Problem Chosen	2024 MCM/ICM Summary Sheet	Team Control Number
ABCDEF		2400609

Shortest Path Algorithms: Taxonomy and Advance in Research

my summary

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2.1 Notations

Symbols	Description
$player$	the current player we are considering (e.g. while calculating momentum)
$point_i$	the i^{th} point of the match, a vector consists of fields stated in the given dictionary
cur	the current index of the point, i.e. the match is currently at the cur^{th} point
H_i	denotes the set $\{point_{cur}, point_{cur-1}, \ldots, point_{cur-i+1}\}$
S_i	the set of latest i points where $player$ serves
R_i	the set of latest i points where $player$ returns
P_{ace}	current probability of hitting an ace by $player$
P_{df}	current probability of double-faulting by $player$
P_{1st}	current first serve goal rate by $player$
P_{fw}	current probability of $player$ winning a served point within 3 rallies
rd	current return depth of $player$
P_{win}	current probability of hitting a winner by $player$
P_{net}	current net win rate of $player$
$dist$	$player$'s running distance on the point
P_{unf}	current probability of hitting an unforced error by $player$
$scored$	whether $player$ scored the current point
$diff$	the score diffrence for $player$ in the current game (by number of points)
M	the current momentum of $player$ after a point

To access a certain field in a point, we simply use the field name stated in the given dictionary as index, i.e. for a point $point$, we use $point_{ace}$ to denote the binary variable that shows whether $player$ hits an ace ball in the point.

2.2 Assumptions

To simplify the problem, we made the following assumptions:

- **Assumption 1:** The `px_unf_err` column of the data only counts those unforced errors that occurred when the player was hitting in baseline.
  Justification: Usually when a player is at net, the point will end in a few strikes, and there's little probability that the player will hit an unforced error within that few strikes. What's more, the `px_net_point` and `px_net_point_won` columns of the data can predominantly reflect the player's ability at net, therefore reducing the impact of counting the unforced errors while at net.

- **Assumption 2:** The current performance on a certain aspect of a player can be reflected by the player's 3 latest shots of that aspect.
  E.g. P_{ace} can be reflected by the proportion of aces in the 3 latest **serves** of the player, P_{win} can be reflected by the proportion of winners in the 3 latest **shots** of the player, rd can be reflected by the return depth of the 3 latest **returns** of the player, etc.
  Justification: The current performance of a player consists of the average performance and the status of the player at the moment, which can be comprehensively reflected in the player's performance on recent shots. For convenience, we specified that the 3 latest shots can reflect the player's current performance.

3 ... Model

Definition 3.1. *Niche width is the range of resources that a species can use.*

Niche width is an indicator [1]

3.1 Model Overview

3.2 Data Processing and Normalization

In order to quantify the factors used in our model, based on our assumptions, we calculate them using the following formulae:

$$P_{ace} = \frac{\sum_{p \in S_3} p_{ace}}{3} \tag{1}$$

$$P_{df} = -\frac{\sum_{p \in S_3} p_{double\_fault}}{3} \tag{2}$$

$$P_{1st} = \frac{\sum_{p \in S_3} [p_{serve\_no} = 1]}{3} \tag{3}$$

$$P_{fw} = \frac{\sum_{p \in S_3} [p_{rally\_count} \leq 3][p_{point\_victor} = player]}{3} \tag{4}$$

$$rd = \frac{\sum_{p\in R_3} \begin{cases} 0, & p_{return\_depth} = ND \\ 1, & p_{return\_depth} = D \\ -1, & p_{return\_depth} = NA \end{cases}}{3} \tag{5}$$

$$P_{win} = \frac{\sum_{p\in H_3} p_{winner}}{3} \tag{6}$$

$$P_{net} = \frac{\sum_{p\in H_3} p_{net\_pt\_won}}{\sum_{p\in H_3} p_{net\_pt}} \tag{7}$$

$$dist = \begin{cases} 0, & point_{cur,distance\_run} < 5 \\ -1, & point_{cur,distance\_run} > 45 \\ \frac{5 - point_{cur,distance\_run}}{40}, & otherwise \end{cases} \tag{8}$$

$$P_{unf} = -\frac{\sum_{p\in H_3} p_{unf\_err}}{3} \tag{9}$$

$$scored = [point_{cur,point\_victor} = player] \tag{10}$$

$$diff = \frac{\sum_{p\in point}[p_{set\_no} = point_{cur,set\_no}][p_{game\_no} = point_{cur,game\_no}](2[p_{point\_victor} = player] - 1)}{\min\{3, \sum_{p\in point}[p_{set\_no} = point_{cur,set\_no}][p_{game\_no} = point_{cur,game\_no}]\}} \tag{11}$$

In order to normalize the data processed, we convert the original data to limit them in $[-1, 1]$. For those factors that negatively influence the momentum, such as P_{df}, we made sure it's in $[-1, 0]$. For those factors that positively influence the momentum, such as P_{win}, we made sure it's in $[0, 1]$. For those factors that influence the momentum in both ways, such as $diff$, we made sure it's in $[-1, 1]$.

Algorithm 1 An algorithm with caption

Require: $n \geq 0$
Ensure: $y = x^n$

```
y ← 1
X ← x
N ← n
while N ≠ 0 do
    if N is even then
        X ← X × X
        N ← N/2                          ▷ This is a comment
    else if N is odd then
        y ← y × X
        N ← N − 1
    end if
end while
```

4 Robustness Analysis

5 Strength and Weaknesses

5.1 Strengths

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5.2 Weaknesses

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References

[1] Alice Axford, Bob Birkin, Charlie Copper, and Danny Dannford. Demostration of bibliography items. *Journal of TEXperts*, 36(7):114–120, Mar 2013.

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A.1.1 1

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1 test

1 test

B report on Use of AI

no use