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# Team assignment strategies in youth sports

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# Team Assignment Strategies in Youth Sports

an undergraduates honors thesis submitted to the

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## I. Background/Motivation

Assigning players to teams is a general dilemma that affects many people every day. Teams are formed in many situations including work environments, school projects, sporting teams, and for general day to day activities. The method used to assign players or members to teams can influence the productivity, efficiency, and the final outcome of the team in question. For this reason, much thought is put into forming a team to meet the specifications of the projects.

Youth sports leagues, specifically Little League baseball leagues, are an integral part of the lives of children and parents in the United States today. Founded in 1939, the Little League Baseball program serves as an outlet for many young children and has become the largest organized youth sports program in the world. The program is active in all 50 states and many countries around the world. The large participation of approximately 180,000 children in the program helps facilitate goals of the Little League program including "espousing the virtues of character, courage and loyalty … to develop superior citizens rather than superior athletes" [1].

Little League and other leagues across the country use many different methods of deciding which participants to assign to which team. A common problem within the league comes from the differing methodology of forming the youth baseball teams. The problem often causes "stacked teams" which causes a large variation between wins and losses in a given season. For example, one team can have an undefeated season while another team may win only one or two games. It is hypothesized that this unequal distribution of team wins and losses is due to the effect of stacked teams.

The best and worst scenario does not foster unity, sportsmanship, or morale among the players or the league as a whole. Winless seasons take the fun out of the sport for many of the players on those teams and may cause some to stop participating in the sport in the future.

Through reducing the variation that results from an unequal distribution of wins and losses, the experience of playing Little League baseball would be enhanced for every participant.

## II. Literature Review

Assigning group participants to teams is not a new conflict within our society. Among the numerous team assignment strategies, there seems to be a consensus that there are three common (or investigated) methods of assignments, as presented by Bacon (2009). Teams are either formed randomly, by the participants themselves or through a facilitator. Other team assignment methods exist such as assigning participants to teams with the goal of evenly distributing skills and also other variations of the three main methodologies. The methods are applied to many simulation and assignment activities including course projects, business problems, creative problem solving, sports, and even personal situations.

The random assignment approach is defined as providing each participant an equal opportunity to be on each team. This method has many benefits but also contains flaws. The initial benefits of random assignment include ease of use and the appearance of fairness from an exterior perspective. Random assignment requires little to no preparation before the actual assignment occurs. Due to this fact, it is a common occurrence in classroom settings where the instructor or leader does not typically know the strengths and weaknesses of each individual participant. The downfall of randomly assigning participants comes from the potential of an unequal distribution of skills among teams. Even though it may appear from the outside that the teams should have an equal talent distribution, there is no guarantee that the performance will be equally distributed.

The self-selection approach, in which group participants are allowed to form teams independently, has individual advantages and disadvantages. From a facilitator's point of view, the self-selection method is an easy technique to implement in a large group setting. Among individual team members, there will initially be a strong group cohesion which will lead to rapid group development [2]. The self-selection technique can also lead to shorter project or completion time due to the expedited group adaptation time. The gains and cohesion of a self-selected group can also lead to team members feeling more ownership of team problems or goals [3]. As applied to the classroom or business setting, another benefit is that participants will improve networking skills due to the interactions required to form a completely self-selected team [2]. Downfalls of the self-selection technique include the fact that "random" teams may still exist because not all participants will know other group members.

Teams formed through self-selection are more likely to form "homogeneous" groups. A homogeneous group occurs when all group members have similar preferences and thinking styles. Homogeneous teams will usually reach a consensus on a topic rapidly. The rapid decision making stems from the fact that the similar thinking patterns will lead a lack of creativity and diversity among candidate solutions for a problem [4] (Lumsdaine).

The facilitator assignment approach, also proposed by Bacon [2], can be described as an external facet (facilitator) assigning teams or groups without participant input. A positive output of the facilitator approach is the maximum diversity that can result. Diversity leads to varying opinions and problem solving techniques which enhance creativity and the quantity of candidate solutions produced when solving a problem.  Another advantage of the facilitator approach is that skills can be evenly dispersed, to the best of the facilitator's ability, amongst groups. Disadvantages of the facilitator assignment technique include the concern that the facilitator may not be able to distribute participants by skills or diversity. If facilitators do not know each individual participant it will be very difficult for an even distribution to occur. There may also be ethical implications of grouping participants through diversity alone.

The facilitator technique is a common strategy for computerized assignment techniques. The fact that the facilitator can use certain criteria to place participants on teams leads to numerous methods and variables that can be created and input into a team assignment tool [3].

Another assignment technique is to separate skills and thinking patterns amongst teams using surveys, questionnaires, or a thinking style application. For creative thinking applications, teams emphasizing “whole brain” thinking can be formed using tools such as the Herrmann Brain Dominance Instrument [4]. Tools such as the HBDI emphasize creativity and using each individual’s experiences to have many creative solution alternatives. Bacon (2009) also suggests forming teams based primarily on their skills and the skill potential that the individual brings to the table.

The process of distributing skills throughout teams is very applicable in every type of group or team that is formed, including sporting teams. Through drawing on each team member’s individual skills and knowledge, the team has the best chance for a positive outcome.

