Price Prediction in Sports Betting Markets

Juan M. Alberola, Ana Garcia-Fornes and Agustín Espinosa

MATES2010, Leipzig

Grup de Tecnologia Informàtica i Intel·ligència Artificial
Universitat Politècnica de València

jalberola@dsic.upv.es

September 2010

Prediction Market

Prediction markets are speculative markets created for the purpose of *making predictions*.

- Assets are created, whose final cash value is tied to:

- Particular event (will the next US president be a Republican??)
- Parameter (total sales next quarter)

The current market **prices** can then be interpreted as predictions of the probability of the event or the expected value of the parameter.

Prediction Market

Prediction markets are speculative markets created for the purpose of *making predictions*.

- Assets are created, whose final cash value is tied to:

- Particular event (will the next US president be a Republican??)
- Parameter (total sales next quarter)

The current market **prices** can then be interpreted as predictions of the probability of the event or the expected value of the parameter.

$\downarrow$

Betting exchanges

Sports Betting Markets

- Assets regarding the outcomes of an event
- Price related with the probability of each outcome
- Participants exchange assets according their expectations

Each market

- n possible outcomes (n-way bet)
- price=1/probability

Sports Betting Markets

Trade

- Participants with different expectations
- On an outcome or against it (*back*/*lay*)
- Bookmaker receive offers
- Compatible ones (price/size) $\longrightarrow$ trade

Sports Betting Markets

Alice wants to bet μ units on a back bet (an individual, a team, a horse, etc.)

Sports Betting Markets

Alice wants to bet μ units on a back bet (an individual, a team, a horse, etc.)

- Choose her own price ρ
- Accept a lay offer

Sports Betting Markets

Alice wants to bet μ units on a back bet (an individual, a team, a horse, etc.)

- Choose her own price ρ
- Accept a lay offer

Bob wants to place a lay bet

Sports Betting Markets

Alice wants to bet μ units on a back bet (an individual, a team, a horse, etc.)

- Choose her own price ρ
- Accept a lay offer

Bob wants to place a lay bet

$$\text{profit(Alice)} = \begin{cases} \mu^*(\rho\text{-}1) & \text{if Alice wins the bet} \\ -\mu & \text{if Alice loses the bet} \end{cases}$$

$$\text{profit(Bob)} = \begin{cases} -\mu^*(\rho\text{-}1) & \text{if Alice wins the bet} \\ \mu & \text{if Alice loses the bet} \end{cases}$$

Sports Betting Markets

The price depends on the probability of the final outcome
Fair coin flip game:

- Probabilities of tails and heads $\longrightarrow$ 0.5
- Fair price $\longrightarrow$ 2 ($price = 1/probability$))
- Value $\longrightarrow$ price higher

Sports Betting Markets

The price depends on the probability of the final outcome
Fair coin flip game:

- Probabilities of tails and heads $\longrightarrow$ 0.5
- Fair price $\longrightarrow$ 2 ($price = 1/probability$))
- Value $\longrightarrow$ price higher $\longrightarrow$ bet

Sports Betting Markets

The price depends on the probability of the final outcome
Fair coin flip game:

- Probabilities of tails and heads $\longrightarrow$ 0.5
- Fair price $\longrightarrow$ 2 ($price = 1/probability$))
- Value $\longrightarrow$ price higher $\longrightarrow$ bet

Bayer-Mainz (Bayer wins)

Trading in Sports Betting Markets

- Similar to an economic trader
- Make benefits whatever the final outcome is

Trading in Sports Betting Markets

- Similar to an economic trader
- Make benefits whatever the final outcome is

- Sports events $\longrightarrow$ Short duration
- Quick price evolution $\longrightarrow$ During the event

Trading in Sports Betting Markets

- Similar to an economic trader
- Make benefits whatever the final outcome is

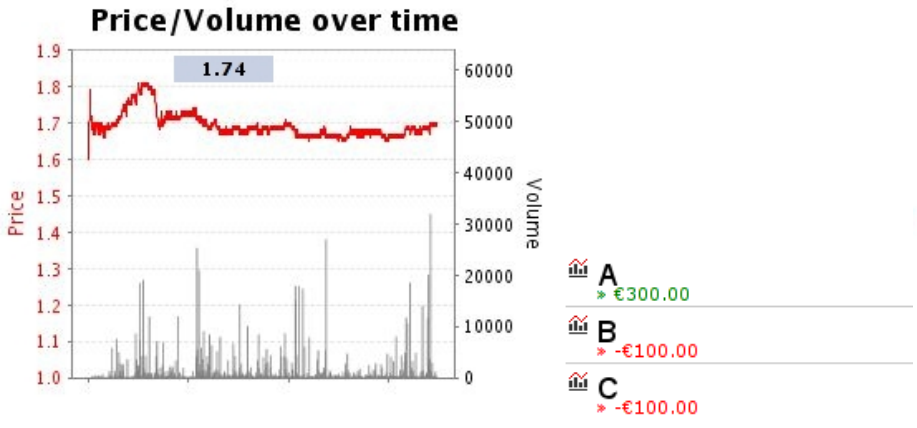
- Sports events $\longrightarrow$ Short duration
- Quick price evolution $\longrightarrow$ During the event

