Creating interactive modules for teaching with sports data

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Sports Content for Outreach, Research, and Education

Why Sports?

Data availability

Lots of **public data**, freely available to anyone

Wide **variety** of data, problems, and methods

Popularity

Sports are widely **popular**. In 2019, 154.4 million U.S. viewers watched live sports at least once per month

Many students start as **subject-matter experts**.

Real-life **validation**

Transferability

Problems are **analogous** to those in non-sports applications.

Experience in sports **translates** to other fields

Sports are a **controlled** environment. Potentially easier to start with

Examples of Sports Analytics Problems

Teams

- Player personnel decisions, evaluate player performance (trades, FA signings)
  - How much is a player contributing to his/her team in terms of goals/points/runs?
  - How much is a player worth on the open market in terms of salary cap dollars?
  - How much is a player worth to us?
- Coaching decisions
  - Should we bunt? go for it on 4th down?
  - When should we pull our goalie?
  - Given locations of the players and ball/puck, what do we expect to happen? What is the best decision?
- Draft decisions
  - Who should we draft with our next pick?
  - Who will be available to draft?
  - How much is our draft pick worth?

Media - Talk about those decisions, team ratings and playoff probabilities
Betting - Many of the above problems, or variants of them
League - What realignment would minimize travel? What schedule would max. fairness and min. travel?
Business - Predicting demand for a game based on day, month, opponent, etc

Learning Objectives

Most of those can be answered reasonably with undergraduate level statistics and data science tools.

Students get experience with

- Solving real problems
- Joining data from multiple sources, working with several different types of data
- Data exploration/visualization
- Multivariable thinking, need for regression or something else
- Modeling
- Interpretation
- Etc

Most of the data is publicly available, or can be done with public available alternatives

Exception: player tracking data

Sports Analytics in Education

Dozens/hundreds of educators around the world have developed

- hundreds of examples,
- using multiple sports, and
- focusing on a variety of statistics and data science topics

Missing:

- Standardization
- Completeness
- Consolidation/centralization
  - Content creation is decentralized = good
  - Content is decentralized = less convenient
- Industry/media perspective

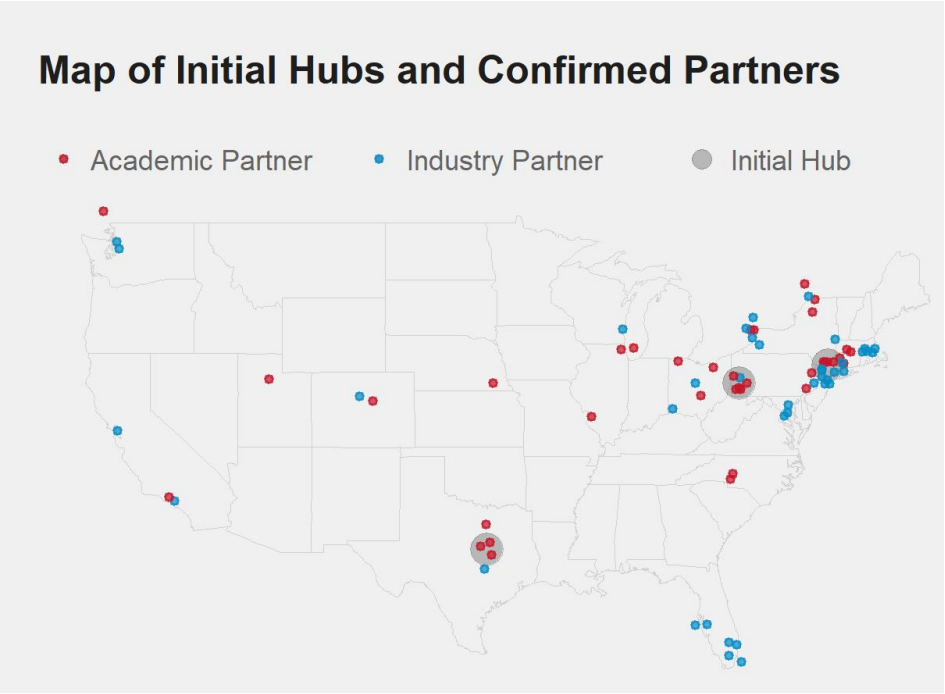
Enter SCORE!

