Backgammon: The Lessons of War

How Difficult is Backgammon?
"My name
is Ozymandias, King of
Kings;

Look on my Works, ye
Mighty, and despair!

Nothing beside remains.
Round the decay

Of that colossal Wreck,
boundless and bare

The lone and level sands
stretch far away."
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,000 BC</td>
<td>Backgammon Invented</td>
</tr>
<tr>
<td>1644</td>
<td>&quot;Backgammon&quot; appears in print</td>
</tr>
<tr>
<td>????</td>
<td>Doublets played four times</td>
</tr>
<tr>
<td>1926</td>
<td>Doubling invented in France</td>
</tr>
<tr>
<td>1930</td>
<td>Doubling Cube introduced</td>
</tr>
<tr>
<td>1973</td>
<td>First recorded match</td>
</tr>
<tr>
<td>1976</td>
<td>&quot;Backgammon&quot; by Magriel published</td>
</tr>
<tr>
<td>1979</td>
<td>First Backgammon Computer Program</td>
</tr>
<tr>
<td>1980s</td>
<td>Notation standardised</td>
</tr>
<tr>
<td>Early 1990s</td>
<td>Neural Nets Arrive</td>
</tr>
<tr>
<td>1994 - Present</td>
<td>Modern Theory Develops</td>
</tr>
</tbody>
</table>
Good Game Learning Curve

- Learn the rules in an hour
- Become competent in six weeks
- Play well in six months
- Become an expert in two years
- Become a master in a lifetime
## Levels of Complexity

<table>
<thead>
<tr>
<th>Game</th>
<th>Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Go</td>
<td>40</td>
</tr>
<tr>
<td>Chess</td>
<td>14</td>
</tr>
<tr>
<td>Bridge</td>
<td>11</td>
</tr>
<tr>
<td>Scrabble</td>
<td>10</td>
</tr>
<tr>
<td>Backgammon</td>
<td>10</td>
</tr>
<tr>
<td>Poker</td>
<td>9</td>
</tr>
<tr>
<td>Draughts</td>
<td>8</td>
</tr>
<tr>
<td>Blackjack</td>
<td>2</td>
</tr>
<tr>
<td>Craps</td>
<td>0.001</td>
</tr>
<tr>
<td>Lottery</td>
<td>0.000001</td>
</tr>
<tr>
<td>Roulette</td>
<td>0</td>
</tr>
</tbody>
</table>
Opening Moves – 1975 and 2017

Money Game. How should Red play 53, 62 and 64?

Correct Plays: 8/3, 6/3; 24/18, 13/11 and ??
Money Game. How should Red play 62, 63 and 64?

Correct Plays: 24/18, 13/11; 24/18, 13/10 & 24/14
First Response (2)

Money Game. How should Red play 64?

Correct Play: 13/3*
Two Roll Combinations

15 Opening rolls x 21 Responses = 315

but there are multiple choices for both the openings and the responses

There are approximately 600 common two roll sequences

Four Scenarios:
- Gammon Go
- Gammon Save
- DMP
- Level/money

A mere 2,400 combinations to learn!
Learning Backgammon

Unlike chess you can’t learn by rote.
Initially, you learn patterns, numbers and tactics.
Basic Learning Strategies:

• Books
• Lessons
• Playing
• Chouettes
• Computer Analysis
• Backgammon Studio

However, learning does equate to playing strength.
The key is being able to apply learning in live play.
# Essential Reading

<table>
<thead>
<tr>
<th>Year</th>
<th>Title</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>The Backgammon Book (Hardback)</td>
<td>Jacoby &amp; Crawford</td>
</tr>
<tr>
<td>1976</td>
<td>Backgammon</td>
<td>Paul Magriel</td>
</tr>
<tr>
<td>1978</td>
<td>Vision Laughs at Counting Volumes 1 &amp; 2</td>
<td>Danny Kleinman</td>
</tr>
<tr>
<td>1982</td>
<td>The Doubling Cube in Backgammon Vol. 1</td>
<td>Jeff Ward</td>
</tr>
<tr>
<td>1993</td>
<td>How to Play Tournament Backgammon</td>
<td>Kit Woolsey</td>
</tr>
<tr>
<td>1996</td>
<td>New Ideas in Backgammon</td>
<td>Kit Woolsey &amp; Hal Heinrich</td>
</tr>
<tr>
<td>2001</td>
<td>Boards Blots and Double Shots</td>
<td>Norm Wiggins &amp; Danny Kleinman</td>
</tr>
<tr>
<td>2001</td>
<td>Classic Backgammon Revisited</td>
<td>Jeremy Bagai</td>
</tr>
<tr>
<td>2001</td>
<td>Modern Backgammon</td>
<td>Bill Robertie</td>
</tr>
<tr>
<td>2002</td>
<td>The Backgammon Encyclopedia</td>
<td>Kit Woolsey</td>
</tr>
<tr>
<td>2004</td>
<td>Backgammon Boot Camp</td>
<td>Walter Trice</td>
</tr>
<tr>
<td>2005</td>
<td>Backgammon Praxis - Volumes 1 &amp; 2</td>
<td>Marty Storer</td>
</tr>
<tr>
<td>2007</td>
<td>Backgammon to Win</td>
<td>Chris Bray</td>
</tr>
<tr>
<td>2008</td>
<td>Backgammon Problems</td>
<td>Mike Corbett</td>
</tr>
<tr>
<td>2011</td>
<td>What's Your Game Plan?</td>
<td>Mary Hickey and Marty Storer</td>
</tr>
</tbody>
</table>
Endings

