

## Poker Cards Analysis - October 2021

### The Directors

Entain Plc

This is to confirm that iTech Labs has examined the game logs for Poker games for the period **October 01, 2021 to October 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	3.43	0.94495
2	9	7.27	0.60926
3	9	6.31	0.70836
4	9	8.87	0.44914
5	9	12.49	0.18708
6	9	19.07	0.02464
7	9	4.17	0.89990
8	9	14.10	0.11877
9	9	12.40	0.19166
10	9	6.89	0.64857
11	9	13.68	0.13409
12	9	9.56	0.38686
13	9	9.37	0.40355
14	9	5.47	0.79145
15	9	6.07	0.73263
16	9	8.28	0.50572
17	9	7.37	0.59917
18	9	4.24	0.89481
19	9	12.74	0.17450
20	9	4.47	0.87780
21	9	15.44	0.07961
22	9	8.47	0.48711
23	9	9.06	0.43178
24	9	10.53	0.30919

25	9	9.73	0.37316
26	9	10.89	0.28320
27	9	8.22	0.51178
28	9	7.96	0.53796
29	9	5.70	0.76961
30	9	5.16	0.81979
31	9	6.35	0.70396
32	9	9.67	0.37780
33	9	10.28	0.32829
34	9	10.26	0.32972
35	9	4.25	0.89402
36	9	11.11	0.26840
37	9	4.19	0.89845
38	9	7.56	0.57931
39	9	5.23	0.81415
40	9	7.27	0.60930
41	9	16.72	0.05333
42	9	4.97	0.83691
43	9	8.70	0.46549
44	9	9.43	0.39887
45	9	11.02	0.27437
46	9	16.08	0.06517
47	9	5.38	0.80023
48	9	20.29	0.01623
49	9	8.18	0.51603
50	9	2.85	0.96979
51	9	10.90	0.28258
52	9	7.77	0.55698
53	9	8.28	0.50623
54	9	5.99	0.74122
55	9	12.22	0.20107
56	9	8.09	0.52494
57	9	9.66	0.37913
58	9	6.81	0.65650
59	9	4.70	0.85993
60	9	9.10	0.42813
61	9	2.09	0.98991
62	9	12.33	0.19556
63	9	8.10	0.52390
64	9	10.12	0.34048
65	9	5.66	0.77377
66	9	6.59	0.67969
67	9	14.43	0.10772
68	9	8.08	0.52643
69	9	11.87	0.22075
70	9	12.74	0.17451
71	9	11.27	0.25762
72	9	4.77	0.85378
73	9	7.82	0.55270
74	9	17.55	0.04083
75	9	5.44	0.79457
76	9	9.86	0.36192
77	9	8.99	0.43785
78	9	12.89	0.16756
79	9	7.33	0.60315

80	9	7.06	0.63134
81	9	6.91	0.64629
82	9	9.66	0.37907
83	9	15.64	0.07479
84	9	12.46	0.18836
85	9	7.70	0.56413
86	9	7.54	0.58068
87	9	2.93	0.96716
88	9	2.51	0.98050
89	9	13.04	0.16096
90	9	5.00	0.83395
91	9	13.57	0.13831
92	9	10.90	0.28255
93	9	12.17	0.20401
94	9	6.22	0.71790
95	9	13.27	0.15076
96	9	7.80	0.55490
97	9	6.73	0.66553
98	9	2.66	0.97627
99	9	2.63	0.97733
100	9	6.84	0.65350
Combined P-value for all tests (Using KS method)			0.98843

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	8.82	0.45414
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	75.05	0.74691
2	7	84	71.85	0.82500
3	7	84	109.19	0.03379
4	7	84	67.84	0.90051
5	7	84	81.42	0.55928

6	7	84	81.87	0.54539
7	7	84	93.38	0.22682
8	7	84	67.32	0.90845
9	7	84	69.82	0.86662
10	7	84	49.43	0.99905
11	7	84	89.95	0.30864
12	7	84	79.91	0.60595
13	7	84	68.98	0.88183
14	7	84	109.52	0.03224
15	7	84	83.61	0.49152
16	7	84	78.58	0.64648
17	7	84	103.40	0.07416
18	7	84	111.98	0.02237
19	7	84	102.43	0.08378
20	7	84	70.17	0.85988
21	7	84	101.21	0.09724
22	7	84	100.11	0.11086
23	7	84	93.90	0.21569
24	7	84	78.87	0.63770
25	7	84	71.10	0.84104
26	7	84	90.41	0.29679
27	7	84	77.86	0.66795
28	7	84	82.83	0.51565
29	7	84	73.16	0.79489
30	7	84	96.48	0.16601
31	7	84	90.91	0.28425
32	7	84	66.85	0.91523
33	7	84	75.04	0.74725
34	7	84	78.18	0.65830
35	7	84	98.78	0.12914
36	7	84	79.72	0.61206
37	7	84	64.99	0.93846
38	7	84	80.16	0.59834
39	7	84	102.29	0.08527
40	7	84	93.05	0.23402
41	7	84	105.43	0.05695
42	7	84	86.38	0.40774
43	7	84	77.50	0.67835
44	7	84	67.66	0.90330
45	7	84	84.27	0.47123
46	7	84	63.78	0.95095
47	7	84	71.97	0.82244
48	7	84	93.93	0.21507
49	7	84	91.15	0.27843
50	7	84	88.30	0.35293
51	7	84	67.01	0.91298
52	7	84	85.33	0.43908
53	7	84	94.86	0.19618
54	7	84	91.49	0.27004
55	7	84	77.83	0.66864
56	7	84	70.13	0.86071
57	7	84	101.48	0.09414
58	7	84	98.08	0.13973
59	7	84	102.30	0.08515
60	7	84	65.60	0.93144

