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Computation time in total

Total	3.336682403087616min.
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Tolerance of physicality constraint violation

Tolerance at estimation	1.000000e-13
Tolerance at physicality violation test	1.000000e-09

Experimental condition

Type of tomography	StandardQst
Nrep	100
N	[100, 1000]
RNG seed	777

True object

Type	State
Dim	2
Vec	[0.70710678 0.40824829 0.40824829 0.40824829]

Tester objects

0	Type	Povm
	Dim	2
	Number of outcomes	2
	Vecs	[[0.70710678 0.70710678 0. 0.] [0.70710678 -0.70710678 0. 0.]]
1	Type	Povm
	Dim	2
	Number of outcomes	2
	Vecs	[[0.70710678 0. 0.70710678 0.] [0.70710678 0. -0.70710678 0.]]
2	Type	Povm
	Dim	2
	Number of outcomes	2
	Vecs	[[0.70710678 0. 0. 0.70710678] [0.70710678 0. 0. -0.70710678]]

Cases

	Name	Param	Tomography	Estimator
0	Linear(True)	True	StandardQst	Linear
1	Linear(False)	False	StandardQst	Linear
2	ProjectedLinear(True)	True	StandardQst	ProjectedLinear
3	ProjectedLinear(False)	False	StandardQst	ProjectedLinear
4	Maximum-Likelihood(True)	True	StandardQst	LossMinimization
5	Maximum-Likelihood(False)	False	StandardQst	LossMinimization

6	Least Squares(True)	True	StandardQst	LossMinimization
7	Least Squares(False)	False	StandardQst	LossMinimization

Computation time of estimators

Table

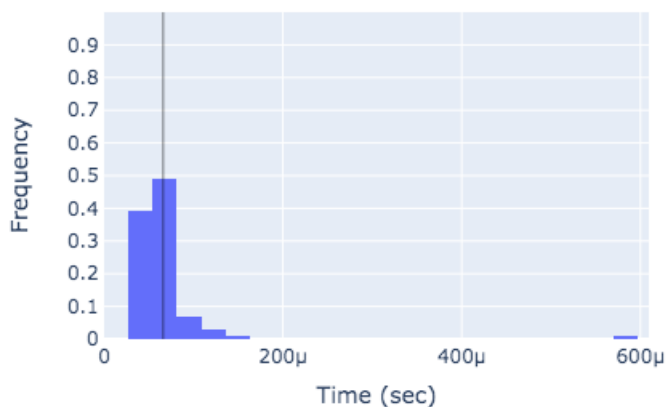
	Name	N	Nrep	Mean (sec)	Std (sec)
0	Linear(True)	100	100	0.000066	0.000056
1	"	1000	100	0.000049	0.000019
2	Linear(False)	100	100	0.000103	0.000237
3	"	1000	100	0.000098	0.000221
4	ProjectedLinear(True)	100	100	0.019767	0.016695
5	"	1000	100	0.016442	0.015623
6	ProjectedLinear(False)	100	100	0.015553	0.018656
7	"	1000	100	0.012452	0.011584
8	Maximum-Likelihood(True)	100	100	0.465067	0.258655
9	"	1000	100	0.337733	0.202310
10	Maximum-Likelihood(False)	100	100	0.497232	0.342469
11	"	1000	100	0.348089	0.295704
12	Least Squares(True)	100	100	0.070885	0.018703
13	"	1000	100	0.065919	0.015838
14	Least Squares(False)	100	100	0.080027	0.014503
15	"	1000	100	0.072527	0.013070

Histogram

Case 0: Linear(True)

N=100, Nrep=100

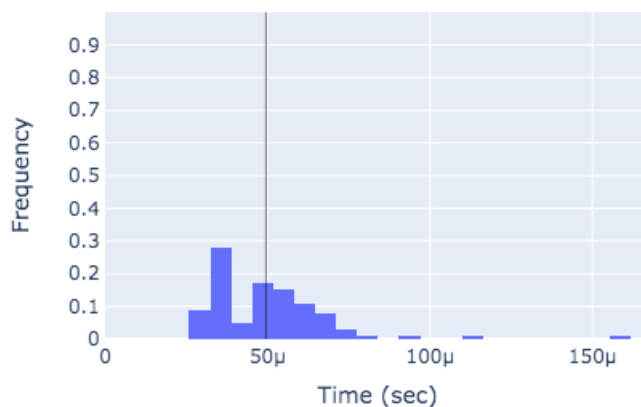
Mean = 6.60538673400879e-05(sec)



Min: 3.910064697265625e-05
Max: 0.0005822181701660156
|Max-Min|: 0.0005431175231933594

N=1000, Nrep=100

Mean = 4.949331283569336e-05(sec)

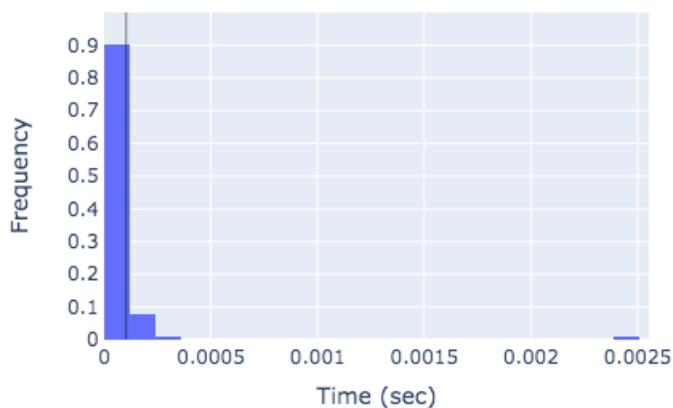


Min: 3.1948089599609375e-05
Max: 0.00016117095947265625
|Max-Min|: 0.00012922286987304688

Case 1: Linear(False)

N=100, Nrep=100

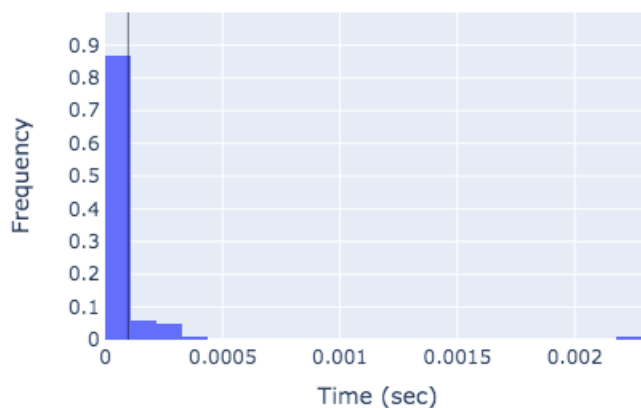
Mean = 0.0001032114028930664(sec)



Min: 4.220008850097656e-05
Max: 0.0024330615997314453
|Max-Min|: 0.0023908615112304688

N=1000, Nrep=100

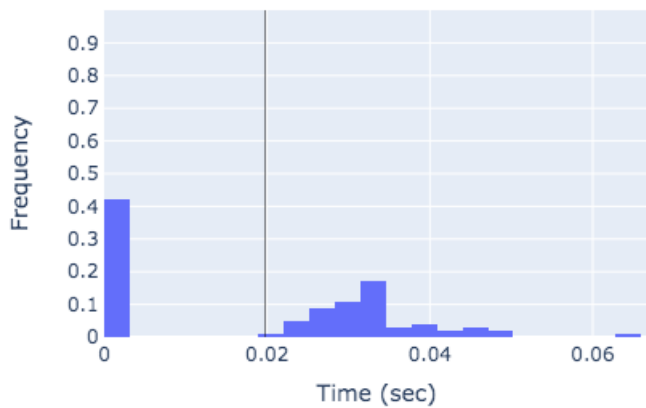
Mean = 9.801387786865235e-05(sec)



Min: 3.409385681152344e-05
Max: 0.0022110939025878906
|Max-Min|: 0.002177000045776367

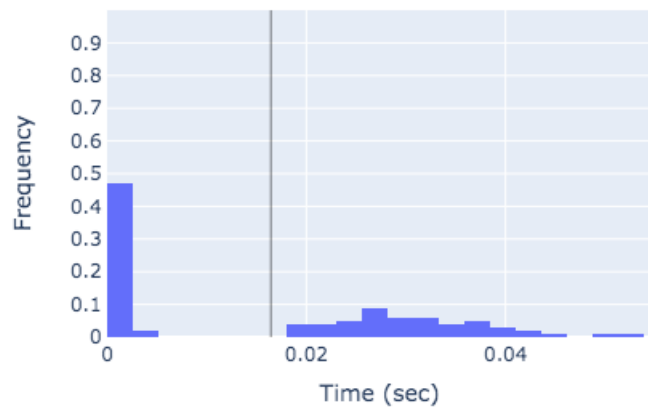
Case 2: ProjectedLinear(True)

N=100, Nrep=100
Mean = 0.01976701259613037(sec)



Min: 0.0009191036224365234
Max: 0.06374716758728027
|Max-Min|: 0.06282806396484375

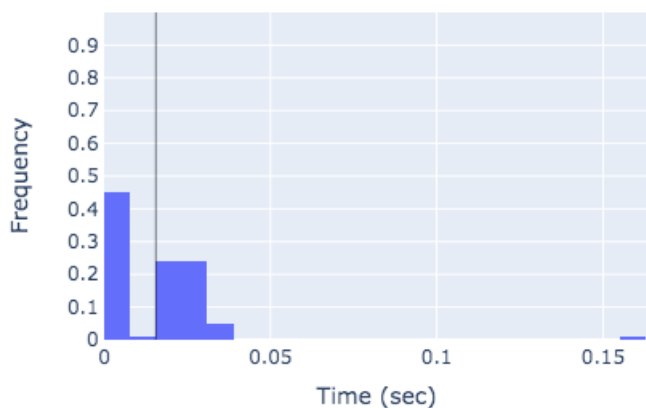
N=1000, Nrep=100
Mean = 0.01644192695617676(sec)



Min: 0.0008561611175537109
Max: 0.05212998390197754
|Max-Min|: 0.05127382278442383

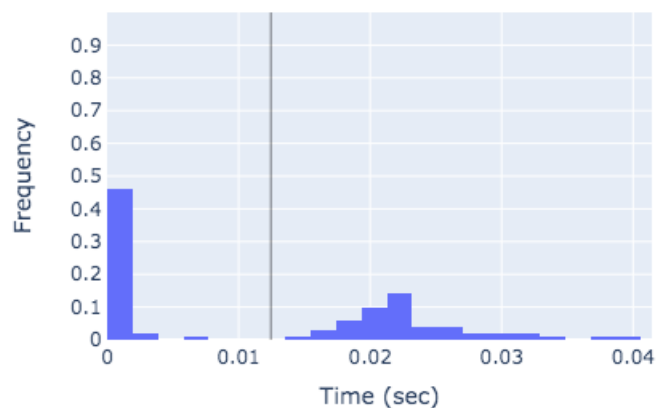
Case 3: ProjectedLinear(False)

N=100, Nrep=100
Mean = 0.015552644729614257(sec)



Min: 0.0008649826049804688
Max: 0.15601420402526855
|Max-Min|: 0.15514922142028809

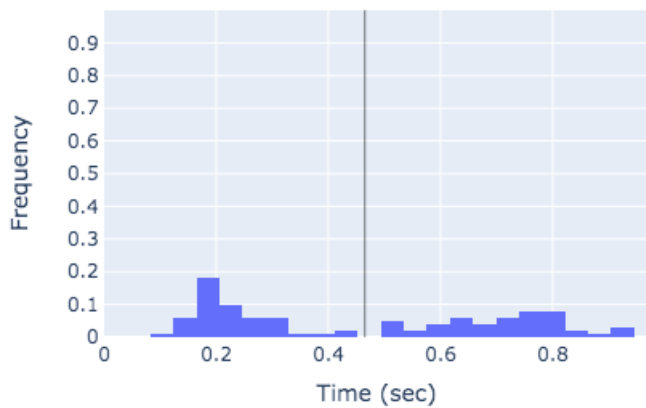
N=1000, Nrep=100
Mean = 0.012451989650726318(sec)



Min: 0.000823974609375
Max: 0.03949308395385742
|Max-Min|: 0.03866910934448242

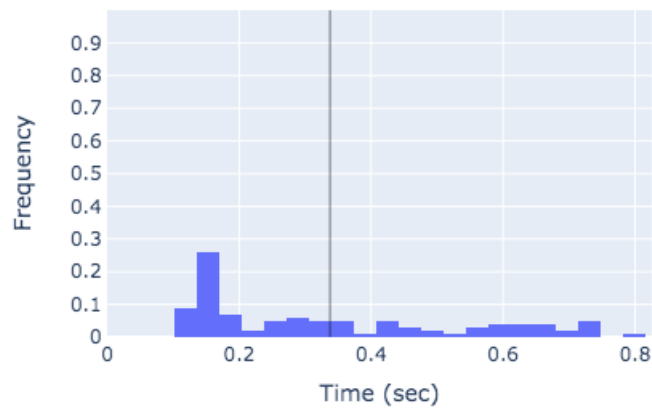
Case 4: Maximum-Likelihood(True)

N=100, Nrep=100
Mean = 0.4650668501853943(sec)



Min: 0.10847234725952148
Max: 0.9304728507995605
|Max-Min|: 0.8220005035400391

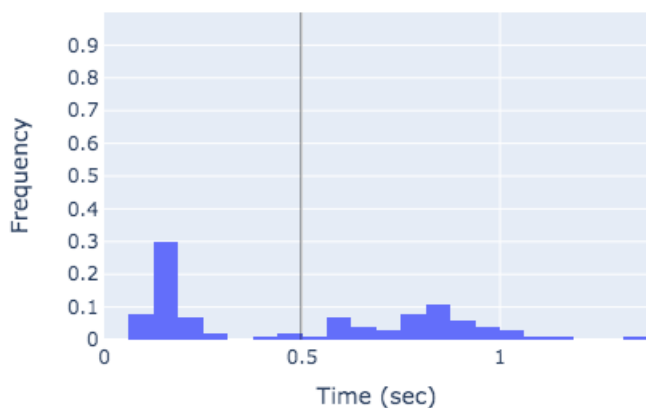
N=1000, Nrep=100
Mean = 0.33773327350616456(sec)



Min: 0.11212491989135742
Max: 0.7915611267089844
|Max-Min|: 0.679436206817627

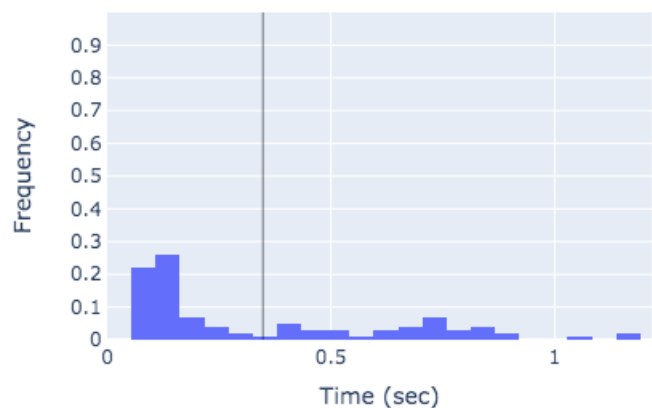
Case 5: Maximum-Likelihood(False)

N=100, Nrep=100
Mean = 0.4972324228286743(sec)



Min: 0.06391525268554688
Max: 1.3136179447174072
|Max-Min|: 1.2497026920318604

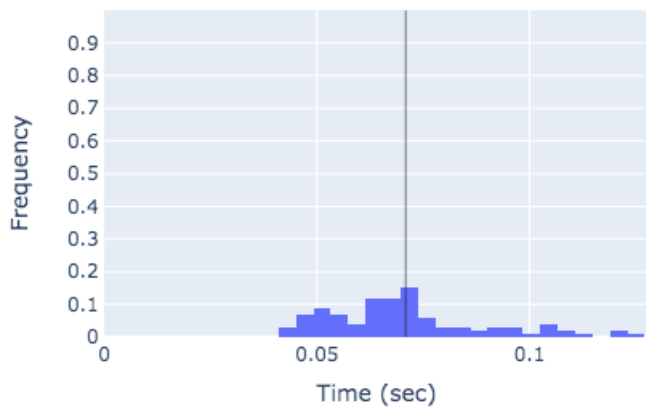
N=1000, Nrep=100
Mean = 0.34808858633041384(sec)