Although pros and cons exist for all assignment types, assigning players to sports teams presents a unique challenge which can be depicted on an everyday playground. Do the children choose two captains who “pick” teams (based on skill)? Do they choose to be on their friends teams (self selection)? Or do they play with anyone who is on the field (random)? These scenarios are examples of how intertwined team formation can be across all groups and teams. By determining how and why a specific assignment model has preference over another can, therefore, have a great impact on team formation in every sector of life.

## III. Problem Statement

The current technique for assigning players to Little League teams varies from league to league. The disparity of methodology causes a variation between wins and losses that can be detrimental to participant morale. In this study, different methods of assigning players to teams are explored in order to determine the best way of assigning players to teams in order to decrease win and loss variation over a season. The teams and seasons are developed and simulated using Microsoft VBA and analyzed using statistical techniques. The ultimate goal of this analysis is to eliminate built-in biases created by the coach/player assignment methods. The expected outcome of the modeling formulation should maximize fair competition between all teams while giving each team an equal chance of enjoying a win.

## IV. Model Formulation

To investigate the affects of using different formulation techniques to decrease variation, six different methods were developed and analyzed. The methods include random assignment, random pre-assigned, random post process, serpentine, serpentine pre-assigned, and serpentine post process. In this study, six teams were developed with 14 players on each team for a total of 84 players within the league. An example situation involving four teams each with six players (24 total players) is used below to simplify the process and show the different affects of each method.

For every method, each of the 24 players is assigned a player number and a random number. The player numbers range from 1 to 24 and the random numbers are generated in Microsoft VBA using the RAND function. The players are then given a ranking ($1^{st}$ to $24^{th}$)

based on the random number that was assigned. This ranking is then used to give each player a "talent". Talent values range from 1 to 5, 1 being the worst and 5 being the best.

Players are then defined as either a "coach's players" or a "regular player". The number of players who are coach's players are determined based on the total number of teams in the league. The ideology is that there will be three coach's players on each team: the head coach's child, the assistant coach's child, and the sponsor's child. In the example, the result would be 12 coach's players but to appropriately demonstrate how assignments are made only two coach's players per team are used.

The number of normal players who are given talents of five, four, three, two and one are determined according to the normal distribution. The distribution is as follows in Table 1:

**Table 1. Talent Distribution for Non-Coach's Children**

| Talent | Percent |
|---:|---:|
| 5 | 20 |
| 4 | 25 |
| 3 | 30 |
| 2 | 15 |
| 1 | 10 |

The distribution of coach's players' talent also follows the normal distribution. The distribution is shown below in Table 2.

Players of coaches may have a different distribution of talent for numerous reasons. The most obvious being that having a parent as a coach leads to more one-on-one practice and instruction that is not available to other children. Another reason is that parents of talented children tend to coach their children's teams. Occasionally, this situation occurs because parents of talented players agree to coach a team together so that their children can be on the same team (resulting in a "stacked" team).

**Table 2. Talent Distribution for Coach's Children**

| Talent | Percent |
|---|---|
| 5 | 80 |
| 4 | 10 |
| 3 | 5 |
| 2 | 5 |
| 1 | 0 |

The number of coach's players that have each talent are determined by putting the players in order by their rank.

**Table 3. Example Player Data**

| Player # | Rand # | Player Rank | Talent | Coach's? |
|---|---|---|---|---|
| 1 | 0.55142 | 12 | 4 | N |
| 2 | 0.2559 | 18 | 3 | N |
| 3 | 0.49931 | 15 | 4 | N |
| 4 | 0.2271 | 20 | 3 | N |
| 5 | 0.78394 | 7 | 5 | N |
| 6 | 0.96849 | 1 | 5 | Y |
| 7 | 0.80107 | 5 | 5 | Y |
| 8 | 0.04508 | 24 | 1 | N |
| 9 | 0.63038 | 9 | 5 | N |
| 10 | 0.54824 | 13 | 4 | N |
| 11 | 0.54723 | 14 | 4 | N |
| 12 | 0.82847 | 3 | 5 | Y |
| 13 | 0.11218 | 22 | 2 | N |
| 14 | 0.23491 | 19 | 3 | N |
| 15 | 0.4377 | 16 | 3 | Y |
| 16 | 0.80971 | 4 | 5 | Y |
| 17 | 0.66496 | 8 | 5 | N |
| 18 | 0.87308 | 2 | 5 | Y |
| 19 | 0.78515 | 6 | 5 | Y |
| 20 | 0.60683 | 10 | 5 | N |
| 21 | 0.59551 | 11 | 4 | Y |
| 22 | 0.06115 | 23 | 2 | N |
| 23 | 0.32296 | 17 | 3 | N |
| 24 | 0.13372 | 21 | 2 | N |

For example if there are 24 total players, 8 players with a talent of five, and 8 coach's players, all of the players would first be put in order by their rank. Next, the number of coach's players that are designated as fives would be calculated (8*.8 = 6.4 = 6) in this case. Finally, the first 6 players with a rank of five would be designated as a coach's player with a talent of five. The example data is shown in Table 3.

### 4.1 Random Assignment Method

In the random assignment method, each player is simply assigned to teams by player number such as in Table 4 shown below. Coach's players are not taken into account and this team formulation will serve as a basis for comparison for the rest of the methods.

