Kicking goals with Maths and Stats
Applications in Sport and Gambling

Stephen R Clarke
Faculty of Life and Social Sciences

Thankyou for opportunity
Was a regular attender 75-91
Remember the great enthusiasm
Joke about brains
What I do is not rocket science lots of the things I do could be tackled by students of varying standards.

Football’s number crunc...
Rugby league tipping

Swinburne statisticians predict England to win

Swinburne sports statisticians believe England is the team to beat in the Rugby World Cup.

Motor Racing

Soccer

Uni zeros in on our chances
Motor Cycling

Computer odds favour The Doc

Tennis

Go for a favourite: don’t curse Patterson

Stats show the Way

Hopes hinder heroes

A Current Affair

Olympic Heroes

Ol, medal tally best yet

Tipping odds predict 60 medals

Hopes hinder heroes

It all adds up to a great medal haul

A Current Affair

13

14

15

16

17

18
Being blond gets votes

The department’s favorites for the medal predictably place Collingwood’s Nathan Buckley and the Bulldogs’ Scott West in spots one and two.

Hair’s to all those blonds and brunette folk.

Shane Warne and Western Australian Brad Haddin, two of the leading candidates for the Allan Border Medal, are expected to be the runner-up and runner-up runner-up respectively.

Last year’s winner, Shane Warne, is another strong contender.

Correct did not put his first vote last night until rounded off the count to 52 votes.

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The West Coast midfielder polled only five votes apiece.

Zimbabwe: Champions of the world?

The substantive point in both votes that their performance matters in the match of the worlds. The beauty is everything, in certain department.

The beauty is everything, in the department’s standards for the long term competitive and the Bulldogs’ vine wire.

Footy’s a matter of maths

The system considers both votes that their performance matters in the match of the worlds.

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Statistics figure out another line of attack

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Why use sport in teaching

Essendon Football club chief executive Peter Jackson, discussing the 3 or 4 corporate leadership seminars the club runs each year, said
“corporate people concentrate more if sport was used as an example because they absorb the lessons because they think we’re interesting”.


Sport is important
- Governments: Olympics, Commonwealth Games
- Business:
  - New AFL TV rights - $1.253 billion
  - Learning Societies - ISI, ASA, RSS, AMS
    - 4 pages on Dili
    - 17 pages on election
    - 45 pages on sport

Simple example
- String around the world problem.
Rail - Surfing Example

- Expanding rail line

\[
(1 \text{ km} + 1 \text{ cm})^2 - (1 \text{ km})^2 = (1 \text{ km} + 1 \text{ cm} + 1 \text{ km})(1 \text{ km} + 1 \text{ cm} - 1 \text{ km}) = 2000 \text{ m} \times 1/100 \text{ m} = 20 \text{ m}
\]

So line rises \sqrt{20} = 4.5 \text{ m}

In race to a buoy 450 m off shore and back, how far down the beach can a swimmer start if prepared to swim an extra metre?

30 metres

Characteristics of scoring systems

- Assume we have a chance \( p = 0.52 \) of winning a point.
- What is chance of winning
  - a game? .55
  - A set? .64
  - A 5 set match? .75
- What is expected length of a 5 set match? 258 pts
Other tennis scoring systems

- Best of 5 sets to 4 games
- First to 4 point games
- 0-30 games
- Super tie break sets

- Table tennis has changed systems
- Squash has always had 2 systems
Tinhead makes a Blue

Footy undergoes a computer revolution

Computer puts Saints, Roos on top

Professor Punt

Round 11

<table>
<thead>
<tr>
<th>Team</th>
<th>Away Team</th>
<th>Ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geelong</td>
<td>Essendon</td>
<td>Telstra Dome</td>
</tr>
<tr>
<td>Richmond</td>
<td>Kangaroos</td>
<td>MCG</td>
</tr>
<tr>
<td>Brisbane Lions</td>
<td>Adelaide</td>
<td>Gabba</td>
</tr>
<tr>
<td>Western Bulldogs</td>
<td>St Kilda</td>
<td>SCG</td>
</tr>
<tr>
<td>Port Adelaide</td>
<td>Hawthorn</td>
<td>AAMI Stadium</td>
</tr>
<tr>
<td>W. Bulldogs</td>
<td>Fremantle</td>
<td>Telstra Dome</td>
</tr>
<tr>
<td>West Coast</td>
<td>Carlton</td>
<td>Subiaco</td>
</tr>
<tr>
<td>Melbourne</td>
<td>Collingwood</td>
<td>MCG</td>
</tr>
</tbody>
</table>