61	7	84	75.66	0.73042
62	7	84	97.80	0.14400
63	7	84	86.68	0.39893
64	7	84	81.80	0.54776
65	7	84	90.05	0.30609
66	7	84	67.37	0.90764
67	7	84	83.15	0.50576
68	7	84	75.89	0.72423
69	7	84	71.68	0.82878
70	7	84	64.80	0.94063
71	7	84	72.85	0.80212
72	7	84	106.79	0.04735
73	7	84	76.44	0.70882
74	7	84	80.85	0.57717
75	7	84	72.60	0.80812
76	7	84	102.62	0.08181
77	7	84	82.96	0.51172
78	7	84	71.75	0.82722
79	7	84	87.09	0.38707
80	7	84	89.64	0.31673
81	7	84	71.05	0.84223
82	7	84	74.18	0.76948
83	7	84	96.24	0.17032
84	7	84	92.14	0.25472
85	7	84	87.34	0.37991
86	7	84	79.40	0.62176
87	7	84	89.31	0.32540
88	7	84	80.70	0.58180
89	7	84	93.39	0.22650
90	7	84	108.38	0.03795
91	7	84	88.42	0.34951
92	7	84	74.68	0.75661
93	7	84	96.23	0.17052
94	7	84	61.97	0.96591
95	7	84	81.18	0.56679
96	7	84	61.11	0.97166
97	7	84	93.25	0.22973
98	7	84	82.12	0.53773
99	7	84	71.42	0.83427
100	7	84	75.49	0.73501
Combined P-value for all tests (Using KS method)				0.78039

**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	62.52	0.25598
2	7	56	51.23	0.65568
3	7	56	55.60	0.48980
4	7	56	49.27	0.72570
5	7	56	73.37	0.05956
6	7	56	39.22	0.95672
7	7	56	72.24	0.07099

8	7	56	42.77	0.90328
9	7	56	42.39	0.91043
10	7	56	32.73	0.99452
11	7	56	51.21	0.65634
12	7	56	43.81	0.88164
13	7	56	72.02	0.07336
14	7	56	70.56	0.09113
15	7	56	59.56	0.34731
16	7	56	69.55	0.10532
17	7	56	53.53	0.56877
18	7	56	37.78	0.97056
19	7	56	61.08	0.29859
20	7	56	54.20	0.54329
21	7	56	58.72	0.37616
22	7	56	48.82	0.74095
23	7	56	64.53	0.20303
24	7	56	76.97	0.03300
25	7	56	47.50	0.78334
26	7	56	55.77	0.48368
27	7	56	56.81	0.44467
28	7	56	50.49	0.68260
29	7	56	56.67	0.45000
30	7	56	49.54	0.71638
31	7	56	68.92	0.11505
32	7	56	42.39	0.91043
33	7	56	63.11	0.23955
34	7	56	73.06	0.06248
35	7	56	52.18	0.62008
36	7	56	34.87	0.98804
37	7	56	61.09	0.29804
38	7	56	53.60	0.56612
Combined P-value for all tests (Using KS method)				0.88853

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 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	17.90	0.65555
2	7	21	14.86	0.82968
3	7	21	20.89	0.46561
4	7	21	19.54	0.55045
5	7	21	17.16	0.70114
6	7	21	17.13	0.70312
7	7	21	17.11	0.70448
8	7	21	19.26	0.56874

