



Poker Cards Analysis - February 2022

The Directors

Entain Plc

This is to confirm that iTech Labs has examined the game logs for Poker games for the period **February 01, 2022 to February 28, 2022** as recorded by the respective game servers and analyzed the Poker cards for statistical randomness. The results of the analysis are given below.

For details on the gaming sites serviced by the Entain Plc game servers and used in this audit refer to the [List](#).

1. Poker hand types statistics

These calculations were done for Royal Flush, Straight Flush, Four of a Kind, Full House, Flush, Straight, 3 of a Kind, 2 pairs, 1 Pair, High Card.

The Poker hand types analysis involved creating subsets of data and conducting Chi-square tests on each subset.

The null hypothesis for the chi-square test is that the observed frequencies of each type of hand matches the theoretical values for a deck that has been shuffled using a perfect random number generator. The p-values observed in these multiple tests are expected to follow a uniform distribution for the range 0.0 to 1.0.

The analysis performs a KS Test (Kolmogorov-Smirnov test) for uniform distribution on the observed p-values, and the combined p-value result of this test is taken as the final result of the Poker hand types statistics tests.

1.1 Poker hand types statistics for 52 cards deck:

Test No.	DOF	ChiSqr	P-Value
1	9	4.28	0.89176
2	9	1.87	0.99342
3	9	5.64	0.77529
4	9	5.46	0.79232
5	9	5.12	0.82368
6	9	6.28	0.71194
7	9	14.78	0.09719
8	9	12.04	0.21131
9	9	10.22	0.33330
10	9	11.01	0.27499
11	9	8.25	0.50960
12	9	6.87	0.65085
13	9	5.27	0.81003
14	9	18.58	0.02901
15	9	8.34	0.50032
16	9	5.01	0.83323
17	9	11.65	0.23403
18	9	15.50	0.07813
19	9	6.49	0.69013
20	9	12.54	0.18451
21	9	5.61	0.77795
22	9	3.75	0.92690
23	9	11.75	0.22777
24	9	14.31	0.11161

25	9	4.17	0.89989
26	9	12.90	0.16705
27	9	14.17	0.11646
28	9	7.08	0.62833
29	9	6.86	0.65124
30	9	4.13	0.90293
31	9	12.97	0.16419
32	9	4.88	0.84424
33	9	10.54	0.30842
34	9	6.06	0.73419
35	9	7.45	0.59024
36	9	9.09	0.42914
37	9	4.86	0.84662
38	9	12.34	0.19475
39	9	5.13	0.82252
40	9	4.81	0.85082
41	9	11.56	0.23937
42	9	13.21	0.15339
43	9	8.34	0.50062
44	9	11.32	0.25411
45	9	7.83	0.55139
46	9	3.88	0.91885
47	9	10.33	0.32468
48	9	8.05	0.52890
49	9	6.39	0.70044
50	9	6.00	0.74006
51	9	13.48	0.14218
52	9	9.47	0.39475
53	9	5.77	0.76221
54	9	3.82	0.92283
55	9	3.94	0.91554
56	9	4.72	0.85802
57	9	26.91	0.00145
58	9	15.35	0.08186
59	9	7.70	0.56452
60	9	13.33	0.14835
61	9	7.07	0.62978
62	9	10.48	0.31282
63	9	12.63	0.18011
64	9	5.62	0.77687
65	9	10.94	0.27961
66	9	12.62	0.18075
67	9	9.77	0.36955
68	9	12.82	0.17075
69	9	12.01	0.21287
70	9	16.87	0.05083
71	9	7.13	0.62319
72	9	6.79	0.65932
73	9	17.10	0.04719
74	9	4.75	0.85525
75	9	9.92	0.35719
76	9	12.67	0.17807
77	9	8.33	0.50106
78	9	3.80	0.92401
79	9	7.45	0.59000

80	9	10.52	0.30996
81	9	10.81	0.28890
82	9	7.88	0.54601
83	9	5.38	0.79968
84	9	4.98	0.83612
85	9	12.34	0.19461
86	9	15.70	0.07345
87	9	8.86	0.45011
88	9	8.71	0.46493
89	9	6.04	0.73608
90	9	6.47	0.69226
91	9	10.50	0.31173
92	9	5.50	0.78870
93	9	14.11	0.11832
94	9	11.30	0.25541
95	9	11.83	0.22334
96	9	14.17	0.11640
97	9	8.52	0.48261
98	9	9.12	0.42586
99	9	5.61	0.77827
100	9	4.84	0.84836
Combined P-value for all tests (Using KS method)			0.74332

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there are sufficient data.

