Blackjack Card Analysis – August 2018

The Directors
GVC Plc

This is to confirm that iTech Labs has examined the game logs for blackjack games for the period **August 01, 2018** to **August 31, 2018** 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	0.04745	0.04527	0.04742	0.04963
Player Blackjack	0.04745	0.04565	0.04694	0.04925
Dealer total 20 (from first 2 cards)	0.10602	0.10287	0.10677	0.10918
Player total 20 (from first 2 cards)	0.10602	0.10342	0.10475	0.10863
Dealer hole card is 10 value card (10-J-Q-K)	0.30769	0.30297	0.31037	0.31242

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

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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	0.07692	0.07578	0.07600	0.07806
2	0.07692	0.07578	0.07752	0.07806
3	0.07692	0.07578	0.07746	0.07806
4	0.07692	0.07578	0.07764	0.07806
5	0.07692	0.07578	0.07622	0.07806
6	0.07692	0.07578	0.07765	0.07806
7	0.07692	0.07578	0.07626	0.07806
8	0.07692	0.07578	0.07595	0.07806
9	0.07692	0.07578	0.07673	0.07806
10	0.07692	0.07578	0.07771	0.07806
J	0.07692	0.07578	0.07677	0.07806
Q	0.07692	0.07578	0.07658	0.07806
K	0.07692	0.07578	0.07751	0.07806

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	0.07533	0.07595	0.07852	0.07499	0.07645	0.07885
2	0.07692	0.07533	0.07793	0.07852	0.07499	0.07827	0.07885
3	0.07692	0.07533	0.07736	0.07852	0.07499	0.07734	0.07885
4	0.07692	0.07533	0.07781	0.07852	0.07499	0.07744	0.07885
5	0.07692	0.07533	0.07638	0.07852	0.07499	0.07645	0.07885
6	0.07692	0.07533	0.07788	0.07852	0.07499	0.07715	0.07885
7	0.07692	0.07533	0.07614	0.07852	0.07499	0.07588	0.07885
8	0.07692	0.07533	0.07567	0.07852	0.07499	0.07594	0.07885
9	0.07692	0.07533	0.07712	0.07852	0.07499	0.07600	0.07885
10	0.07692	0.07533	0.07683	0.07852	0.07499	*0.07888*	*0.07885*
J	0.07692	0.07533	0.07737	0.07852	0.07499	0.07583	0.07885
Q	0.07692	0.07533	0.07608	0.07852	0.07499	0.07756	0.07885
K	0.07692	0.07533	0.07747	0.07852	0.07499	0.07681	0.07885

Result: All sample values except one (1) 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	0.0051	0.0058	0.0064	0.0050	0.0058	0.0065
3	0.01186	0.0109	0.0122	0.0128	0.0108	0.0118	0.0130
4	0.01761	0.0165	0.0181	0.0187	0.0163	0.0176	0.0190
5	0.02373	0.0224	0.0239	0.0250	0.0222	0.0238	0.0253
6	0.02947	0.0280	0.0295	0.0309	0.0277	0.0296	0.0312
7	0.03559	0.0340	0.0350	0.0372	0.0337	0.0357	0.0375
8	0.04133	0.0396	*0.0432*	*0.0430*	0.0393	0.0417	0.0434
9	0.04745	0.0457	0.0466	0.0493	0.0453	0.0461	0.0496
10	0.05320	0.0513	0.0521	0.0551	0.0509	0.0533	0.0555
11	0.09490	0.0924	0.0944	0.0974	0.0919	0.0979	0.0979
12	0.08879	0.0864	0.0881	0.0912	0.0859	0.0885	0.0917
13	0.08304	0.0807	0.0831	0.0854	0.0802	0.0819	0.0859
14	0.07692	0.0747	0.0769	0.0792	0.0742	0.0770	0.0797
15	0.07118	0.0690	0.0723	0.0734	0.0685	0.0708	0.0738
16	0.06506	0.0630	0.0663	0.0671	0.0625	0.0656	0.0676
17	0.05931	0.0573	0.0584	0.0613	0.0569	0.0585	0.0617
18	0.05320	0.0513	0.0524	0.0551	0.0509	0.0529	0.0555
19	0.04745	0.0457	0.0484	0.0493	0.0453	0.0468	0.0496
20	0.09416	0.0917	0.0934	0.0966	0.0912	0.0947	0.0972

Result: All sample values except one (1) 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", 2 out of 82 sample values (2.44%) 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.

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Date: 19 September 2018

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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.