黄色表示为10次10折交叉验证结果

表1 数据集描述

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 索引 | 数据集 | 样本总数 | 属性数 | 少数类 | 多数类 | 不平衡率 |
| 1 | breast-w | 699 | 9 | 241 | 485 | 1.90 |
| 2 | vehicle | 846 | 18 | 199 | 647 | 3.25 |
| 3 | segment-challenge | 1500 | 19 | 205 | 1295 | 6.32 |
| 4 | Diabetes | 768 | 8 | 268 | 500 | 1.87 |
| 5 | Ionosphere | 351 | 34 | 126 | 225 | 1.79 |
| 6 | Sonar | 208 | 60 | 97 | 111 | 1.14 |

# 不同算法的对比

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 100% | | | 200% | | | 300% | | |
|  | VAE | NDO | SMOTE | VAE | NDO | SMOTE | VAE | NDO | SMOTE |
| 1 | 94.65 | 94.38 | 94.38 | **94.63** | 94.38 | 94.38 | **94.67** | 94.38 | 94.38 |
| 2 | **58.22** | 55.66 | 56.26 | **58.12** | 56.63 | 56.45 | **58.78** | 56.27 | 56.45 |
| 3 | **66.88** | 65.47 | 62.44 | **69.45** | 66.55 | 61.15 | **71.21** | 61.90 | 61.15 |
| 4 | **65.51** | 65.93 | 66.27 | **66.96** | 66.74 | 66.33 | **66.34** | 65.59 | 66.33 |
| 5 | **87.00** | 82.34 | 80.54 | **85.89** | 82.63 | 82.71 | **84.26** | 81.44 | 82.71 |
| 6 | 66.12 | **71.85** | 70.40 | 64.78 | **73.90** | 70.41 | 64.00 | **73.89** | 70.43 |

# 不同算法的对比

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 100% | | | 200% | | | 300% | | |
|  | VAE | NDO | SMOTE | VAE | NDO | SMOTE | VAE | NDO | SMOTE |
| 1 | 96.95 | **96.89** | **96.89** | **96.94** | 96.89 | 96.89 | **96.96** | 96.89 | 96.89 |
| 2 | **74.50** | 72.06 | 72.35 | **75.90** | 71.98 | 71.87 | **77.82** | 71.73 | 71.90 |
| 3 | 91.68 | **91.79** | 89.69 | **92.78** | 92.22 | 89.41 | **93.43** | 92.47 | 89.03 |
| 4 | **79.78** | 79.73 | 80.25 | **77.44** | 77.78 | 76.71 | **76.29** | 74.95 | 74.48 |
| 5 | **93.70** | 89.62 | 87.79 | **93.42** | 89.84 | 88.56 | **92.82** | 90.07 | 89.45 |
| 6 | 59.94 | 63.77 | **64.67** | 61.87 | **65.13** | 65.03 | 61.83 | 65.02 | **65.39** |

# 不同算法的对比

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 100% | | | 200% | | | 300% | | |
|  | VAE | NDO | SMOTE | VAE | NDO | SMOTE | VAE | NDO | SMOTE |
| 1 | 96.50 | **96.35** | **96.35** | **96.50** | 96.35 | 96.35 | **96.55** | 96.35 | 96.35 |
| 2 | **75.14** | 72.71 | 73.27 | **75.19** | 73.50 | 73.18 | **75.79** | 73.30 | 73.34 |
| 3 | **90.34** | 89.55 | 88.91 | **91.40** | 89.23 | 89.36 | **91.88** | 89.41 | 89.01 |
| 4 | **73.15** | 73.57 | 73.84 | **74.04** | 74.07 | 73.01 | **73.35** | 73.24 | 73.03 |
| 5 | **88.54** | 86.47 | 85.32 | **87.46** | 86.66 | 85.99 | **86.07** | 86.86 | 86.98 |
| 6 | 61.75 | 67.31 | **67.37** | 62.28 | **68.81** | 67.59 | 61.99 | **68.73** | 67.81 |

# 以下均为10次10折交叉验证结果

## 自己实现的Smote

wpbc

[ 0.40991733 0.73907425 0.65040852 0.55980199 0.5495 0.67298333]

[ 0.41172796 0.72579389 0.63810902 0.56688719 0.575 0.6728 ]

[ 0.41404275 0.71986168 0.63316416 0.57458838 0.593 0.6742 ]

vote

[ 0.91470447 0.94673644 0.93452507 0.92802383 0.90433824 0.97165164]

[ 0.91346333 0.94628932 0.93381078 0.92683135 0.90128676 0.97095976]

[ 0.91368571 0.94650923 0.93403805 0.92702409 0.90128676 0.97103936]

SRBCT

[ 0.974 0.99 0.98555556 0.97614456 0.95666667 1. ]

[ 0.966 0.98692308 0.98111111 0.96880442 0.94333333 1. ]

