**Assignment 2**

Rony Azrak – 260606812

**DS1**

LDA

Estimated parameters:

µnegative = [1.31075372 1.24121352 1.27392147 1.28518757 1.29700413 1.2773558 1.32859703 1.35771985 1.30792921 1.3310553 1.28294456 1.33119005 1.32502052 1.26371795 1.32326695 1.3953818 1.26303064 1.31569072 1.28922682 1.28404204]

µpositive = [1.98969791 1.95710686 1.99483756 2.06053192 2.02865681 1.95969669 1.93895154 1.9935373 1.9723008 2.01341369 2.00306553 1.99787338 2.06843742 2.05514725 2.01465332 1.96199881 1.98194064 2.02425157 1.98310723 2.10029022]

**∑** = [[7.83301463 5.38626461 6.16466234 5.14069941 5.7958879 6.11576211

4.54663589 5.44228543 4.9934017 5.2666217 3.90916169 5.228243

7.09155688 5.96998888 6.01473396 5.93608321 5.86925324 5.68173222

5.44327273 5.7743297 ]

[5.38626461 6.77036209 5.28175983 4.27980464 5.44867927 5.46818824

4.26784649 3.793345 4.13272396 5.00925202 3.37128608 4.5245329

5.79920329 5.02462903 5.36683779 5.12756967 5.58119311 5.02463412

5.19720064 5.22622053]

[6.16466234 5.28175983 7.31114585 4.84787191 5.80110258 6.61326532

4.55157697 4.83036194 4.92374543 5.1696072 3.30564726 4.63533652

6.36247678 5.17992319 6.1032119 6.04685959 6.25177625 4.96550426

4.61975331 5.02523216]

[5.14069941 4.27980464 4.84787191 5.71664935 5.25695088 4.50404438

3.63256713 4.39035041 3.38496325 4.26906731 2.78561296 4.12927115

5.85567729 4.78554449 4.76208554 5.08158988 4.68474742 4.54272508

3.85662925 5.66841514]

[5.7958879 5.44867927 5.80110258 5.25695088 7.06184048 5.38635359

4.97024292 4.36737843 4.6702206 5.20936978 4.13221075 4.97528462

6.20496797 5.87241159 5.98497861 6.208071 5.94634704 5.17613688

5.31710587 5.63716817]

[6.11576211 5.46818824 6.61326532 4.50404438 5.38635359 6.73321666

4.3561187 4.8901254 4.76949158 5.42319675 3.00191641 4.77563004

6.42521468 4.98356596 5.78972325 6.01101405 5.9313551 4.98297088

4.66242241 5.1732533 ]

[4.54663589 4.26784649 4.55157697 3.63256713 4.97024292 4.3561187

5.03753627 3.78545015 3.90752768 4.32421096 2.99755216 4.22174387

4.60135635 4.09912927 4.64066397 5.16482707 4.28069953 3.62481341

4.4942791 3.73519469]

[5.44228543 3.793345 4.83036194 4.39035041 4.36737843 4.8901254

3.78545015 6.06977348 3.54652055 4.94264536 2.5195018 4.84717247

6.18591 5.18346565 4.86597644 6.16489631 4.50751998 4.93288298

4.70357636 4.39010139]

[4.9934017 4.13272396 4.92374543 3.38496325 4.6702206 4.76949158

3.90752768 3.54652055 4.95976108 4.70016023 3.13486329 4.03153042

5.1001747 4.62254342 4.90514977 5.08060538 5.1206462 4.03699589

4.14083327 4.01223199]

[5.2666217 5.00925202 5.1696072 4.26906731 5.20936978 5.42319675

4.32421096 4.94264536 4.70016023 7.13300221 3.31772309 4.74989634

6.90160037 5.24434521 5.05600507 5.96429227 4.85201642 5.30494677

4.50866684 5.30341409]

[3.90916169 3.37128608 3.30564726 2.78561296 4.13221075 3.00191641

2.99755216 2.5195018 3.13486329 3.31772309 3.36029406 2.89238468

3.71063822 3.89922614 3.59532687 3.62751968 3.68601129 3.18885215

3.69030891 3.40998911]

