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|  |
| 数值代数上机实验 |
| 兰宇恒-201686043 |
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前言

1. 程序介绍

Forward 前代法

Back 回代法

1. 习题一
2. 第一问

D11——主程序

Liegauss 列主元gauss

Gauss gauss法

1. 第二问

D12

Cholesky 平方根法

Gcholesky 改进平方根法

Gauss

Liegauss

1. 习题二
2. 第一问

D21

Normin 估计矩阵1范数

1. 第二问

D22

Normin

Liegauss

1. 习题三
2. 第一问

D31

Gauss

Liegauss

Qrfj QR分解

1. 第二问

D32

Qrfj QR分解

House house变换

1. 习题四
2. 第一问

D41

Jacobi

Gs

Sor

1. 第二问

D42

Gs

1. 习题五
2. 第一问（模型问题老师没细讲）
3. 第二问

D52

Cg 共轭梯度

1. 第三问

D53

Cg

Gs GS迭代

Jacobi jacobi迭代法

1. 习题六
2. 第一问

D61

Powerm幂法

1. 第二问

D62

SchurQR schurQR分解

Eigvalue 计算矩阵的特征值

Francis QR法迭代

Ifreducible 判断是否已经是schur型

1. 习题七
2. 第一问

Jacobi2 jacobi方法

Twofenfa 二分法

Sn 计算变号数

结果展示

1. 第一章
2. 第一题

* Guass

1 1.00000000000000 1.00000000000000 1.00000000000000 0.999999999999998 1.00000000000000 0.999999999999993 1.00000000000001 0.999999999999972 1.00000000000006 0.999999999999886 1.00000000000023 0.999999999999545 1.00000000000091 0.999999999998181 1.00000000000364 0.999999999992725 1.00000000001455 0.999999999970898 1.00000000005820 0.999999999883592 1.00000000023282 0.999999999534367 1.00000000093127 0.999999998137469 1.00000000372506 0.999999992549874 1.00000001490025 0.999999970199497 1.00000005960101 0.999999880797986 1.00000023840403 0.999999523191946 1.00000095361611 0.999998092767783 1.00000381446444 0.999992371071130 1.00001525785774 0.999969484284520 1.00006103143096 0.999877937138081 1.00024412572384 0.999511748552323 1.00097650289535 0.998046994209291 1.00390601158141 0.992187976837187 1.01562404632557 0.968751907349088 1.06249618530092 0.875007629401807 1.24998474118183 0.500030517694535 1.99993896437811 -0.999877927824961 4.99975585192486 -6.99951168894947 16.9990233182979 -30.9980463981918 64.9960918427676 -126.992179871071 256.984344484284 -510.968627937136 1024.93701174855 -2046.87304699420 4096.74218797682 -8190.46875190732 16383.8750076293 -32764.5000305175 65531.0001220701 -131055.000488281 262097.001953124 -524127.007812498 1048001.03125000 -2094975.12499999 4185857.49999999 -8355328.99999997 16645128.9999999 -33028126.9999999 65007744.9999998 -125821439.000000 234866688.999999 -402628606.999999 536838144.999998

* Lieguass

1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 1.00000000000000 0.999999999999999 1.00000000000000 0.999999999999995 1.00000000000001 0.999999999999979 1.00000000000004 0.999999999999917 1.00000000000017 0.999999999999667 1.00000000000067 0.999999999998666 1.00000000000267 0.999999999994664 1.00000000001067 0.999999999978657 1.00000000004269 0.999999999914629 1.00000000017074 0.999999999658526 1.00000000068293 0.999999998634227 1.00000000273121 0.999999994538909 1.00000001091685 0.999999978187649 1.00000004353933 0.999999913262824 1.00000017210841 0.999999661246936 1.00000065565109 0.999998776117961 1.00000209808350 0.999997202555339

