Regression of KL Software Distribution

KL Software Libraries

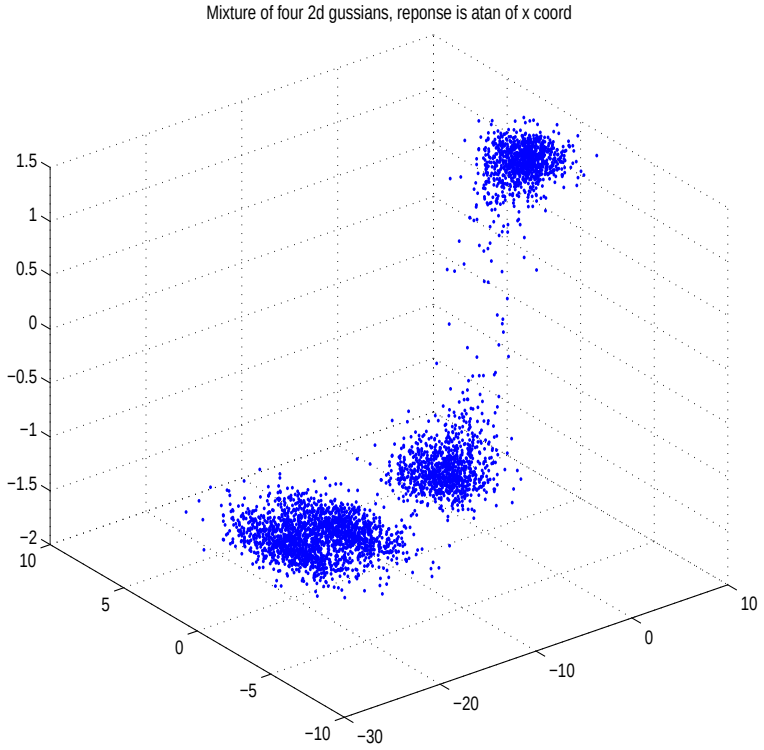
Wed Jun 11 17:21:34 2014

KL Library test output. This LaTex file and the associated diagrams are produced by the KL software libraries.

0.0.1 Matrix Quick Check ¡double¿

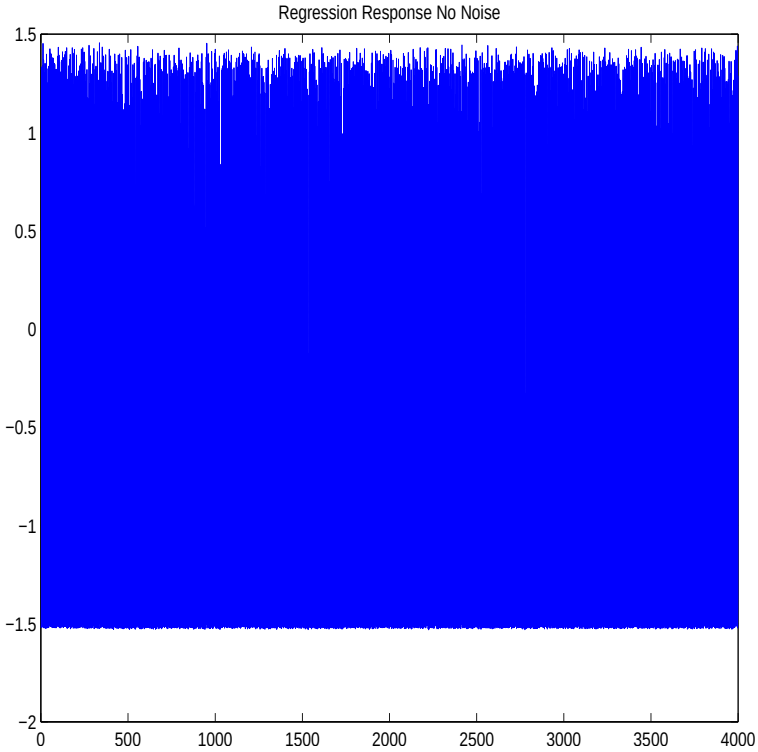
QueryPerformanceCounter = 0.0949109

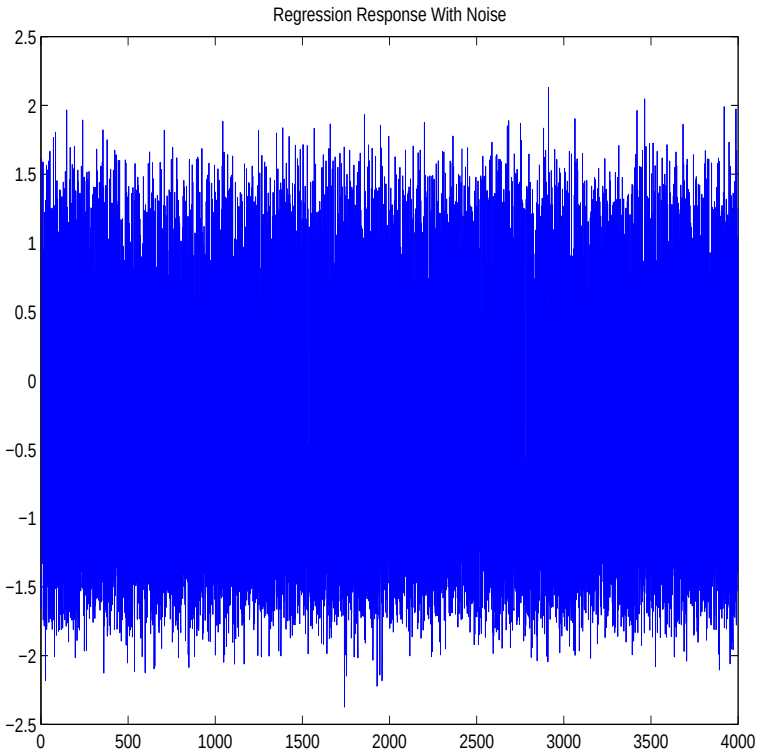
0.0.2 Linear Regression atan data 3x1

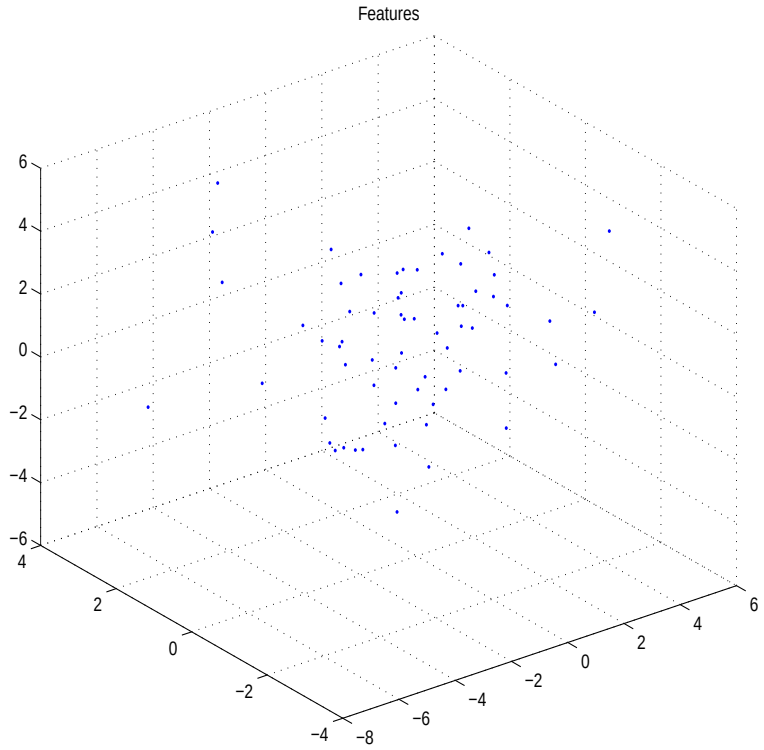


0.0.3 3 x 1 Linear Regression

Sample size = 4000
Number of features = 3


Regression Response No Noise
1.5
1
0.5
0
−0.5
−1
−1.5
−2
0
500
1000
1500
2000
2500
3000
3500
4000


Regression Response With Noise
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
0
500
1000
1500
2000
2500
3000
3500
4000



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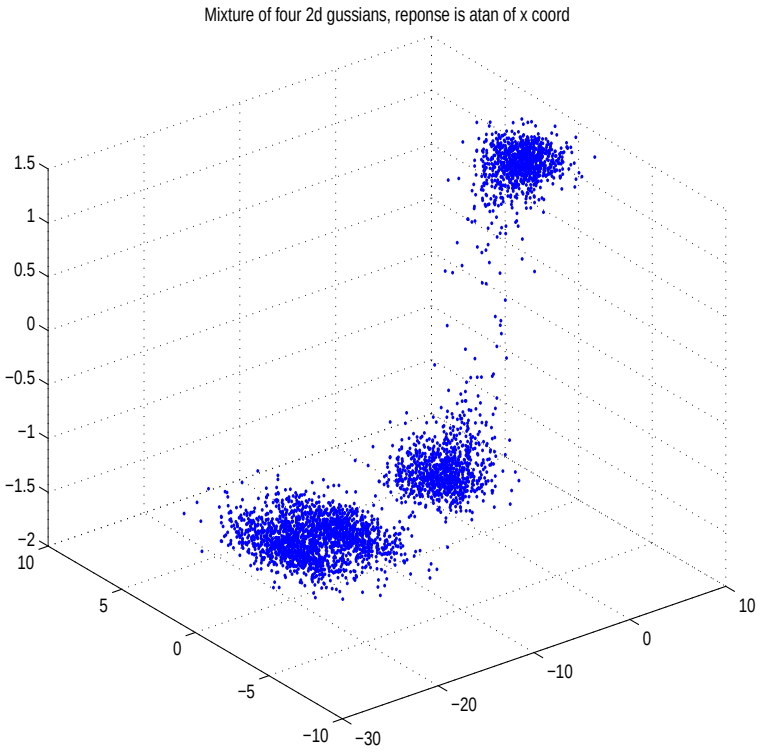
-1.47741 0.905063 -1.51949 -1.52463 -1.19559 1.43507 -1.63939 -1.66798 -1.16853 1.45091 -1.21482 -1.40142 -1.50426 1.26729 -1.57874 -1.36823 -1.68928 1.06279 -1.391 -0.937474 -1.13887 1.4552 -1.24915 -1.07482 -1.53638 0.651209 -1.5181 -1.50894 -1.39637 1.15578 -1.7398 -1.71256 -1.38184 0.988645 -1.44643 -1.39208 -1.10971 0.960311 -1.53805 -1.55491 -1.54969 1.18112 -1.52249 -2.01894 -1.15611 1.22784 -1.63908 -1.62521 -1.31932 1.41418 -1.20001 -1.40431 -1.59238 1.31588 -1.58626 -1.75972 -1.64831 0.990902 -1.57917 -1.52962 -0.853677 1.38609 -1.67734 -1.41637 -1.16782 1.47548 -1.53101 -1.5243 -1.46128 1.4616 -1.40622 -1.19908 -1.4466 0.753155 -1.2373 -1.69995 -1.0109 1.30156 -1.60618 -1.26321 -1.62251 1.09787 -1.91458 -1.87668 -1.52332 1.39675 -1.77303 -1.7498 -1.28851 1.54281 -1.25017 -1.37815 -0.996041 1.33211 -1.32659 -1.41559 -1.09788 1.30096 -1.49803 -1.59582 -1.18242 1.19559 -1.64257 -1.58394 -1.70432 0.92546 -1.05531 -1.44201 -1.46108 1.11658 -1.2455 -1.32694 -1.13594 1.41225 -1.23196 -1.33555 -1.10145 1.33463 -1.42009 -1.23814 -1.65735 1.36416 -1.55117 -1.42634 -0.124848 1.61372 -1.86889 -1.63872 -0.911589 1.06841 -1.64643 -1.7417 -1.38107 1.38995 -1.79521 -1.50997 -1.71466 1.30671 -1.57079 -1.67859 -1.23461 1.28174 -1.71214 -1.5876 -1.21891 1.15684 -1.67032 -1.35793 -1.32024 1.04082 -1.49838 -1.49041 -0.874913 1.51795 -1.57606 -1.10683 -1.40227 1.44979 -1.47473 -1.10795 -1.32173 1.13822 -1.40803 -1.48314 -1.46321 1.20369 -1.40137 -1.61318 -0.924267 1.27243 -1.7874 -1.72772 -1.52188 1.2956 -1.77559 -1.27139 -1.51661 1.25402 -1.23719 -1.47324 -1.0697 1.29977 -1.8327 -1.356 -1.34816 1.51166 -1.79225 -1.24116 -0.985712 1.31729 -1.341 -1.41286 -1.3706 1.14608 -1.43686 -1.29587 -1.45506 1.47704 -1.50783 -1.8602 -1.21901 1.43983 -1.10665 -1.66794 -1.33132 1.70926 -1.04048 -1.15199 -1.51278 1.05587 -1.62835 -1.36508 -1.42912 1.31929 -1.17418 -1.40979 -1.42821 0.693001 -1.78687 -1.51472 -1.19247 1.20145 -1.52765 -1.66178 -1.20635 1.47679 -1.26346 -1.71825 -1.59339 1.19612 -1.53254 -1.7443 -1.11654 1.32025 -1.822 -1.57888 -0.984779 1.06345 -1.4809 -1.60542 -0.992633 1.01288 -1.70422 -1.51068 -1.50213 1.25293 -1.90183 -1.58803 -1.14731 1.06207 -1.59877 -1.12989 -1.19499 1.30308 -1.49159 -1.34977 -1.65633 1.34437 -1.43 -1.71483 -0.926707 1.35502 -1.51141 -1.34642 -1.26215 0.996357 -1.54352 -1.7837 -1.0198 1.20571 -1.65175 -1.74357 -1.14834 0.767488 -1.17647 -1.19836 -0.853417 1.35009 -1.70613 -1.77519 -1.34589 1.42596 -1.99386 -1.34461 -1.60626 0.881308 -1.67724 -1.12175 -1.61939 1.1385 -1.89442 -1.13315 -1.12558 1.4163 -1.63759 -1.34259 -1.11983 1.54809 -1.83206 -1.44109 -0.854114 1.64428 -1.56209 -1.46521 -1.14783 1.36508 -1.31023 -1.73689 -0.699035 1.96347 -1.0466 -1.50157 -0.884015 1.38306 -1.83273 -1.16477 -1.22997 1.3284 -1.32824 -1.15025 -1.35926 1.21652 -1.69646 -1.51102 -1.09779 1.5579 -1.63054 -1.44146 -1.37987 1.14865 -1.42686 -1.24365 -0.185233 1.55226 -1.26638 -1.92519 -1.02708 1.26346 -1.27077 -1.60892 -1.02749 1.67338 -1.53533 -1.30722 -1.25567 0.734469 -1.36356 -1.32218 -1.48904 0.869207 -1.57764 -1.83541 -1.03712 2.04832 -1.54804 -1.46024 -1.18777 1.3098 -1.30369 -1.21691 -1.24394 1.70131 -1.42767 -1.44358 -1.4282 1.1602 -1.69015 -1.3451 -1.13772 1.33759 -1.66513 -1.59146 -1.47536 0.906408 -1.71367 -1.54744 -1.28337 1.32592 -1.61133 -1.50675 -1.15231 1.72325 -1.31918 -1.81546 -1.19579 0.754347 -1.3837 -1.42326 -1.24691 1.17893 -1.31604 -1.60293 -1.29162 1.5034 -1.17991

-1.65519 -1.14445 1.21557 -1.86479 -1.31428 -1.12867 1.72705 -1.6785 -1.66425 -1.628 0.944428 -1.45149 -1.35921 -1.26467 1.37196 -1.09606 -1.55446 -0.986062 1.56251 -1.35214 -2.07898 -1.42558 0.872438 -1.4552 -1.50197 -1.5258 0.777759 -1.63766 -1.18809 -1.36716 1.66607 -1.83129 -1.29778 -1.24453 1.36661 -1.32231 -1.65181 -1.28164 1.35484 -1.36952 -1.20625 -1.14194 1.17075 -1.71989 -1.54549 -1.42162 1.41231 -1.44114 -1.8692 -1.09178 0.852253 -1.48671 -1.22655 -0.93306 1.30727 -1.17038 -1.46652 -1.28087 1.61854 -1.43274 -1.66401 -1.33149 1.21673 -1.47066 -1.41198 -1.65996 1.4249 -1.64648 -1.32681 -1.36238 1.3911 -1.61502 -1.54533 -0.996945 1.50068 -1.3198 -1.8435 -1.43456 1.30755 -1.61618 -1.64789 -1.63136 1.41789 -1.8662 -1.42854 -1.39703 1.7147 -1.77069 -1.58078 -1.52639 1.27815 -1.29222 -1.05864 -1.61767 1.0127 -1.59416 -1.26642 -1.1299 0.870424 -1.79321 -1.20178 -1.0689 1.59567 -1.3935 -1.62933 -1.43602 1.36416 -1.65834 -1.0446 -0.687962 1.25061 -1.86245 -1.30132 -1.23852 1.27992 -1.45861 -1.55771 -1.37621 0.971177 -1.42356 -1.16158 -1.09081 1.34043 -1.07505 -1.34998 -1.36774 1.4287 -1.63847 -2.00947 -0.937314 1.54879 -1.67293 -1.79198 -1.19053 1.22872 -1.64246 -1.59744 -1.6731 1.66075 -1.86453 -1.54824 -1.65688 1.56039 -1.35108 -1.60201 -1.07763 1.32868 -1.75418 -1.68671 -1.11519 1.29009 -1.73537 -1.6873 -1.47816 1.24378 -1.13506 -1.76798 -1.6403 1.04418 -1.30704 -1.41268 -1.01004 1.21124 -1.41361 -1.4422 -1.40133 1.42187 -1.61572 -1.77477 -1.04579 1.27379 -1.67674 -1.6583 -1.5242 1.33046 -1.46043 -1.49247 -1.23826 1.86342 -0.960575 -1.60592 -1.27122 1.57428 -1.24707 -1.97 -1.02268 1.45133 -1.55125 -1.31307 -1.39311 1.32312 -1.56827 -1.68908 -1.28515 1.10828 -1.64023 -1.7666 -0.872034 1.56278 -2.03966 -1.38525 -1.07292 1.60889 -1.20189 -1.55942 -1.1642 0.532046 -1.18414 -1.12756 -1.49287 1.38933 -1.57712 -1.4511 -1.52861 1.36624 -1.44109 -1.27768 -1.32817 1.27147 -1.38188 -1.41689 -0.962444 1.14416 -1.62259 -1.48775 -0.968078 1.11054 -1.51735 -1.24087 -1.39546 0.854537 -1.63913 -1.35472 -1.41267 1.03456 -1.57882 -1.27878 -1.14562 1.6414 -1.63094 -1.85192 -0.996913 1.15151 -1.84268 -1.80336 -1.52417 1.27163 -1.43106 -1.55452 -0.985712 1.45808 -1.3719 -1.6061 -1.10301 1.48252 -1.43208 -1.72046 -1.17546 1.1863 -1.8251 -1.07028 -1.21126 1.2692 -1.67441 -1.903 -1.61482 1.42773 -1.85957 -1.74094 -1.19867 1.1741 -1.40708 -1.21052 -1.48034 1.42084 -1.26667 -1.52834 -1.23555 1.05175 -1.51381 -1.71195 -1.2782 0.863682 -1.41995 -1.27495 -0.0971476 1.3539 -1.68011 -1.34408 -1.39139 1.22574 -1.43957 -1.6037 -1.22561 1.32766 -1.58889 -1.45881 -1.48528 1.19418 -1.57905 -1.43679 -1.06319 1.57517 -1.67881 -1.5535 -0.406248 1.67155 -1.63633 -1.54532 -1.24799 1.46771 -1.65209 -1.53892 -1.88754 1.33801 -1.80283 -1.63614 -1.47635 1.61158 -1.41225 -1.50741 -0.881467 1.44355 -1.60903 -1.51572 -0.987592 1.61019 -1.18453 -1.71465 -1.72688 0.755218 -1.58096 -1.64428 -1.43137 0.929263 -1.11605 -1.76012 -1.19389 0.915804 -1.7781 -1.35244 -0.535522 1.58183 -0.694799 -1.41471 -1.4977 1.26079 -1.46779 -1.44475 -0.983746 1.02199 -1.39852 -1.38355 -0.977771 1.24388 -1.56798 -1.81144 -1.32078 1.30134 -1.7207 -1.70917 -1.2752 1.09895 -1.11209 -1.20652 -1.05006 1.25714 -1.44485 -1.8119 -1.42833 1.4041 -1.32275 -1.50627 -1.07743 0.916211 -1.13779 -1.52854 -1.45042 1.57917 -1.38263 -1.35727 -1.25805 1.61677 -1.98907 -1.49229 -1.54909 1.59253 -2.10398 -1.41441 -1.59264 1.12008 -1.3697 -1.66223 -1.1947 1.1938 -1.19147 -1.31025 -1.12905 1.23239 -1.14227 -1.41195 -1.72831 1.273 -1.38419 -1.50281 -1.15899 0.798089 -1.65706 -1.46002 -1.0177 1.36527 -1.32254 -1.18454 -1.30933 1.99183 -1.79637 -1.66828 -0.995727 1.15464 -1.59542 -1.39042 -1.62131 1.08312 -1.58194 -1.50116 -1.57535 1.31803 -1.80581 -1.75309 -1.14167 1.17427 -0.589121 -1.66842 -1.73096 1.20446 -1.6489 -1.12024 -1.62622 1.15003 -1.30617 -1.51204 -1.13434 1.73278 -1.5461 -1.20907 -1.5389 0.907571 -1.78324 -2.06005 -1.22097 1.55636 -1.35659 -1.80766 -1.7002 1.34488 -1.95257 -1.56042 -1.21632 1.25346 -1.32922 -1.89247 -1.20382 0.19202 -1.63868 -1.80098 -1.95668 1.36165 -1.5254 -1.56737 -1.64261 1.23639 -1.70655 -1.19567 -1.25804 1.44601 -1.72262 -1.3587 -1.32884 1.36488 -1.58242 -1.60421 -0.279258 1.97472 -1.65437 -1.77785 -0.946302 1.6693 -1.41126 -1.52884 0.198092 1.04135 -1.08062 -1.39281 -1.21884 1.25925 Estimate for Beta 0.000299912 -0.000395098 0.996784 QueryPerformanceCounter = 5.3626

