

## Basic statistical test of bit sequences

Date/Time: 2.07.2017,10:16 hour

file: PRG420\_p20.rnd size: 10240000 Bytes

## Test of null-hypothesis:

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 Bit stream ist a stream of truly randomly  
 drawn number 0,1 with same probability  $p = 0.5$

## Non-overlapping byte count:

00	39695	39844	40229	40178	39791	40091	39998	40262
08	40505	39944	39779	40073	39889	40150	40297	39996
10	40060	39873	40103	40242	40485	39882	40220	40108
18	39897	40131	39975	40063	40216	40366	40255	39929
20	40324	40179	40189	39791	40221	40079	39475	39797
28	39968	39780	40042	39963	40312	39761	40122	39904
30	39972	39810	40088	40085	40075	40153	39995	39974
38	40143	40171	39826	40051	39747	39947	39856	39961
40	39777	39955	39750	39897	39927	40496	39942	39955
48	39982	40284	39783	39691	39785	39446	40035	40077
50	39965	39798	40365	39792	40139	40116	39745	39624
58	39940	40226	39889	40038	40124	40088	39718	39753
60	40009	40202	40098	39947	39708	39918	39568	39921
68	40149	40045	40073	40003	40205	40404	39951	39919
70	40050	39992	40109	39633	40212	39716	40071	39535
78	40383	40173	39800	40077	39858	40208	40035	40051
80	40301	40034	40000	40060	40010	40051	39602	39880
88	40016	40149	39692	40130	39939	40229	40397	39861
90	40256	39910	40051	40106	40168	40077	40167	40187
98	40362	40132	40066	39990	39963	40150	39602	40319
a0	40099	39822	39995	39874	40128	39902	40091	40104
a8	40170	40092	39984	40128	39939	40143	40032	39983
b0	39867	40440	39999	40105	39728	40298	39877	39725
b8	39868	39886	39960	40106	40239	39889	39749	39714
c0	39879	40022	39996	39969	40031	40376	40237	39874
c8	39707	40317	39636	39851	39867	40046	39482	39958
d0	39803	39859	39982	39683	39457	40335	40169	39721
d8	40133	39814	39771	39966	39914	40139	39910	40219
e0	40091	40201	39857	39767	40054	40242	39766	39384
e8	39901	40172	40081	40239	40055	40173	39766	40051
f0	39751	40168	39818	40126	40194	40097	40053	40307
f8	39693	40088	39900	39831	39943	40095	39921	39887

Evaluation of count of 10240000 Bytes = 81920000 Bits:

Theoretical average of byte-frequencies: 40000  
 'e7' = 39384 (minimum) '08' = 40505 (maximum)

Theoretical interval I of byte-frequencies:  
 I = (39609 to 40391) (for 95 % of 256 frequency)

## Test 1:

The theoretical permissible number of the 5% outliers (average 13)  
 from the interval I is between 6 and 20

The real number of the outliers from interval I:  
 smaller: 9 greater: 6 summary: 15

## Test 2:

Evaluation of byte-frequencies

Chi-square non-overlapping:  
Theoretical maximum chi-square = 293.25  
Chi-square value = 267.50

Chi-square overlapping:  
Theoretical maximum chi-square = 155.40  
Chi-square value = 135.65

Test 3:

$r = 0.49990097$  (relative frequency of bit 1 in the bit stream)

For a truly random sequence, the probability for  $r$  to have values in the complement of the open interval  $(0.49990097, 0.50009906)$  is  $w = 0.07293598$ . If  $w$  is very small (e.g.,  $w < 0.05$ ), the null-hypothesis is rejected. If more sequences can be tested, the probability  $w$  has to be  $\geq 0.05$  for about 95% of the tested bit sequences.

Test 4:

Frequencies of overlapping 2-tuples:  
tuples 00: 20486514      tuples 01: 20481599  
tuples 10: 20481598      tuples 11: 20470289

Check size: Chi-square of 2-bit patterns minus chi square of 1-bit patterns  
Theoretical maximum chi-square = 5.99  
Chi-square value = 3.71

Test 5:

Frequencies of 2-tuples on even places:  
tuples 00: 10242320      tuples 01: 10243698  
tuples 10: 10239774      tuples 11: 10234208

Theoretical maximum chi-square = 7.81  
Chi-square value = 5.14

Test 6:

Frequencies of 2-tuples on odd places:  
tuples 00: 10244194      tuples 01: 10237901  
tuples 10: 10241824      tuples 11: 10236081

Theoretical maximum chi-square = 7.81  
Chi-square value = 3.97

Result of statistical analysis of file PRG420\_p20.rnd:

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The tests: 1 2 3 4 5 6 were fulfilled!