SCORE with Data: building a **sustainable national network** for **developing and disseminating Sports Content** for Outreach, Research, Education in data science

Unique NSF-funded project combining academia, professional sports, and media to build a repository of educational materials for statistics & data science via sports applications/analytics

Strong emphasis on outreach, inclusiveness, and building pipelines

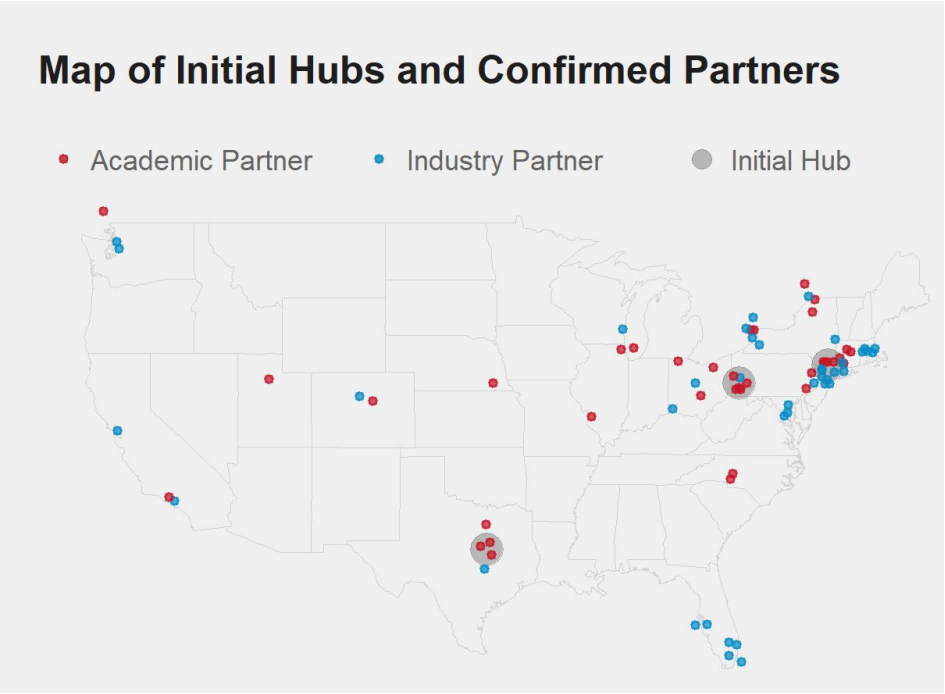
Sustainable National Network



Why a network?

- Decentralized/crowdsourced content creation
  - Ideally sustainable
- Diverse experience and skills
  - Academia, industry and media
  - Key part of review process
- Pre-existing informal network already

Sustainable National Network



Initial Network

- Over 80 initial confirmed partners in academia, industry and media
- 3 initial hubs
  - PIT - Carnegie Mellon, Pitt
  - NY - St Lawrence, West Point, Yale
  - TX - Baylor
- High level advisory board from academia and industry

SCORE with Data

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Disseminating Content

ScoreNetwork.org

SCORE Module and Data Repository

Modules can be found at:

https://modules.scorenetwork.org/

Data can be found at:

https://data.scorenetwork.org/

Module

Educational materials for statistics and data science

Plug and Play into your classroom with flexibility

Open Access (download and edit)

Peer Vetted with DOIs

- Pedagogical, Industry, Student (optional)

Following best educational practices

Sports motivated with background materials

Diversity of sports esp. Non-traditional sports

Examples: Published

Outliers using League of Legends data

Correlations with Female Ironman Lake Placid Finisher data

Lacrosse faceoff proportions hypothesis testing

NHL shooting percentages with linear regression

Module Components

Learning Goals

Introduction/Motivational Video

Methods (Statistical/Data Science)

Exercises/Activities

Conclusion

Dataset(s)

