SCORING AND WINNING ODDS IN MAPUCHE INDIAN FIELD HOCKEY

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1. ABSTRACT

Chueca is a Mapuche Indian ball game. Its unusual scoring and cultural importance implied the need of an interdisciplinary approach. Modelling and analysing the scoring led to interesting results, which called attention to new contents in the cultural context of chueca, thus enriching the picture of the Mapuche society and the Indian ball games.

2. DESCRIPTION OF THE GAME

There were several kinds of ball game played in Argentina and Chile. [1,4] The best known of them is the chueca, a field hockey-like game of the Araucan Indians, who call themselves Mapuches: men of the Earth. It is a richly ritualized game, which became the symbol of the Mapuche culture.

Groups (or rather, teams) composed of 10 to 15 people of the same kin, village or tribe competed with each other on a very long, bushy field covering nearly 100 m^2, or on the sandy shore of a river. The balls were made of wood. These were hit or driven with bent-ended sticks towards the goals, which were constructed of branches and stood at the two ends of the field. There was no free kick, throw-in, or any other strict rules. The essence of the game was to hit the ball into the goal as many times as possible. [3]

The method of keeping the score was highly original: the teams agreed in advance that they were going to play until they reach, say, 4 points. This does not sound like too many, but after every goal that a team scored, one point was subtracted from the opponent. (That is, if team A scored a goal, the score was 1:0, if then team B scored a goal, then the point of team A was subtracted and given over to team B, so now the score was 0:1, and so on.) If teams of more or less equal ability competed, the game was exciting and could go on for quite a long time.

The Indians themselves admitted that these games were in effect a substitute for open warfare. They also used hockey to settle disputes or disagreements (instead of "digging up the tomahawk"). The players were quite tough with each other; a lot of people got injured in the course of the game. Thus they had good reason to use shin-protectors made of sticks, which they fastened onto their legs. Winners were appreciated as successful warriors; their names were known in several villages.

At the beginning of the game and after every goal, the two teams line up facing each other on two lines. The ball is hit out of a small hole in the middle of the field. This is where the two team captains stand. Their task is to get the ball as far as possible, out to their own offense. In the area of Lumaco, first they cross the sticks in the air, and only hit the ball after that.

Figure 1. a-b
Indian field hockey in Chile: in the past and today
(Source: [4])

Indians distinguish everyday 'small' hockey from 'great' hockey and hockey festivals, to which they invite the neighboring communities. To ensure the purity of the game, the shamans smoke the balls, and dip the sticks into the blood of sacrificial animals. People try to secure victory in a number of ways. The players pipe, sing, and dance together, circle around their ritual tree, strike their sticks together, and breathe in the breath of their horses to acquire their strength and endurance. The shaman offers the game to the sacred Motherland. A couple of women gather on the narrower end of the playing field and put a spell on the ball, so that it will go through the goal-line. The players are cheered on by loud music and shouting. [2,3]
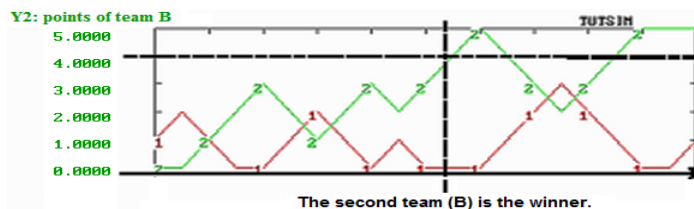
Figure 2.
Simulation of chueca (in case of equal probability random walk) with the TUTSIM v.6.06 program

3. ANALAYSIS OF THE SCORING

3.1 Some remarkable features of the scoring of chueca

In soccer, the number of goals defines the outcome of the game. In chueca, the final result depends to a great extent on the order of the goals. Suppose team A scored 2 goals, team B scored 1 goal. They can score the goals in three different orders. What do the differences in order and in points reflect?

1) **AAB**: 1:0 → 2:0 → **1:1**
   B is able to score a goal from a losing position, thus they can get even: the difference is 0 point.

2) **ABA**: 1:0 → 0:1 → **1:0**
   Teams of approximately equal ability are playing with each other, but team A is more persevering: they have 1 point more.

3) **BAA**: 0:1 → 1:0 → **2:0**
   After B's first moment of success, team A achieves an overwhelming victory: thus they exceed team B by 2 points.

It is not the same to score goals from a score of 0:0 or from 1:1, because if from a score of 0:0 one of the teams scores a goal, the difference between their points is going to be 1 (1:0), while if they do this from 1:1, then the difference will be 2 points (0:2).