The null-hypothesis is accepted!

#####  
THE NIST STATISTICAL TEST SUITE  
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1. FREQUENCY TEST  
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Computational information:  
(a) The nth partial sum = -1606  
(b)  $S_n/n$  = -0.001606

p\_value = 0.108274, SUCCESS

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2. BLOCK FREQUENCY TEST  
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Computational information:  
(a)  $\chi^2$  = 124445.500000  
(b) # of substrings = 125000  
(c) block length = 8

p\_value = 0.866352, SUCCESS

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3. CUMULATIVE SUMS TEST  
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Cumulative sums forward test:  
Computational information:  
(a) The maximum partial sum =

p\_value = 0.082303, SUCCESS

Cumulative sums reverse test:  
Computational information:  
(a) The maximum partial sum =

p\_value = 0.120762, SUCCESS

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4. RUNS TEST  
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Computational information:  
(a)  $P_i$  = 0.499197  
(b)  $V_{n\_obs}$  (Total # of runs) = 500238  
(c)  $V_{n\_obs} - 2 n p_i (1-p_i)$   
----- = 0.338407  
 $2 \sqrt{2n} p_i (1-p_i)$

p\_value = 0.632237, SUCCESS

-----  
5. LONGEST RUNS OF ONES TEST  
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Computational information:

- (a) N (# of substrings) = 100
- (b) M (Substring Length) = 10000
- (c) Chi<sup>2</sup> = 10.711020

Frequency

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<=10	11	12	13	14	15	>=16
11	20	32	10	17	6	4

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p\_value = 0.097729, SUCCESS

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6. RANK TEST  
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Computational information:

- (a) Probability P<sub>32</sub> = 0.288788
- (b) P<sub>31</sub> = 0.577576
- (c) P<sub>30</sub> = 0.133636
- (d) Frequency F<sub>32</sub> = 267
- (e) F<sub>31</sub> = 584
- (f) F<sub>30</sub> = 125
- (g) # of matrices = 976
- (h) Chi<sup>2</sup> = 1.739073
- (i) NOTE: 576 BITS WERE DISCARDED.

p\_value = 0.419146, SUCCESS

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7. DFT TEST  
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Computational information:

- (a) Percentile = 95.044200
- (b) N<sub>1</sub> = 475221.000000
- (c) N<sub>o</sub> = 475000.000000
- (d) d = 1.434037

p\_value = 0.151562, SUCCESS

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8. NONOVERLAPPING TEMPLATES TEST  
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Computational information:

LAMBDA = 122.061523  
M = 125000, N = 8, m = 10, n = 1000000

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Template	W <sub>1</sub>	W <sub>2</sub>	W <sub>3</sub>	W <sub>4</sub>	W <sub>5</sub>	W <sub>6</sub>	W <sub>7</sub>	W <sub>8</sub>
1100100100	119	109	112	140	130	129	137	131

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chi2\_value = 8.490572  
p\_value = 0.387072, SUCCESS

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9. OVERLAPPING TEMPLATE OF ALL ONES TEST

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Computational information:

(a) n (sequence\_length) = 1000000  
(b) m (block length of 1s) = 10  
(c) M (length of substring) = 1032  
(d) N (number of substrings) = 968  
(e) lambda [(M-m+1)/2^m] = 0.999023  
(f) eta = 0.499512

Frequency:

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0	1	2	3	4	>=5	Chi^2
613	135	79	60	36	45	4.8403

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p\_value = 0.435681, SUCCESS

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10. UNIVERSAL TEST

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Computational information:

(a) L = 7  
(b) Q = 1280  
(c) K = 141577  
(d) sum = 877223.704781  
(e) sigma = 0.002768  
(f) variance = 3.125000  
(g) exp\_value = 6.196251  
(h) phi = 6.196089  
(i) WARNING: 1 bits were discarded.

