



## Poker Cards Analysis - February 2023

### The Directors

Entain Plc

This is to confirm that iTech Labs has examined the game logs for Poker games for the period **Feb 01, 2023** to **Feb 28, 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	7.85	0.54913
2	9	5.37	0.80056
3	9	6.06	0.73408
4	9	6.87	0.65062
5	9	16.69	0.05380
6	9	5.10	0.82520
7	9	5.57	0.78213
8	9	13.29	0.14982
9	9	8.70	0.46531
10	9	18.49	0.02991
11	9	6.93	0.64485
12	9	9.51	0.39133
13	9	7.25	0.61076
14	9	9.21	0.41790
15	9	9.74	0.37174
16	9	6.62	0.67623
17	9	20.33	0.01598
18	9	8.46	0.48869
19	9	5.27	0.80973
20	9	11.99	0.21407
21	9	4.50	0.87552
22	9	7.12	0.62514
23	9	9.26	0.41404
24	9	3.72	0.92886
25	9	3.81	0.92356

26	9	5.15	0.82076
27	9	5.42	0.79665
28	9	3.54	0.93885
29	9	9.00	0.43725
30	9	10.39	0.31972
31	9	10.43	0.31649
32	9	5.85	0.75442
33	9	4.46	0.87879
34	9	14.56	0.10381
35	9	15.66	0.07433
36	9	6.94	0.64287
37	9	18.11	0.03391
38	9	17.61	0.03993
39	9	4.34	0.88790
40	9	14.31	0.11165
41	9	4.24	0.89509
42	9	16.07	0.06547
43	9	4.27	0.89256
44	9	9.25	0.41427
45	9	7.40	0.59558
46	9	5.02	0.83265
47	9	7.64	0.57062
48	9	7.80	0.55420
49	9	6.09	0.73097
50	9	8.06	0.52824
51	9	5.34	0.80327
52	9	8.47	0.48797
53	9	9.07	0.43058
54	9	4.14	0.90229
55	9	12.98	0.16348
56	9	14.69	0.09989
57	9	13.19	0.15404
58	9	8.24	0.50982
59	9	13.88	0.12670
60	9	9.20	0.41872
61	9	10.13	0.33995
62	9	6.32	0.70791
63	9	5.83	0.75657
64	9	7.55	0.57973
65	9	18.37	0.03115
66	9	3.23	0.95444
67	9	10.88	0.28411
68	9	13.01	0.16223
69	9	4.38	0.88465
70	9	3.80	0.92412
71	9	11.34	0.25328
72	9	10.98	0.27719
73	9	5.83	0.75643
74	9	11.56	0.23937
75	9	6.79	0.65884
76	9	3.18	0.95683
77	9	10.99	0.27609
78	9	9.44	0.39764
79	9	6.09	0.73099
80	9	11.19	0.26315
81	9	14.18	0.11618

82	9	5.09	0.82639
83	9	7.36	0.59921
84	9	6.69	0.66919
85	9	12.14	0.20567
86	9	13.67	0.13475
87	9	9.28	0.41145
88	9	15.61	0.07540
89	9	11.20	0.26232
90	9	9.83	0.36460
91	9	13.14	0.15618
92	9	10.90	0.28244
93	9	3.35	0.94855
94	9	4.57	0.87015
95	9	9.22	0.41699
96	9	13.94	0.12459
97	9	5.01	0.83369
98	9	5.22	0.81457
99	9	11.42	0.24810
100	9	7.08	0.62911
Combined P-value for all tests (Using KS method)			0.95250

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	9.17	0.42159
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 (1) 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 Nov 2022 to Feb 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.	Positions	DOF	ChiSqr	P-Value
1	7	84	89.95	0.30873

2	7	84	71.84	0.82517
3	7	84	64.11	0.94774
4	7	84	88.38	0.35071
5	7	84	101.96	0.08884
6	7	84	84.70	0.45818
7	7	84	78.26	0.65588
8	7	84	70.81	0.84706
9	7	84	118.73	0.00756
10	7	84	66.78	0.91612
11	7	84	95.37	0.18630
12	7	84	107.79	0.04124
13	7	84	62.38	0.96287
14	7	84	67.81	0.90099
15	7	84	82.64	0.52147
16	7	84	130.10	0.00094
17	7	84	80.23	0.59641
18	7	84	77.41	0.68095
19	7	84	65.41	0.93363
20	7	84	79.17	0.62881
21	7	84	81.82	0.54709
22	7	84	92.04	0.25689
23	7	84	111.07	0.02566
24	7	84	91.12	0.27909
25	7	84	101.81	0.09048
26	7	84	110.08	0.02968
27	7	84	66.83	0.91543
28	7	84	74.39	0.76427
29	7	84	76.27	0.71351
30	7	84	66.00	0.92644
31	7	84	94.44	0.20464
32	7	84	99.91	0.11354
33	7	84	94.38	0.20574
34	7	84	93.04	0.23422
35	7	84	72.43	0.81195
36	7	84	62.44	0.96241
37	7	84	89.97	0.30811
38	7	84	84.40	0.46723
39	7	84	75.22	0.74248
40	7	84	87.29	0.38131
41	7	84	71.86	0.82473
42	7	84	88.96	0.33487
43	7	84	96.63	0.16344
44	7	84	90.61	0.29168
45	7	84	95.36	0.18653
46	7	84	98.74	0.12972
47	7	84	86.62	0.40067
48	7	84	72.46	0.81135
49	7	84	70.46	0.85413
50	7	84	94.20	0.20945
51	7	84	106.39	0.05006
52	7	84	67.64	0.90371
53	7	84	79.54	0.61726
54	7	84	88.25	0.35416
55	7	84	79.50	0.61852
56	7	84	93.02	0.23471
57	7	84	88.13	0.35749