**Table 4. Random Assignment Method**

| Team 1 | Team 2 | Team 3 | Team 4 |
|---:|---:|---:|---:|
| 1 | 7 | 13 | 19 |
| 2 | 8 | 14 | 20 |
| 3 | 9 | 15 | 21 |
| 4 | 10 | 16 | 22 |
| 5 | 11 | 17 | 23 |
| 6 | 12 | 18 | 24 |

The random assignment method can be classified as completely random due to the fact that players are given talents based on random numbers but are never reorganized by talent or rank. Therefore, there is no guarantee that a player will end up on a specific team or that any team will have a certain number of players with high or low talent.

### 4.2 Random Pre-Assigned Method

The random pre-assigned method is similar to the completely random assignment in that the players are not reordered anytime before they are assigned to teams. The difference in the two methods is the assignment of coach's players. Coach's players are assigned to a specific team before any other team assignments are made. This pre-assignment takes place so that parents who are coaching teams will always be assigned to the same team as their child and vice versa. The coach's players are assigned in numerical order (by player number) as shown below in Table 5.

**Table 5. Coach's Players in the Random Pre-Assignment Method**

| Team 1 | Team 2 | Team 3 | Team 4 |
|---:|---:|---:|---:|
| 6 | 12 | 7 | 21 |
| 18 | 16 | 19 | 15 |

After the coach's players have been assigned, the remaining players are assigned to the empty spots on each team in order by player number. The complete team assignments are shown below in Table 6. The line in the middle of the Figure shows the break between coach's players and normal players.

**Table 6. Random Pre-Assigned Method**

| Team 1 | Team 2 | Team 3 | Team 4 |
|---:|---:|---:|---:|
| 6 | 12 | 16 | 19 |
| 7 | 15 | 18 | 21 |
| 1 | 5 | 11 | 20 |
| 2 | 8 | 13 | 22 |
| 3 | 9 | 14 | 23 |
| 4 | 10 | 17 | 24 |

### 4.3 Random Post Process Method

The random post process method combines different aspects of both the completely random and the random pre-assigned methods. The random post process method is similar to the completely random method in that the players are not reordered anytime before they are assigned to teams. Also, this process is similar to the random pre-assigned method because coach's players are assigned to teams before any normal players. In the random post process method, players are first assigned exactly like the completely random method, in order by player number.

Once players are initially assigned to teams, each team is inspected to see if the team contains the correct coach's players. For this example, the correct coach's players were designated in the random pre-assigned method (i.e. team one coach's players are players 6 and 7). In theory if a coach's player is found on a team that it is not assigned to, the coach's player will be traded to the correct team in exchange for a player of equal talent. Equal talent is defined as the exact same talent or a talent one above or one below the coach's player's talent. If a team does not possess a player that meets the needed talent requirement the talent level is decremented until an appropriate trade can be made. The consequences of this stipulation are that ultimately a player with a talent level of 5 may be traded with a talent level of 3 or even 2. This trading scheme is depicted in Table 7 below.

**Table 7. Random Post-Process Player Trades**

| Team 1 | Team 2 | Team 3 | Team 4 |
|---:|---:|---:|---:|
| 1 | 5 | 13 | 19 |
| 2 | 8 | 14 | 20 |
| 3 | 9 | 10 | 21 |
| 4 | 15 | 16 | 22 |
| 7 | 11 | 17 | 23 |
| 6 | 12 | 18 | 24 |

Trades are shown in Table 7 by color coding. Players that are traded with one another are shown in the same color. For example, player 5 and player 7 were traded because player 7 is a coach's player assigned to team one and both players were assigned a talent of 5. For each necessary trade, the team is examined from the first player to the last. Due to this fact, it is possible for normal players to be traded numerous times while players are being assigned to teams.

Random assignment, random pre-assigned, and random post-process are all acceptable methods for assigning players to teams. Although these processes result in the formation of teams, it is necessary to compare other assignment methods in order to determine if random assignment is a valid technique.

### 4.4 Serpentine Assignment Method

The basic Serpentine Method implements the idea of distributing players with the same talent equally between each team. For example in the previous illustration, there are ten players with a talent of 5 along with four teams. The serpentine method guarantees that within this example each team will have at least two players with a talent level of five.

The even distribution of talent levels is possible due to the altered method of assigning the players to teams. After players are assigned a talent, they are put in order by talent. The arrays for player number, random number, rank, talent, and coach are sorted by talent to provide for the appropriate assignments. The sorted data is shown in Table 8.

After the data has been reordered, assigning players to teams can begin. The top ranked player (player 6) is assigned to team one, the second ranked player (player 18) is assigned to team two, etc.., until all teams (in this case 4) have received a player.

**Table 8. Example Data Sorted by Player Rank**

| Player # | Rand # | Rank | Talent | Coach's? |
|---|---|---|---|---|
| 6 | 0.96849 | 1 | 5 | Y |
| 18 | 0.87308 | 2 | 5 | Y |
| 12 | 0.82847 | 3 | 5 | Y |
| 16 | 0.80971 | 4 | 5 | Y |
| 7 | 0.80107 | 5 | 5 | Y |
| 19 | 0.78515 | 6 | 5 | Y |
| 5 | 0.78394 | 7 | 5 | N |
| 17 | 0.66496 | 8 | 5 | N |
| 9 | 0.63038 | 9 | 5 | N |
| 20 | 0.60683 | 10 | 5 | N |
| 21 | 0.59551 | 11 | 4 | Y |
| 1 | 0.55142 | 12 | 4 | N |
| 10 | 0.54824 | 13 | 4 | N |
| 11 | 0.54723 | 14 | 4 | N |
| 3 | 0.49931 | 15 | 4 | N |
| 15 | 0.4377 | 16 | 3 | Y |
| 23 | 0.32296 | 17 | 3 | N |
| 2 | 0.2559 | 18 | 3 | N |
| 14 | 0.23491 | 19 | 3 | N |
| 4 | 0.2271 | 20 | 3 | N |
| 24 | 0.13372 | 21 | 2 | N |
| 13 | 0.11218 | 22 | 2 | N |
| 22 | 0.06115 | 23 | 2 | N |
| 8 | 0.04508 | 24 | 1 | N |