p\_value = 0.953448, SUCCESS

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11. APPROXIMATE ENTROPY TEST

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Computational information:

(a) m (block length) = 5  
(b) n (sequence length) = 1000000  
(c) Chi^2 = 38.800964  
(d) Phi(m) = -3.465709  
(e) Phi(m+1) = -4.158837  
(f) ApEn = 0.693128  
(g) Log(2) = 0.693147

p\_value = 0.189840, SUCCESS

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12. RANDOM EXCURSIONS TEST  
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Computational information:

- (a) Number Of Cycles (J) = 0804
- (b) Sequence Length (n) = 1000000
- (c) Rejection Constraint = 500.000000

x = -4 chi^2 = 3.269459 p\_value = 0.658521, SUCCESS  
x = -3 chi^2 = 2.788716 p\_value = 0.732520, SUCCESS  
x = -2 chi^2 = 6.204779 p\_value = 0.286800, SUCCESS  
x = -1 chi^2 = 9.621891 p\_value = 0.086686, SUCCESS  
x = 1 chi^2 = 6.689055 p\_value = 0.244812, SUCCESS  
x = 2 chi^2 = 5.241631 p\_value = 0.387109, SUCCESS  
x = 3 chi^2 = 4.014579 p\_value = 0.547319, SUCCESS  
x = 4 chi^2 = 4.695597 p\_value = 0.454147, SUCCESS

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13. RANDOM EXCURSIONS VARIANT TEST  
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Computational information:

- (a) Number Of Cycles (J) = 804
- (b) Sequence Length (n) = 1000000

(x = -9) Total visits = 1007; p-value = 0.219521  
SUCCESS  
(x = -8) Total visits = 981; p-value = 0.254418  
SUCCESS  
(x = -7) Total visits = 906; p-value = 0.480511  
SUCCESS  
(x = -6) Total visits = 840; p-value = 0.786634  
SUCCESS  
(x = -5) Total visits = 828; p-value = 0.841870  
SUCCESS  
(x = -4) Total visits = 846; p-value = 0.692198  
SUCCESS  
(x = -3) Total visits = 796; p-value = 0.928907  
SUCCESS  
(x = -2) Total visits = 775; p-value = 0.676286  
SUCCESS  
(x = -1) Total visits = 836; p-value = 0.424866  
SUCCESS  
(x = 1) Total visits = 756; p-value = 0.231302  
SUCCESS  
(x = 2) Total visits = 800; p-value = 0.954074  
SUCCESS  
(x = 3) Total visits = 858; p-value = 0.547018  
SUCCESS  
(x = 4) Total visits = 837; p-value = 0.755767  
SUCCESS  
(x = 5) Total visits = 824; p-value = 0.867959  
SUCCESS  
(x = 6) Total visits = 829; p-value = 0.850896  
SUCCESS

(x = 7) Total visits = 741; p-value = 0.663027  
SUCCESS  
(x = 8) Total visits = 665; p-value = 0.370784  
SUCCESS  
(x = 9) Total visits = 677; p-value = 0.442408  
SUCCESS

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14. SERIAL TEST

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Computational information:

(a) Block length (m) = 5  
(b) Sequence length (n) = 1000000  
(c) Psi\_m = 53.007296  
(d) Psi\_m-1 = 32.695648  
(e) Psi\_m-2 = 15.806208  
(f) Del\_1 = 20.311648  
(g) Del\_2 = 3.422208

p\_value1 = 0.206511, SUCCESS  
p\_value2 = 0.905143, SUCCESS

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15. LEMPEL-ZIV COMPRESSION TEST

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Computational information:

(a) W (# of words) = 69596

p\_value = 0.818910, SUCCESS

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#####
Diehard Test-Suite
#####
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```
BIRTHDAY SPACINGS TEST, M= 512 N=2**24 LAMBDA= 2.0000
PRG420_p20.rnd using bits 1 to 24 p-value= .023697
PRG420_p20.rnd using bits 2 to 25 p-value= .196875
PRG420_p20.rnd using bits 3 to 26 p-value= .264219
PRG420_p20.rnd using bits 4 to 27 p-value= .147827
PRG420_p20.rnd using bits 5 to 28 p-value= .559621
PRG420_p20.rnd using bits 6 to 29 p-value= .106632
PRG420_p20.rnd using bits 7 to 30 p-value= .942099
PRG420_p20.rnd using bits 8 to 31 p-value= .323984
PRG420_p20.rnd using bits 9 to 32 p-value= .308631
```