0.0.4 Linear Regression 3x1

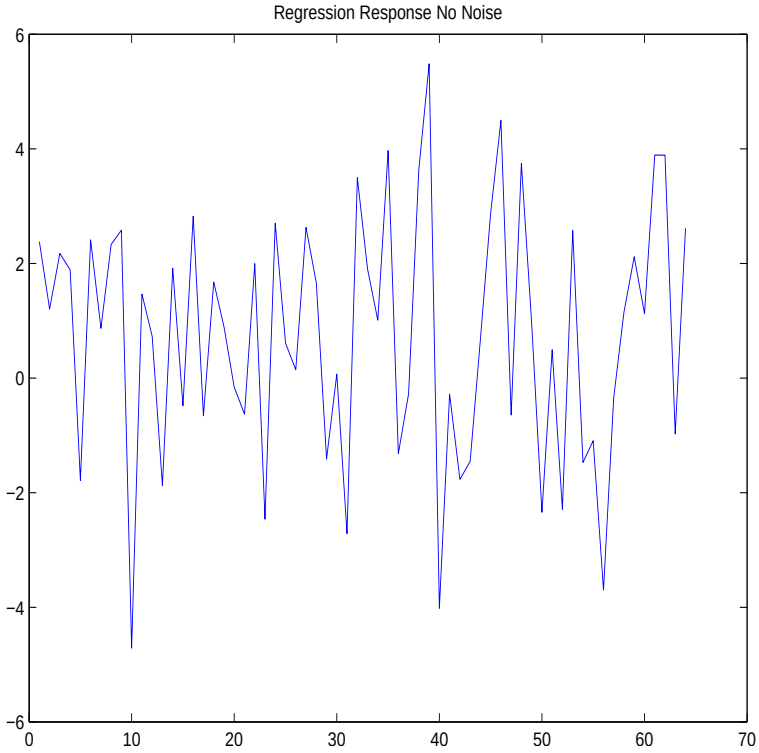


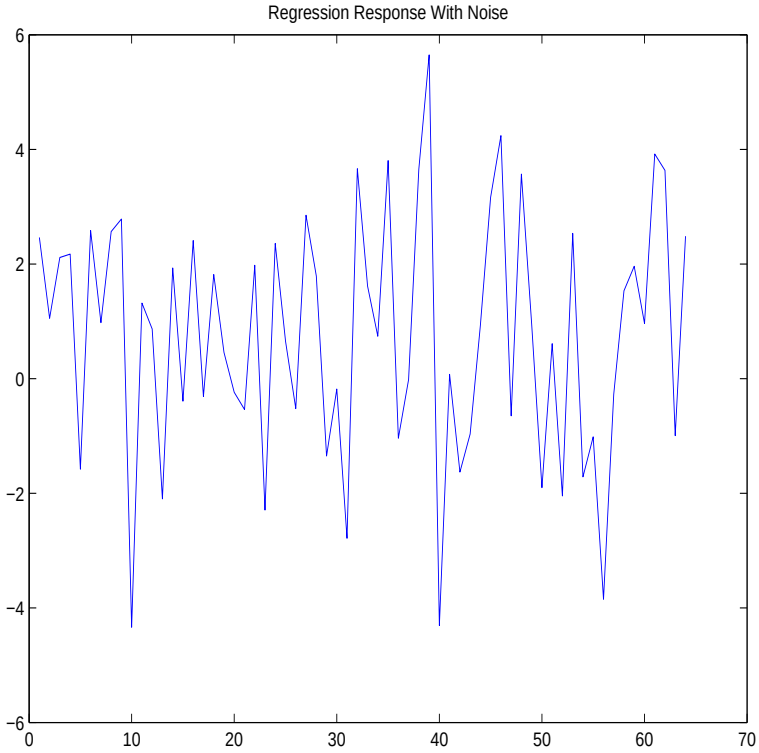
0.0.5 3 x 1 Linear Regression

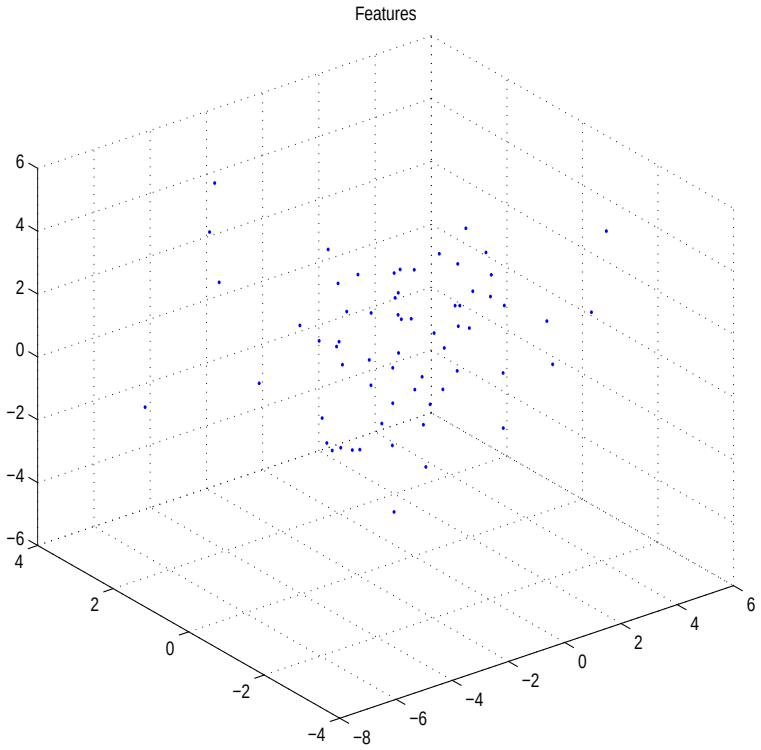
Sample size = 64

Number of features = 3

$$\sigma = \begin{pmatrix} +3.952 & -0.499 & -0.010 \\ -0.499 & +1.895 & +0.465 \\ -0.010 & +0.465 & +4.477 \end{pmatrix}$$





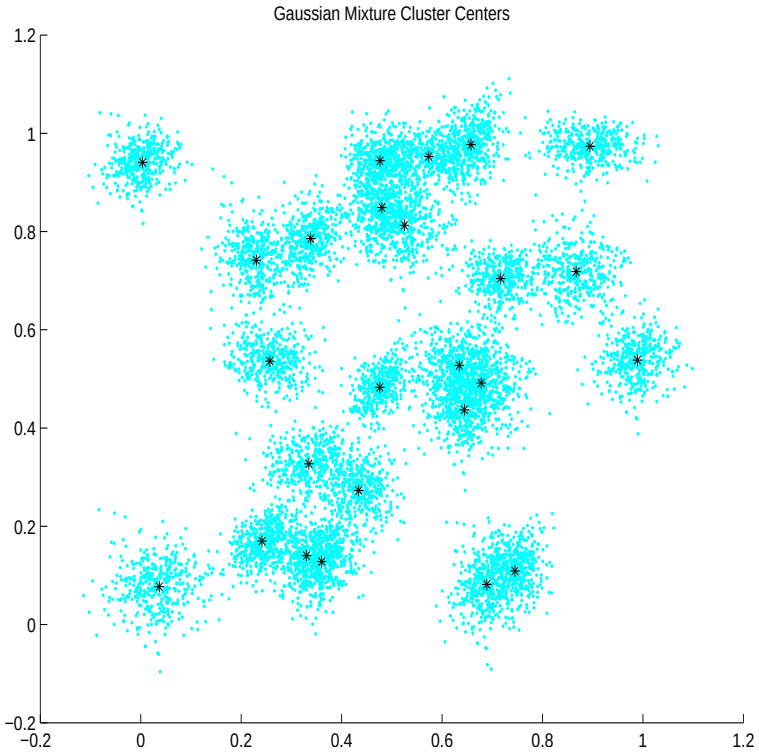


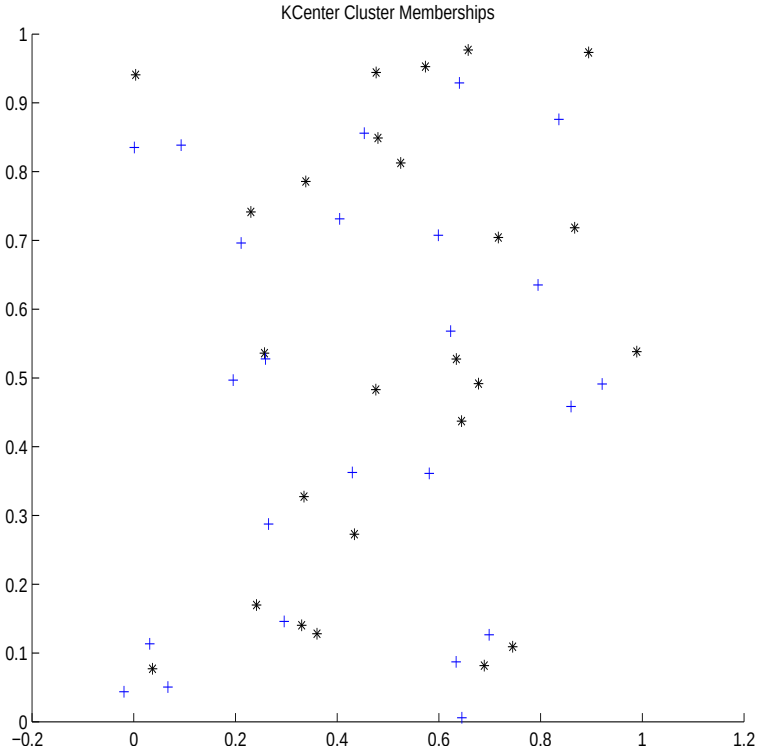
Beta +0.817, +0.999, +0.510

Response +2.463 +1.053 +2.113 +2.172 -1.579 +2.584 +0.976 +2.566 +2.785 -4.338 +1.319 +0.865 -2.100 +1.931 -0.394 +2.410 -0.311 +1.817 +0.458 -0.239 -0.538 +1.979 -2.294 +2.359 +0.652 -0.523 +2.852 +1.788 -1.352 -0.181 -2.786 +3.664 +1.615 +0.739 +3.805 -1.041 -0.017 +3.651 +5.649 -4.307 +0.074 -1.631 -0.965 +0.930 +3.163 +4.241 -0.650 +3.570 +0.939 -1.903 +0.610 -2.049 +2.536 -1.714 -1.016 -3.850 -0.274 +1.533 +1.959 +0.962 +3.920 +3.633 -0.995 +2.486 Estimate for Beta +0.812 +1.004 +0.484 Error: -0.005, +0.005, -0.026

QueryPerformanceCounter = +4.194

0.0.6 Fast Gauss Transform




KCenter Cluster Memberships
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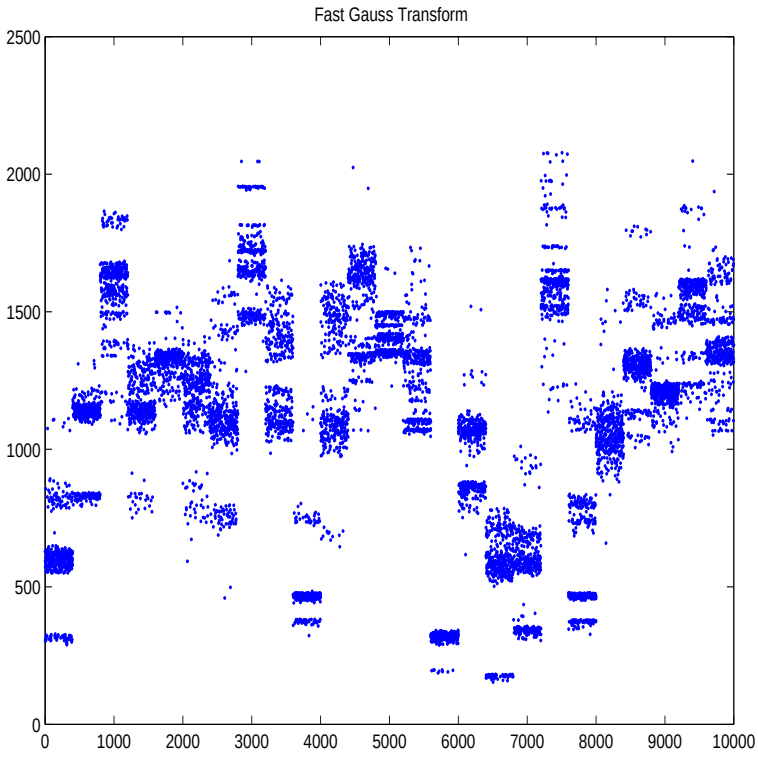
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
−0.2
0
0.2
0.4
0.6
0.8
1
1.2


Fast Gauss Transform
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1500
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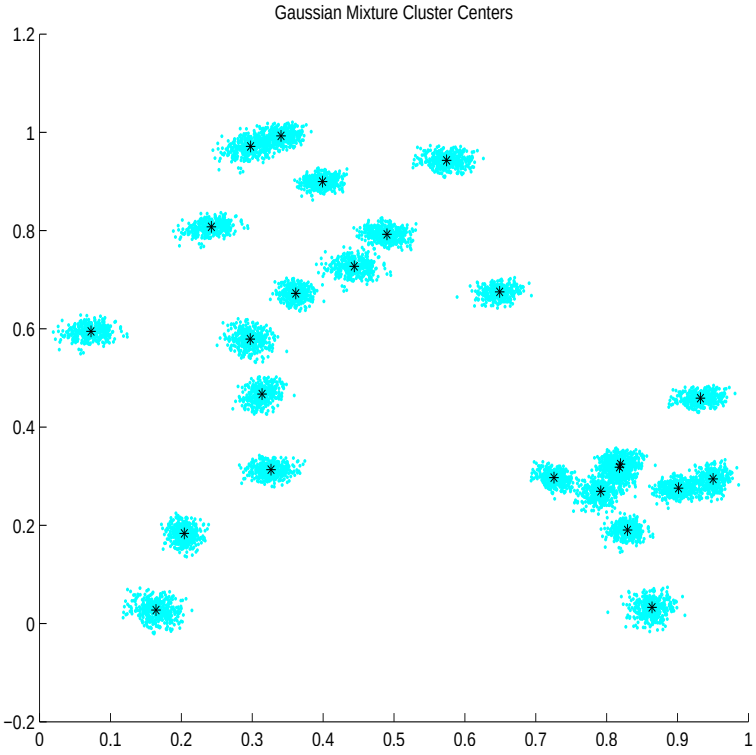
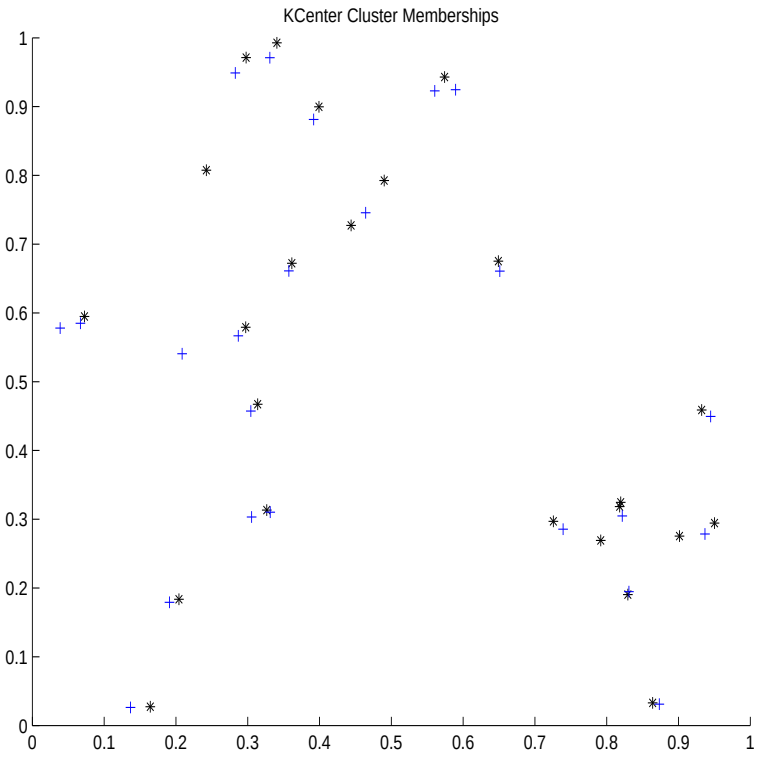
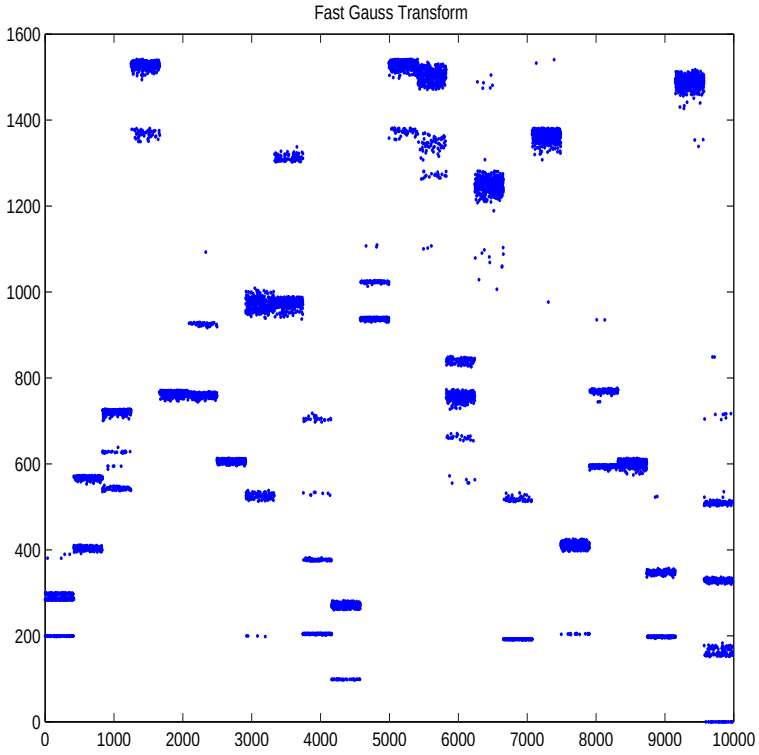
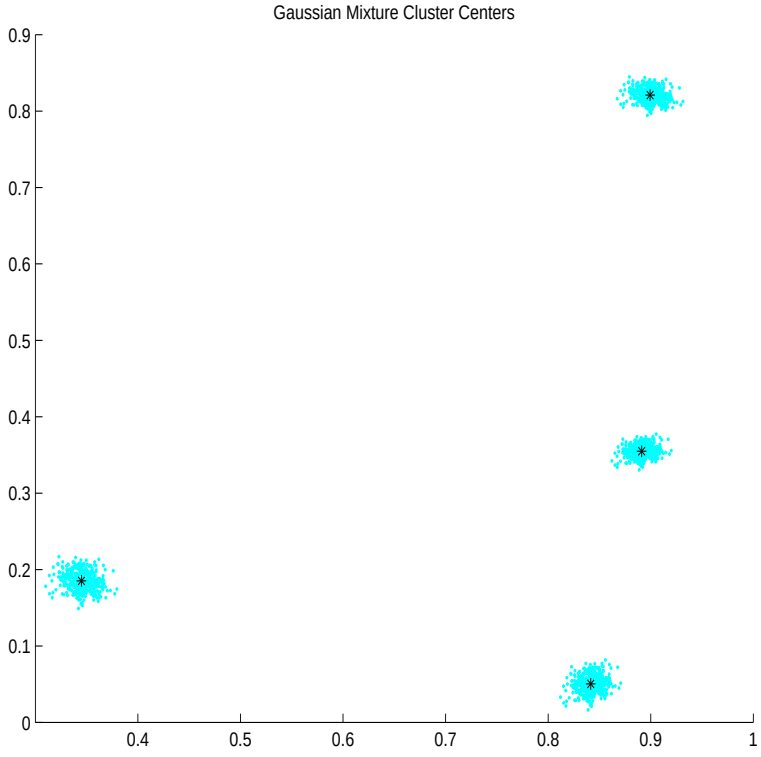
500
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000



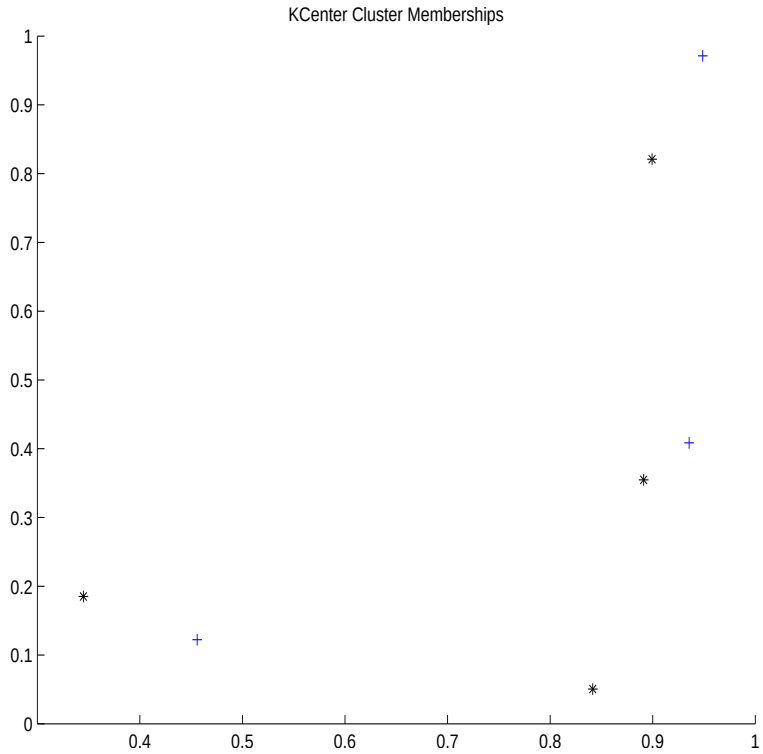
$\mathrm{QueryPerformanceCounter} = +6.518$







QueryPerformanceCounter = +6.948


KCenter Cluster Memberships
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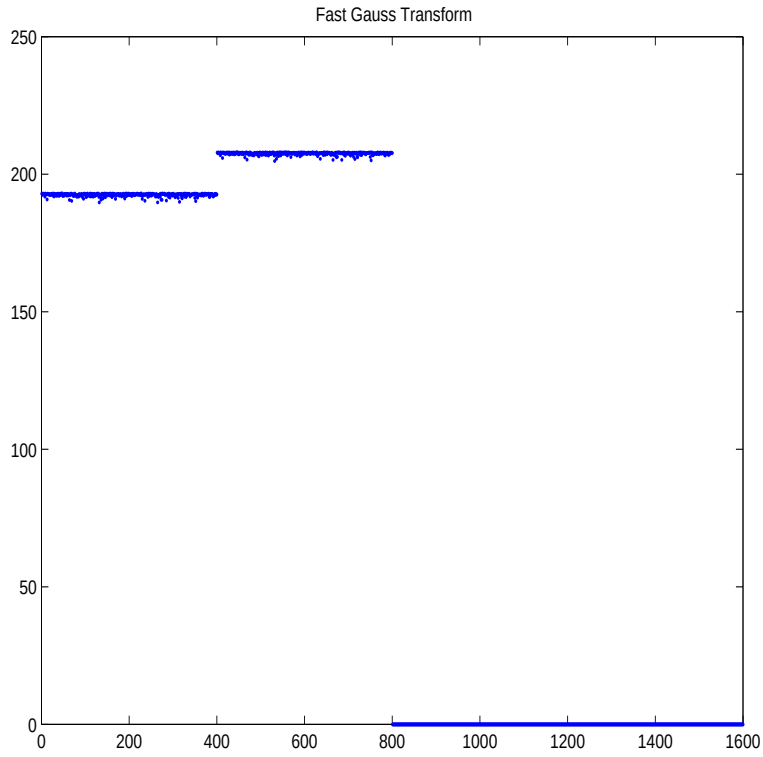
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.4
0.5
0.6
0.7
0.8
0.9
1


