Curling: Why The _ Do You _?

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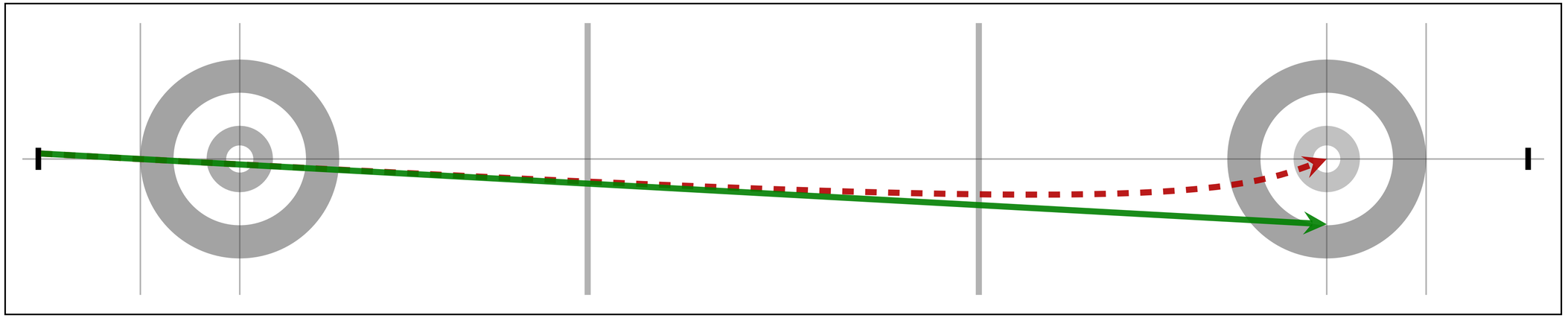
Rational Behaviour

- Rational agents play to maximize expected utility in games
- Humans are not always rational in reality
- Difficult to analyze rationality in all games