1. 看法

从两个结果可以看出，不选主元的guass消去法由于主元小等问题导致在多次迭代后所得结果影响越来越大，而列主元法则很好的避免了这个问题

1. 第二题
2. 结果

* 第一题平方根法

0.0853383537063108 0.0105813749970164 0.0834463311925077 -0.00488074953270613 0.0361164084039013 0.0225087405556716 0.00696561987135227 0.0607562395155535 0.0164715648957232 0.0909029277664336 0.0336110099698429 0.0716609617771492 -0.0116121110159151 0.0572158172742731 0.0448071267896482 0.0711642362854929 0.0509293312587585 0.0745105126455069 0.0821939374216666 0.00592303857998866 0.0108085334510248 0.0785717137162889 -0.00555002197243525 0.0376336102320291 0.0190411121056003 0.0719211229734044 -0.00407243526373011 0.0730124834212076 0.0665230886058072 0.0444855732726038 0.0210188718869022 -0.00132195032037471 0.0631552163284989 -0.00442688179357394 0.00579507173623941 0.00851865694070869 0.0386303411349889 0.0557920039968380 0.0757854628192094 0.0424642012891838 -0.00198205145645598 0.0261408173115040 0.0544062382142078 0.0714279682669366 0.0177007227310025 0.0407152975992374 0.0730143119636722 0.0475761987409918 0.0463519931556346 0.0253284786208625 0.0312363612556814 0.0739981350737363 0.0227885286941825 0.0413247984937921 0.0265702223352145 0.0607966459537275 0.0450339377317665 0.0566430085992940 0.0403128224058368 0.0313425156501189 0.0447202560047803 -0.00106086669993566 0.0324760339461819 0.0873290144217226 0.0633257802910684 0.0601342135579549 0.0643499728123772 0.0620166743269399 0.0720640877810451 0.0606127649077782 0.0919651130930063 -0.00160296710627247 0.0354240005235759 0.0434399030799706 0.0222376195162495 -0.00772147995763078 0.0919434013687345 0.0626687893039888 0.00779468461340748 0.00734919494769663 0.0666079232812249 0.0313956713467428 0.000428885653864913 0.0407269162805112 0.00314229457365562 0.0708406920720772 0.0873709052361868 -0.0143015812959006 0.0603643855996287 0.0606983067223275 0.0111850082295868 0.0810744527710933 0.0212513769303674 0.000370552139074610 0.00190348583149234 0.0739017524427990 0.0569639620330144 0.0678612534479405 0.0478302873298370 0.0777585172743856

* 第一题改进平方根法

-0.000383590379613568 0.0388584888850481 0.0172736738224017 0.0380735281744411 0.0828878860753212 0.0138867385320849 0.0589295461990956 -0.00403969121444741 0.00769350459298857 0.0823033115531873 0.00318425059149441 0.0807475497817643 0.0191282866949383 0.0660444422983148 -0.00845616014710629 0.0708834782354869 0.0339304441773929 0.0892938578110410 0.0164309151725721 0.0361694068308029 -0.00156455648771679 0.0932315196972895 0.0341000667836770 -0.00172062032163978 0.0676693374258536 0.0417036586560844 0.0220814555481852 0.0655695271108119 0.0757474144378436 0.0129621531141061 0.0483474066979973 0.0379887966962411 0.00692985930374976 0.0504167559618407 0.0893837847496829 -0.00680384342626640 0.0864132282880835 0.0426529952743065 0.0375218101593206 0.00948558995375518 0.0200031206658956 0.0380292059007529 0.0470736140302152 0.0240180914940435 0.0673966053279226 0.0751306674991089 0.0629778621313958 0.0291828046630600 0.0516262975980889 0.0587329649581186 0.00214910448081240 0.0472428262491324 0.0216146299737950 0.0470802295199199 0.0861575387117753 0.0349533204011681 -0.00875113344709672 0.0856864552398882 0.0813204598341802 0.0260911977512277 0.0160744822078557 0.0731530964926880 0.0392541984688154 0.0458871621994926 0.0644013329261644 -0.00510672731760861 0.0790625355976138 0.0870603383809157 -0.00672803918706628 0.0768142900916626 0.0844676434918677 -0.0120951101543157 0.0478245986110502 0.0575318277892680 0.0272023971552139 0.0555895513645259 0.0662041386569171 0.0452225418186477 0.0572564245397878 0.0141323614957083 0.0796239643902279 0.0294644174018236 0.0525668178306104 0.0764897826417359 0.0160023372727981 0.0336723082448433 0.0480753164510465 0.0398291196583458 -0.00250115620188437 0.0755665643891090 -0.00878317770213182 0.0448806619351121 -0.0102808982159681 0.0951905996985900 0.0341726542661785 0.0854227656527147 0.0212296678044892 0.0855284776424085 0.00793779267620855 0.0901112049266593