Once the first round is completed, the second round begins. Instead of team one being assigned the fifth ranked player (player 7), as the pattern may indicate, team four is assigned the fifth player. The second round continues in the same pattern as round one, only players are assigned from team five to team one (opposite of round one). This pattern continues until all players have been assigned to a team. The complete Serpentine process is depicted in the table below.

**Table 9. Serpentine Assignment Method**

| Team 1 | Team 2 | Team 3 | Team 4 |
|---|---|---|---|
| 6 | 18 | 12 | 16 |
| 17 | 5 | 19 | 7 |
| 9 | 20 | 21 | 1 |
| 15 | 3 | 11 | 10 |
| 23 | 2 | 14 | 4 |
| 8 | 22 | 13 | 24 |

### 4.5 Serpentine Pre-Assignment Method

The serpentine pre-assigned method is a combination of the random pre-assigned method and the serpentine method. It is similar to the serpentine method in that the assignment mechanism is the same (rank the players and evenly distribute the top ranked players first) but uses the random pre-assigned methodology in that the coach's players are assigned to their designated teams before any normal players are assigned.

For the example in this paper, the assigned coach's players remain the same and are assigned to the appropriate teams prior to the assignment of the normal players. The remaining 16 normal players are then assigned using the serpentine method as previously described. The results of the serpentine pre-assigned method are shown below in Table 10.

**Table 10. Serpentine Pre-Assignment Method**

| Team 1 | Team 2 | Team 3 | Team 4 |
|---|---|---|---|
| 6 | 12 | 16 | 19 |
| 7 | 15 | 18 | 21 |
| 5 | 17 | 9 | 20 |
| 3 | 11 | 10 | 1 |
| 23 | 2 | 14 | 4 |
| 8 | 22 | 13 | 24 |

## 4.6 Serpentine Post-Process Assignment Method

The serpentine post process is a combination of the Serpentine Method and the Random Post Process method. Serpentine Post Process is similar to the Serpentine in that initially all players are assigned with the same methodology (not distinguishing coach's players). After the players have been initially assigned to teams, the same trading scheme that is depicted in the Random Post Process Method is used to swap coach's players into their appropriate team in exchange for a player of approximate equal value.

The illustration of the first three trades for the Serpentine Post Process method is shown in Table 11.

**Table 11. First Three Trades of Serpentine Post-Process**

| Team 1 | Team 2 | Team 3 | Team 4 |
|---|---|---|---|
| 6 | 11 | 5 | 14 |
| 7 | 12 | 1 | 17 |
| 9 | 20 | 21 | 19 |
| 15 | 3 | 18 | 20 |
| 23 | 2 | 16 | 4 |
| 8 | 22 | 13 | 24 |

As seen above, the algorithm checks if the players are on the appropriate team in the order that the players were assigned. Therefore, coach's player 6 remains on team 1, coach's player 18 (talent level 5) is swapped with player 11 (talent level 4), and coach's player 12 (talent level 5) is exchanged with player 5 (talent level 5). This pattern continues and no trades overlap until player 21 must be traded to team four. In this case, player 21 will also be traded with player 14 due to the location in the team array. A double trade happens again with the last trade. Player 15 is traded with player 11, who has already been traded once. The final teams are shown in Table 12 below. Players shown in grey denote a trade occurred involving that player. All trades are shown in order in Table 13.

**Table 12. Serpentine Post-Process Method**

| Team 1 | Team 2 | Team 3 | Team 4 |
|---|---|---|---|
| 6 | 15 | 5 | 21 |
| 7 | 12 | 1 | 17 |
| 9 | 20 | 14 | 19 |
| 11 | 3 | 18 | 10 |
| 23 | 2 | 16 | 4 |
| 8 | 22 | 13 | 24 |

**Table 13. Serpentine Post Process Player Trades**

| Coach's | Player |
|---|---|
| 18 | 11 |
| 12 | 5 |
| 16 | 14 |
| 7 | 17 |
| 19 | 1 |
| 21 | 14 |
| 15 | 11 |

## V. Model Development & Verification

The model for each team assignment strategy was constructed through a continuous process of learning, understanding, and testing outputs and results of the simulation. It was necessary to establish a thorough understanding of the problem which, in turn, led to the assignment method algorithms. Each of the six assignment models were organized into Excel worksheets and manually altered to reflect how the resulting teams would emerge after trades were implemented.

The manual process included generating player numbers, random numbers and player ranks in a full scale model. The manual process was conducted using 84 players and 6 teams along with the correct distribution of coach's children and non-coach's children.  An excerpt of the initial numbers generated from the manual case is shown in Table 14. If a player number contains a *'c'* the player was designated as a coach's player in the model.

