



## Poker Cards Analysis - August 2021

### The Directors

Entain Plc

This is to confirm that iTech Labs has examined the game logs for Poker games for the period **August 01, 2021 to August 31, 2021** 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	8.98	0.43923
2	9	4.95	0.83861
3	9	16.40	0.05891
4	9	1.27	0.99854
5	9	6.60	0.67878
6	9	5.03	0.83205
7	9	23.07	0.00605
8	9	5.99	0.74140
9	9	8.61	0.47389
10	9	11.16	0.26500
11	9	3.76	0.92625
12	9	15.85	0.07010
13	9	10.43	0.31697
14	9	5.32	0.80550
15	9	10.32	0.32530
16	9	8.24	0.51051
17	9	4.46	0.87884
18	9	14.97	0.09181
19	9	13.33	0.14839
20	9	14.01	0.12180
21	9	9.43	0.39830
22	9	7.77	0.55752
23	9	5.74	0.76535
24	9	11.89	0.21959

25	9	14.17	0.11626
26	9	12.69	0.17704
27	9	8.46	0.48898
28	9	15.80	0.07125
29	9	7.85	0.54899
30	9	5.30	0.80780
31	9	6.31	0.70884
32	9	10.56	0.30671
33	9	12.71	0.17618
34	9	9.59	0.38492
35	9	6.67	0.67159
36	9	11.84	0.22274
37	9	5.19	0.81709
38	9	13.48	0.14199
39	9	4.29	0.89166
40	9	8.40	0.49425
41	9	12.43	0.19001
42	9	8.07	0.52668
43	9	16.31	0.06068
44	9	10.97	0.27773
45	9	10.24	0.33124
46	9	13.48	0.14219
47	9	5.59	0.77977
48	9	6.47	0.69244
49	9	8.08	0.52578
50	9	8.30	0.50374
51	9	9.41	0.39997
52	9	9.65	0.37931
53	9	25.91	0.00211
54	9	1.57	0.99661
55	9	7.75	0.55968
56	9	10.76	0.29242
57	9	6.33	0.70678
58	9	10.46	0.31456
59	9	4.15	0.90112
60	9	7.86	0.54814
61	9	6.59	0.67951
62	9	12.73	0.17536
63	9	22.23	0.00817
64	9	7.13	0.62355
65	9	12.94	0.16513
66	9	11.89	0.21945
67	9	5.47	0.79183
68	9	7.62	0.57314
69	9	5.96	0.74387
70	9	3.17	0.95715
71	9	9.75	0.37084
72	9	7.22	0.61463
73	9	7.92	0.54178
74	9	4.93	0.84027
75	9	8.13	0.52152
76	9	15.67	0.07401
77	9	16.36	0.05977
78	9	12.58	0.18245
79	9	12.50	0.18677

80	9	9.13	0.42567
81	9	8.57	0.47744
82	9	12.38	0.19280
83	9	14.60	0.10249
84	9	6.96	0.64123
85	9	4.20	0.89775
86	9	14.03	0.12133
87	9	7.26	0.61054
88	9	5.85	0.75469
89	9	13.64	0.13556
90	9	7.17	0.61988
91	9	4.51	0.87498
92	9	2.68	0.97575
93	9	17.04	0.04806
94	9	17.78	0.03783
95	9	10.30	0.32660
96	9	9.51	0.39184
97	9	5.92	0.74835
98	9	16.03	0.06628
99	9	8.72	0.46353
100	9	10.66	0.29984
Combined P-value for all tests (Using KS method)			0.41509

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	2.80	0.94641
2	8	11.98	0.15222
3	8	4.76	0.78336
4	8	12.51	0.12994
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	81.72	0.54999
2	7	84	95.26	0.18849

