The Home Run Explosion - Part II

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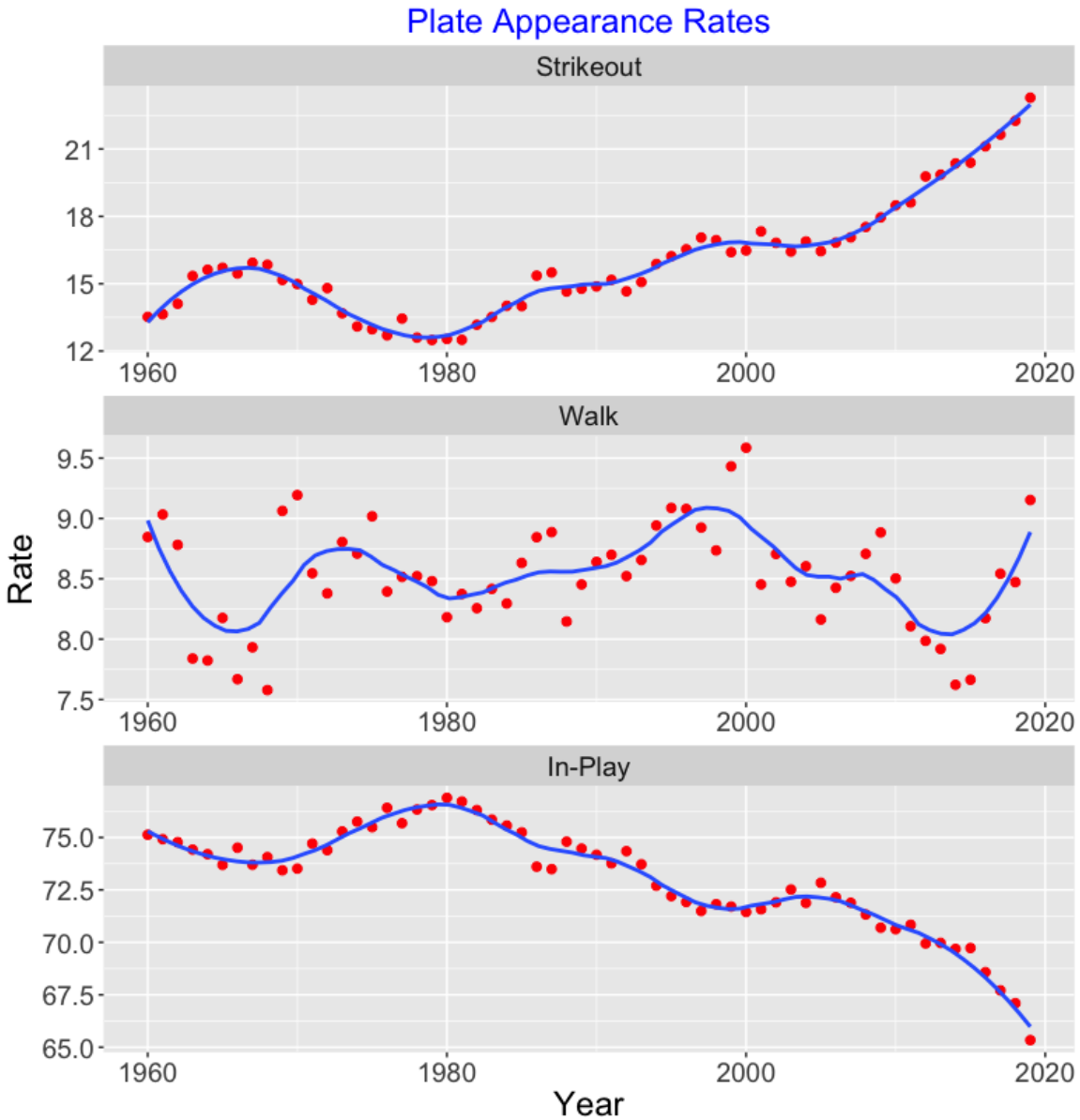
Baseball is Changing

- Three basic outcomes of a plate appearance
  - Strikeout
  - Walk
  - Ball in-play
- How have the rates of these outcomes changed in recent baseball history?