**Table 14. Manual Assignment Process**

| Player # | Random Sorted | In order of talent | Rank (1-5) |
|---|---|---|---|
| 24c | 0.005400296 | 1 | 5 |
| 33c | 0.028569126 | 2 | 5 |
| 38c | 0.029592672 | 3 | 5 |
| 84c | 0.032885807 | 4 | 5 |
| 67c | 0.074222057 | 5 | 5 |
| 83c | 0.089395277 | 6 | 5 |

The manual depiction of the Random Pre-Assigned method is shown below in Table 15. Note the similarity of the manually created table and the final output tables (Table 16-Table 21). The resemblance between the tables was the ultimate goal of creating the manual teams before continuing into the automation phase of the simulation.

**Table 15. Manual Random Pre-Assignment Method**

| Team 1 | Team 2 | Team 3 | Team 4 | Team 5 | Team 6 |
|---|---|---|---|---|---|
| 77c | 22c | 14c | 24c | 33c | 63c |
| 84c | 29c | 74c | 82c | 41c | 75c |
| 81c | 71c | 38c | 31c | 83c | 67c |
| 1 | 12 | 26 | 42 | 53 | 65 |
| 2 | 13 | 27 | 43 | 54 | 66 |
| 3 | 15 | 28 | 44 | 55 | 68 |
| 4 | 16 | 30 | 45 | 56 | 69 |
| 5 | 17 | 32 | 46 | 57 | 70 |
| 6 | 18 | 34 | 47 | 58 | 72 |
| 7 | 19 | 35 | 48 | 59 | 73 |
| 8 | 20 | 36 | 49 | 60 | 76 |
| 9 | 21 | 37 | 50 | 61 | 78 |
| 10 | 23 | 39 | 51 | 62 | 79 |
| 11 | 25 | 40 | 52 | 64 | 80 |

Once the problem and algorithms for each method were established, it was necessary to develop base code that could be consistent within each assignment strategy. These base algorithms were developed through creation from each of the manual assignments. The common sub-routines helped keep consistency throughout each of the methods.

The first sub routine developed was “Define”. This function designates the number of players, teams, and the distribution of players throughout the simulation. This function also assigns the random numbers to each player which ultimately determines the talent of each individual player. Each of the characteristics assigned in “Define” were written into a worksheet to establish the validity of the methodology and to make sure the outputs and arrays were parallel to the goals of this function.

The next process was to assign the players to teams. This process was completely separate for each of the six methods. Each assignment algorithm is its own separate function and called independently in a separate worksheet. When players are initially assigned (either through serpentine or random assignment), the six initial teams are written into the appropriate worksheet for error checking purposes. After trades or final assignment takes place, each player is again reassigned into the six team arrays and output into the same screen to confirm the trades and assignment was completed appropriately. The final teams for each method used for the data analysis are shown in Table 16 through Table 21 below. Note that the first cell in every column is a count of the number of players assigned to the team. Therefore, each first cell should be 14 to represent each player assigned to the team. The remaining numbers in each column are the player numbers that are assigned to each team. “T1” represents Team 1, “T2” represent Team 2 and so forth.

**Table 16**

| Random Assignment | | | | | |
|---|---|---|---|---|---|
| **T1** | **T2** | **T3** | **T4** | **T5** | **T6** |
| 14 | 14 | 14 | 14 | 14 | 14 |
| 1 | 15 | 29 | 43 | 57 | 71 |
| 2 | 16 | 30 | 44 | 58 | 72 |
| 3 | 17 | 31 | 45 | 59 | 73 |
| 4 | 18 | 32 | 46 | 60 | 74 |
| 5 | 19 | 33 | 47 | 61 | 75 |
| 6 | 20 | 34 | 48 | 62 | 76 |
| 7 | 21 | 35 | 49 | 63 | 77 |
| 8 | 22 | 36 | 50 | 64 | 78 |
| 9 | 23 | 37 | 51 | 65 | 79 |
| 10 | 24 | 38 | 52 | 66 | 80 |
| 11 | 25 | 39 | 53 | 67 | 81 |
| 12 | 26 | 40 | 54 | 68 | 82 |
| 13 | 27 | 41 | 55 | 69 | 83 |
| 14 | 28 | 42 | 56 | 70 | 84 |

**Table 17**

| Random Pre-Assigned | | | | | |
|---|---|---|---|---|---|
| **T1** | **T2** | **T3** | **T4** | **T5** | **T6** |
| 14 | 14 | 14 | 14 | 14 | 14 |
| 1 | 7 | 13 | 24 | 29 | 36 |
| 2 | 8 | 14 | 25 | 30 | 49 |
| 5 | 11 | 17 | 27 | 32 | 55 |
| 3 | 21 | 39 | 51 | 63 | 74 |
| 4 | 22 | 40 | 52 | 64 | 75 |
| 6 | 23 | 41 | 53 | 65 | 76 |
| 9 | 26 | 42 | 54 | 66 | 77 |
| 10 | 28 | 43 | 56 | 67 | 78 |
| 12 | 31 | 44 | 57 | 68 | 79 |
| 15 | 33 | 45 | 58 | 69 | 80 |
| 16 | 34 | 46 | 59 | 70 | 81 |
| 18 | 35 | 47 | 60 | 71 | 82 |
| 19 | 37 | 48 | 61 | 72 | 83 |
| 20 | 38 | 50 | 62 | 73 | 84 |