* 第二题平方根法

1.19871172509262 -22.1454786779225 589.469053147682 -4442.06112737472 -14178.2323580008 424043.442490786 -2979974.36716111 11418983.6040148 -27334802.3256389 42538889.7474006 -43017999.1925020 27732885.4251417 -11989441.9176839 5406227.09879012 -3687871.58052612 3284514.75410458 -4437743.36430207 4621418.78739470 -2512641.02406372 564979.338450489 437.555896676046 -50506.9366959482 70608.1363656702 -27230.0026538601 -31326.3616846117 36395.5557215072 -19280.0822919554 9312.03363953090 2059.86498041694 -1616.10172211679 -6206.66854761662 4050.32340343190 861.603380379230 -1538.32059605323 730.774995821443 20.5002306291336 -242.337317775667 109.587228955476 -14.0650697474991 -1.32226758235655

* 第二题改进平方根法

0.999999913290885 1.00000918178025 0.999829166457361 0.999415282424132 1.03993230727563 0.578381347730962 3.19452677303254 -5.52789470130828 12.2028095323546 -8.39502983841401 -0.361753131497770 12.5531809736821 -9.32595401765139 5.01726018329354 -12.9254223155260 36.2415939532170 -32.3343179424172 13.8745172360177 9.57137209051112 -29.4337302385174 12.7650916940746 18.5816044562808 -2.57106008868493 12.9201690200283 -16.9817087799563 -1.57849790038210 -16.2705239795095 15.8221465271766 8.54304023739873 -5.55911656570450 18.6559487290216 -10.1169883552969 12.7445336337595 9.43358568492301 -85.9579758803560 79.2601823111460 13.0457886924907 -39.9288382809832 19.5801656564802 -2.35627310725471

1. 第三题





1. 第二章

* 第一问

943655.999999910 29070279.0029490 985194889.824179 33872790723.7211 1099650909217.98 35353781399082.3 1.23061870713206e+15 3.83166754802773e+16 4.62924553140343e+17 1.37208784828859e+19 1.12497925693168e+18 1.34435748094319e+18 1.97086865441787e+18 9.61788605262183e+19 3.38035918099530e+19 3.16360753337547e+18

* 第二问



1. 第三章

* 第一问（顺序依次1,2,3题）







* 第二问（结果依次为）

2.72199170124481

1.35165975103734

1.62354307493906

1. 第四章

* Jacobi

0.0127790749175373 0.0254812872530712 0.0381072271282112 0.0506581312241926 0.0631342483354606 0.0755371156783691 0.0878666494724384 0.100124678383454 0.112310795908353 0.124427112029310 0.136472908413159 0.148450565240448 0.160359064217552 0.172201043685489 0.183975198171313 0.195684411286180 0.207327104002402 0.218906391528033 0.230420435678561 0.241872568874064 0.253260708872609 0.264588390282474 0.275853302531945 0.287059166828527 0.298203460552237 0.309290075430276 0.320316293554648 0.331286160677231 0.342196780765434 0.353052336760517 0.363849771996146 0.374593389502499 0.385279989722215 0.395913978483401 0.406492031257137 0.417018639261885 0.427490371019041 0.437911785686167 0.448279362885939 0.458597712291739 0.468863242635567 0.479080596781412 0.489246130465295 0.499364502582976 0.509432033587237 0.519453381479434 0.529424848893348 0.539351076306442 0.549228365684983 0.559061323711289 0.568846268461109 0.578587756967502 0.588282139759139 0.597933908838902 0.607539463042110 0.617103214486774 0.626621625625765 0.636099014413617 0.645531921638933 0.654924557436820 0.664273555010504 0.673583003685501 0.682849642476171 0.692077427613675 0.701263216598101 0.710410821022872 0.719517228790616 0.728586096087315 0.737614552345025 0.746606088374804 0.755557985446737 0.764473559856461 0.773350254177873 0.782191201898616 0.790994015498676 0.799761638230179 0.808491860201139 0.817187427878997 0.825846315828409 0.834471068070838 0.843059849553701 0.851614997084827 0.860134871012646 0.868621597059382 0.877073735083203 0.885493196742874 0.893878744607518 0.902232074183546 0.910552153050349 0.918840459353438 0.927096167088962 0.935320536701361 0.943512949129692 0.951674447630284 0.959804619746661 0.967904292894775 0.975973260038473 0.984012134914485 0.992020913899032