Historical Change in SO, BB, In-Play Rates



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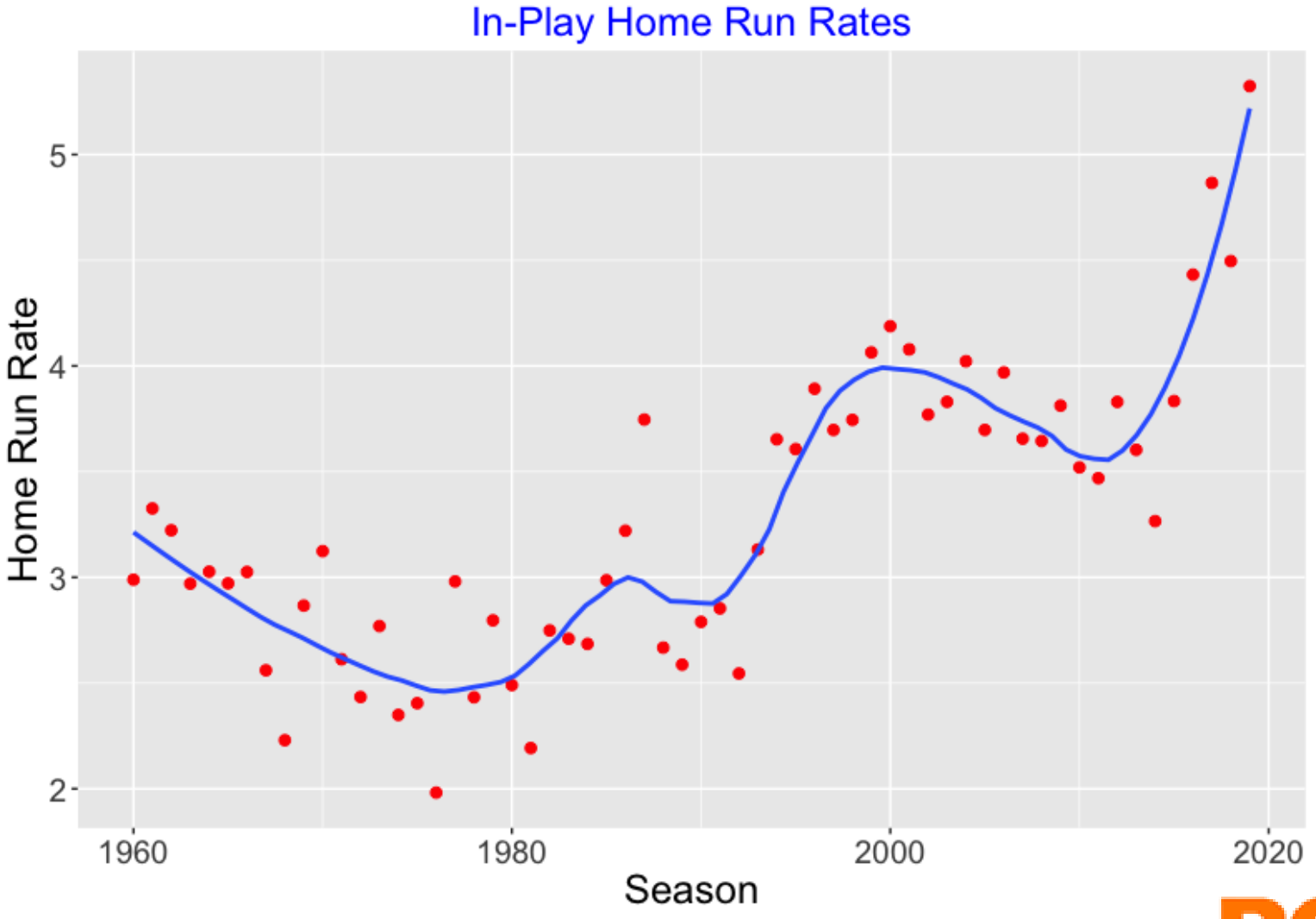
Home Runs

- How to define home run rate?
- Focus on the rate of home runs among batted balls
- Look at history of home run rates from 1960 to 2019

History - Home Runs per Batted Ball



MLB Home Run Report (Part I)

- In Fall of 2017 a committee was charged by Major League Baseball to identify the potential causes of the increase in the rate at which home runs were hit in 2015, 2016, and 2017.
- Report was released in May 2018. (Available online.)

Committee explored reasons for the increase in home run hitting

- The batters? (Changes in characteristics of batted balls)
- The pitchers? (Types of pitches)
- Characteristics of ball?
- The ballpark? (Coors field)
- The weather? (April vs. August)

Process of Hitting a Home Run

- **IN-PLAY**: Have to put the ball in play
- **HIT IT RIGHT**: The batted ball needs to have the "right" launch angle and exit velocity
- **REACH THE SEATS:** Given the exit velocity and launch angle, needs to have sufficient distance and height to clear the fence (the carry of ball)

Committee's Findings from 2015 - 2017 Data

- We found modest changes in launch angle and exit velocity among batters
- Focused on RED zone – launch angle in (15, 40) degrees, launch speed between 90 and 115 mpg
- The RED zone balls are showing more carry – they travel further

Committee's Findings (January 2018)

- Increase in home runs is due to better carry (less drag) for given launch conditions
- Likely due to the aerodynamic properties of the baseball
- Didn't appear to be a property of the manufactured baseballs
- Recommend that MLB monitor the climate environment of the baseballs

