

# Clayton Kershaw

## Notebook Contents

- Imports
- Data
  - Index DataFrame to Get Pitch Types
- Pitcher Overview
  - General Pitch Data
    - Pitch Usage
      - HB & VB Axis
      - HB & VB Due to Magnus Force
    - Pitch Usage by Batter Handedness
    - Velocity by Pitch Type
    - Pitch Velocity by Inning
  - Pitcher Stuff
    - Spin Rate by Pitch Type
    - Spin Axis
    - Spin Efficiency
    - HB & VB Axis
    - HB & VB Due to Magnus Force
    - Release Position
    - Release Extension
    - Velocity & Spin Rate
    - Avg. Bauer Units by Pitch Type
  - Count Breakdown
    - Pitch Usage by Count
  - Heatmaps
    - Pitch Location by Pitch Type
    - Hard Hit Summary by Pitch Type
    - Slider Heatmaps
    - 4-Seam Heatmaps
    - Curveball Heatmaps
    - Changeup Heatmaps

## Imports

```
In [1]: import math
import matplotlib.patches as mpatches
from matplotlib.patches import Rectangle
from matplotlib.ticker import PercentFormatter

import warnings
warnings.filterwarnings('ignore')
```

## Data

```
In [2]: kershaw = pd.read_csv('..data/clayton-kershaw.csv')
kershaw.drop(columns = ['Unnamed: 0'], inplace = True)

# Font Dictionary
font_title = {
    'size': 14,
    'weight': 'bold',
    'verticalalignment': 'center_baseline',
    'horizontalalignment': 'center'
}

pd.set_option('max_columns', None)
print(kershaw.shape)
kershaw.head(2)
```

	pitch_type	game_date	release_speed	release_pos_x	release_pos_z	player_name	batter	pitcher	events	description	zone
0	SL	2021-05-30	87.5	1.6	6.13	Kershaw, Clayton	592332	477132	strikeout	called_strike	8
1	FF	2021-05-30	90.4	1.6	6.12	Kershaw, Clayton	592332	477132	NaN	called_strike	6

```
In [3]: gen_data = kershaw[['pitch_type', 'release_speed', 'release_spin_rate',
                           'true_spin', 'spin_eff', 'phi', 'theta', 'pfx_x', 'pfx_z',
                           'is_strike', 'release_pos_x', 'release_pos_z', 'bauer_units']]
col_dict = {'release_speed': 'velo', 'release_spin_rate': 'spin', 'phi': 'spin_axis', 'theta': 'gyro_spin_deg',
            'pfx_x': 'hb', 'pfx_z': 'vb', 'is_strike': 'strike', 'release_pos_x': 'r_side',
            'release_pos_z': 'f_side'}

gen_data.rename(columns = col_dict, inplace = True)

hit_labels = [1, 2, 3, 4, 5]
kershaw[['hard_hit_summary']] = pd.qcut(kershaw['launch_speed'], [0, .5262, .617, .7283, .8278, 1],
                                       labels = hit_labels)
```

## Index DataFrame to Get Pitch Types

```
In [4]: # kershaw.pitch_type.value_counts(normalize = True)
r_kershaw = kershaw.loc[kershaw['stand'] == 'R']
l_kershaw = kershaw.loc[kershaw['stand'] == 'L']

# All Hitters
sl = kershaw.loc[kershaw['pitch_type'] == 'SL']
ff = kershaw.loc[kershaw['pitch_type'] == 'FF']
cu = kershaw.loc[kershaw['pitch_type'] == 'CU']
ch = kershaw.loc[kershaw['pitch_type'] == 'CH']

# RHH
r_sl = r_kershaw.loc[l_kershaw['pitch_type'] == 'SL']
r_ff = r_kershaw.loc[l_kershaw['pitch_type'] == 'FF']
r_cu = r_kershaw.loc[l_kershaw['pitch_type'] == 'CU']
r_ch = r_kershaw.loc[l_kershaw['pitch_type'] == 'CH']

# LHH
l_sl = l_kershaw.loc[l_kershaw['pitch_type'] == 'SL']
l_ff = l_kershaw.loc[l_kershaw['pitch_type'] == 'FF']
l_cu = l_kershaw.loc[l_kershaw['pitch_type'] == 'CU']
l_ch = l_kershaw.loc[l_kershaw['pitch_type'] == 'CH']

order = ['SL', 'FF', 'CU', 'CH']

sl_tilt = sl['phi'].mean()
ff_tilt = ff['phi'].mean()
cu_tilt = cu['phi'].mean()
ch_tilt = ch['phi'].mean()
```

## Pitcher Overview

### General Pitch Data

```
In [5]: gen_data.groupby(['pitch_type'], sort = False).mean()
```

	velo	spin	true_spin	spin_eff	spin_axis	gyro_spin_deg	hb	vb	strike	r_side
SL	87.075000	2654.045402	501.376237	0.192000	223.276316	78.878947	8.182326	4.712372	0.734884	1.513756
FF	90.636707	2506.066566	1532.492784	0.624158	184.323024	51.099656	19.353897	0.525661	0.641994	1.525310
CU	74.239927	2535.468664	1372.878019	0.658889	345.722222	56.777778	-15.283516	4.782857	0.538462	1.178608
CH	87.045457	2163.272727	1684.480000	0.780000	137.383636	38.000000	15.665455	-12.892727	0.272727	1.790909

Slider: combo sweeping slider/gyro ball movement profile

Fastball: more of a Cutter/4-Seam profile

Curveball: True 12-6 banger

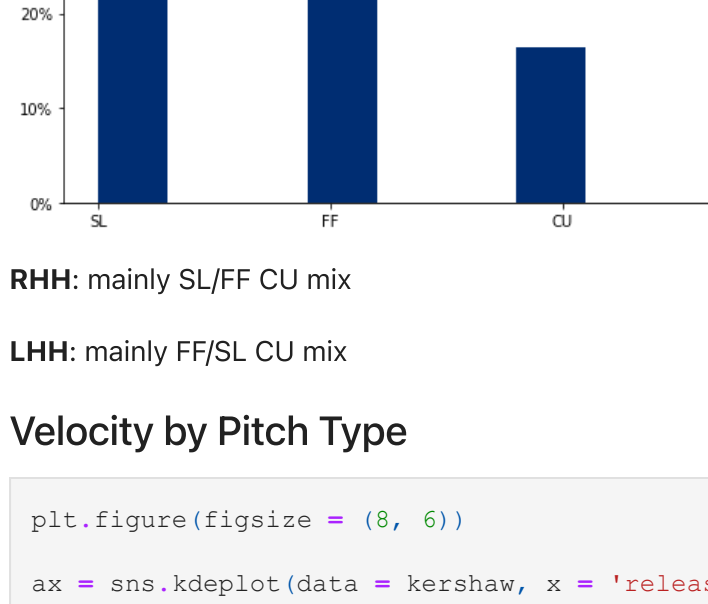
Change: straight change

### Pitch Usage

```
In [6]: plt.figure(figsize = (8, 6))

dict = round(kershaw.pitch_type.value_counts(normalize = True), 2)
color = sns.color_palette('coolwarm_r')

plt.pie(dict, labels = order, colors = color, autopct = '%.0f%%')
plt.title('Distribution of Pitch Types - Clayton Kershaw', fontdict = font_title, pad = 15);
```



