



## Poker Cards Analysis - July 2023

### The Directors

Entain Plc

This is to confirm that iTech Labs has examined the game logs for Poker games for the period **July 01, 2023** to **July 31, 2023** 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	8.84	0.45229
2	9	9.85	0.36262
3	9	13.18	0.15478
4	9	5.80	0.75996
5	9	6.47	0.69189
6	9	9.39	0.40233
7	9	5.15	0.82086
8	9	6.51	0.68808
9	9	3.39	0.94679
10	9	5.63	0.77614
11	9	2.94	0.96648
12	9	3.81	0.92331
13	9	3.93	0.91592
14	9	17.53	0.04097
15	9	7.58	0.57718
16	9	5.67	0.77228
17	9	3.45	0.94388
18	9	11.53	0.24086
19	9	11.16	0.26475
20	9	14.48	0.10617
21	9	4.06	0.90722
22	9	15.59	0.07587
23	9	9.21	0.41815
24	9	9.14	0.42404
25	9	11.25	0.25921
26	9	4.57	0.86999
27	9	3.60	0.93579

28	9	6.13	0.72693
29	9	14.73	0.09855
30	9	10.89	0.28319
31	9	9.63	0.38124
32	9	15.01	0.09060
33	9	8.65	0.46988
34	9	12.25	0.19970
35	9	10.62	0.30251
36	9	5.81	0.75841
37	9	9.44	0.39762
38	9	12.45	0.18922
39	9	10.39	0.32014
40	9	11.91	0.21824
41	9	17.40	0.04278
42	9	7.54	0.58157
43	9	11.07	0.27096
44	9	11.18	0.26361
45	9	8.93	0.44398
46	9	4.53	0.87311
47	9	8.86	0.44985
48	9	4.48	0.87738
49	9	10.79	0.29008
50	9	6.53	0.68598
51	9	6.37	0.70280
52	9	9.68	0.37685
53	9	4.51	0.87493
54	9	3.58	0.93696
55	9	11.38	0.25055
56	9	8.84	0.45193
57	9	8.31	0.50347
58	9	12.00	0.21338
59	9	12.54	0.18431
60	9	12.34	0.19467
61	9	3.44	0.94434
62	9	6.50	0.68880
63	9	10.77	0.29201
64	9	10.71	0.29622
65	9	4.08	0.90615
66	9	7.60	0.57490
67	9	6.93	0.64439
68	9	9.31	0.40876
69	9	2.42	0.98298
70	9	12.12	0.20652
71	9	6.62	0.67674
72	9	9.48	0.39442
73	9	8.12	0.52209
74	9	11.80	0.22471
75	9	8.52	0.48279
76	9	9.43	0.39835
77	9	4.29	0.89128
78	9	12.20	0.20219
79	9	5.52	0.78645
80	9	2.87	0.96907
81	9	14.23	0.11454
82	9	17.39	0.04295
83	9	8.23	0.51110

84	9	9.52	0.39075
85	9	6.36	0.70355
86	9	4.52	0.87412
87	9	7.46	0.58890
88	9	4.89	0.84364
89	9	4.93	0.84053
90	9	6.24	0.71531
91	9	11.23	0.26048
92	9	5.46	0.79220
93	9	10.69	0.29770
94	9	7.76	0.55899
95	9	7.44	0.59163
96	9	10.42	0.31737
97	9	11.02	0.27449
98	9	8.09	0.52520
99	9	6.60	0.67823
100	9	9.13	0.42580
Combined P-value for all tests (Using KS method)			0.32085

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	7.54	0.47917
2	8	5.45	0.70892
3	8	7.03	0.53358
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 (3) 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 4 months - i.e April 2023 to July 2023.

## 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	80.18	0.59768
2	84	87.68	0.37033
3	84	82.16	0.53654
4	84	74.92	0.75021

