(x_3), \mu(x_3)))$$

Putting the required values we get,

$$\int_{n=1}^{3} r(x) d\mu = max(min(0.2,1), min(0.3,0.846), min(0.5,0.5))$$

So, finally the value of the Sugeno integral is 0.5.