Min: 0.08003807067871094
Max: 1.1629390716552734
|Max-Min|: 1.0829010009765625

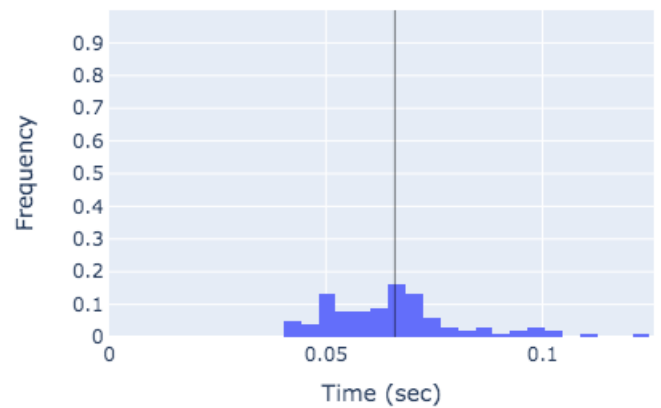
Case 6: Least Squares(True)

N=100, Nrep=100
Mean = 0.07088496685028076(sec)



Min: 0.04197216033935547
Max: 0.12394523620605469
|Max-Min|: 0.08197307586669922

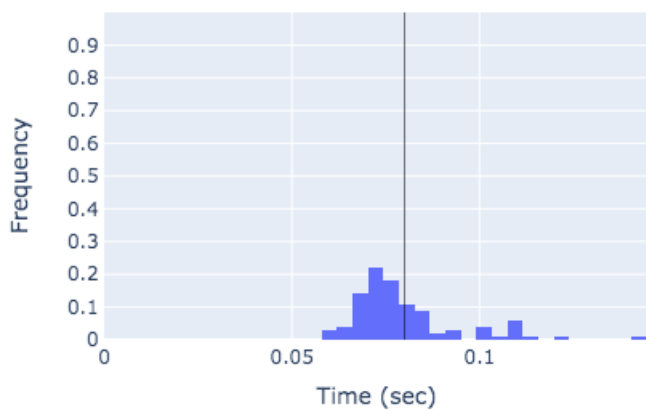
N=1000, Nrep=100
Mean = 0.06591945648193359(sec)



Min: 0.04118514060974121
Max: 0.12162899971008301
|Max-Min|: 0.0804438591003418

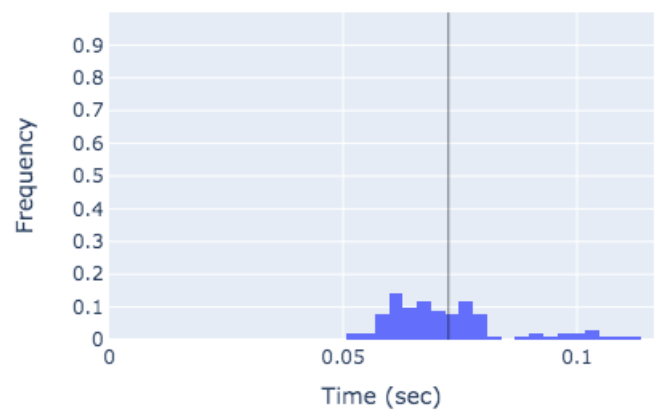
Case 7: Least Squares(False)

N=100, Nrep=100
Mean = 0.08002694845199584(sec)



Min: 0.0583498477935791
Max: 0.14096283912658691
|Max-Min|: 0.08261299133300781

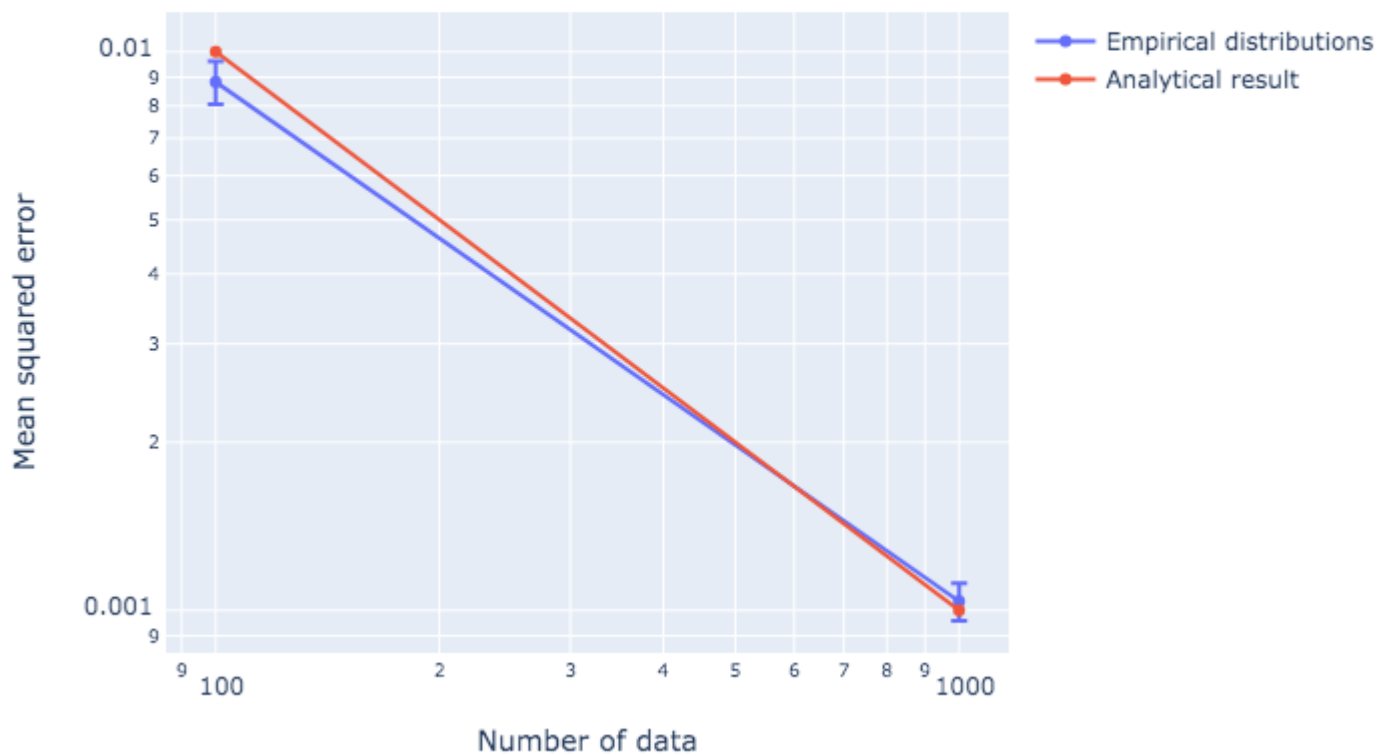
N=1000, Nrep=100
Mean = 0.0725265908241272(sec)



Min: 0.05362105369567871
Max: 0.1134481430053711
|Max-Min|: 0.05982708930969238

MSE of empirical distributions

Mean squared error

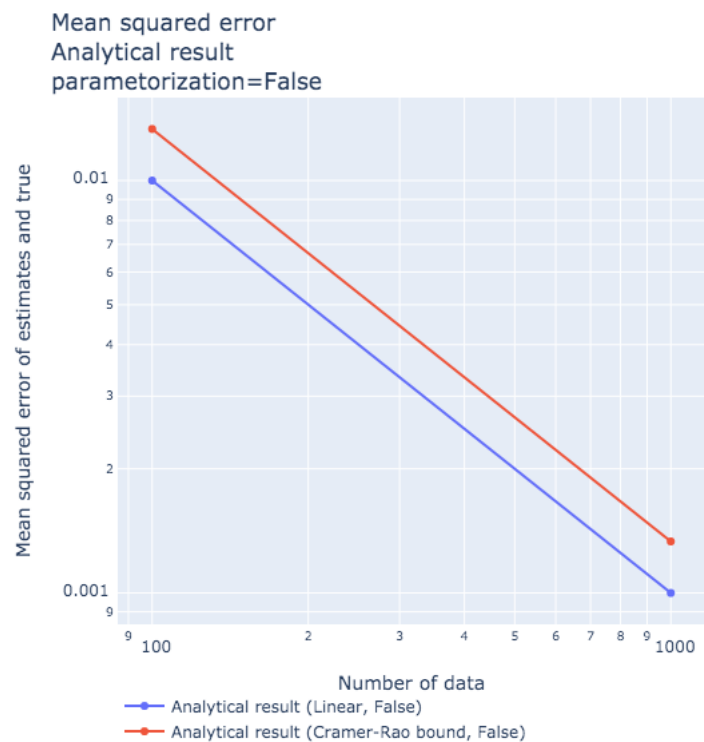
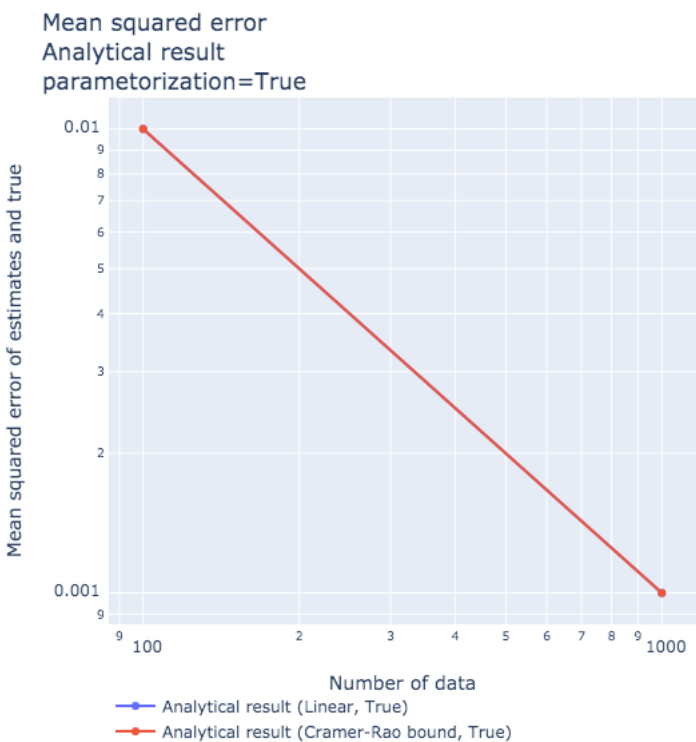
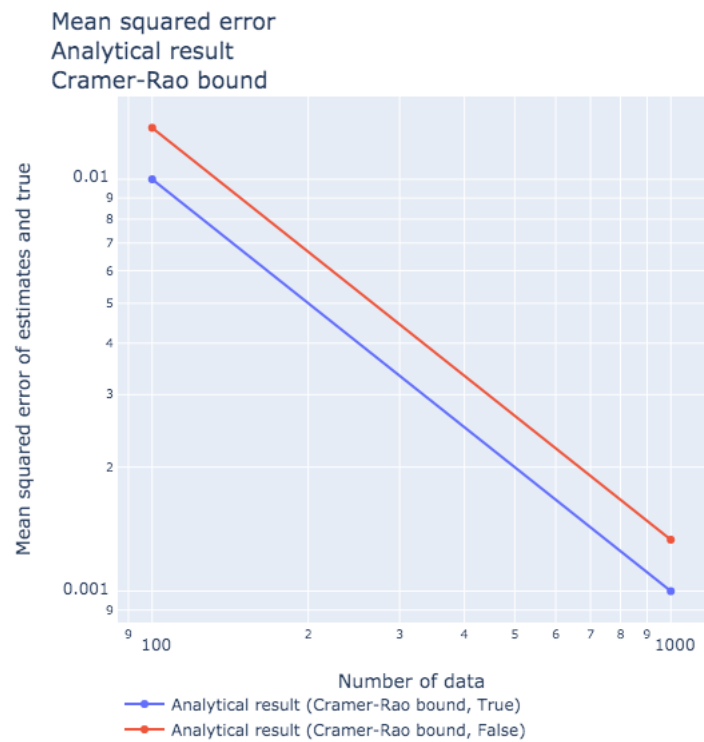
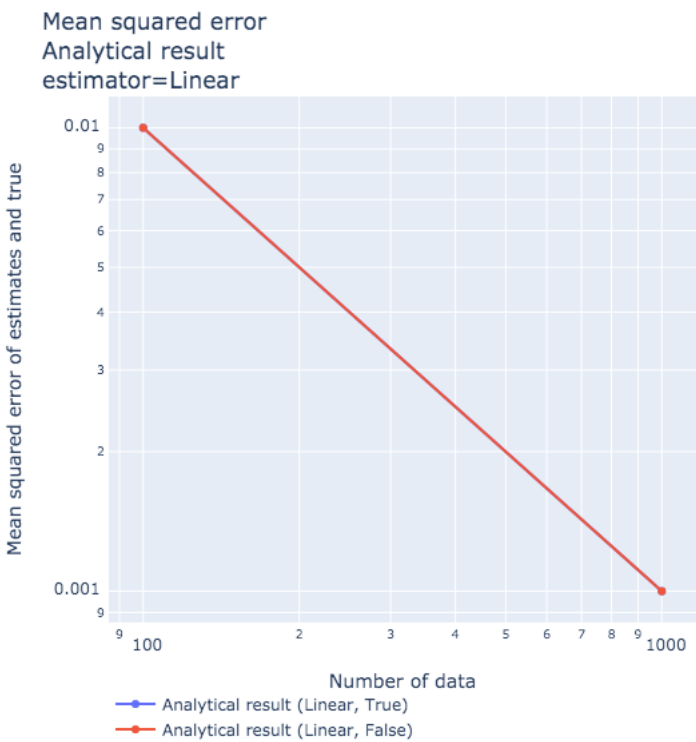


Consistency test

	Name	Type of tomography	Param	Estimator	Loss	Algo	Result
0	Linear(True)	Standard Qst	True	Linear	None	None	9.24e-33
1	Linear(False)	Standard Qst	False	Linear	None	None	5.85e-32
2	ProjectedLinear(True)	Standard Qst	True	Projected Linear	None	None	2.10e-31
3	ProjectedLinear(False)	Standard Qst	False	Projected Linear	None	None	3.05e-31
4	Maximum-Likelihood(True)	Standard Qst	True	Loss Minimization	Weighted Relative Entropy	Projected Gradient Descent Backtracking	4.26e-27
5	Maximum-Likelihood(False)	Standard Qst	False	Loss Minimization	Weighted Relative Entropy	Projected Gradient Descent Backtracking	6.37e-28
6	Least Squares(True)	Standard Qst	True	Loss Minimization	Weighted Probability Based Squared Error	Projected Gradient Descent Backtracking	1.66e-29
7	Least Squares(False)	Standard Qst	False	Loss Minimization	Weighted Probability Based Squared Error	Projected Gradient Descent Backtracking	2.97e-29