5	84	108.86	0.03543
6	84	80.85	0.57713
7	84	90.14	0.30373
8	84	84.26	0.47144
9	84	75.61	0.73170
10	84	88.87	0.33739
11	84	99.68	0.11657
12	84	90.58	0.29255
13	84	91.73	0.26421
14	84	83.23	0.50332
15	84	104.46	0.06471
16	84	88.46	0.34852
17	84	80.80	0.57875
18	84	80.86	0.57675
19	84	109.54	0.03211
20	84	99.66	0.11677
21	84	70.36	0.85624
22	84	74.78	0.75394
23	84	93.31	0.22831
24	84	97.31	0.15195
25	84	61.31	0.97037
26	84	82.95	0.51195
27	84	64.28	0.94603
28	84	77.70	0.67259
29	84	70.05	0.86221
30	84	72.81	0.80303
31	84	78.35	0.65337
32	84	92.34	0.24999
33	84	91.82	0.26209
34	84	60.82	0.97341
35	84	98.92	0.12715
36	84	70.73	0.84880
37	84	59.03	0.98242
38	84	61.42	0.96965
39	84	68.40	0.89158
40	84	87.27	0.38193
41	84	98.61	0.13169
42	84	71.00	0.84325
43	84	81.87	0.54535
44	84	87.38	0.37890
45	84	86.35	0.40874
46	84	86.24	0.41184
47	84	69.74	0.86803
48	84	87.69	0.36990
49	84	72.79	0.80371
50	84	87.99	0.36155
51	84	81.14	0.56815
52	84	66.17	0.92426
53	84	105.23	0.05844
54	84	78.91	0.63653
55	84	70.56	0.85214
56	84	79.33	0.62369
57	84	84.09	0.47666
58	84	88.84	0.33798
59	84	94.96	0.19426
60	84	94.10	0.21151

61	84	74.04	0.77302
62	84	66.88	0.91480
63	84	102.03	0.08806
64	84	84.85	0.45341
65	84	81.06	0.57057
66	84	74.56	0.75987
67	84	94.98	0.19384
68	84	109.91	0.03046
69	84	89.72	0.31451
70	84	78.70	0.64281
71	84	104.08	0.06797
72	84	89.28	0.32634
73	84	57.92	0.98664
74	84	94.13	0.21100
75	84	81.28	0.56373
76	84	83.03	0.50956
77	84	76.65	0.70284
78	84	99.09	0.12465
79	84	76.79	0.69888
80	84	82.63	0.52185
81	84	73.88	0.77717
82	84	66.99	0.91321
83	84	75.83	0.72576
84	84	76.36	0.71115
85	84	55.64	0.99275
86	84	70.01	0.86300
87	84	77.86	0.66772
88	84	107.14	0.04514
89	84	82.44	0.52768
90	84	69.81	0.86667
91	84	104.45	0.06478
92	84	79.08	0.63143
93	84	99.63	0.11727
94	84	59.35	0.98100
95	84	69.24	0.87726
96	84	78.41	0.65152
97	84	60.11	0.97731
98	84	102.08	0.08752
99	84	68.27	0.89370
100	84	81.59	0.55422
Combined P-value for all tests (Using KS method)			0.47426

**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	50.80	0.67151
2	7	56	47.86	0.77207
3	7	56	58.77	0.37429
4	7	56	50.40	0.68584
5	7	56	73.75	0.05611
6	7	56	54.83	0.51921
7	7	56	49.03	0.73367
8	7	56	62.26	0.26316
9	7	56	59.31	0.35579
10	7	56	61.02	0.30026
11	7	56	47.04	0.79759
12	7	56	38.41	0.96499
13	7	56	69.32	0.10886
14	7	56	57.39	0.42355
15	7	56	65.63	0.17754
Combined P-value for all tests (Using KS method)				1.00000

### Notes:

- 1) 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 4 months - i.e April 2023 to July 2023.

## 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	38.05	0.01271
2	7	21	17.00	0.71112
3	7	21	30.28	0.08650
4	7	21	14.87	0.82955
5	7	21	23.59	0.31328
6	7	21	13.42	0.89337
7	7	21	11.42	0.95399
8	7	21	19.01	0.58472
9	7	21	10.00	0.97893
10	7	21	30.01	0.09177
11	7	21	13.51	0.88961
12	7	21	16.78	0.72415
13	7	21	10.96	0.96356
14	7	21	27.17	0.16541
15	7	21	20.57	0.48518
16	7	21	16.43	0.74498
17	7	21	14.43	0.85024

