Poker Cards Analysis – November 2024

The Directors
Entain Plc

This is to confirm that iTech Labs has examined the game logs for Poker games for the period **November 01, 2024,** to **November 30, 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	4.72	0.85808
2	9	5.54	0.78502
3	9	9.76	0.37039
4	9	8.00	0.53437
5	9	20.48	0.01516
6	9	5.03	0.83139
7	9	9.04	0.43317
8	9	12.64	0.17951
9	9	12.41	0.19133
10	9	7.87	0.54688
11	9	14.48	0.10618
12	9	5.80	0.75941
13	9	10.22	0.33305
14	9	8.39	0.49572
15	9	8.30	0.50439
16	9	9.33	0.40709
17	9	16.65	0.05447
18	9	9.30	0.41005
19	9	9.09	0.42874
20	9	3.61	0.93532
21	9	7.27	0.60926
22	9	4.03	0.90909
23	9	16.45	0.05810
24	9	3.50	0.94118
25	9	2.91	0.96778
26	9	3.96	0.91396
27	9	7.24	0.61200

28	9	3.30	0.95141
29	9	5.20	0.81617
30	9	5.01	0.83349
31	9	7.40	0.59592
32	9	10.37	0.32109
33	9	18.57	0.02907
34	9	18.19	0.03309
35	9	7.87	0.54708
36	9	18.20	0.03288
37	9	7.48	0.58696
38	9	8.72	0.46395
39	9	8.63	0.47167
40	9	5.09	0.82602
41	9	5.05	0.82960
42	9	9.45	0.39687
43	9	6.67	0.67184
44	9	5.95	0.74530
45	9	4.69	0.86049
46	9	18.76	0.02729
47	9	12.15	0.20487
48	9	4.67	0.86206
49	9	5.53	0.78570
50	9	6.28	0.71203
51	9	6.58	0.68029
52	9	6.65	0.67391
53	9	10.41	0.31815
54	9	7.32	0.60336
55	9	8.48	0.48611
56	9	3.73	0.92821
57	9	14.62	0.10179
58	9	11.17	0.26399
59	9	16.48	0.05750
60	9	12.58	0.18250
61	9	6.05	0.73515
62	9	4.69	0.86066
63	9	12.28	0.19823
64	9	9.95	0.35434
65	9	5.54	0.78491
66	9	6.61	0.67757
67	9	12.19	0.20262
68	9	8.57	0.47740
69	9	3.33	0.94957
70	9	8.38	0.49657
71	9	25.56	0.00241
72	9	15.31	0.08271
73	9	6.61	0.67788
74	9	12.32	0.19562
75	9	4.01	0.91058
76	9	14.10	0.11896
77	9	13.86	0.12755
78	9	17.76	0.03811
79	9	4.48	0.87673
80	9	14.15	0.11706
81	9	11.73	0.22868
82	9	8.53	0.48135
83	9	13.59	0.13780

84	9	6.37	0.70225
85	9	14.69	0.09993
86	9	11.34	0.25326
87	9	16.66	0.05436
88	9	9.93	0.35649
89	9	9.05	0.43261
90	9	9.07	0.43096
91	9	4.60	0.86738
92	9	2.59	0.97838
93	9	6.62	0.67628
94	9	3.72	0.92874
95	9	3.37	0.94799
96	9	13.17	0.15518
97	9	7.75	0.55918
98	9	10.11	0.34128
99	9	10.93	0.28066
100	9	10.07	0.34490
Combined P-value for all tests (Using KS method)			0.91405

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.
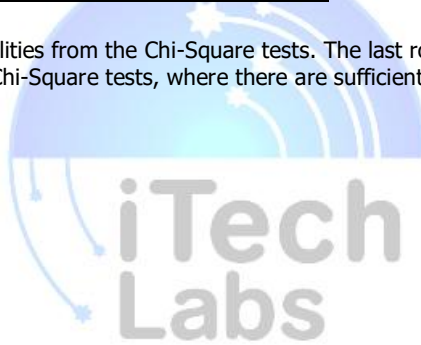
2.1 Poker rank statistics for 52 cards deck:

Test No.	DOF	ChiSqr	P-Value
1	84	84.37	0.46817
2	84	82.85	0.51506
3	84	66.30	0.92256
4	84	86.22	0.41260
5	84	94.80	0.19736
6	84	86.26	0.41143
7	84	90.62	0.29139
8	84	88.90	0.33634
9	84	95.51	0.18373
10	84	83.97	0.48029
11	84	95.98	0.17498
12	84	80.28	0.59478
13	84	68.81	0.88464
14	84	79.52	0.61797
15	84	70.55	0.85243
16	84	70.83	0.84674
17	84	81.34	0.56191
18	84	83.21	0.50373
19	84	63.30	0.95527
20	84	83.50	0.49501
21	84	70.00	0.86314
22	84	76.69	0.70174
23	84	96.15	0.17186

24	84	87.40	0.37810
25	84	94.24	0.20867
26	84	94.03	0.21301
27	84	56.17	0.99160
28	84	85.14	0.44484
29	84	85.22	0.44241
30	84	95.08	0.19193
31	84	96.56	0.16476
32	84	90.34	0.29858
33	84	79.86	0.60765
34	84	72.75	0.80446
35	84	91.83	0.26197
36	84	104.68	0.06287
37	84	73.21	0.79355
38	84	91.86	0.26129
39	84	98.91	0.12725
40	84	84.21	0.47296
41	84	53.01	0.99671
42	84	72.07	0.82010
43	84	85.24	0.44168
44	84	80.37	0.59197
45	84	79.16	0.62885
46	84	59.87	0.97853
47	84	92.49	0.24654
48	84	74.40	0.76403
49	84	73.63	0.78332
50	84	85.71	0.42777
51	84	99.39	0.12049
52	84	90.87	0.28536
53	84	58.94	0.98279
54	84	87.22	0.38349
55	84	91.94	0.25942
56	84	98.45	0.13405
57	84	78.25	0.65628
58	84	95.59	0.18222
59	84	120.54	0.00554
60	84	82.14	0.53701
61	84	74.85	0.75212
62	84	81.46	0.55810
63	84	84.07	0.47742
64	84	106.85	0.04696
65	84	80.36	0.59231
66	84	65.56	0.93189
67	84	87.04	0.38854
68	84	91.04	0.28107
69	84	93.40	0.22632
70	84	99.32	0.12153
71	84	78.14	0.65972
72	84	69.29	0.87633
73	84	90.45	0.29568
74	84	96.00	0.17462
75	84	98.69	0.13052
76	84	98.13	0.13888
77	84	56.96	0.98961
78	84	89.92	0.30938
79	84	86.35	0.40866

80	84	88.74	0.34072
81	84	86.04	0.41791
82	84	80.01	0.60314
83	84	56.43	0.99099
84	84	86.89	0.39290
85	84	72.76	0.80421
86	84	68.32	0.89291
87	84	77.76	0.67077
88	84	60.93	0.97274
89	84	99.97	0.11266
90	84	68.45	0.89073
91	84	83.50	0.49497
92	84	79.67	0.61354
93	84	89.68	0.31568
94	84	72.44	0.81177
95	84	79.07	0.63184
96	84	74.85	0.75220
97	84	92.14	0.25457
98	84	79.65	0.61418
99	84	97.20	0.15379
100	84	87.72	0.36923
Combined P-value for all tests (Using KS method)			0.48468