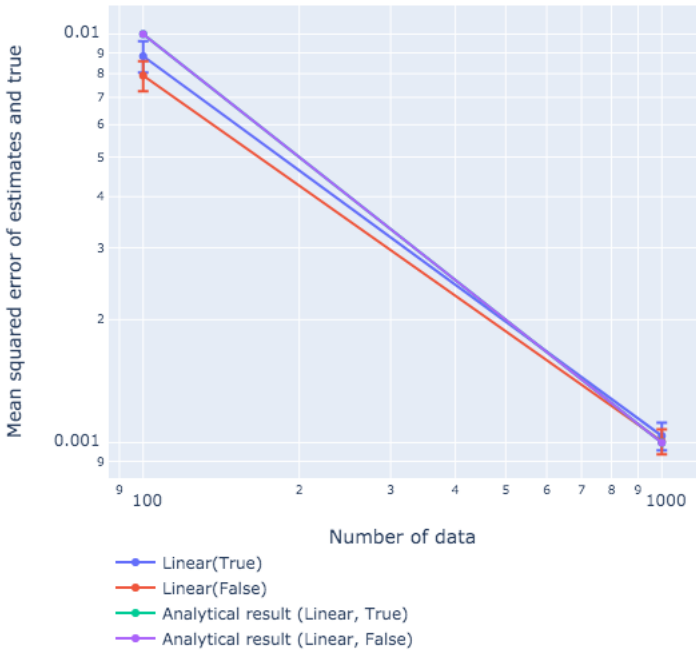
MSE of estimators

Comparison of analytical results

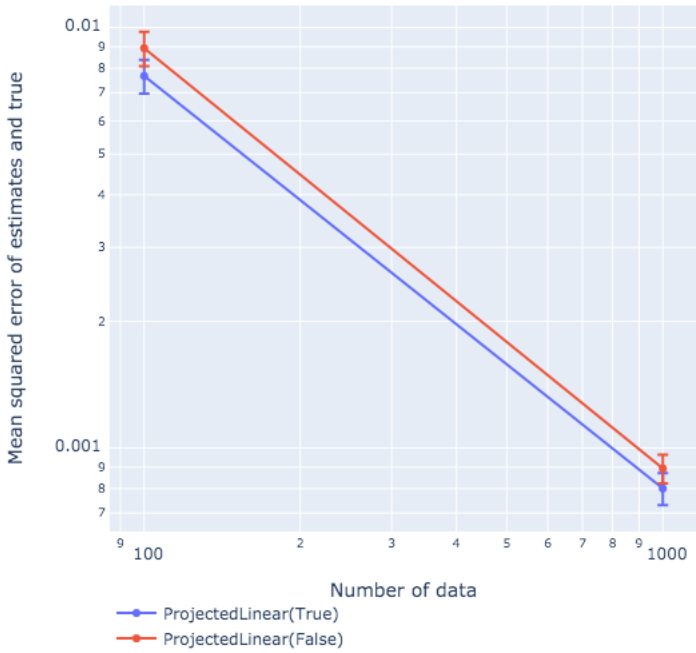


Comparison of parametrization

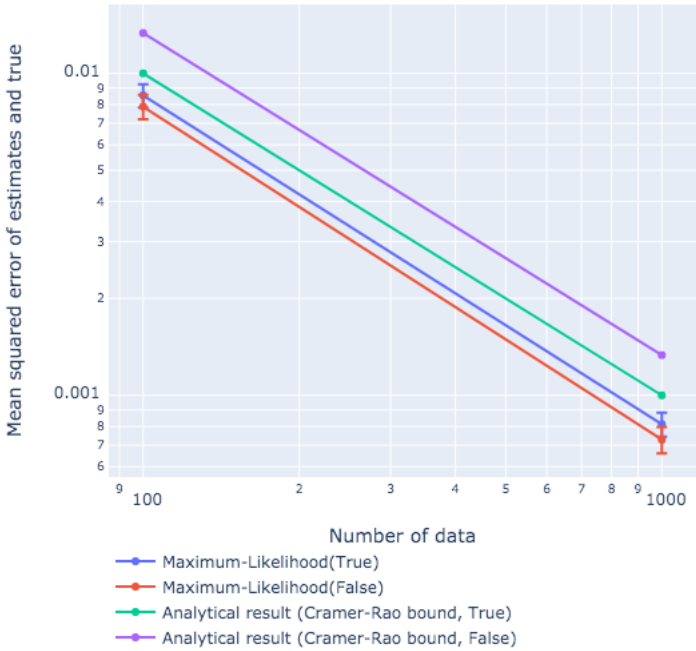
Mean squared error
Estimator=Linear



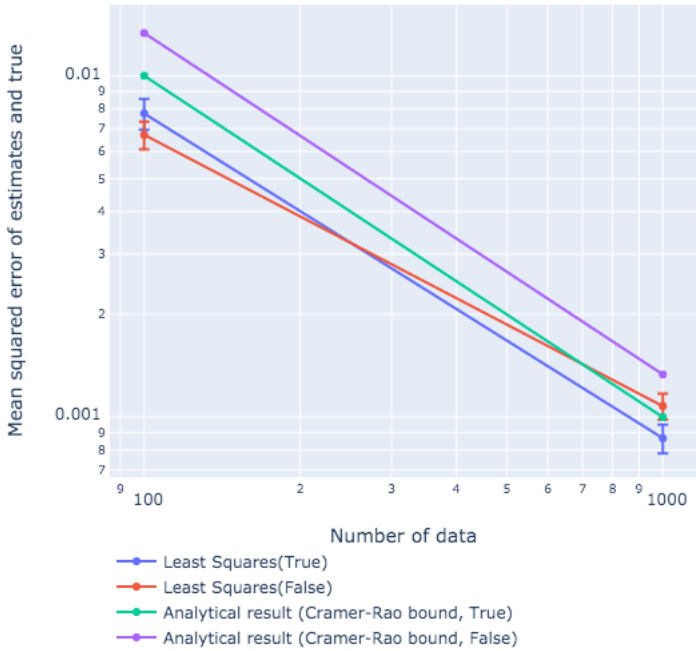
Mean squared error
Estimator=ProjectedLinear



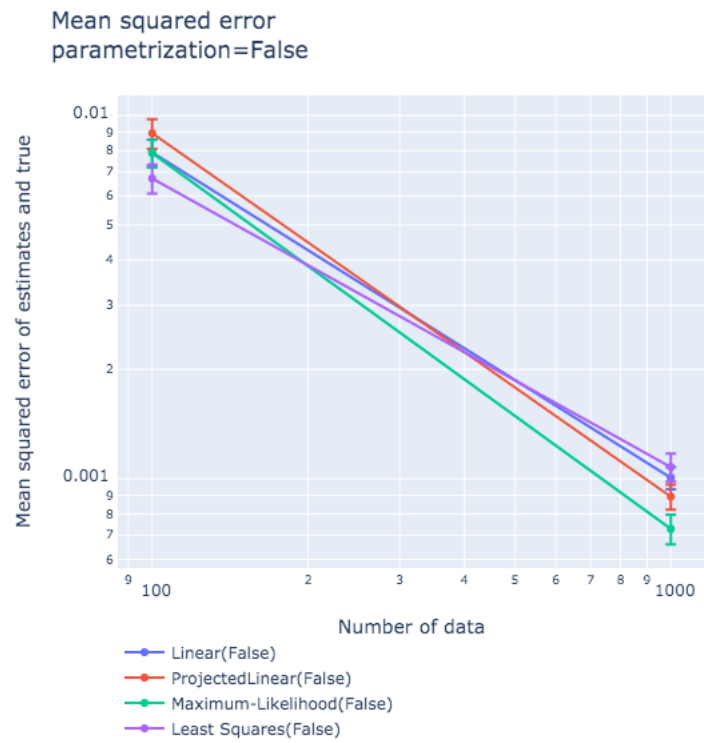
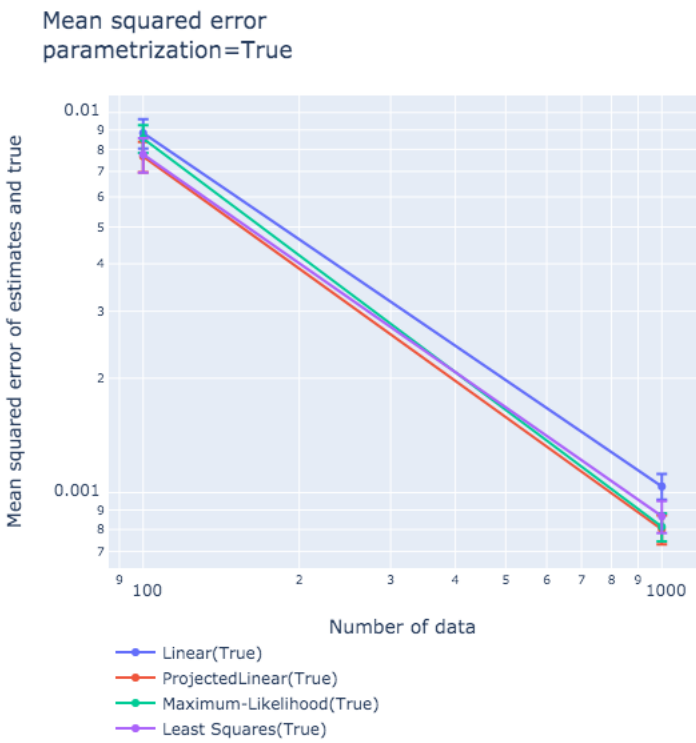
Mean squared error
Estimator=LossMinimization
Loss=WeightedRelativeEntropy
Algo=ProjectedGradientDescentBacktracking



Mean squared error
Estimator=LossMinimization
Loss=WeightedProbabilityBasedSquaredError
Algo=ProjectedGradientDescentBacktracking



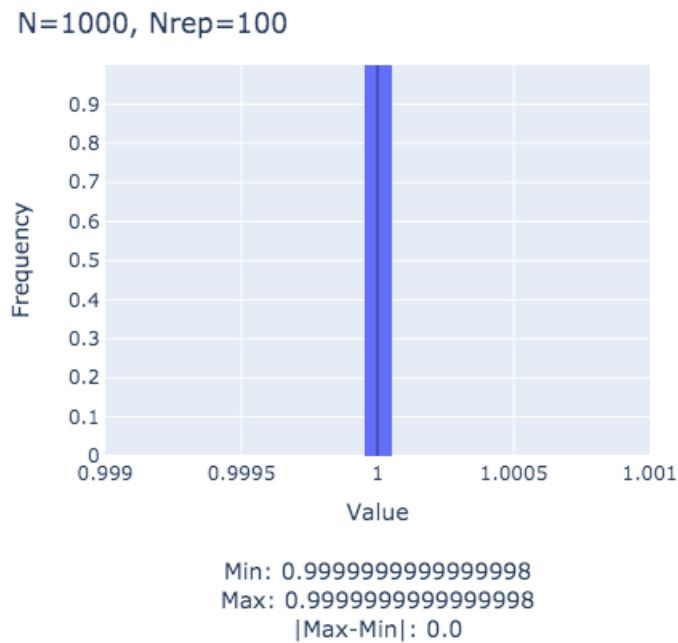
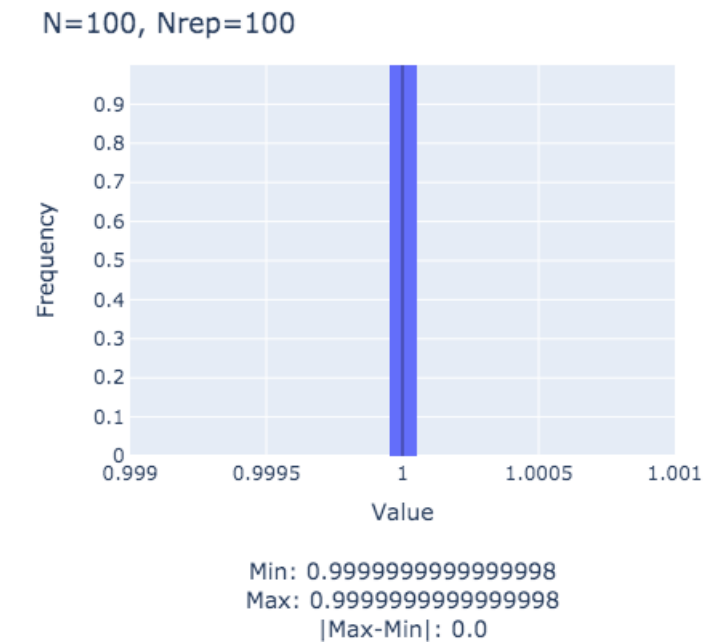
Comparison of estimators



Physicality violation test

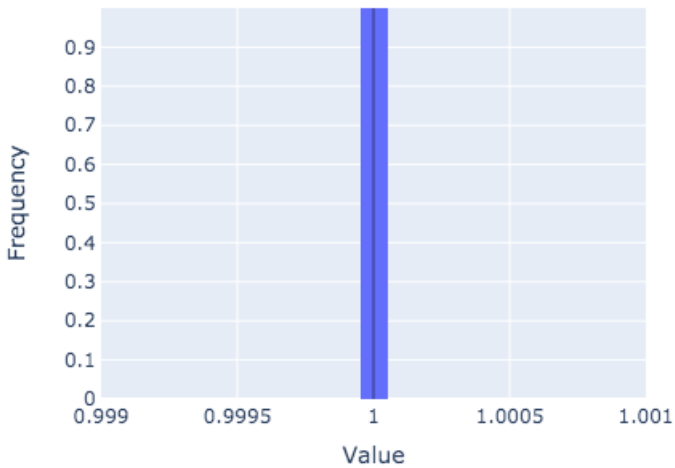
Test of equality constraint violation

Case 0: Linear(True)



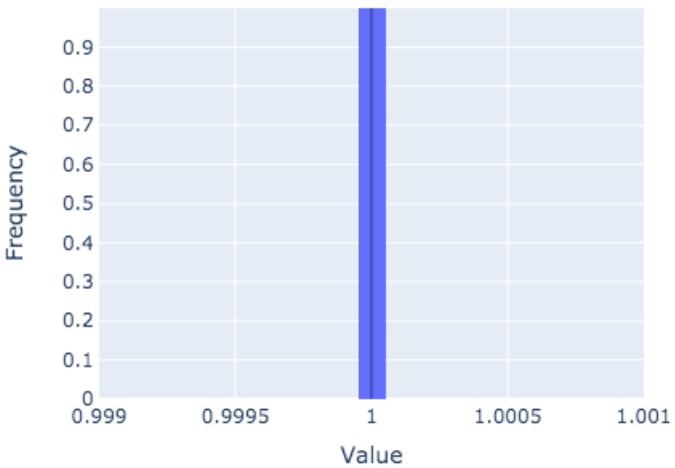
Case 1: Linear(False)

N=100, Nrep=100



Min: 0.9999999999999998
Max: 1.0000000000000002
|Max-Min|: 4.440892098500626e-16

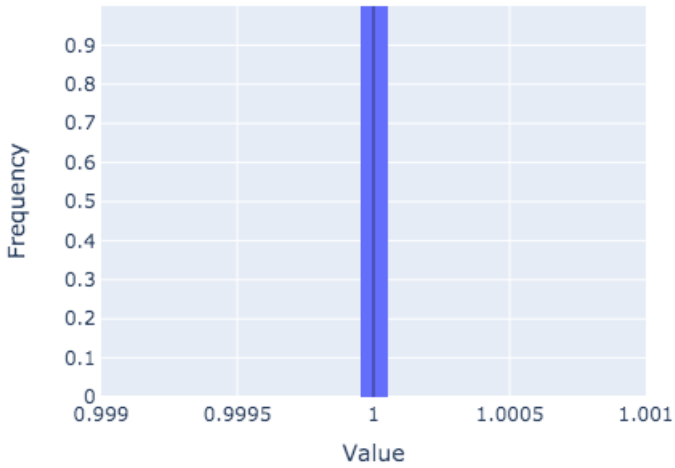
N=1000, Nrep=100



Min: 0.9999999999999998
Max: 1.0000000000000002
|Max-Min|: 4.440892098500626e-16

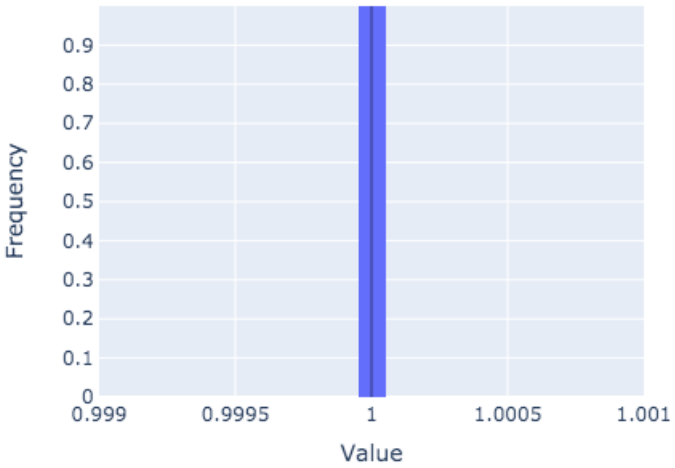
Case 2: ProjectedLinear(True)

N=100, Nrep=100



Min: 0.9999999999999998
Max: 0.9999999999999998
|Max-Min|: 0.0

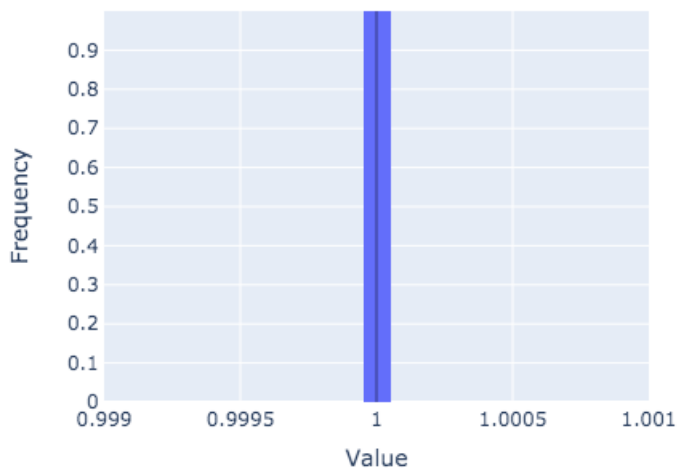
N=1000, Nrep=100



Min: 0.9999999999999998
Max: 0.9999999999999998
|Max-Min|: 0.0

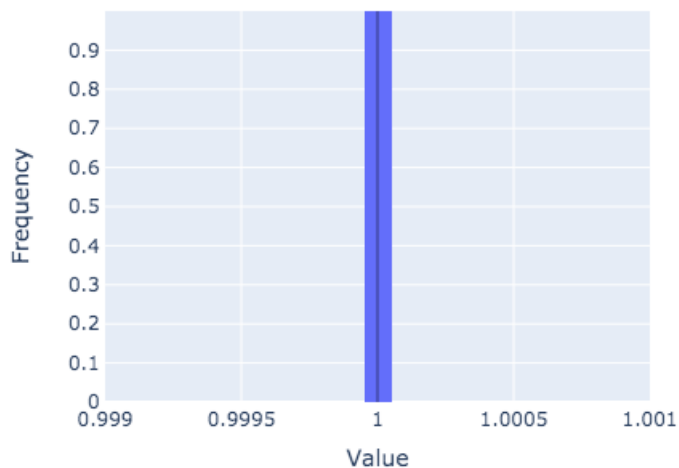
Case 3: ProjectedLinear(False)

