

Supplementary Information

The following table shows the 13 versions of BNF Grammar for achieving optimal entropy. The evolutionary parameters like population and generation varied between [1-20]. The time taken by the initial versions was much higher as 10 seconds while the time drastically reduced from 5 seconds to 1 in the versions from 10 onwards.

Supplementary Table S1. BNF Grammar versions

[illegible]

[illegible]

Optimal crossover rates were tuned with experiments carried over 100 runs against the time taken by them.
 Supplementary Table S2: Varying crossover rates for tuning the genetic operators

#runs	Crossover Rates						
	0.01	0.05	0.001	0.003	0.005	0.1	0.0001
1	7.389	7.64	6.018	5.005	6.361	8.029	4.753
2	6.525	6.714	4.961	4.663	5.905	8.106	4.676
3	6.109	7.744	6.218	4.547	4.897	6.948	4.835
4	6.408	7.643	6.12	5.047	5.72	9.596	4.719
5	7.207	7.398	5.846	5.543	6.716	7.194	5.442
6	6.754	6.901	6.057	4.923	5.457	8.128	4.891
7	6.501	7.233	7.002	5.051	5.443	7.119	4.919
8	6.735	7.444	5.763	5.337	6.676	7.849	4.879
9	6.453	6.943	6.079	5.156	6.035	7.208	4.738
10	6.956	8.425	5.99	4.75	5.53	7.871	4.699
11	6.66	7.265	7.027	5.523	5.555	7.726	4.75
12	6.188	7.404	6.204	5.211	5.687	7.942	4.938
13	6.976	6.735	7.7	5.773	4.976	7.65	5.922
14	6.794	7.398	5.814	5.355	5.51	7.635	5.79
15	6.493	7.642	5.432	5.162	5.944	6.259	5.259
16	6.837	7.501	5.763	5.22	4.673	7.828	5.092
17	6.31	7.35	6.266	5.437	4.163	7.575	5.03
18	6.632	7.335	6.827	4.705	5.214	8.059	5.135
19	7.242	7.408	5.798	4.546	6.224	7.92	5.036
20	7.152	7.095	5.375	5.064	6.003	7.125	5.128
21	7.387	7.594	6.035	5.75	5.936	8.341	5.044
22	7.589	6.941	4.879	5.143	5.215	6.995	4.924
23	6.58	7.349	5.06	5.866	5.068	8.802	4.717
24	6.67	7.569	5.778	5.853	6.045	6.835	5.202
25	7.009	6.595	5.799	5.615	5.391	7.948	5.357
26	7.141	7.104	5.423	5.529	5.614	7.377	6.022
27	6.768	7.562	5.158	4.796	5.983	6.013	5.155
28	6.517	7.556	5.861	4.929	5.947	6.88	4.929
29	6.451	7.923	5.48	4.387	5.856	7.864	5.446
30	6.752	7.597	6.012	5.726	5.294	6.067	5.282
31	6.415	7.307	5.957	4.982	6.317	7.195	5.38
32	7.273	7.532	5.611	4.75	5.905	8.07	5.149
33	6.885	7.419	5.532	5.726	5.558	8.172	4.921
34	6.66	7.49	5.352	4.987	5.09	8.142	4.931
35	6.41	7.286	5.621	5.284	5.43	7.568	5.203
36	6.809	7.242	5.67	5.574	5.989	6.691	6.028
37	6.561	7.48	5.261	5.336	6.292	8.141	5.483
38	6.895	5.684	6.131	5.755	6.029	8.31	5.66
39	6.526	5.202	5.802	5.705	5.211	7.76	5.762
40	6.982	5.301	5.268	5.495	5.675	7.301	5.394
41	6.76	5.204	5.472	5.295	5.208	7.036	5.318
42	6.877	5.738	5.302	5.211	6.044	7.953	5.024
43	6.764	4.723	5.964	6.06	5.728	7.535	6.138
44	7.078	5.588	5.908	5.424	5.653	7.776	6.604
45	7.209	5.51	5.838	4.594	6.031	8.358	5.024
46	6.923	4.929	5.953	4.685	5.939	7.592	5.364