3	7	84	83.77	0.48664
4	7	84	87.89	0.36437
5	7	84	95.90	0.17653
6	7	84	92.40	0.24862
7	7	84	72.59	0.80839
8	7	84	68.91	0.88296
9	7	84	68.94	0.88245
10	7	84	76.37	0.71091
11	7	84	64.15	0.94733
12	7	84	103.83	0.07021
13	7	84	61.62	0.96835
14	7	84	73.42	0.78849
15	7	84	81.35	0.56150
16	7	84	91.02	0.28162
17	7	84	76.27	0.71364
18	7	84	71.86	0.82486
19	7	84	83.36	0.49925
20	7	84	81.47	0.55779
21	7	84	81.55	0.55544
22	7	84	89.22	0.32780
23	7	84	67.69	0.90281
24	7	84	64.27	0.94609
25	7	84	98.30	0.13633
26	7	84	83.90	0.48262
27	7	84	76.87	0.69669
28	7	84	97.89	0.14261
29	7	84	84.18	0.47408
30	7	84	90.43	0.29641
31	7	84	81.06	0.57063
32	7	84	93.46	0.22509
33	7	84	83.58	0.49245
34	7	84	93.99	0.21387
35	7	84	83.48	0.49544
36	7	84	74.46	0.76234
37	7	84	75.11	0.74529
38	7	84	87.05	0.38824
39	7	84	100.80	0.10212
40	7	84	79.69	0.61279
41	7	84	73.65	0.78297
42	7	84	79.44	0.62039
43	7	84	94.11	0.21127
44	7	84	82.61	0.52235
45	7	84	84.11	0.47615
46	7	84	76.66	0.70246
47	7	84	78.39	0.65222
48	7	84	83.12	0.50669
49	7	84	88.73	0.34106
50	7	84	100.13	0.11059
51	7	84	90.73	0.28863
52	7	84	88.63	0.34378
53	7	84	87.48	0.37604
54	7	84	96.06	0.17363
55	7	84	83.33	0.50012
56	7	84	112.22	0.02158
57	7	84	74.94	0.74988

58	7	84	98.30	0.13634
59	7	84	76.82	0.69801
60	7	84	76.36	0.71111
61	7	84	75.02	0.74768
62	7	84	72.11	0.81918
63	7	84	52.45	0.99726
64	7	84	84.12	0.47594
65	7	84	77.32	0.68361
66	7	84	107.70	0.04177
67	7	84	110.06	0.02977
68	7	84	68.03	0.89763
69	7	84	84.22	0.47277
70	7	84	80.97	0.57352
71	7	84	90.03	0.30644
72	7	84	108.22	0.03879
73	7	84	89.15	0.32984
74	7	84	88.47	0.34808
75	7	84	74.96	0.74922
76	7	84	88.53	0.34669
77	7	84	88.88	0.33689
78	7	84	52.09	0.99756
79	7	84	89.46	0.32152
80	7	84	98.40	0.13481
81	7	84	57.80	0.98706
82	7	84	65.24	0.93565
83	7	84	128.25	0.00135
84	7	84	94.57	0.20205
85	7	84	84.94	0.45084
86	7	84	95.54	0.18317
87	7	84	73.68	0.78206
88	7	84	85.52	0.43316
89	7	84	89.38	0.32359
90	7	84	78.91	0.63646
91	7	84	56.93	0.98968
92	7	84	80.32	0.59345
93	7	84	89.72	0.31467
94	7	84	85.45	0.43548
95	7	84	99.70	0.11633
96	7	84	100.71	0.10323
97	7	84	87.78	0.36739
98	7	84	79.80	0.60959
99	7	84	86.87	0.39354
100	7	84	69.97	0.86369
Combined P-value for all tests (Using KS method)				0.94736

**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	80.52	0.01760
2	7	56	69.50	0.10613
3	7	56	43.06	0.89759
4	7	56	37.86	0.96996

5	7	56	73.21	0.06109
6	7	56	43.47	0.88904
7	7	56	60.21	0.32596
8	7	56	56.22	0.46676
9	7	56	40.45	0.94160
10	7	56	51.46	0.64702
11	7	56	41.31	0.92888
12	7	56	69.57	0.10506
13	7	56	37.87	0.96981
14	7	56	58.74	0.37553
15	7	56	58.65	0.37866
16	7	56	57.15	0.43218
Combined P-value for all tests (Using KS method)				0.18157

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	15.85	0.77784
2	7	21	24.18	0.28451
3	7	21	20.00	0.52128
4	7	21	21.17	0.44846
5	7	21	16.10	0.76411
6	7	21	26.30	0.19541
7	7	21	18.31	0.62945
8	7	21	27.04	0.16959
9	7	21	22.98	0.34498
10	7	21	19.36	0.56213
11	7	21	15.31	0.80716
12	7	21	9.66	0.98294
13	7	21	11.58	0.95029
14	7	21	23.89	0.29827
15	7	21	11.82	0.94439
16	7	21	34.89	0.02899
17	7	21	30.46	0.08313
18	7	21	18.46	0.61999
19	7	21	34.04	0.03585
20	7	21	24.03	0.29162
21	7	21	16.63	0.73345
22	7	21	14.42	0.85101
23	7	21	20.82	0.47022
24	7	21	17.54	0.67800
25	7	21	29.02	0.11349
26	7	21	20.54	0.48763
27	7	21	18.29	0.63056