N=100, Nrep=100



Min: 0.9999999999999998
Max: 0.9999999999999998
|Max-Min|: 0.0

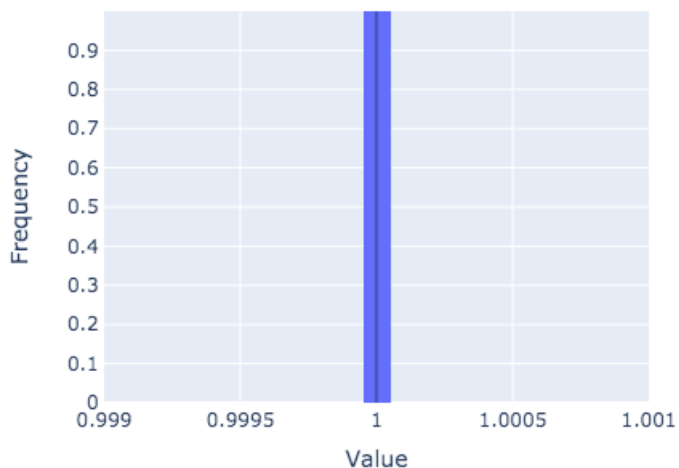
N=1000, Nrep=100



Min: 0.9999999999999998
Max: 0.9999999999999998
|Max-Min|: 0.0

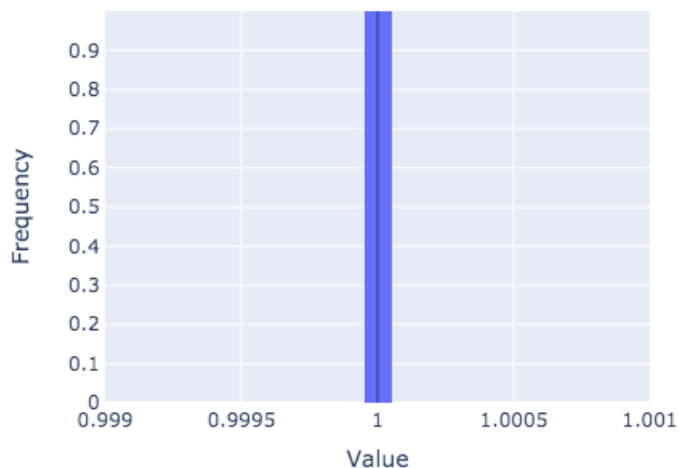
Case 4: Maximum-Likelihood(True)

N=100, Nrep=100



Min: 0.9999999999999998
Max: 0.9999999999999998
|Max-Min|: 0.0

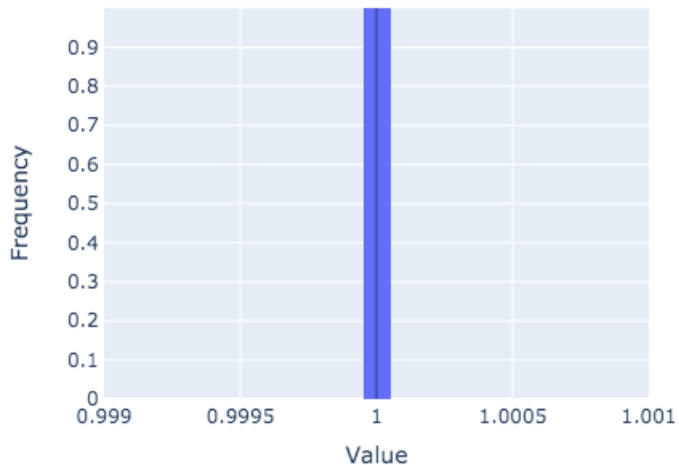
N=1000, Nrep=100



Min: 0.9999999999999998
Max: 0.9999999999999998
|Max-Min|: 0.0

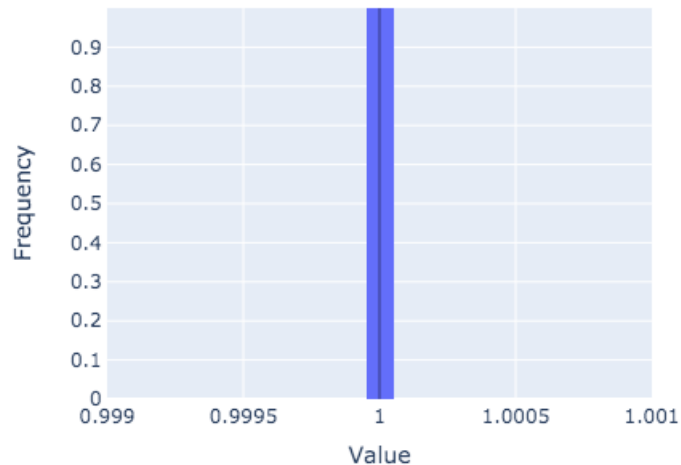
Case 5: Maximum-Likelihood(False)

N=100, Nrep=100



Min: 0.9999999999999998
Max: 0.9999999999999998
|Max-Min|: 0.0

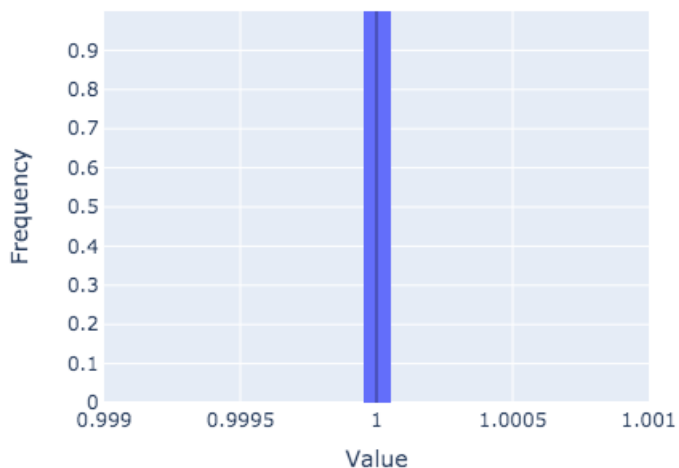
N=1000, Nrep=100



Min: 0.9999999999999998
Max: 0.9999999999999998
|Max-Min|: 0.0

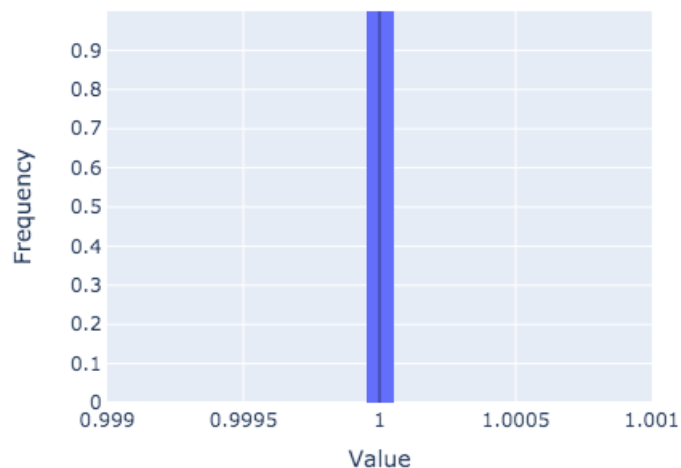
Case 6: Least Squares(True)

N=100, Nrep=100



Min: 0.9999999999999998
Max: 0.9999999999999998
|Max-Min|: 0.0

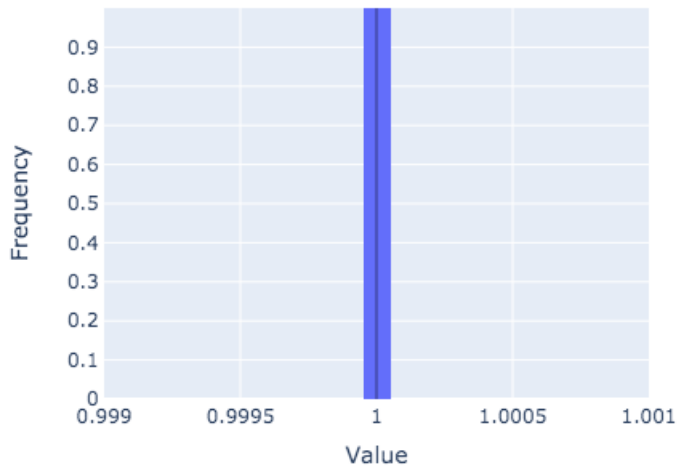
N=1000, Nrep=100



Min: 0.9999999999999998
Max: 0.9999999999999998
|Max-Min|: 0.0

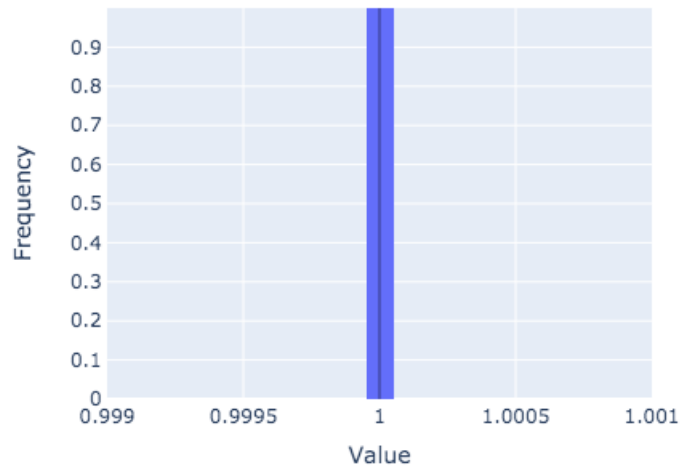
Case 7: Least Squares(False)

N=100, Nrep=100



Min: 0.9999999999999998
Max: 0.9999999999999998
|Max-Min|: 0.0

N=1000, Nrep=100



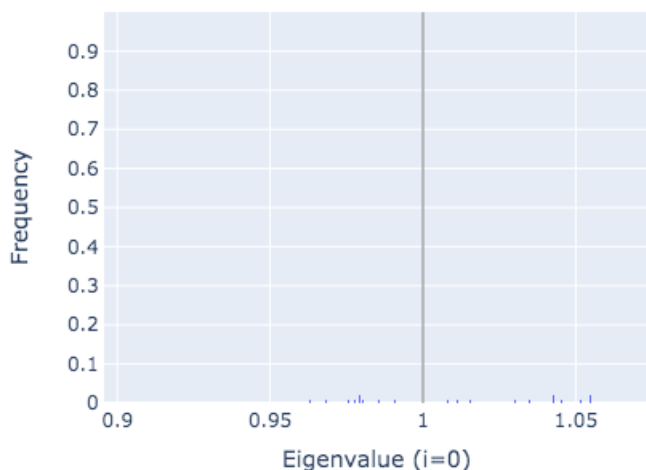
Min: 0.9999999999999998
Max: 0.9999999999999998
|Max-Min|: 0.0

Test of inequality constraint violation

Eigenvalue

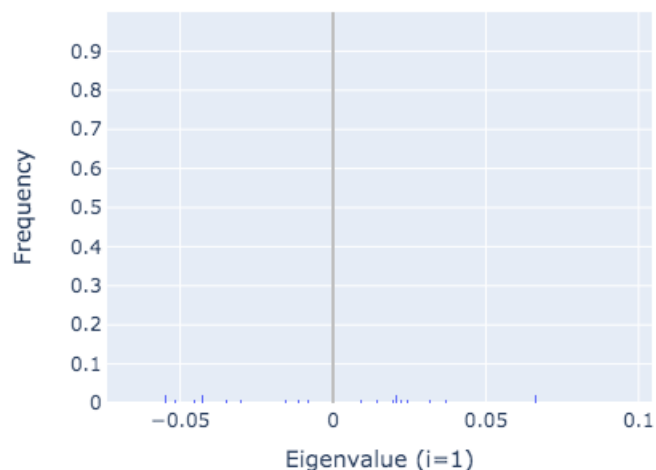
Case 0: Linear(True)

N=100, Nrep=100



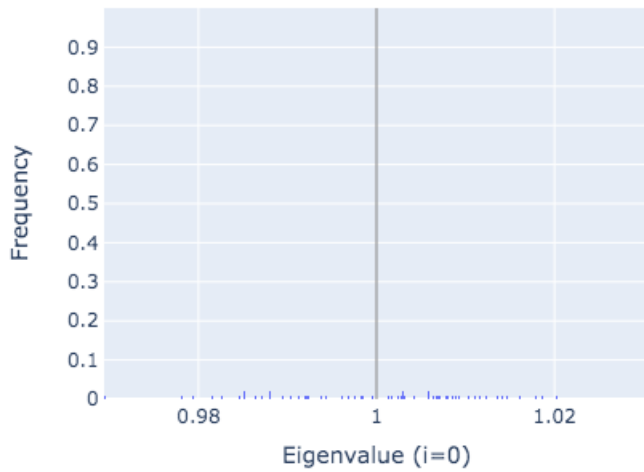
Min: 0.8957271787481875
Max: 1.0738466694161428
|Max-Min|: 0.1781194906679553

N=100, Nrep=100



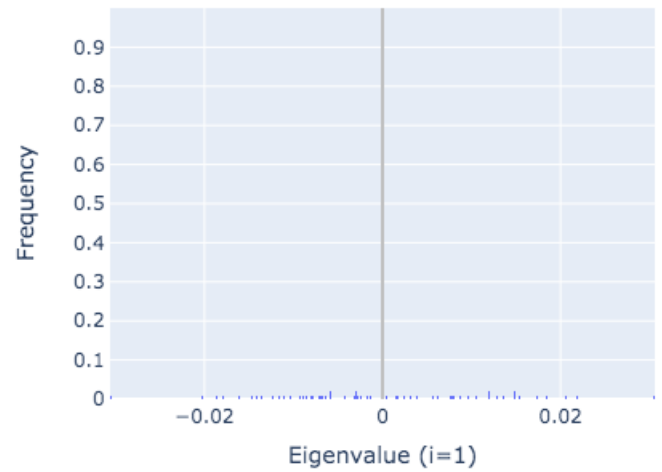
Min: -0.07384666941614303
Max: 0.10427282125181224
|Max-Min|: 0.17811949066795527

N=1000, Nrep=100



Min: 0.9694773689966321
Max: 1.0305223840706443
|Max-Min|: 0.06104501507401228

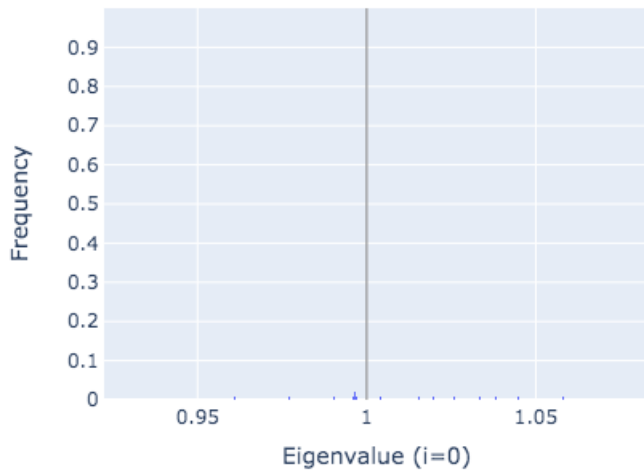
N=1000, Nrep=100



Min: -0.030522384070644254
Max: 0.030522631003367565
|Max-Min|: 0.06104501507401182