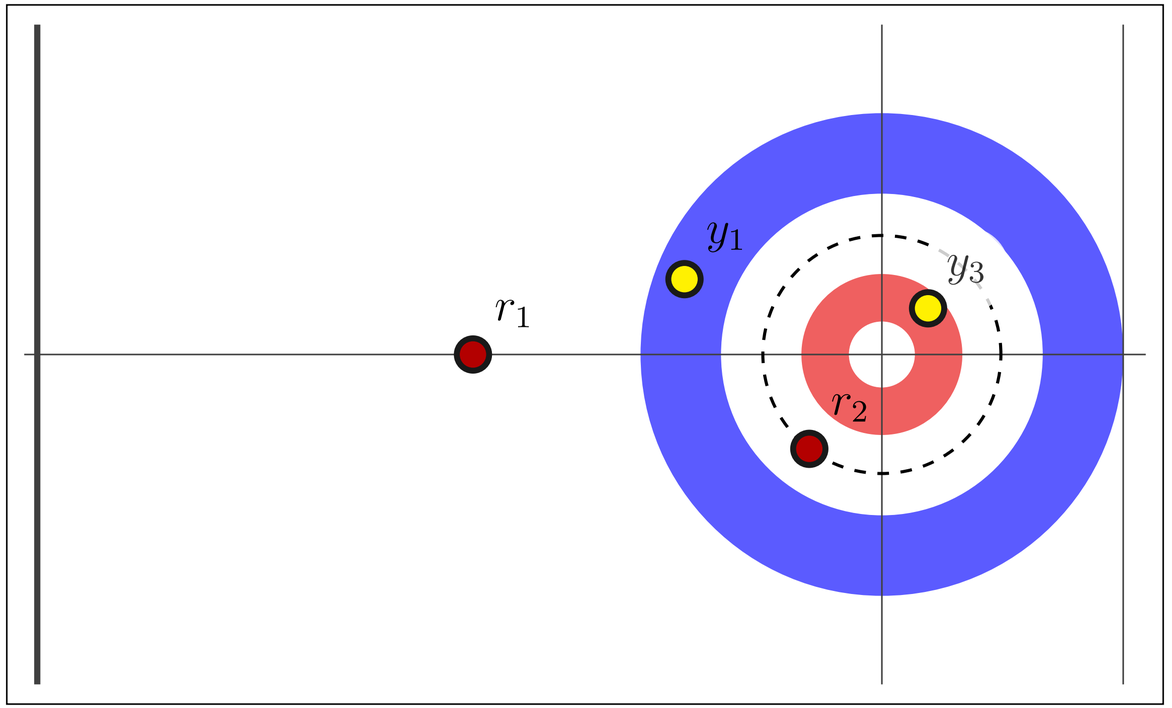
Curling

- Sport played on ice
- Two teams, 10 rounds (ends), 16 shots per round

Curling - Shooting



Curling - Scoring



Hammer Shots

- Last shot of an end
- Largely determines the outcome of an end
- Other shots mainly set up the hammer shot
- Teams have a 55.7% chance of winning beginning game with hammer

Strategies in Curling

- Intuitively, we'd think about scoring as much as we can per end
- The best sequences of shots to establish a good hammer shot (if we possess it)
- But retain the hammer in ends that count more

Willoughby and Kostuk, 2004

Points vs Hammer

- Last end
- Is it better to be:
  - +1, without hammer
  - -1, with hammer

Model

$$P(X = k \mid e, h)$$

- k, points scored
- e, end number
- h, possession of hammer
- 410 games, 221 up to 10 ends

Frequency Tables of Scores

END	-4	-3	-2	-1	0	1	2	3	4	5	
10	1	5	4	39	12	113	34	8	4	1	**221**
11			2	9	4	55	4	1	1		**76**
12						3	1				

Results and Comparison

- E(UP, Not Hammer) = 0.713
- E(DOWN, Hammer) = 0.287
- Contrasts with players from survey of 113
  - UP, Not Hammer = 41.6
  - DOWN, Hammer = 58.4

Willoughby and Kostuk, 2005

Blank the 9th End?

- Keep the house clean in 9th end
- TAKE 1 or BLANK end?

Frequency Tables of Scores

After 9th	-4	-3	-2	-1	0	1	2	3	4	5	
0			3	15	8	70	12	2			**110**
1	1	5	4	39	12	113	34	8	4	1	**221**
2		1	1	20	1	16	34	1			**74**
3			1	1	1	1		1			**5**
	1	**6**	**9**	**75**	**22**	**200**	**80**	**12**	**4**	**1**	**410**

Results of Shots

Beginning of 9th	E(TAKE)	E(BLANK)
3	1.0000	1.0000
2	0.9678	0.9843
1	0.9125	0.9263
0	0.7050	0.8247
-1	0.1753	0.2950
-2	0.0737	0.0875
-3	0.0157	0.0322

Blank the 9th End

- Regardless of situation
- BLANK in 9th end, retain hammer
- Only consider draw for one

Something's Not Right

- Aggregated -1 and 1 differentials together
  - Playing when down by 1 is different than when up by 1
- Only looks at differentials of 1

Clement, 2012

Blanking Other Ends

- The author expanded on BLANK or TAKE on other ends
- Multinomial logistic regression + transition matrices

