Blackjack Card Analysis – February 2019

The Directors
GVC Plc

This is to confirm that iTech Labs has examined the game logs for blackjack games for the period **February 01, 2019** to **February 28, 2019** as recorded by the respective game servers. The game logs were for blackjack games using 8 decks. iTech Labs has analysed the blackjack cards for statistical randomness. The results of the analysis are given below.
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URLs: www.partycasino.com   www.partypoker.com   www.gamebookers.com   www.bwin.dk
www.bwin.es   www.bwin.it   www.bwin.gr   www.bwin.com   partycasino.dk   www.giocodigitale.it
www.partypoker.es   www.sportingbet.ro   www.bwin.be

1.   Actual and Theoretical probabilities for Blackjack, 20 and 10

The following tables compare the observed proportion of times the various types of events occurred (**Sample** column) to the theoretical values (**Probability** column). **Lower** and **Upper** are the 95% confidence limits.

Actual and Theoretical probabilities (8 decks)

Description	Probability	Lower	Sample	Upper
Dealer Blackjack	0.047451	0.04251	0.04722	0.05239
Player Blackjack	0.047451	0.04351	0.04752	0.05139
Dealer total 20 (from first 2 cards)	0.106024	0.09887	0.10766	0.11318
Player total 20 (from first 2 cards)	0.106024	0.10032	0.10578	0.11173
Dealer hole card is 10 value card (10-J-Q-K)	0.307692	0.29697	0.30808	0.31842

Result: All sample values are within the 95% confidence limits.

2.   Actual and theoretical probabilities for Ranks

The following tables compare theoretical probabilities against actual probabilities for the ranks of all cards dealt. Theoretical probabilities are shown in the **Probability** column. The **Sample** column shows observed probabilities for all cards dealt to Player and Dealer. **Lower** and **Upper** are the 95% confidence limits.

Actual and Theoretical probabilities (8 decks)

Rank	Probability	Lower	Sample	Upper
A	0.076923	0.07439	0.07691	0.07946
2	0.076923	0.07439	0.07490	0.07946
3	0.076923	0.07439	0.07585	0.07946
4	0.076923	0.07439	0.07802	0.07946
5	0.076923	0.07439	0.07580	0.07946
6	0.076923	0.07439	0.07802	0.07946
7	0.076923	0.07439	0.07859	0.07946
8	0.076923	0.07439	0.07573	0.07946
9	0.076923	0.07439	0.07762	0.07946
10	0.076923	0.07439	0.07722	0.07946
J	0.076923	0.07439	0.07804	0.07946
Q	0.076923	0.07439	0.07783	0.07946
K	0.076923	0.07439	0.07547	0.07946

Result: All sample values are within the 95% confidence limits.

3.   Comparison of Player's and Dealers first two cards

Using production data, we have calculated the distribution of the first two cards dealt to the player and the dealer. The following table compares the observed proportion of times the player and the dealer have received the cards shown in the **Sample** column. **Lower** and **Upper** are the 95% confidence limits.

Comparison of Player's and Dealers first two cards (8 decks)

Cards	Probability	Lower	Player (Sample)	Upper	Lower	Dealer (Sample)	Upper
Ace	0.07692	0.07343	0.07840	0.08042	0.07254	0.07540	0.08130
2	0.07692	0.07343	0.07665	0.08042	*0.07254*	*0.07119*	0.08130
3	0.07692	0.07343	0.07817	0.08042	0.07254	0.07470	0.08130
4	0.07692	0.07343	0.07602	0.08042	0.07254	0.08096	0.08130
5	0.07692	0.07343	0.07522	0.08042	0.07254	0.07639	0.08130
6	0.07692	0.07343	0.07692	0.08042	0.07254	0.07976	0.08130
7	0.07692	0.07343	*0.08104*	*0.08042*	0.07254	0.07829	0.08130
8	0.07692	0.07343	0.07509	0.08042	0.07254	0.07583	0.08130
9	0.07692	0.07343	0.07576	0.08042	0.07254	0.07997	0.08130
10	0.07692	0.07343	0.07580	0.08042	0.07254	0.07871	0.08130
J	0.07692	0.07343	0.07799	0.08042	0.07254	0.07807	0.08130
Q	0.07692	0.07343	0.07911	0.08042	0.07254	0.07470	0.08130
K	0.07692	0.07343	0.07383	0.08042	0.07254	0.07604	0.08130

Result: All sample values except two (2) are within the 95% confidence limits.