```
The 9 p-values were
.023697 .196875 .264219 .147827 .559621
.106632 .942099 .323984 .308631
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A KSTEST for the 9 p-values yields .918766
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OPERM5 test for file PRG420_p20.rnd
chisquare for 99 degrees of freedom=126.087; p-value= .965576
OPERM5 test for file PRG420_p20.rnd
chisquare for 99 degrees of freedom= 87.426; p-value= .209125
-----
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```
Binary rank test for PRG420_p20.rnd
Rank test for 31x31 binary matrices:
rows from leftmost 31 bits of each 32-bit integer
rank observed expected (o-e)^2/e sum
28 238 211.4 3.342203 3.342
29 5105 5134.0 .163925 3.506
30 23179 23103.0 .249702 3.756
31 11478 11551.5 .467976 4.224
```

```
chisquare= 4.224 for 3 d. of f.; p-value= .781641
```

```
Binary rank test for PRG420_p20.rnd
Rank test for 32x32 binary matrices:
rows from leftmost 32 bits of each 32-bit integer
rank observed expected (o-e)^2/e sum
29 207 211.4 .092324 .092
30 5075 5134.0 .678263 .771
31 23119 23103.0 .011016 .782
32 11599 11551.5 .195120 .977
```

```
chisquare= .977 for 3 d. of f.; p-value= .354621
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b-rank test for bits 1 to 8 p=1-exp(-SUM/2)= .91423
b-rank test for bits 2 to 9 p=1-exp(-SUM/2)= .82041
b-rank test for bits 3 to 10 p=1-exp(-SUM/2)= .93084
b-rank test for bits 4 to 11 p=1-exp(-SUM/2)= .12527
b-rank test for bits 5 to 12 p=1-exp(-SUM/2)= .66050
b-rank test for bits 6 to 13 p=1-exp(-SUM/2)= .43433
b-rank test for bits 7 to 14 p=1-exp(-SUM/2)= .91859
b-rank test for bits 8 to 15 p=1-exp(-SUM/2)= .86943
b-rank test for bits 9 to 16 p=1-exp(-SUM/2)= .82379
b-rank test for bits 10 to 17 p=1-exp(-SUM/2)= .58883
b-rank test for bits 11 to 18 p=1-exp(-SUM/2)= .83036
b-rank test for bits 12 to 19 p=1-exp(-SUM/2)= .56213
b-rank test for bits 13 to 20 p=1-exp(-SUM/2)= .10872
b-rank test for bits 14 to 21 p=1-exp(-SUM/2)= .65557
b-rank test for bits 15 to 22 p=1-exp(-SUM/2)= .06741
b-rank test for bits 16 to 23 p=1-exp(-SUM/2)= .40102
b-rank test for bits 17 to 24 p=1-exp(-SUM/2)= .48277
b-rank test for bits 18 to 25 p=1-exp(-SUM/2)= .15165
b-rank test for bits 19 to 26 p=1-exp(-SUM/2)= .49957
b-rank test for bits 20 to 27 p=1-exp(-SUM/2)= .75323
b-rank test for bits 21 to 28 p=1-exp(-SUM/2)= .87008
b-rank test for bits 22 to 29 p=1-exp(-SUM/2)= .94590
b-rank test for bits 23 to 30 p=1-exp(-SUM/2)= .85237
b-rank test for bits 24 to 31 p=1-exp(-SUM/2)= .90677
b-rank test for bits 25 to 32 p=1-exp(-SUM/2)= .82835
```



TEST SUMMARY, 25 tests on 100,000 random 6x8 matrices  
 These should be 25 uniform [0,1] random variables:

.914230	.820409	.930843	.125273	.660497
.434333	.918588	.869427	.823792	.588827
.830362	.562134	.108720	.655571	.067410
.401019	.482767	.151652	.499567	.753230
.870083	.945902	.852367	.906771	.828354

brank test summary for PRG420\_p20.rnd

The KS test for those 25 supposed UNI's yields

KS p-value= .986511

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No. missing words should average 141909. with sigma=428.

tst no 1:	141676 missing words,	-.55 sigmas from mean,	p-value= .29282
