# Physics model could optimize basketball player positioning

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A student takes a shot at Bartels Hall. Credit: Sreang Hok/Cornell University

A physics theory that's proven useful to predict the crowd behavior of molecules and fruit flies also seems to work in a very different context—a basketball court.

A model based on density functional theory can suggest the best positioning for each player on the basketball court in a given scenario if

they want to raise their probability of either scoring or defending successfully.

Boris Barron, a doctoral student in physics working with Tomás Arias, professor in the Department of Physics, in the College of Arts and Sciences, presented his work on March 9 at the American Physical Society conference in Las Vegas.

Barron got the idea for his project from Nathan Sitaraman, who consults with an NBA team to help them improve their play through data analysis. Sitaraman was able to secure highly detailed data of player positions from this season's NBA games, which Barron then used to develop his model.

Using the results, Barron is able to:

- predict where a particular player may go next;
- determine which players tend to be in good or bad positions;
- calculate the probability of success, either offensively or defensively, based on player positioning; and
- create simulations of how the opposing team will or should respond if a player performs a particular move, such as running across the court.

"We can see precisely where a player should be to help their team, and those few feet can result in as much as a 3% difference (in success)," he said.

"In these high-scoring games, three points out of 100 is a big deal for one player," said Arias, a Stephen H. Weiss Presidential Fellow.

The mathematical models that Barron employs are based on Nobel Prize-winning methods originally developed to study large collections of

quantum mechanically interacting electrons. The work builds on Arias' research, which combines mathematical concepts and approaches from density-functional fluctuation theory to study everything from crowd behavior to social phenomena such as migration and segregation.

These methods work when you're analyzing a game like basketball, Arias said, because the behavior of groups of people is difficult to quantify.

"Our physics techniques come into play because you're not looking at players individually, but how they are collaborating on the court," he said. "That's why you need this higher-level analysis."

The implications for team sports like basketball are obvious, Barron said.

Coaches could input team- or player-specific data for their opponents into this model to develop a strategy to thwart the most common plays. Coaches could run computations before a game, then display them on a smart device they could use on the bench, helping them illustrate the precise routes players should take, based on data. They could obtain data specific to each of their players to find out which players are adding the most to the team's success.

Think of the 2011 movie "Moneyball," Arias said, Brad Pitt plays Billy Beane, manager of Major League Baseball's Oakland A's, who puts together a team based on data analysis, using players' on-base percentages rather than more traditional measures of success.

"Our approach is quite general," Barron said, "so I can see that it could benefit sports more broadly. Detailed positional data is becoming increasingly available."

**More information:** Density-Functional Fluctuation Theory (DFFT)

Approach to Modeling Basketball: march.aps.org/sessions/S14/7

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