# Causal Inference UConn Sports Analytics Symposium

Kevin Cummiskey

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For this handout and some R code, please go here:

github

user: kfcaby

repo: UCSAS_causal_inference_workshop

## Introduction to Causal Inference

1. What is the goal of causal inference?

2. How is causation different from correlation (i.e. an association)?

**Table 1—Examples of Tasks Conducted by Data Scientists Working with Electronic Health Records**

| | Data Science Task | | |
|---|---|---|---|
| | **Description** | **Prediction** | **Causal inference** |
| Example of scientific question | How can women aged 60–80 years with stroke history be partitioned in classes defined by their characteristics? | What is the probability of having a stroke next year for women with certain characteristics? | Will starting a statin reduce, on average, the risk of stroke in women with certain characteristics? |
| Data | • Eligibility criteria<br>• Features (symptoms, clinical parameters …) | • Eligibility criteria<br>• Output (diagnosis of stroke over the next year)<br>• Inputs (age, blood pressure, history of stroke, diabetes at baseline) | • Eligibility criteria<br>• Outcome (diagnosis of stroke over the next year)<br>• Treatment (initiation of statins at baseline)<br>• Confounders<br>• Effect modifiers (optional) |
| Examples of analytics | Cluster analysis<br>… | Regression<br>Decision trees<br>Random forests<br>Support vector machines<br>Neural networks<br>… | Regression<br>Matching<br>Inverse probability weighting<br>G-formula<br>G-estimation<br>Instrumental variable estimation<br>… |

Figure 1: Hernan, Hse, and Healy 2019

# Fundamentals of Causal Inference

Traditional conditional probability notation cannot distinguish between causation and association. We need to introduce different notation to express causation.

## Counterfactuals and the Potential Outcomes Framework

## Confounding

## Causal Diagrams

1. Confounding

2. Collider

## Assumptions of Causal Inference

- SUTVA (Stable Unit Treatment Value Assumption)