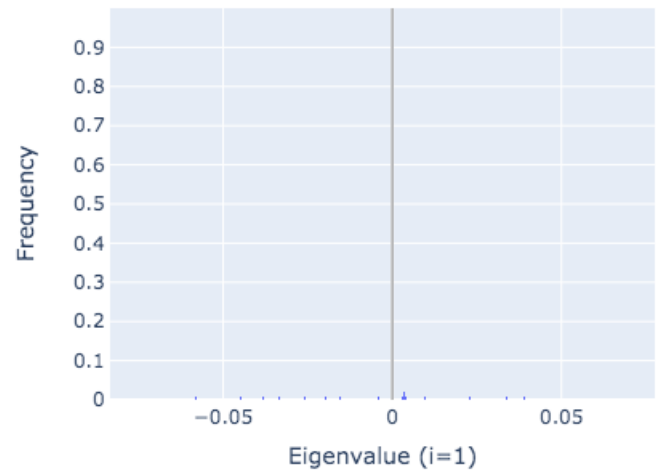
Case 1: Linear(False)

N=100, Nrep=100



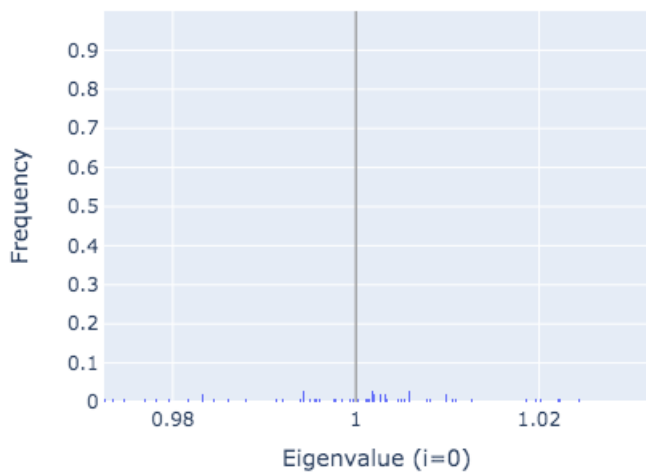
Min: 0.9224926034855522
Max: 1.0833523806414103
|Max-Min|: 0.16085977715585809

N=100, Nrep=100



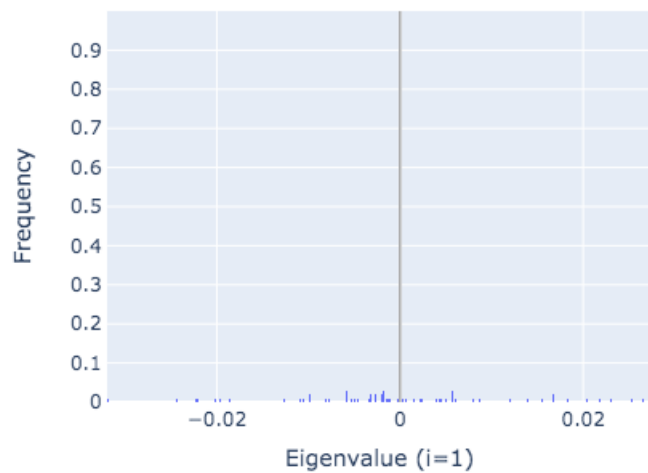
Min: -0.08335238064140982
Max: 0.07750739651444777
|Max-Min|: 0.1608597771558576

N=1000, Nrep=100



Min: 0.972573803759793
Max: 1.0319107067920326
|Max-Min|: 0.059336903032239596

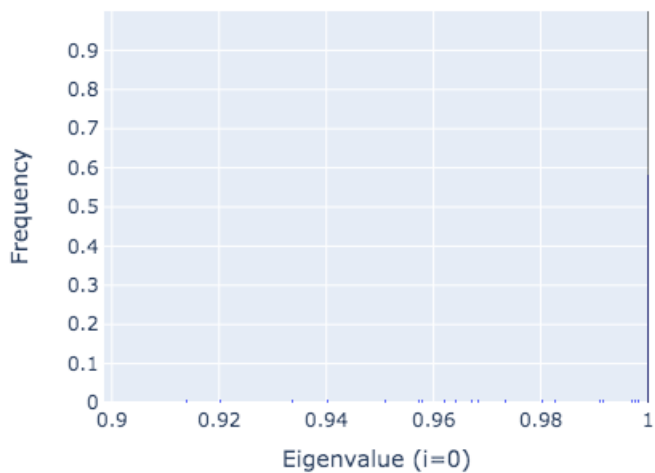
N=1000, Nrep=100



Min: -0.031910706792032915
Max: 0.02742619624020604
|Max-Min|: 0.05933690303223896

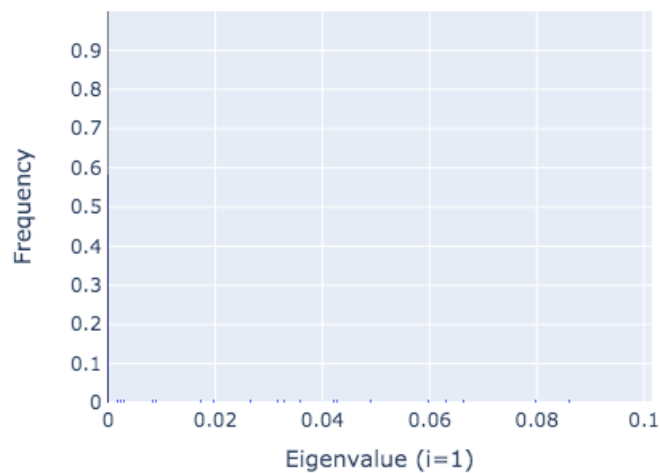
Case 2: ProjectedLinear(True)

N=100, Nrep=100



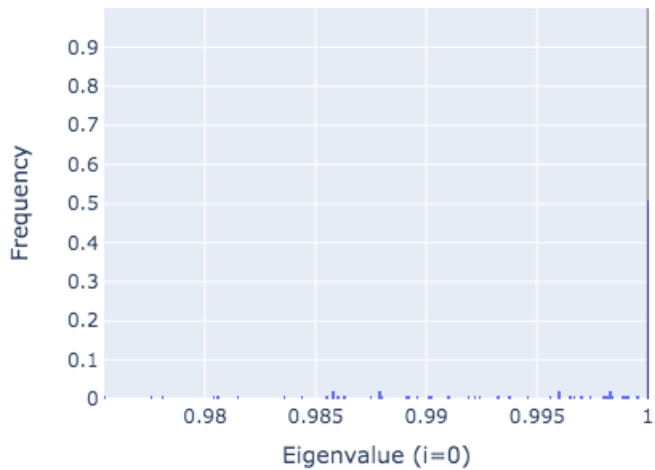
Min: 0.8986226285598948
Max: 1.00000000000006035
|Max-Min|: 0.10137737144070869

N=100, Nrep=100



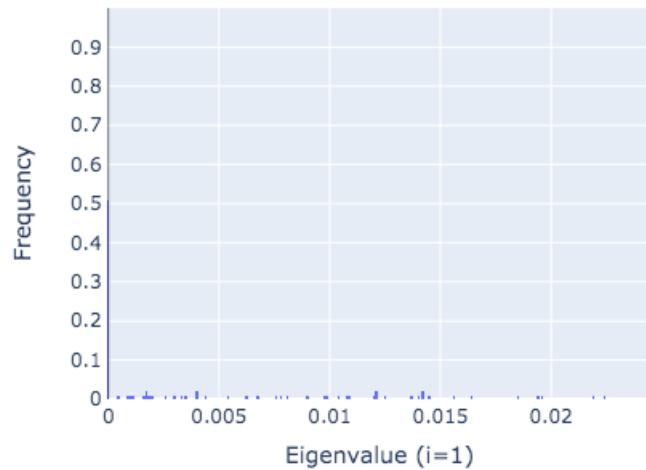
Min: -6.039008229280467e-13
Max: 0.10137737144010506
|Max-Min|: 0.10137737144070896

N=1000, Nrep=100



Min: 0.975538641962985
Max: 1.0000000000005184
|Max-Min|: 0.024461358042199066

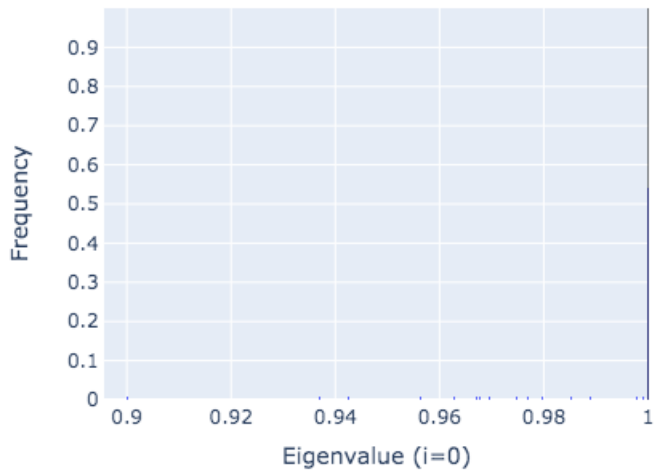
N=1000, Nrep=100



Min: -5.184662910032525e-12
Max: 0.024461358037014748
|Max-Min|: 0.02446135804219941

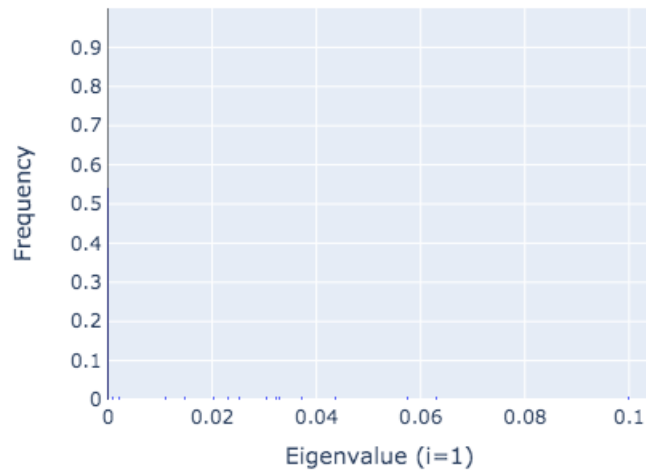
Case 3: ProjectedLinear(False)

N=100, Nrep=100



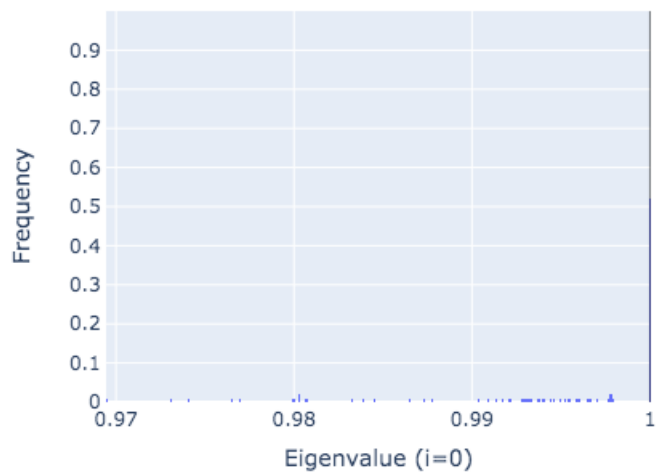
Min: 0.8957271787481873
Max: 1.0000000000009297
|Max-Min|: 0.1042728212527424

N=100, Nrep=100



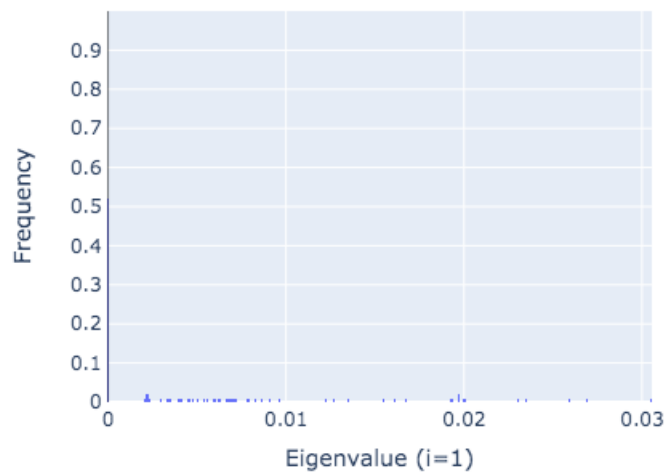
Min: -9.303964064993807e-13
Max: 0.10427282125181248
|Max-Min|: 0.10427282125274287

N=1000, Nrep=100



Min: 0.9695157079374443
Max: 1.0000000000976561
|Max-Min|: 0.030484293039116706

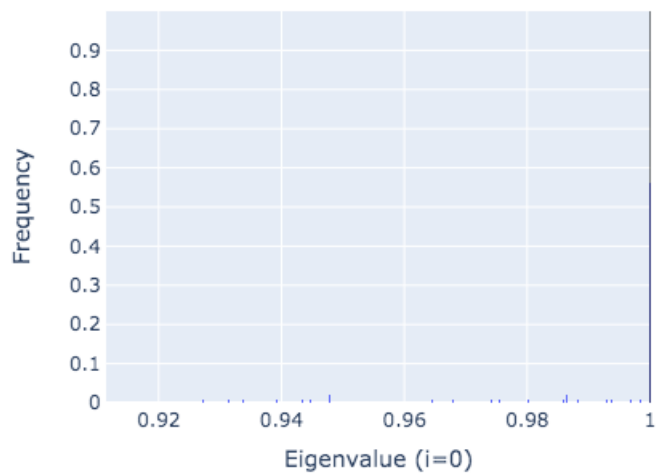
N=1000, Nrep=100



Min: -9.765616615728533e-10
Max: 0.03048429206255536
|Max-Min|: 0.03048429303911702

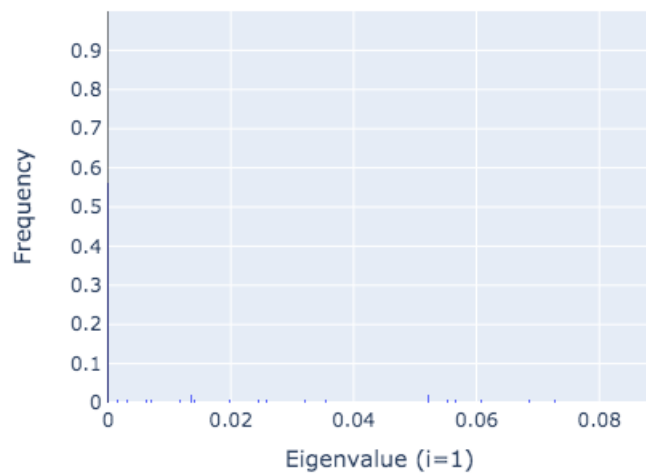
Case 4: Maximum-Likelihood(True)

N=100, Nrep=100



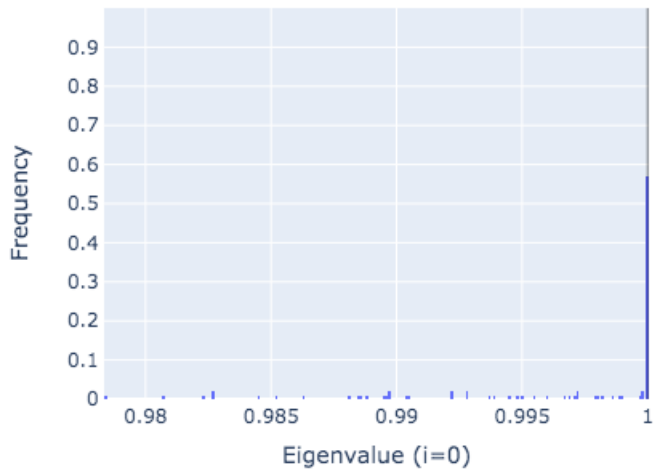
Min: 0.9114608211527193
Max: 1.0000000000005353
|Max-Min|: 0.08853917885263418

N=100, Nrep=100



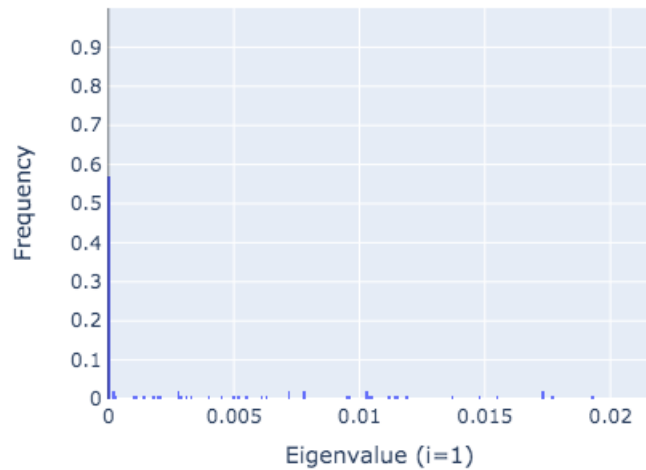
Min: -5.354217988982624e-12
Max: 0.08853917884728026
|Max-Min|: 0.08853917885263447