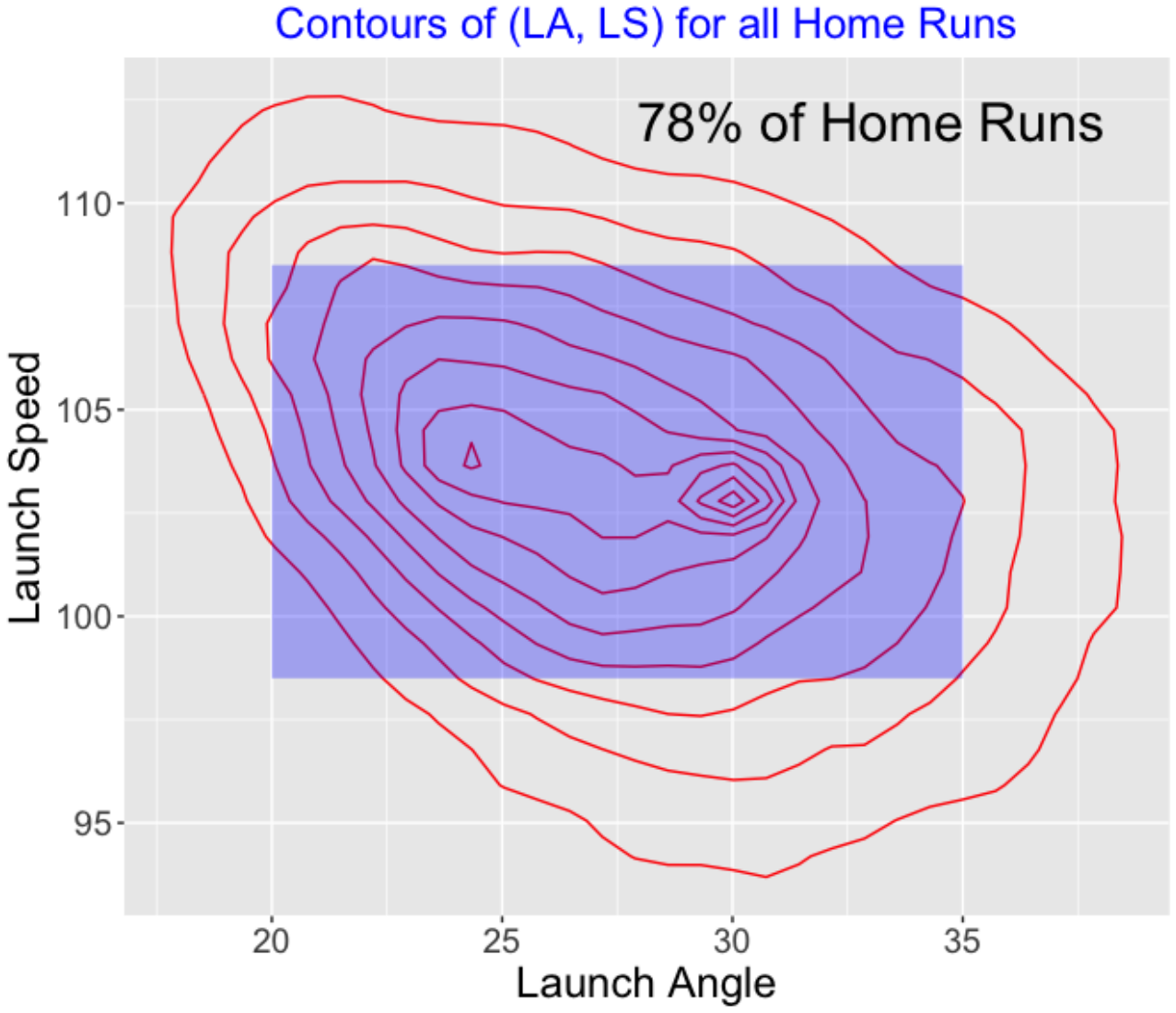
August 2019 (HR Report Part II)

- Four and a half seasons of Statcast data (2015 - 2019) are available
- Have launch speed and launch angle measurements for all seasons
- Take a broader perspective on home run hitting
  - Empirical perspective
  - Modeling perspective

