



Poker Cards Analysis - January 2022

The Directors

Entain Plc

This is to confirm that iTech Labs has examined the game logs for Poker games for the period **January 01, 2022** to **January 31, 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	11.76	0.22726
2	9	10.79	0.29051
3	9	15.27	0.08382
4	9	14.85	0.09524
5	9	3.10	0.96007
6	9	5.54	0.78481
7	9	5.29	0.80795
8	9	9.48	0.39391
9	9	9.42	0.39966
10	9	7.24	0.61168
11	9	9.41	0.39993
12	9	5.12	0.82398
13	9	7.71	0.56334
14	9	10.63	0.30213
15	9	7.91	0.54297
16	9	5.09	0.82668
17	9	7.67	0.56735
18	9	8.75	0.46103
19	9	16.24	0.06208
20	9	7.63	0.57146
21	9	5.07	0.82773
22	9	4.65	0.86362
23	9	11.07	0.27127
24	9	13.44	0.14380

25	9	13.07	0.15961
26	9	15.56	0.07655
27	9	2.68	0.97574
28	9	4.88	0.84482
29	9	4.99	0.83515
30	9	8.12	0.52219
31	9	4.50	0.87564
32	9	7.00	0.63683
33	9	3.97	0.91345
34	9	20.45	0.01532
35	9	5.44	0.79479
36	9	3.59	0.93623
37	9	3.06	0.96194
38	9	9.60	0.38411
39	9	18.51	0.02968
40	9	10.84	0.28682
41	9	7.26	0.61029
42	9	12.41	0.19106
43	9	16.60	0.05530
44	9	8.26	0.50851
45	9	16.20	0.06282
46	9	5.88	0.75184
47	9	5.53	0.78555
48	9	8.54	0.48125
49	9	8.95	0.44147
50	9	9.84	0.36354
51	9	7.45	0.59000
52	9	14.05	0.12042
53	9	22.41	0.00765
54	9	3.66	0.93243
55	9	7.15	0.62154
56	9	8.52	0.48317
57	9	9.32	0.40788
58	9	11.27	0.25743
59	9	7.13	0.62366
60	9	4.02	0.91016
61	9	12.13	0.20599
62	9	4.28	0.89174
63	9	7.64	0.57091
64	9	13.97	0.12331
65	9	6.98	0.63958
66	9	9.35	0.40540
67	9	9.18	0.42121
68	9	10.51	0.31065
69	9	6.24	0.71556
70	9	17.93	0.03595
71	9	8.35	0.49971
72	9	9.56	0.38684
73	9	13.44	0.14365
74	9	5.40	0.79776
75	9	5.99	0.74058
76	9	3.08	0.96090
77	9	7.07	0.62942
78	9	10.94	0.28014
79	9	9.42	0.39939

80	9	10.21	0.33397
81	9	18.20	0.03297
82	9	13.73	0.13223
83	9	8.73	0.46276
84	9	4.30	0.89064
85	9	7.00	0.63707
86	9	9.40	0.40103
87	9	12.29	0.19720
88	9	10.41	0.31862
89	9	11.52	0.24164
90	9	4.01	0.91067
91	9	5.14	0.82170
92	9	6.80	0.65794
93	9	8.49	0.48556
94	9	19.09	0.02440
95	9	10.93	0.28076
96	9	3.67	0.93197
97	9	24.04	0.00424
98	9	7.13	0.62351
99	9	9.25	0.41431
100	9	5.06	0.82880
Combined P-value for all tests (Using KS method)			0.95662

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	7.16	0.62091
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	80.14	0.59916
2	7	84	83.65	0.49032
3	7	84	78.04	0.66262
4	7	84	81.18	0.56699
5	7	84	86.10	0.41592

6	7	84	88.90	0.33648
7	7	84	74.71	0.75576
8	7	84	97.24	0.15305
9	7	84	104.70	0.06273
10	7	84	61.92	0.96622
11	7	84	82.16	0.53632
12	7	84	79.97	0.60422
13	7	84	116.33	0.01127
14	7	84	79.44	0.62043
15	7	84	78.13	0.65978
16	7	84	78.56	0.64695
17	7	84	85.44	0.43560
18	7	84	82.23	0.53414
19	7	84	80.23	0.59626
20	7	84	93.76	0.21862
21	7	84	70.27	0.85799
22	7	84	70.86	0.84603
23	7	84	84.22	0.47288
24	7	84	75.11	0.74529
25	7	84	71.78	0.82650
26	7	84	137.03	0.00023
27	7	84	97.76	0.14473
28	7	84	60.54	0.97499
29	7	84	92.88	0.23772
30	7	84	88.18	0.35610
31	7	84	75.78	0.72722
32	7	84	78.62	0.64513
33	7	84	78.75	0.64124
34	7	84	90.01	0.30696
35	7	84	83.74	0.48754
36	7	84	91.63	0.26676
37	7	84	84.73	0.45715
38	7	84	75.36	0.73872
39	7	84	93.67	0.22053
40	7	84	93.68	0.22045
41	7	84	89.57	0.31851
42	7	84	79.36	0.62301
43	7	84	79.87	0.60738
44	7	84	93.97	0.21422
45	7	84	65.22	0.93586
46	7	84	69.37	0.87483
47	7	84	93.04	0.23416
48	7	84	72.98	0.79906
49	7	84	82.75	0.51808
50	7	84	76.32	0.71211
51	7	84	71.62	0.82999
52	7	84	104.53	0.06411
53	7	84	74.30	0.76655
54	7	84	89.22	0.32789
55	7	84	75.11	0.74518
56	7	84	55.69	0.99266
57	7	84	68.03	0.89765
58	7	84	83.65	0.49015
59	7	84	78.36	0.65295
60	7	84	108.36	0.03808

