Improving Duckworth-Lewis: Statistical Methods for Resetting Score Targets in Limited-Overs Cricket

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Plan for the Talk

1. Background
2. Neural Networks in Cricket
3. Resetting Score Targets
4. Conclusions

Cricket

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- Score measured in runs. Aim: Score as many as you can before losing 10 wickets.
- Focus in this project is limited overs cricket. Games last 50 overs, which takes about 3 hours.

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- If it gets too dark, the ball becomes very hard to see and so the game is stopped.
- Similarly, if it rains, the game is stopped due to the adverse affect this has on the pitch.

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- Clearly, at this point it is unfair to expect team B to chase down 222 runs in 6 overs instead of the 16 they should have had. So for this reason, score target adjustment is needed to keep the game fair, despite the loss of time.

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Which gives the runs scored with u overs remaining and w wickets lost. Note that the actual value of Z_0 and b, the decay constant are not given due to commercial agreements.

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- Consider the special case at the start of an N-over innings. I.e $u = N$ and $w = 0$.

$$Z(N,0) = Z_0(1 - e^{-bN}).$$

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- Computing all values for P with $1 \leq u \leq 50$ and $0 \leq w \leq 10$ gives a table of results. It is from this table that the revised score target is calculated.

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- Steven Stern introduced updates in 2015 to account for the new increase in game scores.

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- DLS has a tendancy to reset score targets that are unrealistic, and as such ruin the competetive nature of a match
- DLS does not account for fielding restrictions that are in place at different pooints in the game
- It is not easy to understand, especially for players and officials without any mathematical education

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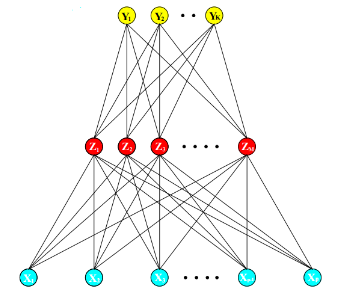
- To artificially create such a model, we use a system of nodes and synapses

Example



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$$W = \begin{bmatrix} w_{1,1} & w_{1,2} & \cdots & w_{1,m} \\ w_{2,1} & w_{2,2} & \cdots & w_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ w_{n,1} & w_{n,2} & \cdots & w_{n,m} \end{bmatrix} \tag{1}$$

Mathematically Representing Neural Networks (contd)

- The values of the nodes in layer $k+1$, denoted $A_{(k+1)}$ is given by the matrix equation $A_{(k+1)} = \sigma(WA_{(k)} + b_{(k)})$. Where b is the vector containing the biases, and $\sigma()$ is the *activation function*.

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- The choice of activation function is pretty much problem dependent, and depends a little bit on the data. In our case, we used the sigmoid activation function $\sigma : \mathbb{R} \to \mathbb{R}$ defined by $\sigma(x) = (1 + \exp(-x))^{-1}$.

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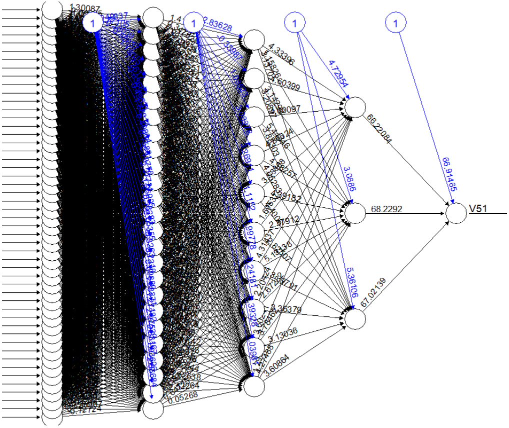
- We pass training data through the network, and see what the output is. By comparing this output to the actual value for that piece of data, we get an error value.
- We then employ the backpropogation algorithm to readjust the values of the weights and biases in accordance with the error. This looks to find a set of weights and biases that give the least error on the training data.

The Run-Rate Network



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Example

Assume 35 overs of play have occured. Leaving 15 overs without data.

1. Assert a value of 0 on the remaining overs and see what the network predicts
2. Draw random values based on historical perfomance of teams in the remaining overs

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- As it turns out, trying to fill in the gaps, didn't work at all. The predictions were way off and the corrolation between predicted results and actual results was almost 0.
- Leaving the unplayed overs blank was much more successfull, and had a corrolation of 0.49. So not great, but much better.

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- Of the 3 games, only 1 had the result changed, which meant the final standings of the tournament were virtually unchanged, except Bangladesh finish above South Africa for 7^{th} place.
- The key difference was in the scores set, the score targets were far more attianable by the batting team, which would have lead to a more competative set of games. The India vs Pakistan game was ruined by DLS in this way. Since they needed 27.2 an over at one point.

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- From an entertainment point of view, this method is better, but from a pure cricket perspective, DLS is still more reliable
- With more data, this method will become more reliable in the future, but this is constrained by the number of cricket games played each year.

Any Questions?