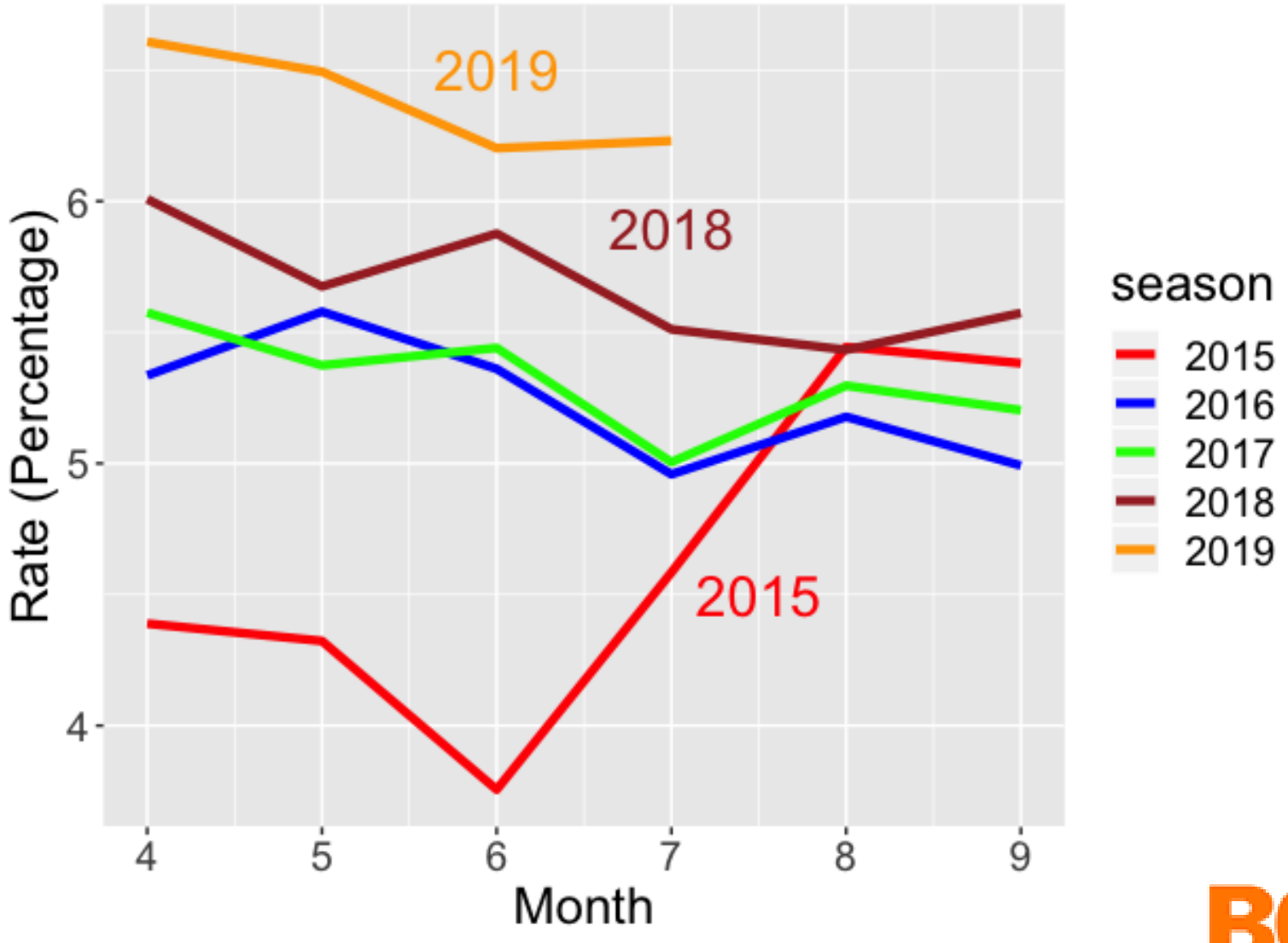
Empirical Approach

- Look at region of launch angle and exit velocity where most of home runs are hit
- Look at **rate of batted balls** in this region – how does it vary by month and season?
- Look at **rate of home runs** for balls hit in this region – how does it vary by month and season?

Focus on Region of Launch Angle and Launch Speed where Home Runs are Hit



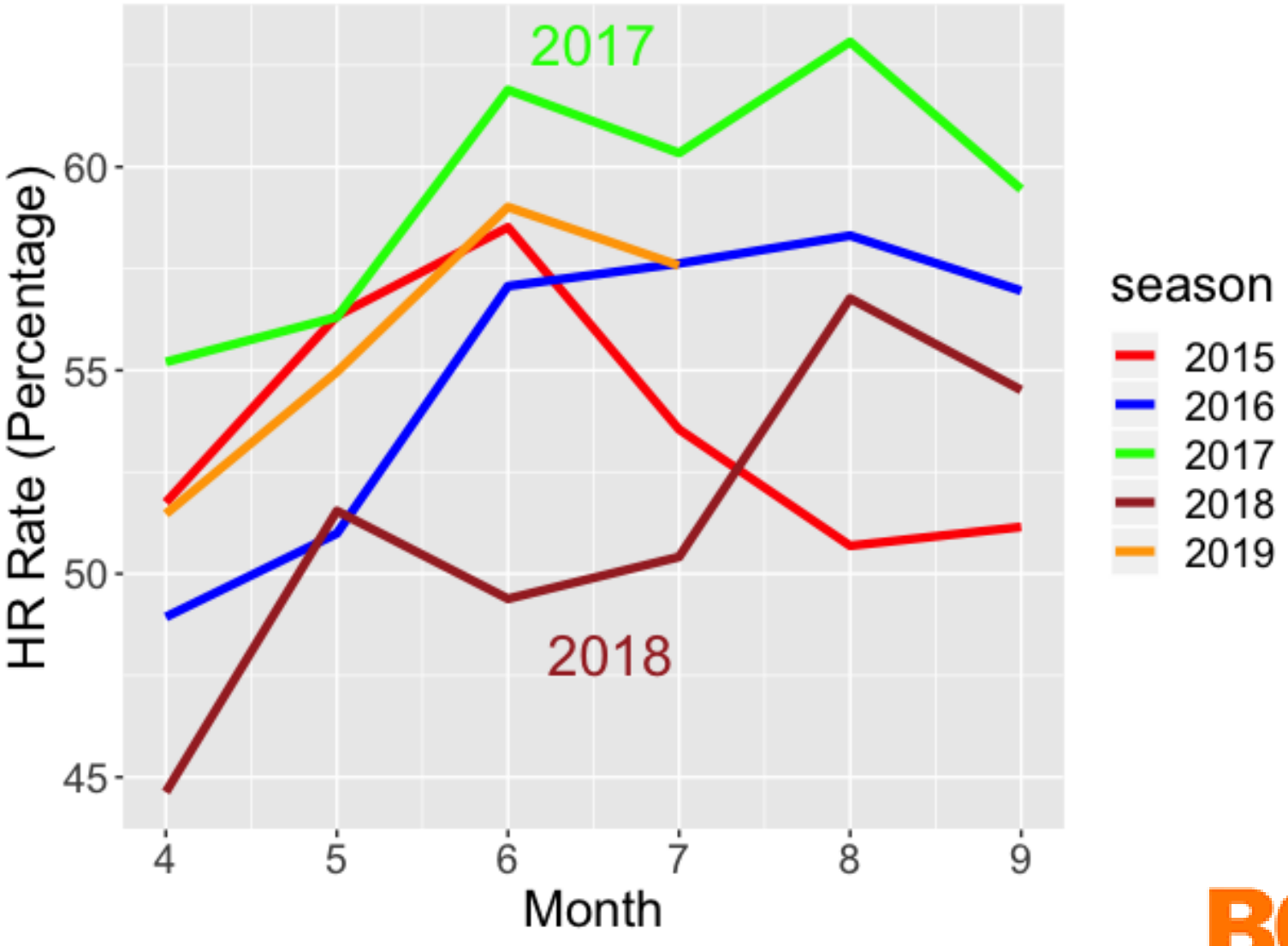
Rate of Batted Balls in Region



Rate of Batted Balls in Region

- General increase from 2015 to 2019 seasons
- There are over 35% additional balls in region in 2019 than in 2015
- Rate tends to decrease during season
- What happened in the 2015 season?