[5.228243 4.5245329 4.63533652 4.12927115 4.97528462 4.77563004

4.22174387 4.84717247 4.03153042 4.74989634 2.89238468 5.2172495

6.0085115 4.97614496 4.75675406 5.49112774 5.00626506 4.87767014

4.91467685 4.38817243]

[7.09155688 5.79920329 6.36247678 5.85567729 6.20496797 6.42521468

4.60135635 6.18591 5.1001747 6.90160037 3.71063822 6.0085115

9.11869746 6.26379057 6.18609196 6.53392733 6.02785068 6.33943898

5.76236705 7.21246153]

[5.96998888 5.02462903 5.17992319 4.78554449 5.87241159 4.98356596

4.09912927 5.18346565 4.62254342 5.24434521 3.89922614 4.97614496

6.26379057 6.87843329 5.83981664 6.18289956 5.6833204 5.56296649

5.78218529 5.36052513]

[6.01473396 5.36683779 6.1032119 4.76208554 5.98497861 5.78972325

4.64066397 4.86597644 4.90514977 5.05600507 3.59532687 4.75675406

6.18609196 5.83981664 6.95854943 7.16573182 5.82880955 5.06711328

5.34975337 5.59528341]

[5.93608321 5.12756967 6.04685959 5.08158988 6.208071 6.01101405

5.16482707 6.16489631 5.08060538 5.96429227 3.62751968 5.49112774

6.53392733 6.18289956 7.16573182 9.28972576 5.86973522 5.85406562

5.52469555 5.72955808]

[5.86925324 5.58119311 6.25177625 4.68474742 5.94634704 5.9313551

4.28069953 4.50751998 5.1206462 4.85201642 3.68601129 5.00626506

6.02785068 5.6833204 5.82880955 5.86973522 6.7457559 5.18208161

5.2348573 4.92165416]

[5.68173222 5.02463412 4.96550426 4.54272508 5.17613688 4.98297088

3.62481341 4.93288298 4.03699589 5.30494677 3.18885215 4.87767014

6.33943898 5.56296649 5.06711328 5.85406562 5.18208161 5.95151681

4.74534281 4.99838164]

[5.44327273 5.19720064 4.61975331 3.85662925 5.31710587 4.66242241

4.4942791 4.70357636 4.14083327 4.50866684 3.69030891 4.91467685

5.76236705 5.78218529 5.34975337 5.52469555 5.2348573 4.74534281

6.17476065 4.77099549]

[5.7743297 5.22622053 5.02523216 5.66841514 5.63716817 5.1732533

3.73519469 4.39010139 4.01223199 5.30341409 3.40998911 4.38817243

7.21246153 5.36052513 5.59528341 5.72955808 4.92165416 4.99838164

4.77099549 7.80805176]]

Learnt parameters:

W0 = 26.406942383894098

W = [13.90925363 -8.01235265 -5.52351363 -3.21283316 -9.24595305 -4.24420032 16.370206 -23.00400214 -28.07743771 8.78945889 -12.59414623 -11.85377802 15.05220526 12.55298838 -5.47390201 12.62387703 28.35241496 -6.60694431 -0.86638513 -4.9059282]

Metrics:

Accuracy = 0.955

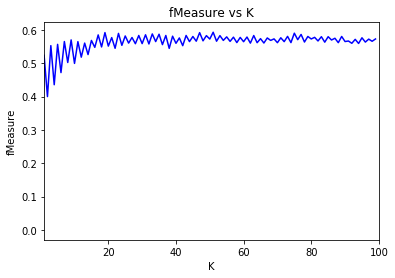
Precision = 0.95652173913

Recall = 0.953333333333

fMeasure = 0.954924874791

KNN

Different K values have been tested from 1 to 100. The f-measure was evaluated for each and the K with the best f-measure was chosen.



The best K was 51.