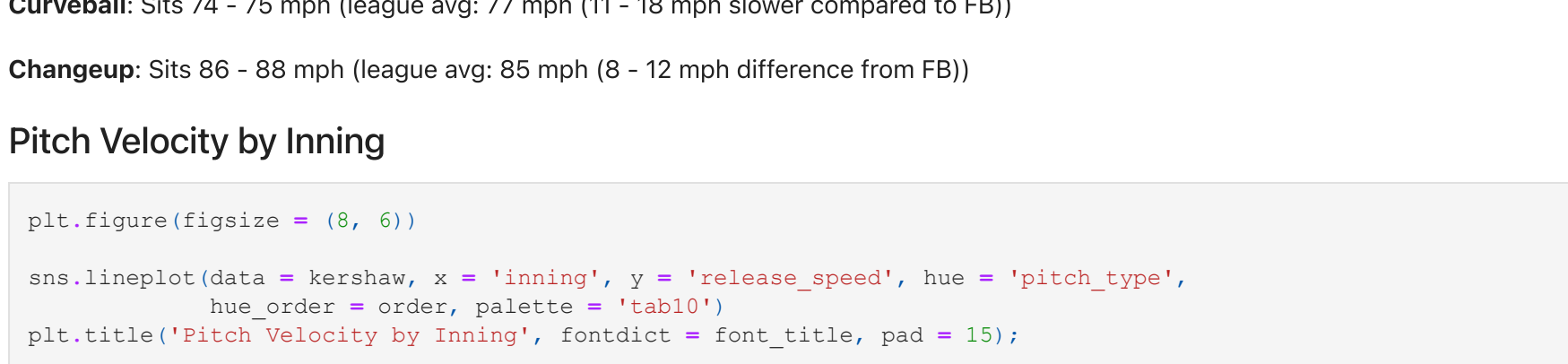
### Pitch Usage by Batter Handedness

```
In [7]: blue = '#002072'
red = '#D60032'

fig, axs = plt.subplots(1, 2, figsize = (20, 6))
fig.suptitle('Pitch Usage by Batter Handedness', fontsize = 16, fontweight = 'bold')

dict_r = r_kershaw.pitch_type.sort_values(ascending = False)
axs[0].hist(dict_r_weights = np.ones(len(dict_r)) / len(dict_r), color = blue)
axs[0].set_title('Distribution of Pitch Types - RHH', fontdict = font_title, pad = 15)

dict_l = l_kershaw.pitch_type.sort_values(ascending = False)
axs[1].hist(dict_l_weights = np.ones(len(dict_l)) / len(dict_l), color = red)
axs[1].set_title('Distribution of Pitch Types - LHH', fontdict = font_title, pad = 15);
```



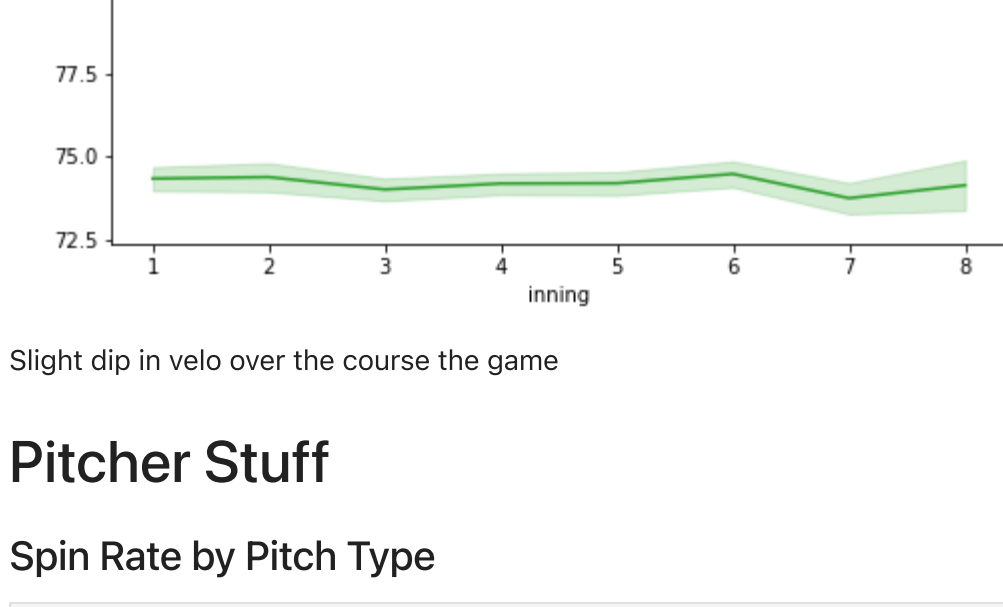
RHH: mainly SL/FF CU mix

LHH: mainly FF/SL CU mix

### Velocity by Pitch Type

```
In [8]: plt.figure(figsize = (8, 6))

ax = sns.kdeplot(data = kershaw, x = 'release_speed', shade = 'fill', hue = 'pitch_type',
                 hue_order = order, palette = 'tab10')
sns.move_legend(ax, 'upper left')
plt.title('Distribution of Velocity by Pitch Type - Clayton Kershaw', fontdict = font_title, pad = 15);
```



Slider: Sits 86 - 88 mph (league avg: 85 mph)

Cutter / 4-Seam: Sits 90 - 91 mph (league avg: 92.3 mph)

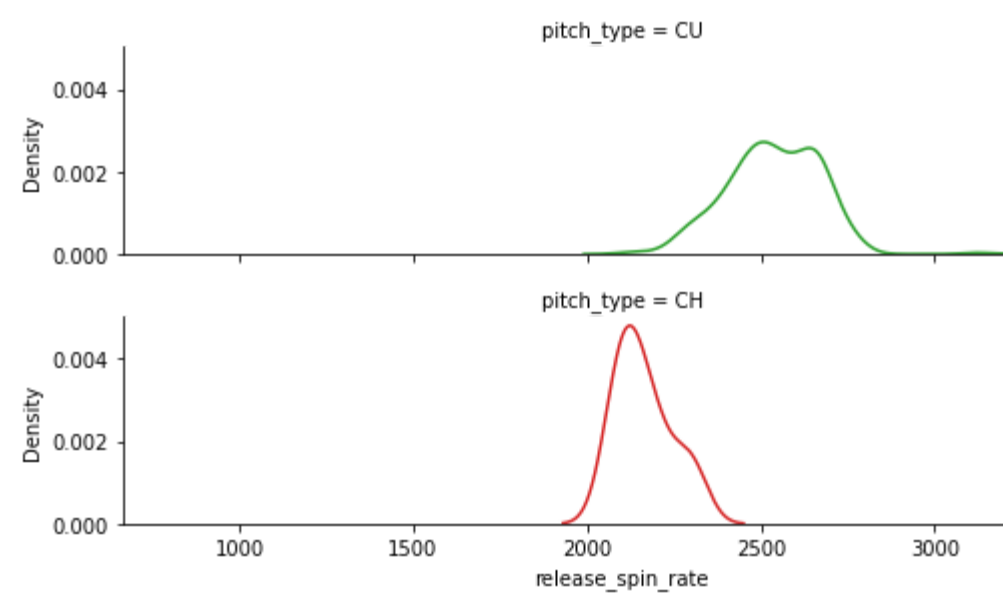
Curveball: Sits 74 - 75 mph (league avg: 77 mph (11 - 18 mph slower compared to FB))

Changeup: Sits 86 - 88 mph (league avg: 85 mph (8 - 12 mph difference from FB))

### Pitch Velocity by Inning

```
In [9]: plt.figure(figsize = (8, 6))

sns.lineplot(data = kershaw, x = 'inning', y = 'release_speed', hue = 'pitch_type',
             hue_order = order, palette = 'tab10')
plt.title('Pitch Velocity by Inning', fontdict = font_title, pad = 15);
```