- A lot of ending checker plays are relatively straightforward.
- In contrast doubling decisions are critical and often complex particularly in match play.
- The higher the cube the more psychology comes into play.

“I will often redouble what I am pretty sure is not a redouble on the chance that my opponent will pass. This is big key to winning matches about which the bots are clueless.” Nack Ballard (2004)
Endings (1)

Money Game. Cube Action?

Correct Play: Double/Take
Endings (2)

Match Play. Red leads 4-2 to 9. Cube Action?

Correct Play: Redouble/Take
Middle Game

• Game types:
  • Races
  • Blitzes
  • Prime vs prime
  • High anchor
  • 3-pt game
  • Low anchor
  • Mutual holding
  • Back games
  • Hybrids
  • Late hit

• Tools:
  • Game plan
  • Checker strategies
  • Doubling strategies
  • Match strategies
  • Time management
  • Risk vs Reward
  • Arithmetic
  • Maxims
  • Psychology
  • T-CUP
T-CUP

T-CUP = Thinking Correctly Under Pressure

“Lack of skill, discipline or fitness are common amongst all but the top sportspeople. Once you get to the top it’s pressure, the influence of the opposition or mental toughness.”

Matthew Pinsent
Match Play. Red leads 4-2 to 7. Cube Action?

Correct Play: No Double/Take
Computers over Time

"Gammonoid" - 1979

Expert Backgammon - 1992

TD-Gammon - 1994

JellyFish - 1995

Snowie - 1998

Gnu - 2002

XG - 2009

Neural Nets (Bots)
Temporal Difference Learning

- **Error signal**: difference between current estimate and improved estimate; drives change of current estimate
  - Supervised learning error:
    \[
    \text{error}(x) = \text{target\_output}(x) - \text{learner\_output}(x)
    \]
  - Bellman error (DP):
    \[
    \text{error}(s) = \max_a \sum_{s'} P_{ss'}^a [R_{ss'}^a + \gamma V(s')] - V(s)
    \]
    “1-step full-width lookahead” - “0-step lookahead”
  - Monte Carlo error:
    \[
    \text{error}(s) = \langle R_t \rangle - V(s)
    \]
    “many-step sample lookahead” - “0-step lookahead”
Computer Analysis

- Rollouts are used to determine the correct play.
- You can analyse your own matches.
- Computers give you a measure of your skill level.
- Extreme Gammon is available on PC and iDevices (Mac later next year).
- A Performance Rating of 4.0 is the Holy Grail of backgammon.
- The best players in the world can play to a PR of about 2.5.
Every player in the world has a higher cube play PR than checker play PR.
What does a PR of 4.0 look like?

<table>
<thead>
<tr>
<th>Cube</th>
<th>Move</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enigma52</td>
<td>Baroech</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Errors (Blunders)</td>
<td>6 (3)</td>
</tr>
<tr>
<td>-0.285</td>
<td>Equity</td>
<td>-0.601</td>
</tr>
<tr>
<td>5 (1)</td>
<td>Doubles (Blunders)</td>
<td>2</td>
</tr>
<tr>
<td>-0.521</td>
<td>Equity</td>
<td>-0.114</td>
</tr>
<tr>
<td>0</td>
<td>Takes (Blunders)</td>
<td>0</td>
</tr>
<tr>
<td>+0.000</td>
<td>Equity</td>
<td>+0.000</td>
</tr>
</tbody>
</table>

-0.806 Total Equity | -0.715
+2.653 (11) Luck (Joker) | -2.653 (11)
World Class | World Class
3.87 Performance Rating | 4.26

A Mistake every 10 moves.