Eagles vs Swans: This game is a crucial confrontation between two teams that have both performed well this season. The Swans have a better record but are coming off a loss against the Eagles, who are looking to continue their winning streak. Expect a close game, with both teams vying for the top spot in the league. Fans are excited for this clash, hoping for an entertaining match.
How good is the computer

- In 2011 we had 145 correct winners over the home and away season, and 9 out of 10 in the finals.
- On the www.footytips.com.au website we topped the table of 14 experts and personalities, 8 ahead of the second placegetter (Matthew Richardson).
- We finished in the top 0.3% of the 375,734 people who entered their weekly tips through this site.
- The Age and the Herald Sun had 54 expert and celebrity tipsters between them. They averaged 8 behind the computer.
AFL tipping Feedback

- Many thanks for your tips each week...Thanks to you I won the tipping comp at my office. On those occasions I thought I knew better I usually bombed out !! Mike
- I religiously look up your wonderfully helpful site each week - in the hope of improving my tipping ability. Cathy
- Thanks to your predictions I came second in my footy tipping competition....

...and beat all the boys! THANKS! Sonia

Swinburne Computer

- Uses exponential smoothing (cf ELO) of past results and simulation to predict
  - Winners
  - Margins
  - Probability of winning
  - Probability of making finals and finishing in any ladder position

Computer tipping - how it works

Rating for each team
- Geelong 118
- Collingwood 112
- Hawthorn 99
- Gold Coast 20
- Home advantage 10

Prediction Equation

Predicted margin = home team rating – away team rating + home advantage

Rnd 1: Hawthorn v Colling - MCG

Hawthorn 99  Collingwood 112

At neutral ground

99 - 112 = -13

(Hawthorn lose by 13, ie Collingwood win by 13)

A negative result means away team wins
How do we get the rating?

- Rating = ladder points
- Rating = 4*win + 2*draw + score for /score against
- Rating = 5*big win + 3*little win + 4*number of wins in previous 5 weeks + 5*Number of top 8 sides beaten + ...

Choose parameters that give the most winners, or smallest average error.

Cf find x that maximises \( y = 3 + 6x - x^2 \)

Using computer

Rating = 5*big win + 3*little win + 4*number of wins in previous 5 weeks + 5*Number of top 8 sides beaten + ...

\[ \begin{align*}
5? & \quad 3? & \quad 4? & \quad 5? & \quad 5? & \quad 8? \\
10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 6 \text{ secs} & = 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 1.6 \text{ hours} & = 10 \times 6 \text{ days}
\end{align*} \]

Exponential Smoothing (Elo - chess)

Old rating

Hawthorn 99  Collingwood 112

Predicted Collingwood by 13

Hawthorn win by 11, 24 more than expected

New rating

Hawthorn 99 + 25% . 24 = 105
Collingwood 113 - 25% . 24 = 107

Why not

- Get class to predict AFL
- Local country competition
  - Football
  - Netball
  - Rugby
  - Cricket
  - Basketball
- Get results on local radio, local paper

How do we get odds?

- Look at Errors
  - Collingwood by 13 points

Look at our past errors

If 40% of the time we out by more than 13 points
Then 20% of the time Collingwood lose, Hawthorn win
And 80% of the time Collingwood win
The Australian

National Affairs

We’re happy to lead the world in gambling

* By John Bell
  * From the Australian
  * May 3 5 2004

We like to rank ourselves against the rest of the world but we could do without our status as the biggest losers.

According to international gaming industry consultant MI Gaming Capital, Australian bettor lost almost $613,000 on gambling the seven weeks post Hillary Clinton’s visit [1] and one! Singapore, which recently lifted betting ban, was out on about $395,000. Those figures, oddly, don’t come as a shock, but what bothers is the rise of less than 1%. While the American and British casinos losses of less than $16,000.

It would be one thing of Australians’ willingness to bet on racing was more than an embarrassing national characteristic. Instead, we have a problem on a scale Australian scale. This was brought home to a report last year from the Productivity Commission. Pundits the following heavy dose of lost bet are staggering. The commission calculated total gambling losses of more than $9.5 billion in 2004-05, a figure that grew 20 years, and an average of $3.50 per gambling visit. Considering the report estimated 15% cost of Australian participants in some sort of gambling at the same tally per the 9M figure.

The expansion of gambling in the 1990s, the share taken by casinos and electronic gaming machines, which used to come at around $100 per cent in 1995 to 30% in 2004. In 2002, there were 198,000 gaming machines in Australia, including 91,000 in NSW (but only 37,000 in Western Australia).