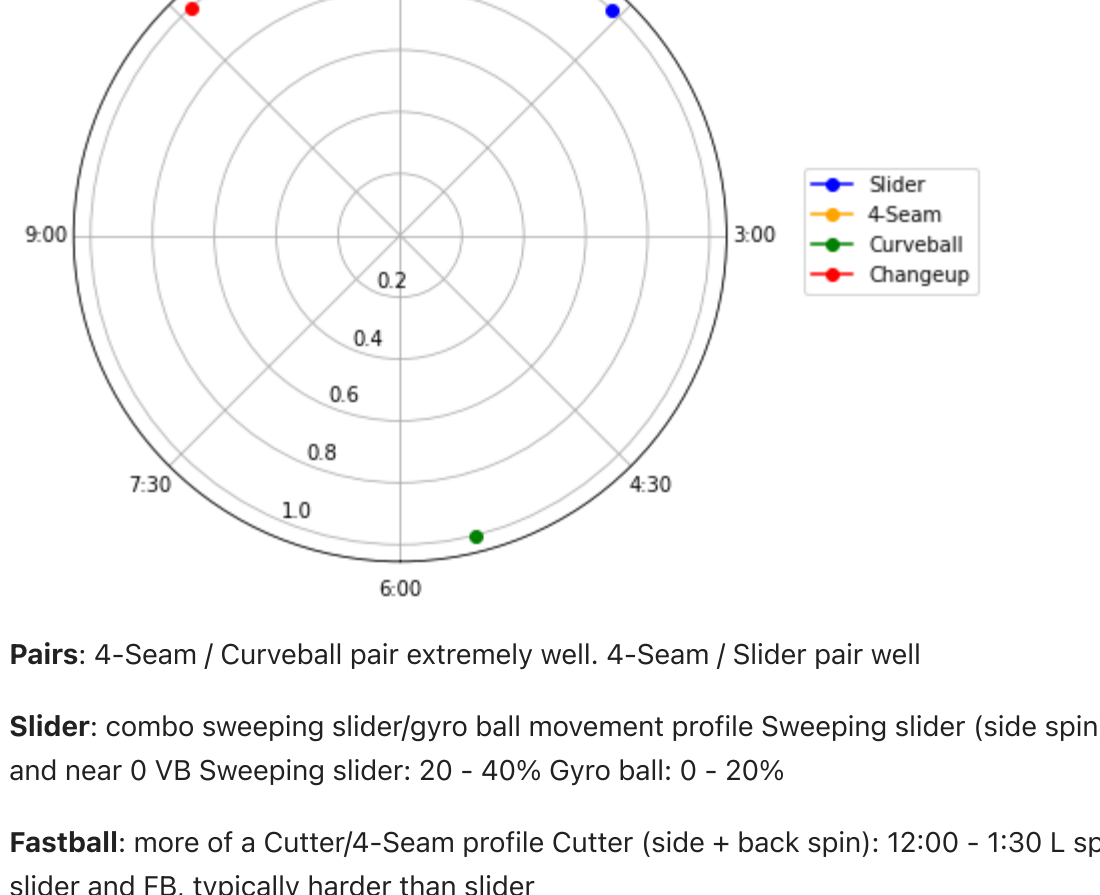


Slight dip in velo over the course the game

## Pitcher Stuff

### Spin Rate by Pitch Type

```
In [10]: g = sns.FacetGrid(kershaw, row = 'pitch_type', hue = 'pitch_type', height = 2, aspect = 4, )
g.map(sns.kdeplot, 'release_spin_rate', palette = 'tab10');
```



Slider: Above avg spin (league avg: ~2450 rpm)

4-Seam: Above avg spin (league avg: ~2200 rpm)

Curveball: Above average spin (league avg: ~2500 rpm)

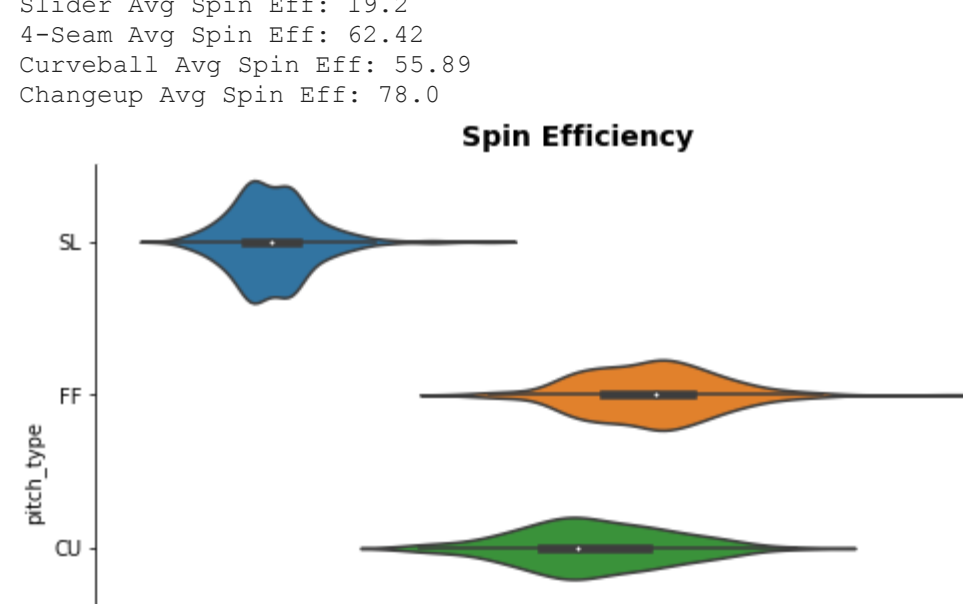
Changeup: Above average spin (league avg range: ~1200 2400 rpm)

### Spin Axis

```
In [11]: ax = plt.figure(figsize = (8, 6))

ax = plt.subplot(polar = True, theta_direction = 1)
ax.plot(math.radians(111), 1, color = 'blue', marker = 'o', label = 'Slider')
ax.plot(math.radians(111), 1, color = 'orange', marker = 'o', label = '4-Seam')
ax.plot(math.radians(111), 1, color = 'green', marker = 'o', label = 'Curveball')
ax.plot(math.radians(111), 1, color = 'red', marker = 'o', label = 'Changeup')

ticks = ('6:00', '7:30', '9:00', '10:30', '12:00', '1:30', '3:00', '4:30')
ax.set_xticklabels(ticks), ax.legend(bbox = (1.4, .62), ax.set_theta_zero_location("S"))
ax.set_title('Spin Axis', fontdict = font_title, pad = 15);
```



Pairs: 4-Seam / Curveball pair extremely well. 4-Seam / Slider pair well

Slider: combo sweeping slider/gyro ball movement profile Sweeping slider (side spin): 2:00 - 4:00 L spin tilt Decent amount of HB and near 0 VB Sweeping slider: 20 - 40% Gyro ball: 0 - 20%

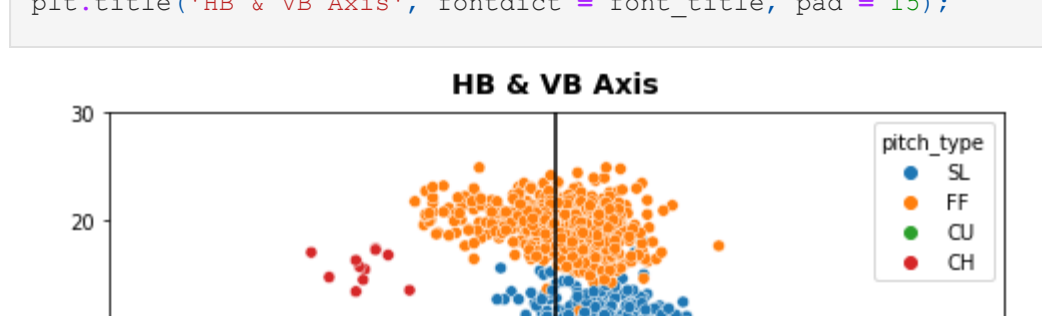
Fastball: more of a Cutter/4-Seam profile Cutter (side + back spin): 12:00 - 1:30 L spin tilt Positive VB & Some HB Hybrid between slider and FB, typically harder than slider

Curveball: True 12-6 banger True 12 - 6 CB: 5:00 - 6:00 L spin tilt Much more negative VB and minimal HB Curveballs thrown with low spin efficiency (below 70% efficiency) Movement profile gets closer to (0, 0) Higher spin efficiency Curveballs profile gets further from (0, 0)

Change: straight change Straight change: 10:30 - 12:00 L spin tilt More VB & less HB Spin rate: 1700 - 1800 rpm Spin efficiency: 90% Arm slot: overhand

### Spin Efficiency

```
In [12]: sns.violinplot(data = kershaw, x = 'spin_eff', y = 'pitch_type', kind = 'violin', aspect = 1.5, palette = 'tab10')
plt.title('Spin Efficiency', fontdict = font_title, pad = 15);
```



Slider: Sweeping: 20 -40% spin eff. / Gyro ball: 0-20% spin eff.

Fastball: Cutter: 40-60% spin eff. / 4-Seam: ~100% spin eff. Hybrid between slider and FB, typically harder than slider

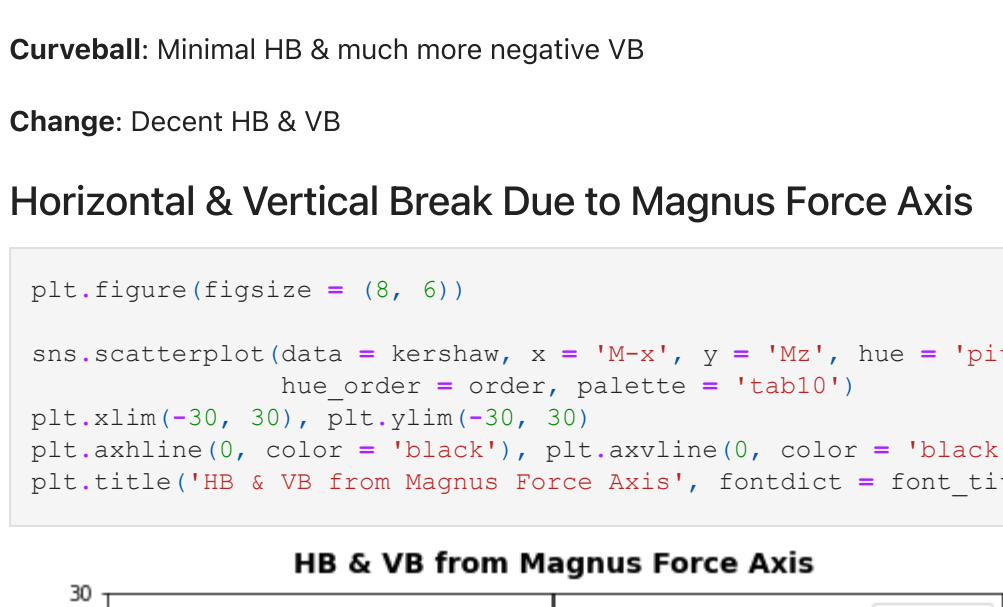
Curveball: Curveballs thrown with low spin efficiency (below 70% efficiency) Movement profile gets closer to (0, 0)

Change: 80-90% spin eff.