47	6.982	3.348	5.581	5.75	4.989	7.272	5.444
48	6.753	3.525	5.755	4.677	7.126	8.088	5.521
49	7.013	3.684	4.157	5.605	5.336	8.383	4.96
50	6.872	4.305	3.8	5.18	6.584	7.743	5.084
51	7.175	2.925	3.659	5.197	5.652	7.475	5.394
52	6.864	3.977	3.645	6.287	4.756	7.549	5.837
53	6.892	3.394	2.81	6.021	6.102	7.891	5.785
54	6.506	3.25	3.096	5.469	4.59	7.559	5.2
55	7.185	4.023	3.136	6.21	5.924	8.012	4.881
56	6.87	3.471	3.328	5.73	5.502	6.996	4.943
57	7.116	3.022	3.742	5.385	5.778	7.706	4.911
58	6.74	3.9	2.786	5.302	5.692	7.459	4.887
59	6.79	3.071	3.171	4.339	5.625	8.422	4.771
60	6.889	2.899	3.555	5.779	5.174	7.857	4.919
61	6.707	2.892	2.879	5.17	5.245	7.267	4.849
62	6.803	2.938	3.041	5.185	5.502	7.573	5.029
63	6.782	3.489	3.372	6.366	6.187	8.35	5.262
64	6.783	3.239	3.427	5.331	6.262	6.456	5.105
65	9.661	3.686	3.362	5.499	5.946	7.381	5.676
66	12.057	4.091	3.901	5.251	5.388	7.733	5.622
67	12.655	4.085	3.537	5.522	6.083	7.508	5.239
68	13.204	3.977	3.309	5.141	5.4	6.994	5.281
69	12.81	3.656	3.254	5.826	5.968	7.43	5.427
70	12.716	3.456	3.657	5.704	5.913	7.863	4.782
71	8.28	2.961	3.736	7.129	5.367	8.18	5.575
72	7.521	4.078	3.218	6.472	5.917	7.269	5.634
73	7.948	3.667	3.02	6.718	5.695	7.358	6.476
74	7.495	3.286	3.538	6.434	6.527	7.963	6.728
75	7.005	4.748	3.955	6.312	5.744	7.282	6.426
76	7.229	3.923	4.496	6.754	5.511	7.107	6.49
77	7.819	3.151	4.463	5.484	5.492	7.045	6.505
78	4.841	3.036	4.295	5.151	6.333	7.47	5.213
79	7.019	3.352	3.865	5.184	5.974	8.191	5.494
80	7.553	3.27	4.453	5.988	5.276	8.739	6.049
81	7.294	3.582	4.512	6.364	5.438	8.014	5.468
82	7.014	3.955	3.915	6.031	5.819	7.4	4.355
83	8.201	3.475	4.401	5.775	5.784	6.925	4.232
84	7.704	4.232	3.079	5.514	4.836	4.571	4.366
85	7.865	3.092	3.732	5.134	5.31	3.681	4.123
86	7.371	3.588	3.923	5.843	5.569	11.089	5.016
87	7.52	3.805	3.483	4.118	6.247	3.936	4.737
88	7.248	3.794	3.257	5.219	6.322	3.762	4.597
89	6.967	3.62	2.773	6.142	5.767	6.421	4.379
90	6.915	3.211	3.356	5.106	7.349	5.189	4.449
91	6.884	2.736	3.48	5.751	7.196	3.876	5.006
92	7.287	3.082	3.711	4.924	6.891	4.094	4.467
93	6.976	4.046	3.59	5.293	6.064	4.095	4.492
94	7.646	3.961	3.507	5.764	5.402	6.472	4.233
95	7.098	3.937	3.583	6.058	4.019	5.628	4.772
96	7.205	3.648	3.092	5.477	5.916	6.583	4.757

97	7.808	3.14	3.259	4.86	5.718	4.689	4.943
98	7.596	3.423	3.378	5.374	5.775	4.117	5.19
99	7.94	3.549	3.043	6.19	6.111	5.214	5.075
100	7.169	3.099	3.421	5.17	5.695	4.07	5.264

Optimal mutation rates were tuned with experiments carried over 100 runs against the time taken by them.
Supplementary Table S3: Varying mutation rates for tuning the genetic operators

#runs	Mutation Rates					
	0.01	0.03	0.05	0.1	0.3	0.5
1	4.753	5.6	6.231	5.801	8.101	5.993
2	4.676	6.823	6.169	5.716	6.599	5.845
3	4.835	5.759	5.626	6.081	5.767	5.705
4	4.719	5.374	5.695	5.962	6.137	6.204
5	5.442	5.63	5.643	6.365	6.236	6.832
6	4.891	5.886	5.683	5.917	6.377	5.869
7	4.919	7.545	6.035	6.29	5.902	5.972
8	4.879	7.487	6.171	6.144	6.126	5.942
9	4.738	6.327	5.564	6.467	6.023	5.902
10	4.699	5.883	6.287	6.422	5.969	5.96
11	4.75	6.063	6.36	5.855	5.837	6.029
12	4.938	5.867	5.814	6.629	5.782	5.819
13	5.922	6.254	5.595	6.37	6.018	5.662
14	5.79	6.762	5.727	6.175	5.927	5.796
15	5.259	5.843	5.811	5.99	5.855	6.057
16	5.092	5.63	5.616	5.516	5.994	5.883
17	5.03	6.116	6.173	6.431	5.79	5.818
18	5.135	5.88	6.43	6.325	5.834	5.76
19	5.036	6.304	5.893	6.099	5.818	5.713
20	5.128	5.818	5.972	6.289	6.701	5.528
21	5.044	6.137	5.752	6.38	5.86	5.903
22	4.924	6.071	6.186	5.92	6.02	5.968
23	4.717	6.182	5.785	5.809	6.069	5.474
24	5.202	6.384	5.785	5.957	5.879	5.853
25	5.357	6.345	6.32	5.957	5.598	5.789
26	6.022	6.458	5.886	5.797	5.836	5.883
27	5.155	6.413	5.7	6.054	5.749	6.351
28	4.929	6.835	5.804	6.241	6.761	5.868
29	5.446	8.575	6.066	5.961	5.449	5.766
30	5.282	6.203	5.647	5.827	6.101	5.785
31	5.38	6.782	6.877	6.024	6.244	6.031
32	5.149	6.416	6.066	6.895	6.297	5.738
33	4.921	5.98	5.671	6.098	6.053	5.761
34	4.931	5.674	6.07	5.911	5.797	5.447
35	5.203	5.919	5.918	5.935	6.042	5.807
36	6.028	5.501	5.78	6.723	6.003	5.865
37	5.483	5.521	5.844	6.066	6.082	5.539
38	5.66	6.064	5.838	6.237	5.961	6.18
39	5.762	5.282	6.232	6.034	6.531	5.991
40	5.394	5.396	6.178	6.034	5.886	6.451
41	5.318	5.638	7.032	6.425	5.824	5.971