HR Rate of Balls in Region



HR Rates of Balls in Region

- This relates to the carry of the ball
- This HR rate was very high in 2017, very low in 2018
- See cold weather effect
- Again 2015 season has unusual pattern

Focus on Changes for Individual Batters

- Look at all hitters who had at least 200 batted balls in 2015 and 100 batted balls in 2019
- Collect fraction of hard-hit/good launch angle balls for each hitter
- How did hitters change in this period?

Scatterplot of Fraction of Hard Hit Balls for 2 Seasons – 75% Had Higher Fraction in 2019

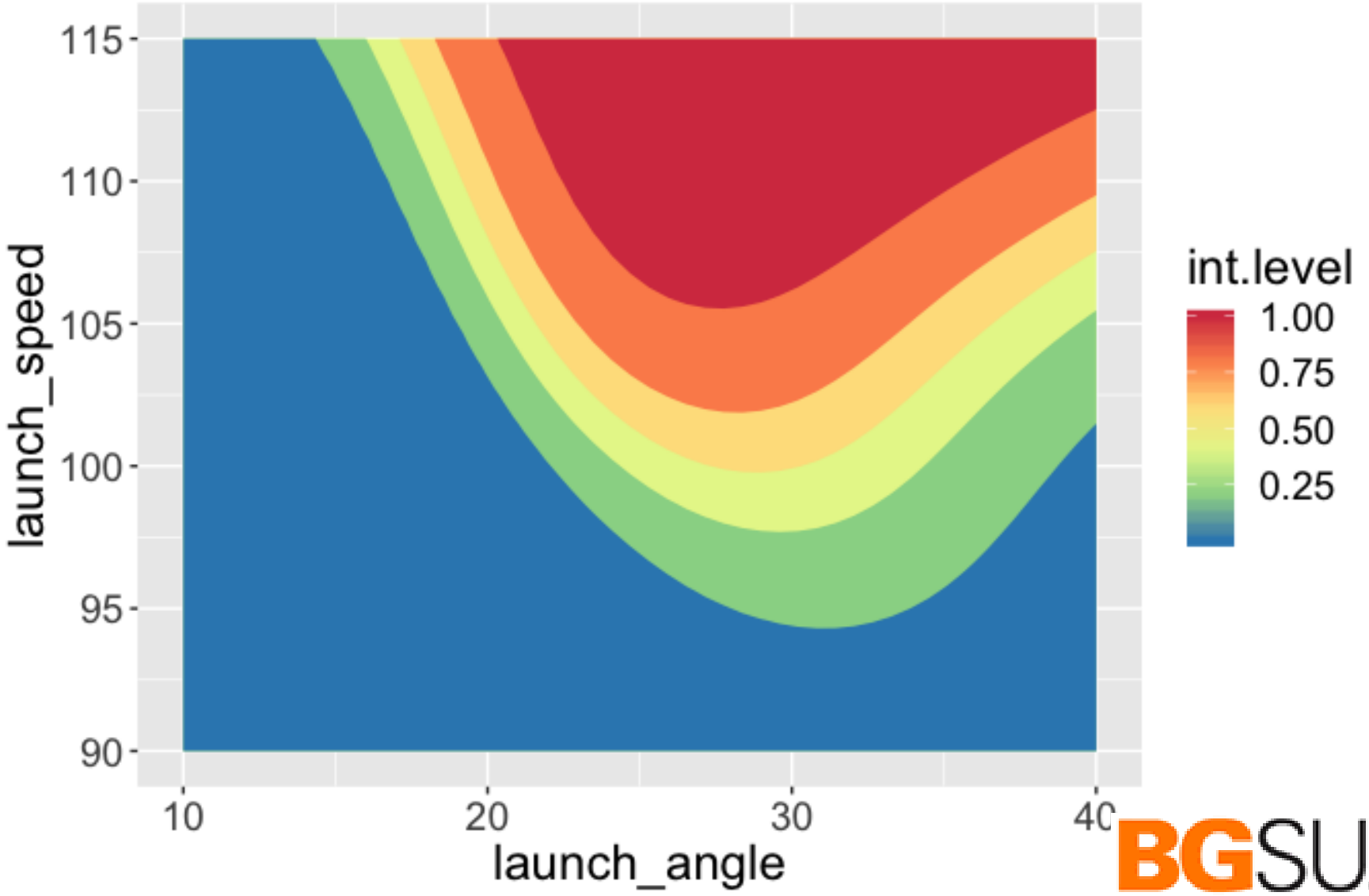
Modeling Perspective

- Use a generalized additive model to estimate the probability of a home run based on launch angle, launch speed, season, and month
- Model

