



Poker Cards Analysis – June 2024

The Directors

Entain Plc

This is to confirm that iTech Labs has examined the game logs for Poker games for the period **June 01, 2024, to June 30, 2024** 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	4.34	0.88781
2	9	8.93	0.44351
3	9	8.19	0.51484
4	9	8.33	0.50109
5	9	10.90	0.28268
6	9	4.37	0.88575
7	9	25.16	0.00279
8	9	9.92	0.35740
9	9	10.47	0.31416
10	9	7.14	0.62269
11	9	9.08	0.43013
12	9	8.29	0.50538
13	9	11.10	0.26884
14	9	2.23	0.98729
15	9	2.99	0.96459
16	9	8.60	0.47459
17	9	20.11	0.01727
18	9	4.62	0.86629
19	9	7.03	0.63372
20	9	5.39	0.79888
21	9	6.14	0.72551
22	9	16.85	0.05114
23	9	6.51	0.68835
24	9	6.57	0.68208
25	9	12.43	0.18993
26	9	10.61	0.30316
27	9	10.97	0.27749

28	9	4.06	0.90738
29	9	18.49	0.02986
30	9	3.97	0.91370
31	9	4.56	0.87123
32	9	2.96	0.96573
33	9	7.38	0.59720
34	9	1.73	0.99503
35	9	10.53	0.30899
36	9	10.70	0.29713
37	9	8.89	0.44764
38	9	11.11	0.26826
39	9	5.12	0.82343
40	9	11.14	0.26602
41	9	7.58	0.57671
42	9	13.55	0.13937
43	9	13.46	0.14294
44	9	6.42	0.69767
45	9	4.19	0.89867
46	9	12.15	0.20510
47	9	5.49	0.78947
48	9	8.27	0.50706
49	9	10.26	0.33019
50	9	10.34	0.32377
51	9	8.24	0.50974
52	9	8.49	0.48528
53	9	12.76	0.17368
54	9	7.93	0.54080
55	9	10.58	0.30574
56	9	5.00	0.83428
57	9	31.43	0.00025
58	9	14.72	0.09899
59	9	4.93	0.84076
60	9	5.21	0.81594
61	9	5.88	0.75141
62	9	9.34	0.40624
63	9	9.68	0.37666
64	9	5.04	0.83092
65	9	2.89	0.96865
66	9	3.75	0.92711
67	9	12.37	0.19339
68	9	7.23	0.61307
69	9	12.04	0.21131
70	9	5.75	0.76455
71	9	8.15	0.51880
72	9	2.31	0.98565
73	9	4.90	0.84312
74	9	15.63	0.07495
75	9	4.86	0.84593
76	9	3.69	0.93084
77	9	15.45	0.07934
78	9	21.60	0.01024
79	9	9.29	0.41130
80	9	9.91	0.35746
81	9	11.66	0.23286
82	9	4.10	0.90498
83	9	4.94	0.83923

84	9	5.41	0.79708
85	9	3.15	0.95805
86	9	5.87	0.75265
87	9	5.91	0.74906
88	9	10.02	0.34867
89	9	5.20	0.81675
90	9	10.01	0.34987
91	9	9.68	0.37668
92	9	10.22	0.33323
93	9	7.76	0.55809
94	9	10.46	0.31448
95	9	13.39	0.14594
96	9	15.10	0.08825
97	9	16.52	0.05685
98	9	15.51	0.07793
99	9	9.85	0.36259
100	9	8.20	0.51372
Combined P-value for all tests (Using KS method)			0.53585

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	8	6.61	0.57893
2	8	12.67	0.12390
Combined P-value for all tests (Using KS method)			N/A (Insufficient data)

Notes:

- 1) Since the number of samples available was insufficient to ensure at least 5 samples in the lowest probability hand type, (Royal Flush), the chi-square test has been performed by merging the Royal Flush and Straight Flush categories.
- 2) As the total number of tests (2) is insufficient to perform a meaningful KS Test, individual p-values from these tests are carried over to the next stage for combining using the Holm's method.
- 3) Since the number of games played each month using 36 card decks is small, the number of samples available this month as well as a few previous months were insufficient to perform a meaningful statistical analysis. Hence the analysis performed this month was done using the cumulative data for the last 11 months - i.e July 2023 to June 2024.