N=1000, Nrep=100



Min: 0.9783555200918326
 Max: 1.0000000001123612
 |Max-Min|: 0.021644480020528656

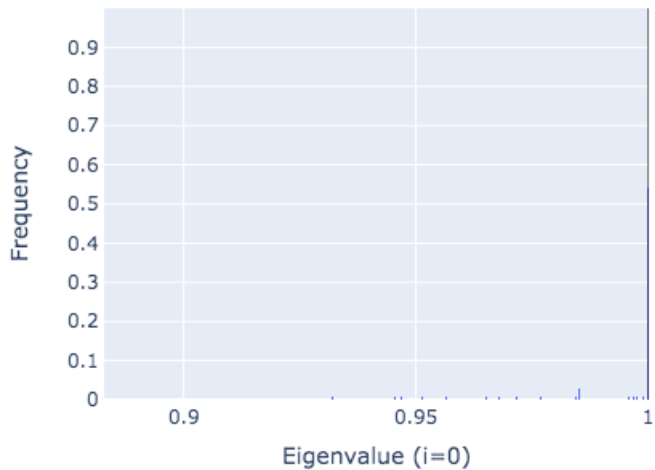
N=1000, Nrep=100



Min: -1.1236145599302914e-10
 Max: 0.02164447990816662
 |Max-Min|: 0.021644480020528076

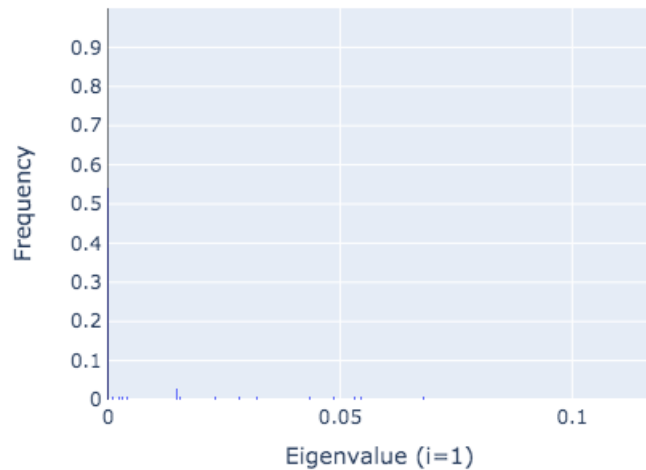
Case 5: Maximum-Likelihood(False)

N=100, Nrep=100



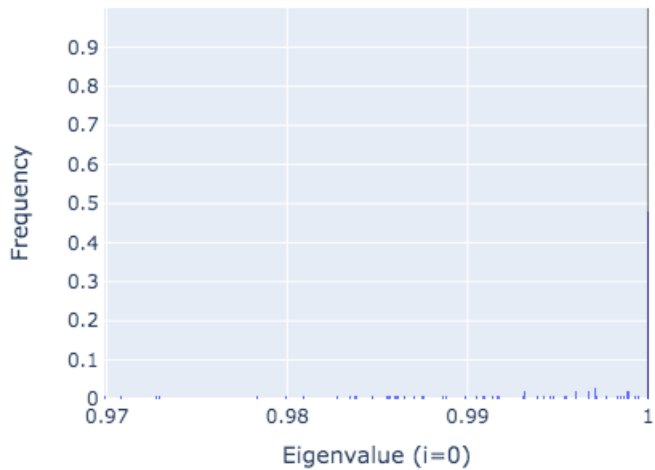
Min: 0.8828837965974647
 Max: 1.00000000000000102
 |Max-Min|: 0.11711620340254547

N=100, Nrep=100



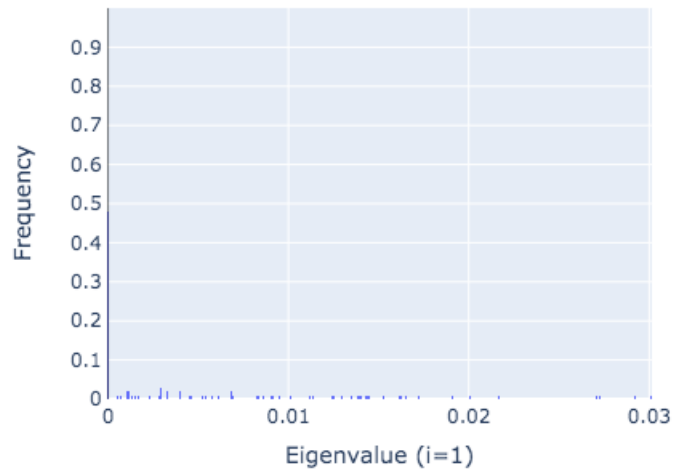
Min: -1.0664939803058045e-14
 Max: 0.11711620340253492
 |Max-Min|: 0.11711620340254558

N=1000, Nrep=100



Min: 0.9698872228031326
 Max: 1.0000000000000109
 |Max-Min|: 0.030112777196878326

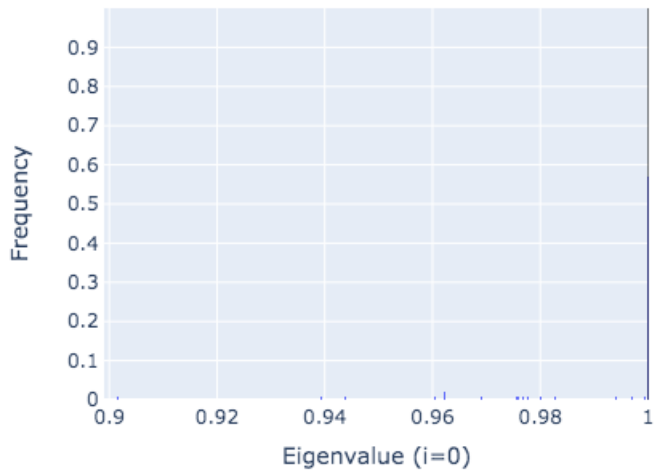
N=1000, Nrep=100



Min: -1.0901152577866491e-14
 Max: 0.030112777196866825
 |Max-Min|: 0.030112777196877726

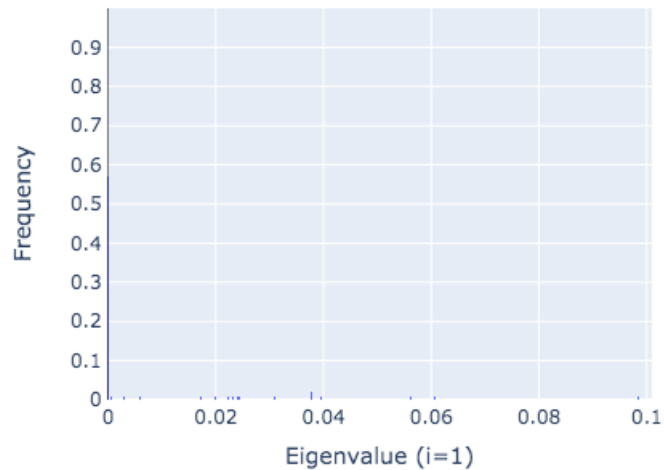
Case 6: Least Squares(True)

N=100, Nrep=100



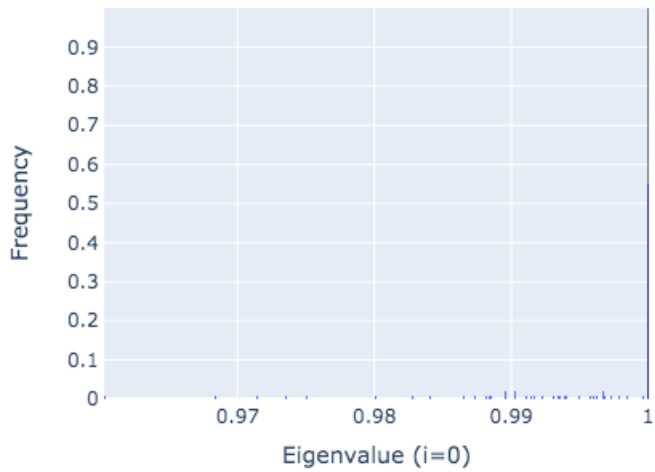
Min: 0.8991240357501609
 Max: 1.00000000000042972
 |Max-Min|: 0.10087596425413636

N=100, Nrep=100



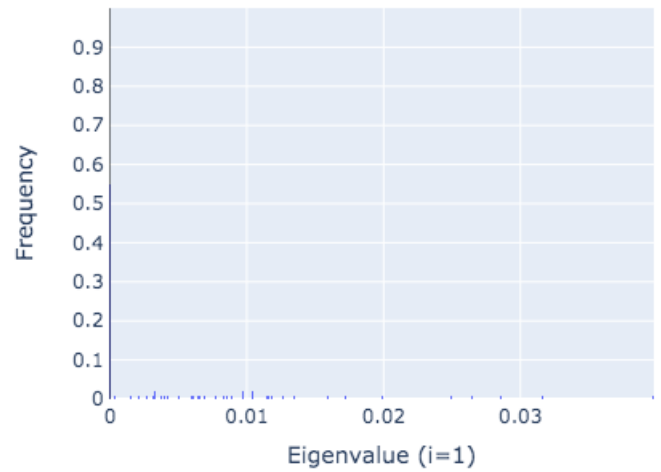
Min: -4.297466172772299e-12
 Max: 0.10087596424983913
 |Max-Min|: 0.1008759642541366

N=1000, Nrep=100



Min: 0.9603053314328076
Max: 1.0000000000814833
|Max-Min|: 0.03969466864867566

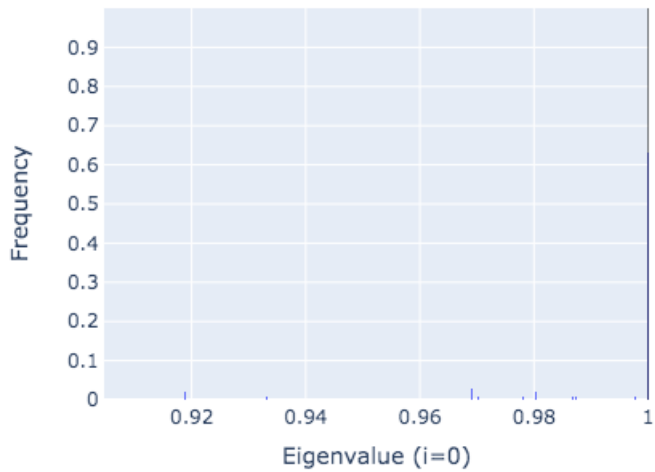
N=1000, Nrep=100



Min: -8.148365220260422e-11
Max: 0.039694668656719204
|Max-Min|: 0.03969466864867569

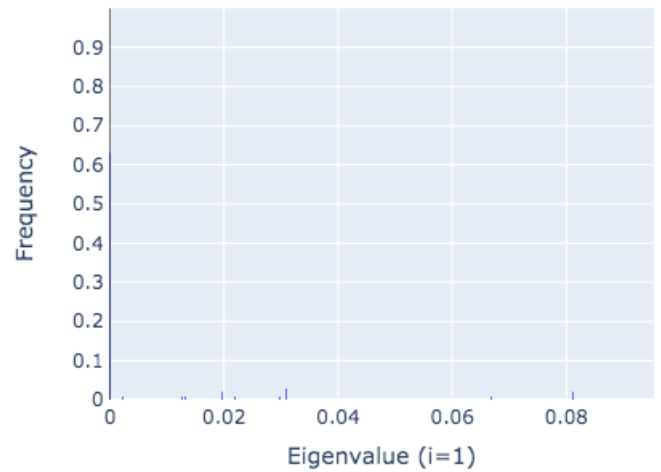
Case 7: Least Squares(False)

N=100, Nrep=100



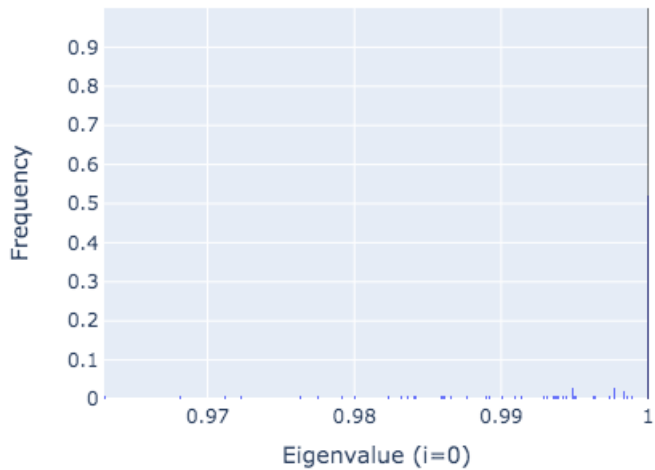
Min: 0.9047221468171974
Max: 1.0000000000004962
|Max-Min|: 0.0952778531877646

N=100, Nrep=100



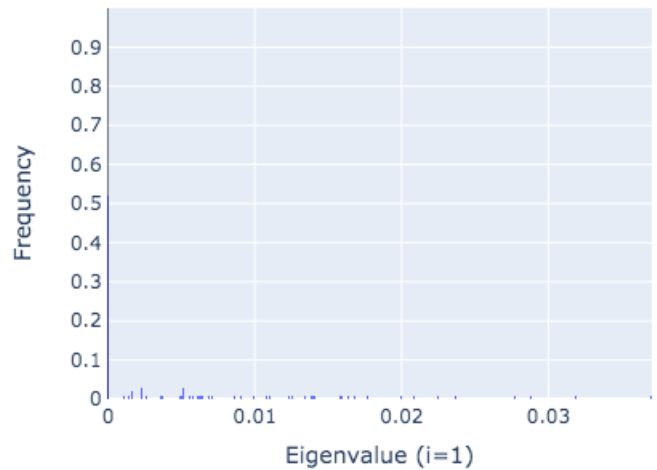
Min: -4.962265100544321e-12
Max: 0.09527785318280231
|Max-Min|: 0.09527785318776458

N=1000, Nrep=100



Min: 0.9629524581256812
 Max: 1.000000000152584
 |Max-Min|: 0.03704754202690275

N=1000, Nrep=100



Min: -1.525835627677721e-10
 Max: 0.03704754187431892
 |Max-Min|: 0.03704754202690248

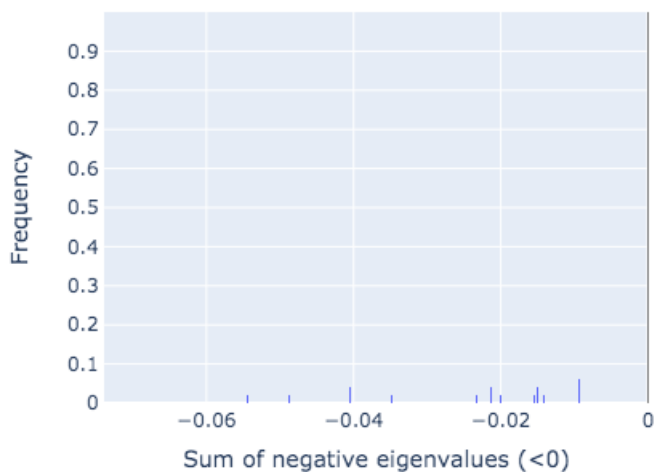
Sum of unphysical eigenvalues

Case 0: Linear(True)

N=100

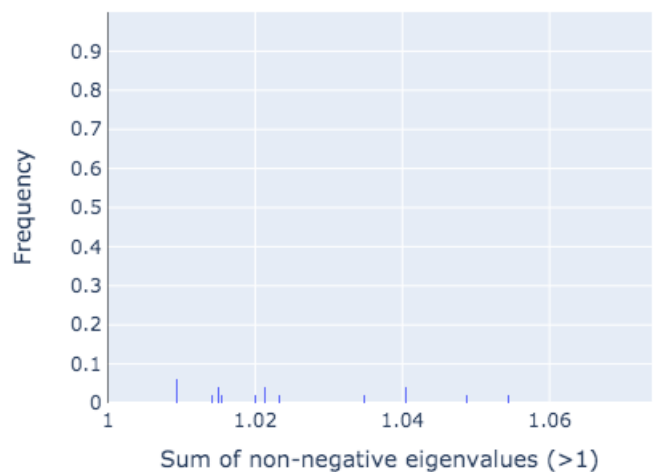
Number of unphysical estimates=50

N=100, Nrep=100



Min: -0.07384666941614303
 Max: -0.0024937810560447166
 |Max-Min|: 0.07135288836009832