Fast Gauss Transform
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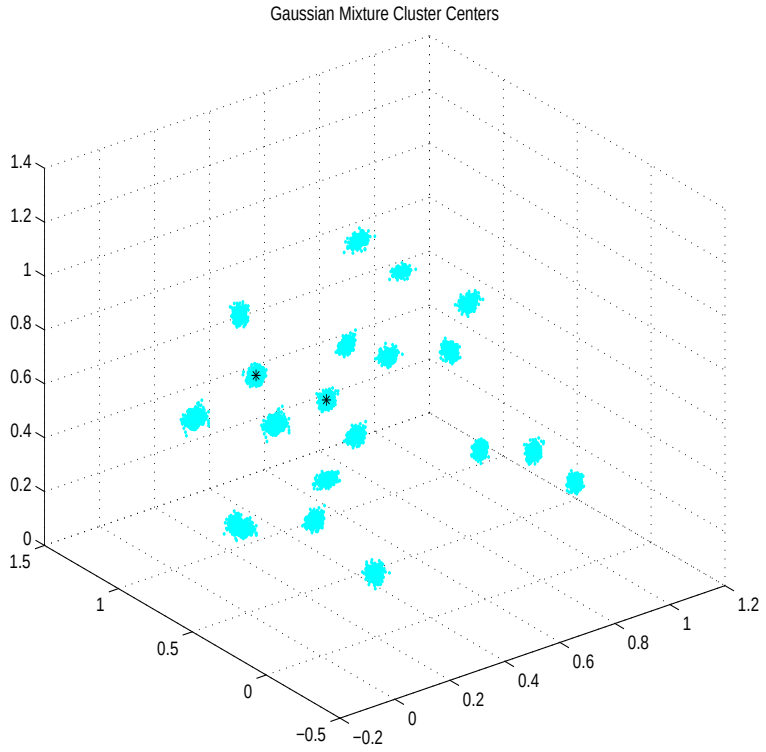
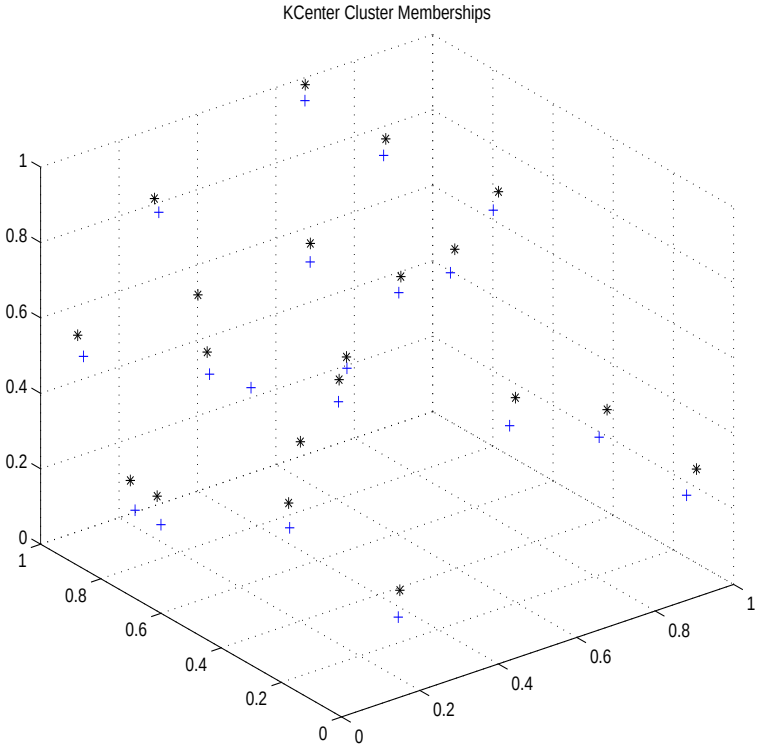
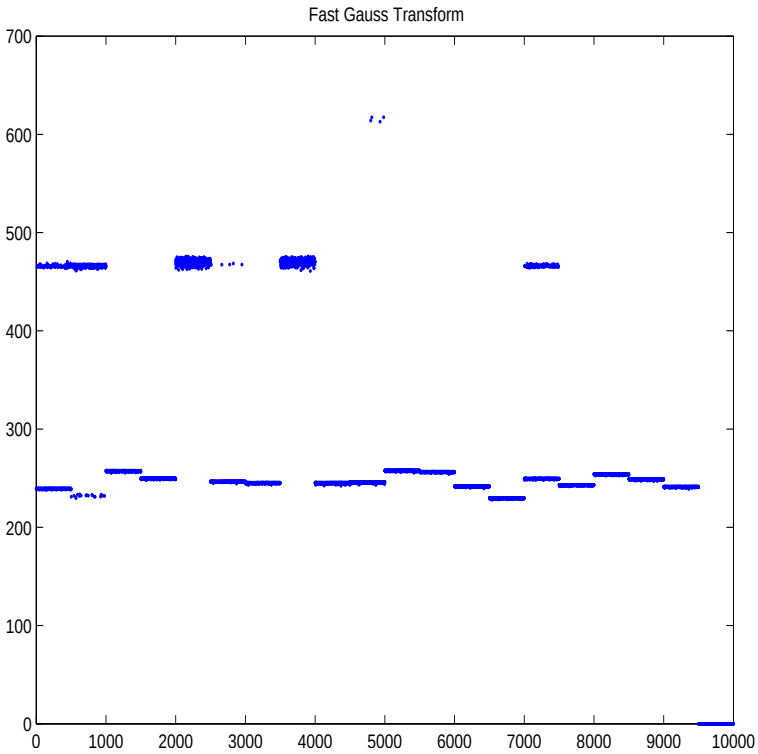
200
150
100
50
0
0
200
400
600
800
1000
1200
1400
1600



QueryPerformanceCounter = +3.846





QueryPerformanceCounter = +6.445

0.0.7 Matrix Norms

0.0.8 Haar Distributed Random Orthogonal Matrix $A \in O(n)$

Testing Operator Norm Number of Dimensions: +12

$$A = \begin{pmatrix} +0.167 & -0.040 & -0.084 & -0.017 & +0.402 & -0.371 & +0.167 & -0.088 & +0.587 & +0.093 & -0.434 & +0.296 \\ -0.425 & -0.489 & -0.431 & +0.091 & -0.091 & -0.284 & -0.411 & -0.245 & +0.126 & -0.159 & +0.164 & +0.022 \\ +0.369 & -0.223 & -0.035 & +0.506 & -0.205 & -0.469 & +0.125 & +0.049 & -0.473 & +0.148 & -0.130 & +0.117 \\ -0.207 & -0.179 & +0.343 & +0.376 & -0.493 & +0.209 & +0.143 & -0.159 & +0.392 & +0.134 & -0.310 & -0.257 \\ -0.055 & +0.053 & +0.041 & +0.589 & +0.550 & +0.229 & +0.158 & -0.379 & -0.010 & +0.003 & +0.345 & -0.054 \\ -0.045 & +0.590 & -0.106 & +0.020 & -0.002 & -0.291 & -0.306 & -0.398 & -0.122 & +0.069 & -0.293 & -0.442 \\ +0.144 & -0.054 & +0.212 & +0.196 & +0.126 & +0.227 & -0.409 & +0.049 & -0.108 & -0.669 & -0.413 & +0.160 \\ -0.523 & +0.361 & -0.023 & +0.287 & -0.005 & -0.300 & +0.254 & +0.510 & +0.054 & -0.307 & +0.033 & +0.032 \\ +0.343 & -0.004 & -0.387 & -0.072 & -0.211 & +0.009 & +0.471 & -0.190 & +0.137 & -0.557 & +0.091 & -0.296 \\ -0.159 & +0.169 & +0.384 & -0.183 & -0.244 & -0.209 & +0.176 & -0.529 & -0.101 & -0.201 & +0.162 & +0.524 \\ -0.391 & -0.330 & +0.030 & -0.259 & +0.293 & +0.028 & +0.396 & -0.128 & -0.436 & -0.027 & -0.423 & -0.202 \\ +0.131 & -0.237 & +0.576 & -0.139 & +0.191 & -0.441 & -0.089 & +0.089 & +0.121 & -0.168 & +0.286 & -0.452 \end{pmatrix}$$

$Det(A) : A \in O(n) =$ (-1.000,+0.000)

$$L = \begin{pmatrix} +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.814 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ -0.250 & +0.188 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ -0.707 & -0.041 & -0.105 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.104 & -0.019 & +0.055 & +0.799 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.397 & +0.412 & +0.806 & +0.505 & -0.762 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.748 & +0.767 & +0.561 & -0.489 & +0.224 & +0.007 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.304 & -0.075 & +0.555 & -0.370 & -0.629 & +0.246 & +0.047 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ -0.320 & -0.097 & -0.203 & +0.076 & +0.650 & -0.606 & +0.319 & +0.215 & +1.000 & +0.000 & +0.000 & +0.000 \\ -0.657 & -0.299 & -0.810 & +0.060 & -0.089 & -0.273 & +0.624 & +0.322 & +0.959 & +1.000 & +0.000 & +0.000 \\ -0.275 & -0.058 & +0.281 & +0.397 & +0.200 & +0.225 & -0.614 & -0.440 & -0.682 & +0.553 & +1.000 & +0.000 \\ +0.086 & -0.715 & -0.615 & -0.187 & +0.039 & -0.435 & -0.829 & +0.956 & -0.220 & -0.470 & +0.362 & +1.000 \end{pmatrix}$$

$$U = \begin{pmatrix} -0.523 & +0.361 & -0.023 & +0.287 & -0.005 & -0.300 & +0.254 & +0.510 & +0.054 & -0.307 & +0.033 & +0.032 \\ +0.000 & -0.782 & -0.412 & -0.142 & -0.088 & -0.040 & -0.617 & -0.660 & +0.082 & +0.090 & +0.137 & -0.004 \\ +0.000 & +0.000 & +0.648 & -0.041 & +0.206 & -0.508 & +0.091 & +0.340 & +0.119 & -0.261 & +0.269 & -0.443 \\ +0.000 & +0.000 & +0.000 & +0.699 & -0.191 & -0.737 & +0.288 & +0.417 & -0.419 & -0.093 & -0.073 & +0.093 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.690 & +0.877 & -0.116 & -0.797 & +0.314 & +0.125 & +0.387 & -0.106 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.794 & -0.011 & -1.181 & +0.692 & +0.571 & -0.264 & -0.038 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.796 & +0.197 & -0.885 & +0.203 & -0.824 & +0.095 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & -0.989 & -0.262 & -0.062 & +0.334 & +0.733 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.221 & +0.172 & -0.571 & +0.067 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & -1.042 & +1.292 & -1.021 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & -1.925 & +1.277 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & -2.264 \end{pmatrix}$$

$$L * U = \begin{pmatrix} -0.523 & +0.361 & -0.023 & +0.287 & -0.005 & -0.300 & +0.254 & +0.510 & +0.054 & -0.307 & +0.033 & +0.032 \\ -0.425 & -0.489 & -0.431 & +0.091 & -0.091 & -0.284 & -0.411 & -0.245 & +0.126 & -0.159 & +0.164 & +0.022 \\ +0.131 & -0.237 & +0.576 & -0.139 & +0.191 & -0.441 & -0.089 & +0.089 & +0.121 & -0.168 & +0.286 & -0.452 \\ +0.369 & -0.223 & -0.035 & +0.506 & -0.205 & -0.469 & +0.125 & +0.049 & -0.473 & +0.148 & -0.130 & +0.117 \\ -0.055 & +0.053 & +0.041 & +0.589 & +0.550 & +0.229 & +0.158 & -0.379 & -0.010 & +0.003 & +0.345 & -0.054 \\ -0.207 & -0.179 & +0.343 & +0.376 & -0.493 & +0.209 & +0.143 & -0.159 & +0.392 & +0.134 & -0.310 & -0.257 \\ -0.391 & -0.330 & +0.030 & -0.259 & +0.293 & +0.028 & +0.396 & -0.128 & -0.436 & -0.027 & -0.423 & -0.202 \\ -0.159 & +0.169 & +0.384 & -0.183 & -0.244 & -0.209 & +0.176 & -0.529 & -0.101 & -0.201 & +0.162 & +0.524 \\ +0.167 & -0.040 & -0.084 & -0.017 & +0.402 & -0.371 & +0.167 & -0.088 & +0.587 & +0.093 & -0.434 & +0.296 \\ +0.343 & -0.004 & -0.387 & -0.072 & -0.211 & +0.009 & +0.471 & -0.190 & +0.137 & -0.557 & +0.091 & -0.296 \\ +0.144 & -0.054 & +0.212 & +0.196 & +0.126 & +0.227 & -0.409 & +0.049 & -0.108 & -0.669 & -0.413 & +0.160 \\ -0.045 & +0.590 & -0.106 & +0.020 & -0.002 & -0.291 & -0.306 & -0.398 & -0.122 & +0.069 & -0.293 & -0.442 \end{pmatrix}$$

$Det(L) := (+1.000, +0.000) Det(U) := (+1.000, +0.000) Det(LU) := (+1.000, +0.000)$

$||A||_{L_1} = +3.103$

$||A||_{L_\infty} = +3.202$

$||A^{-1}||_{L_1} = +3.202$

$||A^{-1}||_{L_\infty} = +3.103$

$||A||_{L_\infty} * ||A^{-1}||_{L_\infty} = +9.933$

$||A||_{L_1} * ||A^{-1}||_{L_1} = +9.933$

Frobenious Norm $||A||_F$ via $\sum_{i,j=0}^{n} \|A_{i,j}|$ of $A \in O(n)$ $+3.464$

L_1 condition number of Haar Distributed Random Orthogonal Matrix $A \in O(n)$ $+9.933$

$$A = \begin{pmatrix} +0.167 & -0.040 & -0.084 & -0.017 & +0.402 & -0.371 & +0.167 & -0.088 & +0.587 & +0.093 & -0.434 & +0.296 \\ -0.425 & -0.489 & -0.431 & +0.091 & -0.091 & -0.284 & -0.411 & -0.245 & +0.126 & -0.159 & +0.164 & +0.022 \\ +0.369 & -0.223 & -0.035 & +0.506 & -0.205 & -0.469 & +0.125 & +0.049 & -0.473 & +0.148 & -0.130 & +0.117 \\ -0.207 & -0.179 & +0.343 & +0.376 & -0.493 & +0.209 & +0.143 & -0.159 & +0.392 & +0.134 & -0.310 & -0.257 \\ -0.055 & +0.053 & +0.041 & +0.589 & +0.550 & +0.229 & +0.158 & -0.379 & -0.010 & +0.003 & +0.345 & -0.054 \\ -0.045 & +0.590 & -0.106 & +0.020 & -0.002 & -0.291 & -0.306 & -0.398 & -0.122 & +0.069 & -0.293 & -0.442 \\ +0.144 & -0.054 & +0.212 & +0.196 & +0.126 & +0.227 & -0.409 & +0.049 & -0.108 & -0.669 & -0.413 & +0.160 \\ -0.523 & +0.361 & -0.023 & +0.287 & -0.005 & -0.300 & +0.254 & +0.510 & +0.054 & -0.307 & +0.033 & +0.032 \\ +0.343 & -0.004 & -0.387 & -0.072 & -0.211 & +0.009 & +0.471 & -0.190 & +0.137 & -0.557 & +0.091 & -0.296 \\ -0.159 & +0.169 & +0.384 & -0.183 & -0.244 & -0.209 & +0.176 & -0.529 & -0.101 & -0.201 & +0.162 & +0.524 \\ -0.391 & -0.330 & +0.030 & -0.259 & +0.293 & +0.028 & +0.396 & -0.128 & -0.436 & -0.027 & -0.423 & -0.202 \\ +0.131 & -0.237 & +0.576 & -0.139 & +0.191 & -0.441 & -0.089 & +0.089 & +0.121 & -0.168 & +0.286 & -0.452 \end{pmatrix}$$

L_∞ condition number of Haar Distributed Random Orthogonal Matrix $A \in O(n)$ $+9.006$

Eigenvalues of $A \in O(n)$

(+0.642,+0.767), (+0.642,-0.767), (-0.287,+0.958), (-0.287,-0.958), (-1.000,+0.000), (-0.707,+0.707), (-0.707,-0.707), (-0.876,+0.482), (-0.876,-0.482), (+1.000,+0.000), (+0.948,+0.318), (+0.948,-0.318)

$|\lambda| : \lambda \in \sigma(A), A \in O(n)$

+1.000, +1.000, +1.000, +1.000, +1.000, +1.000, +1.000, +1.000, +1.000, +1.000, +1.000, +1.000

Calculating $A^\dagger A$, we expect $A^\dagger A \approx I$

$$A^\dagger A = \begin{pmatrix}
+1.000 & +0.000 & -0.000 & +0.000 & -0.000 & +0.000 & -0.000 & +0.000 & +0.000 & -0.000 & +0.000 & +0.000 \\
+0.000 & +1.000 & +0.000 & -0.000 & -0.000 & -0.000 & -0.000 & +0.000 & -0.000 & -0.000 & +0.000 & +0.000 \\
-0.000 & +0.000 & +1.000 & -0.000 & +0.000 & +0.000 & -0.000 & -0.000 & +0.000 & -0.000 & -0.000 & +0.000 \\
+0.000 & -0.000 & -0.000 & +1.000 & +0.000 & -0.000 & -0.000 & -0.000 & -0.000 & -0.000 & +0.000 & +0.000 \\
-0.000 & -0.000 & +0.000 & +0.000 & +1.000 & +0.000 & +0.000 & -0.000 & +0.000 & +0.000 & -0.000 & -0.000 \\
+0.000 & -0.000 & +0.000 & -0.000 & +0.000 & +1.000 & +0.000 & +0.000 & -0.000 & -0.000 & +0.000 & +0.000 \\
-0.000 & -0.000 & -0.000 & -0.000 & +0.000 & +0.000 & +1.000 & -0.000 & -0.000 & +0.000 & +0.000 & +0.000 \\
+0.000 & +0.000 & -0.000 & -0.000 & -0.000 & +0.000 & -0.000 & +1.000 & +0.000 & +0.000 & -0.000 & -0.000 \\
+0.000 & -0.000 & +0.000 & -0.000 & +0.000 & -0.000 & -0.000 & +0.000 & +1.000 & -0.000 & +0.000 & +0.000 \\
-0.000 & -0.000 & -0.000 & -0.000 & +0.000 & -0.000 & +0.000 & +0.000 & -0.000 & +1.000 & +0.000 & -0.000 \\
+0.000 & +0.000 & -0.000 & +0.000 & -0.000 & +0.000 & +0.000 & -0.000 & +0.000 & +0.000 & +1.000 & +0.000 \\
+0.000 & +0.000 & +0.000 & +0.000 & -0.000 & +0.000 & +0.000 & -0.000 & +0.000 & -0.000 & +0.000 & +1.000
\end{pmatrix}$$

Calculating $A^{-1}, A \in O(n)$.

$$A^{-1} = \begin{pmatrix}
+0.167 & -0.425 & +0.369 & -0.207 & -0.055 & -0.045 & +0.144 & -0.523 & +0.343 & -0.159 & -0.391 & +0.131 \\
-0.040 & -0.489 & -0.223 & -0.179 & +0.053 & +0.590 & -0.054 & +0.361 & -0.004 & +0.169 & -0.330 & -0.237 \\
-0.084 & -0.431 & -0.035 & +0.343 & +0.041 & -0.106 & +0.212 & -0.023 & -0.387 & +0.384 & +0.030 & +0.576 \\
-0.017 & +0.091 & +0.506 & +0.376 & +0.589 & +0.020 & +0.196 & +0.287 & -0.072 & -0.183 & -0.259 & -0.139 \\
+0.402 & -0.091 & -0.205 & -0.493 & +0.550 & -0.002 & +0.126 & -0.005 & -0.211 & -0.244 & +0.293 & +0.191 \\
-0.371 & -0.284 & -0.469 & +0.209 & +0.229 & -0.291 & +0.227 & -0.300 & +0.009 & -0.209 & +0.028 & -0.441 \\
+0.167 & -0.411 & +0.125 & +0.143 & +0.158 & -0.306 & -0.409 & +0.254 & +0.471 & +0.176 & +0.396 & -0.089 \\
-0.088 & -0.245 & +0.049 & -0.159 & -0.379 & -0.398 & +0.049 & +0.510 & -0.190 & -0.529 & -0.128 & +0.089 \\
+0.587 & +0.126 & -0.473 & +0.392 & -0.010 & -0.122 & -0.108 & +0.054 & +0.137 & -0.101 & -0.436 & +0.121 \\
+0.093 & -0.159 & +0.148 & +0.134 & +0.003 & +0.069 & -0.669 & -0.307 & -0.557 & -0.201 & -0.027 & -0.168 \\
-0.434 & +0.164 & -0.130 & -0.310 & +0.345 & -0.293 & -0.413 & +0.033 & +0.091 & +0.162 & -0.423 & +0.286 \\
+0.296 & +0.022 & +0.117 & -0.257 & -0.054 & -0.442 & +0.160 & +0.032 & -0.296 & +0.524 & -0.202 & -0.452
\end{pmatrix}$$

Calculating $A^{-1} * A, A \in O(n)$. We expect $A^{-1} * A \approx I$.

$$A^{-1} * A = \begin{pmatrix}
+1.000 & +0.000 & +0.000 & +0.000 & -0.000 & -0.000 & +0.000 & +0.000 & -0.000 & -0.000 & -0.000 & +0.000 \\
+0.000 & +1.000 & -0.000 & -0.000 & -0.000 & +0.000 & -0.000 & -0.000 & -0.000 & +0.000 & +0.000 & -0.000 \\
+0.000 & +0.000 & +1.000 & +0.000 & -0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & -0.000 \\
-0.000 & +0.000 & +0.000 & +1.000 & +0.000 & +0.000 & +0.000 & -0.000 & +0.000 & +0.000 & +0.000 & -0.000 \\
+0.000 & +0.000 & +0.000 & -0.000 & +1.000 & +0.000 & -0.000 & -0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\
+0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & -0.000 & -0.000 & +0.000 & -0.000 & -0.000 & +0.000 \\
-0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & -0.000 & -0.000 & -0.000 & -0.000 & -0.000 \\
+0.000 & -0.000 & -0.000 & -0.000 & -0.000 & -0.000 & -0.000 & +1.000 & +0.000 & +0.000 & -0.000 & -0.000 \\
-0.000 & -0.000 & +0.000 & +0.000 & +0.000 & +0.000 & -0.000 & -0.000 & +1.000 & +0.000 & +0.000 & +0.000 \\
+0.000 & +0.000 & +0.000 & +0.000 & +0.000 & -0.000 & -0.000 & -0.000 & +0.000 & +1.000 & -0.000 & -0.000 \\
-0.000 & -0.000 & +0.000 & +0.000 & +0.000 & -0.000 & -0.000 & +0.000 & -0.000 & -0.000 & +1.000 & +0.000 \\
+0.000 & +0.000 & +0.000 & +0.000 & -0.000 & -0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000
\end{pmatrix}$$