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.	DOF	ChiSqr	P-Value
1	84	66.25	0.92326
2	84	101.97	0.08872
3	84	64.96	0.93882
4	84	113.35	0.01812
5	84	67.57	0.90475
6	84	75.77	0.72756

7	84	64.75	0.94114
8	84	66.46	0.92045
9	84	73.29	0.79170
10	84	110.37	0.02846
11	84	103.41	0.07406
12	84	76.85	0.69720
13	84	76.64	0.70320
14	84	89.44	0.32189
15	84	73.09	0.79660
16	84	70.59	0.85167
17	84	75.75	0.72802
18	84	69.89	0.86517
19	84	122.90	0.00365
20	84	88.09	0.35862
21	84	64.95	0.93893
22	84	92.54	0.24541
23	84	80.10	0.60031
24	84	102.60	0.08200
25	84	84.71	0.45771
26	84	67.65	0.90346
27	84	56.80	0.99002
28	84	77.42	0.68079
29	84	82.29	0.53252
30	84	81.91	0.54417
31	84	101.68	0.09191
32	84	99.42	0.12012
33	84	76.32	0.71215
34	84	98.81	0.12870
35	84	66.22	0.92363
36	84	71.74	0.82756
37	84	77.12	0.68947
38	84	84.87	0.45281
39	84	72.70	0.80581
40	84	83.31	0.50075
41	84	80.93	0.57470
42	84	112.07	0.02208
43	84	76.41	0.70957
44	84	78.22	0.65724
45	84	88.51	0.34721
46	84	92.58	0.24457
47	84	55.80	0.99242
48	84	93.79	0.21805
49	84	74.66	0.75714
50	84	59.42	0.98069
51	84	70.62	0.85103
52	84	95.13	0.19092
53	84	71.39	0.83501
54	84	85.67	0.42894
55	84	92.07	0.25641
56	84	84.02	0.47894
57	84	71.73	0.82766
58	84	74.24	0.76796
59	84	99.20	0.12309
60	84	89.96	0.30829
61	84	67.34	0.90818
62	84	108.53	0.03715

63	84	98.57	0.13231
64	84	95.27	0.18834
65	84	75.33	0.73953
66	84	85.65	0.42945
67	84	109.44	0.03258
68	84	100.07	0.11133
69	84	82.24	0.53392
70	84	74.23	0.76825
71	84	73.15	0.79496
72	84	103.04	0.07764
73	84	105.74	0.05465
74	84	75.50	0.73467
75	84	82.51	0.52565
76	84	67.57	0.90468
77	84	89.39	0.32328
78	84	96.24	0.17027
79	84	80.03	0.60251
80	84	90.09	0.30489
81	84	73.73	0.78090
82	84	85.72	0.42724
83	84	87.93	0.36327
84	84	91.44	0.27128
85	84	100.43	0.10673
86	84	98.77	0.12933
87	84	73.16	0.79488
88	84	84.34	0.46905
89	84	84.98	0.44971
90	84	79.36	0.62295
91	84	91.48	0.27034
92	84	76.08	0.71887
93	84	72.37	0.81331
94	84	122.33	0.00404
95	84	89.78	0.31313
96	84	96.48	0.16601
97	84	68.28	0.89358
98	84	68.00	0.89799
99	84	82.71	0.51925
100	84	60.23	0.97670
Combined P-value for all tests (Using KS method)			0.16091

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	72.74	0.06570
2	7	56	50.37	0.68714
3	7	56	43.04	0.89795
4	7	56	62.19	0.26523
5	7	56	47.02	0.79813
6	7	56	47.63	0.77943
7	7	56	61.51	0.28541
8	7	56	56.71	0.44831
Combined P-value for all tests (Using KS method)				N/A (Insufficient data)

Notes:

- 1) As the total number of tests (8) is insufficient to perform a meaningful KS Test, individual p-values from these tests are carried over to the next stage for combining using the Holm's method.
- 2) Since the number of games played each month using 36 card decks is small, the number of samples available this month as well as a few previous months were insufficient to perform a meaningful statistical analysis. Hence the analysis performed this month was done using the cumulative data for the last 11 months - i.e July 2023 to June 2024.

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	16.34	0.75034
2	7	21	23.07	0.34011
3	7	21	9.61	0.98359
4	7	21	16.85	0.72017
5	7	21	34.78	0.02982
6	7	21	17.22	0.69745
7	7	21	21.32	0.43957
8	7	21	8.23	0.99409
9	7	21	11.64	0.94872
10	7	21	27.74	0.14781
11	7	21	18.40	0.62340
12	7	21	22.47	0.37301
13	7	21	12.29	0.93146
14	7	21	21.60	0.42302
15	7	21	36.04	0.02166
16	7	21	22.44	0.37453
17	7	21	21.79	0.41168
18	7	21	18.85	0.59486
19	7	21	18.65	0.60738
20	7	21	20.36	0.49848
21	7	21	12.78	0.91618
22	7	21	13.33	0.89654
23	7	21	12.79	0.91584