61	7	84	81.58	0.55453
62	7	84	87.61	0.37225
63	7	84	62.17	0.96440
64	7	84	70.83	0.84672
65	7	84	109.08	0.03434
66	7	84	99.37	0.12081
67	7	84	80.36	0.59230
68	7	84	88.55	0.34610
69	7	84	83.14	0.50603
70	7	84	66.16	0.92448
71	7	84	90.87	0.28514
72	7	84	74.64	0.75774
73	7	84	87.89	0.36443
74	7	84	87.87	0.36495
75	7	84	62.90	0.95873
76	7	84	73.09	0.79643
77	7	84	100.51	0.10576
78	7	84	93.69	0.22018
79	7	84	95.05	0.19245
80	7	84	77.67	0.67339
81	7	84	70.86	0.84617
82	7	84	100.05	0.11169
83	7	84	74.24	0.76810
84	7	84	104.93	0.06080
85	7	84	75.29	0.74038
86	7	84	69.80	0.86695
87	7	84	89.99	0.30757
88	7	84	74.66	0.75707
89	7	84	107.15	0.04506
90	7	84	62.09	0.96500
91	7	84	89.97	0.30818
92	7	84	78.45	0.65022
93	7	84	93.73	0.21925
94	7	84	79.60	0.61567
95	7	84	84.48	0.46469
96	7	84	80.02	0.60286
97	7	84	69.80	0.86699
98	7	84	92.64	0.24326
99	7	84	88.68	0.34236
100	7	84	66.33	0.92219
Combined P-value for all tests (Using KS method)				0.49028

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	63.65	0.22521
2	7	56	41.98	0.91784
3	7	56	71.12	0.08395
4	7	56	59.53	0.34851
5	7	56	43.36	0.89131
6	7	56	56.32	0.46272
7	7	56	49.00	0.73489

8	7	56	52.90	0.59281
9	7	56	77.89	0.02816
10	7	56	48.24	0.75995
11	7	56	58.93	0.36869
12	7	56	55.57	0.49116
13	7	56	60.41	0.31957
14	7	56	60.75	0.30870
15	7	56	60.05	0.33123
16	7	56	69.63	0.10426
17	7	56	50.47	0.68325
18	7	56	65.88	0.17206
19	7	56	47.00	0.79866
20	7	56	54.36	0.53709
21	7	56	61.24	0.29361
22	7	56	67.05	0.14809
23	7	56	51.86	0.63225
24	7	56	56.25	0.46542
25	7	56	40.70	0.93807
26	7	56	35.14	0.98690
27	7	56	61.87	0.27468
28	7	56	45.83	0.83202
29	7	56	63.94	0.21780
30	7	56	59.75	0.34114
Combined P-value for all tests (Using KS method)				0.92247

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 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	18.39	0.62396
2	7	21	26.13	0.20165
3	7	21	16.87	0.71895
4	7	21	25.63	0.22101
5	7	21	15.38	0.80358
6	7	21	23.92	0.29677
7	7	21	27.91	0.14263
8	7	21	15.30	0.80766
9	7	21	10.74	0.96753
10	7	21	23.63	0.31111
11	7	21	22.12	0.39256
12	7	21	20.24	0.50625
13	7	21	15.27	0.80914
14	7	21	12.58	0.92265
15	7	21	12.82	0.91473
16	7	21	16.95	0.71419