* GS

0.0127975297840728 0.0255179706220212 0.0381621418526821 0.0507308539188651 0.0632249084080501 0.0756450980940392 0.0879922069795857 0.100267010340019 0.112470274767884 0.124602758218618 0.136665210057261 0.148658371106240 0.160582973694213 0.172439741705989 0.184229390633546 0.195952627628121 0.207610151553407 0.219202653039838 0.230730814539971 0.242195310384956 0.253596806842099 0.264935962173501 0.276213426695779 0.287429842840846 0.298585845217755 0.309682060675575 0.320719108367309 0.331697599814818 0.342618138974745 0.353481322305422 0.364287738834737 0.375037970228933 0.385732590862336 0.396372167887974 0.406957261309059 0.417488424051322 0.427966202036160 0.438391134254578 0.448763752841883 0.459084583153116 0.469354143839182 0.479572946923643 0.489741497880154 0.499860295710495 0.509929833023170 0.519950596112547 0.529923065038482 0.539847713706413 0.549725009947878 0.559555415601415 0.569339386593815 0.579077373021684 0.588769819233277 0.598417163910569 0.608019840151514 0.617578275552467 0.627092892290714 0.636564107207083 0.645992331888590 0.655377972751076 0.664721431121812 0.674023103322006 0.683283380749199 0.692502649959494 0.701681292749579 0.710819686238518 0.719918202949252 0.728977210889789 0.737997073634034 0.746978150402223 0.755920796140929 0.764825361602593 0.773692193424555 0.782521634207540 0.791314022593565 0.800069693343243 0.808788977412426 0.817472202028184 0.826119690764059 0.834731763614582 0.843308737069008 0.851850924184252 0.860358634656980 0.868832174894836 0.877271848086782 0.885677954272509 0.894050790410904 0.902390650447542 0.910697825381185 0.918972603329251 0.927215269592251 0.935426106717152 0.943605394559653 0.951753410345364 0.959870428729849 0.967956721857536 0.976012559419465 0.984038208709862 0.992033934681524

* SOR

0.0126863470279292 0.0252968170338776 0.0378323280893192 0.0502937870731745 0.0626820896380988 0.0749981201808474 0.0872427518167838 0.0994168463585869 0.111521254299209 0.123556814799135 0.135524355677974 0.147424693410433 0.159258633126694 0.171026968617211 0.182730482341971 0.194369945444205 0.205946117768571 0.217459747883821 0.228911573109922 0.240302319549663 0.251632702124695 0.262903424616019 0.274115179708882 0.285268649042060 0.296364503261494 0.307403402078249 0.318385994330741 0.329312918051205 0.340184800536333 0.351002258422050 0.361765897762354 0.372476314112157 0.383134092614072 0.393739808089066 0.404294025130910 0.414797298204341 0.425250171746866 0.435653180274111 0.446006848488639 0.456311691392131 0.466568214400858 0.476776913464323 0.486938275186985 0.497052776952970 0.507120887053650 0.517143064817987 0.527119760745541 0.537051416642021 0.546938465757268 0.556781332925561 0.566580434708118 0.576336179537687 0.586048967865092 0.595719192307634 0.605347237799199 0.614933481741976 0.624478294159644 0.633982037851907 0.643445068550259 0.652867735074849 0.662250379492317 0.671593337274479 0.680896937457739 0.690161502803098 0.699387349956630 0.708574789610313 0.717724126663079 0.726835660381962 0.735909684563231 0.744946487693363 0.753946353109763 0.762909559161093 0.771836379367092 0.780727082577774 0.789581933131895 0.798401191014559 0.807185112013857 0.815933947876437 0.824647946461882 0.833327351895798 0.841972404721497 0.850583342050192 0.859160397709576 0.867703802390708 0.876213783793102 0.884690566767922 0.893134373459200 0.901545423442981 0.909923933864312 0.918270119571994 0.926584193251013 0.934866365552573 0.943116845221661 0.951335839222063 0.959523552858777 0.967680189897734 0.975805952682794 0.983901042249932 0.991965658438569

