



## Poker Cards Analysis – February 2024

### The Directors

Entain Plc

This is to confirm that iTech Labs has examined the game logs for Poker games for the period **February 01, 2024** to **February 29, 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	4.98	0.83563
2	9	12.99	0.16302
3	9	5.70	0.76968
4	9	10.14	0.33936
5	9	8.18	0.51629
6	9	7.70	0.56422
7	9	6.51	0.68785
8	9	9.00	0.43759
9	9	8.40	0.49445
10	9	9.69	0.37598
11	9	12.17	0.20378
12	9	8.45	0.48967
13	9	9.12	0.42625
14	9	11.47	0.24456
15	9	4.69	0.86034
16	9	10.88	0.28435
17	9	8.68	0.46752
18	9	5.43	0.79498
19	9	14.15	0.11701
20	9	7.74	0.56013
21	9	9.24	0.41500
22	9	4.30	0.89084
23	9	5.76	0.76320
24	9	5.56	0.78302
25	9	3.15	0.95821
26	9	6.66	0.67267
27	9	5.64	0.77544

28	9	10.09	0.34300
29	9	4.85	0.84719
30	9	6.59	0.67952
31	9	10.21	0.33357
32	9	2.93	0.96707
33	9	11.13	0.26679
34	9	6.49	0.68972
35	9	6.78	0.66027
36	9	9.45	0.39694
37	9	13.88	0.12676
38	9	12.20	0.20243
39	9	9.24	0.41560
40	9	7.47	0.58838
41	9	6.56	0.68306
42	9	8.86	0.44984
43	9	5.27	0.81038
44	9	9.52	0.39066
45	9	15.28	0.08352
46	9	7.81	0.55295
47	9	16.57	0.05589
48	9	4.15	0.90097
49	9	11.61	0.23609
50	9	10.26	0.33000
51	9	14.57	0.10348
52	9	14.51	0.10525
53	9	6.35	0.70469
54	9	8.42	0.49263
55	9	8.54	0.48089
56	9	7.99	0.53496
57	9	8.89	0.44730
58	9	6.00	0.74027
59	9	6.74	0.66389
60	9	3.34	0.94946
61	9	19.93	0.01834
62	9	6.15	0.72497
63	9	4.20	0.89754
64	9	11.51	0.24231
65	9	4.05	0.90820
66	9	5.79	0.76041
67	9	8.86	0.45054
68	9	9.71	0.37421
69	9	15.36	0.08162
70	9	8.66	0.46885
71	9	8.01	0.53304
72	9	11.94	0.21661
73	9	5.59	0.77986
74	9	3.18	0.95659
75	9	6.10	0.73024
76	9	13.50	0.14125
77	9	6.21	0.71848
78	9	5.62	0.77729
79	9	7.78	0.55695
80	9	14.47	0.10646
81	9	8.64	0.47074
82	9	10.45	0.31543
83	9	9.38	0.40299

84	9	6.63	0.67554
85	9	5.29	0.80832
86	9	12.01	0.21299
87	9	2.97	0.96535
88	9	20.41	0.01556
89	9	6.55	0.68375
90	9	4.73	0.85701
91	9	8.17	0.51716
92	9	9.90	0.35895
93	9	6.34	0.70573
94	9	10.23	0.33222
95	9	5.83	0.75646
96	9	8.57	0.47759
97	9	10.77	0.29151
98	9	6.72	0.66649
99	9	5.53	0.78612
100	9	8.11	0.52261
Combined P-value for all tests (Using KS method)			0.25621

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	2.99	0.93498
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 7 months - i.e July 2023 to February 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	91.37	0.27285
2	84	72.18	0.81762
3	84	74.91	0.75050
4	84	80.19	0.59739
5	84	71.99	0.82201
6	84	87.21	0.38371