1.2 Poker hand types statistics for 36 cards deck:

Test No.	DOF	ChiSqr	P-Value
1	9	10.08	0.34416
Combined P-value for all tests (Using KS method)			N/A (Insufficient data)

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there are sufficient data.

2. Poker rank statistics

The Poker rank analysis aims to establish that the rank of the cards in each position was equally distributed in one of the 13 possible ranks (2, 3, 4, 5, 6, 7, 8, 9, 10, J, Q, K, A) for a 52 card deck and 9 ranks (6, 7, 8, 9, 10, J, Q, K, A) for a 36 card deck.

The Poker rank analysis involved creating subsets of data and conducting Chi-square tests on each subset. The analysis performs a KS Test (Kolmogorov-Smirnov test) for uniform distribution on the observed p-values, and the combined p-value result of this test is taken as the final result of the Ranks statistics tests.

2.1 Poker rank statistics for 52 cards deck:

Test No.	Positions	DOF	ChiSqr	P-Value
1	7	84	78.96	0.63510
2	7	84	82.32	0.53134
3	7	84	92.09	0.25590
4	7	84	68.85	0.88399
5	7	84	114.76	0.01452

6	7	84	83.60	0.49174
7	7	84	87.88	0.36464
8	7	84	115.44	0.01302
9	7	84	77.06	0.69123
10	7	84	90.79	0.28732
11	7	84	95.57	0.18261
12	7	84	77.00	0.69295
13	7	84	84.03	0.47869
14	7	84	73.48	0.78700
15	7	84	74.38	0.76445
16	7	84	78.96	0.63515
17	7	84	98.16	0.13840
18	7	84	113.56	0.01754
19	7	84	66.00	0.92645
20	7	84	97.75	0.14488
21	7	84	90.97	0.28283
22	7	84	110.48	0.02800
23	7	84	86.67	0.39935
24	7	84	78.75	0.64127
25	7	84	84.23	0.47228
26	7	84	68.48	0.89024
27	7	84	104.23	0.06666
28	7	84	76.24	0.71436
29	7	84	82.30	0.53210
30	7	84	68.43	0.89111
31	7	84	92.25	0.25208
32	7	84	81.09	0.56976
33	7	84	103.72	0.07119
34	7	84	82.30	0.53195
35	7	84	88.58	0.34515
36	7	84	90.09	0.30493
37	7	84	84.10	0.47639
38	7	84	62.00	0.96563
39	7	84	72.95	0.79992
40	7	84	106.11	0.05200
41	7	84	81.99	0.54163
42	7	84	71.54	0.83178
43	7	84	105.86	0.05375
44	7	84	72.61	0.80775
45	7	84	82.93	0.51238
46	7	84	84.62	0.46057
47	7	84	95.41	0.18565
48	7	84	80.90	0.57560
49	7	84	82.24	0.53396
50	7	84	75.18	0.74355
51	7	84	95.92	0.17603
52	7	84	104.85	0.06149
53	7	84	71.21	0.83879
54	7	84	81.24	0.56514
55	7	84	88.48	0.34796
56	7	84	65.69	0.93036
57	7	84	78.25	0.65628
58	7	84	72.97	0.79926
59	7	84	77.28	0.68493
60	7	84	82.10	0.53826