Calculating SVD of $A \in O(n)$

$$U = \begin{pmatrix}
-0.254 & +0.661 & +0.123 & +0.090 & +0.076 & -0.316 & -0.419 & -0.219 & -0.070 & +0.373 & +0.040 & +0.023 \\
-0.026 & -0.386 & -0.098 & -0.101 & +0.043 & +0.290 & -0.139 & -0.515 & -0.025 & +0.543 & -0.246 & -0.323 \\
+0.622 & +0.233 & -0.573 & +0.192 & -0.089 & +0.035 & -0.071 & -0.032 & -0.351 & +0.046 & -0.186 & +0.132 \\
-0.417 & -0.037 & -0.188 & +0.239 & -0.685 & -0.195 & +0.146 & -0.031 & +0.050 & -0.039 & -0.444 & +0.048 \\
+0.122 & -0.258 & +0.186 & +0.161 & -0.006 & -0.542 & +0.451 & +0.015 & -0.382 & +0.401 & +0.233 & +0.012 \\
-0.167 & +0.040 & +0.084 & +0.017 & -0.402 & +0.371 & -0.167 & +0.088 & -0.587 & -0.093 & +0.434 & -0.296 \\
-0.059 & +0.020 & +0.176 & -0.095 & +0.242 & -0.018 & -0.090 & +0.588 & -0.320 & +0.092 & -0.586 & -0.299 \\
-0.033 & -0.088 & +0.227 & -0.061 & -0.126 & +0.364 & -0.081 & +0.199 & -0.087 & +0.375 & -0.058 & +0.768 \\
+0.392 & -0.245 & +0.542 & +0.171 & -0.211 & -0.206 & -0.461 & -0.217 & -0.040 & -0.286 & -0.182 & +0.035 \\
-0.328 & -0.122 & -0.122 & -0.257 & +0.315 & -0.128 & +0.009 & -0.378 & -0.511 & -0.389 & -0.157 & +0.319 \\
+0.249 & +0.275 & +0.166 & -0.790 & -0.349 & -0.080 & +0.235 & -0.117 & +0.002 & +0.031 & -0.101 & -0.056 \\
-0.058 & -0.363 & -0.389 & -0.360 & -0.119 & -0.384 & -0.515 & +0.297 & +0.078 & +0.101 & +0.222 & +0.050
\end{pmatrix}$$

$$S = \begin{pmatrix} +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 \end{pmatrix}$$

$$V = \begin{pmatrix} -0.000 & +0.000 & +0.000 & +0.000 & +0.000 & -1.000 & +0.000 & -0.000 & -0.000 & -0.000 & +0.000 & +0.000 \\ -0.012 & +0.192 & -0.157 & +0.305 & -0.099 & -0.000 & -0.351 & -0.217 & +0.066 & +0.303 & -0.419 & +0.627 \\ -0.044 & -0.073 & +0.499 & +0.264 & +0.701 & -0.000 & +0.102 & +0.016 & +0.343 & -0.000 & -0.232 & +0.000 \\ -0.114 & +0.326 & -0.357 & +0.581 & -0.074 & +0.000 & -0.051 & +0.010 & +0.236 & -0.455 & -0.083 & -0.372 \\ +0.108 & +0.115 & -0.040 & -0.389 & +0.105 & -0.000 & -0.335 & -0.163 & -0.130 & +0.076 & -0.618 & -0.518 \\ +0.710 & +0.200 & +0.241 & +0.148 & -0.159 & +0.000 & +0.142 & -0.521 & +0.095 & +0.076 & +0.173 & -0.116 \\ -0.185 & -0.231 & +0.122 & -0.031 & -0.526 & -0.000 & +0.269 & +0.051 & +0.598 & +0.303 & -0.250 & -0.179 \\ +0.155 & -0.724 & -0.252 & +0.362 & +0.035 & +0.000 & +0.214 & -0.162 & -0.341 & +0.000 & -0.250 & -0.076 \\ -0.538 & -0.169 & +0.283 & +0.104 & -0.092 & +0.000 & -0.346 & -0.594 & -0.092 & +0.000 & +0.273 & -0.160 \\ +0.223 & -0.219 & -0.230 & +0.150 & +0.167 & +0.000 & -0.523 & +0.250 & +0.251 & +0.455 & +0.368 & -0.240 \\ -0.264 & +0.358 & -0.233 & +0.120 & +0.216 & +0.000 & +0.451 & -0.122 & -0.228 & +0.606 & +0.078 & -0.205 \\ -0.030 & -0.126 & -0.523 & -0.384 & +0.309 & +0.000 & +0.130 & -0.441 & +0.445 & -0.152 & +0.102 & +0.156 \end{pmatrix}$$

$$USV = \begin{pmatrix} -0.087 & +0.290 & -0.277 & +0.188 & +0.370 & +0.254 & -0.604 & +0.145 & -0.008 & +0.205 & -0.131 & +0.387 \\ +0.387 & +0.205 & +0.323 & -0.185 & -0.069 & +0.026 & -0.418 & +0.322 & +0.082 & +0.059 & +0.521 & -0.323 \\ +0.268 & +0.152 & -0.516 & -0.041 & -0.377 & -0.622 & -0.111 & +0.124 & -0.008 & -0.154 & +0.026 & +0.236 \\ -0.183 & -0.209 & -0.066 & +0.227 & -0.357 & +0.417 & +0.025 & +0.226 & +0.266 & -0.436 & +0.370 & +0.342 \\ -0.257 & -0.176 & -0.265 & +0.022 & +0.149 & -0.122 & +0.181 & +0.658 & +0.387 & +0.265 & -0.092 & -0.318 \\ +0.448 & +0.322 & +0.002 & +0.383 & +0.084 & +0.167 & +0.564 & +0.245 & -0.207 & +0.217 & +0.103 & +0.188 \\ +0.480 & -0.559 & +0.127 & +0.140 & +0.050 & +0.059 & -0.207 & +0.284 & -0.195 & -0.229 & -0.449 & -0.002 \\ +0.411 & -0.306 & -0.317 & -0.079 & +0.446 & +0.033 & +0.079 & -0.369 & +0.450 & +0.014 & +0.288 & +0.046 \\ -0.154 & +0.167 & +0.284 & +0.073 & +0.564 & -0.392 & +0.089 & +0.176 & +0.005 & -0.569 & +0.101 & +0.133 \\ +0.139 & +0.259 & -0.082 & -0.750 & +0.028 & +0.328 & +0.193 & +0.184 & +0.098 & -0.224 & -0.286 & +0.156 \\ -0.042 & -0.278 & +0.420 & -0.243 & -0.038 & -0.249 & +0.035 & +0.109 & +0.113 & +0.443 & +0.082 & +0.627 \\ -0.162 & -0.307 & -0.313 & -0.279 & +0.193 & +0.058 & +0.044 & +0.143 & -0.684 & +0.033 & +0.415 & +0.007 \end{pmatrix}$$

0.0.9 Wishart Matrix $A \in W(n)$

L_1 condition number of Wishart Matrix +56267.800 L_infty condition number of Wishart Matrix +56267.800

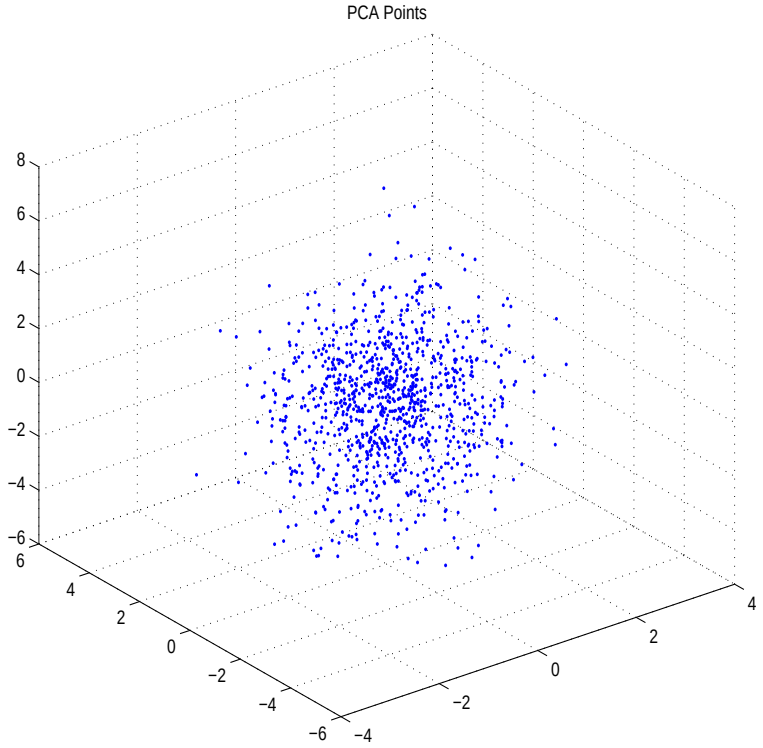
0.0.10 Gaussian Orthogonal Ensemble $A \in GOE(n)$

L_1 condition number of GOE Matrix +470.231 L_∞ condition number of GOE Matrix +470.231

0.0.11 The Identity Matrix $I \in M(n)$

L_1 condition number of I = +1.000 L_∞ condition number of I = +1.000 QueryPerformanceCounter = +0.387

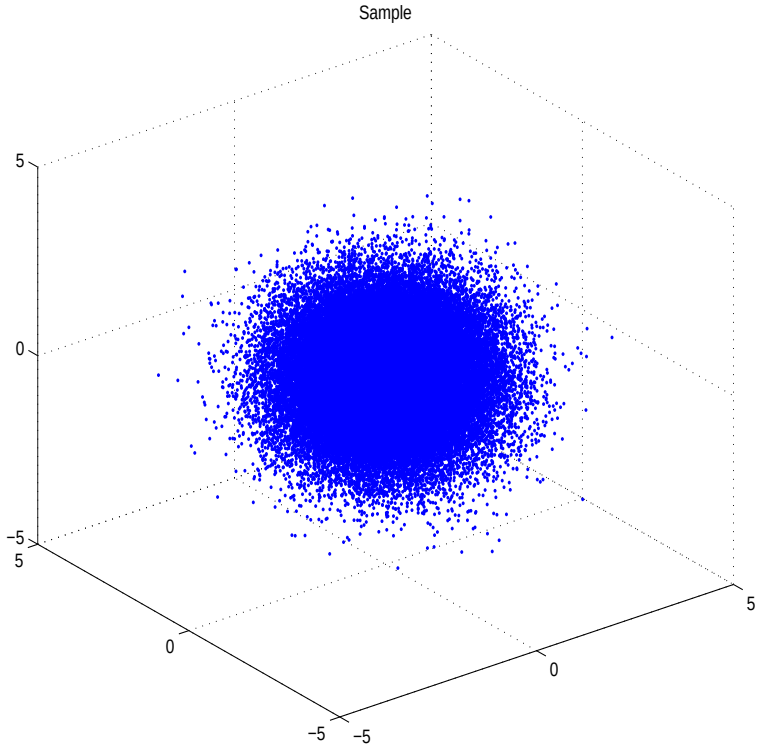
0.0.12 Principal Components Matlab

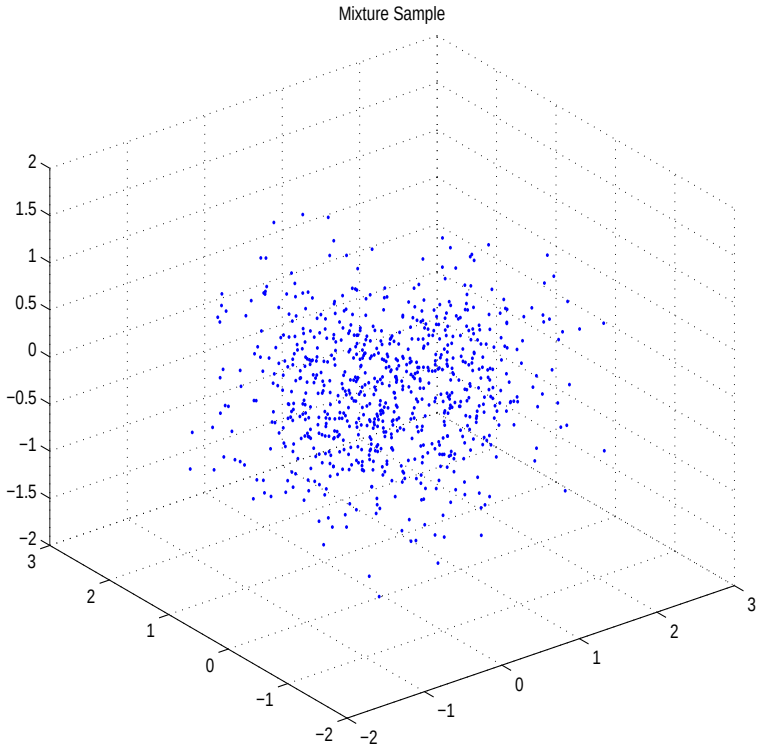


The eigenvectors: +0.121, +0.241, +0.963 +0.199, +0.944, -0.261 -0.972, +0.224, +0.067
All of the eigenvalues of the covariance matrix: (+0.958,+0.000), (+2.025,+0.000), (+3.017,+0.000)
QueryPerformanceCounter = +1.040

0.0.13 Multi Variate Random Number Generator

Sample from $N(\mu, \Sigma)$ mean= -0.002, variance=+1.004, skewness=+0.006, kurtosis=+3.003 mean= -0.001, variance=+1.017, skewness=-0.005, kurtosis=+2.988 mean= -0.002, variance=+1.006, skewness=-0.016, kurtosis=+3.014 Covariance Matrix +1.004, +0.009, +0.003 +0.009, +1.017, -0.003 +0.003, -0.003, +1.006





Generate a sample from a unifom mixture of three Gaussians in R^3
QueryPerformanceCounter = +16.975

0.0.14 Matrix Multiply

Comparing naive matrix multiply verus Intel MKL dgemm for matrix of size +2048. This is for type double (hence the d in dgemm). Naive type double matrix multiply tic toc = +0.411 dgemm plus row to column major transpose operation tic toc = +0.318 Comparing naive matrix multiply verus Intel MKL sgemm for matrix of size +2048. This is for type float (hence the s in dgemm). Naive type float matrix multiply tic toc = +0.255 sgemm plus row to column major transpose operation tic toc = +0.229 QueryPerformanceCounter = +1.336

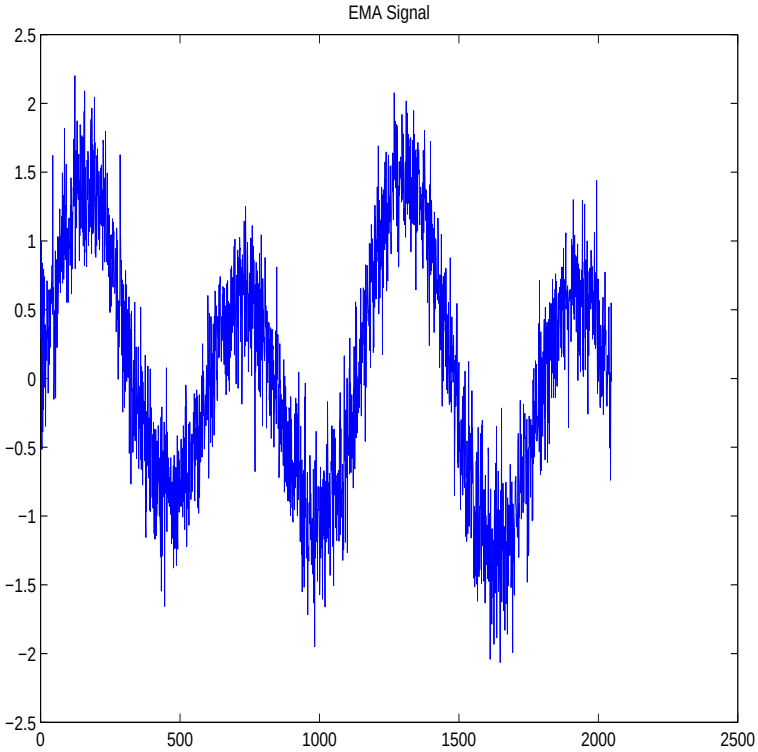
0.0.15 Descriptive Statistics

Mean N(0,1): +0.003 Variance N(0,1): +1.006 Mean N(0,1) [recurrence relation method] :+0.003 Variance [recurrence relation method] :+1.006 Skewness : +0.007 Kurtosis : +2.997 QueryPerformanceCounter = +0.032

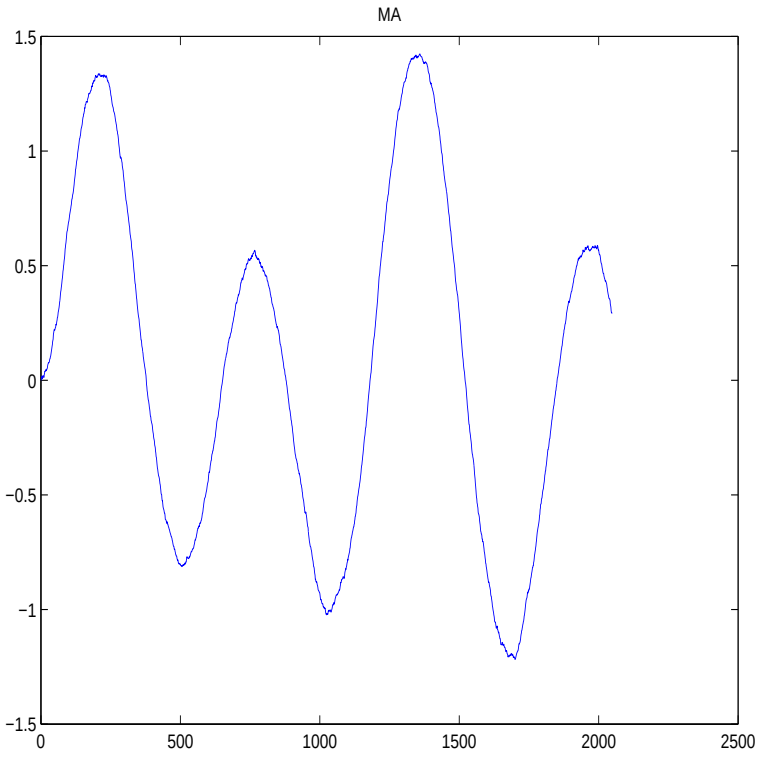
0.0.16 Time Series

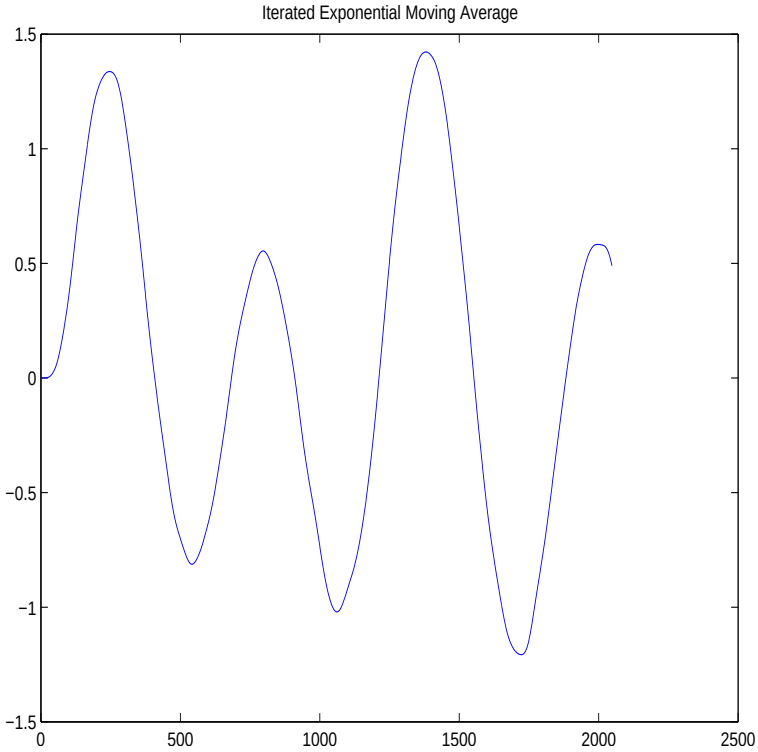
+0.093 +0.726 +0.011 +2.178 QueryPerformanceCounter = +0.034 QueryPerformanceCounter = +6.281

