

## Poker Cards Analysis - June 2021

### The Directors

Entain Plc

This is to confirm that iTech Labs has examined the game logs for Poker games for the period **June 01, 2021** to **June 30, 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	8.65	0.47020
2	9	5.57	0.78194
3	9	2.76	0.97298
4	9	10.72	0.29511
5	9	15.08	0.08886
6	9	8.97	0.44011
7	9	12.68	0.17774
8	9	9.85	0.36241
9	9	6.06	0.73361
10	9	6.37	0.70270
11	9	14.93	0.09281
12	9	4.96	0.83776
13	9	3.55	0.93841
14	9	1.45	0.99749
15	9	5.73	0.76637
16	9	8.66	0.46892
17	9	6.31	0.70807
18	9	14.19	0.11583
19	9	10.13	0.34025
20	9	12.78	0.17269
21	9	4.75	0.85549
22	9	3.82	0.92270
23	9	2.53	0.98005
24	9	6.30	0.70926

25	9	12.70	0.17642
26	9	9.15	0.42332
27	9	6.21	0.71913
28	9	3.51	0.94063
29	9	3.14	0.95830
30	9	11.23	0.26047
31	9	4.82	0.84999
32	9	10.17	0.33708
33	9	4.16	0.90072
34	9	5.44	0.79425
35	9	6.94	0.64285
36	9	8.74	0.46153
37	9	4.13	0.90252
38	9	7.99	0.53523
39	9	17.53	0.04103
40	9	7.21	0.61477
41	9	9.67	0.37783
42	9	12.13	0.20624
43	9	5.34	0.80340
44	9	10.44	0.31608
45	9	5.18	0.81809
46	9	7.08	0.62843
47	9	5.99	0.74053
48	9	11.51	0.24224
49	9	9.39	0.40220
50	9	11.39	0.25008
51	9	9.00	0.43754
52	9	2.32	0.98530
53	9	1.03	0.99938
54	9	6.38	0.70185
55	9	4.00	0.91145
56	9	9.38	0.40340
57	9	6.21	0.71878
58	9	9.10	0.42805
59	9	3.75	0.92689
60	9	6.02	0.73828
61	9	12.04	0.21087
62	9	7.15	0.62119
63	9	11.39	0.24996
64	9	8.50	0.48462
65	9	7.99	0.53511
66	9	9.15	0.42313
67	9	4.97	0.83696
68	9	9.39	0.40205
69	9	14.16	0.11658
70	9	10.13	0.34013
71	9	11.79	0.22535
72	9	23.94	0.00440
73	9	12.88	0.16800
74	9	7.72	0.56217
75	9	11.71	0.23030
76	9	7.48	0.58763
77	9	5.70	0.76975
78	9	8.75	0.46108
79	9	17.27	0.04470

80	9	5.64	0.77535
81	9	5.16	0.82044
82	9	11.32	0.25428
83	9	12.88	0.16821
84	9	6.02	0.73788
85	9	6.77	0.66151
86	9	6.40	0.69937
87	9	13.69	0.13369
88	9	9.86	0.36222
89	9	9.53	0.38943
90	9	8.00	0.53415
91	9	3.53	0.93944
92	9	4.94	0.83919
93	9	12.24	0.20006
94	9	2.44	0.98235
95	9	15.73	0.07283
96	9	9.35	0.40571
97	9	12.66	0.17856
98	9	13.35	0.14744
99	9	8.29	0.50521
100	9	14.64	0.10124
Combined P-value for all tests (Using KS method)			0.38536

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	12.66	0.17858
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	73.41	0.78888
2	7	84	77.93	0.66593
3	7	84	87.39	0.37855
4	7	84	76.96	0.69390
5	7	84	97.95	0.14169

6	7	84	69.77	0.86743
7	7	84	72.61	0.80773
8	7	84	96.99	0.15725
9	7	84	62.92	0.95854
10	7	84	106.41	0.04991
11	7	84	77.38	0.68185
12	7	84	67.40	0.90721
13	7	84	85.09	0.44620
14	7	84	110.12	0.02953
15	7	84	89.52	0.31995
16	7	84	88.35	0.35159
17	7	84	81.43	0.55922
18	7	84	64.73	0.94133
19	7	84	89.67	0.31590
20	7	84	87.99	0.36144
21	7	84	91.68	0.26543
22	7	84	87.41	0.37783
23	7	84	73.85	0.77785
24	7	84	109.98	0.03015
25	7	84	73.22	0.79327
26	7	84	70.25	0.85836
27	7	84	87.75	0.36831
28	7	84	97.39	0.15074
29	7	84	74.74	0.75520
30	7	84	62.05	0.96533
31	7	84	55.26	0.99351
32	7	84	83.49	0.49529
33	7	84	78.55	0.64745
34	7	84	71.08	0.84164
35	7	84	75.73	0.72865
36	7	84	78.21	0.65756
37	7	84	75.89	0.72418
38	7	84	88.83	0.33847
39	7	84	76.79	0.69896
40	7	84	100.18	0.10990
41	7	84	72.48	0.81084
42	7	84	99.42	0.12010
43	7	84	84.22	0.47286
44	7	84	91.65	0.26620
45	7	84	91.70	0.26506
46	7	84	74.17	0.76972
47	7	84	111.65	0.02352
48	7	84	99.83	0.11455
49	7	84	77.85	0.66805
50	7	84	96.39	0.16769
51	7	84	88.49	0.34766
52	7	84	87.97	0.36200
53	7	84	92.34	0.25010
54	7	84	64.84	0.94016
55	7	84	80.54	0.58662
56	7	84	77.50	0.67842
57	7	84	80.98	0.57294
58	7	84	83.32	0.50040
59	7	84	79.18	0.62848
60	7	84	79.67	0.61337