61	7	84	99.52	0.11874
62	7	84	77.41	0.68091
63	7	84	104.01	0.06859
64	7	84	80.44	0.58975
65	7	84	85.43	0.43606
66	7	84	77.12	0.68929
67	7	84	94.79	0.19767
68	7	84	90.80	0.28704
69	7	84	65.51	0.93253
70	7	84	79.00	0.63387
71	7	84	67.99	0.89829
72	7	84	94.20	0.20944
73	7	84	78.37	0.65276
74	7	84	82.66	0.52080
75	7	84	74.69	0.75650
76	7	84	50.97	0.99833
77	7	84	62.16	0.96453
78	7	84	79.51	0.61822
79	7	84	111.47	0.02414
80	7	84	129.61	0.00104
81	7	84	70.22	0.85880
82	7	84	88.48	0.34787
83	7	84	72.27	0.81568
84	7	84	77.28	0.68482
85	7	84	80.02	0.60277
86	7	84	91.60	0.26737
87	7	84	78.34	0.65378
88	7	84	82.47	0.52672
89	7	84	85.72	0.42736
90	7	84	112.65	0.02021
91	7	84	85.95	0.42047
92	7	84	60.15	0.97714
93	7	84	77.31	0.68395
94	7	84	86.30	0.41021
95	7	84	98.31	0.13618
96	7	84	90.45	0.29574
97	7	84	83.84	0.48448
98	7	84	108.70	0.03625
99	7	84	84.19	0.47372
100	7	84	56.31	0.99126
Combined P-value for all tests (Using KS method)				0.82083

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there are sufficient data.

2.2 Poker rank statistics for 36 cards deck:

Test No.	Positions	DOF	ChiSqr	P-Value
1	7	56	67.02	0.14879
2	7	56	60.36	0.32131
3	7	56	50.31	0.68907
4	7	56	69.09	0.11249
5	7	56	57.66	0.41377
6	7	56	71.61	0.07809
7	7	56	46.73	0.80664

8	7	56	31.61	0.99651
9	7	56	64.06	0.21461
10	7	56	54.70	0.52402
11	7	56	54.43	0.53434
12	7	56	57.30	0.42683
13	7	56	63.36	0.23279
14	7	56	51.28	0.65368
15	7	56	82.48	0.01220
16	7	56	67.27	0.14395
17	7	56	67.03	0.14844
18	7	56	38.22	0.96682
19	7	56	48.82	0.74095
20	7	56	56.00	0.47486
21	7	56	60.07	0.33064
22	7	56	54.88	0.51715
23	7	56	61.99	0.27098
24	7	56	70.63	0.09017
25	7	56	66.37	0.16179
26	7	56	58.29	0.39128
27	7	56	57.85	0.40665
28	7	56	54.92	0.51578
29	7	56	59.98	0.33359
30	7	56	53.03	0.58801
31	7	56	54.13	0.54604
32	7	56	47.16	0.79380
33	7	56	50.01	0.69997
34	7	56	61.02	0.30026
35	7	56	75.30	0.04369
36	7	56	76.65	0.03487
37	7	56	77.96	0.02781
38	7	56	67.71	0.13570
Combined P-value for all tests (Using KS method)				0.11093

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there are sufficient data.

3. Poker suits statistics

The Poker suits analysis aims to verify that that the cards dealt exhibit an equal probability of all 4 suits (Clubs, Diamonds, Hearts and Spades) in all positions.

The Poker suits analysis involved creating subsets of data and conducting Chi-square tests on each subset. The analysis performs a KS Test (Kolmogorov-Smirnov test) for uniform distribution on the observed p-values, and the combined p-value result of this test is taken as the final result of the Suits statistics tests.