$$\log\left(\frac{p}{1-p}\right) = s(LA, LS) + Season + Month + Season * Month$$

where $p = P(HR)$, $LA =$ launch angle, $LS =$launch speed

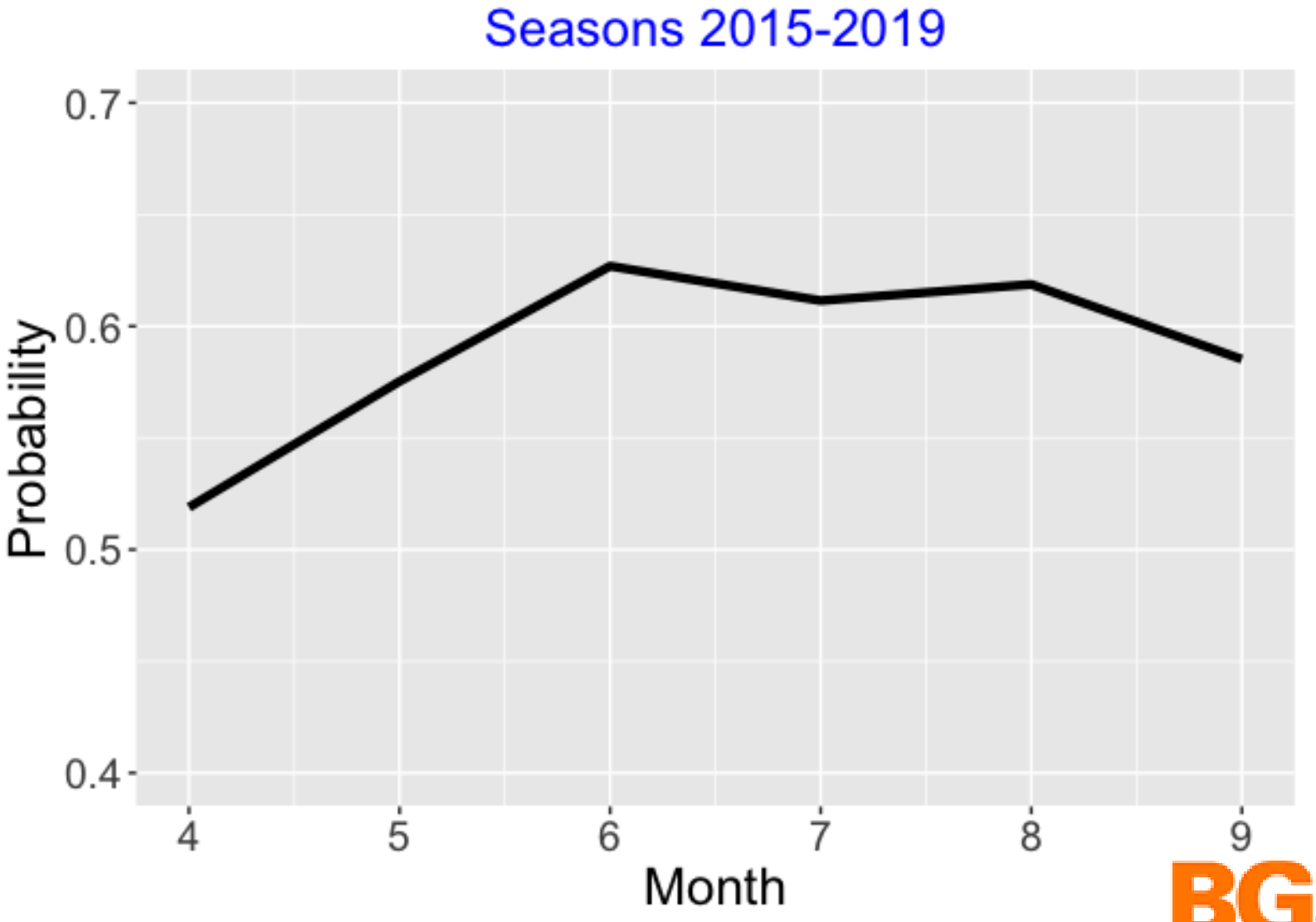
GAM Model – Contours of Home Run Probability