N=100, Nrep=100

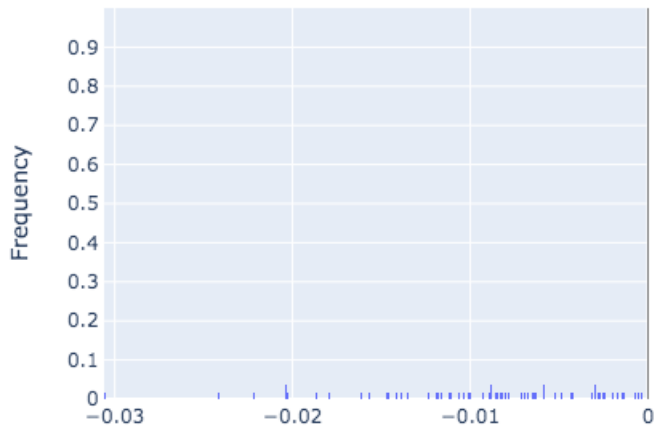


Min: 1.0024937810560441
 Max: 1.0738466694161428
 |Max-Min|: 0.07135288836009868

N=1000

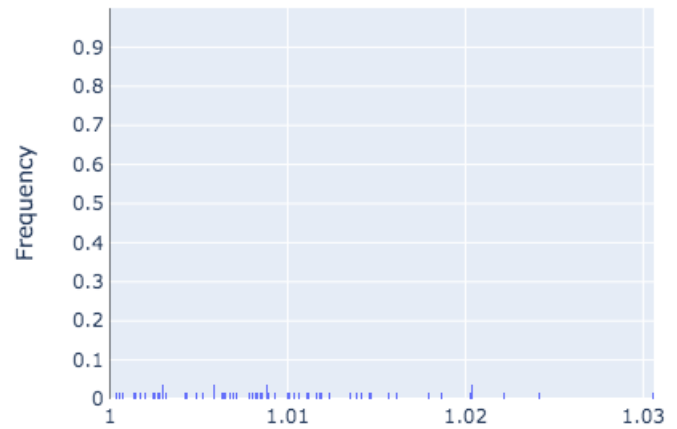
Number of unphysical estimates=55

N=1000, Nrep=100



Min: -0.030522384070644254
Max: -0.0003938448862057985
|Max-Min|: 0.030128539184438457

N=1000, Nrep=100



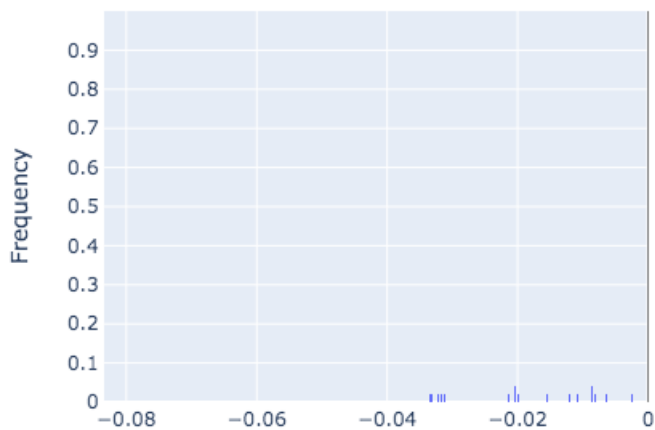
Min: 1.0003938448862053
Max: 1.0305223840706443
|Max-Min|: 0.03012853918443903

Case 1: Linear(False)

N=100

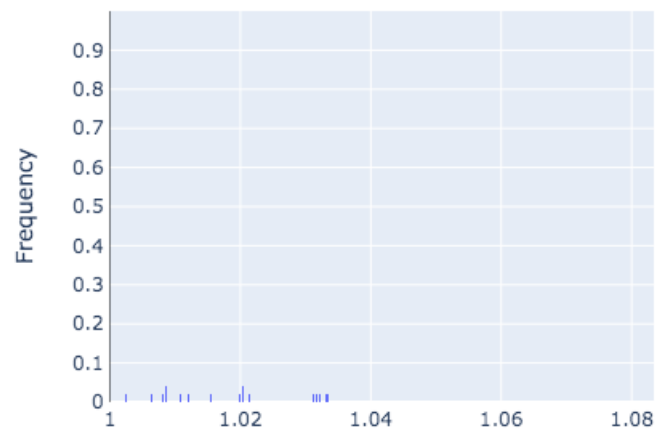
Number of unphysical estimates=50

N=100, Nrep=100



Min: -0.08335238064140982
Max: -0.0024937810560446767
|Max-Min|: 0.08085859958536513

N=100, Nrep=100



Min: 1.0024937810560444
Max: 1.0833523806414103
|Max-Min|: 0.0808585995853659

N=1000

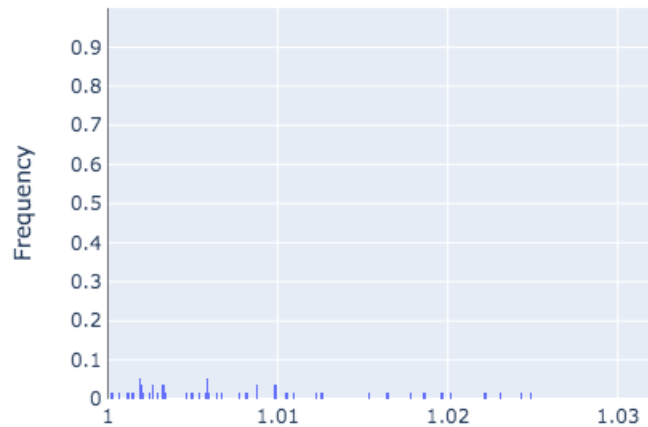
Number of unphysical estimates=55

N=1000, Nrep=100



Min: -0.031910706792032915
Max: -0.00013798096125442778
|Max-Min|: 0.03177272583077849

N=1000, Nrep=100



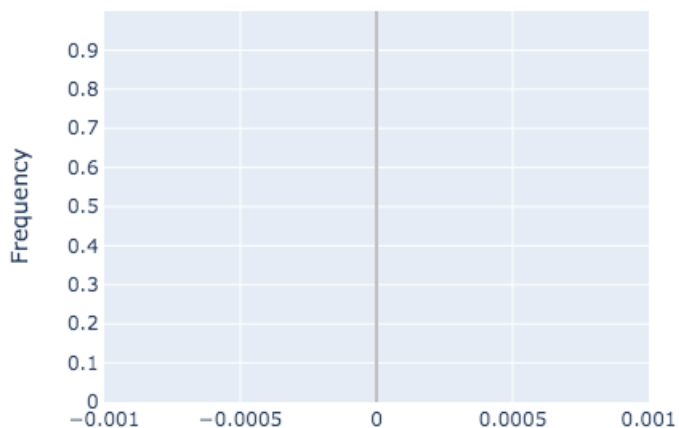
Min: 1.0001379809612543
Max: 1.0319107067920326
|Max-Min|: 0.03177272583077828

Case 2: ProjectedLinear(True)

N=100

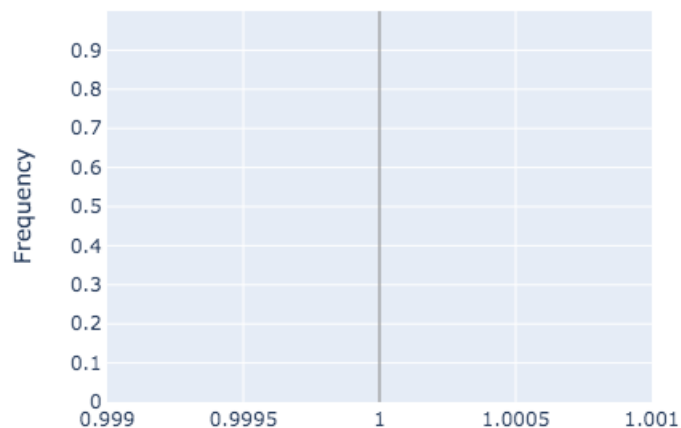
Number of unphysical estimates=0

N=100, Nrep=100



Min: -
Max: -
|Max-Min|: -

N=100, Nrep=100

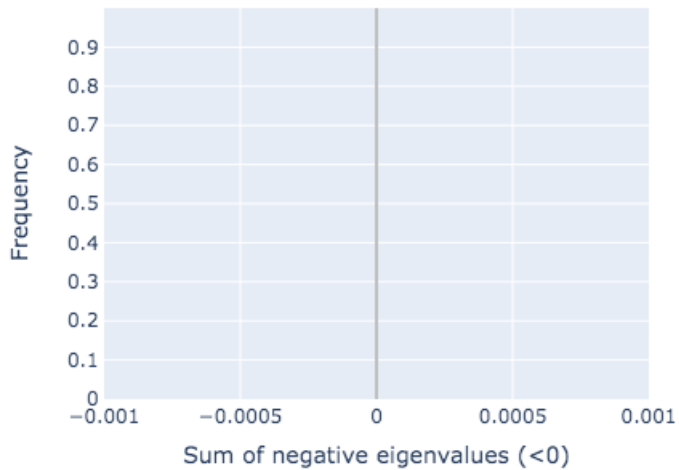


Min: -
Max: -
|Max-Min|: -

N=1000

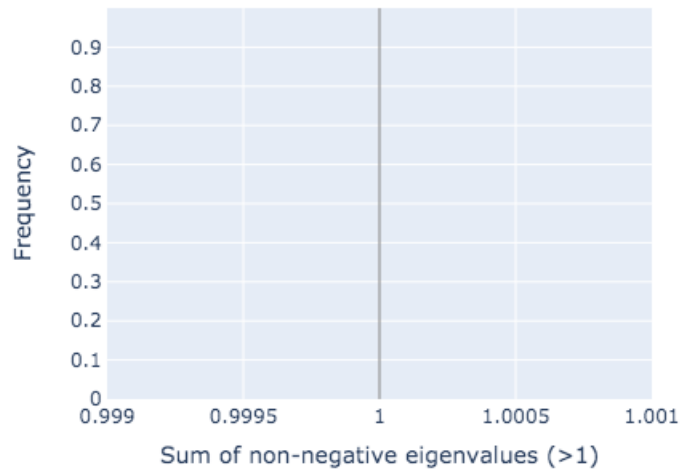
Number of unphysical estimates=0

N=1000, Nrep=100



Min: -
Max: -
|Max-Min|: -

N=1000, Nrep=100



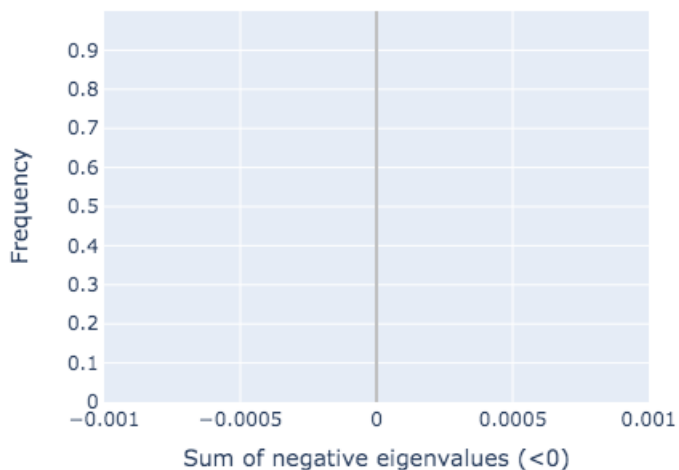
Min: -
Max: -
|Max-Min|: -

Case 3: ProjectedLinear(False)

N=100

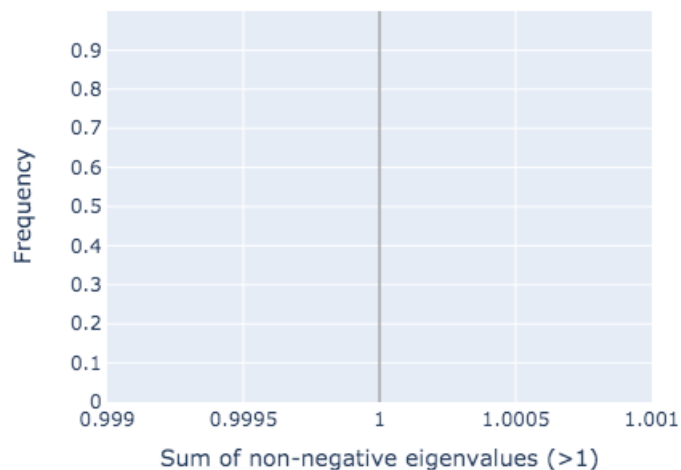
Number of unphysical estimates=0

N=100, Nrep=100



Min: -
Max: -
|Max-Min|: -

N=100, Nrep=100

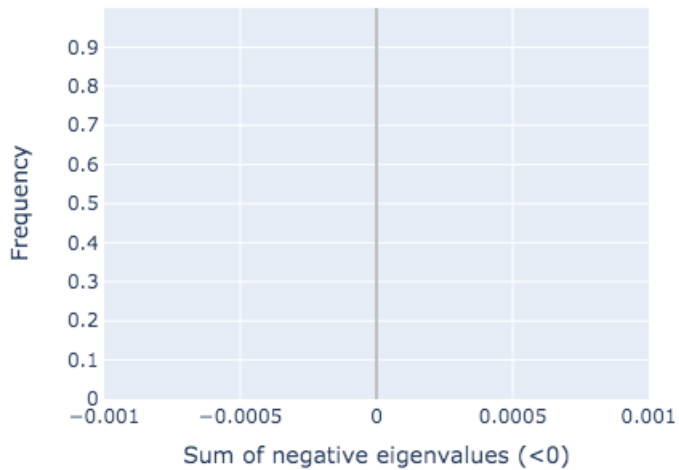


Min: -
Max: -
|Max-Min|: -

N=1000

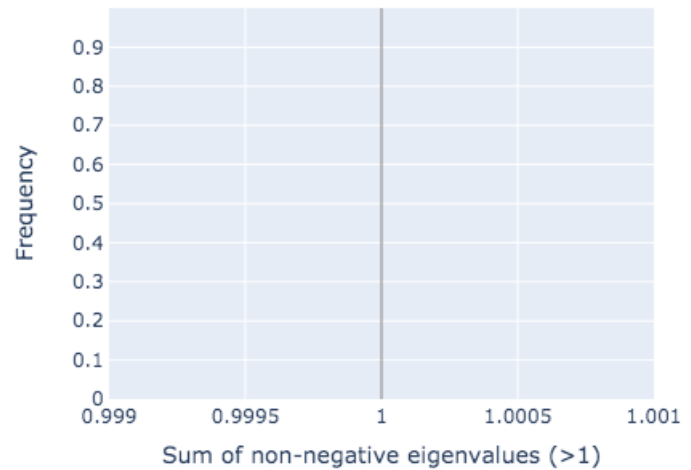
Number of unphysical estimates=0

N=1000, Nrep=100



Min: -
Max: -
|Max-Min|: -

N=1000, Nrep=100



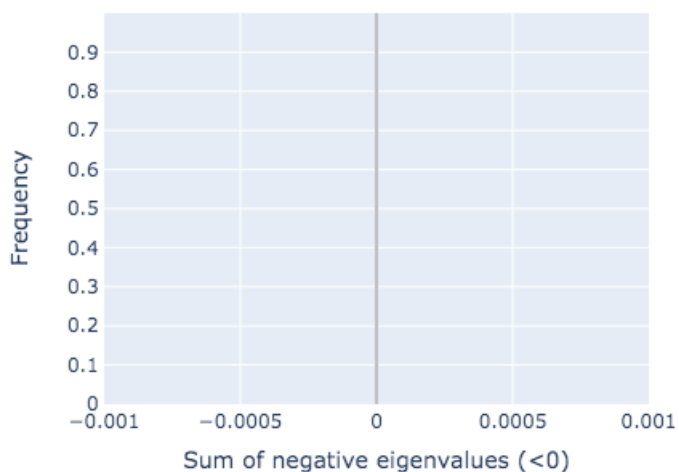
Min: -
Max: -
|Max-Min|: -

Case 4: Maximum-Likelihood(True)