17	7	21	17.58	0.67531
18	7	21	21.57	0.42491
19	7	21	26.22	0.19802
20	7	21	14.10	0.86534
21	7	21	15.85	0.77789
22	7	21	19.18	0.57341
23	7	21	11.75	0.94618
24	7	21	21.56	0.42533
25	7	21	29.03	0.11326
26	7	21	27.12	0.16684
27	7	21	10.65	0.96915
28	7	21	14.73	0.83614
29	7	21	22.37	0.37848
30	7	21	26.27	0.19650
31	7	21	16.80	0.72295
32	7	21	32.49	0.05224
33	7	21	20.53	0.48788
34	7	21	22.32	0.38135
35	7	21	13.70	0.88210
36	7	21	16.48	0.74215
37	7	21	21.34	0.43838
38	7	21	33.51	0.04087
39	7	21	21.17	0.44856
40	7	21	29.21	0.10895
41	7	21	29.02	0.11343
42	7	21	20.05	0.51836
43	7	21	16.10	0.76422
44	7	21	27.28	0.16167
45	7	21	25.50	0.22632
46	7	21	16.56	0.73764
47	7	21	23.83	0.30149
48	7	21	21.19	0.44727
49	7	21	22.10	0.39369
50	7	21	10.47	0.97220
51	7	21	22.33	0.38053
52	7	21	17.77	0.66366
53	7	21	21.98	0.40044
54	7	21	22.58	0.36702
55	7	21	18.92	0.59052
56	7	21	13.92	0.87280
57	7	21	27.84	0.14465
58	7	21	25.28	0.23530
59	7	21	13.94	0.87214
60	7	21	23.31	0.32771
61	7	21	30.94	0.07467
62	7	21	13.67	0.88338
63	7	21	20.40	0.49609
64	7	21	31.38	0.06760
65	7	21	13.56	0.88770
66	7	21	17.03	0.70945
67	7	21	19.03	0.58330
68	7	21	11.83	0.94399
69	7	21	22.38	0.37764
70	7	21	15.56	0.79395
71	7	21	16.24	0.75629

72	7	21	24.63	0.26342
73	7	21	24.21	0.28278
74	7	21	13.26	0.89927
75	7	21	27.10	0.16769
76	7	21	9.01	0.98910
77	7	21	21.92	0.40410
78	7	21	28.18	0.13514
79	7	21	24.07	0.28977
80	7	21	37.01	0.01677
81	7	21	13.68	0.88282
82	7	21	21.04	0.45652
83	7	21	20.13	0.51296
84	7	21	21.12	0.45173
85	7	21	16.75	0.72638
86	7	21	14.91	0.82722
87	7	21	19.74	0.53758
88	7	21	28.79	0.11911
89	7	21	13.84	0.87625
90	7	21	15.44	0.80015
91	7	21	23.66	0.30989
92	7	21	25.53	0.22512
93	7	21	28.21	0.13441
94	7	21	13.28	0.89853
95	7	21	19.43	0.55780
96	7	21	20.10	0.51496
97	7	21	29.15	0.11037
98	7	21	11.49	0.95232
99	7	21	17.34	0.69041
100	7	21	19.46	0.55598
Combined P-value for all tests (Using KS method)				0.70525

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	19.78	0.53498
2	7	21	21.30	0.44100
3	7	21	17.01	0.71062
4	7	21	23.05	0.34142
5	7	21	15.55	0.79427
6	7	21	20.78	0.47220
7	7	21	12.33	0.93034
8	7	21	13.41	0.89366
9	7	21	28.86	0.11750
10	7	21	11.72	0.94687
11	7	21	13.89	0.87436
12	7	21	26.17	0.20012
13	7	21	18.14	0.63987
14	7	21	26.50	0.18816
15	7	21	25.56	0.22373
16	7	21	16.89	0.71787
17	7	21	21.05	0.45602
18	7	21	17.60	0.67416

19	7	21	17.95	0.65204
20	7	21	23.35	0.32550
21	7	21	20.18	0.51014
22	7	21	25.30	0.23424
23	7	21	19.90	0.52735
24	7	21	14.48	0.84811
25	7	21	20.60	0.48359
26	7	21	40.57	0.00634
27	7	21	33.14	0.04464
28	7	21	15.34	0.80572
29	7	21	33.34	0.04254
30	7	21	16.98	0.71250
Combined P-value for all tests (Using KS method)				0.85787

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	0.49028	1.00000
Suits Test	0.70525	1.00000
Hand Types Test	0.95662	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	0.92247	1.00000
Suits Test	0.85787	1.00000

Hands Type Test	0.62091	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 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

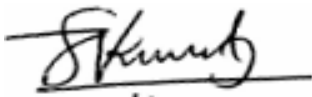
Analysis of actual data from game logs for 'Hand Types', 'Ranks' and 'Suits' for **52-card decks** and **36-card decks** indicated statistical randomness.

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:

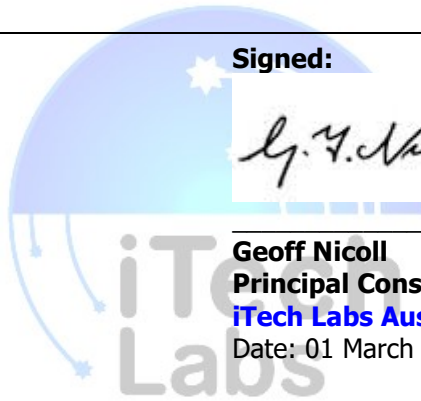


Kiren Sreekumar
Principal Consultant
iTech Labs Australia
Date: 01 March 2022

Signed:



Geoff Nicoll
Principal Consultant
iTech Labs Australia
Date: 01 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.