Statistical Learning of Basketball Strategy: The Potential Field Approach
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Observe the technologies that enable us to track, nearly-continuously, players and ball movement in the NBA.
We propose a statistical framework harnessing this data based on stochastic differential equations to model the movement of both the players and the ball.

Methods Overview
We model the movement of the players and/or the basketball via a stochastic differential equation (SDE).
The expected movement direction and velocity for any location on the basketball court is described by a 3-dimensional surface called the potential field (PF).
The potential field approach was originally developed to analyze the movement of animals by learning tendencies in their velocity.

Potential Field Method
The movement of the players and/or the basketball is modelled via the SDE:
\[ dr(t) = -\nabla H(r(t), t; \beta) dt + \sigma(r(t), t; \theta) dB(t). \]
The function \( H : \mathbb{R}^2 \rightarrow \mathbb{R} \) is the potential field.
The negative gradient of the potential field, \( -\nabla H(r(t), t; \beta) \), is interpreted as the expected velocity of the object at the location \( r(t) \in \mathbb{R}^2 \).
The diffusion coefficient, \( \sigma(r(t), t; \theta) \), captures the uncertainty in the movement of the object.

Analysis Results for Ball Movement
Our illustrations use data from the 2015 NBA Western conference semi-finals: Houston Rockets (HOU) vs Los Angeles Clippers (LAC). We use HOU’s offensive plays for Games 4 (G4) and 5 (G5) as an example.

Experimental Work: PF with Covariates
We have experimented with including other players’ locations as covariates in the potential field. These coefficients reflect the likeliness of one player passing the ball to another.

Conclusions
The potential field approach is promising in summarizing and analyzing basketball strategies from large tracking datasets.
SDEs are flexible and can be parameterized to analyze other sports.