tst no 2:	142217 missing words,	.72 sigmas from mean,	p-value= .76389
tst no 3:	141563 missing words,	-.81 sigmas from mean,	p-value= .20921
tst no 4:	142606 missing words,	1.63 sigmas from mean,	p-value= .94821
tst no 5:	142371 missing words,	1.08 sigmas from mean,	p-value= .85963
tst no 6:	141811 missing words,	-.23 sigmas from mean,	p-value= .40915
tst no 7:	142036 missing words,	.30 sigmas from mean,	p-value= .61637
tst no 8:	141885 missing words,	-.06 sigmas from mean,	p-value= .47734
tst no 9:	142336 missing words,	1.00 sigmas from mean,	p-value= .84059
tst no 10:	142035 missing words,	.29 sigmas from mean,	p-value= .61548
tst no 11:	141592 missing words,	-.74 sigmas from mean,	p-value= .22922
tst no 12:	141859 missing words,	-.12 sigmas from mean,	p-value= .45320
tst no 13:	141667 missing words,	-.57 sigmas from mean,	p-value= .28563
tst no 14:	141863 missing words,	-.11 sigmas from mean,	p-value= .45690
tst no 15:	141549 missing words,	-.84 sigmas from mean,	p-value= .19993
tst no 16:	142239 missing words,	.77 sigmas from mean,	p-value= .77943
tst no 17:	141892 missing words,	-.04 sigmas from mean,	p-value= .48385
tst no 18:	141794 missing words,	-.27 sigmas from mean,	p-value= .39379
tst no 19:	142119 missing words,	.49 sigmas from mean,	p-value= .68789
tst no 20:	142277 missing words,	.86 sigmas from mean,	p-value= .80484

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OPSO for PRG420_p20.rnd	using bits 23 to 32	142203	1.013	.8444
OPSO for PRG420_p20.rnd	using bits 22 to 31	142221	1.075	.8588
OPSO for PRG420_p20.rnd	using bits 21 to 30	142340	1.485	.9312
OPSO for PRG420_p20.rnd	using bits 20 to 29	142000	.313	.6227
OPSO for PRG420_p20.rnd	using bits 19 to 28	141733	-.608	.2716
OPSO for PRG420_p20.rnd	using bits 18 to 27	141462	-1.543	.0615
OPSO for PRG420_p20.rnd	using bits 17 to 26	142202	1.009	.8436
OPSO for PRG420_p20.rnd	using bits 16 to 25	141682	-.784	.2166
OPSO for PRG420_p20.rnd	using bits 15 to 24	141859	-.174	.4311
OPSO for PRG420_p20.rnd	using bits 14 to 23	141548	-1.246	.1064
OPSO for PRG420_p20.rnd	using bits 13 to 22	142050	.485	.6862
OPSO for PRG420_p20.rnd	using bits 12 to 21	141834	-.260	.3975
OPSO for PRG420_p20.rnd	using bits 11 to 20	141825	-.291	.3856
OPSO for PRG420_p20.rnd	using bits 10 to 19	141420	-1.687	.0458
OPSO for PRG420_p20.rnd	using bits 9 to 18	142415	1.744	.9594
OPSO for PRG420_p20.rnd	using bits 8 to 17	141584	-1.122	.1310
OPSO for PRG420_p20.rnd	using bits 7 to 16	141531	-1.305	.0960
OPSO for PRG420_p20.rnd	using bits 6 to 15	141483	-1.470	.0708
OPSO for PRG420_p20.rnd	using bits 5 to 14	141296	-2.115	.0172
OPSO for PRG420_p20.rnd	using bits 4 to 13	141916	.023	.5092
OPSO for PRG420_p20.rnd	using bits 3 to 12	142102	.664	.7468
OPSO for PRG420_p20.rnd	using bits 2 to 11	141885	-.084	.4666
OPSO for PRG420_p20.rnd	using bits 1 to 10	141956	.161	.5639
OQSO for PRG420_p20.rnd	using bits 28 to 32	141932	.077	.5306
OQSO for PRG420_p20.rnd	using bits 27 to 31	142509	2.033	.9790
OQSO for PRG420_p20.rnd	using bits 26 to 30	141821	-.299	.3823
OQSO for PRG420_p20.rnd	using bits 25 to 29	141930	.070	.5279
OQSO for PRG420_p20.rnd	using bits 24 to 28	141818	-.310	.3784
OQSO for PRG420_p20.rnd	using bits 23 to 27	142191	.955	.8302