99 Moves
9 Errors
1 Blunders
What does a PR of 3.0 look like?

<table>
<thead>
<tr>
<th>Move</th>
<th>Summary</th>
<th>Pterodactyl</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Errors (Blunders)</td>
<td>13 (7)</td>
</tr>
<tr>
<td></td>
<td>Equity</td>
<td>-1.172</td>
</tr>
<tr>
<td>0</td>
<td>Doubles (Blunders)</td>
<td>2 (1)</td>
</tr>
<tr>
<td></td>
<td>Equity</td>
<td>-0.214</td>
</tr>
<tr>
<td>0</td>
<td>Takes (Blunders)</td>
<td>2 (1)</td>
</tr>
<tr>
<td></td>
<td>Equity</td>
<td>-0.151</td>
</tr>
<tr>
<td></td>
<td>Total Equity</td>
<td>-1.537</td>
</tr>
<tr>
<td></td>
<td>Luck (Joker)</td>
<td>-1.465 (17)</td>
</tr>
</tbody>
</table>

World Class: Expert
Performance Rating: 6.35

134 Moves
10 Errors
3 Blunders
A Mistake every 10 moves.
Blunder Free – a PR under 2!

<table>
<thead>
<tr>
<th>Move</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enigma52</td>
<td>pkrbum</td>
</tr>
<tr>
<td>7</td>
<td>Errors (Blunders) 10 (2)</td>
</tr>
<tr>
<td>-0.478</td>
<td>Equity -0.884</td>
</tr>
<tr>
<td>0</td>
<td>Doubles (Blunders) 5 (3)</td>
</tr>
<tr>
<td>-0.012</td>
<td>Equity -0.547</td>
</tr>
<tr>
<td>0</td>
<td>Takes (Blunders) 0</td>
</tr>
<tr>
<td>+0.000</td>
<td>Equity +0.000</td>
</tr>
<tr>
<td>-0.490</td>
<td>Total Equity -1.431</td>
</tr>
<tr>
<td>-0.717 (12)</td>
<td>Luck (Joker) +0.717 (16)</td>
</tr>
</tbody>
</table>

133 Moves  
7 Errors  
0 Blunders  
-ve Luck

A Rare Best: one per month at best

The key to winning backgammon is the elimination of blunders
Perfection!

<table>
<thead>
<tr>
<th>Move</th>
<th>Summary</th>
<th>taulajoe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enigma52</td>
<td>Errors</td>
<td>7 (1)</td>
</tr>
<tr>
<td></td>
<td>Equity</td>
<td>-0.431</td>
</tr>
<tr>
<td>-0.001</td>
<td>Doubles</td>
<td>1 (1)</td>
</tr>
<tr>
<td></td>
<td>Equity</td>
<td>-0.084</td>
</tr>
<tr>
<td>-0.007</td>
<td>Takes</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Equity</td>
<td>+0.000</td>
</tr>
<tr>
<td>-0.008</td>
<td>Total Equity</td>
<td>-0.515</td>
</tr>
<tr>
<td>-2.134 (7)</td>
<td>Luck (Joker)</td>
<td>+2.134 (8)</td>
</tr>
</tbody>
</table>

An Even Rarer Beast: One per year at best

75 Moves
0 Errors
0 Blunders
-ve Luck
Luck & Skill

• In a match between two players with PRs of 4 luck will dominate the outcome 75% of the time in match lengths up to around 11pts.

• In a match between two players with PRs of 8 skill will dominate the outcome in the majority of matches.

• When your PR gets below 2 your skill can overcome the equity lost through luck. This is why Michy/Mochy win a lot of tournaments.

• This understanding has driven the emergence of different tournament formats such as group qualification and double elimination which favour stronger players.
Bot Learning

• Playing strength in the last twenty years has improved exponentially. An “expert” of the 1970s (with a few exceptions) would be heavily defeated by strong modern players.

• As well overall playing strength the bots have given us much better understanding of the game and taught us new techniques.
New Concept

Money Game. How should Red Play 51?
New Concept

Money Game. How should Red Play 51?

Correct Play: $8/7^* / 2!!$
The Ability to See

Money Game. How should Red 44?
Money Game. How should Red 44?

Correct Play: 13/5, 6/2(2)
Tactical Opportunity

Money Game. How should Red 54?
Tactical Opportunity

Money Game. How should Red 54?

Correct Play: 20/16, 20/15
Out of the Box

Money Game. How should Red 54?
Correct Play: 9/5*, 6/1* or 8/3, 7/3
Very, Very Difficult!!

Money Game. How should Red 21?
Very, Very Difficult!!

Money Game. How should Red 21?

Correct Play: 24/22*, 2/1!!!
Summary

- Cube handling in general is still too weak and misunderstood
- Only a handful of players can play with a PR below 3
- We are still learning new techniques
- Clocks are influencing our approach
- Computers will improve and further broaden our own play
- You will never master backgammon, even with Malcolm Gladwell’s 10,000 hours

How Difficult is Backgammon? **Very!**

(Samuel Beckett)
Any Questions?