* 第二问



1. 第五章

* 第二问

0.333350908768261 0.333008058199139 0.334490848288268 0.332720461945240 0.332372938631511 0.332890076685723 0.333526874810725 0.333952813182998 0.334105078172951 0.334035173067678 0.333825185962385 0.333551363033907 0.333271973648140 0.333026020451164 0.332836066161857 0.332712104006607 0.332655207271309 0.332660534166186 0.332719628815771 0.332822099724725 0.332956796295410 0.333112601427411 0.333278940385605 0.333446085694082 0.333605318795885 0.333748993648999 0.333870535191218 0.333964396142706 0.334025988890809 0.334051603942009 0.334038322767301 0.333983930287532 0.333886830342315 0.333745966117783 0.333560746696032 0.333330980188091 0.333056813568578 0.332738678984328 0.332377246201997 0.331973380808012

* 第三问

1. Cg（迭代5次）

1.00000000000000

-2

3

-2.00000000000000

1

1. GS（迭代32次）

1.00000883048593

-2.00000724932144

2.99998745467590

-1.99999882575307

0.999992091847895

1. Jacobi（迭代55次）

1.00001591771638

-2.00001458658499

2.99997325479230

-1.99999571096046

0.999980900790958

* 共轭梯度法速度大于GS大于jacobi

1. 第六章
2. 第一问

* -3
* 1.8794
* -100

1. 第二问

* X=0.9

17.4396781837058 + 0.00000000000000i 2.87040175956248 + 0.642891245413736i 2.87040175956248 - 0.642891245413736i 6.81951829716920 + 0.00000000000000i

* X=1

17.4764850764172 + 0.00000000000000i 2.86799916544191 + 0.688747567099800i 2.86799916544191 - 0.688747567099800i 6.78751659269898 + 0.00000000000000i

* X=1.1

17.5130283794497 + 0.00000000000000i 2.86545771642024 + 0.732169960587801i 2.86545771642024 - 0.732169960587801i 6.75605618770979 + 0.00000000000000i