42	5.024	5.494	6.795	5.96	6.035	5.922
43	6.138	5.531	6.361	5.898	5.945	5.996
44	6.604	5.591	6.05	6.411	6.42	5.837
45	5.024	5.577	8.016	6.748	6.365	5.932
46	5.364	5.644	6.733	6.787	6.235	5.759
47	5.444	5.723	6.471	6.115	6.254	6.358
48	5.521	5.647	6.878	6.018	6.258	6.183
49	4.96	5.346	6.142	6.542	6.547	6.532
50	5.084	5.729	6.325	6.123	6.341	5.901
51	5.394	5.358	6.575	6.351	6.156	6.036
52	5.837	5.395	5.974	5.967	6.79	6.066
53	5.785	5.439	6.16	6.1	6.318	5.781
54	5.2	5.784	6.013	5.728	6.218	5.943
55	4.881	5.491	6.588	5.9	6.386	5.997
56	4.943	6.134	7.28	5.955	7.05	5.897
57	4.911	5.489	12.545	5.833	6.754	5.809
58	4.887	6.297	6.396	5.82	6.11	6.07
59	4.771	6.858	5.982	7.585	6.228	6.022
60	4.919	5.88	6.234	4.994	6.059	5.852
61	4.849	5.478	6.398	5.192	6.32	5.913
62	5.029	5.457	6.197	4.846	6.151	5.941
63	5.262	5.351	6.197	4.908	6.359	6.028
64	5.105	5.705	5.711	4.559	6.419	5.79
65	5.676	5.427	5.841	4.968	6.183	5.757
66	5.622	5.359	5.795	5.294	6.18	5.71
67	5.239	5.523	5.817	5.183	6.022	6.141
68	5.281	5.574	5.681	5.578	5.937	5.751
69	5.427	5.567	5.726	4.528	5.843	5.934
70	4.782	5.544	6.078	4.659	5.938	5.765
71	5.575	5.608	5.994	5.124	5.921	5.898
72	5.634	5.545	6.026	4.548	5.606	5.559
73	6.476	5.967	5.697	4.485	5.885	5.802
74	6.728	5.229	5.527	4.799	5.744	5.804
75	6.426	5.274	5.959	5.026	5.709	5.657
76	6.49	5.226	5.781	6.181	5.846	5.871
77	6.505	5.287	6.495	5.621	5.816	5.772
78	5.213	5.649	6.748	7.567	6.01	5.918
79	5.494	5.401	5.96	7.82	5.869	5.859
80	6.049	5.395	5.656	5.289	5.595	6.594
81	5.468	5.336	6.38	5.205	5.697	5.934
82	4.355	5.498	5.964	5.005	5.763	5.937
83	4.232	5.425	5.783	4.798	6.639	6.145
84	4.366	5.448	5.766	6.87	6.248	6.022
85	4.123	5.852	6.541	5.834	5.801	6.149
86	5.016	5.559	5.851	5.968	5.9	5.654
87	4.737	5.304	6.277	5.553	5.858	5.838
88	4.597	5.486	5.798	5.9	6.022	5.698
89	4.379	5.399	6.208	5.982	6.001	5.571
90	4.449	5.451	5.803	6.022	6.102	5.737
91	5.006	6.044	5.927	6.205	6.072	6.144

92	4.467	6.305	5.972	6.499	6.078	5.892
93	4.492	5.463	5.972	6.106	5.86	6.436
94	4.233	5.41	5.726	6.17	6.253	5.772
95	4.772	5.547	6.071	6.051	5.807	6.045
96	4.757	5.569	6.274	6.333	5.867	5.772
97	4.943	5.399	5.979	7.259	6.002	5.775
98	5.19	5.577	6.213	6.55	6.103	5.911
99	5.075	5.335	5.778	5.416	5.835	5.672
100	5.264	5.413	6.078	4.939	6.117	6.066

Supplementary Table S4: Entropy over 100 runs

#runs	Entropy
1	7.91102
2	7.91703
3	7.9262
4	7.92163
5	7.90775
6	7.92124
7	7.90564
8	7.93104
9	7.93119
10	7.93074
11	7.92313
12	7.91097
13	7.92033
14	7.92928
15	7.9215
16	7.91987
17	7.91225
18	7.93464
19	7.9204
20	7.9228
21	7.91559
22	7.91357
23	7.91692
24	7.93121
25	7.94383
26	7.92122
27	7.92764
28	7.92918
29	7.91402
30	7.91927
31	7.92784
32	7.91364
33	7.92074
34	7.94268
35	7.90352
36	7.92589
37	7.92231

