Tournament Design in Doubles Pickleball

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Abstract

This paper considers a common tournament design in doubles pickleball where N players compete across n matches. The research question involves the assignment of partners and opponents over the n matches. It is demonstrated that a particular design for the practical tournament corresponding to $N = 16$ and $n = 5$ has the desirable property that each player will either compete with or against every other player exactly once. Commentary is provided for other choices of N and n.

Keywords: mutually orthogonal Latin squares, orthogonal arrays, resolvable balanced incomplete block designs, scheduling, sports analytics.

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1 INTRODUCTION

The sport of pickleball is booming. According to USA Pickleball (https://usapickleball.org/about-us/organizational-docs/pickleball-annual-growth-report/) 4,000 US pickleball court locations were added in 2024, bringing the total to 15,910 courts nationwide. In terms of participation, the Sports & Fitness Industry Association (2024) deemed pickleball the fastest-growing sport in America for the third consecutive year. Academics are attempting to understand the pickleball phenomenon from a health perspective, leading to a number of recent papers including Cerezuela, Lirola and Cangas (2023), Stroesser, Mulcaster and Andrews (2024) and Casper, Bocarro and Drake (2023).

Despite the popularity of pickleball, there has been limited analytics research that has been published on the sport. Gill and Swartz (2019) consider the impact of strong and weak links on success in doubles pickleball. In the analysis, it is determined that pickleball is a strong link game where success is based more on the quality of the stronger partner. Emond, Sun and Swartz (2024) study pickleball projectile motion and concluded that playing into a moderate wind is preferable than playing with the wind. Steyn et al. (2025) propose optimal speeds for executing the third shot drop. Notably, Swartz (2024) looks at various questions of pickleball strategy where some of the recommendations break with established tradition.

In this paper, we add to the pickleball analytics literature by considering tournament design (Devriesere, Csató and Goosens 2025). In particular, we are interested in a popular recreational doubles tournament sometimes known as a "random draw tournament" or a "scramble" or a "luck of the draw tournament". Henceforth, for brevity, we refer to this type of tournament as a scramble. In this format, we have N players where typically N is divisible by 4; this enables all players to play at the same time given that there are a sufficient number of available pickleball courts. Further, we let n be the number of *rounds* which is the number of matches in which each player participates. In this more social type of tournament (where players do not have fixed partners), for each round, a player is assigned a partner and two opponents. The research focus of this paper is the assignment of partners and opponents.

A "low-tech" solution to the assignment problem involves randomly drawing names in each round (Kang, Ragan and Park 2008). This approach has the disadvantage that a player can end up playing with someone or against someone frequently. Obviously, frequent pairings with a weak partner is a disadvantage. By borrowing from the literature on experimental design (Street and Street 1986), we attempt to minimize the occurrences of frequent partners and opponents. We note that the internet provides a number of resources to carry out assignments including the method of random draws. These include the website Plan 2 Play (https://app.plan2play.com/tournaments/roundRobin.php) and the website Pickleheads (https://www.pickleheads.com/round-robin-simulator?format=popcorn). However, neither of these sites provide draws that have the optimality properties proposed by the methods in this paper.

The topic of draws falls generally under the umbrella of "scheduling". Scheduling has a prominent role in sport, and has been influential in major sports including soccer (Goossens and Spieksma 2009), Major League Baseball (Trick 2009), and even fringe sports such as highland dance (Swartz 2007). However, the problem considered in this paper has a structure that differs from the traditional scheduling problem.

In Section 2, we provide some background material on the theory used to construct the proposed designs for the scramble tournament. The material relies on resolvable balanced incomplete block designs (Hanani 1974). This section is more technical and is not essential reading. However, the material may be useful to readers who wish to develop designs for combinations (N, n) that are not discussed in this manuscript. In Section 3, we outline the methods and procedures that convert the theory from Section 2 into the context of scramble tournaments in pickleball. In Section 4, we provide the explicit and practical designs that can be utilized for scramble pickleball tournaments, and we explain the optimality of the designs. The designs are "ready to use" and do not require any expertise. Some concluding remarks are given in Section 5.

2 ASSOCIATED THEORY

The theory used in designing scramble pickleball tournaments is that of resolvable balanced incomplete block designs. We refer to Street and Street (1986) for a general reading on combinatorial designs. Our discussion is expository.