- Ignorability

- Positivity

# Methods for Causal Inference

## Matching

## Propensity Score Matching

## Stratification on the Propensity Score

## Inverse Probability of Treatment Weighting

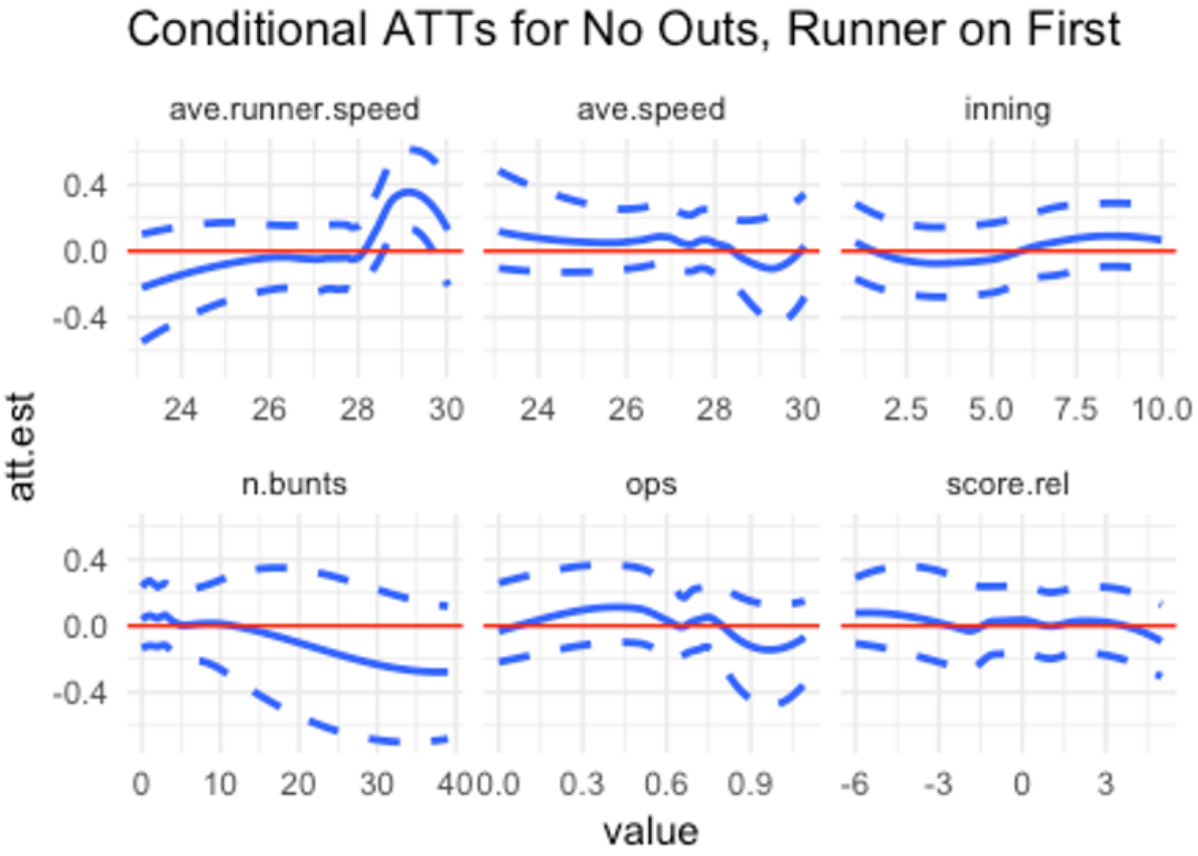
## Applications

**Estimating how the bunting effect varies**

Authors: Katherine Evans and Michael Lopez

Title: Treatment Effect Heterogeneity in MLB Bunting Strategies

Where: JSM 2019



**Player effects using location data**

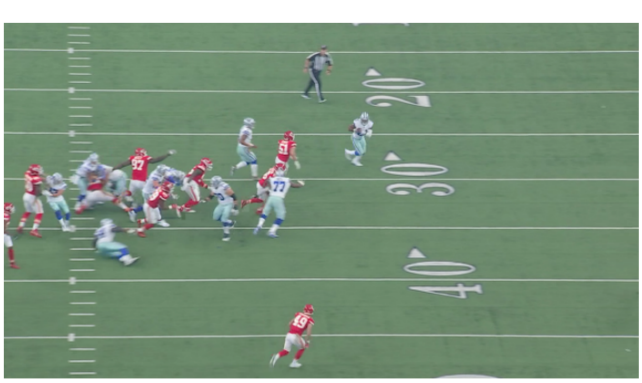
Author: Michael Lopez

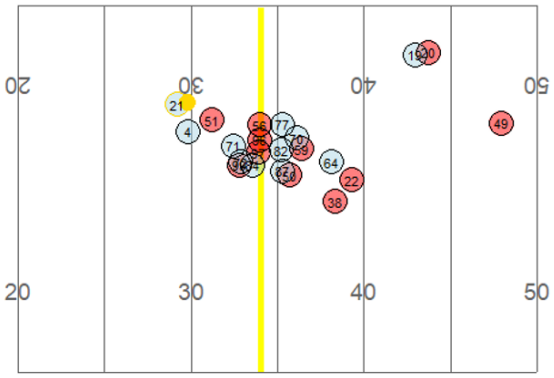
Title: Building Blocks for Estimating Causal Effects of Athlete Behavior in Football and Hockey Using Player Tracking Data

Where: JSM 2019

Using player location data, we can better estimate player effects by comparing players in similar situations.

See also http://www.lukebornn.com/papers/fernandez_ssac_2018.pdf by Fernandez and Bornn for soccer.