38	7.92816
39	7.93054
40	7.92257
41	7.90599
42	7.91851
43	7.9199
44	7.90858
45	7.91651
46	7.91752
47	7.9321
48	7.92753
49	7.89722
50	7.93413
51	7.91413
52	7.93433
53	7.92043
54	7.91905
55	7.91722
56	7.92222
57	7.93068
58	7.91159
59	7.92226
60	7.93006
61	7.92065
62	7.91629
63	7.92531
64	7.92401
65	7.90452
66	7.91955
67	7.93319
68	7.91651
69	7.92468
70	7.91583
71	7.91736
72	7.92062
73	7.91077
74	7.90494
75	7.92135
76	7.92066
77	7.92674
78	7.9205
79	7.93148
80	7.93045
81	7.90999
82	7.92389
83	7.91119
84	7.92563
85	7.909
86	7.92343
87	7.92534

Supplementary Table S6: Best Individuals over 100 runs

Best Individual	Entropy
Bq}1g0B?c0U:U4b'2o<M4h'N8i^AG8c]	7.914675
F1\$0vH9}jY3-&dE9P1q]?X3iIi;6#Q2h	7.901449
2b!J'U4uJ8u>?W9nWf>3o5E~Y9s?4c)J	7.910861
4x~FoA8?@M4ouH3~6t~02t,DeU6&,I0c	7.910869
8y&UPa=5i5E~rG5}k5U~Mq\$6Fu}9#C5t	7.904819
Z9e@T6w=,jL6>W2bJh+0^G6wLg^3Dh!6	7.900141
4b~A7s&DIv~99i]LFq[9K1n{`pY4E2m`	7.907121
{nP6T5p!2w=KaV8?M4tO9x)P6y)^aQ0	7.909224
^zC6aD5)d6S~xI2{16V!0f*XgR9-i5V>	7.904688
tP0;Lz:3nH4}-W5o}H9g100~aO2=dR1	7.927946
K3o:d7O.U0a~G5i2j=J@W4aUv_8\$Q9i	7.920372
?pO6Gy!6z0E#Z1w>Aq}2V7b{aL7(i2S\$	7.913996
t5E>3w~Z+oB1i4Q=U8s>l3B<?rE1vO6'	7.900216
3o>HRz+1*jE3t0C]Q9f}E1b_E5m[Ge<4	7.910652
J9g~~G4hZ9l+qT8^-nC7^J5nQ2w]P7q~	7.915857
^kV6B6m~S1}3Z0q!e6L(Q9n.1k=CyW3(	7.904797
{R1e+U0heH6;c7Q~rC6-J0z>O3k<g8X{	7.908137
e8Y(6p#L~X7aI3k(z9X]V1q?Kg_0o4K~	7.920218
mO2:+bU1V81(>bO2c5P=J9d`xB2+Uz>5	7.904202
0e:JfB1;<bZ8oS2\$fK6=m2L(k2D`1E6!	7.917384
8k<KcQ6'&nH1Y2o+&Y1p@yN8~vF97i]J	7.910542
Q0i{3z}Y?W8zq9V&3u{Tp1U_Fz}3aE9;	7.901148
L2c_J4c?'iN79n!BkH1'^U6p0p+7Wk}5	7.901444
q7Y=5v>Fz8A&Q8r\$W5b.K1l~P3p<0s;J	7.913708
kX9:A8j[0h~S,N8lIq<8Hv<5Wi~9(dJ4	7.906525
Fc,9C2d.;G3aRr~3K7m#(oT6V0a-]dA9	7.905599
t7Q@0x_Q0x(U_fA8wH2`M7u<1a<GjP8^	7.911254
?qR9,F4yWy)67q^HV7h}He]9`tA6<P6e	7.913
Kd[5V1p(N0v#&M6vR6z-I2f\$Jt{9U9c.	7.91705
Cm+4N7z\$c0P(<wF5B0v`.C4e0f~CZt)0	7.920103
Q9b-Xn+7~dZ8r1T^c7Q=Qw,9?E9j~W3w	7.91891
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Ho#6g8E@Dw~7e7F(7e?BG7d+6a@DQw*0	7.911356
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G0a]=vB0*nL4H4k.=T1z1W3[8x]TGq<8	7.92842
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xL6#^1G6'uP4jT1}Q6t[H8e#~fB3Q7g\$	7.901453
tZ7}sX4(5h[KXf)1z3I-R7b[B3h+U4g'	7.906757
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-Z8f5o}HcL0.!M9p0q.Fr4W#Zm)8}D2z	7.913965
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eO2~Z41~y5Q[wA0\$gP4+h6H(`H9y=gW2	7.924929
c3E?>J2fF6u:8v=VcY2*J7h\$U8j[6i;U	7.900652

