Poker Cards Analysis – October 2024

The Directors
Entain Plc

This is to confirm that iTech Labs has examined the game logs for Poker games for the period **October 01, 2024,** to **October 31, 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	2.02	0.99121
2	9	5.85	0.75490
3	9	10.40	0.31921
4	9	1.89	0.99313
5	9	5.31	0.80675
6	9	13.12	0.15706
7	9	8.16	0.51845
8	9	4.89	0.84388
9	9	21.71	0.00983
10	9	13.17	0.15512
11	9	15.10	0.08810
12	9	6.78	0.65966
13	9	9.54	0.38888
14	9	11.75	0.22806
15	9	5.43	0.79502
16	9	12.08	0.20892
17	9	10.43	0.31676
18	9	16.62	0.05504
19	9	11.72	0.22966
20	9	6.04	0.73552
21	9	4.14	0.90217
22	9	4.84	0.84828
23	9	11.60	0.23704
24	9	9.43	0.39864
25	9	6.26	0.71339
26	9	13.56	0.13885
27	9	13.95	0.12411

28	9	11.53	0.24132
29	9	7.89	0.54513
30	9	7.05	0.63223
31	9	10.89	0.28311
32	9	12.23	0.20053
33	9	4.33	0.88822
34	9	13.55	0.13939
35	9	6.96	0.64121
36	9	6.98	0.63953
37	9	4.65	0.86375
38	9	17.46	0.04198
39	9	11.02	0.27434
40	9	9.12	0.42615
41	9	7.17	0.61904
42	9	3.68	0.93144
43	9	15.51	0.07795
44	9	2.53	0.98009
45	9	6.47	0.69199
46	9	10.99	0.27637
47	9	15.80	0.07116
48	9	7.79	0.55551
49	9	8.05	0.52909
50	9	7.70	0.56471
51	9	7.16	0.62094
52	9	8.34	0.50068
53	9	12.39	0.19210
54	9	19.22	0.02335
55	9	9.30	0.41010
56	9	14.55	0.10418
57	9	9.75	0.37134
58	9	4.57	0.87015
59	9	6.24	0.71594
60	9	5.72	0.76714
61	9	4.26	0.89351
62	9	13.01	0.16196
63	9	8.12	0.52228
64	9	7.65	0.56968
65	9	10.79	0.29030
66	9	13.17	0.15486
67	9	4.37	0.88528
68	9	15.57	0.07634
69	9	8.19	0.51500
70	9	8.89	0.44704
71	9	10.79	0.29064
72	9	11.94	0.21674
73	9	6.53	0.68640
74	9	5.85	0.75514
75	9	8.99	0.43803
76	9	5.37	0.80085
77	9	11.04	0.27298
78	9	9.50	0.39248
79	9	4.07	0.90694
80	9	6.08	0.73230
81	9	23.50	0.00517
82	9	13.24	0.15203
83	9	6.68	0.67036

84	9	6.24	0.71531
85	9	8.51	0.48339
86	9	2.82	0.97100
87	9	8.67	0.46805
88	9	6.34	0.70561
89	9	8.75	0.46067
90	9	7.18	0.61877
91	9	12.09	0.20814
92	9	8.71	0.46420
93	9	3.90	0.91808
94	9	10.07	0.34464
95	9	13.14	0.15651
96	9	9.00	0.43772
97	9	4.11	0.90399
98	9	15.20	0.08547
99	9	9.64	0.38038
100	9	6.36	0.70342
Combined P-value for all tests (Using KS method)			0.96390

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.

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.
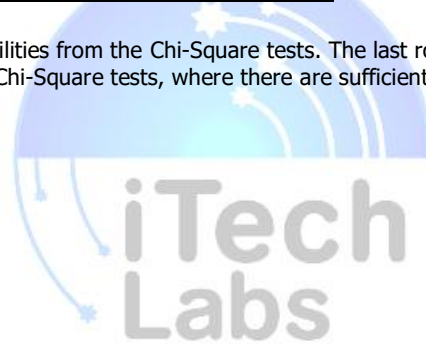
2.1 Poker rank statistics for 52 cards deck:

Test No.	DOF	ChiSqr	P-Value
1	84	97.38	0.15083
2	84	91.25	0.27576
3	84	87.69	0.37003
4	84	84.84	0.45390
5	84	96.88	0.15925
6	84	82.89	0.51388
7	84	88.54	0.34616
8	84	86.14	0.41488
9	84	95.49	0.18410
10	84	81.92	0.54388
11	84	95.51	0.18365
12	84	72.84	0.80251
13	84	60.68	0.97418
14	84	92.15	0.25446
15	84	80.11	0.59995
16	84	94.37	0.20611
17	84	79.05	0.63245
18	84	67.08	0.91185
19	84	73.29	0.79171
20	84	88.10	0.35837
21	84	84.03	0.47851
22	84	87.52	0.37484
23	84	89.14	0.32997

24	84	64.34	0.94537
25	84	86.04	0.41790
26	84	86.55	0.40268
27	84	87.00	0.38966
28	84	110.79	0.02675
29	84	95.63	0.18137
30	84	82.14	0.53707
31	84	74.57	0.75961
32	84	106.67	0.04815
33	84	109.68	0.03147
34	84	76.79	0.69875
35	84	86.95	0.39120
36	84	87.10	0.38683
37	84	102.59	0.08214
38	84	102.52	0.08282
39	84	90.82	0.28658
40	84	99.94	0.11304
41	84	71.29	0.83711
42	84	61.28	0.97053
43	84	83.06	0.50859
44	84	66.75	0.91657
45	84	104.73	0.06242
46	84	77.97	0.66454
47	84	67.13	0.91120
48	84	76.27	0.71350
49	84	78.81	0.63968
50	84	55.65	0.99274
51	84	66.74	0.91671
52	84	115.29	0.01334
53	84	84.19	0.47371
54	84	72.23	0.81649
55	84	75.01	0.74786
56	84	76.75	0.69996
57	84	81.99	0.54172
58	84	78.05	0.66214
59	84	66.88	0.91475
60	84	106.15	0.05170
61	84	68.96	0.88218
62	84	81.62	0.55314
63	84	78.29	0.65518
64	84	95.89	0.17671
65	84	107.06	0.04565
66	84	63.44	0.95408
67	84	81.17	0.56723
68	84	82.63	0.52196
69	84	85.04	0.44775
70	84	66.87	0.91491
71	84	78.70	0.64285
72	84	89.54	0.31934
73	84	55.91	0.99219
74	84	74.61	0.75837
75	84	92.61	0.24379
76	84	76.79	0.69890
77	84	114.39	0.01540
78	84	103.27	0.07541
79	84	90.39	0.29732

80	84	66.87	0.91493
81	84	77.72	0.67184
82	84	98.04	0.14027
83	84	73.26	0.79249
84	84	74.90	0.75096
85	84	97.90	0.14242
86	84	94.65	0.20038
87	84	63.73	0.95139
88	84	86.70	0.39838
89	84	104.46	0.06470
90	84	89.73	0.31437
91	84	79.27	0.62548
92	84	78.04	0.66246
93	84	97.92	0.14213
94	84	80.56	0.58612
95	84	90.14	0.30364
96	84	91.01	0.28168
97	84	87.03	0.38878
98	84	86.17	0.41388
99	84	96.92	0.15851
100	84	80.52	0.58736
Combined P-value for all tests (Using KS method)			0.94331

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	14.59	0.84293
2	7	21	26.30	0.19532
3	7	21	17.71	0.66710
4	7	21	24.42	0.27324
5	7	21	21.57	0.42447
6	7	21	21.01	0.45812
7	7	21	17.64	0.67140
8	7	21	19.33	0.56418
9	7	21	13.38	0.89466
10	7	21	25.56	0.22365
11	7	21	26.97	0.17187
12	7	21	20.66	0.47999
13	7	21	25.28	0.23521
14	7	21	15.50	0.79731
15	7	21	16.94	0.71479
16	7	21	23.99	0.29354
17	7	21	13.48	0.89085
18	7	21	27.42	0.15737
19	7	21	13.74	0.88033
20	7	21	27.57	0.15283
21	7	21	11.24	0.95789
22	7	21	21.05	0.45603
23	7	21	19.00	0.58542
24	7	21	39.09	0.00958
25	7	21	15.62	0.79035
26	7	21	25.86	0.21196
27	7	21	18.74	0.60205
28	7	21	16.40	0.74689
29	7	21	13.52	0.88917
30	7	21	12.94	0.91072
31	7	21	30.75	0.07785
32	7	21	18.40	0.62361
33	7	21	28.16	0.13574
34	7	21	17.10	0.70489
35	7	21	12.84	0.91424
36	7	21	18.71	0.60398
37	7	21	13.78	0.87873
38	7	21	26.15	0.20081
39	7	21	25.03	0.24606
40	7	21	23.87	0.29947
41	7	21	34.92	0.02878
42	7	21	19.69	0.54091
43	7	21	21.74	0.41487