**Table 18**

| Random Post-Process Assignment | | | | | |
|---|---|---|---|---|---|
| **T1** | **T2** | **T3** | **T4** | **T5** | **T6** |
| 14 | 14 | 14 | 14 | 14 | 14 |
| 1 | 5 | 29 | 18 | 25 | 38 |
| 2 | 7 | 30 | 19 | 58 | 72 |
| 3 | 35 | 63 | 45 | 26 | 51 |
| 4 | 43 | 11 | 46 | 60 | 52 |
| 15 | 44 | 14 | 24 | 61 | 75 |
| 6 | 20 | 34 | 48 | 62 | 76 |
| 16 | 10 | 17 | 49 | 31 | 77 |
| 8 | 22 | 36 | 50 | 64 | 78 |
| 9 | 23 | 37 | 73 | 65 | 79 |
| 21 | 47 | 71 | 74 | 66 | 80 |
| 32 | 57 | 39 | 53 | 67 | 81 |
| 12 | 59 | 40 | 54 | 68 | 82 |
| 13 | 27 | 41 | 55 | 69 | 83 |
| 33 | 28 | 42 | 56 | 70 | 84 |

**Table 19**

| Serpentine Assignment | | | | | |
|---|---|---|---|---|---|
| **T1** | **T2** | **T3** | **T4** | **T5** | **T6** |
| 14 | 14 | 14 | 14 | 14 | 14 |
| 56 | 40 | 77 | 63 | 1 | 84 |
| 23 | 83 | 50 | 67 | 10 | 29 |
| 66 | 73 | 46 | 80 | 42 | 25 |
| 43 | 64 | 5 | 9 | 17 | 27 |
| 59 | 45 | 76 | 71 | 14 | 22 |
| 68 | 82 | 18 | 11 | 3 | 39 |
| 35 | 47 | 41 | 57 | 70 | 2 |
| 69 | 51 | 61 | 75 | 79 | 74 |
| 53 | 24 | 28 | 16 | 7 | 13 |
| 72 | 12 | 4 | 55 | 21 | 34 |
| 60 | 19 | 44 | 54 | 15 | 20 |
| 33 | 65 | 8 | 6 | 62 | 26 |
| 48 | 49 | 31 | 81 | 78 | 38 |
| 36 | 52 | 30 | 32 | 37 | 58 |

**Table 20**

| Serpentine Pre-Assigned | | | | | |
|---|---|---|---|---|---|
| **T1** | **T2** | **T3** | **T4** | **T5** | **T6** |
| 14 | 14 | 14 | 14 | 14 | 14 |
| 1 | 6 | 13 | 22 | 26 | 35 |
| 4 | 7 | 17 | 24 | 28 | 37 |
| 5 | 9 | 21 | 25 | 34 | 38 |
| 73 | 33 | 23 | 44 | 80 | 51 |
| 81 | 56 | 2 | 61 | 39 | 20 |
| 3 | 68 | 40 | 31 | 41 | 64 |
| 72 | 76 | 62 | 50 | 12 | 75 |
| 69 | 36 | 83 | 27 | 15 | 66 |
| 60 | 52 | 29 | 8 | 84 | 16 |
| 82 | 32 | 18 | 19 | 71 | 30 |
| 46 | 59 | 43 | 14 | 49 | 57 |
| 10 | 11 | 58 | 67 | 48 | 54 |
| 70 | 78 | 55 | 53 | 79 | 45 |
| 74 | 65 | 47 | 42 | 77 | 63 |

**Table 21**

| Serpentine Post-Process | | | | | |
|---|---|---|---|---|---|
| **T1** | **T2** | **T3** | **T4** | **T5** | **T6** |
| 14 | 14 | 14 | 14 | 14 | 14 |
| 25 | 21 | 19 | 62 | 65 | 60 |
| 4 | 39 | 34 | 57 | 82 | 50 |
| 66 | 53 | 61 | 16 | 24 | 30 |
| 12 | 36 | 43 | 69 | 10 | 9 |
| 48 | 79 | 58 | 7 | 47 | 70 |
| 29 | 40 | 5 | 2 | 56 | 15 |
| 84 | 14 | 6 | 52 | 20 | 64 |
| 13 | 72 | 41 | 32 | 37 | 33 |
| 54 | 18 | 31 | 3 | 49 | 73 |
| 63 | 42 | 74 | 35 | 26 | 46 |
| 68 | 22 | 76 | 83 | 80 | 77 |
| 71 | 38 | 55 | 27 | 44 | 59 |
| 28 | 51 | 78 | 75 | 81 | 67 |
| 11 | 45 | 17 | 1 | 8 | 23 |

The random and serpentine post-process methods use the same function for player trades after the initial assignment. The pre-assignment method also uses the same function for the serpentine and random pre-assignment methods.

In order to determine if the correct coach's children were on the appropriate team after the final assignment process, the coach's children arrays were also output into the worksheet. A simple Excel formula was used to depict if a coach's child was on the correct team. The verification method for the serpentine post-process method is shown in Table 22.

**Table 22. Verification Method for Serpentine Post-Process**

| C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|
| 66 | 79 | 34 | 16 | 24 | 70 |
| 4 | 39 | 43 | 57 | 65 | 73 |
| 25 | 21 | 19 | 62 | 56 | 23 |

| C1? | C2? | C3? | C4? | C5? | C6? |
|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 |

If the player number in the "C1" column is contained in the "T1" column (in the final team output), then the corresponding "C1?" cell will be a 1. If the player is not in the final "T1" column, then the value of "C1?" will be a 0 indicating that the player is not assigned to the correct team.