9	7	21	10.58	0.97034
10	7	21	25.88	0.21094
11	7	21	25.01	0.24669
12	7	21	19.37	0.56123
13	7	21	22.50	0.37137
14	7	21	12.21	0.93379
15	7	21	11.09	0.96102
16	7	21	35.44	0.02526
17	7	21	12.02	0.93918
18	7	21	20.60	0.48363
19	7	21	29.08	0.11215
20	7	21	26.53	0.18709
21	7	21	24.76	0.25760
22	7	21	22.85	0.35192
23	7	21	16.38	0.74793
24	7	21	19.87	0.52982
25	7	21	22.81	0.35442
26	7	21	28.93	0.11573
27	7	21	27.62	0.15114
28	7	21	33.49	0.04110
29	7	21	16.04	0.76758
30	7	21	17.38	0.68786
31	7	21	19.82	0.53295
32	7	21	28.22	0.13415
33	7	21	16.76	0.72562
34	7	21	22.41	0.37642
35	7	21	21.05	0.45583
36	7	21	28.90	0.11651
37	7	21	16.06	0.76623
38	7	21	22.99	0.34471
39	7	21	22.36	0.37916
40	7	21	14.68	0.83865
41	7	21	22.46	0.37333
42	7	21	18.71	0.60353
43	7	21	27.99	0.14054
44	7	21	19.24	0.56954
45	7	21	15.42	0.80139
46	7	21	15.16	0.81494
47	7	21	20.66	0.47992
48	7	21	21.00	0.45898
49	7	21	25.88	0.21118
50	7	21	18.21	0.63586
51	7	21	41.83	0.00442
52	7	21	21.41	0.43412
53	7	21	19.08	0.58000
54	7	21	28.28	0.13241
55	7	21	25.93	0.20921
56	7	21	31.48	0.06600
57	7	21	12.79	0.91576
58	7	21	13.83	0.87680
59	7	21	17.39	0.68741
60	7	21	19.24	0.56979
61	7	21	26.36	0.19306
62	7	21	23.74	0.30580
63	7	21	12.71	0.91847

64	7	21	23.12	0.33755
65	7	21	14.28	0.85738
66	7	21	20.05	0.51822
67	7	21	17.14	0.70233
68	7	21	19.33	0.56427
69	7	21	13.88	0.87482
70	7	21	16.71	0.72870
71	7	21	13.09	0.90537
72	7	21	16.99	0.71160
73	7	21	16.27	0.75427
74	7	21	15.69	0.78675
75	7	21	27.67	0.14979
76	7	21	24.46	0.27126
77	7	21	16.27	0.75416
78	7	21	16.79	0.72389
79	7	21	11.71	0.94710
80	7	21	16.80	0.72302
81	7	21	13.74	0.88038
82	7	21	15.73	0.78474
83	7	21	11.64	0.94880
84	7	21	22.67	0.36162
85	7	21	19.87	0.52956
86	7	21	16.37	0.74834
87	7	21	24.91	0.25112
88	7	21	29.54	0.10156
89	7	21	20.68	0.47864
90	7	21	19.01	0.58469
91	7	21	10.58	0.97042
92	7	21	17.64	0.67175
93	7	21	20.75	0.47444
94	7	21	19.29	0.56625
95	7	21	21.04	0.45620
96	7	21	32.52	0.05184
97	7	21	33.68	0.03920
98	7	21	11.53	0.95152
99	7	21	17.08	0.70628
100	7	21	20.92	0.46372
Combined P-value for all tests (Using KS method)				0.20047

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	26.42	0.19074
2	7	21	14.68	0.83866
3	7	21	23.38	0.32385
4	7	21	8.70	0.99141
5	7	21	26.20	0.19893
6	7	21	20.98	0.45992
7	7	21	22.76	0.35691
8	7	21	18.58	0.61232
9	7	21	22.01	0.39905
10	7	21	27.26	0.16228



11	7	21	35.74	0.02336
12	7	21	23.22	0.33215
13	7	21	19.72	0.53905
14	7	21	25.06	0.24440
15	7	21	25.30	0.23424
16	7	21	15.72	0.78517
17	7	21	25.91	0.20982
18	7	21	26.07	0.20372
19	7	21	15.06	0.82013
20	7	21	22.41	0.37633
21	7	21	26.58	0.18505
22	7	21	16.94	0.71498
23	7	21	15.53	0.79556
24	7	21	19.99	0.52177
25	7	21	17.90	0.65507
26	7	21	28.58	0.12456
27	7	21	16.86	0.71980
28	7	21	27.50	0.15503
29	7	21	16.44	0.74444
30	7	21	23.94	0.29578
31	7	21	21.74	0.41486
32	7	21	11.05	0.96184
33	7	21	21.94	0.40274
34	7	21	22.14	0.39125
35	7	21	23.42	0.32179
36	7	21	32.06	0.05768
37	7	21	35.40	0.02551
38	7	21	18.54	0.61455
Combined P-value for all tests (Using KS method)				0.23519

**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	0.78039	1.00000
Suits Test	0.20047	0.60140
Hand Types Test	0.98843	1.00000
<b>Combined P-Value using Holm's Method</b>		0.60140

**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	0.88853	0.90827
Suits Test	0.23519	0.70557
Hands Type Test	0.45414	0.90827
<b>Combined P-Value using Holm's Method</b>		0.70557

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

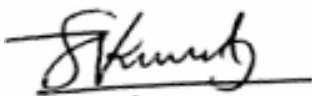
Analysis of actual data from game logs for 'Hand Types', 'Ranks' and 'Suits' for **52-card decks** and **36-card decks** indicated statistical randomness.

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.

Signed:



**Kiren Sreekumar**  
**Principal Consultant**  
**iTech Labs Australia**  
Date: 23 December 2021

Signed:



**Geoff Nicoll**  
**Principal Consultant**  
**iTech Labs Australia**  
Date: 23 December 2021

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.