Lotteries

**House Percentage**

- Craps 1.4%
- Roulette 3%
- Poker machines 10%-12%
- Tattslotto and Keno over 40%
- Racing - Totalisator 13% -18%
- Sports betting ? 2.5% - 5%

Examples on inefficiency

- Michael Bailey – cricket - 99 bets 16% ROI
- Australian Maths Society - MCS conference - Hong Kong company
- PhD on greyhound racing
- D. B. Hausch et al : Efficiency of Racetrack Betting markets
- Student project on Rugby

Market Inefficiencies in Player Head to Head Betting on the 2003 Cricket World Cup

Michael J Bailey and Stephen R Charle

School of Mathematical Sciences, Swinburne University

1 Background

The first official one-day international cricket match, (ODI) was played at the Melbourne Cricket Ground on January 1 1971 between Australia and England. Since the inception of limited over cricket, there have been various rule changes, although general principles have remained the same. Each side bat one for a limited time (maximum 01 every team in the first innings) sooner than may now be possible, and the second innings to score more than the target set at the first innings. Prior to the 2003 World Cup, 16 countries had played 999 official ODIs, although 90% of all matches have been played by 9 main competing nations (Australia, England, India, Pakistan, South Africa, New Zealand, Switzerland, and Zimbabwe). Just over 3900 cricket players have represented their countries in ODIs.

Traditional betting markets have been in sports such as horse and dog racing, where the most popular outcome because of the associated betting
**Prediction Performance**

- 46 of 48 predicted winners correct
- Betting pool of $75 rose to nearly $1000 by end of tournament
- Continued on a range of sports
- Pool rose to $15,000, before plummeting in a couple of weeks to $2,000
- Currently about $800, dividends of $11,000
- Simple forecasting models can be effective and profitable

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**3 wise men**

- Each invested $1
- First put $1 under the mattress (straw?) $1
- Second put $1 in the bank at 4% interest, and put the interest under the mattress. $81.40
- Third put $1 in the bank at 4% interest, but reinvested the interest in the same account.
- $18,660,000,000,000,000,000,000,000,000,000,000,000

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**Compound growth**

- Rule of 72
  - 10% doubles in 7 (and a bit) years
  - 5% doubles in 14 (and a bit) years
  - 2% doubles in 36 years
  - 6% profit on turnover, but you turn over your pot with 50 bets in a week. Then in 72/6 = 12 weeks (3 months) you double your pool.

---

**Compound growth**

- Rule of 10 doubles - $2^{10} = 1024$
  - At 10% a year a house value will increase 1000 fold in 10 periods of 7 years.
  - 6% profit on turnover, but you turn over your pot with 50 bets in a week. Then in 72/6 = 12 weeks (3 months) you double your pool.
  - In 10 periods of 3 months (2.5 years) you have 1000 times what you started with.

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- **Priomha** Company investment portfolios. has set up investment funds, currently have nearly $1m invested in their 3 Funds, audited returns show 43% return in 2010, 21% first half of 2011. Of course such a fund is unaffected by stockmarket downturns.
Field Equity
- The “value” of having the ball at a certain point on the field.
  - Expected number of points a team will score from that situation
  - Observed Equity:
  - Trace forward to find next score, {-6, -1, 0, 1, 6}

Zone Boundaries

Mark, free kick

3 PHASES

Advanced Kicking

/ Take into account “difficulty” of each kick
/ Each kick measured on whether it hit its target
/ ELO-like rating system

$$R_i = H_i - \mathbb{E}(H_i; \theta_i)$$

$$R = \frac{\sum_{i=1}^{n} R_i}{n}$$

If Hit Rate $\in \{0, 1\}$

$f = 1, 2, \ldots, \theta$

$\theta$ = Direction, Distance, Intent, Location, Pressure
### 3 PHASES

**Pressure**

<table>
<thead>
<tr>
<th></th>
<th>Set Position</th>
<th>No Pressure</th>
<th>Implied Pressure</th>
<th>Physical Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>K/H</td>
<td>5.29</td>
<td>1.48</td>
<td>0.88</td>
<td>0.39</td>
</tr>
<tr>
<td>Kick Eff</td>
<td>77.7%</td>
<td>72.4%</td>
<td>57.2%</td>
<td>26.9%</td>
</tr>
<tr>
<td>Hand Eff</td>
<td>95.0%</td>
<td>94.6%</td>
<td>55.2%</td>
<td>55.6%</td>
</tr>
<tr>
<td>Eff Disp Rate</td>
<td>80.9%</td>
<td>81.4%</td>
<td>60.8%</td>
<td>28.4%</td>
</tr>
<tr>
<td>Value</td>
<td>0.75</td>
<td>1.00</td>
<td>1.79</td>
<td>3.75</td>
</tr>
</tbody>
</table>

\[
p \bar{F} = \frac{\sum Values}{n}
\]