After each team was assigned the appropriate players, a season of game play was simulated. The game play schedule was determined by the simple methodology that each team will play every other team twice, resulting in 30 games per season. The same season schedule is used for every methodology. The game play schedule is shown in Table 23.

**Table 23**

| Game Play Schedule | | | | | | |
|---|---|---|---|---|---|---|
| **Game #** | **Team 1** | **Team 2** | | **Game #** | **Team 1** | **Team 2** |
| 1 | 1 | 2 | | 16 | 4 | 1 |
| 2 | 1 | 3 | | 17 | 4 | 2 |
| 3 | 1 | 4 | | 18 | 4 | 3 |
| 4 | 1 | 5 | | 19 | 4 | 5 |
| 5 | 1 | 6 | | 20 | 4 | 6 |
| 6 | 2 | 1 | | 21 | 5 | 1 |
| 7 | 2 | 3 | | 22 | 5 | 2 |
| 8 | 2 | 4 | | 23 | 5 | 3 |
| 9 | 2 | 5 | | 24 | 5 | 4 |
| 10 | 2 | 6 | | 25 | 5 | 6 |
| 11 | 3 | 1 | | 26 | 6 | 1 |
| 12 | 3 | 2 | | 27 | 6 | 2 |
| 13 | 3 | 4 | | 28 | 6 | 3 |
| 14 | 3 | 5 | | 29 | 6 | 4 |
| 15 | 3 | 6 | | 30 | 6 | 5 |

Game play was simulated using the *NormInv* (normal distribution) values within VBA. For each game, every player on the two active teams was given a “player score”. This player score is calculated using the *NormInv* function. The inputs for the Excel function for each talent level are shown below in Table 24. The standard deviation for the normal distribution was determined by 6 – talent. The methodology of this input comes from the fact that the most experienced players (talent level 5) will play at a more consistent level and have a much smaller variation is their performance level than a less experienced player. Note that it is possible to receive a negative player score therefore decreasing the total team output.

**Table 24. Excel NormInv Inputs**

| Talent | Mean | StDev |
|---|---|---|
| 1 | 1 | 5 |
| 2 | 2 | 4 |
| 3 | 3 | 2 |
| 4 | 4 | 3 |
| 5 | 5 | 1 |

After every player receives a player score, the scores are summed for each team to get a “team score”. The team scores are compared and the team with the highest score is determined the winning team. This process is repeated and recorded throughout each of the thirty games in every season.

After a season (all 30 games) is complete, the season stats and results are calculated. For each season, the team number, number of wins and number of losses are output into a results database. From those values, a “Delta” for every team is determined. The delta is the absolute value between the wins and losses for the individual team. The delta values are used to calculate the average delta, standard deviation, and the coefficient of variation. A sample season for each method is shown below in Table 25.

**Table 25. Sample Seasons for Each Assignment Method**

| Random Method | | | |
|---|---|---|---|
| **Team** | **Wins** | **Losses** | **Delta** |
| 1 | 3 | 7 | 4 |
| 2 | 7 | 3 | 4 |
| 3 | 4 | 6 | 2 |
| 4 | 5 | 5 | 0 |
| 5 | 4 | 6 | 2 |
| 6 | 7 | 3 | 4 |
| | | **Avg Delta** | 2.667 |
| | | **StDev Delta** | 1.633 |
| | | **Coefficient of Variance** | 0.612 |

| Random Pre-Assignment Method | | | |
|---|---|---|---|
| **Team** | **Wins** | **Losses** | **Delta** |
| 1 | 5 | 5 | 0 |
| 2 | 4 | 6 | 2 |
| 3 | 4 | 6 | 2 |
| 4 | 5 | 5 | 0 |
| 5 | 6 | 4 | 2 |
| 6 | 6 | 4 | 2 |
| | | **Avg_Delta** | 1.333 |
| | | **StDev_Delta** | 1.033 |
| | | **Coefficient of Variance** | 0.775 |

| Random Post-Process Method | | | |
|---|---|---|---|
| Team | Wins | Losses | Delta |
| 1 | 4 | 6 | 2 |
| 2 | 5 | 5 | 0 |
| 3 | 7 | 3 | 4 |
| 4 | 5 | 5 | 0 |
| 5 | 4 | 6 | 2 |
| 6 | 5 | 5 | 0 |
| | | Avg Delta | 1.333 |
| | | StDev Delta | 1.633 |
| | | Coefficient of Variance | 1.225 |

| Serpentine Method | | | |
|---|---|---|---|
| Team | Wins | Losses | Delta |
| 1 | 5 | 5 | 0 |
| 2 | 6 | 4 | 2 |
| 3 | 5 | 5 | 0 |
| 4 | 7 | 3 | 4 |
| 5 | 2 | 8 | 6 |
| 6 | 5 | 5 | 0 |
| | | Avg Delta | 2.000 |
| | | StDev Delta | 2.530 |
| | | Coefficient of Variance | 1.265 |

| Serpentine Pre-Assignment Method | | | |
|---|---|---|---|
| Team | Wins | Losses | Delta |
| 1 | 8 | 2 | 6 |
| 2 | 7 | 3 | 4 |
| 3 | 5 | 5 | 0 |
| 4 | 1 | 9 | 8 |
| 5 | 6 | 4 | 2 |
| 6 | 3 | 7 | 4 |
| | | Avg Delta | 4.000 |
| | | StDev Delta | 2.828 |
| | | Coefficient of Variance | 0.707 |

| Serpentine Post-Process Method | | | |
|---|---|---|---|
| Team | Wins | Losses | Delta |
| 1 | 3 | 7 | 4 |
| 2 | 4 | 6 | 2 |
| 3 | 7 | 3 | 4 |
| 4 | 3 | 7 | 4 |
| 5 | 7 | 3 | 4 |
| 6 | 6 | 4 | 2 |
| | | Avg Delta | 3.333 |
| | | StDev Delta | 1.033 |
| | | Coefficient of Variance | 0.310 |