7	84	84.29	0.47049
8	84	81.40	0.55991
9	84	69.66	0.86960
10	84	79.46	0.61996
11	84	81.85	0.54622
12	84	100.67	0.10381
13	84	72.35	0.81382
14	84	64.10	0.94779
15	84	82.93	0.51253
16	84	104.39	0.06529
17	84	93.73	0.21935
18	84	72.99	0.79896
19	84	95.75	0.17917
20	84	84.85	0.45340
21	84	72.47	0.81098
22	84	93.03	0.23451
23	84	75.75	0.72809
24	84	84.41	0.46688
25	84	98.88	0.12776
26	84	53.37	0.99632
27	84	90.41	0.29683
28	84	96.29	0.16942
29	84	102.93	0.07875
30	84	73.55	0.78538
31	84	58.43	0.98483
32	84	91.42	0.27181
33	84	77.58	0.67609
34	84	84.04	0.47824
35	84	98.11	0.13928
36	84	76.51	0.70675
37	84	92.46	0.24727
38	84	84.13	0.47541
39	84	88.12	0.35798
40	84	100.11	0.11089
41	84	72.16	0.81811
42	84	125.98	0.00208
43	84	91.51	0.26951
44	84	77.67	0.67331
45	84	65.03	0.93808
46	84	92.65	0.24287
47	84	73.99	0.77429
48	84	89.13	0.33027
49	84	87.62	0.37186
50	84	76.79	0.69895
51	84	68.56	0.88897
52	84	107.61	0.04231
53	84	111.09	0.02559
54	84	62.69	0.96042
55	84	78.55	0.64748
56	84	61.32	0.97031
57	84	111.26	0.02492
58	84	64.36	0.94522
59	84	78.99	0.63403
60	84	71.26	0.83774
61	84	86.91	0.39240
62	84	94.56	0.20228

63	84	76.30	0.71286
64	84	72.89	0.80127
65	84	84.25	0.47186
66	84	86.57	0.40220
67	84	90.05	0.30606
68	84	75.60	0.73196
69	84	102.95	0.07854
70	84	71.29	0.83718
71	84	92.58	0.24455
72	84	92.68	0.24231
73	84	118.26	0.00818
74	84	80.87	0.57650
75	84	64.25	0.94630
76	84	89.98	0.30795
77	84	73.33	0.79063
78	84	103.89	0.06964
79	84	77.09	0.69038
80	84	78.40	0.65173
81	84	62.21	0.96412
82	84	85.09	0.44612
83	84	76.41	0.70964
84	84	79.56	0.61680
85	84	86.18	0.41362
86	84	82.51	0.52542
87	84	92.59	0.24426
88	84	59.91	0.97834
89	84	92.16	0.25424
90	84	73.58	0.78458
91	84	101.97	0.08871
92	84	68.06	0.89716
93	84	80.13	0.59929
94	84	98.99	0.12617
95	84	80.97	0.57346
96	84	88.29	0.35306
97	84	78.25	0.65625
98	84	65.21	0.93603
99	84	100.40	0.10719
100	84	84.01	0.47919
Combined P-value for all tests (Using KS method)			0.97479

**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	52.81	0.59623
2	7	56	65.86	0.17245
3	7	56	43.76	0.88283
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 7 months - i.e July 2023 to February 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	25.90	0.21040
2	7	21	29.08	0.11198
3	7	21	13.22	0.90072
4	7	21	21.09	0.45317
5	7	21	26.18	0.19952
6	7	21	37.11	0.01637
7	7	21	31.46	0.06635
8	7	21	24.06	0.28997
9	7	21	12.39	0.92847
10	7	21	28.69	0.12165
11	7	21	14.68	0.83881
12	7	21	17.48	0.68152
13	7	21	28.22	0.13406
14	7	21	21.60	0.42296
15	7	21	22.12	0.39261
16	7	21	23.65	0.31047
17	7	21	22.41	0.37601
18	7	21	25.35	0.23252
19	7	21	12.57	0.92281
20	7	21	21.54	0.42644
21	7	21	17.91	0.65455
22	7	21	13.82	0.87717
23	7	21	17.38	0.68768

