

Using Information Entropy to Measure the Merits of Contract Bridge Bidding Systems

Fanghao Shao 521070910035

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Abstract

A few sentences here: the background of the topic, and what this paper covers.

1 Introduction

Motivations. Contract Bridge (Bridge for short below) is a popular intellectual sport that involves multiple players, simple rules and intense competition. The bidding process is a very important part of bridge, as a good bidding process can convey information clearly to the partner and determine the best contract. Different bidding systems have different meanings for each bid, and using different bidding systems may lead to different final results. At present, mature bidding systems include natural, precision and others, and it is generally difficult to distinguish which system is better or worse. However, we can study the specific information conveyed by each bid and judge the rationality of the bidding process accordingly.

Main results. This paper mainly studies the information conveyed by the bids of the same team players when seeking the best contract, the bidding process in Bridge can be regarded as a noisy random process, and we need to determine the information transmitted based on the noise reduction. Even though different bidding systems have gaps, the functions of the bids can be roughly divided into several categories: natural bids, limiting bids, forcing bids, unlimited bids and conventional bids. Limiting bids convey more information and have smaller information entropy, while natural bids convey less information and have larger information entropy. Adding conventional bids appropriately may sacrifice some meanings covered by natural bids, but it can convey the information needed by the partner more effectively in the limited bidding space, and thus reach a suitable contract.

2 Preliminaries

The basic bids in bridge consist of a level and a suit, where the level from 1 to 7 indicates the number of tricks needed to win, and the suits in descending order are no trump (NT), spades (S), hearts (H), diamonds (D), clubs (C), as well as three other bids: pass, double and redouble. The bidding process follows the rule of increasing bids, where double can only be used after the opponents bid a basic bid, and redouble can only be used after the opponents double. For simplification purposes, this paper does not consider the interference bids from the defenders.

The final result of the contract determines the score, it is more complex to simulate a real Bridge bidding and scoring, so we just consider more simple condition. When the play is over, completing

a partial contract awards 50 points, completing a game contract awards 300 points, completing a small slam contract awards 500 points, and completing a grand slam contract awards 800 points. The game contracts are any bid of 3NT or higher, 4S or 4H or higher, 5D or 5C or higher. Any bid of level 6 is a small slam contract, and any bid of level 7 is a grand slam contract. Therefore, the bidding process in bridge should avoid stopping at a low-level contract when a game or slam contract is possible, as this would result in a huge loss.

3 The bidding logistics

We take the natural bidding system as an example. The basic principle of bidding is to use non-limiting bids or forcing bids to force the bidding after the partner conveys the point count information, to use limiting bids or natural bids to invite the game when the point count is uncertain whether it can reach the game level, and to use limiting bids to show weakness and end the bidding when the point count is clearly not enough for the game. In determining the trump suit, the main goal is to seek high suit fit, sacrificing some low suit bids for conventional bids and forcing bids. When the high suits are mismatched, choose no trump contract.

For example, your partner opens 1S, which means he has 11 or more high card points(hcp) and 21 or less hcp, and 5 or more spades. You have 4 spades, but only 4 hcp. You should choose 3S to indicate that you have 4 or more spades in your hand, but only 5 or less hcp and have no more strength. Only when your partner has 18 or more hcp and good control (such as a singleton in another suit) can he be confident to bid 4S to reach the game. Otherwise, your partner knows your upper limit and chooses Pass to stop the bidding.

Here, your 3S is a limiting bid. It clearly expresses your upper limit of points, conveying a large amount of information and having a small information entropy. At the same time, your at least 5-4 fit in spades with your partner can guarantee the completion of the contract in most cases. Even if your partner does not have enough points to support this partial contract, you can also successfully block the opponents' more points bidding and ruin their game. Considering all these factors, the benefits of this bid are very obvious.

Let's consider another situation. Your partner still opens 1S, but this time you have 3 spades and 9 hcp in your hand. Based on your high card points estimation, you find that as long as your partner is not at the lowest limit of opening strength (below 14 points), then you have a good chance of making a 4S game contract. In this case, you should choose 2S to raise. Here, 2S is a natural bid. It defines your adjustment point (according to your trump suit-spades and your hand shape, you may adjust your point) range as 7 to 10, but it does not specify any other information, that is, it has a large information entropy. You let your partner judge whether he can complete the game contract.

However we can reverse the meanings of the two bids, but this usage does exist, but it is not effective. Because the higher the level of the bid, the smaller the bidding space left. If you have not been able to express your point range clearly, whether you can reach the game, and stay in a larger information entropy, then this bid is bound to be a failure.