The only way for a team to overtake the other in points is by bringing the points of the other to 0 or keeping them at 0. This means that the only possible outcome of the game is 4:0 (or 0:4), which is an absolute, indisputable final result. (It is stunning that there is no mention anywhere in the literature of the remarkable fact that every single chueca game ends with this final score.)

3.2 Winning odds in chueca

3.2.1 In the case of teams of equal ability

Teams A and B have an equal chance of scoring a goal, that is, the probability of team A scoring a goal is the same as that of team B, namely, 0,5 (p). Thus: P(A scores a goal) = P(B scores a goal) = 0,5.

In the model, we can decide which team scores a goal by tossing a coin or with the help of a random generator, and we can depict the development of the score of the game with the help of a graph or with computer simulation based on the results. (Figure 2)

Sooner or later the game ends. Now team B is the winner. This had a probability of 0,5, as team A had the same chance of winning.

Thus even in the case of an even balance of forces, the scoring of chueca increases the influence of chance on the outcome (4:0), which thus, because of its extremity, can be, and is indeed, attributed to supernatural powers. It is no accident that the Indians perform so many rituals during and before the game.

3.2.2 In the case of teams of unequal ability

If team A scores a goal with probability p, what chance do they have of winning?

Let us suppose that based on its games so far, we judge team A to be stronger. We think that it has a higher than 0,5 probability of scoring a goal (p). What are the chances of this team for winning? To sum up: P(A scores a goal) = $p > 0,5$. In this case P(A wins) = ?

A) If the two teams are playing until 1 point, then obviously the probability of team A winning is equal to the probability of them scoring a goal, that is p.

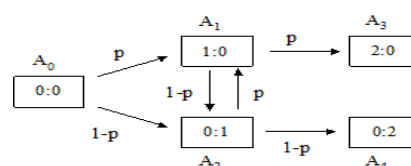B) If they are playing until 2 points, the possible scenarios are the following:
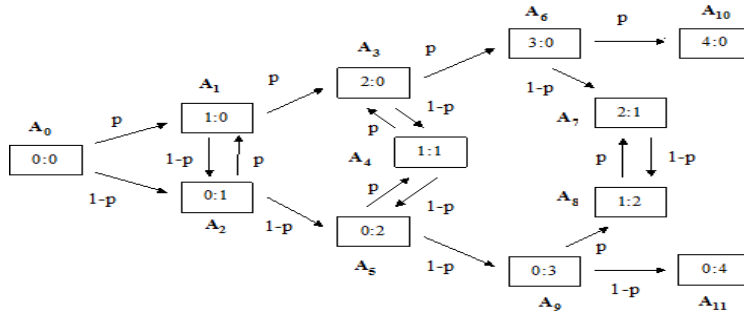

Figure 3.
Transition diagram for 2-point games

Figure 4.
Transition diagram for 4-point games

In addition to the initial (A_0) and the final states (A_3, A_4), there are also two intermediate stages (A_1, A_2). Let us use a_i to denote the conditional probability of somebody getting from state A_i to a final state determined in advance (e.g. A_3) ($i = 0$, 1, 2, 3, 4). We want to find out the value of a_0.

The probability of someone getting from A_0 to A_3 is equal to the probability of the person getting there from A_1 and A_2 together. The probability of getting to A_1 and to A_2 is p, and $1-p$. Put formally: $a_0 = p \cdot a_1 + (1-p) \cdot a_2$. We can obtain equations for the other conditional probabilities in a similar fashion:

$$a_4 = 0; \quad a_3 = 1$$
$$a_2 = p \cdot a_1 + (1-p) \cdot a_4 = p \cdot a_1$$
$$a_1 = p \cdot a_3 + (1-p) \cdot a_2 = p + (1-p) \cdot a_2,$$
$$\textit{from where } a_1 = p + (1-p) \cdot p \cdot a_1$$
$$a_1 = \frac{p}{1 - p \cdot (1-p)}$$
$$a_0 = p \cdot a_1 + (1-p) \cdot a_2 = p \cdot a_1 + (1-p) \cdot p \cdot a_1 =$$
$$= (2-p) \cdot p \cdot a_1 = \frac{(2-p) \cdot p^2}{1 - p \cdot (1-p)}$$

C) If teams are playing until 4 points, we get the structure can be seen above (Figure 4)