24	7	21	16.82	0.72172
25	7	21	15.80	0.78072
26	7	21	36.02	0.02178
27	7	21	23.39	0.32329
28	7	21	14.02	0.86886
29	7	21	22.85	0.35186
30	7	21	13.32	0.89690
31	7	21	18.91	0.59115
32	7	21	27.94	0.14196
33	7	21	23.02	0.34291
34	7	21	20.59	0.48408
35	7	21	19.49	0.55401
36	7	21	26.12	0.20174
37	7	21	23.20	0.33318
38	7	21	16.36	0.74881
39	7	21	24.29	0.27913
40	7	21	14.35	0.85426
41	7	21	24.54	0.26761
42	7	21	21.39	0.43521
43	7	21	22.47	0.37296
44	7	21	29.58	0.10067
45	7	21	11.87	0.94301
46	7	21	26.77	0.17859
47	7	21	17.94	0.65292
48	7	21	18.51	0.61672
49	7	21	18.17	0.63794
50	7	21	21.22	0.44536
51	7	21	17.91	0.65482
52	7	21	25.18	0.23925
53	7	21	27.53	0.15414
54	7	21	15.30	0.80754
55	7	21	25.61	0.22179
56	7	21	19.55	0.54995
57	7	21	27.07	0.16847
58	7	21	15.94	0.77295
59	7	21	12.90	0.91214
60	7	21	10.47	0.97214
61	7	21	27.40	0.15788
62	7	21	15.20	0.81288
63	7	21	15.77	0.78248
64	7	21	17.31	0.69206
65	7	21	27.11	0.16718
66	7	21	19.35	0.56266
67	7	21	22.65	0.36318
68	7	21	26.33	0.19420
69	7	21	19.27	0.56804
70	7	21	22.19	0.38839
71	7	21	11.88	0.94272
72	7	21	21.58	0.42419
73	7	21	33.31	0.04294
74	7	21	19.70	0.54004
75	7	21	17.30	0.69272
76	7	21	16.63	0.73352
77	7	21	12.88	0.91269
78	7	21	19.24	0.56972
79	7	21	29.80	0.09602

80	7	21	17.54	0.67813
81	7	21	32.26	0.05508
82	7	21	21.46	0.43124
83	7	21	22.19	0.38872
84	7	21	21.32	0.43961
85	7	21	14.49	0.84771
86	7	21	22.82	0.35352
87	7	21	21.36	0.43729
88	7	21	14.07	0.86646
89	7	21	16.58	0.73634
90	7	21	29.30	0.10707
91	7	21	17.15	0.70213
92	7	21	13.11	0.90467
93	7	21	20.82	0.47010
94	7	21	21.65	0.41991
95	7	21	16.66	0.73158
96	7	21	23.96	0.29493
97	7	21	18.38	0.62508
98	7	21	19.29	0.56661
99	7	21	14.01	0.86927
100	7	21	14.67	0.83902
Combined P-value for all tests (Using KS method)				0.22355

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	14.42	0.85071
2	7	21	17.25	0.69597
3	7	21	29.54	0.10172
4	7	21	22.69	0.36084
5	7	21	20.49	0.49057
6	7	21	11.97	0.94048
7	7	21	23.44	0.32097
8	7	21	38.59	0.01098
Combined P-value for all tests (Using KS method)				N/A (Insufficient data)

Notes:

- 1) As the total number of tests (8) is insufficient to perform a meaningful KS Test, individual p-values from these tests are carried over to the next stage for combining using the Holm's method.
- 2) Since the number of games played each month using 36 card decks is small, the number of samples available this month as well as a few previous months were insufficient to perform a meaningful statistical analysis. Hence the analysis performed this month was done using the cumulative data for the last 11 months - i.e July 2023 to June 2024.

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	0.16091	0.48272
Suits Test	0.22355	0.48272
Hand Types Test	0.53585	0.53585
Combined P-Value using Holm's Method		0.48272

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 is 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 1	0.06570	1.00000
Ranks Test 2	0.68714	1.00000
Ranks Test 3	0.89795	1.00000
Ranks Test 4	0.26523	1.00000
Ranks Test 5	0.79813	1.00000
Ranks Test 6	0.77943	1.00000
Ranks Test 7	0.28541	1.00000
Ranks Test 8	0.44831	1.00000
Suits Test 1	0.85071	1.00000
Suits Test 2	0.69597	1.00000
Suits Test 3	0.10172	1.00000
Suits Test 4	0.36084	1.00000
Suits Test 5	0.49057	1.00000
Suits Test 6	0.94048	1.00000
Suits Test 7	0.32097	1.00000
Suits Test 8	0.01098	0.19761
Hand Types Test 1	0.57893	1.00000
Hand Types Test 2	0.12390	1.00000
Combined P-Value using Holm's Method		0.19761

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.
- 2) Since the number of games played each month using 36 card decks is small, the number of samples available this month as well as a few previous months were insufficient to perform a meaningful statistical analysis. Hence the analysis performed this month was done using the cumulative data for the last 10 months - i.e July 2023 to June 2024.

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:



Alvin Rizaldi
Chief Executive Officer
iTech Labs

Date: 15 July 2024

Signed:



Divya Bhargava
Project Manager
iTech Labs

Date: 15 July 2024

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.