Metrics:

Accuracy 0.5825

Precision 0.578446909667

Recall 0.608333333333

fMeasure 0.593013809911

**DS2**

LDA

Estimated parameters:

µnegative = [1.28745075 1.30680821 1.22782105 1.20889673 1.26385601 1.24842539 1.21231605 1.2733429 1.21287657 1.15305029 1.22741302 1.26697755 1.22108494 1.20308532 1.30056108 1.25425766 1.23141902 1.35449738 1.15481195 1.2492258]

µpositive = [1.04672668 1.05844091 1.02170827 1.07938353 0.98293461 1.09640948 1.03432959 1.02938333 1.05707546 1.05429878 1.04345858 1.03086226 0.99881149 1.0451089 1.04919493 1.04185004 1.08182844 1.07353928 1.01112263 1.08048638]

**∑** = [[7.71059873 5.39812565 4.60525215 5.11732978 4.33574495 5.62332496

5.97665273 5.76598763 4.69997554 5.4027417 5.5984332 4.98504982

5.03694995 6.07576537 5.40557206 5.63984119 5.32134798 5.53244152

5.5825669 5.77032284]

[5.39812565 7.33669204 4.91021694 5.35394807 5.04292758 5.99303384

6.607358 5.4900267 4.69345347 5.17381326 4.87690278 5.05140023

4.97332759 6.06645919 5.68759841 6.02337174 5.22700426 5.19781308

6.13736602 5.62138103]

[4.60525215 4.91021694 6.63459066 5.18453758 4.75501391 4.76481989

5.94385851 4.56099453 4.50536706 4.77547185 4.71866214 4.92089491

5.09424527 5.94264625 5.30463269 4.88870804 5.28971612 4.40936346

5.66367242 5.59993764]

[5.11732978 5.35394807 5.18453758 6.77174033 4.26314381 5.58854425

6.36121039 5.5130327 4.80040005 5.53359207 5.02916415 4.79334918

5.05429447 5.5430401 5.39741852 5.41462654 5.18540063 5.24451705

5.89034744 5.6866618 ]

[4.33574495 5.04292758 4.75501391 4.26314381 5.64878776 4.65536568

5.07042318 4.53222957 3.70645618 4.06524167 3.79266078 4.17491402

4.32005785 4.81480858 5.24986463 4.87774532 4.30537034 4.52825885

5.20867436 4.86753775]

[5.62332496 5.99303384 4.76481989 5.58854425 4.65536568 7.7322554

6.63885986 5.32163748 5.47093651 5.52989627 4.72398035 4.83367832

5.3593829 6.29704525 5.59547062 5.88205084 5.49859606 5.46559265

6.45095781 6.01458304]

[5.97665273 6.607358 5.94385851 6.36121039 5.07042318 6.63885986

8.56175878 6.10294372 5.83665016 6.18481922 5.95091684 5.70746715

5.70519017 6.96378106 6.00253665 6.3582534 5.83956126 5.71681978

7.22944002 6.27707368]

[5.76598763 5.4900267 4.56099453 5.5130327 4.53222957 5.32163748

6.10294372 6.68656066 4.7570233 5.16983666 4.70073431 4.78691842

4.3706706 5.55851321 5.3551935 5.3774534 4.86217898 5.73969804

5.57144812 5.4419565 ]

[4.69997554 4.69345347 4.50536706 4.80040005 3.70645618 5.47093651

5.83665016 4.7570233 5.9231179 4.62737451 4.30460702 4.34047479

4.42817809 5.11623347 4.71777645 4.5482049 4.72084919 4.67254492

4.92037461 4.76341198]

[5.4027417 5.17381326 4.77547185 5.53359207 4.06524167 5.52989627

6.18481922 5.16983666 4.62737451 6.87464226 4.68665952 4.58298673

4.94374795 5.68807447 5.17257929 5.20684023 5.02473543 4.63919078

6.16042243 5.27214856]

[5.5984332 4.87690278 4.71866214 5.02916415 3.79266078 4.72398035

5.95091684 4.70073431 4.30460702 4.68665952 6.19510377 5.06678026

4.72831043 5.13047019 5.09224074 4.76517991 4.77945098 4.75653586

5.63930379 5.29404956]

[4.98504982 5.05140023 4.92089491 4.79334918 4.17491402 4.83367832

5.70746715 4.78691842 4.34047479 4.58298673 5.06678026 6.43499373

4.56376898 5.3244903 5.4492219 4.9801061 5.1090274 4.99041804

5.55681566 5.13036279]