Data Glossary

ReadMe file

Module Repository

19 Published Modules

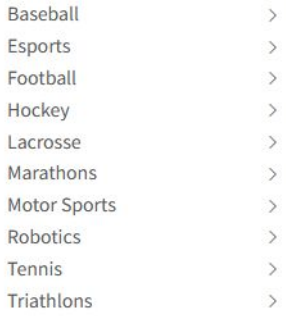
70 more in pre-print

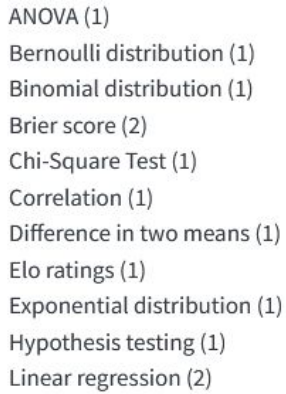
13 different sports among published

Numerous more in pre-print

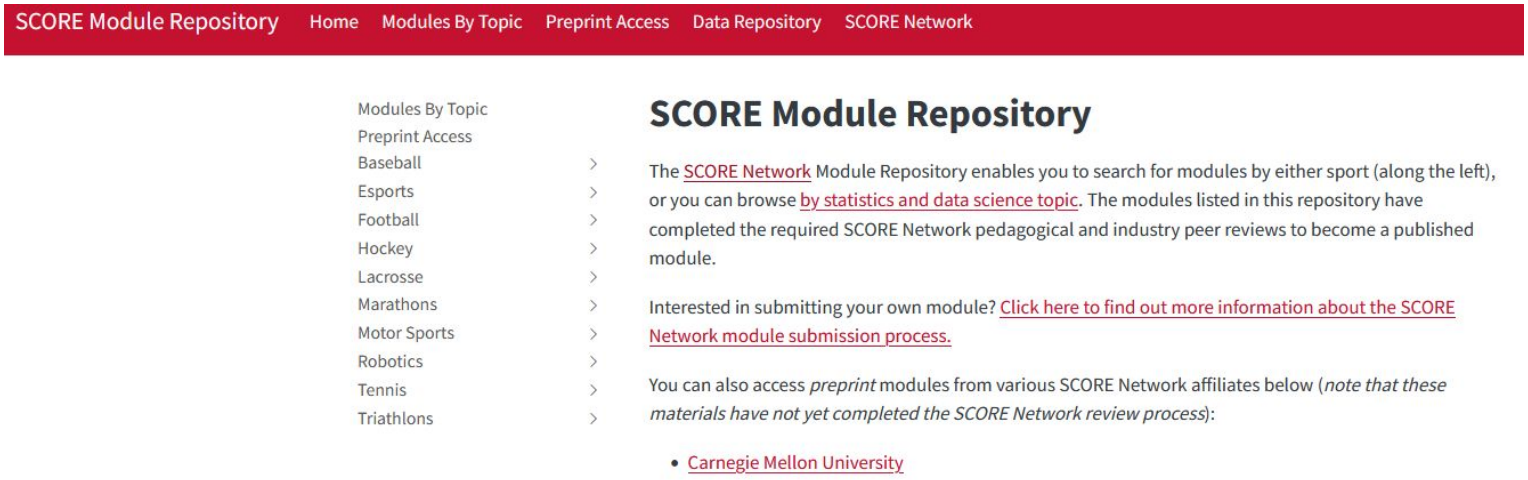
Searchable by topic

What other modules would you use?





Module landing page



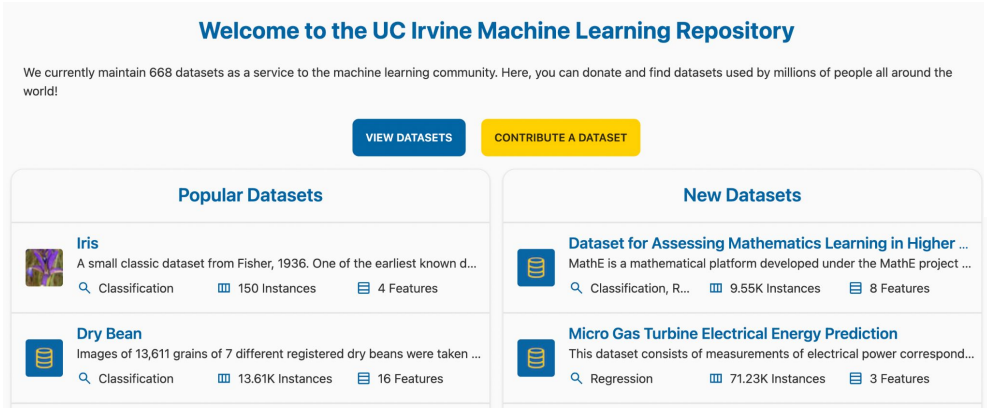
DOI (Digital Object Identifier)