[ 0.964 0.98615385 0.98 0.96696938 0.94 1. ]

spect

[ 0.50715517 0.6750294 0.6135816 0.69342287 0.91433333 0.84125253]

[ 0.51417623 0.6975044 0.63291819 0.70236446 0.88633333 0.83632468]

[ 0.51649159 0.70574701 0.63975885 0.70676214 0.88066667 0.8365184 ]

movement

[ 0.52670168 0.9541999 0.92209395 0.60455495 0.56333333 0.90620766]

[ 0.51859804 0.95345608 0.92065294 0.58246897 0.55333333 0.88973708]

[ 0.4938366 0.94963687 0.91396203 0.5541977 0.525 0.88277184]

letter

[ 0.82215068 0.99251942 0.98564434 0.91676486 0.84960526 0.95591924]

[ 0.80957201 0.99179225 0.98426454 0.91911279 0.85521053 0.95554737]

[ 0.80070675 0.99127522 0.98328401 0.91978237 0.85728947 0.95535318]

landsat

[ 0.86244874 0.95630944 0.93430754 0.89969862 0.84717391 0.96014938]

[ 0.86434134 0.95668079 0.9349593 0.90188978 0.85173913 0.96053494]

[ 0.86422371 0.9566031 0.93485905 0.9019871 0.85217391 0.96058292]

heart

[ 0.82841095 0.85131639 0.84236819 0.83752534 0.84049451 0.89894554]

[ 0.81978246 0.84049773 0.83231442 0.8284677 0.83978022 0.89880111]

[ 0.81500408 0.83435432 0.82675306 0.82334456 0.84049451 0.89874758]

haberman

[ 0.37867827 0.8519495 0.76280578 0.48649083 0.29722222 0.69168286]

[ 0.3971872 0.83510369 0.74408333 0.51691865 0.36222222 0.69194417]

[ 0.47357713 0.79877102 0.71777151 0.61044524 0.51972222 0.69343517]

K=5

breastw

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 0.9328056 | 0.9642806 | 0.95339865 | 0.9492878 | 0.93833333 | 0.98477516 |
| 0.93193557 | 0.96469138 | 0.95354755 | 0.9478183 | 0.93266667 | 0.98472299 |
| 0.93064074 | 0.96421123 | 0.95283326 | 0.94659409 | 0.93016667 | 0.9847056 |

vehicle

[ 0.02909091 0.86699581 0.76607902 0.06914544 0.0155 0.50874193]

[ 0.02813853 0.86693697 0.76595997 0.06690937 0.015 0.50875082]

[ 0.02813853 0.86693697 0.76595997 0.06690937 0.015 0.50875082]

segment-challenge

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 0.61226521 | 0.88999553 | 0.82874217 | 0.88945054 | 0.98428571 | 0.97621279 |
| 0.60973012 | 0.8886035 | 0.82680741 | 0.88839027 | 0.9847619 | 0.97617335 |
| 0.60756883 | 0.88756778 | 0.82533535 | 0.88743779 | 0.9847619 | 0.97614171 |

diabetes

[ 0.65639309 0.79958922 0.74718729 0.73234752 0.69290598 0.81829772]

[ 0.65553435 0.77214984 0.72607997 0.73032852 0.75054131 0.81921481]

[ 0.66513854 0.74814774 0.71290841 0.73173872 0.81612536 0.81982849]

ionosphere

[ 0.86388477 0.93207224 0.90951681 0.88510122 0.81980769 0.93898551]

[ 0.869865 0.93390939 0.91244164 0.89020595 0.82858974 0.94298584]

[ 0.86916211 0.933437 0.91186975 0.88958772 0.82775641 0.94467391]

sonar

[ 0.64184452 0.54689907 0.61192424 0.57472289 0.73788889 0.72191414]

[ 0.63496397 nan 0.60606061 0.56941812 0.727 0.7165101 ]

[ 0.63599983 0.54784419 0.60812771 0.57340655 0.72844444 0.7114899 ]

German

[ 0.57454912 0.74359287 0.6808 0.68878982 0.71566667 0.74755238]

[ 0.56536464 0.70944381 0.6527 0.67509556 0.74966667 0.74416667]

[ 0.56032682 0.68581991 0.6346 0.66488955 0.77233333 0.7424381 ]

Vertebral

[ 0.78998225 0.73607082 0.7783871 0.74770878 0.891 0.85495238]

[ 0.78971235 0.73454908 0.77774194 0.74632163 0.891 0.85514286]

[ 0.79372134 0.73579814 0.77967742 0.75006068 0.898 0.85547619]

## 自己实现的ndo

wpbc

[ 0.40183172 0.73081026 0.64261654 0.54507529 0.54 0.66285833]

[ 0.39032722 0.71244654 0.62429825 0.53355549 0.54 0.66116667]

[ 0.41010398 0.70753499 0.62200752 0.57041252 0.56 0.66143333]

vote

[ 0.9170743 0.94618101 0.93488221 0.93096086 0.91830882 0.97344111]

[ 0.92109772 0.94792503 0.93738221 0.9350625 0.92830882 0.97350647]

[ 0.92100945 0.94730619 0.93692767 0.93506734 0.93066176 0.97350647]

SRBCT

[ 1. 1. 1. 1. 1. 1.]