How to ensure that the information entropy is reduced while the bidding level is increased, and express one's own hand situation as much as possible for the partner to judge. The natural bidding system has two means: one is to leave more bidding space for unlimited bids, forcing bids and natural bids, and the other is to transform some natural bids into conventional bids. In the above example, we showed the benefits of the first method: setting 3S as a limiting bid and 2S as a natural bid. This approach seems puzzling at first glance, but after 2S, there are four more options than after 3S, which also gives both sides more ability to explore the fit in the side suits.

For example, if the opener bids 3D, it indicates that he has 3 or more diamonds and invites you to bid game if you have a long or good control in diamonds. Even if you and your partner do not fit in diamonds, you can return to 3S and ensure that the contract will not be defeated. The second method is similar to splitting some situations of natural bids, and conventionally using some other bidding, which can convey information more clearly. Here’s an another example.

The same as before, your partner opens 1S. This time you and your partner have a conventional bid: 3C and 3D. They respectively indicate that your hcp is 7-9 and 10-12, and both guarantee 4 spades support. Before you agreed on this bid, the meanings of 3C and 3D were weak but long in clubs or diamonds for preemptive bids. You should choose to bid 2S or 3S according to your point range if you have spades support instead. You can see that before agreeing on this bid, the meanings of 2S and 3S were too broad, making it difficult for your partner to judge your true ability range. And the meaning of weak singletons for preemption is not very significant after your partner opens with 11 hpc guaranteed, and the frequency of occurrence is not high either. Therefore, giving up these two low-frequency and low-benefit bids to represent more precise bids can bring a lot of advantages to the bidding.

4 Methods

To measure the information conveyed by the bids, we selected a specific bidding process opens 1S and ends with Spades , constructed possible hands, wrote simple bidding logic to test the final results using different bidding systems, and used double dummy solver to analyze the final contract that could be completed by the hands for comparison. A good bid should make the final bid consistent with the double dummy result, and calculate the information entropy based on the proportion of possible hands. The final results are shown at Table 1 and 2 and Figure 1.

	Grand Slam	Small Slam	Game	Part Score	Other
Total	1195	2778	7923	4227	972
Overbid	-	103	1032	1442	416
Just Right	498	1468	5899	2785	128
Underbid	697	1207	992	-	428

Table 1: Simple natural bidding simulation

	Grand Slam	Small Slam	Game	Part Score	Other
Total	1195	2778	7923	4227	972
Overbid	-	94	1015	1034	399
Just Right	567	1681	6341	3193	126
Underbid	628	1003	567	-	447

Table 2: Conventional natural bidding simulation

5 Conclusion

The core idea of the bidding logic I wrote is to ensure that the game contract is not lost, and it does not mean that it can achieve the most correct result. According to the experimental results, it can be found that using some conventional bids can improve the pass rate, but the effect is weak.

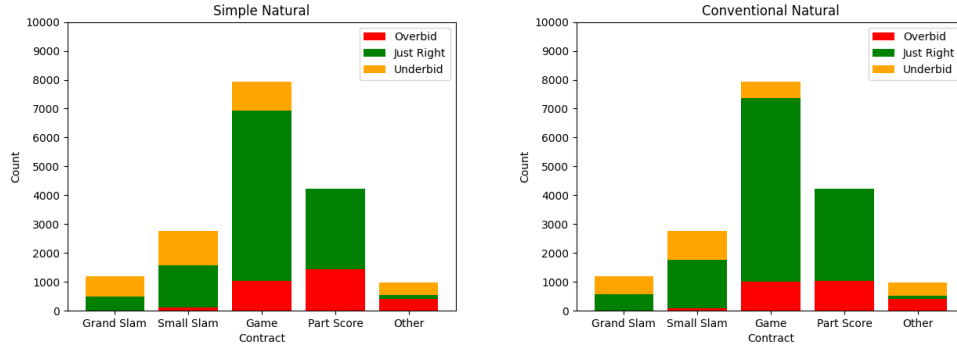


Figure 1: Comparison of Simple and Conventional natural bidding

Generally speaking, using some conventional bids can reduce the error rate to some extent. As we said before, it worth sacrificing natural bids for a frequent and significant bids which conveys the information needed by the partner more effectively in the limited bidding space, and thus reach a suitable contract. But from another perspective, too many conventional bids will squeeze the space of natural bids and limiting bids, and ignore other possible fits.

This paper is not a real research, but only restores part of the bidding process from the perspective of probability and information theory, and discusses the rationality of the bidding system. In the future, we can continue to study how to define a reasonable proportion between conventional bids and natural bids and other bids, and quantify the whole process with numerical values.

6 Appendix

Source code repository <https://github.com/DAntyNoel/Information-Theorem-Bridge>

References

- [1] Li Na. Construction of Bridge Bidding Database with Cooperative Competition Relationship[D]. Beijing University of Posts and Telecommunications, 2009.