44	7	21	24.24	0.28180
45	7	21	17.08	0.70640
46	7	21	21.47	0.43052
47	7	21	11.04	0.96204
48	7	21	24.12	0.28739
49	7	21	23.44	0.32123
50	7	21	42.82	0.00332
51	7	21	18.76	0.60033
52	7	21	17.51	0.67976
53	7	21	15.60	0.79159
54	7	21	21.18	0.44784
55	7	21	17.03	0.70906
56	7	21	12.48	0.92570
57	7	21	32.02	0.05829
58	7	21	18.56	0.61322
59	7	21	18.56	0.61349
60	7	21	12.63	0.92118
61	7	21	17.24	0.69667
62	7	21	19.83	0.53217
63	7	21	30.17	0.08862
64	7	21	20.69	0.47804
65	7	21	13.87	0.87525
66	7	21	21.45	0.43180
67	7	21	21.39	0.43530
68	7	21	24.75	0.25813
69	7	21	16.96	0.71370
70	7	21	27.98	0.14079
71	7	21	20.43	0.49445
72	7	21	24.36	0.27581
73	7	21	33.62	0.03977
74	7	21	16.91	0.71659
75	7	21	20.53	0.48816
76	7	21	20.23	0.50671
77	7	21	21.72	0.41557
78	7	21	9.38	0.98588
79	7	21	16.39	0.74707
80	7	21	43.05	0.00310
81	7	21	23.74	0.30607
82	7	21	15.67	0.78807
83	7	21	31.70	0.06277
84	7	21	30.23	0.08742
85	7	21	18.89	0.59230
86	7	21	13.13	0.90383
87	7	21	23.55	0.31550
88	7	21	17.62	0.67307
89	7	21	22.88	0.35039
90	7	21	40.09	0.00726
91	7	21	14.98	0.82378
92	7	21	30.73	0.07819
93	7	21	11.53	0.95150
94	7	21	30.71	0.07868
95	7	21	16.66	0.73141
96	7	21	32.79	0.04856
97	7	21	24.74	0.25873
98	7	21	17.20	0.69877
99	7	21	17.16	0.70130

100	7	21	16.07	0.76579
Combined P-value for all tests (Using KS method)				0.97672

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.
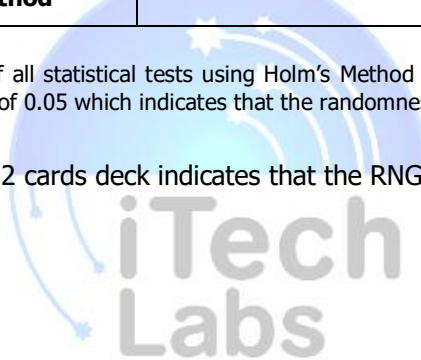
The combined p-value produced using the Holm's method is used as indication for statistical randomness.

Combination of p-values using Holm's Method		
Test	**P-Value**	**P-Adjusted**
Ranks Test	0.94331	1.00000
Suits Test	0.97672	1.00000
Hand Types Test	0.96390	1.00000
Combined P-Value using Holm's Method		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. Conclusion

Analysis of actual data from game logs for 'Hand Types, 'Ranks' and 'Suits' for **52-card decks** indicated statistical randomness. Since there is no data in the case of 36 card deck, this report does not contain the details of 36 card deck.

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:

Signed:

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Alvin Rizaldi
Chief Executive Officer
iTech Labs
Date: 15 November 2024

Divya Bhargava
Project Manager
iTech Labs
Date: 15 November 2024

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.