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K7m&pF8,qY9]S1h+71]Lq7T]d7A;Q2h]	7.911989
0x)LdZ5,!C7f)E9odZ8#x6Y,=H2vN3w#	7.900591
>A6c1V4`Kc-5}S0vU6i,fR7}Qb.6nA5<	7.905348

s0I)X7k[uN7<Y9d(Ta]9Ut_0C7i!l4D:	7.906396
Ku;5-B2d-K3o_cL7X3n~Vn<711V^A7k'	7.918687
w5c-Dg`9Y1y\$]sX89l;QP0l?x7A~U1s]	7.924059
~yH1Xl;1[rI6wI7#]bS6Wi\$3+C4en8Z^	7.917602
&y07~I7iI2w&M1n_Ym!2uW0.3s>GG8s-	7.911195
Ts(3=0V6!P6n7i_F.N6dL7b<Cp}5uM2[	7.928549
Y4v=(I3uG0g-bT2&4a?DY3b(o1K:4g!W	7.906055
=P4ndF5)Zs*18t*AK8q&qZ8:U1r.Z9p}	7.914371
eB7{mU9#+hL9'L1mG7l)1p?K+B6xs4D#	7.910801
Z3t_@rW98e@Z`K0yZ9i!Eg>9U4g}0m;T	7.908119
d2V,uC8<B6o[aE3)F6e~+vG6<B0nW0b-	7.902731
i8X^!yR9d1D*-H1vx9S,b1E*X2e!Sk)2	7.914851
aJ1eY7?o0Y-S3zf0F(c5A(E8o;t6D_	7.905223
[lQ1Ew&7+A6q8c[PDj?1qA0#h2Y\$E4r?	7.902197
w5d+o4Z#1k{Z5n{D>L9fW7e=Ud.9T8m{	7.90492
=fP2J6h_1l+PE0i,B2l*b7C(&S2uH3i@	7.924671
]Q6i6k=QM6w=<qG2~yJ7_eF0d3Z-rN4>	7.910491
N9f_9v:S3c&JN5f:~eQ91f?Q~zZ7Ys@1	7.906485
V2d&>X0wZh+5iB8#T0n='uD1tJ0#vM5-	7.91521
1a;GoS5'*T5t1n(EQ6k?2e~N'eG9Um#7	7.905162
k2Q<&J1t>hC2c1T:j9U)l8D`m5H}6e!R	7.901911
)Z1wZ5l@zD7^5u;Nt6F]eK8#[oB2sV2]	7.909464
6c?E4u,Zf1H[4v\$KyK9;D0k]x5U=x3N!	7.906843
B4j*zQ3~-V1f0g)B~mS97n,TQ3w*C3b]	7.908906
Jk#5Jg~73s@FIb[1eR3?0e\$9M5q_0i:V	7.903913
}F5wQ3o>z0P'h9S(Bi(4Qe}5z00~+dK4	7.939958
&oH1fY1\$~xR1rV7@<qW2W2v?Ft-101a-	7.908484
0c~01l~H'H4hG2a}Ti<9uF8;(zN3N7o<	7.904683
qH7!5p-JJ6m*^tE9E6s>3n.RwD5\$u7V\$	7.905611
w7C_8h#S1e-Da3Y}oP0=j3Y>A7j;jG6[	7.903416
_uB6Q7x@.K8lpV9!c1X]W4y`7q<LnS1)	7.911683
{rM4(Z0qeX9.8u~Y*A5e`H5m9t`AFg\$3	7.902958
w3h*X2v-Yl(6Ku#5;S9arL1)zT3)8g]B	7.902012
F5c[Mt_6}z09K5s\$6l(L9z!TxA5\$Se?2	7.90563
01j*=u08=G1fH6o;v2T_F3n}k7N?3k(H	7.922074
Qv'8J6c>u09{Oc&0Sr@8D7x@A0k@w03<	7.909867
P8q^nU5>Nm^7a9G`p3G>O6g{@R6t&V6n	7.905189
U1b#t0Y-`jA59v:HfK>7S9y][S7hF2x'	7.913334
Mj=5}aE6L8a_)P5dZ3d]@M3lQ3o^,uW5	7.918948
_jJ0Ha&10w&J:M5fV5z{U2m?1e*N9z#E	7.908515
-mZ8Pc@2+F8vE8f^K6i^I5e'U9k*kB1-	7.90604
l9I'Wo`4D2h?So^0<lQ5Zo'2'vG4l1Y\$	7.907211
Lw=9eN4=j5L~Ex)6`cG5!iS3\$A9n]M5z	7.914062
A6p?P2h[H2j+K4u]0c_QC5n<~eL9s2D@	7.905229
zM5~o7D=Ji[5lY7;Q8s=w0~6]bG8(fB7	7.916388
4h]GXn.7(kL9zK7_d1R]F0g?K9u{D0i\$	7.902855