24	7	21	20.02	0.52020
25	7	21	14.25	0.85878
26	7	21	34.39	0.03291
27	7	21	27.82	0.14542
28	7	21	23.68	0.30877
29	7	21	37.71	0.01393
30	7	21	21.47	0.43056
31	7	21	19.54	0.55035
32	7	21	20.13	0.51289
33	7	21	18.28	0.63146
34	7	21	8.76	0.99100
35	7	21	22.52	0.37014
36	7	21	31.45	0.06642
37	7	21	16.38	0.74813
38	7	21	30.83	0.07649
39	7	21	15.63	0.78982
40	7	21	16.96	0.71357
41	7	21	17.94	0.65266
42	7	21	22.59	0.36608
43	7	21	32.67	0.05002
44	7	21	29.62	0.09995
45	7	21	30.48	0.08270
46	7	21	22.43	0.37493
47	7	21	27.34	0.15997
48	7	21	31.44	0.06660
49	7	21	21.42	0.43339
50	7	21	25.12	0.24197
51	7	21	16.88	0.71848
52	7	21	24.31	0.27839
53	7	21	37.32	0.01546
54	7	21	21.07	0.45453
55	7	21	35.78	0.02314
56	7	21	18.10	0.64279
57	7	21	20.40	0.49607
58	7	21	21.17	0.44864
59	7	21	19.58	0.54800
60	7	21	22.32	0.38111
61	7	21	12.68	0.91933
62	7	21	14.68	0.83857
63	7	21	23.23	0.33180
64	7	21	9.19	0.98762
65	7	21	19.71	0.53962
66	7	21	17.04	0.70879
67	7	21	15.21	0.81242
68	7	21	19.71	0.53995
69	7	21	13.07	0.90619
70	7	21	10.99	0.96296
71	7	21	11.61	0.94959
72	7	21	29.41	0.10444
73	7	21	16.86	0.71970
74	7	21	28.19	0.13487
75	7	21	44.29	0.00214
76	7	21	20.96	0.46157
77	7	21	18.13	0.64069
78	7	21	19.25	0.56941
79	7	21	23.30	0.32812

80	7	21	13.65	0.88425
81	7	21	7.14	0.99784
82	7	21	17.54	0.67821
83	7	21	17.89	0.65572
84	7	21	19.01	0.58443
85	7	21	29.37	0.10533
86	7	21	17.42	0.68531
87	7	21	17.65	0.67113
88	7	21	14.73	0.83635
89	7	21	25.79	0.21451
90	7	21	19.48	0.55417
91	7	21	16.71	0.72835
92	7	21	11.11	0.96052
93	7	21	36.02	0.02176
94	7	21	13.38	0.89488
95	7	21	14.59	0.84306
96	7	21	26.98	0.17140
97	7	21	20.03	0.51910
98	7	21	22.24	0.38587
99	7	21	20.97	0.46103
100	7	21	8.70	0.99139
Combined P-value for all tests (Using KS method)				0.91405

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	14.21	0.86050
2	7	21	27.94	0.14175
3	7	21	32.46	0.05251
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 7 months - i.e July 2023 to February 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.



<b>Combination of p-values using Holm's Method</b>		
<b>Test</b>	<b>P-Value</b>	<b>P-Adjusted</b>
Ranks Test	0.97479	1.00000
Suits Test	0.91405	1.00000
Hand Types Test	0.25621	0.76862
<b>Combined P-Value using Holm's Method</b>		0.76862

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	0.59623	1.00000
Ranks Test 2	0.17245	1.00000
Ranks Test 3	0.88283	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	0.86050	1.00000
Suits Test 2	0.14175	1.00000
Suits Test 3	0.05251	0.89265
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	0.93498	1.00000
Hand Types Test 2	0.12390	1.00000
<b>Combined P-Value using Holm's Method</b>		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 7 months - i.e July 2023 to February 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.

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**Signed:**



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**Alvin Rizaldi**  
**Chief Executive Officer**  
**iTech Labs**  
Date: 20 March 2024

**Signed:**



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**Divya Bhargava**  
**Project Manager**  
**iTech Labs**  
Date: 20 March 2024

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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.