### Horizontal & Vertical Break Axis

```
In [13]: plt.figure(figsize = (8, 6))

sns.scatterplot(data = kershaw, x = 'pfx_x', y = 'pfx_z', hue = 'pitch_type',
               hue_order = order, palette = 'tab10')
plt.xlim(-30, 30), plt.ylim(-30, 30)
plt.xlabel(0, color = 'black'), plt.ylabel(0, color = 'black')
plt.axhline(0, color = 'black'), plt.axvline(0, color = 'black')
plt.title('HB & VB from Magnus Force Axis', fontdict = font_title, pad = 15);
```



Slider: Decent amount of HB & minimal VB

Fastball: Ton of HB & near 0 VB

Curveball: Minimal HB & much more negative VB

Change: Decent HB & VB

### Horizontal & Vertical Break Due to Magnus Force Axis

```
In [14]: plt.figure(figsize = (8, 6))

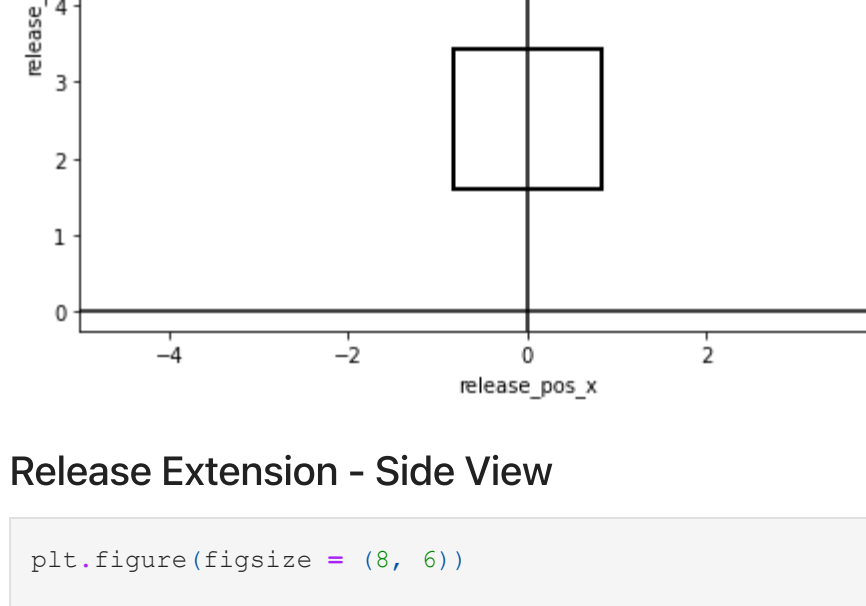
sns.scatterplot(data = kershaw, x = 'M-x', y = 'M-z', hue = 'pitch_type',
               hue_order = order, palette = 'tab10')
plt.xlim(-30, 30), plt.ylim(-30, 30)
plt.xlabel(0, color = 'black'), plt.ylabel(0, color = 'black')
plt.axhline(0, color = 'black'), plt.axvline(0, color = 'black')
plt.title('HB & VB from Magnus Force Axis', fontdict = font_title, pad = 15);
```



### Release Postion

```
In [15]: plt.figure(figsize = (8, 6))

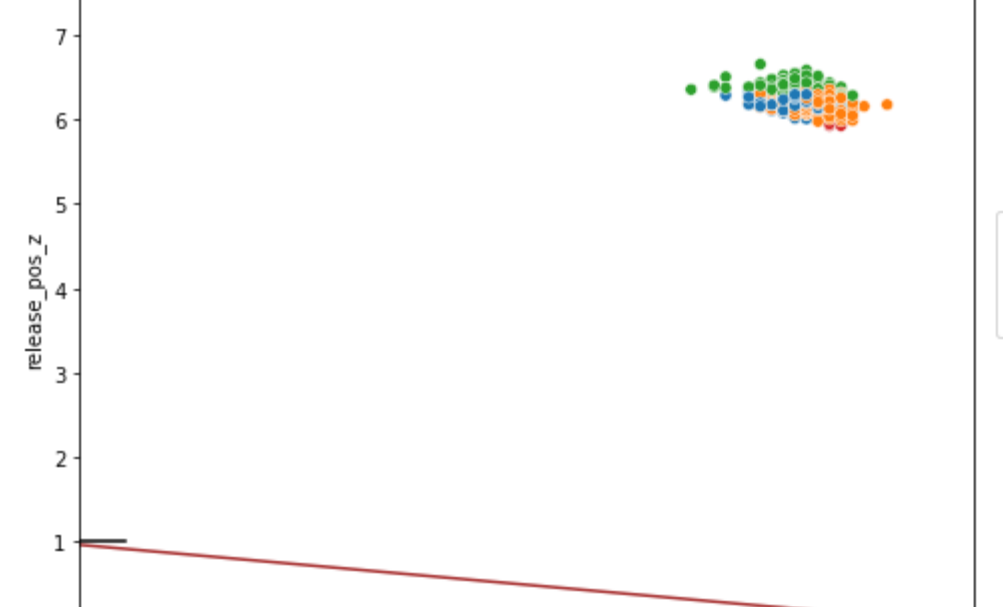
sns.scatterplot(data = kershaw, x = 'release_pos_x', y = 'release_pos_z', hue = 'pitch_type',
               hue_order = order, palette = 'tab10')
plt.xlim(-5, 5), plt.ylim(0.25, 8.25)
plt.axvline(0, color = 'black'), plt.axhline(0, color = 'black')
left, bottom, width, height = (-.85, 1.39, 1.46, 1.82)
rect = mpatches.Rectangle((left, bottom), width, height, fill = False, color = 'black', linewidth = 2)
plt.gca().add_patch(rect)
plt.title('Release Position from Hitter Perspective', fontdict = font_title, pad = 15);
```



### Release Extension - Side View

```
In [16]: plt.figure(figsize = (8, 6))

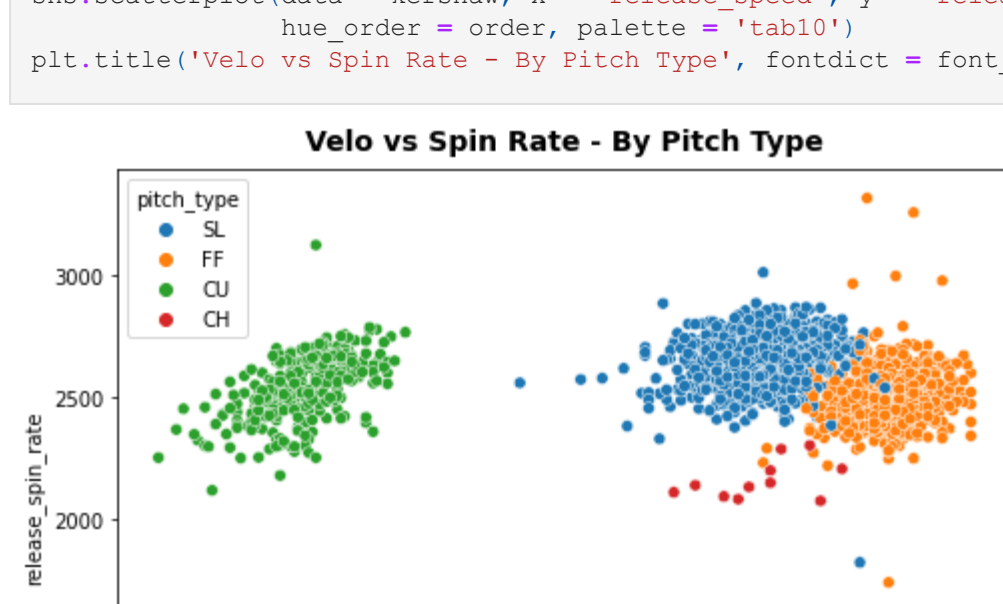
sns.scatterplot(data = kershaw, x = 'release_extension', y = 'release_pos_x', hue = 'pitch_type',
               hue_order = order, palette = 'tab10')
plt.xlim(0, 7.5), plt.ylim(0, 7.5)
plt.axhline(0, color = 'brown'), plt.axvline(1, 0, .05, color = 'black')
plt.legend(bbox = (1.15, .65))
plt.title('Release Extension - Side View', fontdict = font_title, pad = 15);
```