6u!X@vZ60u`F_D3eG9s*L9n#Hb?9j9C+	7.90468
Ic(4iC8.g6E-{P3qmZ9.3t?IE0q~cW2:	7.900014
<iE6C7n*Y7x&Xm-2Z2b&P8b.!cB5?K3d	7.901339
L0j[K0j{Z5a?J8b#Ed(6L2n#E6i<U9u]	7.925259
\$qJ0e8E:}zA64f.GU1v?u8E>oB8<D4z_	7.901975
f0Y`Hg&2P1!38n-Q\$jF61M7\$@uR1C2v#	7.909038
Hr?2W9j=Y8i}B3p[}S6sJz=5k8R+kN8~	7.915092
}A5j]eT5}X2l@I7nt5C=#bR2E9x]w3L_	7.920163
Kx-7@E3uY1u,#X5mtA4#Uy}4Xe\$7Rf=0	7.905835
R7v`Lq#6.xA7_N9ny1W^Em}5L5j}4k(V	7.913285
M4d#*07ib3E\$Mq-3-R9e6q@Z7o.CG0d]	7.909511
~P5hqM5)&V2nU6y,;B6p`S8pq9B*vM4^	7.909116
f9S~}uD9@fB21H9{V4k_D3w^gF0{aL6#	7.908432
:L7hyF1<Ye-9hE7-_rW2W5o~C6r&V1x]	7.919307
Er[3a1X-8r=FSi:9S2o-8i^B?L7hL1f:	7.915821
I7l<dH1]nI4<sI3.1c+NBx=5Wd<9yT7<	7.912211
I6r{pP9<\$d030q@8M9z\$M5w.fs7Nc=4	7.904686
7x[FI7o`]pZ5[jW0H6h~G9j?8s*E;I9u	7.919707
8q>V6s<ZFr~9C5i&#zJ76p^CU8g@9t\$G	7.923633
K7d*Wk,1X5a;d9H#bY9]2l[K;jZ8A1x`	7.900252
0q+Qz8U!D9x#~S5wT1h:xN5='B2qu7C(	7.909204
&C8ibT3>xY3&Ic)80j.9P7f\$F3g&01&B	7.904049
iE3\$*J2c.K0ju3C<`aI6;A6xoT9*>yT5	7.907661
Q9b-&Q0w8s[U`tR2[cK1z1V&Vv~4nL0(	7.904126
}rS44y#U3m#TK4f~M9i&=iS3&Y2wv1Q,	7.911858
.lZ3Bg.6x7A[Si`7!iQ4.L0tc00.7r!C	7.902058
]X3go4J=4c.VzR6~}Y4b&P1uk4R@tA2\$	7.914781
L6x;y4E]z2R]+R2k3a_WA3g'n8X(mJ3.	7.907642
p0M\$Nw&1S2o-Oz*2nE4<{vF5a3B*6k<F	7.916002
K8c`gN0@v4U0<sA9h6H?'dL4H6a(9p*F	7.920913
6n>WcT2}T8v-6l!DQ6f~1c,Nc7R<C1k_	7.902891
E61*(rA5[d00r3D^Ef*7kX8)Lg?5Bk\$5	7.904843
n3T?Jq(6lD2:0m<MU3r*Z7j*-Q2r2b*R	7.903294
Ly!3Bh~7zH7*b50-?K8a;yM3N4o\${mJ5	7.931716
{gD2[H3bD9y')W7wR7c)C2f<C2p--k08	7.902743
bE1>g8K-;L3xL2w{t6H`N7o_m02~F9w:	7.903878
Y9a=~mG6H5q~-y05B0n<~Q1jn2S~,iP0	7.916817
Y4t@0q`UC8x-;xE9Q7y)Q8c.P6s~Uf-9	7.905678
#iZ0x6S~Ax]3s2T){X8ye00'C5d{St(1	7.912176
3b<CZ1m~;wC6qY3).A6uu4D@,A9x@dM6	7.902712
rH5`#P7u,W21bB0,Ip,5v7D<>I0zHe}2	7.918051
^aH9mY5=12F,bJ2@]iL2iV4.Aq&0tJ8'	7.913819
Uw=8f0F;~P6uA2s^S0o&N2dw8R\$nC6,	7.905449
Sb-56z^AN0z&(A3j2p~IdT6=f80+Rn[3	7.916854
E1u+p5B`j0K>hU5@N0a`M6i!Jv(6xG7~	7.910637
W8x*B7z#04l}B0r0x\$PdL9\$f1I>@A6y	7.912283