58	7	84	64.72	0.94145
59	7	84	78.41	0.65166
60	7	84	83.18	0.50482
61	7	84	86.61	0.40109
62	7	84	67.43	0.90687
63	7	84	82.20	0.53514
64	7	84	81.40	0.56017
65	7	84	88.05	0.35986
66	7	84	95.16	0.19039
67	7	84	69.55	0.87148
68	7	84	76.56	0.70552
69	7	84	66.63	0.91826
70	7	84	77.38	0.68192
71	7	84	59.14	0.98194
72	7	84	63.81	0.95062
73	7	84	97.26	0.15275
74	7	84	69.84	0.86612
75	7	84	100.86	0.10148
76	7	84	95.23	0.18902
77	7	84	92.22	0.25270
78	7	84	74.91	0.75065
79	7	84	97.13	0.15504
80	7	84	76.22	0.71509
81	7	84	62.15	0.96457
82	7	84	69.31	0.87601
83	7	84	75.76	0.72781
84	7	84	105.34	0.05762
85	7	84	70.52	0.85294
86	7	84	89.26	0.32671
87	7	84	63.78	0.95088
88	7	84	80.04	0.60206
89	7	84	71.23	0.83850
90	7	84	69.16	0.87860
91	7	84	78.70	0.64282
92	7	84	72.54	0.80953
93	7	84	85.98	0.41951
94	7	84	99.69	0.11647
95	7	84	95.86	0.17724
96	7	84	86.70	0.39831
97	7	84	57.04	0.98937
98	7	84	96.63	0.16354
99	7	84	85.18	0.44342
100	7	84	79.31	0.62433
Combined P-value for all tests (Using KS method)				0.17033

**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	65.70	0.17598
2	7	56	45.56	0.83925
3	7	56	30.53	0.99781
4	7	56	50.19	0.69358
5	7	56	55.15	0.50687
6	7	56	50.28	0.69036
7	7	56	56.02	0.47419
8	7	56	54.78	0.52127
9	7	56	56.13	0.47013
10	7	56	70.76	0.08853
11	7	56	46.87	0.80241
12	7	56	68.49	0.12212
13	7	56	52.33	0.61465
14	7	56	52.62	0.60375
15	7	56	62.12	0.26731
16	7	56	59.08	0.36375
17	7	56	46.87	0.80241
18	7	56	40.29	0.94379
19	7	56	73.46	0.05872
20	7	56	66.37	0.16179
21	7	56	66.85	0.15196
22	7	56	47.63	0.77943
23	7	56	58.77	0.37429
24	7	56	53.34	0.57634
25	7	56	51.63	0.64099
26	7	56	41.19	0.93084
27	7	56	54.65	0.52608
28	7	56	60.07	0.33064
29	7	56	62.86	0.24644
30	7	56	40.21	0.94475
31	7	56	62.98	0.24298
32	7	56	51.36	0.65102
33	7	56	52.80	0.59692
34	7	56	66.75	0.15411
35	7	56	61.85	0.27521
36	7	56	55.73	0.48504
37	7	56	58.57	0.38117
38	7	56	53.97	0.55224
39	7	56	66.07	0.16814
Combined P-value for all tests (Using KS method)				0.97386