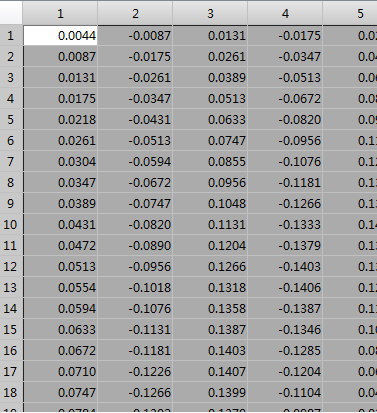
1. 第七章

* 特征值（选了100阶作为特例其余详见代码）

5.99903256458400 5.99613119426720 5.99129869593802 5.98453974472655 5.97586087948152 5.96527049644454 5.95277884112721 5.93839799839933 5.92214188079745 5.90402621506545 5.88406852693999 5.86228812419532 5.83870607796447 5.81334520235415 5.78623003237358 5.75738680019853 5.72684340979334 5.69462940991555 5.66077596552960 5.62531582765648 5.58828330168949 5.54971421420576 5.50964587830652 5.46811705751893 5.42516792829501 5.38084004114349 5.33517628043232 5.28822082290080 5.24001909492154 5.19061772855332 5.14006451642756 5.08840836551205 5.03569924979663 4.98198816194665 4.92732706397066 4.87176883695074 4.81536722988338 4.75817680768076 4.70025289838279 4.64165153963073 4.58242942445451 4.52264384642572 4.46235264422994 4.40161414571143 4.34048711144480 4.27903067788784 4.21730430017094 4.15536769457800 4.09328078077482 4.03110362384069 3.96889637615928 3.90671921922516 3.84463230542200 3.78269569982905 3.72096932211215 3.65951288855520 3.59838585428856 3.53764735577006 3.47735615357427 3.41757057554550 3.35834846036927 3.29974710161721 3.24182319231924 3.18463277011662 3.12823116304926 3.07267293602934 3.01801183805335 2.96430075020335 2.91159163448794 2.85993548357244 2.80938227144667 2.75998090507845 2.71177917709921 2.66482371956769 2.61915995885651 2.57483207170499 2.53188294248109 2.49035412169348 2.45028578579422 2.41171669831049 2.37468417234350 2.33922403447041 2.30537059008445 2.27315659020668 2.24261319980146 2.21376996762642 2.18665479764585 2.16129392203553 2.13771187580468 2.11593147306002 2.09597378493454 2.07785811920255 2.06160200160067 2.04722115887278 2.03472950355548 2.02413912051849 2.01546025527345 2.00870130406197 2.00386880573281 2.00096743541603

* 特征向量

太长了助教学姐看代码结果，部分截图如下



1. 第二问

* 最小特征值

0.000965118408203125

* 最大特征值

3.99903488159180

* 最小特征值对应向量

0.113280377149217 -0.224958117261609 0.333468283284122 -0.437320099461444 0.535130987512973 -0.625657092928019 0.707819362673942 -0.780724418559043 0.843679681174324 -0.896202427361936 0.938022698512563 -0.969080206677080 0.989515600102805 -0.999656640149005 1.00000000000000 -0.991189516541985 0.973991806740541 -0.949270197632776 0.917957915592326 -0.881031438785729 0.839484841356970 -0.794305854815212 0.746454248218508 -0.696842991359044 0.646322521602937 -0.595668292288384 0.545571644900032 -0.496633923901360 0.449363646252835 -0.404176450152622 0.361397481025507 -0.321265827667500 0.283940597060837 -0.249508211128863 0.217990520315875 -0.189353354574332 0.163515169065351 -0.140355486499311 0.119722887537773 -0.101442352274275 0.0853218071013246 -0.0711577802814905 0.0587401147713271 -0.0478557272712980 0.0382914375131884 -0.0298359212651141 0.0222808645776467 -0.0154214158063710 0.00905604648503893 -0.00298594282960915 -0.00298594282960916 0.00905604648503894 -0.0154214158063710 0.0222808645776467 -0.0298359212651141 0.0382914375131884 -0.0478557272712980 0.0587401147713271 -0.0711577802814905 0.0853218071013246 -0.101442352274275 0.119722887537773 -0.140355486499311 0.163515169065351 -0.189353354574332 0.217990520315875 -0.249508211128863 0.283940597060837 -0.321265827667499 0.361397481025507 -0.404176450152622 0.449363646252835 -0.496633923901360 0.545571644900032 -0.595668292288384 0.646322521602937 -0.696842991359044 0.746454248218508 -0.794305854815212 0.839484841356970 -0.881031438785729 0.917957915592326 -0.949270197632776 0.973991806740541 -0.991189516541985 1 -0.999656640149005 0.989515600102805 -0.969080206677080 0.938022698512563 -0.896202427361936 0.843679681174324 -0.780724418559043 0.707819362673942 -0.625657092928019 0.535130987512973 -0.437320099461444 0.333468283284122 -0.224958117261609 0.113280377149217

* 最大特征值对应特征向量

0.624939672822507 0.937469829130760 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0.937469829130760 0.624939672822507