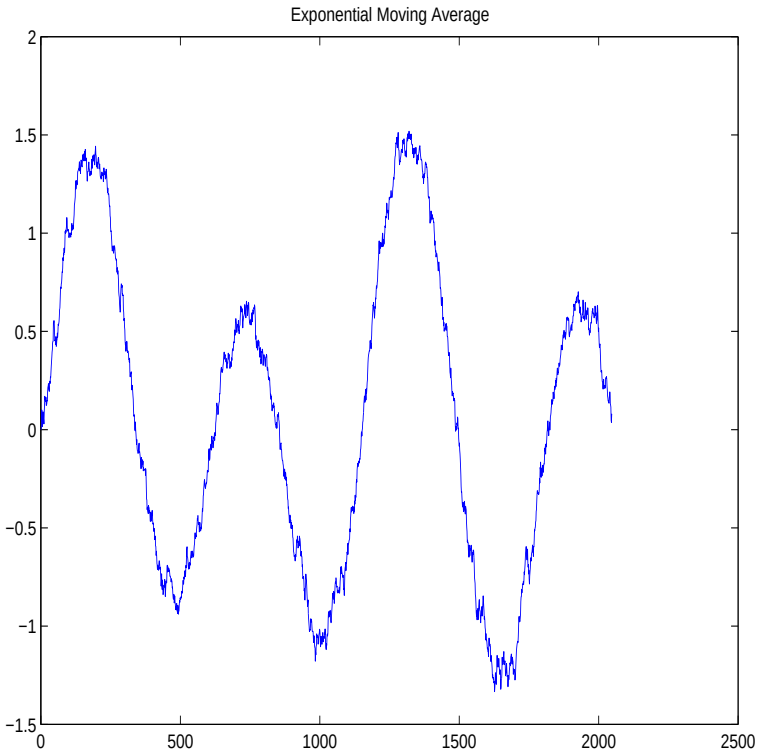
0.0.17 Iterated Exponential Filtering

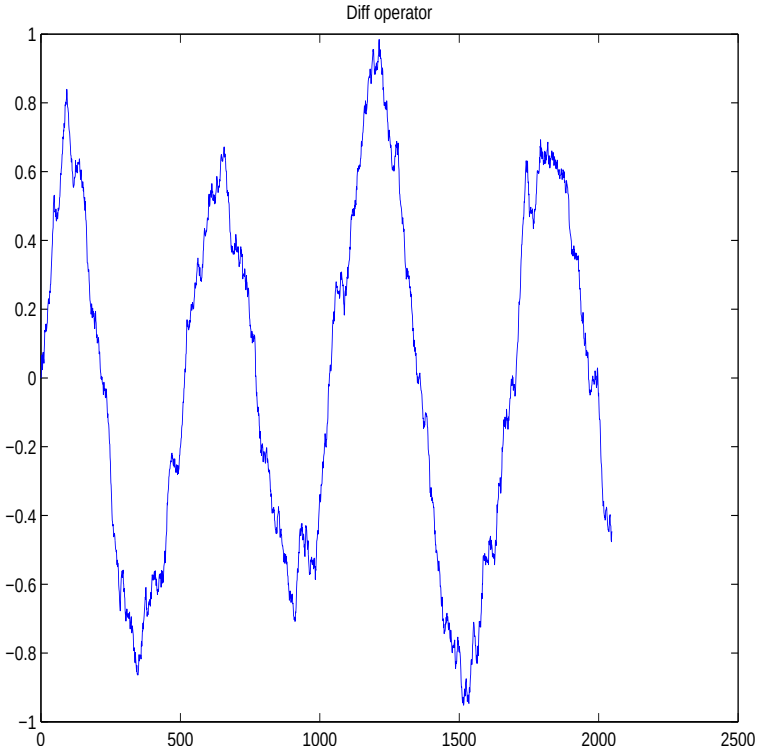


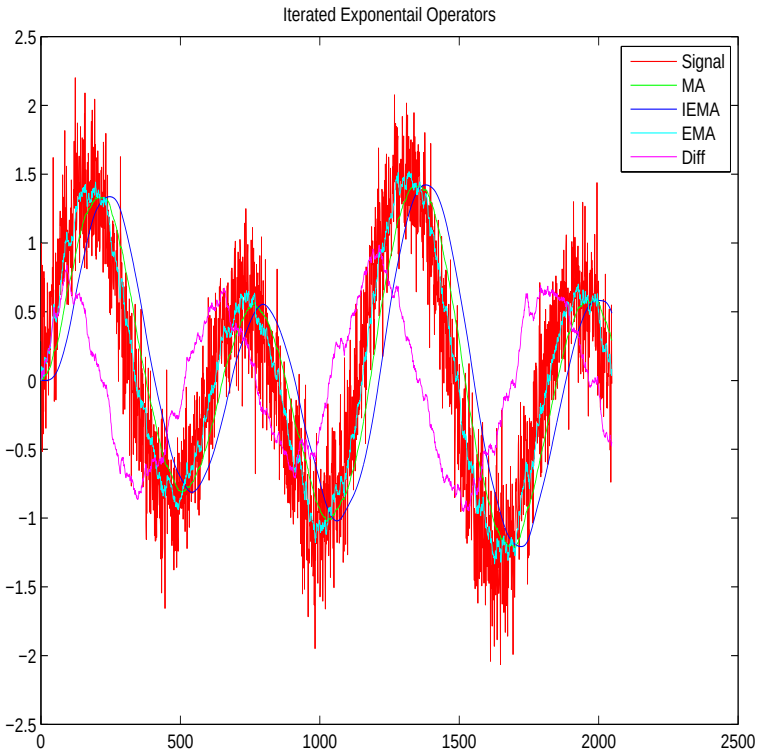
$\mu_1 = +0.093$ $\mu_2 = +0.726$ $\mu_3 = +0.011$ $\mu_4 = +2.178$

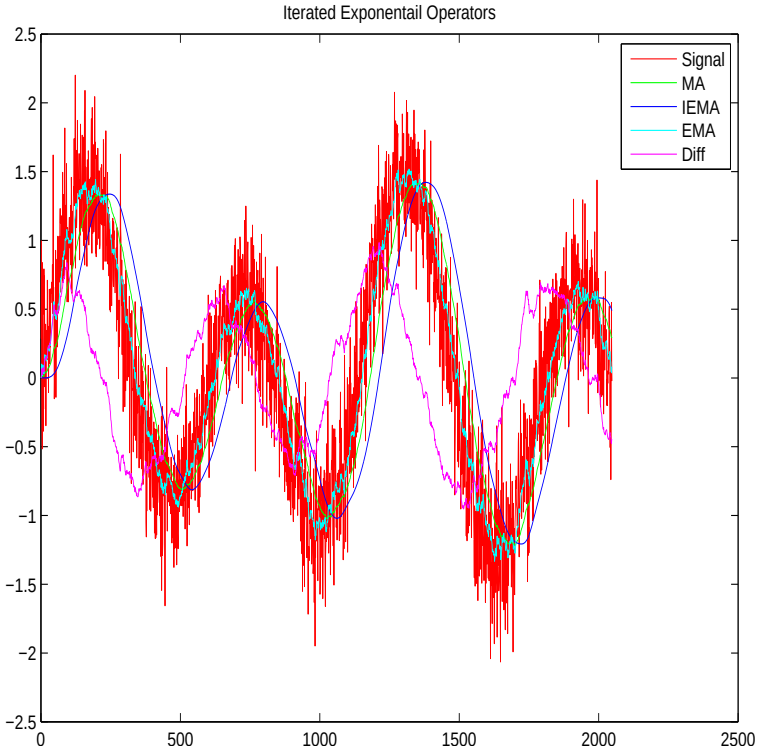



Iterated Exponential Moving Average
1.5
1
0.5
0
−0.5
−1
−1.5
0
500
1000
1500
2000
2500


Exponential Moving Average
2
1.5
1
0.5
0
−0.5
−1
−1.5
0
500
1000
1500
2000
2500


Diff operator
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
0
500
1000
1500
2000
2500


Iterated Exponentail Operators
Signal
MA
IEMA
EMA
Diff
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
0
500
1000
1500
2000
2500

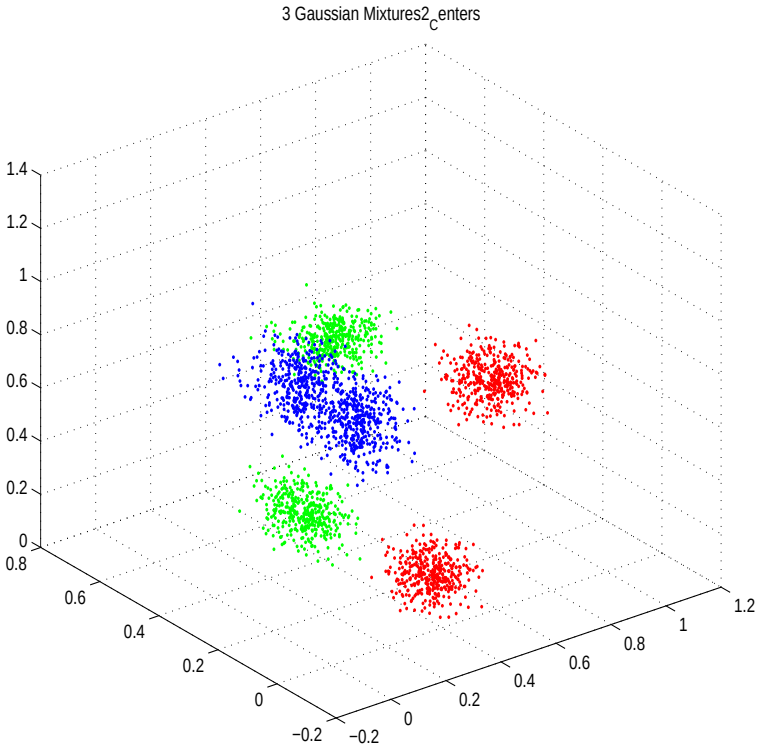


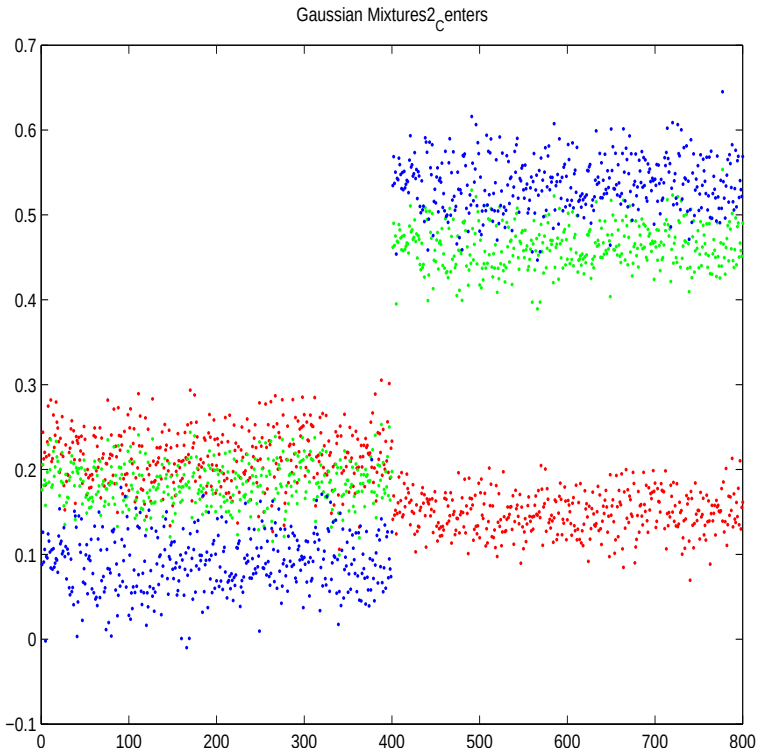
QueryPerformanceCounter = +8.134

0.0.18 Testing binary writer

Binary writer Speedup 1GB Double Matrix +63.144
Binary reader Speedup 1GB Double Matrix +195.705
Binary writer Speedup 1GB Double vector +10.109
Binary reader Speedup 1GB Double Matrix +201.560
QueryPerformanceCounter = +1.026

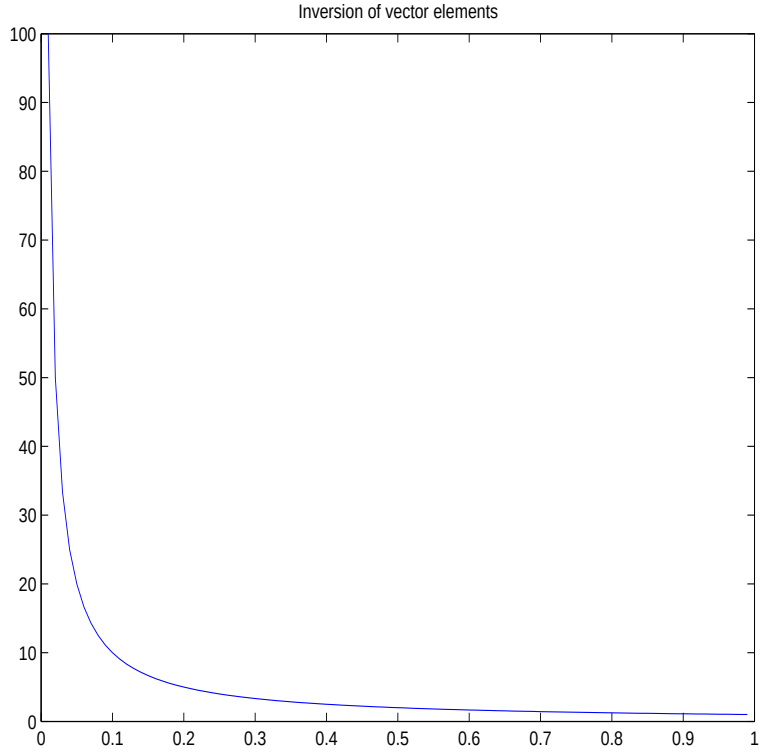
0.0.19 Testing Gaussian Mixture Point Cloud and Latex Plotting Capabilities.

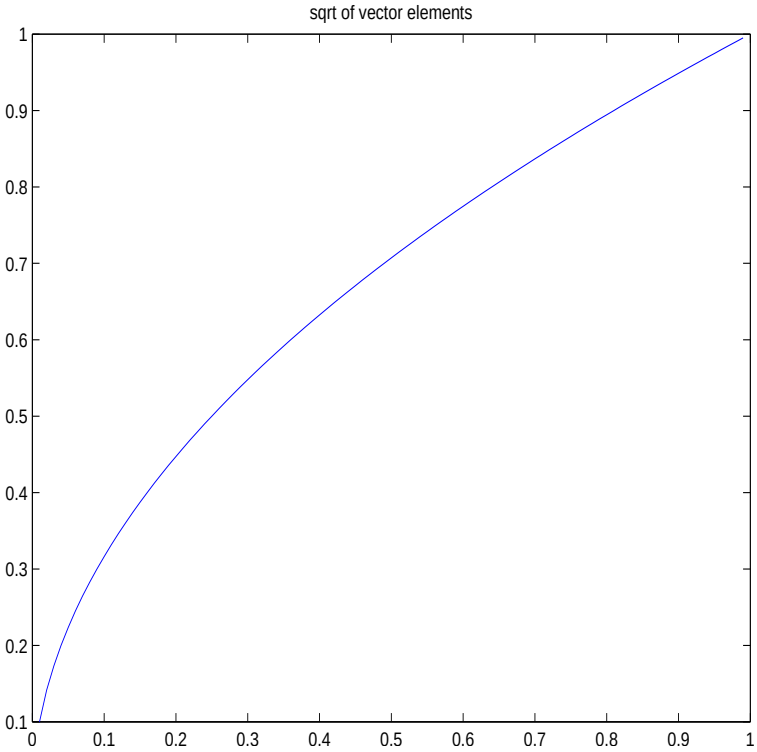


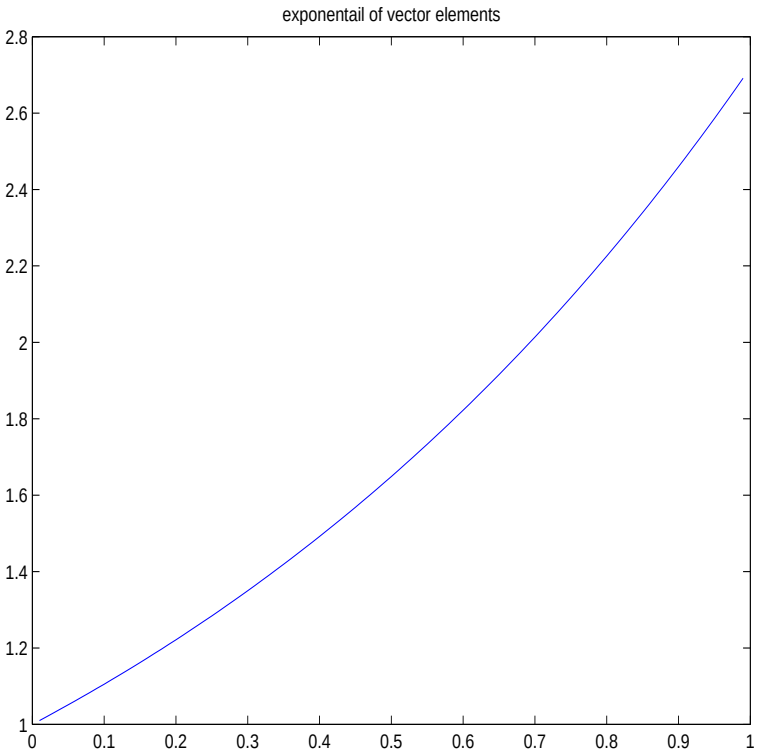


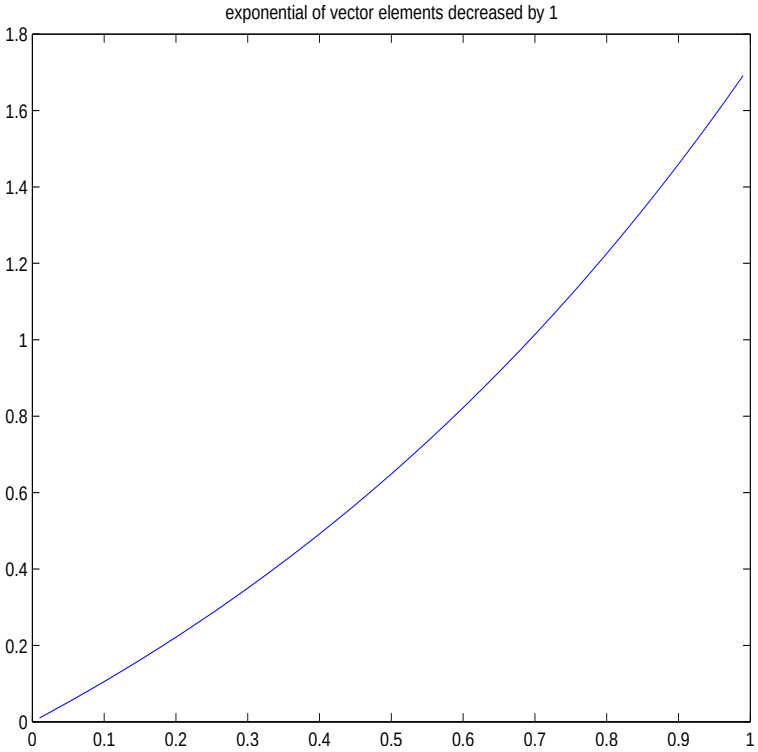
QueryPerformanceCounter = +2.906

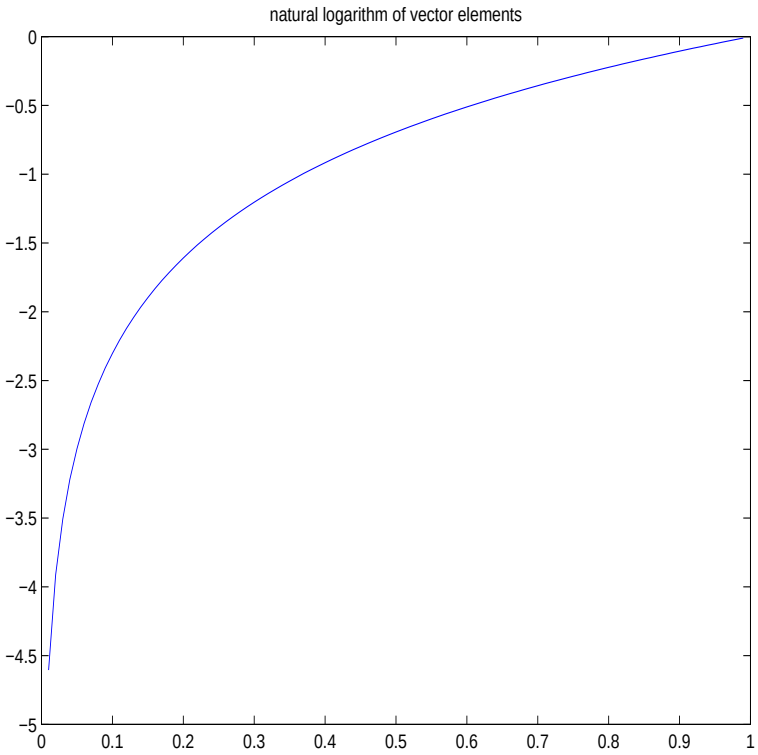
0.0.20 Intel VSL Function Check

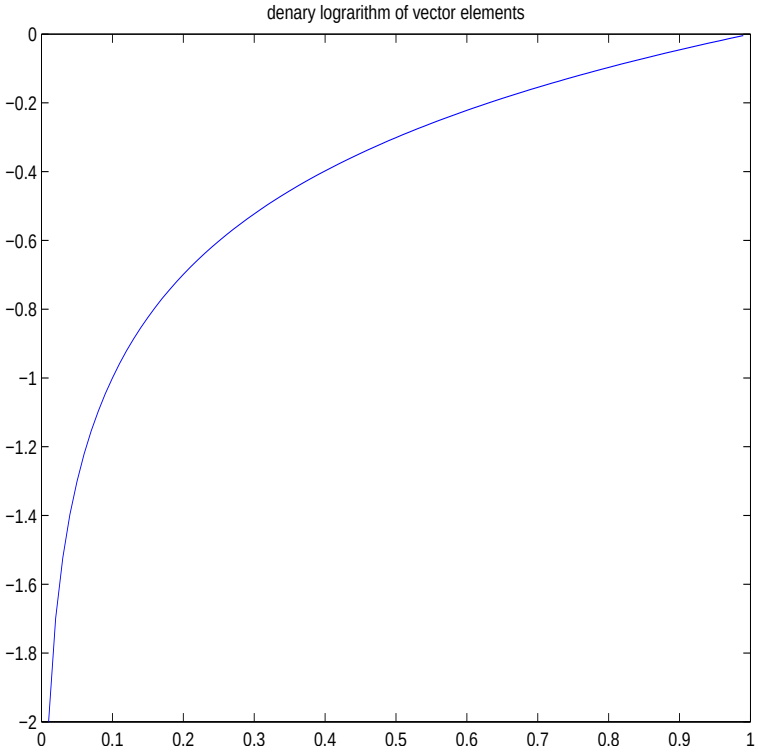


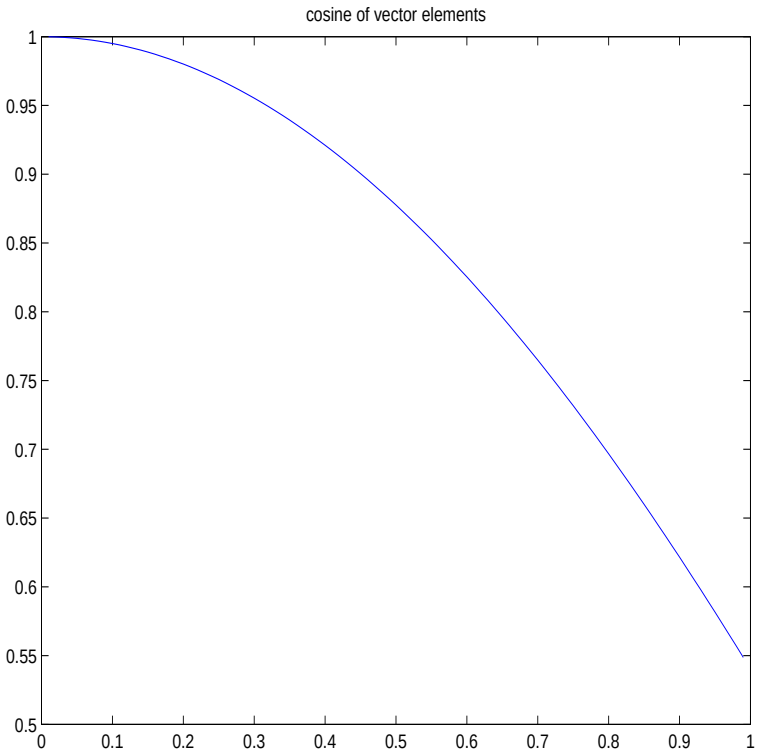

sqrt of vector elements
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

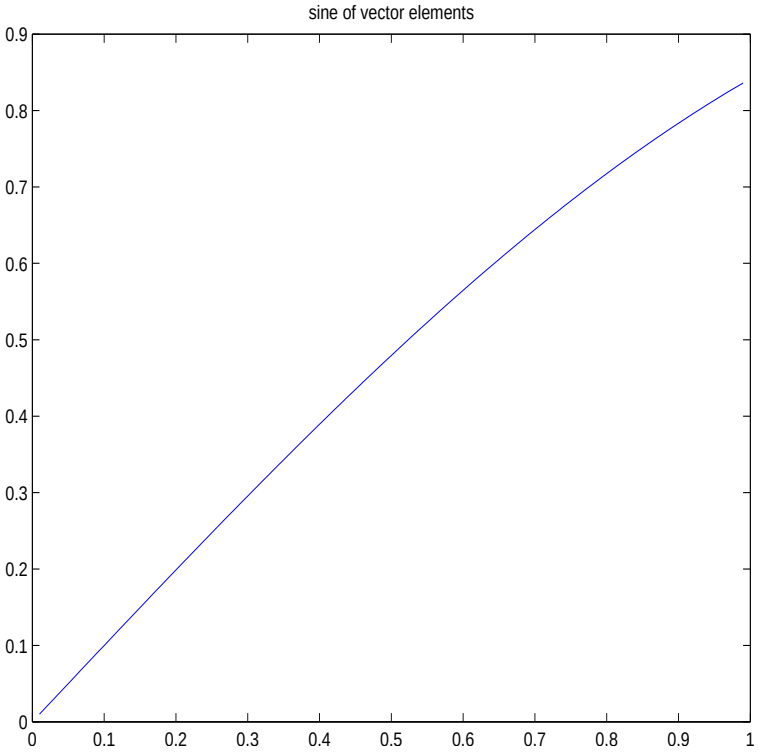

exponentail of vector elements
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