### 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 Nov 2022 to Feb 2023.

## 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	12.72	0.91801
2	7	21	13.85	0.87592
3	7	21	11.07	0.96139
4	7	21	27.68	0.14937
5	7	21	11.02	0.96237
6	7	21	18.38	0.62466
7	7	21	20.43	0.49417
8	7	21	16.96	0.71378
9	7	21	27.36	0.15925
10	7	21	23.20	0.33315
11	7	21	16.31	0.75190
12	7	21	22.22	0.38707
13	7	21	19.60	0.54649
14	7	21	21.92	0.40408
15	7	21	16.77	0.72506
16	7	21	17.67	0.66995
17	7	21	34.01	0.03613
18	7	21	16.87	0.71908
19	7	21	18.43	0.62168
20	7	21	21.07	0.45478
21	7	21	14.51	0.84658
22	7	21	36.68	0.01833
23	7	21	29.18	0.10985
24	7	21	24.76	0.25755
25	7	21	24.18	0.28461
26	7	21	15.18	0.81358
27	7	21	15.78	0.78182
28	7	21	21.47	0.43079
29	7	21	21.58	0.42390
30	7	21	22.59	0.36629
31	7	21	13.24	0.90001
32	7	21	18.30	0.62968
33	7	21	14.87	0.82964
34	7	21	18.87	0.59373
35	7	21	13.16	0.90277
36	7	21	15.36	0.80440
37	7	21	19.55	0.54996
38	7	21	20.32	0.50122
39	7	21	27.49	0.15514
40	7	21	28.84	0.11785
41	7	21	17.67	0.66995
42	7	21	16.07	0.76595
43	7	21	24.45	0.27189
44	7	21	20.22	0.50721
45	7	21	18.29	0.63028
46	7	21	27.32	0.16056
47	7	21	13.55	0.88818
48	7	21	29.99	0.09214
49	7	21	10.53	0.97115

50	7	21	14.83	0.83118
51	7	21	29.59	0.10054
52	7	21	23.19	0.33395
53	7	21	25.38	0.23112
54	7	21	22.59	0.36597
55	7	21	19.44	0.55668
56	7	21	33.40	0.04197
57	7	21	22.43	0.37507
58	7	21	17.90	0.65555
59	7	21	19.38	0.56047
60	7	21	16.30	0.75276
61	7	21	13.23	0.90041
62	7	21	29.81	0.09580
63	7	21	15.79	0.78124
64	7	21	14.32	0.85568
65	7	21	24.81	0.25567
66	7	21	16.91	0.71685
67	7	21	26.18	0.19956
68	7	21	19.85	0.53055
69	7	21	9.81	0.98128
70	7	21	21.45	0.43188
71	7	21	24.97	0.24829
72	7	21	24.28	0.27976
73	7	21	15.90	0.77541
74	7	21	22.76	0.35684
75	7	21	18.97	0.58700
76	7	21	10.70	0.96828
77	7	21	15.07	0.81923
78	7	21	20.55	0.48655
79	7	21	17.39	0.68723
80	7	21	14.12	0.86423
81	7	21	37.16	0.01614
82	7	21	12.56	0.92331
83	7	21	19.44	0.55667
84	7	21	15.17	0.81436
85	7	21	26.71	0.18078
86	7	21	18.15	0.63927
87	7	21	20.14	0.51249
88	7	21	16.32	0.75122
89	7	21	17.09	0.70562
90	7	21	15.70	0.78652
91	7	21	15.11	0.81751
92	7	21	20.84	0.46847
93	7	21	21.37	0.43680
94	7	21	26.10	0.20260
95	7	21	19.34	0.56349
96	7	21	24.42	0.27296
97	7	21	29.96	0.09271
98	7	21	18.54	0.61434
99	7	21	36.72	0.01812
100	7	21	11.48	0.95264
Combined P-value for all tests (Using KS method)				0.42550

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	23.01	0.34355
2	7	21	11.33	0.95601
3	7	21	29.00	0.11400
4	7	21	23.60	0.31284
5	7	21	15.97	0.77145
6	7	21	21.06	0.45504
7	7	21	28.07	0.13812
8	7	21	16.57	0.73694
9	7	21	26.72	0.18031
10	7	21	19.02	0.58360
11	7	21	21.11	0.45212
12	7	21	28.16	0.13567
13	7	21	11.26	0.95757
14	7	21	11.26	0.95740
15	7	21	17.13	0.70332
16	7	21	25.98	0.20737
17	7	21	17.38	0.68758
18	7	21	34.54	0.03166
19	7	21	26.29	0.19568
20	7	21	23.18	0.33425
21	7	21	13.44	0.89243
22	7	21	21.71	0.41627
23	7	21	23.10	0.33846
24	7	21	12.19	0.93429
25	7	21	18.70	0.60463
26	7	21	41.23	0.00525
27	7	21	19.53	0.55131
28	7	21	20.56	0.48608
29	7	21	15.87	0.77680
30	7	21	22.31	0.38173
31	7	21	36.50	0.01918
32	7	21	19.85	0.53091
33	7	21	17.97	0.65103
34	7	21	18.26	0.63275
35	7	21	9.59	0.98374
36	7	21	29.62	0.09981
37	7	21	26.70	0.18114
38	7	21	18.57	0.61283
39	7	21	27.93	0.14226
Combined P-value for all tests (Using KS method)				0.97693

**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 Nov 2022 to Feb 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.

Combination of p-values using Holm's Method		
Test	P-Value	P-Adjusted
Ranks Test	0.17033	0.51100
Suits Test	0.42550	0.85100
Hand Types Test	0.95250	0.95250
<b>Combined P-Value using Holm's Method</b>		0.51100

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	0.97386	1.00000
Suits Test	0.97693	1.00000
Hand Types Test	0.42159	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 Nov 2022 to Feb 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: 04 July 2023

**Signed:**



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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.