N=100

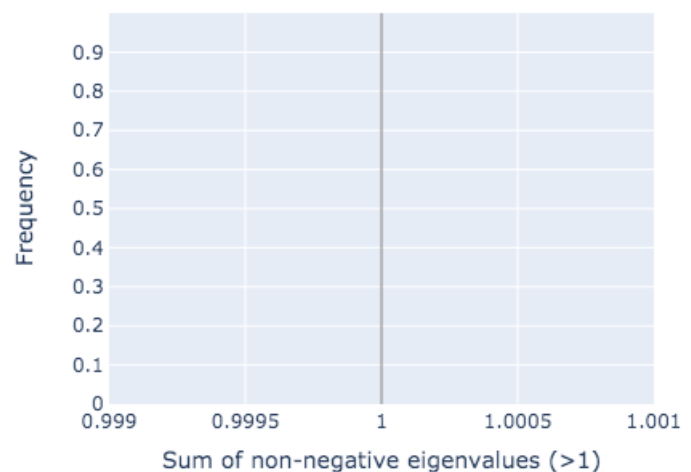
Number of unphysical estimates=0

N=100, Nrep=100



Min: -
Max: -
|Max-Min|: -

N=100, Nrep=100

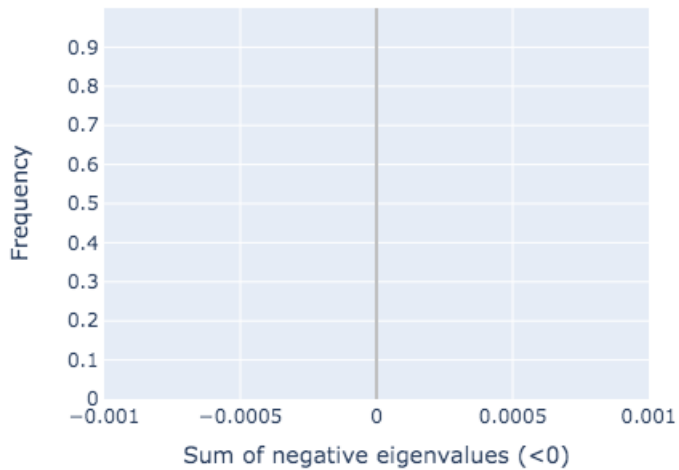


Min: -
Max: -
|Max-Min|: -

N=1000

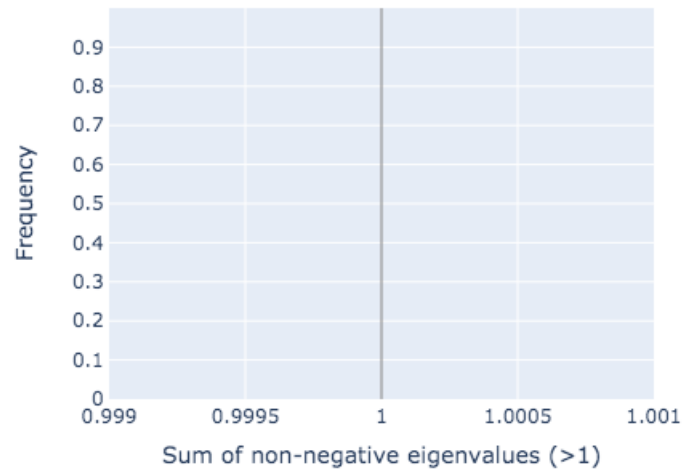
Number of unphysical estimates=0

N=1000, Nrep=100



Min: -
Max: -
|Max-Min|: -

N=1000, Nrep=100



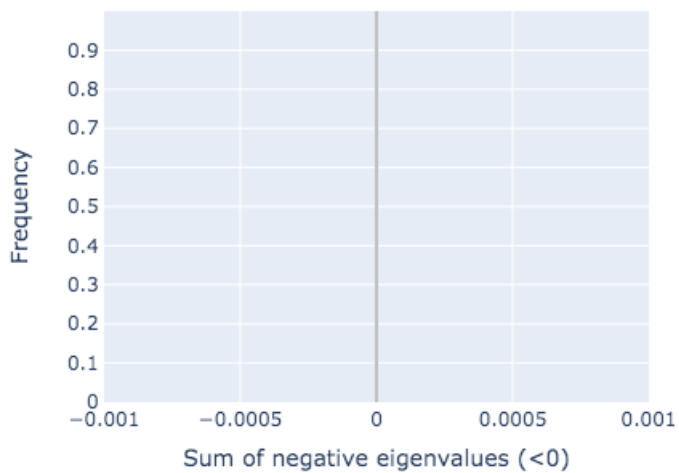
Min: -
Max: -
|Max-Min|: -

Case 5: Maximum-Likelihood(False)

N=100

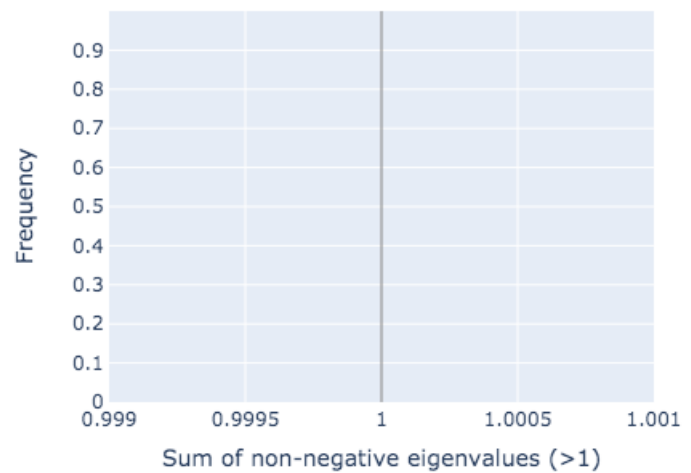
Number of unphysical estimates=0

N=100, Nrep=100



Min: -
Max: -
|Max-Min|: -

N=100, Nrep=100

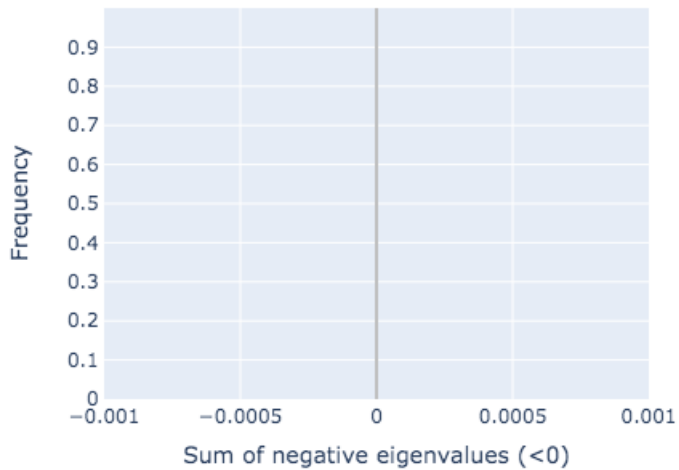


Min: -
Max: -
|Max-Min|: -

N=1000

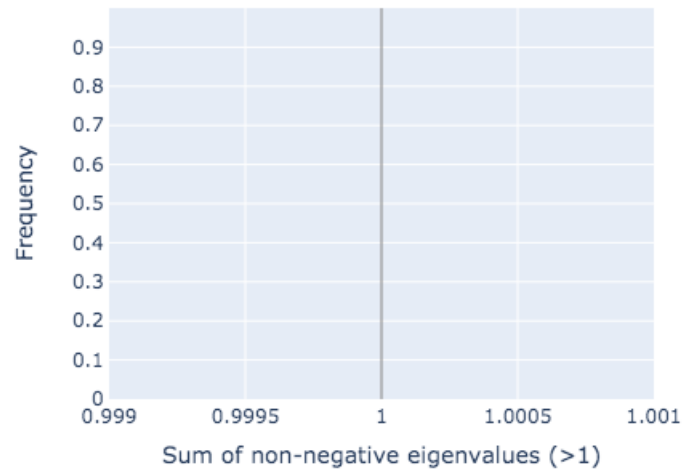
Number of unphysical estimates=0

N=1000, Nrep=100



Min: -
Max: -
|Max-Min|: -

N=1000, Nrep=100



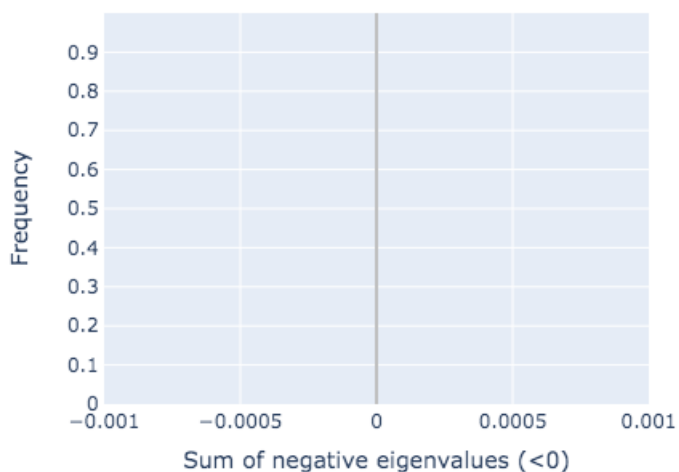
Min: -
Max: -
|Max-Min|: -

Case 6: Least Squares(True)

N=100

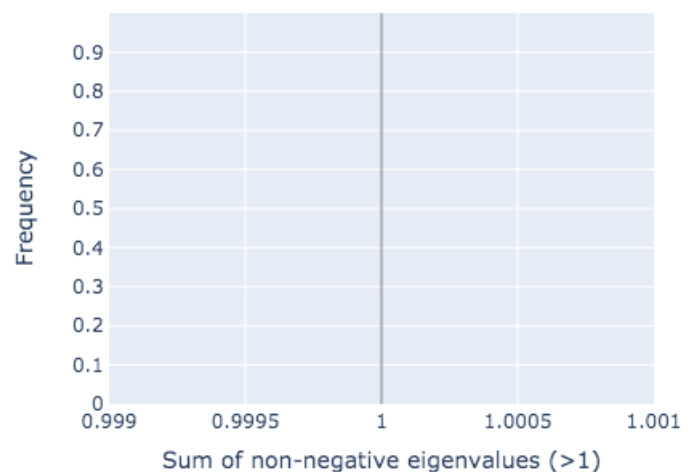
Number of unphysical estimates=0

N=100, Nrep=100



Min: -
Max: -
|Max-Min|: -

N=100, Nrep=100

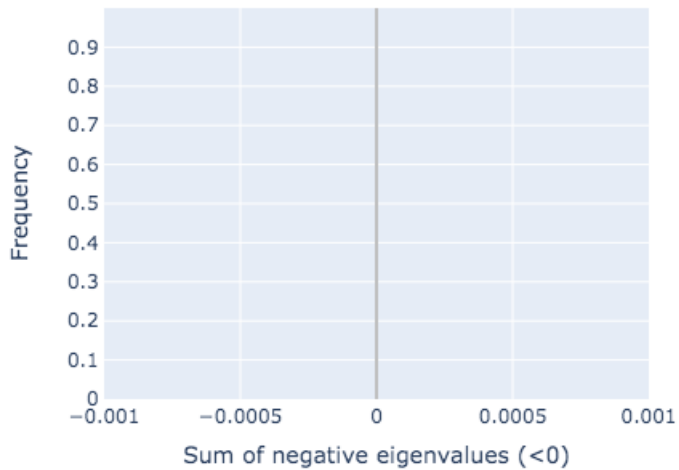


Min: -
Max: -
|Max-Min|: -

N=1000

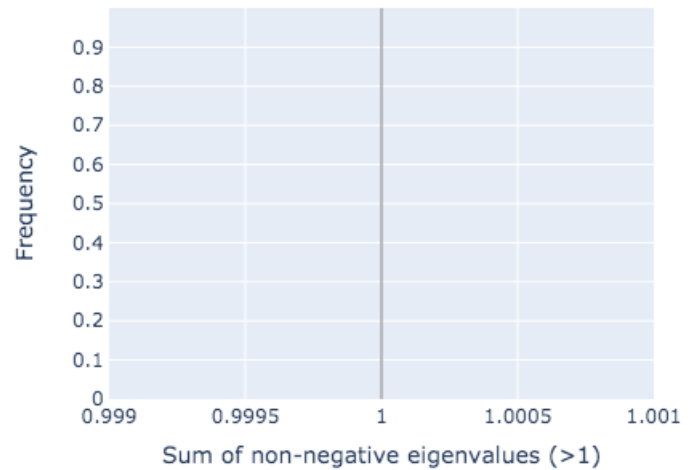
Number of unphysical estimates=0

N=1000, Nrep=100



Min: -
Max: -
|Max-Min|: -

N=1000, Nrep=100



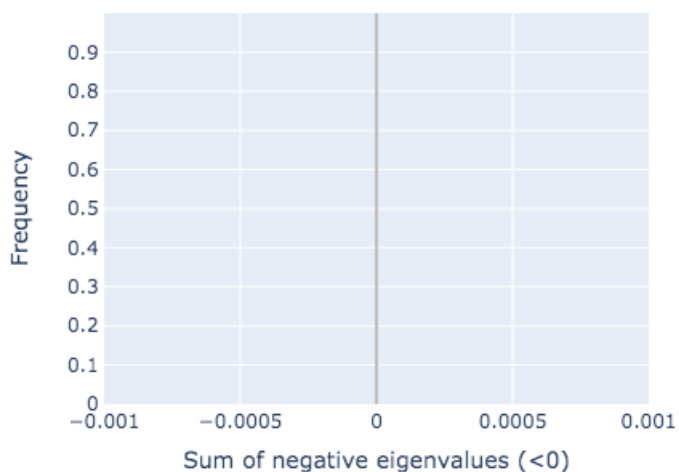
Min: -
Max: -
|Max-Min|: -

Case 7: Least Squares(False)

N=100

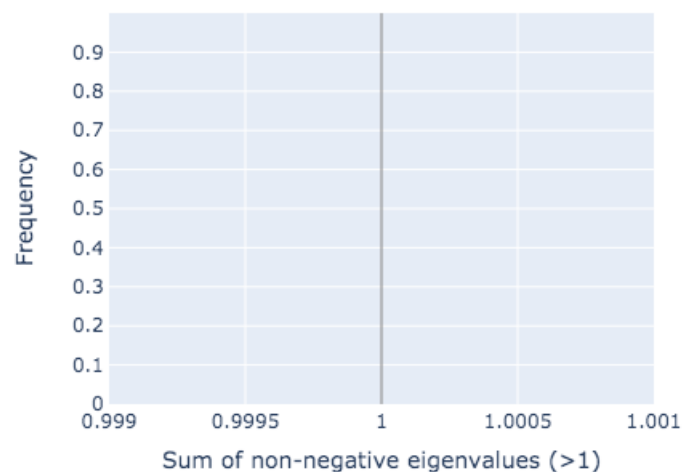
Number of unphysical estimates=0

N=100, Nrep=100



Min: -
Max: -
|Max-Min|: -

N=100, Nrep=100

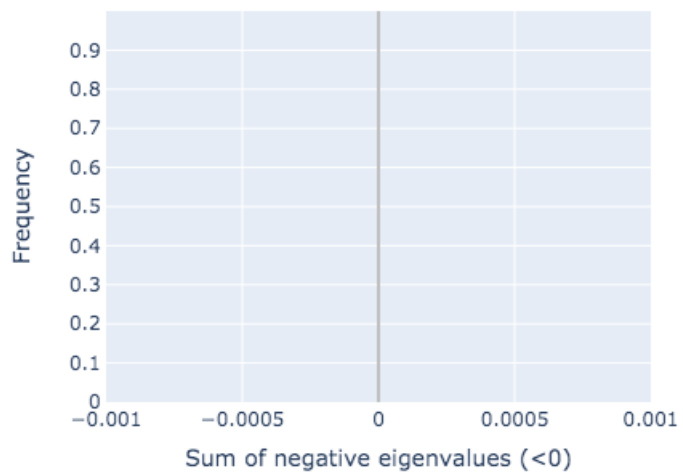


Min: -
Max: -
|Max-Min|: -

N=1000

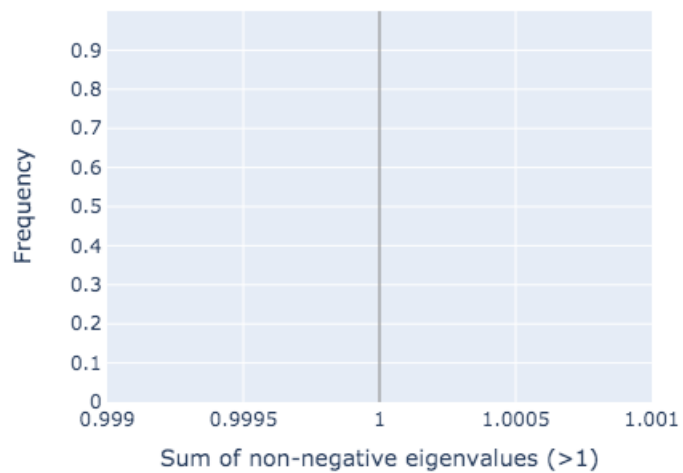
Number of unphysical estimates=0

N=1000, Nrep=100



Min: -
Max: -
|Max-Min|: -

N=1000, Nrep=100



Min: -
Max: -
|Max-Min|: -