### Velocity & Spin Rate

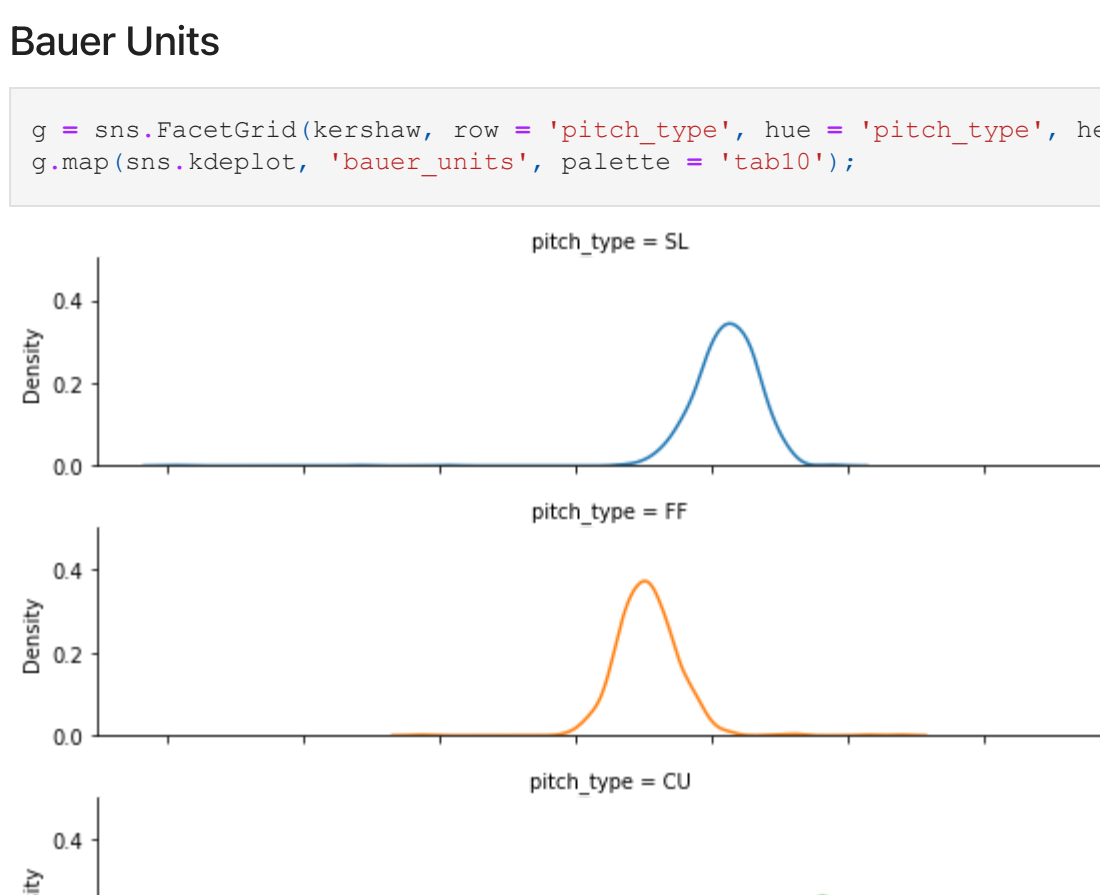
```
In [17]: plt.figure(figsize = (8, 6))

sns.scatterplot(data = kershaw, x = 'release_speed', y = 'release_spin_rate', hue = 'pitch_type',
               hue_order = order, palette = 'tab10')
plt.title('Velo vs Spin Rate - By Pitch Type', fontdict = font_title, pad = 15);
```



### Bauer Units

```
In [18]: g = sns.FacetGrid(kershaw, row = 'pitch_type', hue = 'pitch_type', height = 2, aspect = 4, )
g.map(sns.kdeplot, 'bauer_units', palette = 'tab10');
```



Slider: Above avg Bauer Units (league avg: 28-30)

Fastball: Above avg Bauer Units (league avg: 24)

Curveball: Above avg Bauer Units (league avg: 28-30)

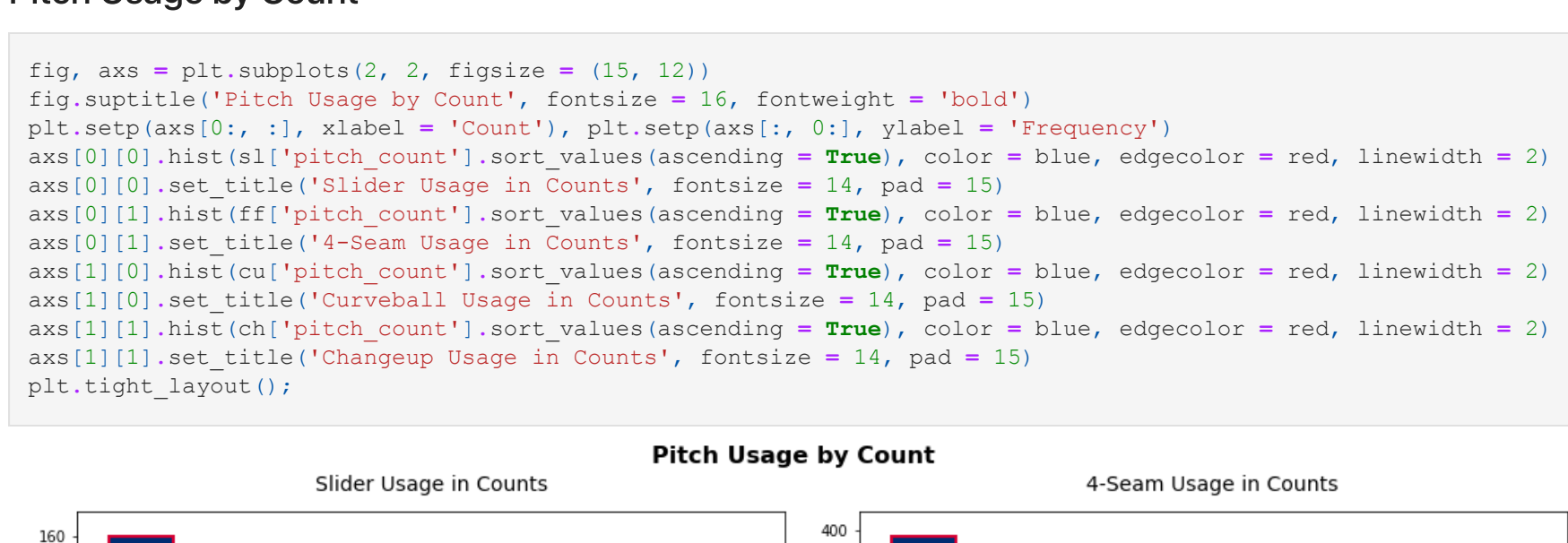
Change: N/A (league avg: N/A)

## Count Breakdown

### Pitch Usage by Count

```
In [19]: fig, axs = plt.subplots(2, 2, figsize = (15, 12))
fig.suptitle('Pitch Usage by Count', fontsize = 16, fontweight = 'bold')

plt.subplot(axs[0, 0], label = 'Count', plt.gca().set_ylabel('Frequency'))
axs[0, 0].hist(axs[0, 0].data['pitch_count'], sort_values(ascending = True), color = blue, edgecolor = red, linewidth = 2)
axs[0, 1].set_title('Slider Usage in Counts', fontsize = 14, pad = 15)
axs[1, 0].set_title('4-Seam Usage in Counts', fontsize = 14, pad = 15)
axs[1, 1].set_title('Curveball Usage in Counts', fontsize = 14, pad = 15)
axs[1, 1].set_title('Changeup Usage in Counts', fontsize = 14, pad = 15)
plt.tight_layout();
```