Suppose that N treatments are to be compared in a scientific or technological investigation, and the experiments are to be run in b blocks of size k ($k < N$) due to heterogeneity of experimental material. This scenario gives rise to an incomplete block design because each block can accommodate only a subset of k treatments out of all the N treatments. An incomplete block design is said to be balanced if every pair of treatments occurs in the same number of blocks. The following is the simplest balanced incomplete block design:

$$(1, 2), (3, 4);\ (1, 3), (2, 4);\ (1, 4), (2, 3).$$

This design has $N = 4$ treatments, labeled as $1, 2, 3$ and 4. It has $b = 6$ blocks, each containing $k = 2$ treatments. We see that every pair of treatments occurs in exactly one block. This design has another appealing property that the six blocks are divided into $n = 3$ groups, delineated by semicolons, such that the two blocks within each group contain all the treatments exactly once. Such a balanced incomplete block design is said to be resolvable.

The following is a resolvable balanced incomplete block design for $N = 9$ treatments with $b = 12$ blocks of size $k = 3$:

$$(1, 2, 3), (4, 5, 6), (7, 8, 9);\ (1, 4, 7), (2, 5, 8), (3, 6, 9);$$

$$(1, 6, 8), (2, 4, 9), (3, 5, 7);\ (1, 5, 9), (2, 6, 7), (3, 4, 8).$$

In this design, each pair of treatments occurs in exactly one block. The design is resolved into $n = 4$ groups of three blocks with each group containing all the nine treatments.

Next, we give a resolvable balanced incomplete block design for $N = 16$ treatments with $b = 20$ blocks of size $k = 4$, with each pair of treatments occurs in exactly one block. The design is resolvable because it has $n = 5$ groups of blocks with each group containing all the 16 treatments.

$$(1, 2, 3, 4), (5, 6, 7, 8), (9, 10, 11, 12), (13, 14, 15, 16);$$

$$(1, 5, 9, 13), (2, 6, 10, 14), (3, 7, 11, 15), (4, 8, 12, 16);$$

$$(1, 6, 11, 16), (2, 5, 12, 15), (3, 8, 9, 14), (4, 7, 10, 13);$$

$$(1, 7, 12, 14), (2, 8, 11, 13), (3, 5, 10, 16), (4, 6, 9, 15);$$

$$(1, 8, 10, 15), (2, 7, 9, 16), (3, 6, 12, 13), (4, 5, 11, 14).$$

From one resolvable balanced incomplete block design, one can obtain other resolvable balanced incomplete block designs by repeatedly using all the blocks. For example, from the design for $N = 4$ with $b = 6$ blocks, one obtains another resolvable balanced incomplete block design for $N = 4$ with $b = 12$:

$$(1, 2), (3, 4);\ (1, 3), (2, 4);\ (1, 4), (2, 3);\ (1, 2), (3, 4);\ (1, 3), (2, 4);\ (1, 4), (2, 3).$$

In this design, each pair of treatment occurs in exactly two blocks.

3 METHODS AND PROCEDURES

When designing scramble doubles pickleball tournaments with N players, resolvable balanced incomplete block designs with block size $k = 4$ are relevant. In this case, one identifies the N treatments with the N players. Then each block contains four players, which can be divided into two teams of two players each. Suppose that the design is resolvable into n groups. Then every group of blocks can be used as one round of matches.

We consider the two attractive cases of $N = 16$ and $N = 28$ players participating in a scramble tournament. These cases are attractive since they are common tournament sizes. Also, these cases yield desirable results in terms of minimizing repetition amongst playing partners.

For the case of $N = 16$ participants and $n = 5$ rounds, we obtain a resolvable balanced incomplete block design. The design corresponds to the case of 20 blocks according to the theory outlined in Section 2. We also obtain related designs for alternative numbers of rounds.

For the case of $N = 28$ participants and $n = 9$ rounds, we obtain a resolvable balanced incomplete block design. The design corresponds to the case of 63 blocks according to the theory outlined in Section 2. We also obtain related designs for alternative numbers of rounds.

In the pickleball scramble context (i.e. $k = 4$), resolvable balanced incomplete block designs are also available for $N = 40$ participants according to Mathon and Rosa (1990).

With $N = 40$, a balanced incomplete block design is available for $b = 130$ and $k = 4$, which is resolvable into $n = 13$ groups of 10 blocks each. However, this tournament is likely too large for practical purposes.

Resolvable balanced incomplete block designs do not always exist. For example, for $N = 20$ and 24, it is not possible to find a resolvable balanced incomplete block design with $k = 4$ such that every pair of treatments occurs in exactly one block. In such situations, we may consider resolvable incomplete block designs that are as balanced as possible.