Y2s>[P1pGu=9P3r>nR5' v8S>E2w^c4K{	7.9116222
8m*BM2w@d4F~E6i\$xM4}J7b-H9k#-Y7u	7.9114688
Vf\$94x{J_V6rh2R~-wA5Fh#4kY9:1b~L	7.9117533
aX6' Q6k+f5Q' Om?5' T1tN8t<Im?98v}T	7.9053144
2z' LV3s*S8h;W6q~Fi_2W0o-qC9{w4P+	7.9016666
.E7uf4G;vZ2(N9y+XW5*k8Y)f0B{ }K9i	7.9138077
@P9uW7a+U2s~q1F+Jh-8(J1rRk-9V0d!	7.9050222
iP1.2p,Hv8S~+hY5nU1_3z?Ei4W\$Hu_6	7.9246999
[N0d!kS00z[H1h.HU2c[Wi<40u;2L5k_	7.9209411
O8w(_B7pm50)1R5*'T2i@1J8*T3sA6n>	7.9120866
\$051nF7{W6f~Rz[1EY:9oV6}F4l(Y1=5	7.9092233
wJ}3Fa,0Uz?9kT7[M6a=n2H\$H1s=-wX1	7.9237266
7d[0rF5}Y4p[Gd;09h&At4N(5t'KiT2!	7.9183444
#W8dF1u#<X2eEh{55k:Uj7N' _dF0Q9t+	7.9191044
R2z{)P3vb8R<N1v h0H}-W0thJ5*c8B=	7.9093177
8g{ZXn)1<uO9w9C^>^T1jA9a!g9U[Ku[7	7.9117888
Ac_8{bG9o2L{Xw;6^L1q4v-E&J6m;jC0	7.9073888
yR6~N4x*Nt*0s7J=G9o;@bC6!E6nLf-2	7.9178333
'yK5W4w&O0y!hA3^A4s!Bp#5Ut[2Eh^9	7.9061122
@V0vdZ8^~vG1{W1h[hC9b7P!o9R<Ng@9	7.9114011
B7p:1m+AF3w:uK1(Gf'7)cD4>V0rZy#6	7.9032399
a7Y?z3U(1d*A=bB20f~VU5t#Qw~6Ki*5	7.9050366
Sq\$4cL7=A01:I9r' eE0!6v' RNk}39x?B	7.9042566
zL9-L0k&Xu}7Iz:0Q2m_M4d#Ub~7u2A_	7.9165866
d8C-\$nA5T0x' 8v@CkY5[vB7\$yT8.Bf~9	7.9263833

Supplementary Table S7: Examples samples from one billion of 4096-bit strings that passed NIST Tests

[illegible]

[illegible]

10011011011100010101101000100101001111111101110000000100001110101100100100011000111000110110101100011010011010000011000000001110101111111
01111111110100100000110111100100011011110011010010100001101010110011100100100001100011110100010011110010010000111001010000110110110100100100
10110101000101001011110010000110011010011101010000101101111101110100100100011001110001000111101110100000111001100010110101001
1110011000111100010101110110100110001001011100100111000011101110100100100111011110000110100111110100111110010001010101110100110110010001
100100001010100010110011111001011101010001100001000110100000001001110010011011101111001110010000110100010101010010001100110110010111001110011
10011000101111110100011111001000001

```
0011110001100010110101011110011110110001011110110110010011111111001000011110000001111011000101101001101001010101100111111011100100101
11110100011011110110000101110011011000100110000101000101000101111111000010100011000110110110000000100101001110010011110100001110000101
11001000101100001010100100010101000010100110010000000101110101110111000000001010111101001100100111001101110111011011011011010100
001111111000111010001101100101110100111000001100001101111011000110011110111000001101001010011101100111011000110000010101010000100
11001000111001010100011011101111001110010101010111100000101001011100100100101010101011100011101011110110001001111001000011111000
001111000011110010001010001101110111111011011101010010000100001100010100000111011010011001010000111011010001101010010101011
1011110001110101010101000111010011000011110101000011110101000011001100000101010011000110000000000000001100110101100010000
01001000101101111011100111111011111001010100010001110001111010000101001010110100111111010111010110101100101010000010101011
100001001011101110101011100110001000010001110010101001000010100010011100101000001001110101010000101001101000010100000
1101001010100000010001110110001011010101010010111010100111110100111000100111010100010101010111011000000101001101111011111
1101010101000001100010001010101000000100000000011001000011010100111000100110011011000100011001000010000011000000001
0111110101010100100010111110111110000010011100001000101010011000011110110011101010110100111011011110111000101010000001011
1000001011001001110011001000010100110011101010011000100001010011001100010000000010100000110101100011010110001101011001100
010111010110000010010110001010101010101010000010001000110110100111000010001111110010001001010000101000110010111101010101011
000010011001001010111110011000010111011011100100001011001000011001101001100011110101100010101010000100100101010001110
010111010000011110111010101000011010101000000110001111111010100111011110001001110001010011000110111111010001100
11101110100001001001100011100111011100111101110000010001110011110100010101000010100010001101101100110
01000110010100110001000000111010101010111000000001111000000011010000001010001010011101000000101000010100011010011
00000101010100110110110001001100110000010011010101000001001101010000100110101000010000100011000010001000010001011
0111101101010000000010000011100101000110100100011010100000101010101110110101000010101011011011010100
110110110110000000001000001110010100011010010011111010110101001011101001000101100101100001100110001100111101000110
0111011100000101111001100110000110100011000001000110001011000001100011000000000001010101000011111
1000001010001011111001100101011010110110100001001010000100100000010110111100000010101000001011111011011
000110111010011100010001110010011011000010110011101000000010010101101001011001011100110001000100101010
01000000110101000000101011110000110101000101111010110100010000010110010101101010001011000110111010011011001
01000011000001101110000100101000100010100001100000010100110010011100001011011111100000010101010001100100
1100000101010101000001111100110110011110101010100001000011101011001110100011010111001000100110100001000100101001100
0101111000111010011011000000100110010101011100011110010110011010111011001110000011110101010110001110010111010110110
100001000100001110011111001011000111100101000111101101010110010110010110010110010110000010100010100000001111
0010111100001001110000011110010101
```