## VI. Initial Results

For each method, 50 complete seasons of each method were simulated and recorded. The recorded variables for each method were the average of the average deltas, the standard deviation of the average deltas, the standard deviation of the team wins and the coefficient of variation. The recorded data is shown below in Table 26.

Table 26. Results of 50 Seasons for Each Assignment Method

| Method | R | RPA | RPP | S | SPA | SPP |
|---|---|---|---|---|---|---|
| Avg of Avg Delta | 2.500 | 2.553 | 2.581 | 2.201 | 2.547 | 2.514 |
| StDev of Avg Delta | 1.123 | 0.824 | 2.063 | 1.804 | 2.049 | 1.948 |
| StDev Wins | 1.636 | 1.615 | 1.705 | 1.707 | 1.707 | 1.705 |
| Coefficient of Var | 0.4493 | 0.3226 | 0.7991 | 0.8196 | 0.8043 | 0.7745 |

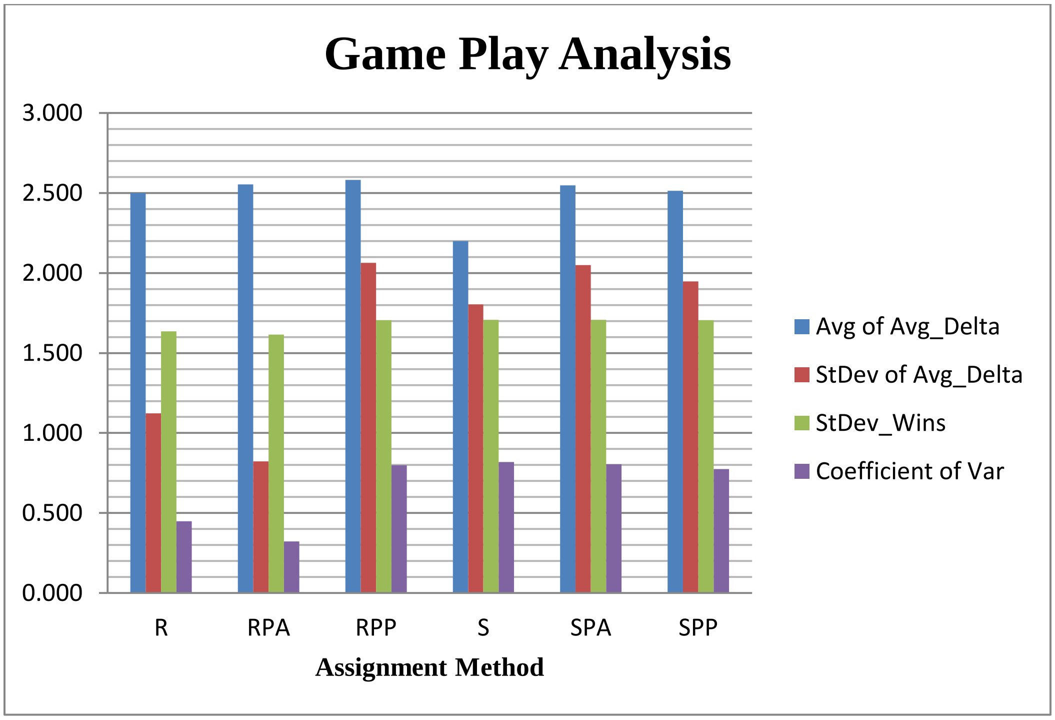


**Figure 1. Game Play Analysis for 50 Seasons of Each Assignment Method**

## Conclusions and Future Work

Through using the data from the initial results and performing various statistical analysis between methods, it was determined that a statistical significance between the distribution of wins and losses occurs between the serpentine method and every other method at a level of $\alpha = 0.1$. It was also determined that no other statistical significance occurs between any other combination of methods. Therefore, if an organization wishes to implement a methodology that and emphasize fair competition the Serpentine Method with no coach's pre-assignment and no post-assignment trades should be enacted.

The serpentine method is the best option for eliminating built-in biases created by coaching/player assignment. This method will maximize fair competition between all teams, give all players and equal change of enjoying a win, increase morale for all participants, and minimize the possibility of stacked teams that exist in Little League baseball today.

Future endeavors into this topic of assigning Little League players to teams are needed to fully understand the implications of how the results of this study may impact team assignments in youth sports. Distributions of talent among coach's children and non-coach's children and the impact of those values on the results of this study would be useful future analysis. Also, adapting the team assignment method to other sporting teams such as youth basketball or soccer would add validity to the simulation results.

Ultimately an official assignment method with formal rules and regulations would need to be implemented and analyzed in a real Little League scenario. A positive application of the assignment method into a youth league scenario could add a new dimension to youth sports and hopefully benefit many participants in the future.

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