3.1 Poker suits statistics for 52 cards deck:

Test No.	Positions	DOF	ChiSqr	P-Value
1	7	21	23.11	0.33805
2	7	21	28.01	0.13985
3	7	21	15.40	0.80255
4	7	21	27.75	0.14752
5	7	21	9.09	0.98846
6	7	21	27.17	0.16517
7	7	21	34.96	0.02849
8	7	21	22.05	0.39652

9	7	21	29.18	0.10981
10	7	21	29.37	0.10540
11	7	21	11.35	0.95559
12	7	21	26.20	0.19908
13	7	21	11.93	0.94153
14	7	21	17.60	0.67393
15	7	21	9.12	0.98825
16	7	21	20.98	0.46012
17	7	21	17.85	0.65823
18	7	21	26.69	0.18147
19	7	21	13.78	0.87889
20	7	21	17.73	0.66613
21	7	21	27.29	0.16143
22	7	21	21.52	0.42735
23	7	21	16.71	0.72828
24	7	21	24.81	0.25545
25	7	21	23.46	0.32002
26	7	21	28.72	0.12093
27	7	21	14.20	0.86071
28	7	21	27.23	0.16328
29	7	21	16.59	0.73560
30	7	21	15.05	0.82046
31	7	21	18.61	0.61038
32	7	21	15.53	0.79545
33	7	21	18.36	0.62643
34	7	21	37.13	0.01625
35	7	21	28.02	0.13965
36	7	21	12.89	0.91255
37	7	21	17.24	0.69665
38	7	21	10.23	0.97575
39	7	21	32.62	0.05058
40	7	21	23.28	0.32928
41	7	21	26.79	0.17791
42	7	21	29.08	0.11202
43	7	21	13.59	0.88658
44	7	21	23.97	0.29475
45	7	21	26.45	0.18988
46	7	21	17.29	0.69349
47	7	21	33.44	0.04159
48	7	21	23.37	0.32459
49	7	21	37.62	0.01427
50	7	21	18.64	0.60832
51	7	21	12.84	0.91421
52	7	21	13.25	0.89949
53	7	21	16.09	0.76452
54	7	21	14.37	0.85334
55	7	21	27.65	0.15026
56	7	21	24.44	0.27221
57	7	21	19.08	0.58012
58	7	21	17.21	0.69800
59	7	21	21.80	0.41098
60	7	21	11.50	0.95215
61	7	21	14.20	0.86079
62	7	21	18.41	0.62311
63	7	21	16.30	0.75274

64	7	21	21.42	0.43344
65	7	21	33.16	0.04450
66	7	21	14.79	0.83310
67	7	21	20.27	0.50400
68	7	21	26.95	0.17249
69	7	21	9.91	0.98002
70	7	21	17.23	0.69709
71	7	21	12.70	0.91865
72	7	21	19.58	0.54795
73	7	21	18.02	0.64743
74	7	21	18.34	0.62710
75	7	21	24.86	0.25335
76	7	21	14.54	0.84545
77	7	21	18.00	0.64921
78	7	21	27.39	0.15836
79	7	21	25.54	0.22469
80	7	21	43.70	0.00255
81	7	21	25.30	0.23449
82	7	21	11.67	0.94812
83	7	21	28.95	0.11509
84	7	21	23.46	0.31972
85	7	21	21.46	0.43133
86	7	21	31.69	0.06288
87	7	21	19.81	0.53323
88	7	21	28.13	0.13663
89	7	21	15.95	0.77257
90	7	21	19.41	0.55909
91	7	21	22.57	0.36743
92	7	21	11.38	0.95495
93	7	21	13.98	0.87047
94	7	21	18.00	0.64902
95	7	21	18.39	0.62444
96	7	21	24.22	0.28232
97	7	21	28.08	0.13783
98	7	21	33.00	0.04626
99	7	21	19.86	0.53000
100	7	21	22.84	0.35232
Combined P-value for all tests (Using KS method)				0.51234

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there are sufficient data.