One billion samples generated by GE-PRNG passed the NIST SP-800 22 tests. Some of the randomly chosen samples

Supplementary Table S8: Comparative analysis of GE-PRNG vs Python rand () for regression datasets sampling

Dataset	RMSE Value		
	Truth Value	GE-PRNG sampling	Python rand() sampling
House Prices	0.161836	0.15	0.144578
Weather	0.00079	0.000756	0.000924
Covid-19 Test Cases	0.009903	0.011449	0.009651
Car Prices	0.074534	0.0625	0.121212
Stock Market	0.780731	0.833333	0.721311
Insurance	0.000001	0.000004	0.000003
German Credit Cards	0.415842	0.45	0.619048
Fish Market	0.116	0.105	0.165
Red Wine	1	1	1
Canada (per capita income)	0.124066	0.115672	0.108209
Salary of Employees	0.342857	0.4	0.571429
Pyramid Profit/Loss	0.124066	0.115672	0.108209
Polynomial	0.104634	0.108209	0.123134
Cancer	0.103139	0.070896	0.130597
Airlines Delay	0.09716	0.093284	0.104478
Breast Cancer	0.094918	0.11194	0.074627
Covid-19 stats	0.107623	0.130597	0.108209

HIV	0.104634	0.13806	0.089552
Heights and Weights	0.093423	0.070896	0.089552
Real Estate	0.068012	0.070896	0.067164
Medical Costs	0.09434	0.085714	0.15625
Zoo Animal	0.075472	0.085714	0.03125
Life Expectancy	0.220126	0.228571	0.21875
Crime Prediction	0.163522	0.085714	0.15625
Crime	2.479307540496706	2.4725059690260234	2.466131762233014
Weather	8.519617258294826	8.58453707599059	8.54010021598746
Sales	1715.5059080722374	1703.376153582508	1751.2075533030948
Cryptocurrency	4.729222190380185	4.521690467840241	4.636451727052952
Stocks	97.87302992503635	96.15210440655348	98.45161832710266

Supplementary Table S9: GE-PRNG vs existing PRNGs

Features	Software PRNGs					Hardware PRNGs					GEPRNG
	Linux (/dev/urandom) [2]	Python [3]	AES [4]	Blum- Blum Shub [5]	ChaChaRNG [6]	ReRAM Based PRNG [7]	1-D Pseudo- Chaotic [8]	PRNG Based on Newton Complex Maps [9]	Fractal Based PRNG [10]	Micro computer based PRNG [11]	
Source of randomness	Operating system API	Random library in Python	Key from any API	API/ System default random library	NA	Resistive Random-Access Memory (ReRAM) with Linear Feedback Shift Register (LFSR)	Arnold Cat chaotic map	Newton Raphson Method	Fractals (Chaos game)	Chaotic system with RK4 method	BNF Grammar
Width of random bits	Variable: [10, max range of system]	- Variable - 64-bits basic version	-Variable: 128, 192, 256	NA	NA	14	- Variable: 32, 48, 64, 80. - Maximum is 80 bits.	49	8	8	-Variable 256, 512, 1024, 2048, 4096
Scheme of statistical evaluation	NA	NA	NIST FIPS 142-2	NA	TESTU01 and NIST SP 800-22	NIST SP 800 – 22	- NIST SP 800 – 22 - Lyapunov exponent calculation for ensuring the chaoticity.	NIST SP 800 - 22	NIST SP 800 - 22	NIST SP 800 - 22	-NIST SP 800-22 -Monte Carlo Simulations -Dataset sampling for regression analysis -Linear complexity analysis
Key space	NA	2 ¹⁹⁹³⁷ - 1	2 ⁵⁶	NA	NA	2 ¹⁴	2 ⁸⁰	2 ⁵⁸⁸ (2nd order)	2 ⁸	2 ⁸	2¹²⁸
Availability of reseeding	Yes	Yes	No	NA	NA	Available on demand. RTN is a control signal has been used to trigger the reseeding.	NA	NA	NA	NA	Yes
Throughput	NA	26.13 billion random samples per second	11 MiB/s	NA	NA	Variable (Mbps to Gbps depends on the system clock)	NA	2.9 Mbps (2nd order)	NA	NA	40.322 Mbps
Remarks/Limitations	-Reseeding requires more time if the entropy pool does not contain randomness	Only CryptMT variant is secure	<u>NA</u>	NA	NA	- On demand reseeding -ReRAM is a costly product	- Quantization issues in float to binary conversion - No Reseeding	- Quantization effects will occur since IEEE 754 double precision was adopted.	- Use of 3D chaotic model for key generation.	- Only 8 bits extracted from a 32 bit	
OS compatible	Linux, Solaris, MacOS, FreeBSD	All systems with Python support	All systems that use AES encryption	Yes	OpenBSD/FreeBSD/NetBSD	NA	NA	NA	NA	NA	

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