OQSO for PRG420_p20.rnd	using bits 22 to 26	141814	-.323	.3733
OQSO for PRG420_p20.rnd	using bits 21 to 25	141898	-.038	.4847
OQSO for PRG420_p20.rnd	using bits 20 to 24	141952	.145	.5575
OQSO for PRG420_p20.rnd	using bits 19 to 23	142033	.419	.6625
OQSO for PRG420_p20.rnd	using bits 18 to 22	141625	-.964	.1676
OQSO for PRG420_p20.rnd	using bits 17 to 21	141566	-1.164	.1222

OQSO for PRG420_p20.rnd	using bits 16 to 20	142051	.480	.6845
OQSO for PRG420_p20.rnd	using bits 15 to 19	142157	.840	.7994
OQSO for PRG420_p20.rnd	using bits 14 to 18	141835	-.252	.4005
OQSO for PRG420_p20.rnd	using bits 13 to 17	141275	-2.150	.0158
OQSO for PRG420_p20.rnd	using bits 12 to 16	141820	-.303	.3810
OQSO for PRG420_p20.rnd	using bits 11 to 15	141940	.104	.5414
OQSO for PRG420_p20.rnd	using bits 10 to 14	141750	-.540	.2946
OQSO for PRG420_p20.rnd	using bits 9 to 13	141590	-1.082	.1395
OQSO for PRG420_p20.rnd	using bits 8 to 12	142014	.355	.6386
OQSO for PRG420_p20.rnd	using bits 7 to 11	141948	.131	.5521
OQSO for PRG420_p20.rnd	using bits 6 to 10	141573	-1.140	.1271
OQSO for PRG420_p20.rnd	using bits 5 to 9	141943	.114	.5454
OQSO for PRG420_p20.rnd	using bits 4 to 8	141581	-1.113	.1329
OQSO for PRG420_p20.rnd	using bits 3 to 7	141591	-1.079	.1403
OQSO for PRG420_p20.rnd	using bits 2 to 6	141738	-.581	.2807
OQSO for PRG420_p20.rnd	using bits 1 to 5	142186	.938	.8258
DNA for PRG420_p20.rnd	using bits 31 to 32	142023	.335	.6313
DNA for PRG420_p20.rnd	using bits 30 to 31	141671	-.703	.2410
DNA for PRG420_p20.rnd	using bits 29 to 30	141667	-.715	.2374
DNA for PRG420_p20.rnd	using bits 28 to 29	141658	-.741	.2292
DNA for PRG420_p20.rnd	using bits 27 to 28	141734	-.517	.3025
DNA for PRG420_p20.rnd	using bits 26 to 27	141748	-.476	.3171
DNA for PRG420_p20.rnd	using bits 25 to 26	142726	2.409	.9920
DNA for PRG420_p20.rnd	using bits 24 to 25	141752	-.464	.3213
DNA for PRG420_p20.rnd	using bits 23 to 24	142283	1.102	.8648
DNA for PRG420_p20.rnd	using bits 22 to 23	142190	.828	.7961
DNA for PRG420_p20.rnd	using bits 21 to 22	142005	.282	.6111
DNA for PRG420_p20.rnd	using bits 20 to 21	142309	1.179	.8808
DNA for PRG420_p20.rnd	using bits 19 to 20	141788	-.358	.3602
DNA for PRG420_p20.rnd	using bits 18 to 19	141006	-2.665	.0039
DNA for PRG420_p20.rnd	using bits 17 to 18	142375	1.374	.9152
DNA for PRG420_p20.rnd	using bits 16 to 17	141751	-.467	.3202
DNA for PRG420_p20.rnd	using bits 15 to 16	141613	-.874	.1910
DNA for PRG420_p20.rnd	using bits 14 to 15	142478	1.677	.9533
DNA for PRG420_p20.rnd	using bits 13 to 14	142239	.972	.8346
DNA for PRG420_p20.rnd	using bits 12 to 13	141491	-1.234	.1086
DNA for PRG420_p20.rnd	using bits 11 to 12	141925	.046	.5184
DNA for PRG420_p20.rnd	using bits 10 to 11	142176	.787	.7843
DNA for PRG420_p20.rnd	using bits 9 to 10	142362	1.335	.9091
DNA for PRG420_p20.rnd	using bits 8 to 9	141405	-1.488	.0684
DNA for PRG420_p20.rnd	using bits 7 to 8	141943	.099	.5396
DNA for PRG420_p20.rnd	using bits 6 to 7	142255	1.020	.8461
DNA for PRG420_p20.rnd	using bits 5 to 6	141768	-.417	.3384
DNA for PRG420_p20.rnd	using bits 4 to 5	141599	-.915	.1800
DNA for PRG420_p20.rnd	using bits 3 to 4	142308	1.176	.8802
DNA for PRG420_p20.rnd	using bits 2 to 3	141873	-.107	.4573