3.2 Poker suits statistics for 36 cards deck:

Test No.	Positions	DOF	ChiSqr	P-Value
1	7	21	17.99	0.64951
2	7	21	23.53	0.31649
3	7	21	37.28	0.01563
4	7	21	17.43	0.68461
5	7	21	18.19	0.63682
6	7	21	18.78	0.59951
7	7	21	12.18	0.93474
8	7	21	18.88	0.59284
9	7	21	18.98	0.58617
10	7	21	14.34	0.85437

11	7	21	24.06	0.28997
12	7	21	17.77	0.66363
13	7	21	23.29	0.32882
14	7	21	24.05	0.29074
15	7	21	22.02	0.39813
16	7	21	25.98	0.20737
17	7	21	18.61	0.61027
18	7	21	33.38	0.04213
19	7	21	30.07	0.09055
20	7	21	16.14	0.76196
21	7	21	26.30	0.19539
22	7	21	27.33	0.16026
23	7	21	29.44	0.10383
24	7	21	23.75	0.30523
25	7	21	19.67	0.54211
26	7	21	22.83	0.35300
27	7	21	20.12	0.51367
28	7	21	17.38	0.68758
29	7	21	17.87	0.65709
30	7	21	29.74	0.09742
31	7	21	17.32	0.69154
32	7	21	19.15	0.57539
33	7	21	28.02	0.13947
34	7	21	21.90	0.40552
35	7	21	33.58	0.04021
36	7	21	27.30	0.16102
37	7	21	20.78	0.47269
38	7	21	16.46	0.74318
Combined P-value for all tests (Using KS method)				0.16648

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there are sufficient data.

4. Summary of the analysis

4.1 Summary of the analysis of 52 cards deck:

The analysis of 52 cards completes by combining the result of the KS Test performed in the 3 types of analysis (Hand Types, Ranks and Suits) for 52 card decks using the Holm's method and producing a single Combined P -value.

The combined p-value produced using the Holm's method is used as indication for statistical randomness.

Combination of p-values using Holm's Method		
Test	P-Value	P-Adjusted
Ranks Test	0.82083	1.00000
Suits Test	0.51234	1.00000
Hand Types Test	0.74332	1.00000
Combined P-Value using Holm's Method		1.00000

Notes:

- 1) The combined p-value of all statistical tests using Holm's Method conducted for 52 card decks is greater than the minimum value of 0.05 which indicates that the randomness of the observed data falls within 95% confidence limits.

The final outcome of the analysis of 52 cards deck indicates that the RNG is working correctly.

4.2 Summary of the analysis of 36 cards deck:

The analysis of 36 cards completes by combining the result of the KS Test performed in the 3 types of analysis (Hand Types, Ranks and Suits) for 36 card decks using the Holm's method and producing a single Combined P -value. Where there are insufficient data the individual Chi-Square tests results are used in the Holm's method for producing a combined p-value.

The combined p-value produced from the using the Holm's method is used as indication for statistical randomness.

Combination of p-values using Holm's Method		
Test	P-Value	P-Adjusted
Ranks Test	0.11093	0.33280
Suits Test	0.16648	0.33295
Hands Type Test	0.34416	0.34416
Combined P-Value using Holm's Method		0.33280

Notes:

- 1) The combined p-value of all statistical tests using Holm's Method conducted for 36 card decks is greater than the minimum value of 0.05 which indicates that the randomness of the observed data falls within 95% confidence limits.

The final outcome of the analysis of 36 cards deck indicates that the RNG is working correctly.

5. Conclusion

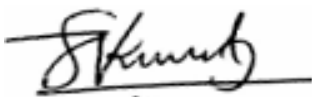
Analysis of actual data from game logs for 'Hand Types', 'Ranks' and 'Suits' for **52-card decks** and **36-card decks** indicated statistical randomness.

iTech Labs has done limited sanity checks to verify the integrity of the game logs. iTech Labs also maintains a copy of the game logs for verification purposes. There were a large enough number of game records to give the calculations sufficient statistical power.

We conclude that the Random Number Generator (RNG) is working correctly.

Please click here to see the [Original](#) report.

Signed:



Kiren Sreekumar
Principal Consultant
iTech Labs Australia
Date: 29 March 2022

Signed:



Geoff Nicoll
Principal Consultant
iTech Labs Australia
Date: 29 March 2022

Disclaimer.

While it is not possible to test all possible scenarios in a laboratory environment, iTech Labs has conducted a level of testing appropriate for a component test of this type.