61	7	84	98.84	0.12829
62	7	84	77.83	0.66887
63	7	84	86.01	0.41872
64	7	84	84.93	0.45121
65	7	84	83.05	0.50885
66	7	84	72.35	0.81382
67	7	84	79.53	0.61781
68	7	84	86.98	0.39031
69	7	84	75.83	0.72590
70	7	84	65.24	0.93560
71	7	84	96.34	0.16854
72	7	84	79.18	0.62849
73	7	84	79.23	0.62689
74	7	84	102.96	0.07844
75	7	84	97.69	0.14575
76	7	84	76.61	0.70409
77	7	84	101.96	0.08883
78	7	84	72.62	0.80754
79	7	84	70.94	0.84441
80	7	84	100.48	0.10607
81	7	84	95.26	0.18843
82	7	84	85.88	0.42262
83	7	84	75.91	0.72368
84	7	84	91.39	0.27256
85	7	84	83.59	0.49216
86	7	84	100.05	0.11168
87	7	84	86.05	0.41750
88	7	84	69.76	0.86759
89	7	84	87.52	0.37473
90	7	84	102.56	0.08239
91	7	84	90.01	0.30714
92	7	84	77.79	0.66983
93	7	84	106.97	0.04623
94	7	84	81.81	0.54728
95	7	84	67.19	0.91030
96	7	84	72.12	0.81893
97	7	84	85.56	0.43207
98	7	84	78.18	0.65825
99	7	84	66.71	0.91712
100	7	84	77.43	0.68042
Combined P-value for all tests (Using KS method)				0.63844

**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	62.82	0.24743
2	7	56	74.00	0.05390
3	7	56	48.13	0.76344
4	7	56	69.23	0.11024
5	7	56	53.71	0.56189
6	7	56	62.84	0.24694
7	7	56	62.34	0.26109

8	7	56	44.95	0.85499
9	7	56	48.60	0.74815
10	7	56	52.17	0.62076
11	7	56	53.75	0.56051
12	7	56	61.29	0.29196
13	7	56	56.63	0.45133
14	7	56	47.40	0.78667
15	7	56	37.75	0.97085
16	7	56	39.26	0.95632
17	7	56	39.64	0.95197
18	7	56	58.47	0.38495
19	7	56	57.82	0.40794
20	7	56	47.65	0.77887
21	7	56	48.33	0.75702
22	7	56	68.02	0.13014
23	7	56	64.01	0.21598
24	7	56	44.44	0.86724
25	7	56	41.28	0.92944
26	7	56	63.96	0.21734
27	7	56	36.60	0.97918
28	7	56	45.81	0.83250
29	7	56	48.71	0.74456
30	7	56	53.10	0.58527
31	7	56	63.29	0.23471
32	7	56	61.71	0.27948
33	7	56	54.20	0.54329
34	7	56	57.93	0.40407
35	7	56	46.64	0.80926
36	7	56	52.80	0.59692
37	7	56	39.80	0.95002
38	7	56	73.80	0.05563
39	7	56	41.64	0.92365
40	7	56	74.94	0.04635
41	7	56	52.24	0.61805
42	7	56	61.99	0.27098
43	7	56	56.72	0.44789
Combined P-value for all tests (Using KS method)				0.34423

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	29.78	0.09654
2	7	21	17.26	0.69539
3	7	21	22.23	0.38620