4 RESULTS

There are an infinite number of combinations of N (number of players) and n number of rounds that can be considered in the pickleball scramble context. However, we restrict attention to values of N and n that are reasonable from a planning perspective and provide attractive results.

4.1 $N = 16$ Players

According to theory of Section 2, $N = 16$ is a special number which yields attractive results for various values of n. From a practical perspective, $N = 16$ demands the availability of four courts if all $N = 16$ players play simultaneously. Many pickleball venues have at least four courts. We think of $N = 16$ as an ideal number. For $N << 16$, it is not much of a tournament with so few participants. With $N >> 16$, scramble tournaments can become unwieldy; e.g. higher chance of dropouts amongst competitors, more courts required for simultaneous play, etc.

We begin with the ideal number of rounds, $n = 5$. From a planning perspective, a doubles pickleball match to 11 points may take roughly 20 minutes (including match breaks). Therefore, a scramble tournament with $n = 5$ rounds may take approximately $5(20) = 100$ minutes. When medal rounds are added in, this may be the ideal length for a tournament. The number of rounds $n = 5$ is also highly attractive from the optimality result that each player will play exactly once with every other player (either as a partner or as an opponent). Table 1 provides an optimal draw for the case $N = 16$ and $n = 5$. Here, the players are randomly numbered 1-16.

Round	Team 1		Team 2	
1	1	2	3	4
1	5	6	7	8
1	9	10	11	12
1	13	14	15	16
2	1	5	9	13
2	2	6	10	14
2	3	7	11	15
2	4	8	12	16
3	1	6	11	16
3	2	5	12	15
3	3	8	9	14
3	4	7	10	13
4	1	7	12	14
4	2	8	11	13
4	3	5	10	16
4	4	6	9	15
5	1	8	10	15
5	2	7	9	16
5	3	6	12	13
5	4	5	11	14

Table 1: The proposed assignment of partners and opponents in the case of $(N = 16, n = 5)$.

At the Country Roads Pickleball Club in Yuma, Arizona, scramble tournaments typically consist of $N = 16$ players with $n = 6$ rounds. With $n = 6$ rounds, it is impossible for each participant to play exactly once with every other player (either as a partner or as an opponent). In this case, we suggest that the tournament organizers use Table 1 for the first five rounds. At the end of round 5, each player's total points can be tallied (i.e. number of points scored in all five matches). Then, for the sixth round, we propose matching the 1st and 2nd ranked players versus the 15th and 16th ranked players, the 3rd and 4th ranked players versus the 13th and 14th ranked players, the 5th and 6th ranked players versus the 11th and 12th ranked players, and the 7th and 8th ranked players versus the 9th and 10th ranked players. This would give the more deserving players (those doing better in rounds

1-5) a better opportunity to advance to the medal rounds.

When $N = 16$ and $n = 7, 8, 9$, then it is possible to have each competitor play with every other player (either as a partner or an opponent) at most twice. We do not find these designs as desirable and do not list them here. We believe that a tournament organizer ought to consider either $(N = 16, n = 5)$ or $(N = 16, n = 6)$ described previously.

When $N = 16$ and $n = 10$, we are beginning to push reasonable time limits for a social tournament as this would require approximately $10(20) = 200$ minutes of play prior to the medal rounds. However, from an optimality perspective, this is an appealing case as there exists a design where each player meets all other players exactly twice.

A simple way of obtaining the design for $(N = 16, n = 10)$ involves using Table 1 for rounds 1-5. Then, repeat Table 1 for rounds 6-10 but make the following modification: when a row lists players x_1, x_2, x_3, x_4, change this to x_1, x_3, x_2, x_4. This method will cause the same four players to play twice together. For example, players 1, 2, 3, and 4 will play together in rounds 1 and 6. However, on the second meeting, each player will have a different partner. An alternative scheme is to re-randomize the players, meaning that another randomization is performed to label the 16 players as players 1-16 for rounds 6-10.

4.2 $N = 28$ Players

The case $N = 28$ may be considered nearly an upper bound for the number of viable players in a scramble tournament that yields "nice" results. Perhaps a tournament with $N = 28$ players would be appropriate over two days.