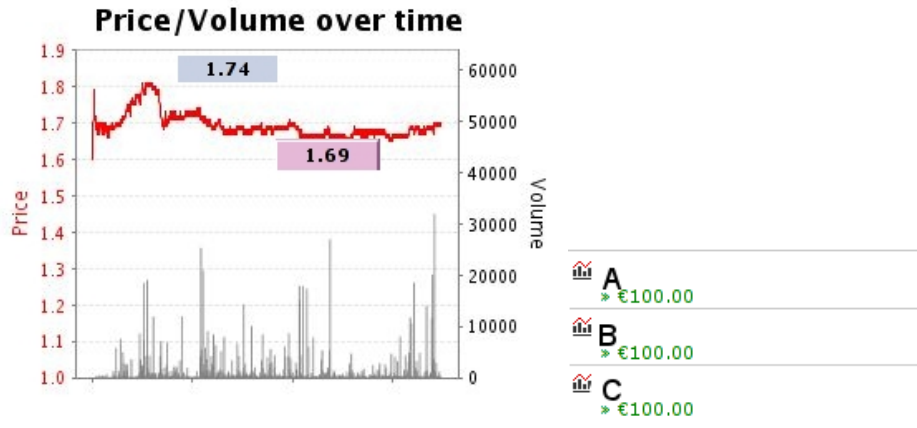
Objective

$\downarrow$

To bet on and against an outcome at different prices:

Prediction of price evolution





Trading in Sports Betting Markets

Markets where the current price is going to change

- Up or down??
- How much??
- When??
- How fast??

Trading in Sports Betting Markets

Markets where the current price is going to change

- Up or down??
- How much??
- When??
- How fast??

Future price movements

CBR agent

- Similarities between events with similars conditions
- Tennis match: favourite is winning
- Soccer match: final score

CBR agent

- Similarities between events with similars conditions
- Tennis match: favourite is winning
- Soccer match: final score

Objectives:

- Repeated patterns and similar price movements
- Observe price evolution
- Predict future price

Market Model

- Betfair
  - 6 million transactions in a average day
  - Mediator
- Bookmaker agent
  - Accept price requests
  - Show best prices (queue)
  - Place bets
- CBR agent

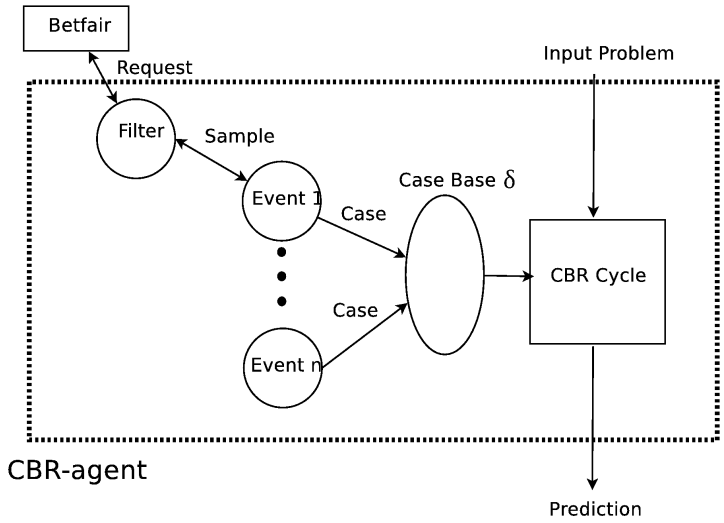
CBR agent

Data acquisition and creation of the case base:

- Interaction with the bookmaker
- Select information of events
- Store samples

CBR cycle:

- Unknown problem
- Retrieve using historical data
- Similarities between events
- Adapt solution
- Predict future price of the new event
- Store the sample



Price Prediction in Soccer Matches

- Barclays Premier League (2008-2009)
- Prediction in under/over 2.5 goals markets

Data aquisition

Several markets related with the 2.5 goals
State of a soccer match as $\langle m, s, h, v, d, u, o \rangle$

- $0 \leq m \leq 45$
- $s \in \{0\text{-}0, 1\text{-}0, 0\text{-}1, 1\text{-}1\}$
- h, v, and d are from the match odds markets.
- u and o are the from the under/over 2.5 goals market.
- Each h, v, d, u and o has two real values $\langle b, l \rangle$

A sequence of samples $x_1, x_2, x_3, \ldots x_n$ is created

Creating the case base

Prediction after δ minutes:

- $x_i = \langle m_i, s_i, h_i, v_i, d_i, u_i, o_i \rangle$ and $x_j = \langle m_j, s_j, h_j, v_j, d_j, u_j, o_j \rangle$
- $m_j - m_i = \delta$
- $c^{\delta} = \langle m_i, s_i, h_i, v_i, d_i, u_i, o_i, u_j, o_j \rangle$

Creating the case base

Prediction after δ minutes:

- $x_i = \langle m_i, s_i, h_i, v_i, d_i, u_i, o_i \rangle$ and $x_j = \langle m_j, s_j, h_j, v_j, d_j, u_j, o_j \rangle$
- $m_j - m_i = \delta$
- $c^\delta = \langle m_i, s_i, h_i, v_i, d_i, u_i, o_i, u_j, o_j \rangle$
- A case base $C^\delta = \{c^\delta \mid c^\delta \text{ is defined}\}$ is created

The CBR cycle

Similarity function:

- Given C^{δ} and a unknown problem

  $x = \langle m, s, h, v, d, \langle b_u, l_u \rangle, \langle b_o, l_o \rangle \rangle$
- Step 1
  - $c_r = \langle m_r, s_r, h_r, v_r, d_r, \langle b'_u, l'_u \rangle, \langle b'_o, l'_o \rangle, u^{\delta}, o^{\delta} \rangle$
  - $s = s_r \wedge \mid b_u\text{-}b'_u \mid \leq \omega \wedge \mid l_u\text{-}l'_u \mid \leq \omega \wedge \mid b_o\text{-}b'_o \mid \leq \omega \wedge \mid l_o\text{-}l'_o \mid \leq \omega$
- Step 2
  - $\mid m\text{-}m_r \mid < \pi$
- Step 3
  - $c_r = \langle m_r, s_r, h_r, v_r, d_r, \langle b_u, l_u \rangle, \langle b_o, l_o \rangle, \langle b'_u, l'_u \rangle, \langle b'_o, l'_o \rangle \rangle$
  - $e(b, u) = (b_u - b'_u);\ \ e(l, u) = (l_u - l'_u);$
  - $e(b, o) = (b_o - b'_o);\ \ e(l, o) = (l_o - l'_o)$
  - $A(b, u) = \frac{1}{R} \sum_{r=1}^{R} e(b, u)_r;\ \ \ A(l, u) = \frac{1}{R} \sum_{r=1}^{R} e(l, u)_r$
  - $A(b, o) = \frac{1}{R} \sum_{r=1}^{R} e(b, o)_r;\ \ \ A(l, o) = \frac{1}{R} \sum_{r=1}^{R} e(l, o)_r$

The CBR cycle

Input problem $x = \langle m, s, h, v, d, \langle b_u, l_u \rangle \langle b_o, l_o \rangle \rangle$
$A(b, u), A(l, u), A(b, o), A(l, o)$
$predicted(p, k) = p_k + A(p, k)$ for each $p = \{b, l\}$ and $k = \{u, o\}$.

- Step 4: Retain (threshold)
- Step 1: no case is retrieved
  - Increase the threshold up to a twice
  - Use h, v and d
- Step 2: no case is retrieved
  - Increase π

Results

Error Rate	50 cases				150 cases				250 cases			
	Under		Over		Under		Over		Under		Over	
	B	L	B	L	B	L	B	L	B	L	B	L
Prediction for the next minute												
±0,02	73	63	71	64	81	75	72	71	83	78	69	73
±0,03	85	78	81	77	89	85	85	80	91	88	83	82
±0,05	93	93	95	90	96	95	95	91	97	97	95	94
±0,1	100	99	99	99	99	99	99	99	100	100	99	99
Prediction for the next 5 minutes												
±0,02	44	46	42	44	62	60	50	46	68	68	46	49
±0,03	52	66	56	56	72	70	54	62	74	77	65	71
±0,05	74	80	72	76	82	86	78	80	94	87	94	84
±0,1	96	94	88	96	100	96	88	92	100	100	100	97
Prediction for the next 10 minutes												
±0,02	32	41	22	32	54	38	32	35	63	62	44	44
±0,03	43	49	32	41	68	49	43	51	69	67	62	64
±0,05	59	65	41	49	84	73	65	73	91	88	84	80
±0,1	84	86	70	84	100	89	79	95	100	98	96	97
Prediction for the next 15 minutes												
±0,02	43	47	17	23	57	57	43	37	64	66	45	42
±0,03	53	50	37	30	73	67	50	43	74	70	61	64
±0,05	67	67	40	47	91	80	60	57	94	89	87	86
±0,1	97	90	63	77	100	93	73	80	100	98	95	97

Results

Success rates for price direction prediction in the next minute:

Event	Price Direction Accuracy [±0,03]	%
Match 1	34	0.77
Match 2	30	0.68
Match 3	39	0.89
Match 4	30	0.68

Conclusions

- Sports Betting Markets can be approached as trading scenarios
- Predict future prices becomes important
- How, how much, when and how fast the price is going to move
- CBR agent

Conclusions

- Sports Betting Markets can be approached as trading scenarios
- Predict future prices becomes important
- How, how much, when and how fast the price is going to move
- CBR agent
- Future price prediction $\longrightarrow$ TRADING!!
- CDA MAS-based scenario for comparing heterogeneous agents performance
- Compare the accuracy with humans

Price Prediction in Sports Betting Markets

Juan M. Alberola, Ana Garcia-Fornes and Agustín Espinosa

MATES2010, Leipzig

Grup de Tecnologia Informàtica i Intel·ligència Artificial
Universitat Politècnica de València

jalberola@dsic.upv.es

September 2010