CS6046: Multi-Armed Bandits
Final Project

The goal of the project is to use multi-armed bandit algorithms to come up with effective batting and bowling strategies in the game of cricket. We now describe the rules and game dynamics that will be considered for the project.

1. Each cricket team will consists of 5 players. Each player can bat as well as bowl. There are 6 batting actions namely $\mathcal{A}_{\text{bat}} = \{0, 1, 2, 3, 4, 6\}$ and 3 bowling actions namely $\mathcal{A}_{\text{bowl}} = \{\text{economical, normal, aggressive}\}$.

2. Each innings will have $t = 1, \ldots, 60$ balls (i.e., 10 overs)[1]. In the batting team, only one[2] player bats at a time and after a player gets out the next players comes into bat. On behalf of the bowling team, each player bowls exactly 2 overs and a given player is also allowed bowl 2 overs continuously.

3. In a given team, each player $i = 1, 2, 3, 4, 5$ has an associated 4 dimensional feature :

$$(\text{avg}^i_{bat}, \text{strike-rate}^i, \text{avg}^i_{ball}, \text{economy}^i) \in [1, 5]^4,$$

   where, $\text{avg}^i_{bat}, \text{strike-rate}^i$ are related to batting skills and $\text{avg}^i_{ball}, \text{economy}^i$ are related to bowling skills. Each of these 4 features take values in $[1, 5]$, where 1 denotes best skill and 5 denotes worst skill. To elaborate,

   (a) $\text{avg}^i_{bat} \in [1, 5]$ is the feature related to the probability that the players gets out while batting.

   (b) $\text{strike-rate}^i_{bat} \in [1, 5]$ is the feature related to the probability that the player scores runs while batting.

   (c) $\text{avg}^i_{ball} \in [1, 5]$ is the feature related to the probability that a player takes a wicket while bowling.

   (d) $\text{avg}^i_{ball} \in [1, 5]$ is the feature related to the probability that a player gives way runs while bowling.

4. At each ball $t = 1, \ldots, 60$ the batting team needs to give a batting action and the bowling team needs to provide a bowling action.

5. Let i be the current player from batting team and let j be the current player from the bowling team. Let $\text{act}_{\text{bat}} \in \mathcal{A}_{\text{bat}}$ and $\text{act}_{\text{bowl}} \in \mathcal{A}_{\text{bowl}}$ be the batting and bowling actions for a particular ball. The game dynamics is simply captured by :

$$\text{wicket}_t \sim p_{\text{out}}(\text{act}_{\text{bat}}, \text{act}_{\text{bowl}}, \text{avg}^i_{\text{bat}}, \text{avg}^j_{\text{bowl}}) \tag{1}$$

$$y_t \sim p_{\text{runs}}(\text{act}_{\text{bowl}}, \text{strike-rate}^i, \text{economy}^j) \tag{2}$$

$$\text{runs}_t = \text{act}_{\text{bat}} \times y_t \tag{3}$$

6. p_{out} is a monotonic function in each of its variables.

   (a) For a fixed $(\text{act}_{\text{bowl}}, \text{avg}_{\text{bat}}, \text{avg}_{\text{bowl}})$, consider p_{out} to be a function of act_{bat}. Then, $p_{\text{out}}(\text{act}_{\text{bat}} = 0) \leq p_{\text{out}}(\text{act}_{\text{bat}} = 1) \leq \ldots p_{\text{out}}(\text{act}_{\text{bat}} = 6)$.

   (b) For a fixed $(\text{act}_{\text{bat}}, \text{avg}_{\text{bat}}, \text{avg}_{\text{bowl}})$, consider p_{out} to be a function of act_{bowl}. Then, $p_{\text{out}}(\text{act}_{\text{bowl}} = \text{economical}) \leq p_{\text{out}}(\text{act}_{\text{bowl}} = \text{normal}) \leq p_{\text{bowl}}(\text{act}_{\text{bowl}} = \text{aggressive})$.

[1] 'No-Balls', wides, byes are not considered

[2] Unlike the actual game where two players namely a striker and a non-striker are batting.

(c) For a fixed $(\text{act}_{\text{bat}}, \text{act}_{\text{bowl}}, \text{avg}_{\text{bowl}})$, consider p_{out} to be a function of avg_{bat}. Then, $p_{\text{out}}(\text{avg}_{\text{bat}} = x) \leq p_{\text{out}}(\text{avg}_{\text{bat}} = y)$ for all $x \leq y, x, y \in [1, 5]$.

(d) For a fixed $(\text{act}_{\text{bowl}}, \text{act}_{\text{bat}}, \text{avg}_{\text{bat}})$, consider p_{out} to be a function of avg_{bowl}. Then, $p_{\text{out}}(\text{avg}_{\text{bowl}} = x) \geq p_{\text{out}}(\text{avg}_{\text{bowl}} = y)$ for all $x \leq y, x, y \in [1, 5]$.

7. p_{runs} is a monotonic function in each of its variables.

(a) For a fixed $(\text{strike-rate}, \text{economy})$, consider p_{runs} to be a function of act_{bowl}. Then, $p_{\text{runs}}(\text{act}_{\text{bowl}} = \text{economical}) \leq p_{\text{runs}}(\text{act}_{\text{bowl}} = \text{normal}) \leq p_{\text{runs}}(\text{act}_{\text{bat}} = \text{aggressive})$.

(b) For a fixed $(\text{act}_{\text{bowl}}, \text{economy})$, consider p_{runs} to be a function of strike-rate. Then, $p_{\text{runs}}(\text{strike-rate} = x) \geq p_{\text{runs}}(\text{strike-rate} = y)$ for all $x \leq y, x, y \in [1, 5]$.

(c) For a fixed $(\text{act}_{\text{bowl}}, \text{strike-rate})$, consider p_{runs} to be a function of economy. Then, $p_{\text{runs}}(\text{economy} = x) \leq p_{\text{runs}}(\text{economy} = y)$ for all $x \leq y, x, y \in [1, 5]$.