0-0 Count: Mainly 4-Seam (47%) & Slider (19%)

Does not throw Curveball / Changeup behind in counts

Heavy Curveball in 0-1-1 Counts

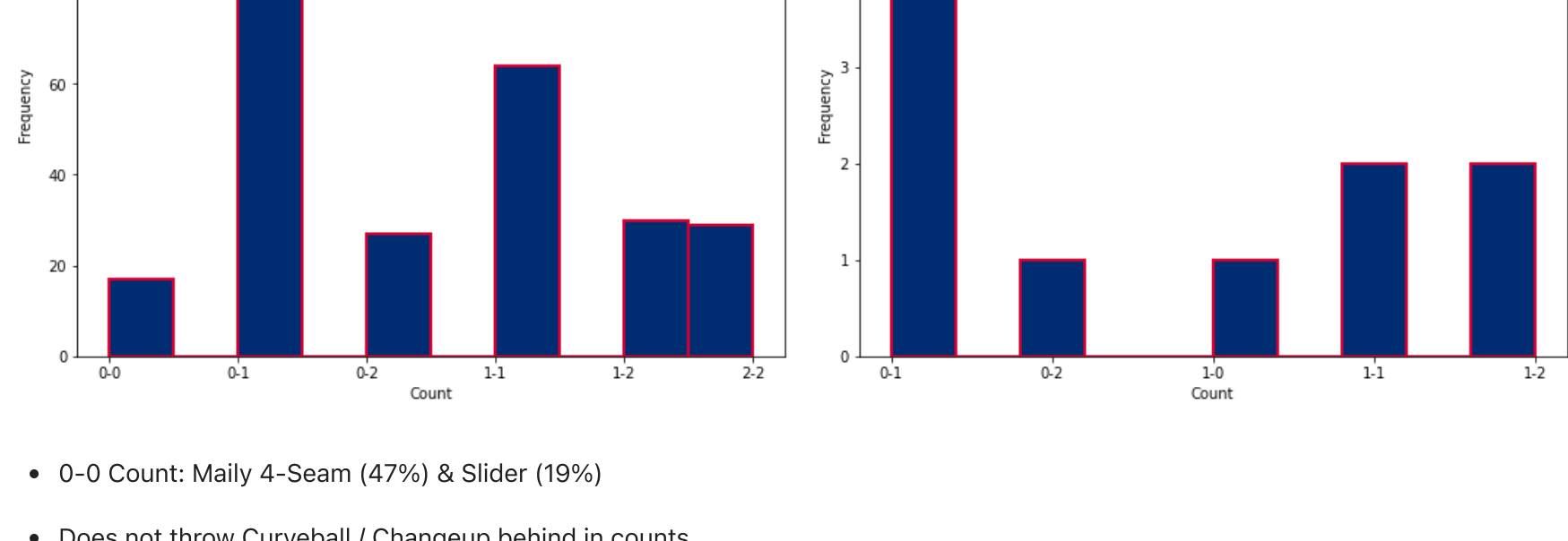
Mainly 4-Seam & Slider in all other counts

## Heatmaps

### Pitch Location by Pitch Type

```
In [20]: fig, axs = plt.subplots(2, 2, figsize = (15, 12))
fig.suptitle('Pitch Location by Pitch Type', fontsize = 16, fontweight = 'bold')

plt.subplot(axs[0, 0], label = 'Count', plt.gca().set_ylabel('Frequency'))
axs[0, 0].hist(axs[0, 0].data['pitch_count'], sort_values(ascending = True), color = blue, edgecolor = red, linewidth = 2)
axs[0, 1].set_title('Slider Location vs All Hitters', fontsize = 14, pad = 15)
axs[1, 0].set_title('4-Seam Location vs All Hitters', fontsize = 14, pad = 15)
axs[1, 1].set_title('Curveball Location vs All Hitters', fontsize = 14, pad = 15)
axs[1, 1].set_title('Changeup Location vs All Hitters', fontsize = 14, pad = 15);
```