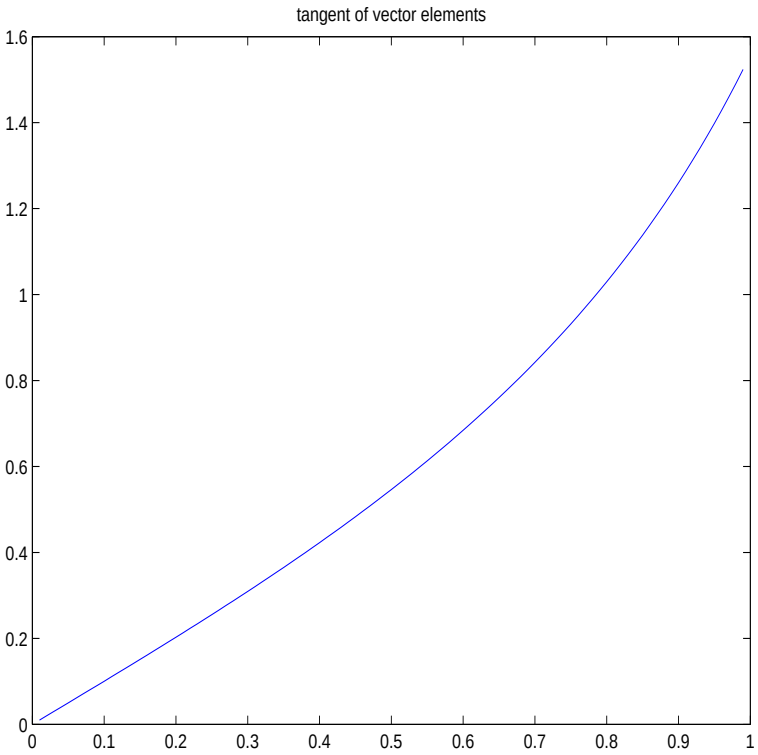

exponential of vector elements decreased by 1
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

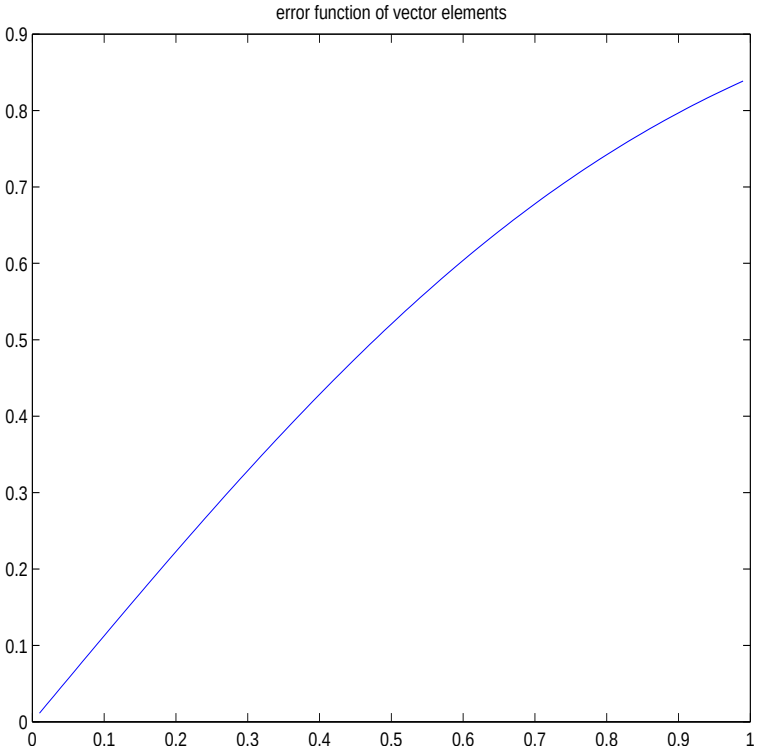

natural logarithm of vector elements
0
−0.5
−1
−1.5
−2
−2.5
−3
−3.5
−4
−4.5
−5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

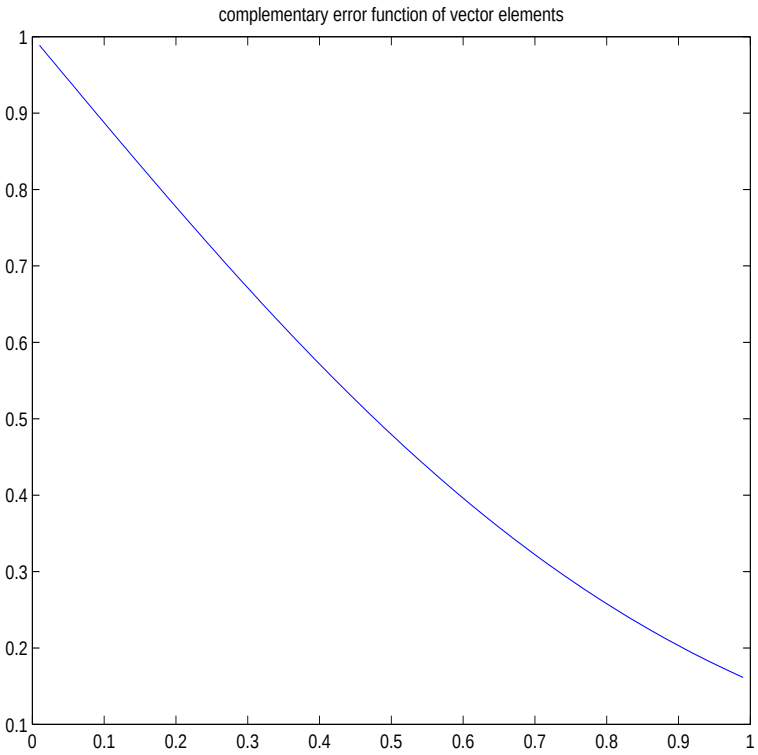

denary logarithm of vector elements
0
−0.2
−0.4
−0.6
−0.8
−1
−1.2
−1.4
−1.6
−1.8
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

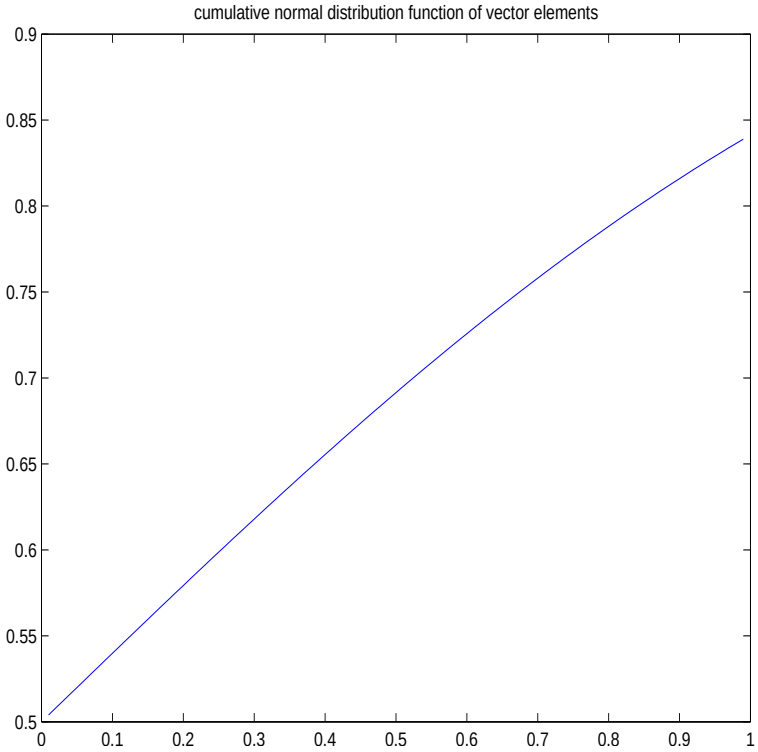

cosine of vector elements
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

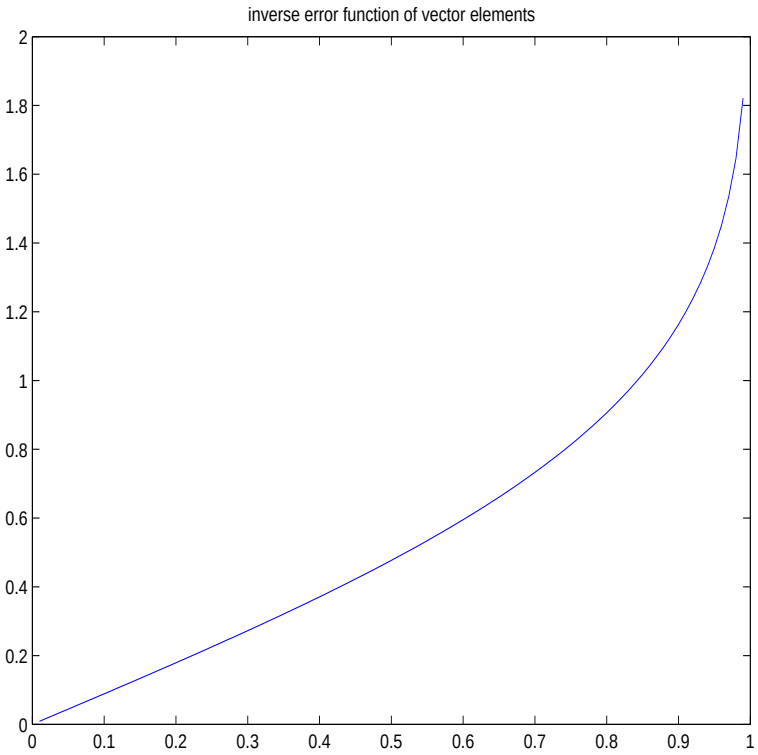

sine of vector elements
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

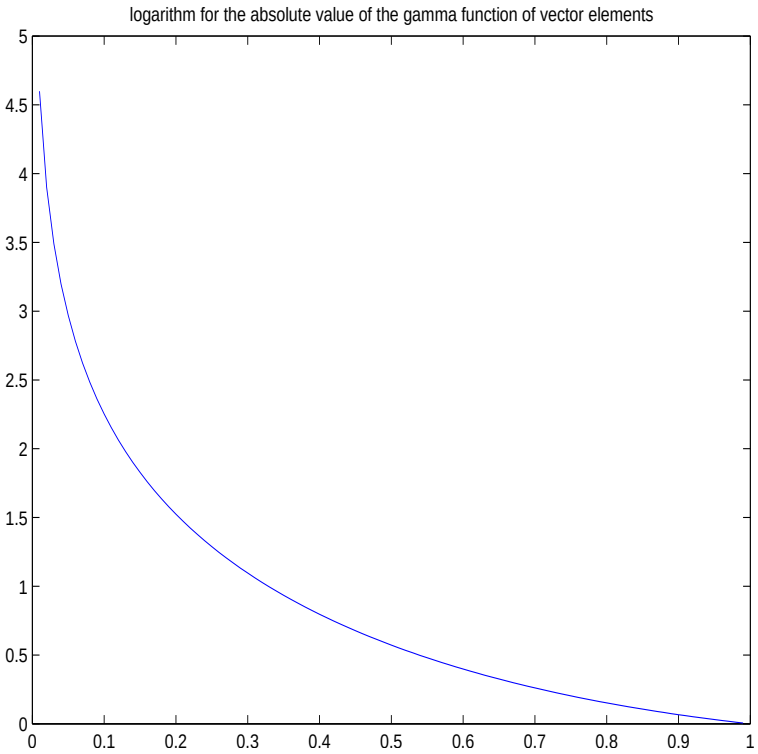

tangent of vector elements
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

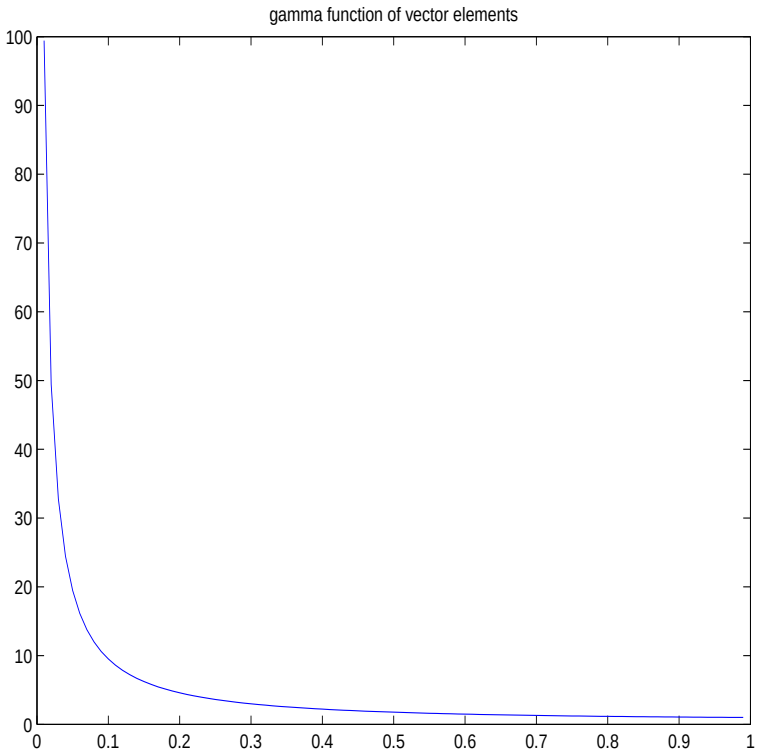

error function of vector elements
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


complementary error function of vector elements
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


cumulative normal distribution function of vector elements
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


inverse error function of vector elements
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1





QueryPerformanceCounter = +15.665

0.0.21 Gram Matrix Consistency Check

Sample Size = 4096 Feature dim = 3

$$Sigma = \begin{pmatrix} +1.140 & +1.535 & +0.581 \\ +1.535 & +9.988 & +1.605 \\ +0.581 & +1.605 & +0.428 \end{pmatrix}$$

$$SampleCovariance = \begin{pmatrix} +1.153 & +1.656 & +0.591 \\ +1.656 & +10.198 & +1.681 \\ +0.591 & +1.681 & +0.437 \end{pmatrix}$$

$$SampleMean = \begin{pmatrix} +1.02688 & +1.08012 & +1.01670 \end{pmatrix}$$

$$SampleCovariance-\text{Omega}=\begin{pmatrix} +0.013 & +0.121 & +0.010 \\ +0.121 & +0.209 & +0.076 \\ +0.010 & +0.076 & +0.009 \end{pmatrix}$$

$$SampleCovarianceEigs = \begin{pmatrix} (+10.79008, +0.00000) & (+0.95798, +0.00000) & (+0.03928, +0.00000) \end{pmatrix}$$

$$CenteredMean = \begin{pmatrix} +0.00000 & -0.00000 & +0.00000 \end{pmatrix}$$

$$CenteredCovariance = \begin{pmatrix} +1.153 & +1.656 & +0.591 \\ +1.656 & +10.198 & +1.681 \\ +0.591 & +1.681 & +0.437 \end{pmatrix}$$

$$GramMatrixGfNotscaledbysamplesize = \begin{pmatrix} +4723.612 & +6780.059 & +2420.098 \\ +6780.059 & +41769.171 & +6884.815 \\ +2420.098 & +6884.815 & +1788.187 \end{pmatrix}$$

$$GramMatrixGfscaledbysamplesize = \begin{pmatrix} +1.153 & +1.655 & +0.591 \\ +1.655 & +10.198 & +1.681 \\ +0.591 & +1.681 & +0.437 \end{pmatrix}$$

$$SampleCovariance - ScaledGf = \begin{pmatrix} +0.000 & +0.000 & +0.000 \\ +0.000 & +0.002 & +0.000 \\ +0.000 & +0.000 & +0.000 \end{pmatrix}$$

$$EigenDecompofSampleCovariance = \begin{pmatrix} -0.177 & -0.970 & -0.168 \\ +0.920 & -0.223 & +0.322 \\ -0.350 & -0.097 & +0.932 \end{pmatrix}$$

$$EigenDecompofGramMatrix = \begin{pmatrix} -0.131 & -0.972 & -0.194 \\ -0.362 & +0.229 & -0.903 \\ +0.923 & -0.048 & -0.382 \end{pmatrix}$$

QueryPerformanceCounter = +1.416

0.0.22 Eigen Solver Checks

0.0.23 Haar Distributed Random Orthogonal Matrix $A \in O(n)$

Testing Operator Norm Number of Dimensions: +8

$$A = \begin{pmatrix} -0.024 & +0.193 & -0.083 & -0.583 & +0.760 & -0.115 & -0.086 & +0.130 \\ +0.409 & -0.023 & -0.263 & -0.536 & -0.324 & -0.149 & +0.428 & -0.407 \\ +0.110 & -0.558 & -0.646 & +0.165 & +0.106 & -0.340 & -0.319 & +0.048 \\ +0.449 & +0.186 & +0.029 & +0.523 & +0.470 & -0.010 & +0.131 & -0.501 \\ +0.322 & +0.590 & -0.023 & +0.085 & -0.245 & -0.558 & -0.272 & +0.306 \\ +0.075 & +0.399 & -0.633 & +0.062 & -0.057 & +0.630 & -0.023 & +0.171 \\ -0.555 & +0.295 & -0.174 & -0.051 & -0.103 & -0.140 & -0.362 & -0.641 \\ -0.448 & +0.144 & -0.271 & +0.243 & +0.103 & -0.347 & +0.696 & +0.175 \end{pmatrix}$$

$Det(A) : A \in O(n)$ = (-1.000,-0.000)

$$L = \begin{pmatrix} +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ -0.581 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ -0.198 & -0.657 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ -0.736 & +0.255 & +0.472 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.044 & +0.237 & +0.060 & +0.893 & +1.000 & +0.000 & +0.000 & +0.000 \\ -0.135 & +0.576 & +0.768 & +0.182 & +0.223 & +1.000 & +0.000 & +0.000 \\ +0.806 & -0.123 & +0.190 & -0.376 & +0.064 & -0.029 & +1.000 & +0.000 \\ -0.810 & +0.558 & +0.056 & -0.650 & +0.359 & +0.331 & +0.349 & +1.000 \end{pmatrix}$$

$$U = \begin{pmatrix} -0.555 & +0.295 & -0.174 & -0.051 & -0.103 & -0.140 & -0.362 & -0.641 \\ +0.000 & +0.762 & -0.124 & +0.055 & -0.305 & -0.639 & -0.482 & -0.066 \\ +0.000 & +0.000 & -0.762 & +0.191 & -0.115 & -0.788 & -0.708 & -0.123 \\ +0.000 & +0.000 & +0.000 & -0.678 & -0.269 & +0.282 & +0.619 & -0.804 \\ +0.000 & +0.000 & +0.000 & +0.000 & +1.084 & -0.162 & -0.466 & +0.899 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.570 & +0.741 & +0.162 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.348 & +0.351 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & -1.997 \end{pmatrix}$$

$$L * U = \begin{pmatrix} -0.555 & +0.295 & -0.174 & -0.051 & -0.103 & -0.140 & -0.362 & -0.641 \\ +0.322 & +0.590 & -0.023 & +0.085 & -0.245 & -0.558 & -0.272 & +0.306 \\ +0.110 & -0.558 & -0.646 & +0.165 & +0.106 & -0.340 & -0.319 & +0.048 \\ +0.409 & -0.023 & -0.263 & -0.536 & -0.324 & -0.149 & +0.428 & -0.407 \\ -0.024 & +0.193 & -0.083 & -0.583 & +0.760 & -0.115 & -0.086 & +0.130 \\ +0.075 & +0.399 & -0.633 & +0.062 & -0.057 & +0.630 & -0.023 & +0.171 \\ -0.448 & +0.144 & -0.271 & +0.243 & +0.103 & -0.347 & +0.696 & +0.175 \\ +0.449 & +0.186 & +0.029 & +0.523 & +0.470 & -0.010 & +0.131 & -0.501 \end{pmatrix}$$