18	7	21	21.03	0.45698
19	7	21	11.39	0.95475
20	7	21	15.05	0.82033
21	7	21	16.27	0.75458
22	7	21	8.83	0.99048
23	7	21	19.90	0.52766
24	7	21	16.36	0.74918
25	7	21	17.80	0.66159
26	7	21	25.88	0.21090
27	7	21	20.47	0.49157
28	7	21	14.04	0.86807
29	7	21	13.37	0.89521
30	7	21	15.81	0.78049
31	7	21	29.30	0.10687
32	7	21	21.23	0.44503
33	7	21	16.22	0.75695
34	7	21	16.57	0.73696
35	7	21	22.95	0.34668
36	7	21	22.50	0.37106
37	7	21	21.80	0.41119
38	7	21	30.92	0.07497
39	7	21	24.24	0.28172
40	7	21	18.84	0.59521
41	7	21	11.16	0.95959
42	7	21	15.65	0.78880
43	7	21	15.65	0.78901
44	7	21	19.10	0.57889
45	7	21	20.02	0.52028
46	7	21	31.33	0.06840
47	7	21	18.97	0.58692
48	7	21	13.22	0.90079
49	7	21	17.39	0.68731
50	7	21	27.99	0.14055
51	7	21	20.02	0.51984
52	7	21	32.33	0.05415
53	7	21	28.54	0.12562
54	7	21	20.31	0.50168
55	7	21	25.53	0.22476
56	7	21	17.47	0.68239
57	7	21	30.36	0.08504
58	7	21	62.12	0.00001
59	7	21	24.75	0.25794
60	7	21	22.50	0.37100
61	7	21	21.74	0.41468
62	7	21	27.47	0.15594
63	7	21	17.79	0.66238
64	7	21	19.70	0.54046
65	7	21	24.97	0.24844
66	7	21	23.57	0.31448
67	7	21	11.59	0.95015
68	7	21	12.04	0.93859
69	7	21	19.59	0.54738
70	7	21	28.74	0.12045
71	7	21	22.94	0.34734
72	7	21	18.09	0.64360
73	7	21	31.01	0.07347

74	7	21	21.55	0.42565
75	7	21	25.20	0.23877
76	7	21	18.06	0.64550
77	7	21	25.90	0.21022
78	7	21	30.31	0.08598
79	7	21	16.66	0.73179
80	7	21	20.46	0.49226
81	7	21	32.12	0.05696
82	7	21	14.91	0.82730
83	7	21	18.87	0.59336
84	7	21	22.09	0.39435
85	7	21	13.18	0.90233
86	7	21	29.01	0.11385
87	7	21	17.66	0.67021
88	7	21	35.48	0.02501
89	7	21	28.28	0.13244
90	7	21	18.90	0.59175
91	7	21	18.36	0.62600
92	7	21	27.99	0.14031
93	7	21	11.37	0.95518
94	7	21	20.56	0.48594
95	7	21	27.56	0.15306
96	7	21	16.55	0.73798
97	7	21	14.22	0.85981
98	7	21	13.71	0.88182
99	7	21	21.96	0.40195
100	7	21	19.43	0.55741
Combined P-value for all tests (Using KS method)				0.77582

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	28.08	0.13790
2	7	21	23.69	0.30842
3	7	21	21.77	0.41298
4	7	21	9.78	0.98158
5	7	21	24.88	0.25240
6	7	21	19.34	0.56308
7	7	21	23.10	0.33888
8	7	21	22.10	0.39354
9	7	21	16.38	0.74817
10	7	21	21.31	0.44004
11	7	21	30.83	0.07650
12	7	21	14.87	0.82932
13	7	21	20.79	0.47171
14	7	21	21.80	0.41111
15	7	21	11.84	0.94384
Combined P-value for all tests (Using KS method)				0.95285

Notes:

- 1) 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 4 months - i.e April 2023 to July 2023.

#### 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.

<b>Combination of p-values using Holm's Method</b>		
<b>Test</b>	<b>P-Value</b>	<b>P-Adjusted</b>
Ranks Test	0.47426	0.96255
Suits Test	0.77582	0.96255
Hand Types Test	0.32085	0.96255
<b>Combined P-Value using Holm's Method</b>		0.96255

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.

<b>Combination of p-values using Holm's Method</b>		
<b>Test</b>	<b>P-Value</b>	<b>P-Adjusted</b>
Ranks Test	1.00000	1.00000
Suits Test	0.95285	1.00000
Hand Types Test 1	0.47917	1.00000
Hand Types Test 2	0.70892	1.00000
Hand Types Test 3	0.53358	1.00000
<b>Combined P-Value using Holm's Method</b>		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.
- 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 4 months - i.e April 2023 to July 2023.

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.

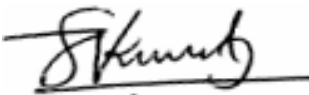
iTech Labs has done limited sanity checks to verify the integrity of the game logs. iTech Labs also maintains a copy of the game logs for verification purposes. There were a large enough number of game records to give the calculations sufficient statistical power.

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

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

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**Signed:**



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**Kiren Sreekumar**  
**Principal Consultant**  
**iTech Labs Australia**  
Date: 23 August 2023

**Signed:**



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**Alvin Rizaldi**  
**Senior Consultant**  
**iTech Labs Australia**  
Date: 23 August 2023

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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.