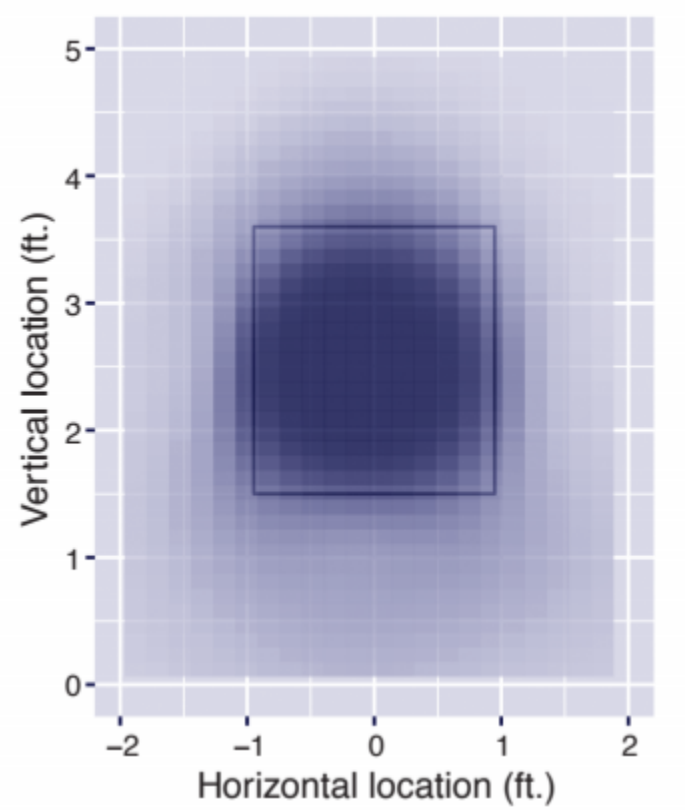


**Catcher framing**

Authors: Marchi, Albert, Baumer

Title: Analyzing Baseball Data with R

Where: Chapter 7



**Player rewards**

Authors: Romain Gauriot and Lionel Page

Title: Fooled by performance randomness: over-rewarding luck

Where: Review of Economics and Statistics, 2019

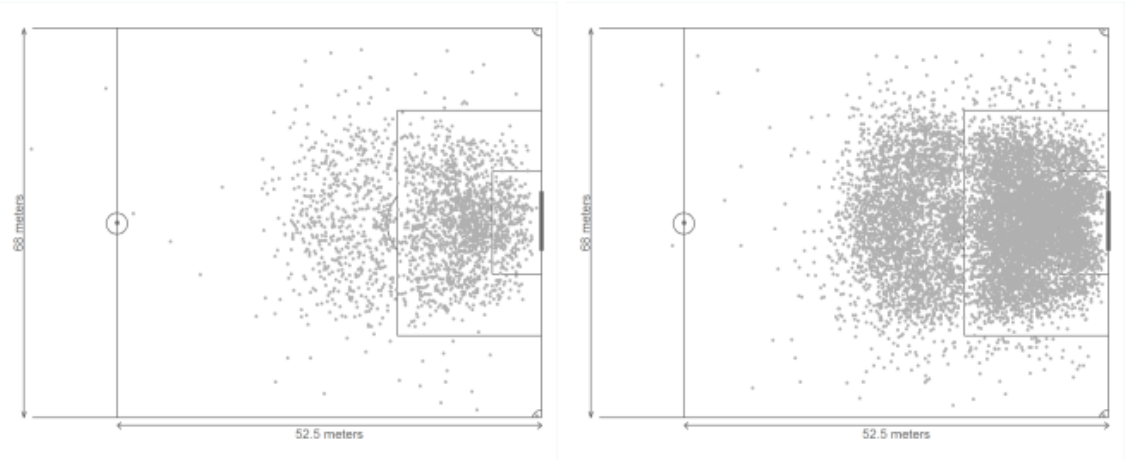



Figure 1: Graphical representation of the starting point of shots ending on the posts. On the left panel the post *in* ($N = 2,387$) and on the right the post *out* ($N = 10,679$) .

# References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- Cummiskey, K., Villanti, L., and Crofford, I. (2024). Bunting and the ghost runner: a causal inference approach. https://arxiv.org/abs/2404.06587
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