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	19.69	0.54112
2	7	21	21.99	0.40021
3	7	21	29.53	0.10179
4	7	21	23.53	0.31653
5	7	21	14.09	0.86555
6	7	21	22.88	0.35039
7	7	21	24.19	0.28402
8	7	21	16.12	0.76305
9	7	21	27.56	0.15321
10	7	21	32.85	0.04790
11	7	21	19.27	0.56758
12	7	21	20.98	0.46028
13	7	21	19.78	0.53508
14	7	21	29.67	0.09879
15	7	21	19.42	0.55852
16	7	21	24.91	0.25122
17	7	21	13.30	0.89780
18	7	21	38.86	0.01019
19	7	21	31.02	0.07332
20	7	21	23.27	0.32989
21	7	21	21.51	0.42828
22	7	21	14.07	0.86656
23	7	21	26.72	0.18020
24	7	21	15.47	0.79847
25	7	21	24.63	0.26359
26	7	21	30.69	0.07902
27	7	21	23.74	0.30585
28	7	21	17.08	0.70641
29	7	21	16.12	0.76303
30	7	21	22.47	0.37282
31	7	21	26.53	0.18698
32	7	21	20.51	0.48905
33	7	21	38.63	0.01087
34	7	21	24.84	0.25410
35	7	21	26.64	0.18295
36	7	21	31.83	0.06092
37	7	21	21.62	0.42155
38	7	21	15.50	0.79709
39	7	21	25.42	0.22944
40	7	21	24.59	0.26558
41	7	21	18.29	0.63048
42	7	21	30.40	0.08422
43	7	21	16.61	0.73443

44	7	21	12.81	0.91529
45	7	21	10.77	0.96709
46	7	21	17.27	0.69456
47	7	21	19.04	0.58276
48	7	21	21.93	0.40351
49	7	21	21.00	0.45882
50	7	21	15.64	0.78974
51	7	21	21.64	0.42047
52	7	21	22.29	0.38274
53	7	21	23.42	0.32194
54	7	21	14.74	0.83563
55	7	21	25.64	0.22034
56	7	21	20.72	0.47631
57	7	21	25.79	0.21446
58	7	21	23.38	0.32405
59	7	21	18.29	0.63057
60	7	21	13.82	0.87700
61	7	21	28.48	0.12699
62	7	21	17.23	0.69693
63	7	21	10.96	0.96351
64	7	21	32.12	0.05687
65	7	21	23.03	0.34244
66	7	21	25.99	0.20688
67	7	21	16.36	0.74921
68	7	21	18.40	0.62326
69	7	21	26.89	0.17450
70	7	21	14.15	0.86303
71	7	21	31.15	0.07114
72	7	21	15.12	0.81693
73	7	21	12.76	0.91680
74	7	21	12.48	0.92570
75	7	21	10.02	0.97860
76	7	21	8.35	0.99347
77	7	21	20.18	0.51010
78	7	21	23.51	0.31716
79	7	21	20.63	0.48151
80	7	21	16.98	0.71226
81	7	21	16.43	0.74521
82	7	21	17.75	0.66460
83	7	21	17.17	0.70094
84	7	21	21.56	0.42547
85	7	21	16.28	0.75371
86	7	21	19.30	0.56589
87	7	21	20.08	0.51603
88	7	21	22.37	0.37826
89	7	21	12.30	0.93123
90	7	21	11.88	0.94282
91	7	21	29.46	0.10340
92	7	21	27.02	0.17019
93	7	21	20.76	0.47369
94	7	21	21.76	0.41325
95	7	21	13.90	0.87394
96	7	21	28.01	0.13990
97	7	21	17.65	0.67093
98	7	21	17.94	0.65278
99	7	21	22.50	0.37131

100	7	21	16.72	0.72765
Combined P-value for all tests (Using KS method)				0.99405

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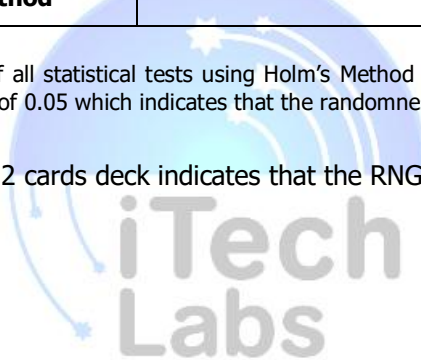
The combined p-value produced using the Holm's method is used as indication for statistical randomness.

Combination of p-values using Holm's Method		
Test	**P-Value**	**P-Adjusted**
Ranks Test	0.48468	1.00000
Suits Test	0.99405	1.00000
Hand Types Test	0.91405	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:

Alvin Rizaldi
Chief Executive Officer
iTech Labs
Date: 13 December 2024

Signed:

Divya Bhargava
Project Manager
iTech Labs
Date: 13 December 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.