[ 1. 1. 1. 1. 1. 1.]

[ 1. 1. 1. 1. 1. 1.]

spect

[ 0.47849175 0.61367197 0.56029915 0.65331416 0.94333333 0.84301876]

[ 0.47504578 0.60664754 0.55394282 0.64869981 0.94666667 0.843114 ]

[ 0.47194747 0.60138543 0.54913614 0.64453372 0.94666667 0.84323737]

movement

[ 0.55764846 0.95570224 0.92498498 0.69195945 0.65333333 0.92845365]

[ 0.55983894 0.95497664 0.92384213 0.70145234 0.67333333 0.92878788]

[ 0.56186275 0.95403987 0.92236722 0.70587864 0.68333333 0.92893494]

letter

[ 0.82222363 0.99238898 0.98540434 0.92329409 0.86184211 0.95661367]

[ 0.80251911 0.99131597 0.98336505 0.9223156 0.86184211 0.95661626]

[ 0.79169718 0.99070423 0.98220433 0.92175416 0.86184211 0.9566374 ]

landsat

[ 0.85947575 0.95459146 0.93200679 0.90028743 0.85217391 0.95915989]

[ 0.85851625 0.95421064 0.93145902 0.89992521 0.85217391 0.95915001]

[ 0.85752663 0.95383551 0.93090927 0.89959303 0.85217391 0.95914577]

heart

[ 0.80920034 0.82751944 0.82072303 0.81658131 0.83406593 0.89762282]

[ 0.80381187 0.8168433 0.81244346 0.80911976 0.84120879 0.89783815]

[ 0.79528519 0.8048411 0.80177605 0.80002074 0.84736264 0.89784159]

haberman

[ 0.36885226 0.84932443 0.75853495 0.47840881 0.28472222 0.69393802]

[ 0.41091292 0.84052147 0.7520457 0.53160835 0.36347222 0.69329216]

[ 0.44815915 0.82520814 0.73714516 0.58551696 0.44722222 0.69356061]

breastw

[ 0.94696967 0.96973058 0.96148718 0.96543715 0.97933333 0.98489473]

[ 0.94696967 0.96973058 0.96148718 0.96543715 0.97933333 0.98494102]

[ 0.94696967 0.96973058 0.96148718 0.96543715 0.97933333 0.98498631]

vehicle

[ 0.55738266 0.71639604 0.65508192 0.72431404 0.91497368 0.81513231]

[ 0.56453571 0.71689071 0.65746288 0.73070518 0.93523684 0.81517094]

[ 0.56992072 0.71764462 0.65968243 0.73535476 0.94973684 0.81515531]

segment-challenge

[ 0.60637654 0.88684609 0.82434642 0.88698811 0.9852381 0.97640651]

[ 0.60070326 0.88376129 0.82006978 0.88423525 0.9852381 0.97640566]

[ 0.59480552 0.8804019 0.81546558 0.88125444 0.9852381 0.97640953]

diabetes

[ 0.65257443 0.79803712 0.74497266 0.72898896 0.6868661 0.81588547]

[ 0.65741867 0.77935334 0.73197027 0.7324346 0.73888889 0.81589943]

[ 0.6513986 0.7530424 0.71139098 0.72311931 0.77413105 0.81590712]

ionosphere

[ 0.8167907 0.9151812 0.88452381 0.84710874 0.76346154 0.93484342]

[ 0.81795882 0.91343316 0.88318394 0.84894727 0.77115385 0.93484342]

[ 0.81863501 0.91271536 0.88266013 0.84982423 0.77423077 0.93484342]

sonar

[ 0.6435377 nan 0.60409091 0.54188722 0.76 0.7360101 ]

[ 0.6490991 nan 0.60725108 0.54583481 0.768 0.73657576]

[ 0.65403558 nan 0.60987446 0.54196969 0.78333333 0.73677778]

Vertebral

[ 0.79497551 0.73654696 0.78064516 0.75120468 0.9 0.85128571]

[ 0.79348153 0.73377402 0.77774194 0.75270869 0.911 0.85104762]

[ 0.79874469 0.73577191 0.78064516 0.75759174 0.92 0.851 ]

german

[ 0.58746379 0.7638902 0.7004 0.70146856 0.71066667 0.75645714]

[ 0.57995229 0.73291947 0.6741 0.69170303 0.74666667 0.75641429]

[ 0.57068667 0.70284509 0.6496 0.67780232 0.774 0.7564619 ]