$Det(L) := (+1.000, +0.000) Det(U) := (+1.000, +0.000) Det(LU) := (+1.000, +0.000)$
$||A||_{L_1} = +2.393$
$||A||_{L_\infty} = +2.539$
$||A^{-1}||_{L_1} = +2.539$
$||A^{-1}||_{L_\infty} = +2.393$
$||A||_{L_\infty} * ||A^{-1}||_{L_\infty} = +6.075$
$||A||_{L_1} * ||A^{-1}||_{L_1} = +6.075$
Frobenious Norm $||A||_F$ via $\sum_{i,j=0}^{n} \|A_{i,j}|$ of $A \in O(n)$ $+2.828$
L_1 condition number of Haar Distributed Random Orthogonal Matrix $A \in O(n)$ $+6.075$

$$A = \begin{pmatrix} -0.024 & +0.193 & -0.083 & -0.583 & +0.760 & -0.115 & -0.086 & +0.130 \\ +0.409 & -0.023 & -0.263 & -0.536 & -0.324 & -0.149 & +0.428 & -0.407 \\ +0.110 & -0.558 & -0.646 & +0.165 & +0.106 & -0.340 & -0.319 & +0.048 \\ +0.449 & +0.186 & +0.029 & +0.523 & +0.470 & -0.010 & +0.131 & -0.501 \\ +0.322 & +0.590 & -0.023 & +0.085 & -0.245 & -0.558 & -0.272 & +0.306 \\ +0.075 & +0.399 & -0.633 & +0.062 & -0.057 & +0.630 & -0.023 & +0.171 \\ -0.555 & +0.295 & -0.174 & -0.051 & -0.103 & -0.140 & -0.362 & -0.641 \\ -0.448 & +0.144 & -0.271 & +0.243 & +0.103 & -0.347 & +0.696 & +0.175 \end{pmatrix}$$

L_∞ condition number of Haar Distributed Random Orthogonal Matrix $A \in O(n)$ $+6.068$
Eigenvalues of $A \in O(n)$
(+0.625,+0.780), (+0.625,-0.780), (+0.232,+0.973), (+0.232,-0.973), (-0.844,+0.537), (-0.844,-0.537), (-1.000,+0.000), (+1.000,+0.000)
$|\lambda| : \lambda \in \sigma(A), A \in O(n)$
+1.000, +1.000, +1.000, +1.000, +1.000, +1.000, +1.000, +1.000
Calculating $A^\dagger A$, we expect $A^\dagger A \approx I$

$$A^\dagger A = \begin{pmatrix} +1.000 & +0.000 & +0.000 & +0.000 & -0.000 & +0.000 & +0.000 & -0.000 \\ +0.000 & +1.000 & +0.000 & -0.000 & -0.000 & -0.000 & -0.000 & -0.000 \\ +0.000 & +0.000 & +1.000 & -0.000 & -0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & -0.000 & -0.000 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ -0.000 & -0.000 & -0.000 & +0.000 & +1.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & -0.000 & +0.000 & +0.000 & +0.000 & +1.000 & +0.000 & -0.000 \\ +0.000 & -0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & +0.000 \\ -0.000 & -0.000 & +0.000 & +0.000 & +0.000 & -0.000 & +0.000 & +1.000 \end{pmatrix}$$

Calculating $A^{-1}, A \in O(n)$.

$$A^{-1} = \begin{pmatrix} -0.024 & +0.409 & +0.110 & +0.449 & +0.322 & +0.075 & -0.555 & -0.448 \\ +0.193 & -0.023 & -0.558 & +0.186 & +0.590 & +0.399 & +0.295 & +0.144 \\ -0.083 & -0.263 & -0.646 & +0.029 & -0.023 & -0.633 & -0.174 & -0.271 \\ -0.583 & -0.536 & +0.165 & +0.523 & +0.085 & +0.062 & -0.051 & +0.243 \\ +0.760 & -0.324 & +0.106 & +0.470 & -0.245 & -0.057 & -0.103 & +0.103 \\ -0.115 & -0.149 & -0.340 & -0.010 & -0.558 & +0.630 & -0.140 & -0.347 \\ -0.086 & +0.428 & -0.319 & +0.131 & -0.272 & -0.023 & -0.362 & +0.696 \\ +0.130 & -0.407 & +0.048 & -0.501 & +0.306 & +0.171 & -0.641 & +0.175 \end{pmatrix}$$

Calculating $A^{-1} * A, A \in O(n)$. We expect $A^{-1} * A \approx I$.

$$A^{-1} * A = \begin{pmatrix} +1.000 & -0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ -0.000 & +1.000 & +0.000 & +0.000 & -0.000 & +0.000 & -0.000 & +0.000 \\ +0.000 & +0.000 & +1.000 & +0.000 & -0.000 & +0.000 & -0.000 & +0.000 \\ -0.000 & +0.000 & -0.000 & +1.000 & -0.000 & +0.000 & +0.000 & -0.000 \\ -0.000 & +0.000 & -0.000 & +0.000 & +1.000 & -0.000 & -0.000 & +0.000 \\ +0.000 & -0.000 & -0.000 & +0.000 & -0.000 & +1.000 & +0.000 & +0.000 \\ +0.000 & -0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & +0.000 \\ +0.000 & +0.000 & -0.000 & -0.000 & -0.000 & -0.000 & -0.000 & +1.000 \end{pmatrix}$$

Calculating SVD of $A \in O(n)$

$$U = \begin{pmatrix} -0.927 & +0.013 & +0.210 & +0.104 & +0.028 & +0.076 & -0.236 & +0.154 \\ +0.022 & -0.641 & +0.013 & -0.382 & -0.260 & -0.224 & -0.012 & +0.569 \\ -0.106 & +0.290 & -0.615 & -0.366 & -0.453 & -0.015 & -0.414 & -0.123 \\ +0.014 & +0.499 & +0.074 & +0.207 & -0.121 & -0.742 & +0.107 & +0.354 \\ -0.024 & +0.193 & -0.083 & -0.583 & +0.760 & -0.115 & -0.086 & +0.130 \\ -0.139 & +0.228 & -0.376 & +0.005 & -0.037 & +0.422 & +0.645 & +0.437 \\ +0.330 & +0.244 & +0.187 & +0.182 & +0.017 & +0.417 & -0.545 & +0.541 \\ -0.020 & -0.326 & -0.624 & +0.541 & +0.363 & -0.167 & -0.199 & +0.108 \end{pmatrix}$$

$$S = \begin{pmatrix} +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +1.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +1.000 \end{pmatrix}$$

$$V = \begin{pmatrix} +0.000 & +0.000 & +0.000 & -0.000 & +1.000 & +0.000 & +0.000 & -0.000 \\ -0.674 & +0.107 & +0.330 & -0.084 & +0.000 & +0.082 & -0.539 & -0.349 \\ -0.168 & +0.369 & +0.247 & -0.068 & +0.000 & -0.232 & -0.131 & +0.836 \\ -0.449 & -0.716 & -0.409 & -0.003 & +0.000 & -0.185 & -0.043 & +0.288 \\ -0.225 & -0.038 & +0.315 & +0.838 & +0.000 & -0.170 & +0.339 & -0.047 \\ -0.112 & -0.315 & +0.480 & -0.237 & +0.000 & +0.647 & +0.382 & +0.194 \\ +0.449 & -0.486 & +0.548 & -0.034 & +0.000 & -0.359 & -0.362 & -0.015 \\ +0.225 & -0.057 & -0.185 & +0.477 & +0.000 & +0.573 & -0.547 & +0.237 \end{pmatrix}$$

$$USV = \begin{pmatrix} -0.177 & +0.085 & -0.099 & +0.071 & -0.927 & +0.151 & +0.000 & +0.255 \\ +0.808 & +0.264 & -0.353 & +0.161 & +0.022 & +0.245 & -0.120 & +0.228 \\ -0.038 & +0.297 & -0.260 & -0.402 & -0.106 & +0.379 & -0.002 & -0.725 \\ -0.204 & +0.098 & -0.302 & +0.192 & +0.014 & -0.310 & -0.844 & -0.109 \\ -0.022 & +0.449 & +0.394 & +0.721 & -0.024 & +0.045 & +0.106 & -0.330 \\ +0.257 & -0.588 & +0.444 & +0.062 & -0.139 & +0.404 & -0.398 & -0.215 \\ -0.452 & +0.067 & -0.142 & +0.158 & +0.330 & +0.716 & -0.097 & +0.340 \\ -0.047 & -0.523 & -0.578 & +0.471 & -0.020 & -0.018 & +0.306 & -0.273 \end{pmatrix}$$

Calculating first few eigenvectors of $A \in O(n)$ using LAPACK syevx

0.0.24 Wishart Matrix $A \in W(n)$

L_1 condition number of Wishart Matrix +1489.694 L_infty condition number of Wishart Matrix +1489.694

0.0.25 Gaussian Orthogonal Ensemble $A \in GOE(n)$

L_1 condition number of GOE Matrix +66.900 L_∞ condition number of GOE Matrix +66.900

0.0.26 The Identity Matrix $I \in M(n)$

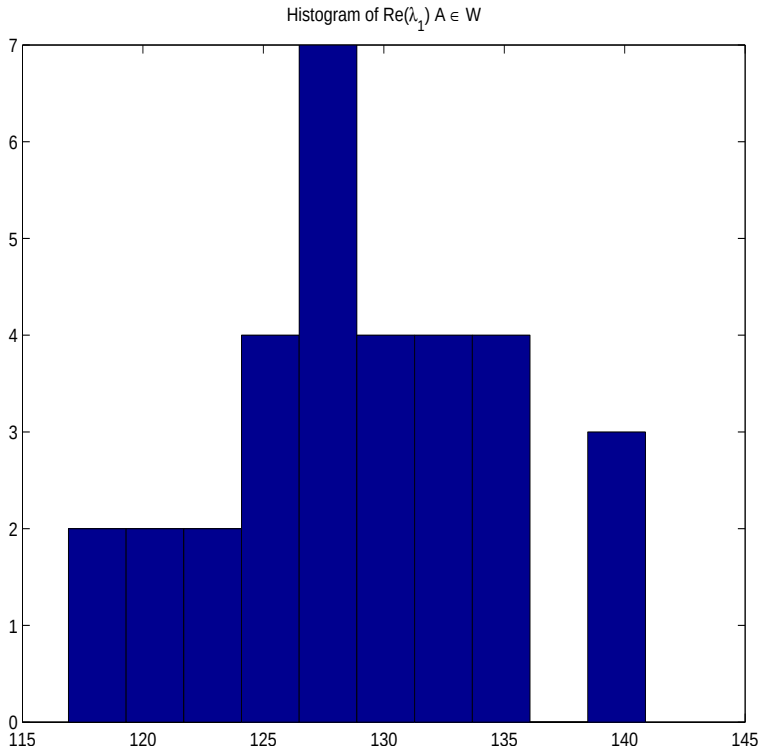
L_1 condition number of $I = +1.000$ L_∞ condition number of $I = +1.000$ QueryPerformanceCounter = +0.326

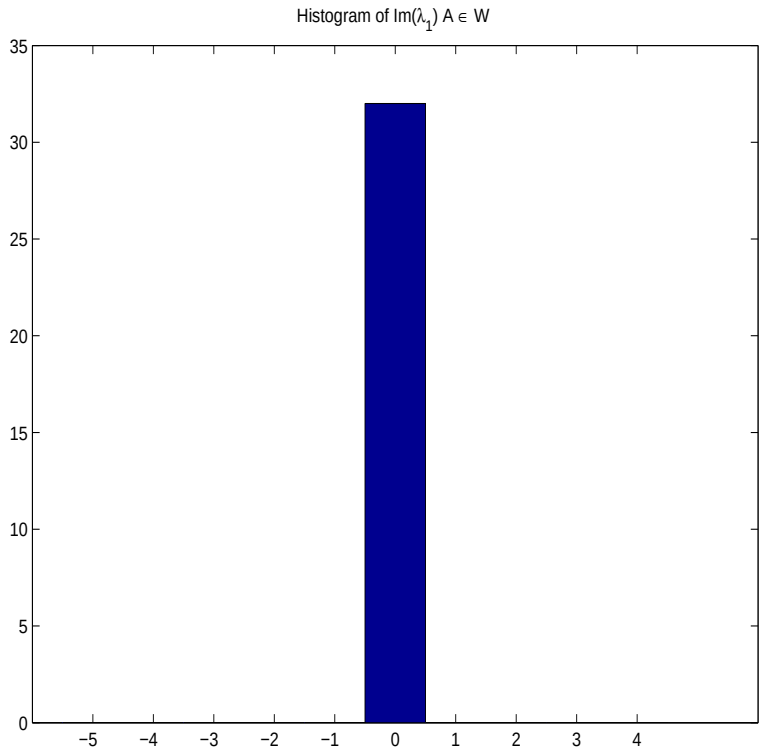
0.0.27 Generate Tracey Widom Sample

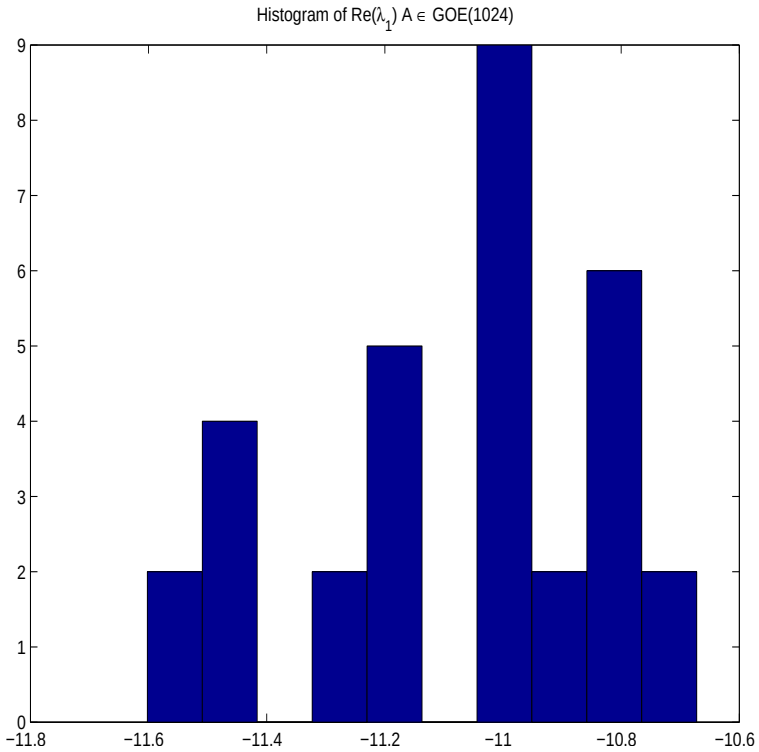
0.0.28 Sample from $W_n m$ times and calculate empirical PDF of the first eig

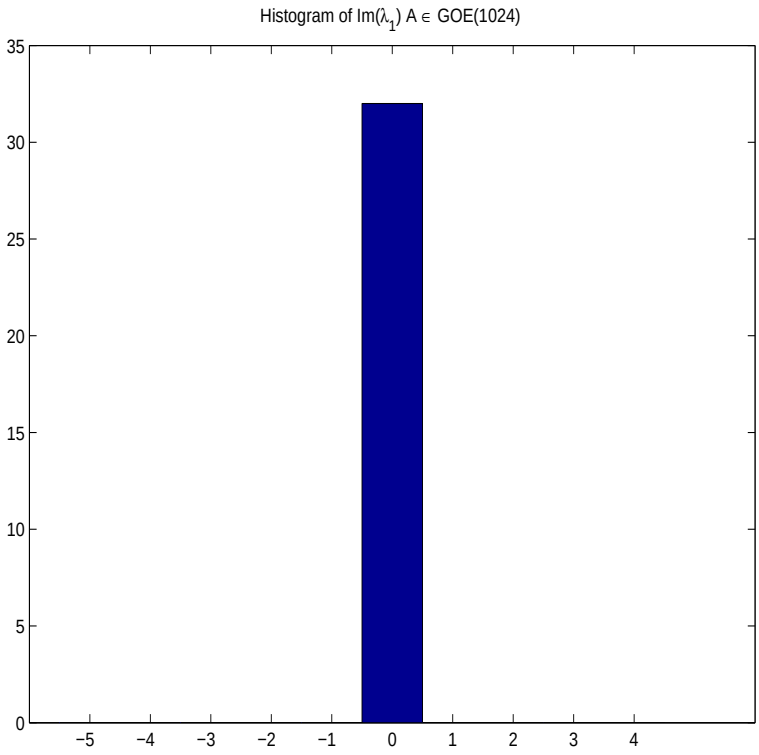
Here we generate histograms of λ_1 for GOE (Gaussian Orthogonal Ensemble), and W (Wishart) distributed of random matrices These should approximate the celebrated Tracy Widom distribution. Dimension $n = +128$

Sample size $m = 32$


Histogram of Re(λ1) A ∈ W
0
1
2
3
4
5
6
7
115
120
125
130
135
140
145


Histogram of Im(λ1) A ∈ W
0
5
10
15
20
25
30
35
−5
−4
−3
−2
−1
0
1
2
3
4





QueryPerformanceCounter = +5.590

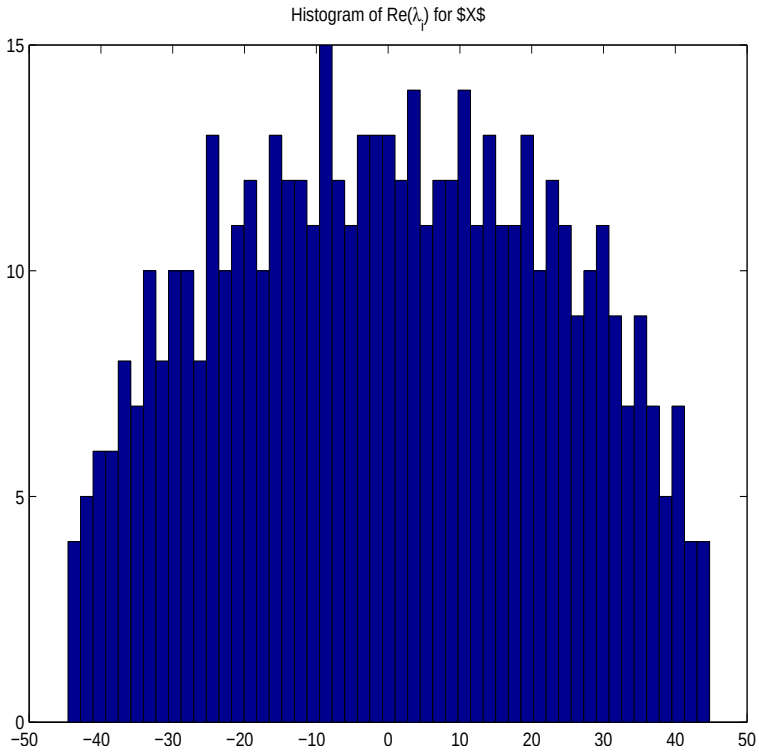
0.0.29 Approximate Winger Distribution

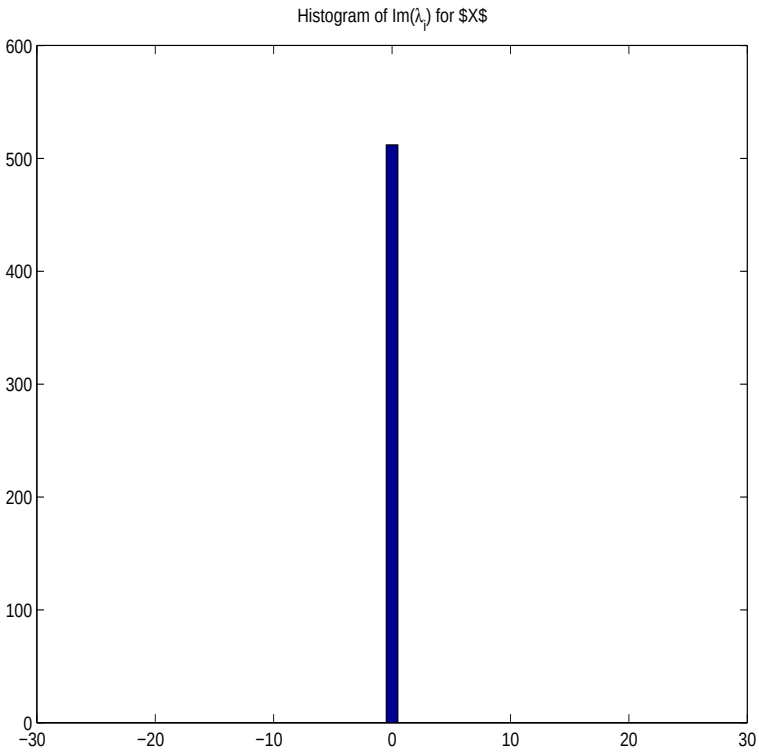
0.0.30 Verfy Winger Law.