We can write the following equations:

$$a_0 = p \cdot a_1 + (1-p) \cdot a_2 \qquad a_6 = p \cdot a_{10} + (1-p) \cdot a_7$$
$$a_1 = p \cdot a_3 + (1-p) \cdot a_2 \qquad a_7 = p \cdot a_6 + (1-p) \cdot a_8$$
$$a_2 = p \cdot a_1 + (1-p) \cdot a_5 \qquad a_8 = p \cdot a_7 + (1-p) \cdot a_9$$
$$a_3 = p \cdot a_6 + (1-p) \cdot a_4 \qquad a_9 = p \cdot a_8 + (1-p) \cdot a_{11}$$
$$a_4 = p \cdot a_3 + (1-p) \cdot a_5 \qquad a_{10} = 1$$
$$a_5 = p \cdot a_4 + (1-p) \cdot a_9 \qquad a_{11} = 0$$

Solving the system of equations for a_0 we get the following parametrical equation:

$$a_0 = P(A \text{ wins}) =$$
$$= \frac{p^4}{[1 - p \cdot (1-p)] \cdot \left\{ p \cdot [1 - 2p \cdot (1-p)] + (1-p)^4 \right\}} \cdot$$
$$\left\{ 1 + (1-p)^2 \cdot \left[2 + \frac{(1 + 2p^2) \cdot (1-p)}{1 - 2p \cdot (1-p)} \right] \right\}$$

Let us examine the probability of team A winning in the cases of different probabilities of scoring goals (p), if the teams play until 2 points (a_0^2), and if they play until 4 points (a_0^4).

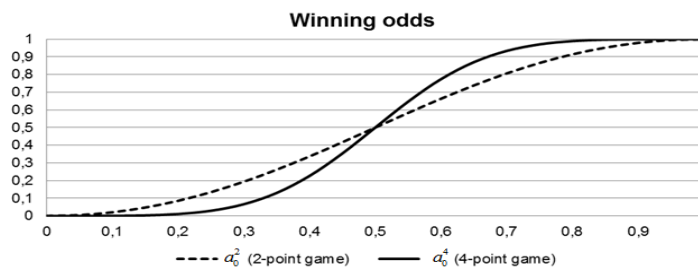| $p =$	0	0,5	0,6	0,75	0,9	0,95	1
$a_0^2 \approx$	0	0,5	0,66316	0,86538	0,97912	0,99488	1
$a_0^4 \approx$	0	0,5	0,77368	0,97066	0,99947	0,99997	1

Figure 5.
Probability distribution functions of winning odds for 2- and 4-point games

We can see that the higher the point is set as the target, the higher the probability that the stronger team (that is, the one more likely to score a goal) wins.

In the case of groups of equal ability ($p = 0,5$) the probability of one team winning is $a_0 = 0,5$, as we supposed earlier. It is also true that if $p = 1$, then $a_0 = 1$.

3.3 Interpretation of scoring in sociocultural context

There are several reasons for such a method of scoring. It is likely that it reflects the fact that chueca was played instead of war. This kind of scoring can make the game last very long, which made it possible for the Indians to use up their energy somewhere else and not in a lethal battle. The experience of the common games served as a base for peace among the tribes, and it added to the cohesion within the group. Some parallels can be drawn between the dynamics of the evolution of scoring and the change of fighting spirit. First, the procedure that if team B scored a goal, 1 point of the opponent (if it had at least one) was subtracted, corresponds well to the feature of war that if one of the parties (A) makes a successful move, and then the other (B) retorts, then this second party did not simply get even, but demoralizes the other party, which is in effect a further loss, a disadvantage to party A. Second, after the first point is obtained, every goal is worth 2 points. This leads to a strategy in which the team with 0 point is motivated to attack aggressively, fighting with all their might, while the goal of the team with more points is to be careful and strengthen defense. Thus the fight becomes exciting, which was expected from this game by peoples with a martial spirit. Third, a small difference between the points could stir up the strife between these peoples. But the outcome 4:0 is so unambiguous that the losing side could not appeal against it. It was attributed to the impact of transcendent powers, which the Indians intended to influence by magical rituals. Nowadays, the Indians bring chueca sticks to cultural events and political demonstrations, and cross them in the air showing their (symbolic) power and cohesion.

4. CONCLUSION

The scoring of ball games is of interest from a mathematical perspective because it reflects the aspiration of people to quantify their ideas somehow (in the light of their worldview and mentality), in the present case, their expectations towards the given game. If we examine the way the points are given and the effect of this on the game, we can draw conclusions concerning the cultural content they reflect. This can be helpful in sociocultural and interdisciplinary research, and can support our hypotheses.

5. REFERENCES

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