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### Top 10 Kick Ratings (100+ Kicks)

1. Barry Hall Western Bulldogs +16.0%
2. Matthew Scarlett Geelong Cats +11.2%
3. Matthew Jaensch Adelaide Crows +10.1%
4. Robert Murphy Western Bulldogs +9.9%
5. Adam Schneider St Kilda +9.6%
6. Brendon Goddard St Kilda +9.1%
7. Chris Newman Richmond +8.8%
8. Jared Rivers Melbourne +8.8%
9. David Rodan Port Adelaide +8.4%
10. Chris Yarran Carlton +8.4%

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### Fitting standard distributions

- In most sports and games, the winner of a particular contest, is decided both by skill and by luck.
- Fitting a standard distribution to scores allows us to measure the skill factor.
- The rest is chance (luck).

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### Consistency - Jamie Siddons

Sheffield Shield competition scores in 1985/6

33, 17, 76, 5, 74, 7, 7, 107, 1, 45, 17, 2, 36

Average = 33,

Probability of going out before scoring an extra run = constant \( p = 1/33 \).

Prob scoring extra run = \((1-p) = q =32/33\)

<table>
<thead>
<tr>
<th>Score</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prob</td>
<td>p</td>
<td>qp</td>
<td>q^2p</td>
<td>q^3p</td>
<td>q^4p</td>
</tr>
</tbody>
</table>

### Jamie Siddon’s cricket scores

J. D. Siddon

Battin Scores - 1985/6 Sheffield Shield

<table>
<thead>
<tr>
<th>Score</th>
<th>0-24</th>
<th>25-50</th>
<th>51-75</th>
<th>76-100</th>
<th>101-125</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.10</td>
<td>0.20</td>
<td>0.30</td>
<td>0.40</td>
<td>0.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Score</th>
<th>Mean of 33</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-24</td>
<td>0.00</td>
</tr>
<tr>
<td>25-50</td>
<td>0.50</td>
</tr>
<tr>
<td>51-75</td>
<td>0.20</td>
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<td>76-100</td>
<td>0.10</td>
</tr>
<tr>
<td>101-125</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Geometric Distribution: mean = 1/p

If m is a player’s average
Pr(score > average) = q^m = (1 – p)^m
= (1 – 1/m)^m
= 1/e
= 37%
Le cricketers usually score less than their average.

Jamie: average = 33,
5 out of 13 scores > 33 (38%)

Don Bradman’s cricket scores
- 18, 1, 79, 112, 40, 58, 123, 37, 8, 131,
- 254, 1, 334, 14, 232, 4, 25, 223, 152, 43,
- 0, 226, 112, 2, 167, 299, 0, 103, 8, 66, 76,
- 24, 48, 71, 29, 25, 36, 13, 30, 304, 244,
- 77, 38, 0, 0, 82, 13, 270, 26, 212, 169, 51,
- 144, 18, 102, 103, 16, 187, 234, 79, 49, 0,
- 56, 12, 63, 185, 13, 132, 127, 201, 57, 138,
- 0, 38, 89, 7, 30, 33, 173, 0

Bradman’s scores – cf geometric

Don Bradman’s – 80 innings Av 100

| 100’s | 29 | 36% | 1/e = 37% |
| 200’s | 12 | 15% | 1/e^2 = 14% |
| 300’s | 2  | 3%  | 1/e^3 = 5% |

Ponting 263 innings Average 53 (49)

| 50’s  | 95 | 36% | 1/e = 37% |
| 100’s | 39 | 15% | 1/e^2 = 14% |

Randomness
- Goals in a soccer match - Poisson
- Goals per quarter in AFL - Poisson
- Dot balls in an over of cricket – Binomial
- Goals from the free throw line in basketball – binomial
- Simulate a season of football
Conclusion

- Sport is a fun area to apply mathematics
- But it also has serious applications
- PhD in Gambling, football, cricket and tennis
- Methods used in other areas
- Check our web site www.swin.edu.au/sport for weekly footy tips
- Career opportunities
- Can be hard work

The End