DNA for PRG420_p20.rnd	using bits 1 to 2	141808	-.299	.3825

-----

Test results for PRG420\_p20.rnd  
Chi-square with  $5^5-5^4=2500$  d.of f. for sample size:2560000  
chisquare equiv normal p-value  
Results fo COUNT-THE-1's in successive bytes:  
byte stream for PRG420\_p20.rnd 2447.14 -.748 .227362  
byte stream for PRG420\_p20.rnd 2483.37 -.235 .407009

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Chi-square with  $5^5-5^4=2500$  d.of f. for sample size: 256000  
chisquare equiv normal p value  
Results for COUNT-THE-1's in specified bytes:  
bits 1 to 8 2573.08 1.034 .849332  
bits 2 to 9 2565.49 .926 .822806  
bits 3 to 10 2404.57 -1.350 .088580  
bits 4 to 11 2559.26 .838 .799006  
bits 5 to 12 2462.76 -.527 .299222  
bits 6 to 13 2408.22 -1.298 .097142  
bits 7 to 14 2432.44 -.955 .169694  
bits 8 to 15 2501.14 .016 .506454  
bits 9 to 16 2475.47 -.347 .364325  
bits 10 to 17 2446.21 -.761 .223428

bits 11 to 18	2531.94	.452	.674271
bits 12 to 19	2494.56	-.077	.469312
bits 13 to 20	2493.09	-.098	.461103
bits 14 to 21	2395.39	-1.479	.069516
bits 15 to 22	2491.26	-.124	.450797
bits 16 to 23	2514.63	.207	.581979
bits 17 to 24	2573.06	1.033	.849254
bits 18 to 25	2490.17	-.139	.444736
bits 19 to 26	2425.49	-1.054	.146000
bits 20 to 27	2469.36	-.433	.332419
bits 21 to 28	2484.43	-.220	.412854
bits 22 to 29	2602.21	1.445	.925828
bits 23 to 30	2460.96	-.552	.290456
bits 24 to 31	2531.51	.446	.672064
bits 25 to 32	2560.84	.860	.805234

-----  
 CDPARK: result of ten tests on file PRG420\_p20.rnd  
 Of 12,000 tries, the average no. of successes  
 should be 3523 with sigma=21.9

Successes: 3512	z-score: -.502	p-value: .307734
Successes: 3508	z-score: -.685	p-value: .246694
Successes: 3524	z-score: .046	p-value: .518210
Successes: 3542	z-score: .868	p-value: .807188
Successes: 3508	z-score: -.685	p-value: .246694
Successes: 3499	z-score: -1.096	p-value: .136563
Successes: 3512	z-score: -.502	p-value: .307734
Successes: 3538	z-score: .685	p-value: .753306
Successes: 3525	z-score: .091	p-value: .536382
Successes: 3482	z-score: -1.872	p-value: .030593

square size	avg. no. parked	sample sigma
100.	3515.000	17.035

KSTEST for the above 10: p= .630774

-----  
 This is the MINIMUM DISTANCE test  
 for random integers in the file PRG420\_p20.rnd

Sample no.	d^2	avg	equiv uni
5	.7170	.8638	.513520
10	1.2369	.7783	.711521
15	.8248	.7156	.563494
20	.4344	.6776	.353763
25	.2469	.7583	.219785
30	.4288	.9071	.350086
35	.5134	1.0375	.403088
40	1.1753	1.0281	.693085
45	.1804	.9399	.165790
50	1.2830	.9868	.724566
55	.8511	.9281	.574891
60	.4653	.9101	.373495
65	.2936	.8972	.255535
70	.7051	.8915	.507681
75	1.6498	.9303	.809491
80	1.2242	.9622	.707803
85	.3715	.9268	.311582
90	.7390	.9416	.524188
95	.6985	.9503	.504417
100	.5992	.9402	.452425

MINIMUM DISTANCE TEST for PRG420\_p20.rnd

Result of KS test on 20 transformed mindist^2's:  
 p-value= .104190

-----  
 The 3DSPHERES test for file PRG420\_p20.rnd

sample no: 1	r^3= 10.714	p-value= .30032
sample no: 2	r^3= 9.812	p-value= .27896
sample no: 3	r^3= 3.928	p-value= .12272
sample no: 4	r^3= 6.719	p-value= .20067
sample no: 5	r^3= 22.613	p-value= .52942
sample no: 6	r^3= 14.042	p-value= .37380