4.   Comparison of Player's opening score against the dealers opening score

Player's opening scores (2-20) is compared against Dealer's opening scores (2-20). Opening scores are calculated from the first 2 cards for the Player and the Dealer. **Probability** column shows theoretical probabilities for Player and Dealer. **Sample** columns show actual values for Player and Dealer. **Lower** and **Upper** are the 95% confidence limits. To simplify the analysis, Ace is counted as 1.

Comparison of Player's & Dealer's opening scores (8 decks)

Opening score	Probability	Lower	Player (Sample)	Upper	Lower	Dealer (Sample)	Upper
2	0.00575	0.0043	0.0062	0.0071	0.0040	0.0053	0.0075
3	0.01186	0.0099	0.0108	0.0139	0.0093	0.0101	0.0144
4	0.01761	0.0152	0.0179	0.0200	0.0146	0.0177	0.0207
5	0.02373	0.0209	0.0245	0.0265	0.0202	0.0238	0.0273
6	0.02947	0.0263	0.0262	0.0326	0.0255	0.0270	0.0334
7	0.03559	0.0322	0.0371	0.0390	0.0313	0.0336	0.0399
8	0.04133	0.0376	0.0437	0.0450	0.0367	0.0378	0.0460
9	0.04745	0.0435	0.0495	0.0514	0.0425	0.0467	0.0524
10	0.05320	0.0490	0.0513	0.0574	0.0480	0.0552	0.0584
11	0.09490	0.0895	0.0940	0.1003	0.0881	0.0942	0.1017
12	0.08879	0.0835	0.0908	0.0941	0.0822	0.0894	0.0954
13	0.08304	0.0779	0.0855	0.0882	0.0766	0.0810	0.0895
14	0.07692	0.0720	0.0734	0.0819	0.0707	0.0870	0.0831
15	0.07118	0.0664	0.0729	0.0759	0.0652	0.0724	0.0772
16	0.06506	0.0605	0.0665	0.0696	0.0593	0.0683	0.0708
17	0.05931	0.0549	0.0610	0.0637	0.0538	0.0595	0.0648
18	0.05320	0.0490	0.0500	0.0574	0.0480	0.0465	0.0584
19	0.04745	0.0435	0.0445	0.0514	0.0425	0.0491	0.0524
20	0.09416	0.0887	0.0941	0.0996	0.0874	0.0956	0.1009

Result: All sample values except three (3) are within the 95% confidence limits.

Comments for 8 decks Blackjack

In the calculations for "Actual and theoretical probabilities for Blackjack, 20, 10", "Ranks for all cards", "Ranks for the first 2 cards" and "Comparison of Player's opening score against the dealers opening score", 5 out of 82 sample values (6.09%) lie outside the 95% confidence limits. It is acceptable for about 5% of the confidence limits to be exceeded.

5.   Conclusion

Calculations for "Actual and theoretical probabilities for Blackjack, 20, 10", "Ranks for all cards", "Ranks for the first 2 cards" and "Comparison of Player's opening score against the dealers opening score" indicated statistical randomness. The results were satisfactory for 8 deck blackjack. iTech Labs concludes that the Random Number Generator is operating correctly and the random numbers are being used in a fair manner.

There were a large enough number of game records to give the probability calculations sufficient statistical power. 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.

The scope of the review did not include reviews of financial controls or casino operations. We believe that the probabilities were calculated correctly from the game logs.

Please click here to see the Original report.

Signed:

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Kiren Sreekumar
Principal Consultant
iTech Labs Australia
Date: 21 March 2019

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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.