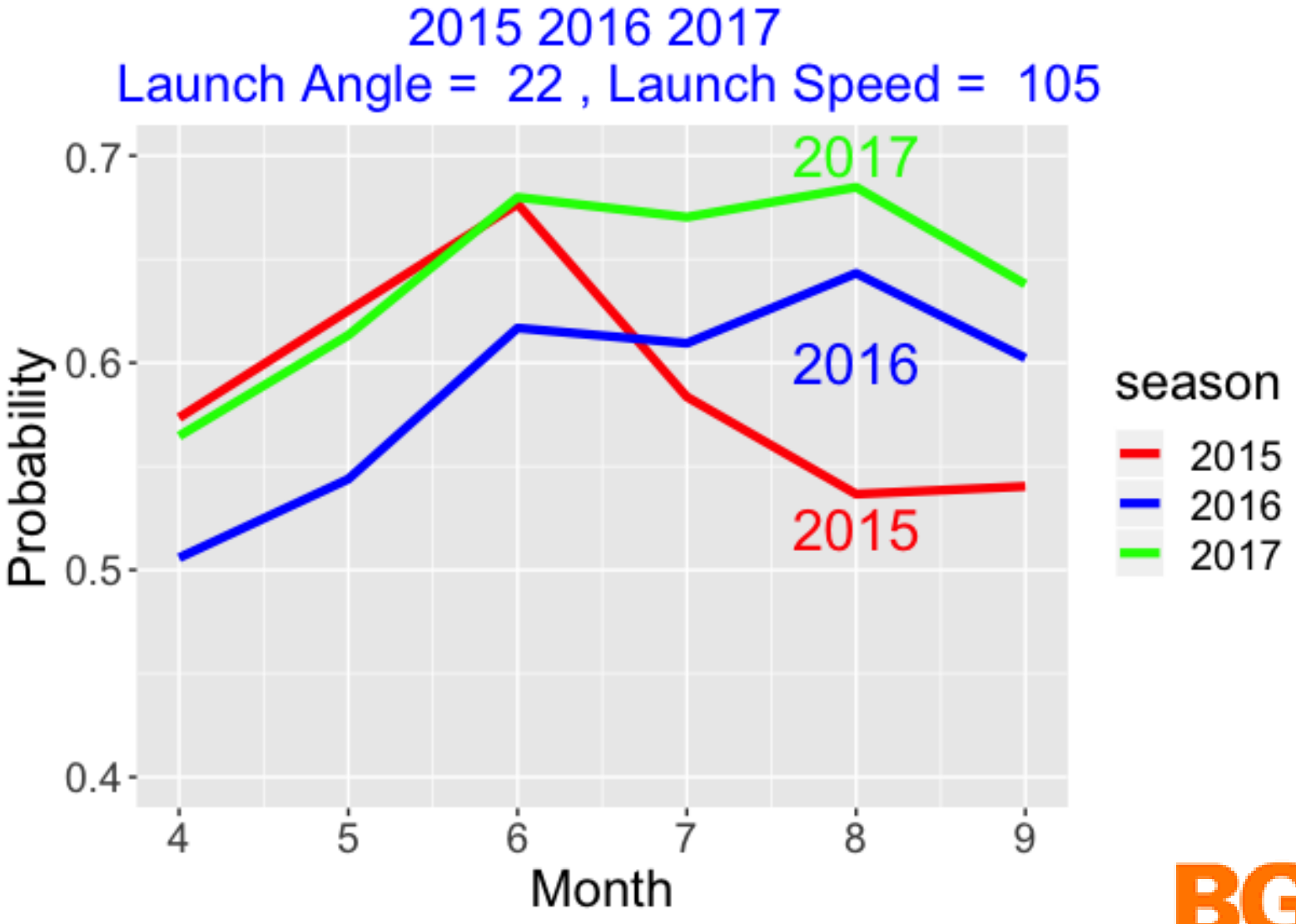
Predictions from Model

- Focus on launch speed of 105 mph, launch angle of 22 degrees
- See how fitted $P(HR)$ depends on season and month
- Look at effects for 2015 - 2017, and then 2017 - 2019

General Pattern by Month - LA = 22, LS = 105



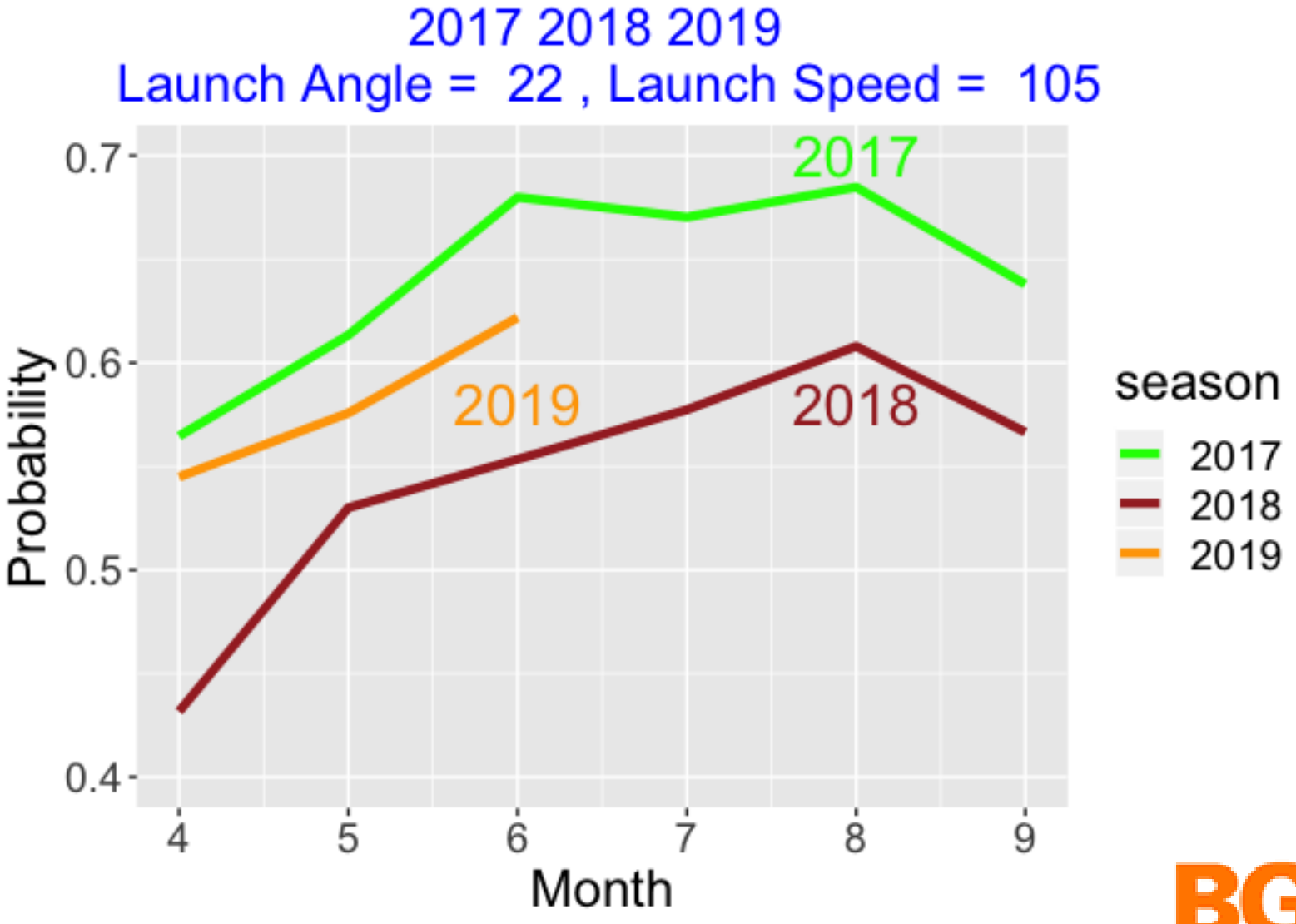
Predictions for Seasons 2015-2017



MLB Committee

- Strange behavior in 2015 – why the midseason drop in P(HR)?
- Reduction in drag from 2015b to 2016 to 2017 (MLB committee report)
- Decided this was the main reason for the HR increase