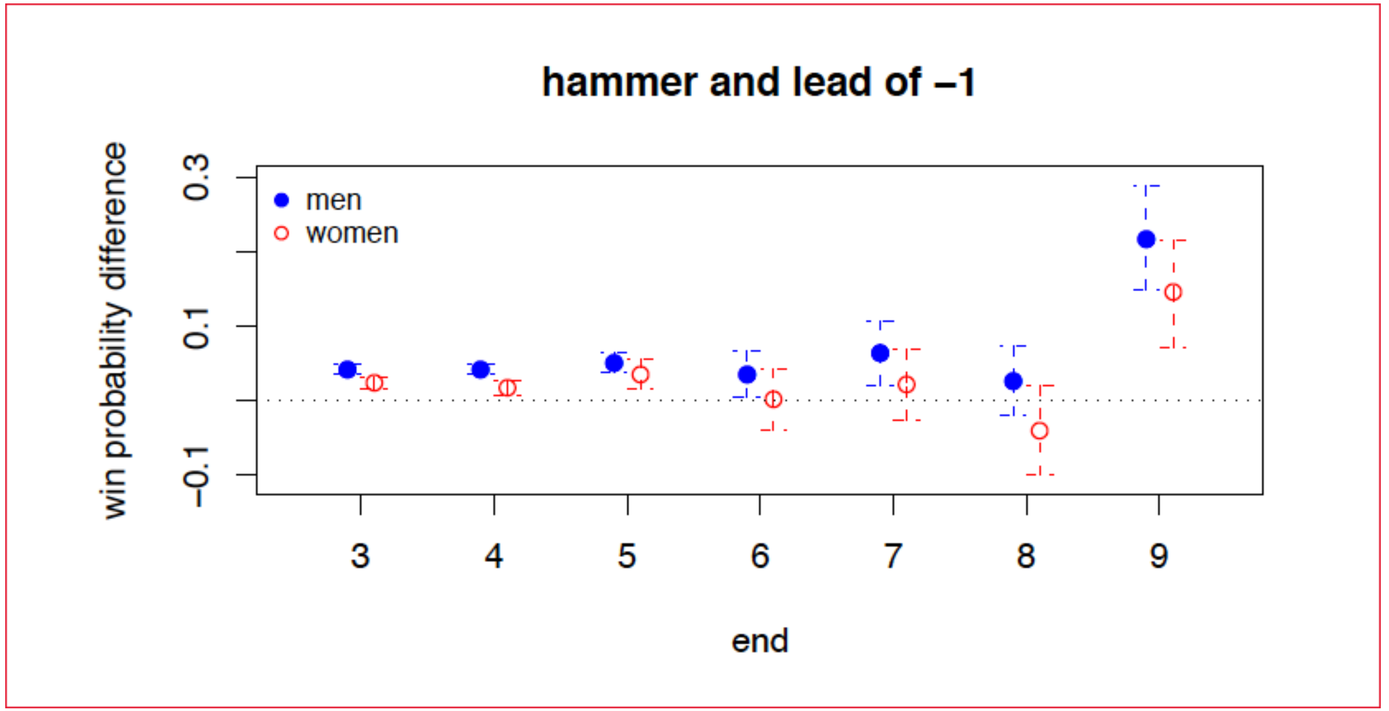
Regression Model

- Trained on game data
- Features: skill difference, point difference, end number
- Label: the distribution of scores of the end