As mentioned in Section 2, a resolvable incomplete block design can be constructed for $N = 28$ and $k = 4$ so that every pair of treatments occurs in exactly one block. This design is resolvable into 9 groups of 7 blocks each. We can use this design to organize a scramble doubles tournament for $N = 28$ players over $n = 9$ rounds of play. All players participate in all 9 rounds. In any one round, the 28 players are divided into 7 sets of four players, and for each set, two teams can then be formed to play against each other. The design guarantees that each player meets every other player (either as a partner or as an opponent) exactly once. If fewer than nine rounds are considered because of the time constraints, the design guarantees that each player meets every other player at most once. Table 2 provides the recommended design.

While the theoretical construction of the design in Table 2 was established previously in the design literature - see for example Street and Street (1986, Chapter 3), the fully displayed design in the ready-to-use format as given in Table 2 appears to be new. Actual construction of this design is no simple matter to most design practitioners as it involves the use of difference sets and Galois fields. The R packages `bibd` and `crossdes` are useful for finding small balanced incomplete block designs but have failed to generate a balanced incomplete block design for $N = 28$ treatments with $b = 7 \times 9 = 63$ blocks of size $k = 4$, the required set of parameters under consideration.

Round	Team 1		Team 2		Round	Team 1		Team 2		Round	Team 1		Team 2	
1	9	3	16	14	2	10	4	14	15	3	8	2	15	16
1	18	12	25	23	2	19	13	23	24	3	17	11	24	25
1	27	21	7	5	2	28	22	5	6	3	26	20	6	7
1	8	19	4	11	2	9	17	2	12	3	10	18	3	13
1	17	28	13	20	2	18	26	11	21	3	19	27	12	22
1	26	10	22	2	2	27	8	20	3	3	28	9	21	4
1	6	15	24	1	2	7	16	25	1	3	5	14	23	1
4	3	6	19	17	5	4	7	17	18	6	2	5	18	19
4	12	15	28	26	5	13	16	26	27	6	11	14	27	28
4	21	24	10	8	5	22	25	8	9	6	20	23	9	10
4	2	13	7	14	5	3	11	5	15	6	4	12	6	16
4	11	22	16	23	5	12	20	14	24	6	13	21	15	25
4	20	4	25	5	5	21	2	23	6	6	22	3	24	7
4	9	18	27	1	5	10	19	28	1	6	8	17	26	1
7	6	9	13	11	8	7	10	11	12	9	5	8	12	13
7	15	18	22	20	8	16	19	20	21	9	14	17	21	22
7	24	27	4	2	8	25	28	2	3	9	23	26	3	4
7	5	16	10	17	8	6	14	8	18	9	7	15	9	19
7	14	25	19	26	8	15	23	17	27	9	16	24	18	28
7	23	7	28	8	8	24	5	26	9	9	25	6	27	10
7	3	12	21	1	8	4	13	22	1	9	2	11	20	1

Table 2: The proposed assignment of partners and opponents in the case of $(N = 28, n = 9)$.

5 DISCUSSION

Scramble pickleball tournaments are popular formats that are both social and competitive. In such tournaments, it is desirable that a player not have frequent repeated partners and opponents. The methods in this paper provide partner and opponent assignments that minimize frequent pairings.

There are many practical issues that are relevant when organizing a scramble tournament in doubles pickleball. How many courts are available? How many competitors are interested in participating? What is a desirable length in time for the tournament? To what degree are repetitive assignments of partners and opponents to be tolerated? These issues are interconnected. For example, it may not be possible to host an appealing tournament for all choices of N (the number of competitors) and n (the number of rounds of play). For this reason, compromises may need to be considered. In this paper, from all perspectives, an appealing tournament schedule is given for the case $(N = 16, n = 5)$ and presented in Table 1. In addition, Table 2 provides a highly appealing tournament schedule for the case $(N = 28, n = 9)$. These schedules are ready-to-go, and can be immediately adapted by organizers. Suggested modifications to these schedules are also suggested for alternative values of n.

Our methods do not differentiate between a pair of players who are either partners or opponents. It seems desirable that if player A and player B must participate together in two rounds, then in one round they should be partners and in the other round, they should be opponents. Taking this into consideration is a topic of future research.

The "perfect" solutions as given by resolvable balanced incomplete block designs are available for $N = 16$, $N = 28$ and $N = 40$ players. For other practically important values of $N = 20$, 24, 32 and 36, it is impossible to find a design such that every player meets all the other players exactly once as the corresponding resolvable balanced incomplete block designs do not exist. Useful designs for these situations can be derived from resolvable incomplete block designs that are nearly balanced. This is another interesting topic for future research.

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