Predictions for Seasons 2017-2019



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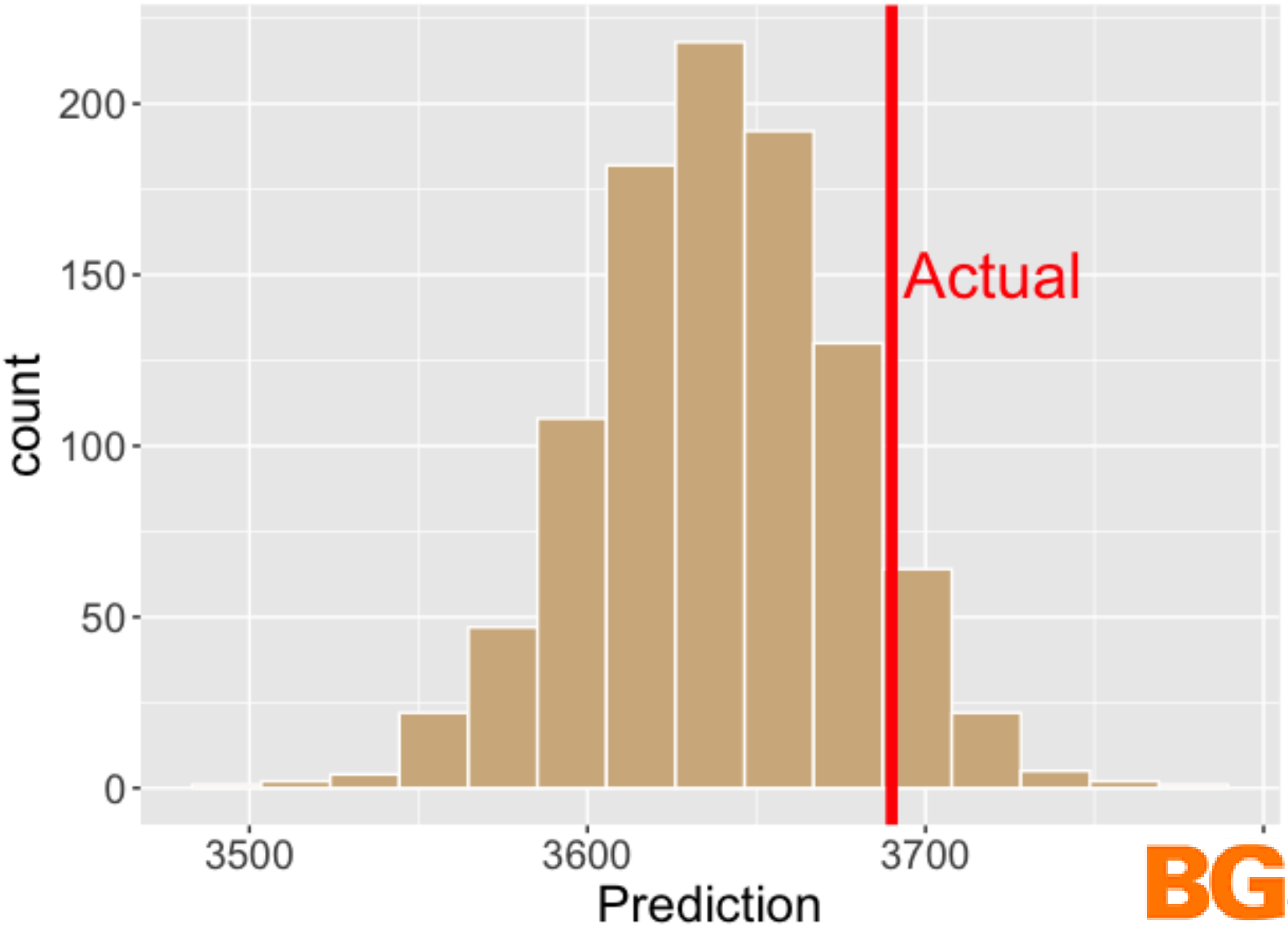
Post Committee Report

- 2017 appears to be an extreme year with respect to drag
- Substantial increase in drag coefficient in 2018
- Drag in 2019 appears moderate among these five seasons

Predicting 2019 Home Runs

- Use the GAM model from data from 2015-2018 seasons to predict home runs based on launch angle and launch velocity
- Predict 2019 HR count (first half of season) allowing for sampling error
- How good is prediction? Compare to actual HR count of 3690

Prediction Using GAM Model



GAM Modeling

- Useful for understanding relationship between home run hitting, launch angle, and launch speed
- Shows month-to-month effect and changes across seasons (drag coefficients)
- GAM model on 2015-2018 data can be used to reasonably predict 2019 total
- Prediction adjusts for changes in 2019 launch angles and launch velocities

Summing Up

- See a steady increase in hard hit balls with higher launch angles
- Changes in launch angles and launch speeds are driving the increase in home runs
- Expect home run rates to continue to increase
- Unless some changes are made by Major League Baseball