28	7	21	8.48	0.99272
29	7	21	29.09	0.11192
30	7	21	16.53	0.73896
31	7	21	24.20	0.28365
32	7	21	19.39	0.56019
33	7	21	33.64	0.03959
34	7	21	17.68	0.66889
35	7	21	20.60	0.48387
36	7	21	26.04	0.20475
37	7	21	30.24	0.08735
38	7	21	25.42	0.22941
39	7	21	35.78	0.02313
40	7	21	24.43	0.27264
41	7	21	28.37	0.12986
42	7	21	16.50	0.74096
43	7	21	14.47	0.84866
44	7	21	10.41	0.97313
45	7	21	22.85	0.35213
46	7	21	13.49	0.89040
47	7	21	16.36	0.74910
48	7	21	15.30	0.80776
49	7	21	21.39	0.43520
50	7	21	27.96	0.14125
51	7	21	17.81	0.66075
52	7	21	14.44	0.85018
53	7	21	17.34	0.69060
54	7	21	22.25	0.38532
55	7	21	27.10	0.16752
56	7	21	26.62	0.18370
57	7	21	27.32	0.16058
58	7	21	16.35	0.74957
59	7	21	18.36	0.62635
60	7	21	17.26	0.69542
61	7	21	27.93	0.14204
62	7	21	12.29	0.93157
63	7	21	14.54	0.84516
64	7	21	15.33	0.80586
65	7	21	33.43	0.04162
66	7	21	23.00	0.34393
67	7	21	19.56	0.54910
68	7	21	19.97	0.52310
69	7	21	19.24	0.56992
70	7	21	28.61	0.12370
71	7	21	24.58	0.26586
72	7	21	23.11	0.33813
73	7	21	27.44	0.15683
74	7	21	24.32	0.27799
75	7	21	34.17	0.03474
76	7	21	26.03	0.20536
77	7	21	21.99	0.40014
78	7	21	21.39	0.43546
79	7	21	17.10	0.70497
80	7	21	28.61	0.12356
81	7	21	26.86	0.17553
82	7	21	22.69	0.36052

83	7	21	21.28	0.44178
84	7	21	21.18	0.44786
85	7	21	12.14	0.93580
86	7	21	15.20	0.81277
87	7	21	18.08	0.64414
88	7	21	25.63	0.22104
89	7	21	26.82	0.17673
90	7	21	17.68	0.66915
91	7	21	17.02	0.71007
92	7	21	24.78	0.25697
93	7	21	18.91	0.59062
94	7	21	23.95	0.29538
95	7	21	14.51	0.84667
96	7	21	24.43	0.27291
97	7	21	13.43	0.89267
98	7	21	12.64	0.92076
99	7	21	18.61	0.60997
100	7	21	17.78	0.66261
Combined P-value for all tests (Using KS method)				0.82902

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	20.14	0.51266
2	7	21	18.56	0.61334
3	7	21	39.64	0.00822
4	7	21	17.01	0.71062
5	7	21	11.74	0.94627
6	7	21	15.43	0.80067
7	7	21	20.88	0.46629
8	7	21	15.38	0.80320
9	7	21	13.15	0.90321
10	7	21	19.44	0.55694
11	7	21	22.19	0.38852
12	7	21	24.22	0.28233
13	7	21	27.81	0.14568
14	7	21	27.26	0.16228
15	7	21	27.70	0.14875
16	7	21	20.33	0.50045
Combined P-value for all tests (Using KS method)				0.99879

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	0.94736	1.00000
Suits Test	0.82902	1.00000
Hand Types Test	0.41509	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 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	0.18157	0.77963
Suits Test	0.99879	1.00000
Hands Type Test	0.94641	1.00000
Hand Type Test	0.15222	0.77963
Hand Type Test	0.78336	1.00000
Hand Type Test	0.12994	0.77963
<b>Combined P-Value using Holm's Method</b>		0.77963

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.

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**Signed:**



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**Kiren Sreekumar**  
**Principal Consultant**  
**iTech Labs Australia**  
Date: 19 November 2021

**Signed:**



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**Geoff Nicoll**  
**Principal Consultant**  
**iTech Labs Australia**  
Date: 19 November 2021

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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.