4	7	21	18.34	0.62733
5	7	21	20.99	0.45977
6	7	21	15.10	0.81776
7	7	21	26.25	0.19698
8	7	21	24.02	0.29223
9	7	21	32.03	0.05815
10	7	21	28.90	0.11637
11	7	21	16.25	0.75573
12	7	21	34.12	0.03520
13	7	21	15.48	0.79828
14	7	21	21.53	0.42719
15	7	21	25.04	0.24548
16	7	21	24.82	0.25509
17	7	21	37.07	0.01650
18	7	21	11.69	0.94765
19	7	21	25.66	0.21982
20	7	21	18.64	0.60828
21	7	21	18.96	0.58764
22	7	21	22.02	0.39863
23	7	21	15.76	0.78289
24	7	21	18.50	0.61722
25	7	21	21.91	0.40452
26	7	21	10.26	0.97534
27	7	21	17.96	0.65143
28	7	21	16.19	0.75890
29	7	21	15.48	0.79818
30	7	21	17.60	0.67440
31	7	21	13.64	0.88467
32	7	21	21.81	0.41073
33	7	21	15.94	0.77320
34	7	21	21.46	0.43111
35	7	21	14.58	0.84326
36	7	21	23.34	0.32586
37	7	21	16.34	0.75005
38	7	21	19.36	0.56179
39	7	21	24.11	0.28772
40	7	21	23.09	0.33922
41	7	21	11.61	0.94952
42	7	21	26.94	0.17287
43	7	21	27.18	0.16493
44	7	21	6.28	0.99918
45	7	21	26.39	0.19197
46	7	21	21.71	0.41647
47	7	21	24.18	0.28434
48	7	21	18.61	0.61023
49	7	21	16.48	0.74213
50	7	21	19.09	0.57950
51	7	21	13.76	0.87951
52	7	21	26.32	0.19440
53	7	21	19.24	0.56961
54	7	21	28.48	0.12706
55	7	21	7.88	0.99562
56	7	21	23.81	0.30248
57	7	21	31.81	0.06125
58	7	21	17.26	0.69512

59	7	21	12.47	0.92595
60	7	21	11.92	0.94181
61	7	21	21.38	0.43571
62	7	21	33.00	0.04625
63	7	21	23.28	0.32942
64	7	21	25.81	0.21379
65	7	21	30.78	0.07744
66	7	21	22.42	0.37547
67	7	21	18.71	0.60356
68	7	21	25.29	0.23487
69	7	21	34.31	0.03355
70	7	21	19.62	0.54567
71	7	21	20.70	0.47710
72	7	21	24.48	0.27028
73	7	21	22.81	0.35446
74	7	21	21.15	0.45005
75	7	21	7.18	0.99775
76	7	21	14.45	0.84970
77	7	21	20.54	0.48723
78	7	21	33.87	0.03745
79	7	21	18.35	0.62689
80	7	21	20.33	0.50061
81	7	21	17.06	0.70763
82	7	21	29.01	0.11383
83	7	21	32.25	0.05526
84	7	21	14.50	0.84737
85	7	21	18.22	0.63532
86	7	21	15.13	0.81656
87	7	21	15.33	0.80600
88	7	21	33.01	0.04610
89	7	21	16.92	0.71587
90	7	21	20.38	0.49727
91	7	21	21.02	0.45785
92	7	21	16.04	0.76722
93	7	21	24.79	0.25651
94	7	21	18.51	0.61682
95	7	21	22.53	0.36932
96	7	21	27.18	0.16493
97	7	21	19.08	0.57979
98	7	21	27.89	0.14342
99	7	21	30.16	0.08877
100	7	21	17.18	0.69986
Combined P-value for all tests (Using KS method)				0.99306

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	32.25	0.05525
2	7	21	27.04	0.16953
3	7	21	15.01	0.82255
4	7	21	29.47	0.10312
5	7	21	27.32	0.16051



6	7	21	17.73	0.66615
7	7	21	20.06	0.51721
8	7	21	20.19	0.50913
9	7	21	9.95	0.97953
10	7	21	23.77	0.30443
11	7	21	21.18	0.44776
12	7	21	25.03	0.24578
13	7	21	12.95	0.91030
14	7	21	13.32	0.89700
15	7	21	30.65	0.07972
16	7	21	20.44	0.49356
17	7	21	17.97	0.65103
18	7	21	21.79	0.41158
19	7	21	19.85	0.53091
20	7	21	31.88	0.06021
21	7	21	27.12	0.16692
22	7	21	44.70	0.00189
23	7	21	20.87	0.46678
24	7	21	21.18	0.44824
25	7	21	21.21	0.44631
26	7	21	13.83	0.87671
27	7	21	19.59	0.54722
28	7	21	24.84	0.25416
29	7	21	19.09	0.57949
30	7	21	23.17	0.33509
31	7	21	19.86	0.52989
32	7	21	27.16	0.16562
33	7	21	20.52	0.48857
34	7	21	21.28	0.44196
35	7	21	28.61	0.12374
36	7	21	16.56	0.73741
37	7	21	24.82	0.25522
38	7	21	26.83	0.17648
39	7	21	19.50	0.55284
40	7	21	21.34	0.43860
41	7	21	15.47	0.79855
42	7	21	16.50	0.74117
43	7	21	20.40	0.49614
Combined P-value for all tests (Using KS method)				0.15889

**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	0.63844	1.00000

Suits Test	0.99306	1.00000
Hand Types Test	0.38536	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	0.34423	0.47666
Suits Test	0.15889	0.47666
Hands Type Test	0.17858	0.47666
<b>Combined P-Value using Holm's Method</b>		0.47666

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

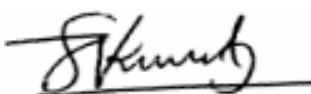
Analysis of actual data from game logs for 'Hand Types', 'Ranks' and 'Suits' for **52-card decks** and **36-card decks** indicated statistical randomness.

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: 28 July 2021

**Signed:**



**Geoff Nicoll**  
Principal Consultant  
**iTech Labs Australia**  
Date: 28 July 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.