Let $M_n = [X_{ij}]$ a symmetric n x n matrix with Random entries such that $X_{i,j} = X_{j,i}$, and $X_{i,j}$ are iid

orall i ¡ j,andXjj$areiid$

orall j : ; E[X_{ij}^2] = $1, E[X_{ij}] = 0$ and that all moments exists for each of the entries. The eigenvector of this random matrix; $lambda_1 leq ... leq lambda_n$ depends continuously on Mn. Dimension $n = +512$





QueryPerformanceCounter = +2.667

0.0.31 Matrix Exponential

$$SPDMatrix = \begin{pmatrix} +10.539 & -0.499 & -0.010 & +0.368 & +0.465 & -0.492 & -0.126 & +0.437 \\ -0.499 & +7.286 & +0.365 & -0.481 & -0.337 & -0.466 & +0.279 & +0.056 \\ -0.010 & +0.365 & +6.705 & -0.205 & +0.467 & +0.131 & +0.077 & -0.089 \\ +0.368 & -0.481 & -0.205 & +6.496 & -0.402 & -0.209 & +0.043 & -0.041 \\ +0.465 & -0.337 & +0.467 & -0.402 & +4.578 & +0.272 & +0.289 & -0.285 \\ -0.492 & -0.466 & +0.131 & -0.209 & +0.272 & +8.181 & +0.343 & -0.244 \\ -0.126 & +0.279 & +0.077 & +0.043 & +0.289 & +0.343 & +5.938 & -0.212 \\ +0.437 & +0.056 & -0.089 & -0.041 & -0.285 & -0.244 & -0.212 & +9.691 \end{pmatrix}$$

$$SPDEigs = \begin{pmatrix} (+10.93611, +0.00000) & (+9.60778, +0.00000) & (+4.23666, +0.00000) & (+8.36911, +0.00000) & (+7.56229, +0.00000) \end{pmatrix}$$

$$exp(SPD) = \begin{pmatrix} +47863.969 & -6460.093 & -1078.770 & +4706.958 & +2535.224 & -8475.398 & -2406.368 & +12977.552 \\ -6460.093 & +2780.574 & +516.920 & -1069.918 & -548.083 & -109.707 & +386.466 & -807.216 \\ -1078.770 & +516.920 & +1015.281 & -385.755 & +176.069 & +458.541 & +212.284 & -859.022 \\ +4706.958 & -1069.918 & -385.755 & +1267.210 & +111.181 & -1018.272 & -287.809 & +1036.628 \\ +2535.224 & -548.083 & +176.069 & +111.181 & +413.265 & +135.193 & +45.490 & -502.411 \\ -8475.398 & -109.707 & +458.541 & -1018.272 & +135.193 & +5613.026 & +968.003 & -4270.737 \\ -2406.368 & +386.466 & +212.284 & -287.809 & +45.490 & +968.003 & +632.432 & -1645.725 \\ +12977.552 & -807.216 & -859.022 & +1036.628 & -502.411 & -4270.737 & -1645.725 & +19362.944 \end{pmatrix}$$

$exp(SPD)eigs = \begin{pmatrix} (+56168.17045, +0.00000) & (+14880.07985, +0.00000) & (+4311.77579, +0.00000) & (+1924.25027, +0.00000) & (+6 \end{pmatrix}$

$log(exp(SPD)eigs) = \begin{pmatrix} (+10.93611, +0.00000) & (+9.60778, +0.00000) & (+8.36911, +0.00000) & (+7.56229, +0.00000) & (+4.23666, +0 \end{pmatrix}$

$$exp(Id) = \begin{pmatrix} +2.718 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +2.718 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +2.718 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +2.718 & +0.000 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +2.718 & +0.000 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +2.718 & +0.000 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +2.718 & +0.000 \\ +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +0.000 & +2.718 \end{pmatrix}$$

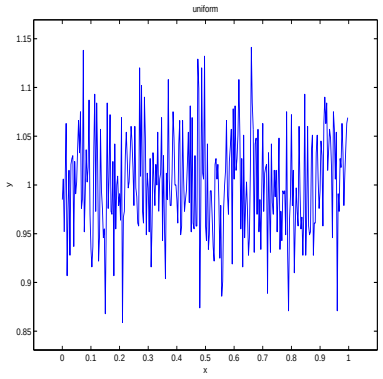
$exp(Id)eigs = \begin{pmatrix} (+2.71828, +0.00000) & (+2.71828, +0.00000) & (+2.71828, +0.00000) & (+2.71828, +0.00000) & (+2.71828, +0.00000) \end{pmatrix}$

$log(exp(Id)eigs) = \begin{pmatrix} (+1.00000, +0.00000) & (+1.00000, +0.00000) & (+1.00000, +0.00000) & (+1.00000, +0.00000) & (+1.00000, +0.000 \end{pmatrix}$

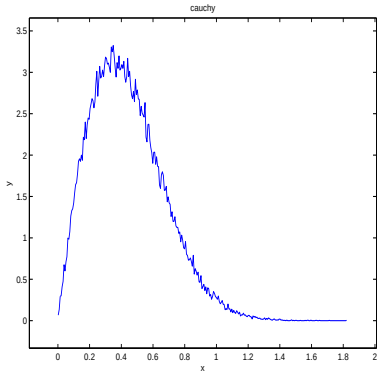
For $n \in \mathbb{Z}[16, 128)$ we calculate $|(SPD(n)Eigs - log(exp(SPD(n))eigs)|_{l^2}$
$|(SPD(n)Eigs - log(exp(SPD(n))eigs)|_{l^2} = \begin{pmatrix} (+5.36543, +0.00000) & (+5.36543, +0.00000) & (+5.36543, +0.00000) & (+5.36543, +0.0 \end{pmatrix}$

QueryPerformanceCounter = +0.00939 The sample size generated for this run is 100000.

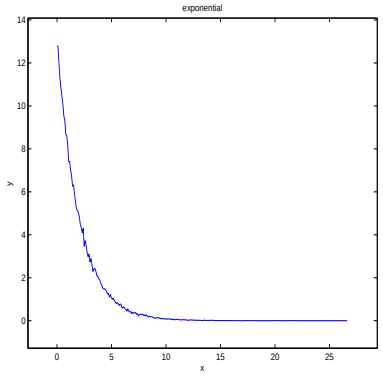
uniform	mean	variance	skewness	kurtosis
	$\mu_1 = +0.50030$	$\mu_2 = +0.08353$	$\mu_3 = +0.00339$	$\mu_4 = +1.80113$



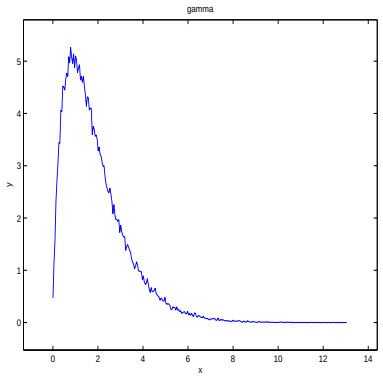
cauchy	mean	variance	skewness	kurtosis
	$\mu_1 = +0.44288$	$\mu_2 = +0.05341$	$\mu_3 = +0.63935$	$\mu_4 = +3.28094$



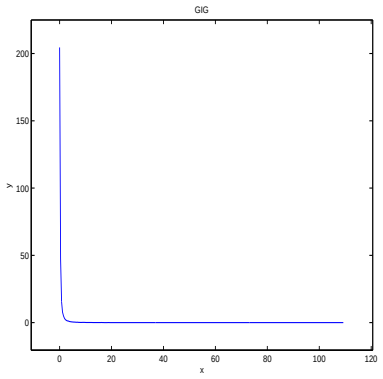
exponential	mean	variance	skewness	kurtosis
	$\mu_1 = +1.99647$	$\mu_2 = +3.99339$	$\mu_3 = +2.03097$	$\mu_4 = +9.30842$



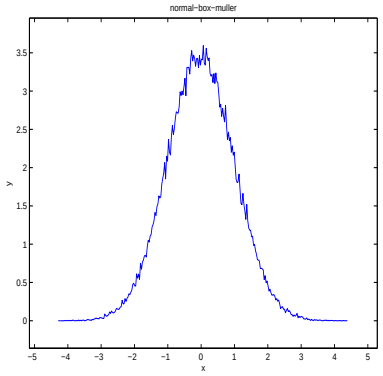
gamma	mean	variance	skewness	kurtosis
	$\mu_1 = +1.90056$	$\mu_2 = +1.91033$	$\mu_3 = +1.44173$	$\mu_4 = +6.04257$



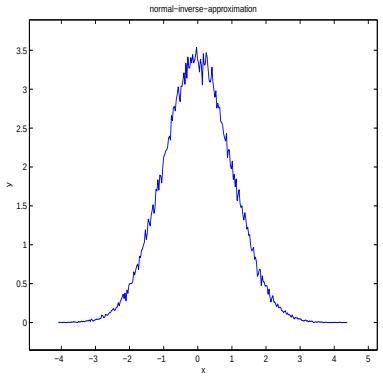
GIG	mean	variance	skewness	kurtosis
	$\mu_1 = +0.80447$	$\mu_2 = +11.40800$	$\mu_3 = +15.21529$	$\mu_4 = +307.90771$



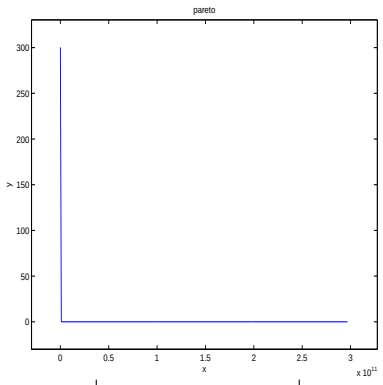
normal-box-muller	mean	variance	skewness	kurtosis
	$\mu_1 = +0.00383$	$\mu_2 = +1.00688$	$\mu_3 = +0.01937$	$\mu_4 = +2.99192$



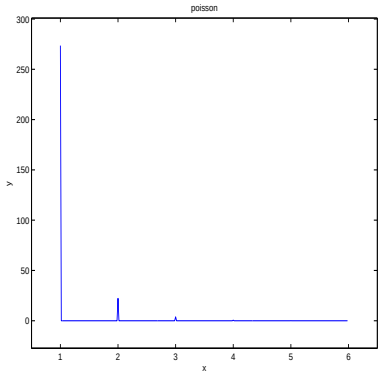
normal-inverse-approximation	mean	variance	skewness	kurtosis
	$\mu_1 = +0.00230$	$\mu_2 = +1.00486$	$\mu_3 = +0.01163$	$\mu_4 = +2.99254$



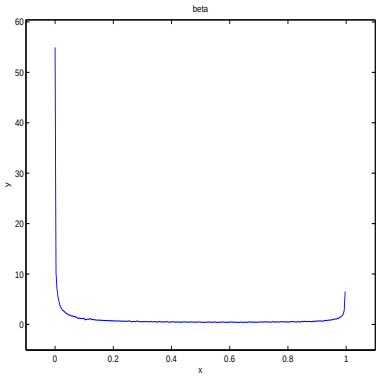
pareto	mean	variance	skewness	kurtosis
	$\mu_1 = +3184578.26493$	$\mu_2 = +8884682461741129 00.00000$	$\mu_3 = +315.36997$	$\mu_4 = +99629.09819$



poisson	mean	variance	skewness	kurtosis
	$\mu_1 = +1.10590$	$\mu_2 = +0.13329$	$\mu_3 = +3.97097$	$\mu_4 = +21.44867$



beta	mean	variance	skewness	kurtosis
	$\mu_1 = +0.33278$	$\mu_2 = +0.12665$	$\mu_3 = +0.68238$	$\mu_4 = +1.91359$



QueryPerformanceCounter = +10.64632

0.0.32 Multiclass Support Vector Machine

- Number or training points = 1024
- Feature dimension = 3
- Number or classes = 3

The mean vectors of the 3 classes

$\mu_1 = \begin{pmatrix} +1.90000 & +0.10000 & +0.10000 \end{pmatrix}$

$\mu_2 = \begin{pmatrix} +0.10000 & +1.90000 & +0.10000 \end{pmatrix}$

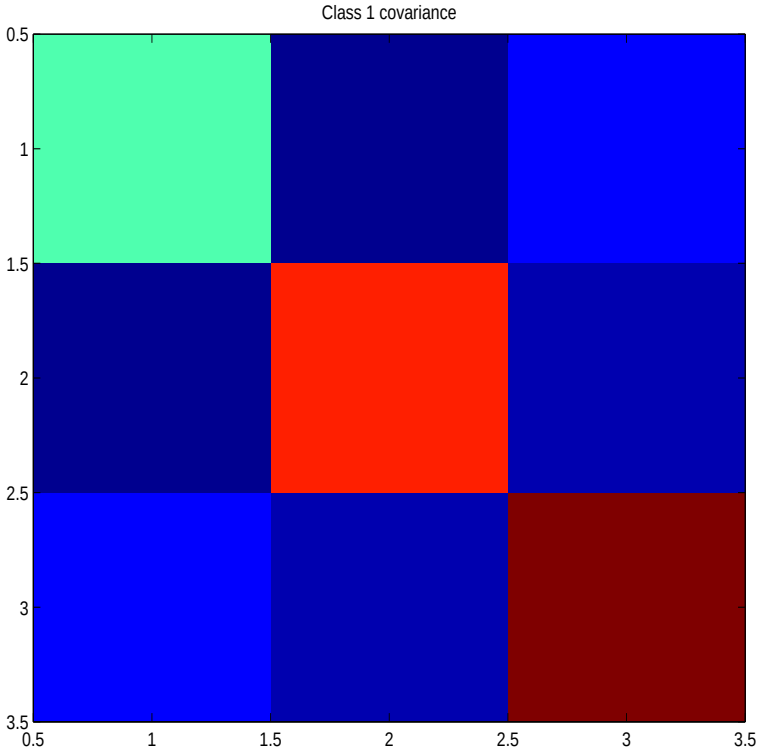
$\mu_3 = \begin{pmatrix} +0.00000 & +0.00000 & +1.90000 \end{pmatrix}$

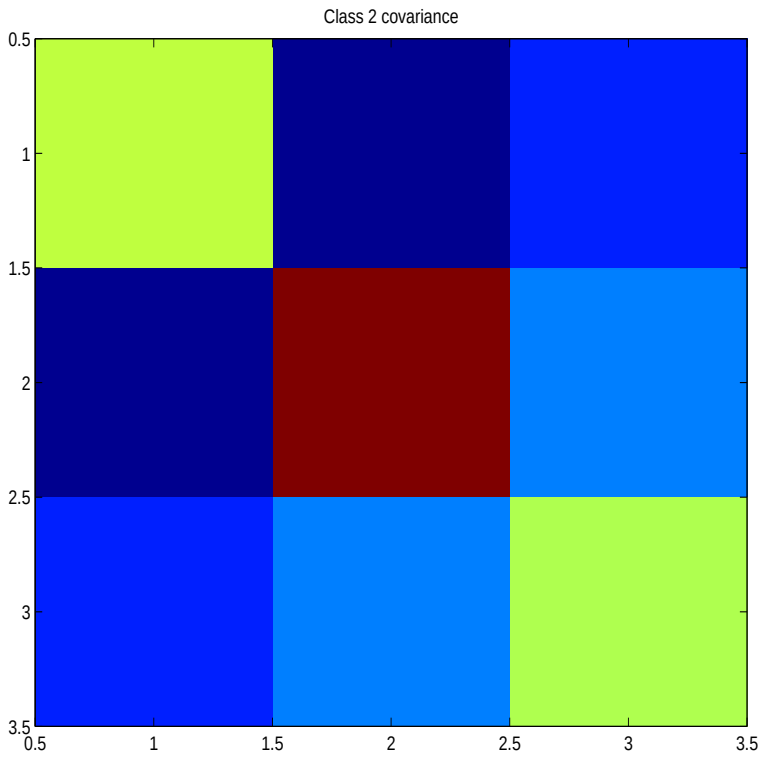
A random SPD covairance matrix is generated for each of the classes.

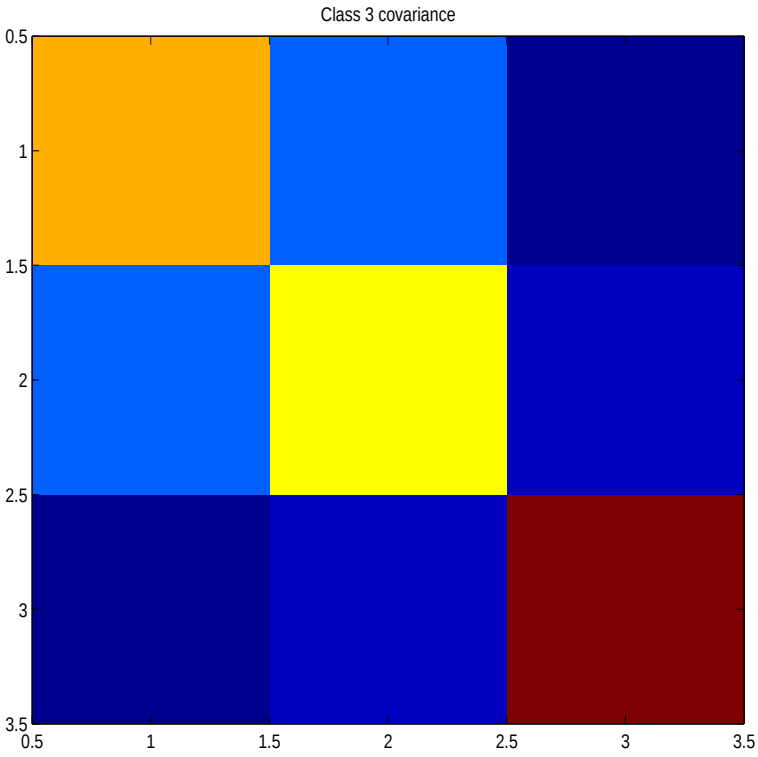
$$\rho_1 = \begin{pmatrix} +1.880 & -0.029 & +0.474 \\ -0.029 & +3.581 & +0.171 \\ +0.474 & +0.171 & +4.276 \end{pmatrix}$$
$$\rho_2 = \begin{pmatrix} +1.662 & -0.414 & +0.131 \\ -0.414 & +3.303 & +0.471 \\ +0.131 & +0.471 & +1.612 \end{pmatrix}$$
$$\rho_3 = \begin{pmatrix} +2.671 & +0.444 & -0.470 \\ +0.444 & +2.297 & -0.196 \\ -0.470 & -0.196 & +4.030 \end{pmatrix}$$

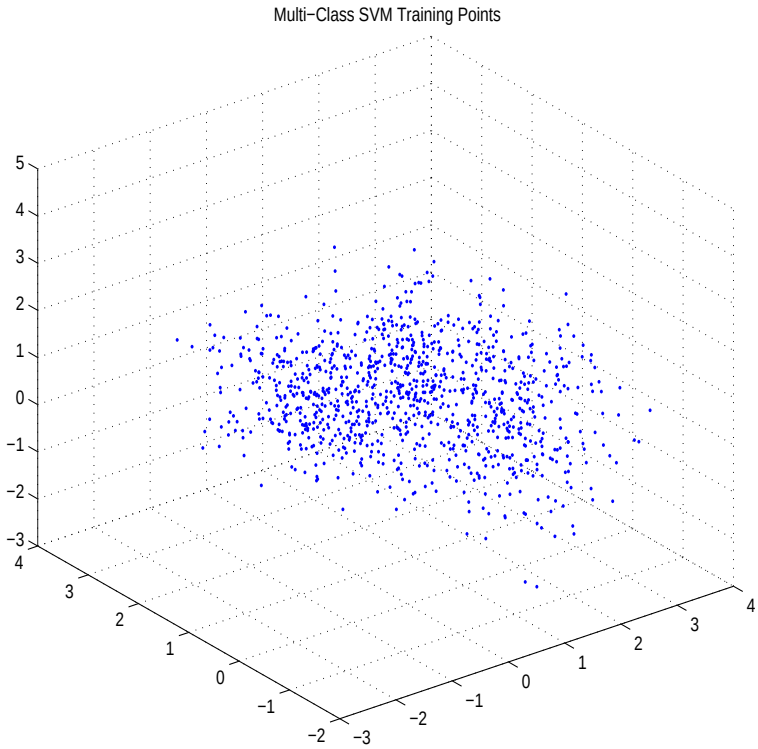
Verify L_1 condition number of covariance. The diagonal entries of the matrix have the form $(0.5 + U(0,1)) * dim(Dom(Cov))$ The lower-diagonal entries take the form $U(0,1) - 0.5$. The L_1 condition numbers are :

- +3.030
- +3.508
- +2.520


Class 1 covariance
0.5
1
1.5
2
2.5
3
3.5
0.5
1
1.5
2
2.5
3
3.5

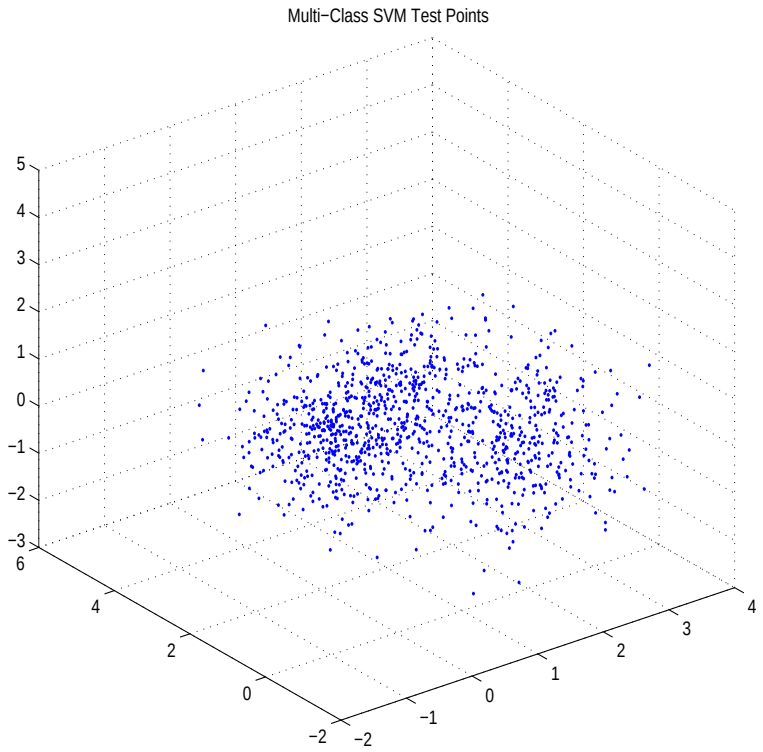

Class 2 covariance
0.5
1
1.5
2
2.5
3
3.5
0.5
1
1.5
2
2.5
3
3.5





These are the SVM parameters - the RBF kernel is used

- allOutlierFraction=0.05
- mixingCoeff=0.3
- smoThresh=1.0/10000.0
- sigma=1

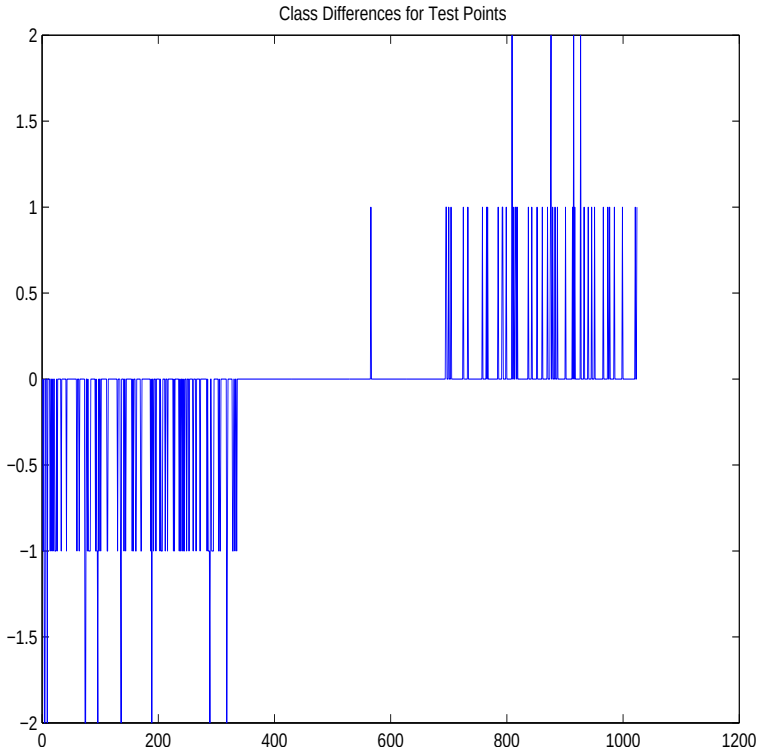


The marginal sample moments (mean var skew kurtosis) for training points.

Feature	μ_1	μ_2	μ_3	μ_4
0	+0.668	+1.181	+0.252	+2.193
1	+0.704	+1.299	+0.349	+2.401
2	+0.711	+1.384	+0.412	+2.687

The marginal sample moments (mean var skew kurtosis) for test points.

Feature	μ_1	μ_2	μ_3	μ_4
0	+0.675	+1.113	+0.365	+2.273
1	+0.666	+1.295	+0.415	+2.434
2	+0.726	+1.293	+0.442	+2.596



The error rate for this run is +0.123

QueryPerformanceCounter = +6.632

0.0.33 Semidefinite Programming SDPA

QueryPerformanceCounter = +0.006