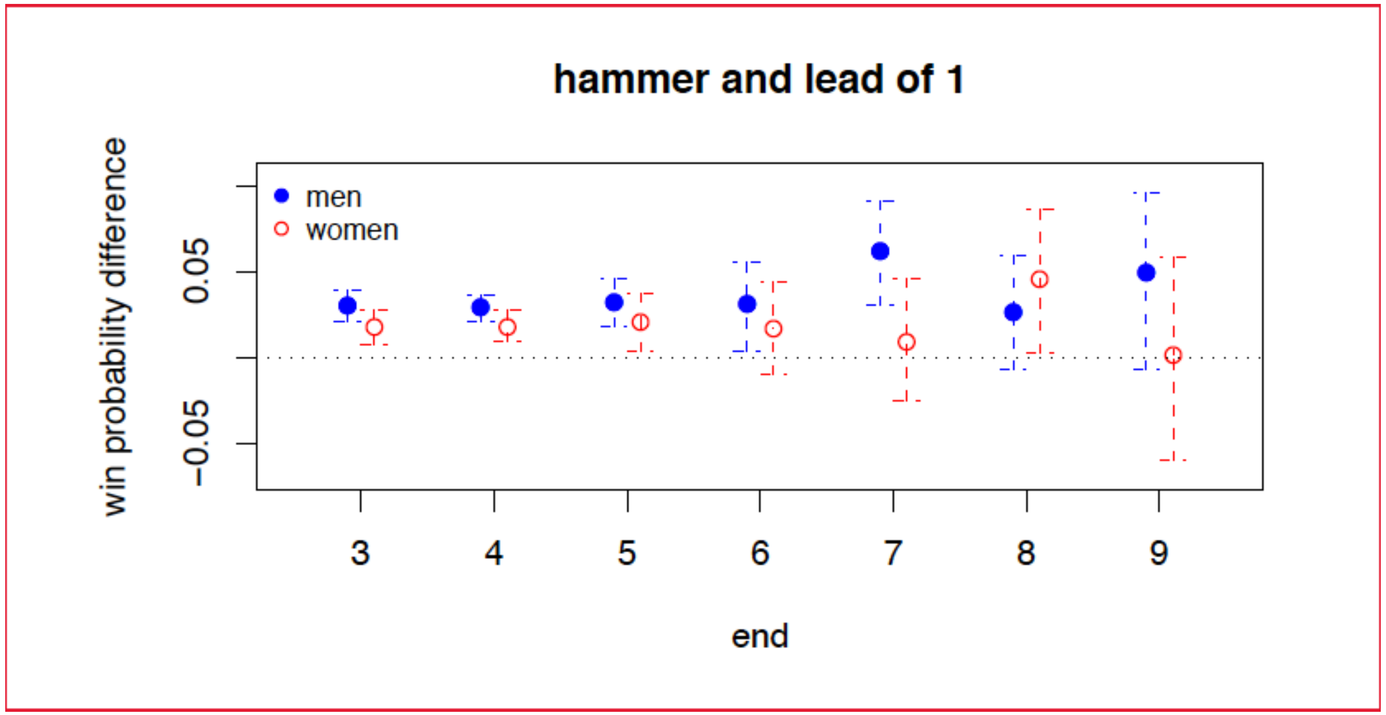
Inference

- Sample from the regression model to get distributions at ends
- Create the transition matrix using distributions
- Calculate the win probabilities using the transitions matrix given the scores at each end
- Difference between blanking and taking one (with leads -1 and 1)

Win Probability Differences



Win Probability Differences



Win Probabilities

end	lead = -1				lead = 1			
	men		women		men		women	
	blank	take 1	blank	take 1	blank	take 1	blank	take 1
3	0.44	0.40	0.44	0.42	0.75	0.72	0.71	0.69
4	0.44	0.40	0.43	0.42	0.76	0.73	0.72	0.70
5	0.44	0.39	0.44	0.40	0.78	0.75	0.73	0.71
6	0.42	0.39	0.41	0.40	0.80	0.77	0.75	0.73
7	0.43	0.36	0.42	0.40	0.84	0.77	0.75	0.74
8	0.38	0.36	0.38	0.41	0.86	0.83	0.82	0.77
9	0.44	0.22	0.49	0.35	0.91	0.86	0.83	0.83

- All work only consider differences of 1 point
- Focus on late ends (or aggregates early ends)
- Is it better to blank earlier ends or take points
- Expand to taking more than 1 point

Win Probability Table

Lead	Ends Remaining									
	10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
-4:	10.1	9.6	8.8	8.0	6.6	6.0	4.3	2.9	1.2	0.1
-3:	17.4	15.6	15.9	15.0	14.6	12.7	10.8	8.4	5.3	2.0
-2:	28.7	27.3	27.5	26.9	25.5	25.2	22.2	22.0	15.2	12.1
-1:	42.7	41.9	42.1	41.1	40.3	41.6	38.4	41.9	31.8	42.7
+0:	55.7	55.1	55.7	56.6	57.3	59.6	58.1	62.2	57.6	71.9
+1:	71.3	70.9	72.1	72.4	74.0	75.1	75.9	79.0	83.0	88.4
+2:	81.8	83.2	82.8	84.8	85.5	86.9	88.3	91.3	94.3	98.0
+3:	89.9	90.2	91.1	91.9	93.0	93.8	95.3	97.3	98.6	99.7
+4:	94.9	95.2	95.8	96.3	97.3	97.6	98.7	99.2	99.7	100.0

Approaches

- More complex models to learn better representations of data
- Simulated experiments
  - Curling simulator
  - AI search for strategies and outcomes