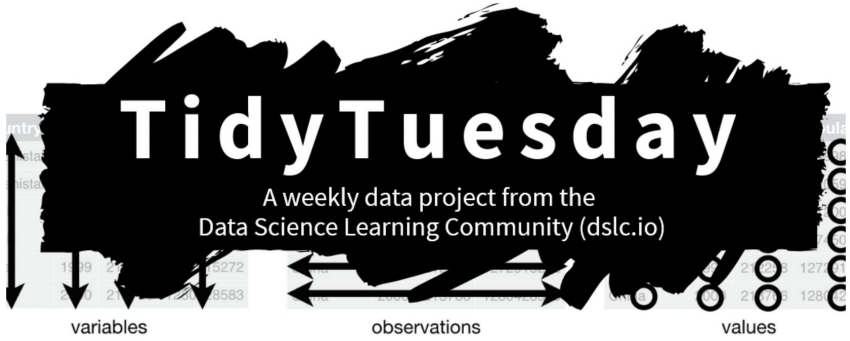
Permanent and persistent link to modules/data

Makes it easier to discover or search for modules/educational materials

Adds credibility and traceability to professional products

Datasets for class?





kaggle

CMU S&DS Data Repository

The Data Repository curates interesting datasets for use in statistics and data science education. Each dataset is supported by a *story* describing its origin and application, and a set of interesting *questions* that can be answered using the data. This means:

- Every dataset has context in a scientific field, pop culture, or daily life.
- Beyond context, datasets are interesting. They feature more than just a dozen observations from an antiquated scientific study — many feature thousands of observations of dozens of variables, and answer questions interesting to a wide audience.
- Just like in science, some datasets give null results.
- Instructors can easily build lessons and assignments from the suggested questions.

Datasets are organized by broad subject areas on the left, or you can browse a sortable list of all datasets.

Data Is Plural

... is a weekly newsletter (and seasonal podcast) of useful/curious datasets, published by Jeremy Singer-Vine. There have been 381 editions, dating from October 21, 2015 to July 31, 2024. To receive future editions, sign up here:

Check out: https://cmustatistics.github.io/data-repository/

What about sports datasets?

SCORE NETWORK

SPORTS REFERENCE

SportsDataverse

An open-source sports analytics and data organization.

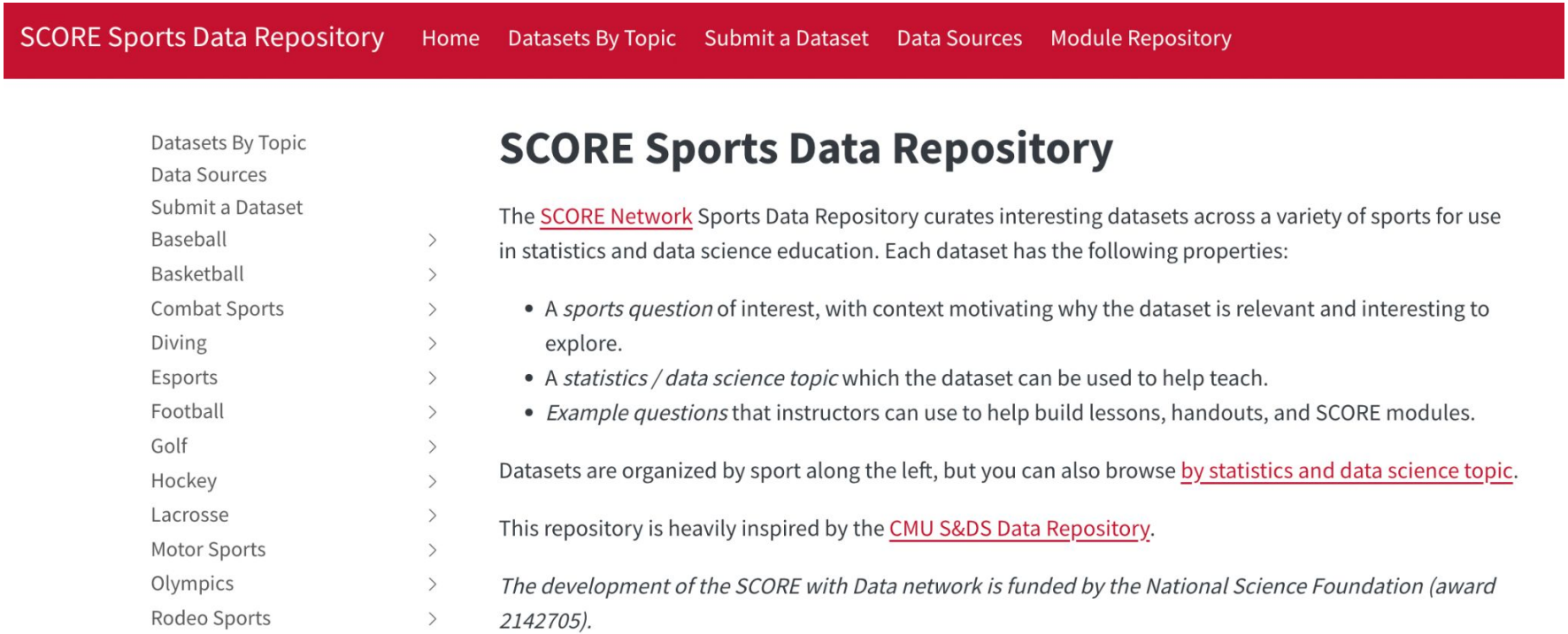
We provide utilities in Python, R, Node.js, etc.