Slider: Sits down and glove side

4-Seam: Sits middle and middle-up glove side

Curveball: Sits middle middle

Changeup: Sits down and arm side

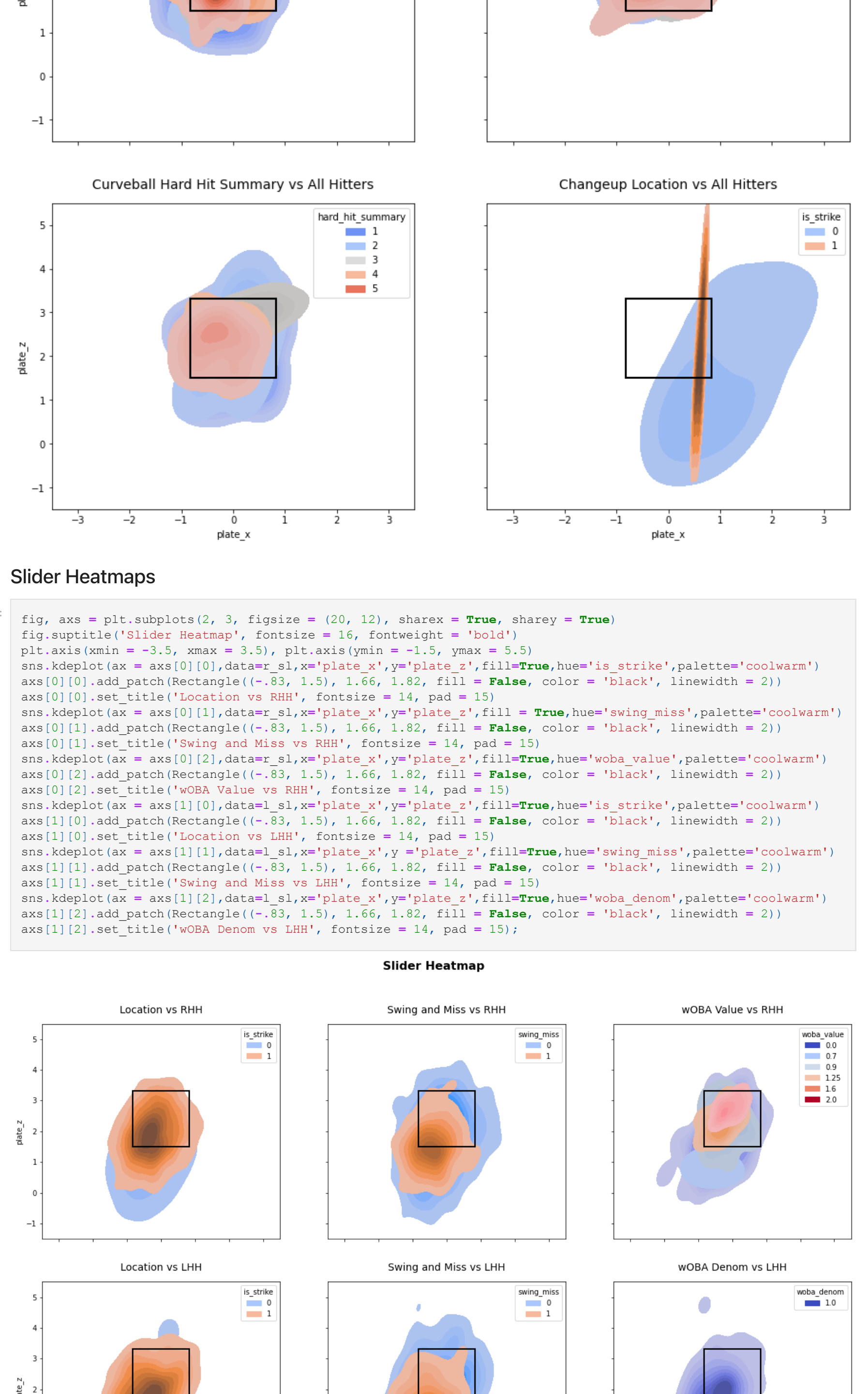
### Hard Hit Summary by Pitch Type



1. 0-85 EV 2. 85-90 EV 3. 90-95 EV 4. 95-100 EV 5. 100+ EV

```
fig, axs = plt.subplots(2, 3, figsize = (15, 13), sharex = True, sharey = True)
fig.suptitle('Slider Hard Hit Summary by Pitch Type', fontsize = 16, fontweight = 'bold')
plt.axis(xmin = -3.5, xmax = 3.5, plt.axis(ymin = -1.5, ymax = 5.5)
plt.axis(xmin = -3.5, xmax = 3.5), plt.axis(ymin = -1.5, ymax = 5.5)
sns.kdeplot(ax = axs[0][0], data=df, x='plate_x', y='plate_z', fill=True, hue='hard_hit_summary', palette='coolwarm')
axs[0][0].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[0][0].set_title('Location vs RHH', fontsize = 14, pad = 15)
axs[0][1].set_title('Swing and Miss vs RHH', fontsize = 14, pad = 15)
axs[0][2].set_title('WOBA Value vs RHH', fontsize = 14, pad = 15)
sns.kdeplot(ax = axs[1][0], data=df, x='plate_x', y='plate_z', fill = True, hue='hard_hit_summary', palette='coolwarm')
axs[1][0].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[1][1].set_title('Swing and Miss vs LHH', fontsize = 14, pad = 15)
axs[1][2].set_title('WOBA Denom vs LHH', fontsize = 14, pad = 15)
sns.kdeplot(ax = axs[0][1], data=df, x='plate_x', y='plate_z', fill=True, hue='hard_hit_summary', palette='coolwarm')
axs[0][1].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[0][1].set_title('Slider Hard Hit Summary vs All Hitters', fontsize = 14, pad = 15)
axs[0][2].set_title('4-Seam Hard Hit Summary vs All Hitters', fontsize = 14, pad = 15)
sns.kdeplot(ax = axs[1][1], data=df, x='plate_x', y='plate_z', fill=True, hue='hard_hit_summary', palette='coolwarm')
axs[1][1].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[1][1].set_title('Curveball Hard Hit Summary vs All Hitters', fontsize = 14, pad = 15)
axs[1][2].set_title('Changeup Location vs All Hitters', fontsize = 14, pad = 15)
```

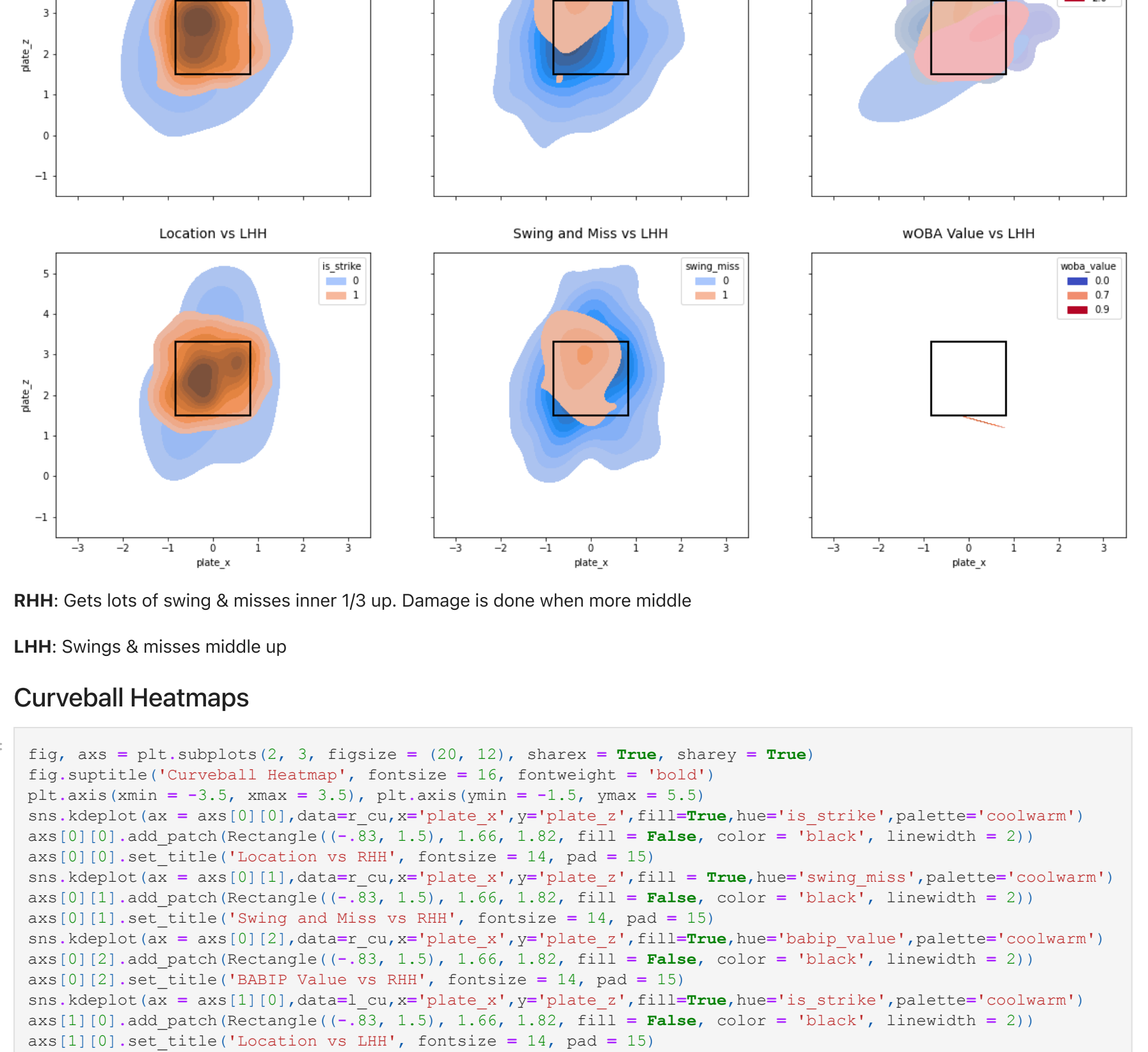
## Hard Hit Summary by Pitch Type



## Slider Heatmaps

```
fig, axs = plt.subplots(2, 3, figsize = (20, 12), sharex = True, sharey = True)
fig.suptitle('Slider Heatmap', fontsize = 16, fontweight = 'bold')
plt.axis(xmin = -3.5, xmax = 3.5, plt.axis(ymin = -1.5, ymax = 5.5)
plt.axis(xmin = -3.5, xmax = 3.5), plt.axis(ymin = -1.5, ymax = 5.5)
sns.kdeplot(ax = axs[0][0], data=df, x='plate_x', y='plate_z', fill=True, hue='is_strike', palette='coolwarm')
axs[0][0].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[0][0].set_title('Location vs RHH', fontsize = 14, pad = 15)
axs[0][1].set_title('Swing and Miss vs RHH', fontsize = 14, pad = 15)
axs[0][2].set_title('WOBA Value vs RHH', fontsize = 14, pad = 15)
sns.kdeplot(ax = axs[1][0], data=df, x='plate_x', y='plate_z', fill = True, hue='is_strike', palette='coolwarm')
axs[1][0].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[1][1].set_title('Swing and Miss vs LHH', fontsize = 14, pad = 15)
axs[1][2].set_title('WOBA Denom vs LHH', fontsize = 14, pad = 15)
sns.kdeplot(ax = axs[0][1], data=df, x='plate_x', y='plate_z', fill=True, hue='is_strike', palette='coolwarm')
axs[0][1].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[0][1].set_title('Slider Hard Hit Summary vs All Hitters', fontsize = 14, pad = 15)
axs[0][2].set_title('4-Seam Hard Hit Summary vs All Hitters', fontsize = 14, pad = 15)
sns.kdeplot(ax = axs[1][1], data=df, x='plate_x', y='plate_z', fill=True, hue='is_strike', palette='coolwarm')
axs[1][1].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[1][1].set_title('Curveball Hard Hit Summary vs All Hitters', fontsize = 14, pad = 15)
axs[1][2].set_title('Changeup Location vs All Hitters', fontsize = 14, pad = 15)
```