[5.03694995 4.97332759 5.09424527 5.05429447 4.32005785 5.3593829

5.70519017 4.3706706 4.42817809 4.94374795 4.72831043 4.56376898

6.37714634 5.4149421 5.60228558 5.34754164 5.22974566 4.7236411

5.83804632 5.28817011]

[6.07576537 6.06645919 5.94264625 5.5430401 4.81480858 6.29704525

6.96378106 5.55851321 5.11623347 5.68807447 5.13047019 5.3244903

5.4149421 8.06549027 5.8537204 5.71234107 6.05456517 4.70765597

6.21226262 6.12254498]

[5.40557206 5.68759841 5.30463269 5.39741852 5.24986463 5.59547062

6.00253665 5.3551935 4.71777645 5.17257929 5.09224074 5.4492219

5.60228558 5.8537204 7.35377594 5.45193954 5.41914949 5.42502809

5.9585136 6.0859936 ]

[5.63984119 6.02337174 4.88870804 5.41462654 4.87774532 5.88205084

6.3582534 5.3774534 4.5482049 5.20684023 4.76517991 4.9801061

5.34754164 5.71234107 5.45193954 6.69300441 5.22782497 5.57801575

6.1907883 5.64249426]

[5.32134798 5.22700426 5.28971612 5.18540063 4.30537034 5.49859606

5.83956126 4.86217898 4.72084919 5.02473543 4.77945098 5.1090274

5.22974566 6.05456517 5.41914949 5.22782497 6.69180358 4.62903662

5.61311593 5.97004825]

[5.53244152 5.19781308 4.40936346 5.24451705 4.52825885 5.46559265

5.71681978 5.73969804 4.67254492 4.63919078 4.75653586 4.99041804

4.7236411 4.70765597 5.42502809 5.57801575 4.62903662 6.87648731

5.64156496 5.3990106 ]

[5.5825669 6.13736602 5.66367242 5.89034744 5.20867436 6.45095781

7.22944002 5.57144812 4.92037461 6.16042243 5.63930379 5.55681566

5.83804632 6.21226262 5.9585136 6.1907883 5.61311593 5.64156496

8.25407561 6.29334106]

[5.77032284 5.62138103 5.59993764 5.6866618 4.86753775 6.01458304

6.27707368 5.4419565 4.76341198 5.27214856 5.29404956 5.13036279

5.28817011 6.12254498 6.0859936 5.64249426 5.97004825 5.3990106

6.29334106 7.68952419]]

Learnt parameters:

W0 = -0.07256552556910145

W = [0.01034595 0.03382382 0.02141851 -0.04159208 0.0554358 0.00405057 -0.00162285 0.04429938 -0.01298182 -0.01177366 0.00694139 0.03549652 0.06729035 -0.02702815 -0.02440235 -0.03155231 -0.02575758 0.02308278 -0.05627954 -0.00845733]

Metrics:

Accuracy 0.5125

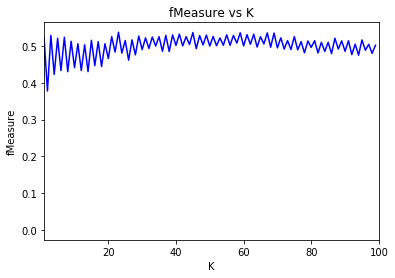
Precision 0.511923688394

Recall 0.536666666667

fMeasure 0.524003254679

KNN

Different K values have been tested from 1 to 100. The f-measure was evaluated for each and the K with the best f-measure was chosen.



The best K was 23.

Metrics:

Accuracy = 0.538333333333

Precision = 0.538461538462

Recall = 0.536666666667

fMeasure = 0.537562604341

**Conclusion**

LDA generates a linear decision boundary. KNN has a non-parametric, lazy learning approach. When the data comes from a single Gaussian function like the one from DS1, it was that LDA would give much better results than KNN, in terms of f-measure.

The data from DS2 was generated by different Gaussian functions, so it was not as pure. For DS2, the f-measure for LDA and KNN were very similar. It seems that when data is noisy, LDA cannot do much better than KNN. It is also worth mentioning that LDA assumes 1 covariance matrix, and 3 were used for DS2.

From what was seen, KNN works best when the data is noisy.