CRAN Task View: Sports Analytics

Maintainer:	Benjamin S. Baumer, Quang Nguyen, Gregory J. Matthews
Contact:	ben.baumer at gmail.com
Version:	2023-04-06
URL:	https://CRAN.R-project.org/view=SportsAnalytics
Source:	https://github.com/cran-task-views/SportsAnalytics/

SCORE Data Repository

https://data.scorenetwork.org/

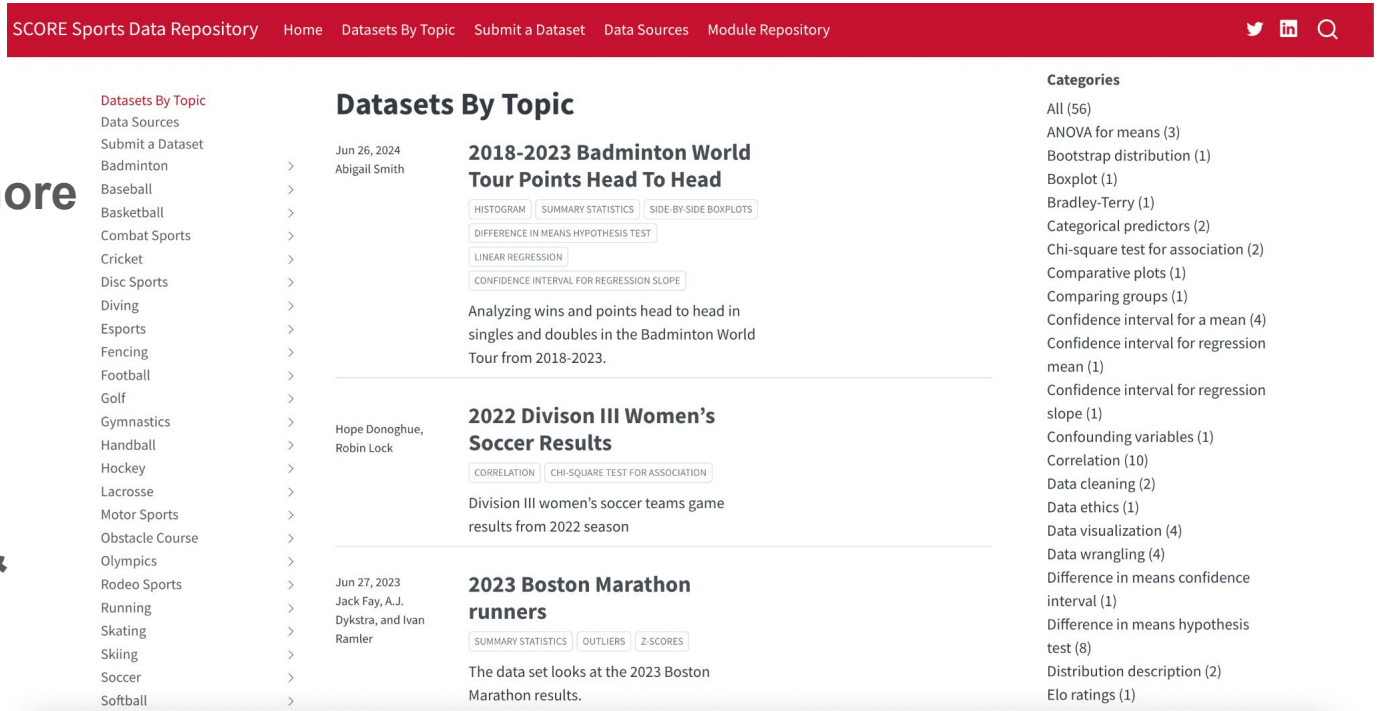


SCORE Data Repository

https://data.scorenetwork.org/

Features over 70 datasets across more than 30 different sports

Can search for datasets by sport and by statistics & data science topic



What does every dataset include?

- **Descriptive title**, e.g., Women's National Basketball Association Shots
- **Brief description the data background**, potentially include a brief summary of the sports problem and statistical situation
- List of **relevant statistics and data science topics/categories** for tags
- Information about **the source of the data motivating its usage**
- **Description of dataset**: what does one row represent? README file serving as the data dictionary for the columns
- **Example questions** associated with the data

Example dataset page information

Basketball > Women's National Basketball Association Shots

Women's National Basketball Association Shots

CLASSIFICATION | LOGISTIC REGRESSION | GENERALIZED ADDITIVE MODELS | MULTINOMIAL LOGISTIC REGRESSION | NAIVE BAYES CLASSIFIER | DENSITY ESTIMATION

Information about shots during the 2021-2022 WNBA season

AUTHOR
Ron Yurko

PUBLISHED
March 25, 2023

Motivation

The Women's National Basketball Association (WNBA) is the top professional women's basketball league in the world. The league records every shot players take along with contextual information about the shot such as its location, a description of the shot type, as well as the outcome. With this dataset, you can predict the success of each shot attempt to compute the expected value of shot types and compare team decision making.

Questions

1. Build a classification model to predict the shot outcome based on the spatial x,y coordinates of the shot.