## Slider Heatmap



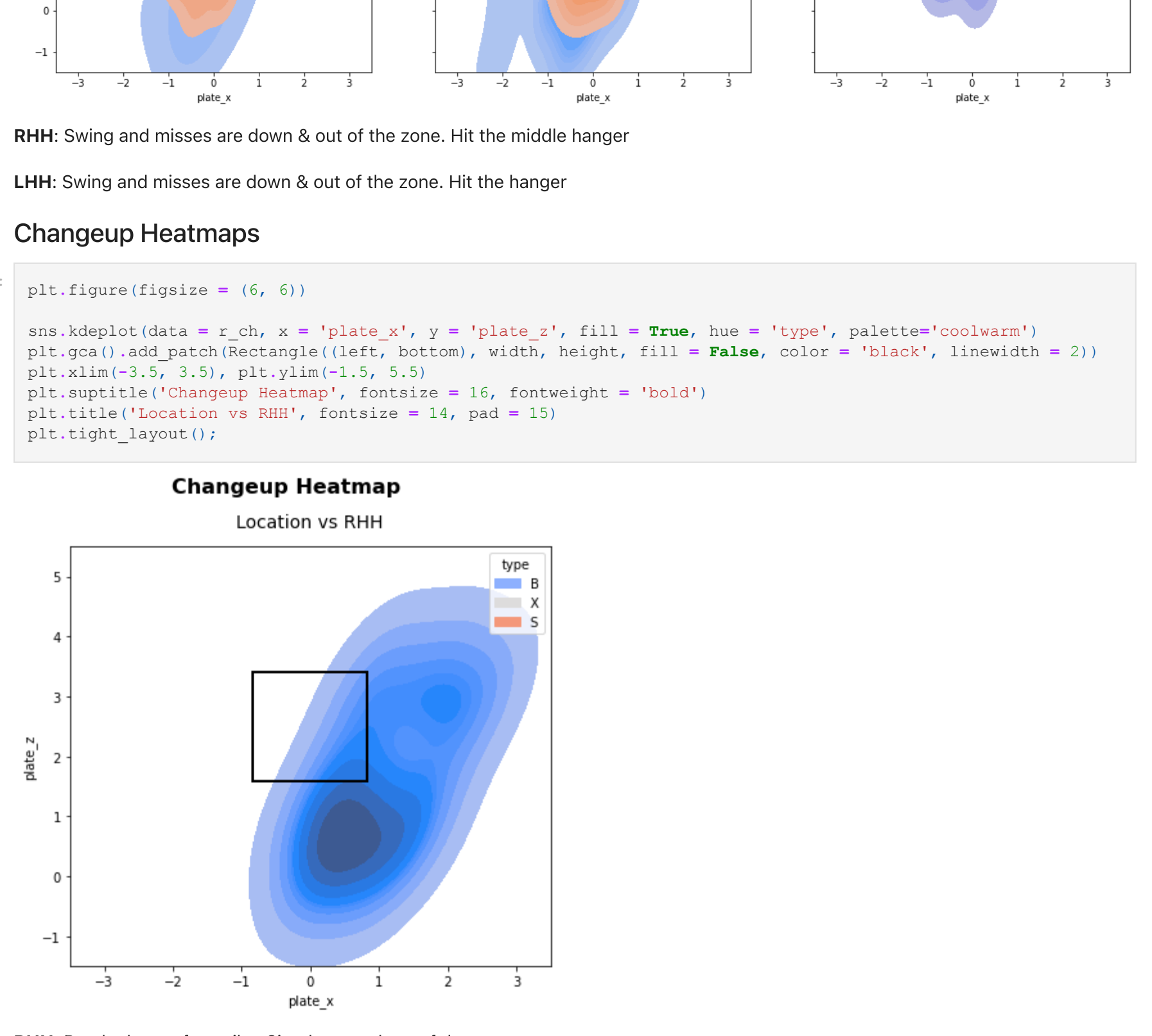
RHH: Lots of swings & misses down & in. Inside corner. Damage is done when more middle

LHH: Lots of swings & misses down & away. Damage done middle middle

## 4-Seam Heatmaps

```
fig, axs = plt.subplots(2, 3, figsize = (20, 12), sharex = True, sharey = True)
fig.suptitle('4-Seam Heatmap', fontsize = 16, fontweight = 'bold')
plt.axis(xmin = -3.5, xmax = 3.5, plt.axis(ymin = -1.5, ymax = 5.5)
plt.axis(xmin = -3.5, xmax = 3.5), plt.axis(ymin = -1.5, ymax = 5.5)
sns.kdeplot(ax = axs[0][0], data=df, x='plate_x', y='plate_z', fill=True, hue='is_strike', palette='coolwarm')
axs[0][0].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[0][0].set_title('Location vs RHH', fontsize = 14, pad = 15)
axs[0][1].set_title('Swing and Miss vs RHH', fontsize = 14, pad = 15)
axs[0][2].set_title('WOBA Value vs RHH', fontsize = 14, pad = 15)
sns.kdeplot(ax = axs[1][0], data=df, x='plate_x', y='plate_z', fill = True, hue='is_strike', palette='coolwarm')
axs[1][0].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[1][1].set_title('Swing and Miss vs LHH', fontsize = 14, pad = 15)
axs[1][2].set_title('WOBA Denom vs LHH', fontsize = 14, pad = 15)
sns.kdeplot(ax = axs[0][1], data=df, x='plate_x', y='plate_z', fill=True, hue='is_strike', palette='coolwarm')
axs[0][1].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[0][1].set_title('Slider Hard Hit Summary vs All Hitters', fontsize = 14, pad = 15)
axs[0][2].set_title('4-Seam Hard Hit Summary vs All Hitters', fontsize = 14, pad = 15)
sns.kdeplot(ax = axs[1][1], data=df, x='plate_x', y='plate_z', fill=True, hue='is_strike', palette='coolwarm')
axs[1][1].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[1][1].set_title('Curveball Hard Hit Summary vs All Hitters', fontsize = 14, pad = 15)
axs[1][2].set_title('Changeup Location vs All Hitters', fontsize = 14, pad = 15)
```

## 4-Seam Heatmap



RHH: Gets lots of swings & misses inner 1/3 up. Damage is done when more middle

LHH: Swings & misses middle up

## Curveball Heatmaps

```
fig, axs = plt.subplots(2, 3, figsize = (20, 12), sharex = True, sharey = True)
fig.suptitle('Curveball Heatmap', fontsize = 16, fontweight = 'bold')
plt.axis(xmin = -3.5, xmax = 3.5, plt.axis(ymin = -1.5, ymax = 5.5)
plt.axis(xmin = -3.5, xmax = 3.5), plt.axis(ymin = -1.5, ymax = 5.5)
sns.kdeplot(ax = axs[0][0], data=df, x='plate_x', y='plate_z', fill=True, hue='is_strike', palette='coolwarm')
axs[0][0].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[0][0].set_title('Location vs RHH', fontsize = 14, pad = 15)
axs[0][1].set_title('Swing and Miss vs RHH', fontsize = 14, pad = 15)
axs[0][2].set_title('WOBA Value vs RHH', fontsize = 14, pad = 15)
sns.kdeplot(ax = axs[1][0], data=df, x='plate_x', y='plate_z', fill = True, hue='is_strike', palette='coolwarm')
axs[1][0].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[1][1].set_title('Swing and Miss vs LHH', fontsize = 14, pad = 15)
axs[1][2].set_title('WOBA Denom vs LHH', fontsize = 14, pad = 15)
sns.kdeplot(ax = axs[0][1], data=df, x='plate_x', y='plate_z', fill=True, hue='is_strike', palette='coolwarm')
axs[0][1].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[0][1].set_title('Slider Hard Hit Summary vs All Hitters', fontsize = 14, pad = 15)
axs[0][2].set_title('4-Seam Hard Hit Summary vs All Hitters', fontsize = 14, pad = 15)
sns.kdeplot(ax = axs[1][1], data=df, x='plate_x', y='plate_z', fill=True, hue='is_strike', palette='coolwarm')
axs[1][1].add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
axs[1][1].set_title('Curveball Hard Hit Summary vs All Hitters', fontsize = 14, pad = 15)
axs[1][2].set_title('Changeup Location vs All Hitters', fontsize = 14, pad = 15)
```

## Curveball Heatmap



RHH: Swing and misses are down & out of the zone. Hit the hanging

LHH: Swing and misses are down & out of the zone. Hit the hanger

## Changeup Heatmaps

```
plt.figure(figsize = (6, 6))
sns.kdeplot(data = r_ch, x = 'plate_x', y = 'plate_z', fill = True, hue = 'type', palette='coolwarm')
plt.gca().add_patch(Rectangle((-83, 1.5), 1.66, 1.82, fill = False, color = 'black', linewidth = 2))
plt.xlim(-3.5, 3.5), plt.ylim(-1.5, 5.5)
plt.suptitle('Changeup Heatmap', fontsize = 16, fontweight = 'bold')
plt.title('Location vs RHH', fontsize = 14, pad = 15)
plt.tight_layout()
```

## Changeup Heatmap



RHH: Barely thrown for strike. Sits down and out of the zone