```

sample no: 7      r^3= 98.778      p-value= .96284
sample no: 8      r^3=   .902      p-value= .02963
sample no: 9      r^3= 41.314      p-value= .74770
sample no: 10     r^3= 11.086      p-value= .30895
sample no: 11     r^3=  2.435      p-value= .07795
sample no: 12     r^3= 51.114      p-value= .81801
sample no: 13     r^3= 32.146      p-value= .65752
sample no: 14     r^3=  1.823      p-value= .05895
sample no: 15     r^3= 24.840      p-value= .56308
sample no: 16     r^3= 19.769      p-value= .48261
sample no: 17     r^3= 11.313      p-value= .31415
sample no: 18     r^3= 11.803      p-value= .32526
sample no: 19     r^3= 23.924      p-value= .54953
sample no: 20     r^3=   .660      p-value= .02177

```

3DSPHERES test for file PRG420\_p20.rnd p-value= .872635

RESULTS OF SQUEEZE TEST FOR PRG420\_p20.rnd

Table of standardized frequency counts

( (obs-exp)/sqrt(exp) )^2

for j taking values <=6,7,8,...,47,>=48:

```

-1.5   .5   -1.1   .3   .1   .8
 .0   1.0   -.8   -1.0  1.5  1.2
 .4   -.9   .5   .6   -.2   .7
-.2   -1.8  .0   -1.3  .4   1.0
 .3   -1.7  .2   -.8   .2   .0
 1.3   -.7  -.6   -.9  1.2  1.9
-1.4   .8   .1   -1.3  -.6   .0
-1.1

```

Chi-square with 42 degrees of freedom: 36.322

z-score= -.620 p-value= .281974

```

Test no. 1      p-value .069030
Test no. 2      p-value .848161
Test no. 3      p-value .211865
Test no. 4      p-value .088901
Test no. 5      p-value .025600
Test no. 6      p-value .645453
Test no. 7      p-value .604299
Test no. 8      p-value .826412
Test no. 9      p-value .541976
Test no. 10     p-value .870446

```

Results of the OSUM test for PRG420\_p20.rnd

KSTEST on the above 10 p-values: .401142

The RUNS test for file PRG420\_p20.rnd

Up and down runs in a sample of 10000

Run test for PRG420\_p20.rnd :

runs up; ks test for 10 p's: .927718

runs down; ks test for 10 p's: .889866

Run test for PRG420\_p20.rnd :

runs up; ks test for 10 p's: .517253

runs down; ks test for 10 p's: .213261

Results of craps test for PRG420\_p20.rnd

No. of wins: Observed Expected

98423 98585.86

Chisq= 32.89 for 20 degrees of freedom, p= .96527

Throws Observed Expected Chisq Sum

SUMMARY FOR PRG420\_p20.rnd

p-value for no. of wins: .233184

p-value for throws/game: .965266

Test completed. File PRG420\_p20.rnd

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