2. Create a visualization displaying the joint frequency of shot locations. Do there appear to be any clear modes of frequently taken shots? Create a conditional version of this display by shot outcome. Does the distribution shape vary by shot outcome? (You can also perform a similar analysis by team and shot type).

Data

This dataset contains information about 41,497 shots during the 2021-2022 WNBA season.

The data was collected using the `wehoop` package in `R`.

Variable	Description
game_id	Unique integer ID for each WNBA game
game_play_number	Integer indicating the recorded play number for the shot attempt, where 1 indicates the first play of the game
desc	String detailed description of shot attempt
shot_type	String description of the shot type (e.g., dunk, layup, jump shot, etc.)
made_shot	Boolean denoting if the shot was made (TRUE) or not (FALSE)
shot_value	Numeric value of the shot outcome (0 for shots that were not made, and a positive value for made shots)
coordinate_x	Horizontal location in feet of shot attempt where the hoop would be located at 25 feet
coordinate_y	Vertical location in feet of shot attempt with respect to the target hoop (the hoop should be a little in front of 0 but the coordinate system is not exact)
shooting_team	String name of the team taking the shot

Dataset requirements

- **The data must be publicly shareable**
- **If you used code (such as an `R` package) to access the data then include your code with your submission.** The code will be publicly available on the repository's GitHub page for others to view.
- **There should be an interesting sports question coupled with a statistics and data science topic to motivate the use of the dataset in educational material.**
- **The dataset should be in a standard format such as a CSV file and be of reasonable size.** GitHub has a file size limit of 100 MB, and large files can be inconvenient for students. We recommend compressing files larger than a few megabytes. Note that gzip compression is a good choice since common tools such as `R` and `Python` feature ways to read `.csv.gz` files directly.
    - e.g., WNBA shot data was compressed and is available to download as .csv.gz