

# Animating NFL play-by-play data using matplotlib's FuncAnimation()

Miranda Auhl



Timescale

April 29th, 2022



# Miranda Auhl

Developer Advocate at Timescale



mirandaauhl



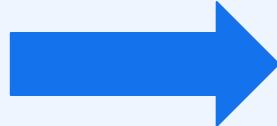
miranda@timescale.com



miranda\_auhl

**I want to take you  
on a journey...**

**Static  
graph**

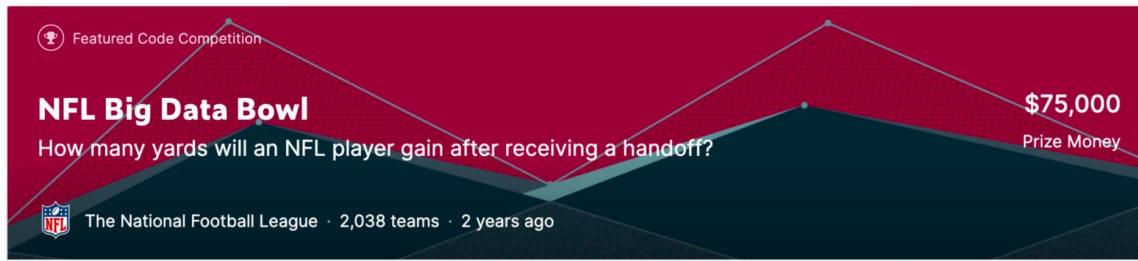


**Data  
animation**

- Understanding the data
- Create a static visualization
- Transform the static graph to an animation







NFL Big Data Bowl via Kaggle: <https://www.kaggle.com/competitions/nfl-big-data-bowl-2021>



**All analysis starts with  
knowing the data**

tracking 1 ×

Enter a SQL expression to filter results (use Ctrl+Space)

Grid Text Record

	time	x	y	s	a	game_id	play_id	frame
1	2018-09-07 01:07:14.599	91.73	26.67	0	0.01	2,018,090,600	75	1
2	2018-09-07 01:07:14.599	88.89	36.47	0.01	0.01	2,018,090,600	75	1
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← T select time, x,y,s,a,gameid as game\_id, play\_id, frame from tracking order by time asc

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Grid

Text

Record

Photo

Panels

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Save

Cancel

Script

E E E E

&lt; &lt; &gt; &gt;

↑ ↓

200

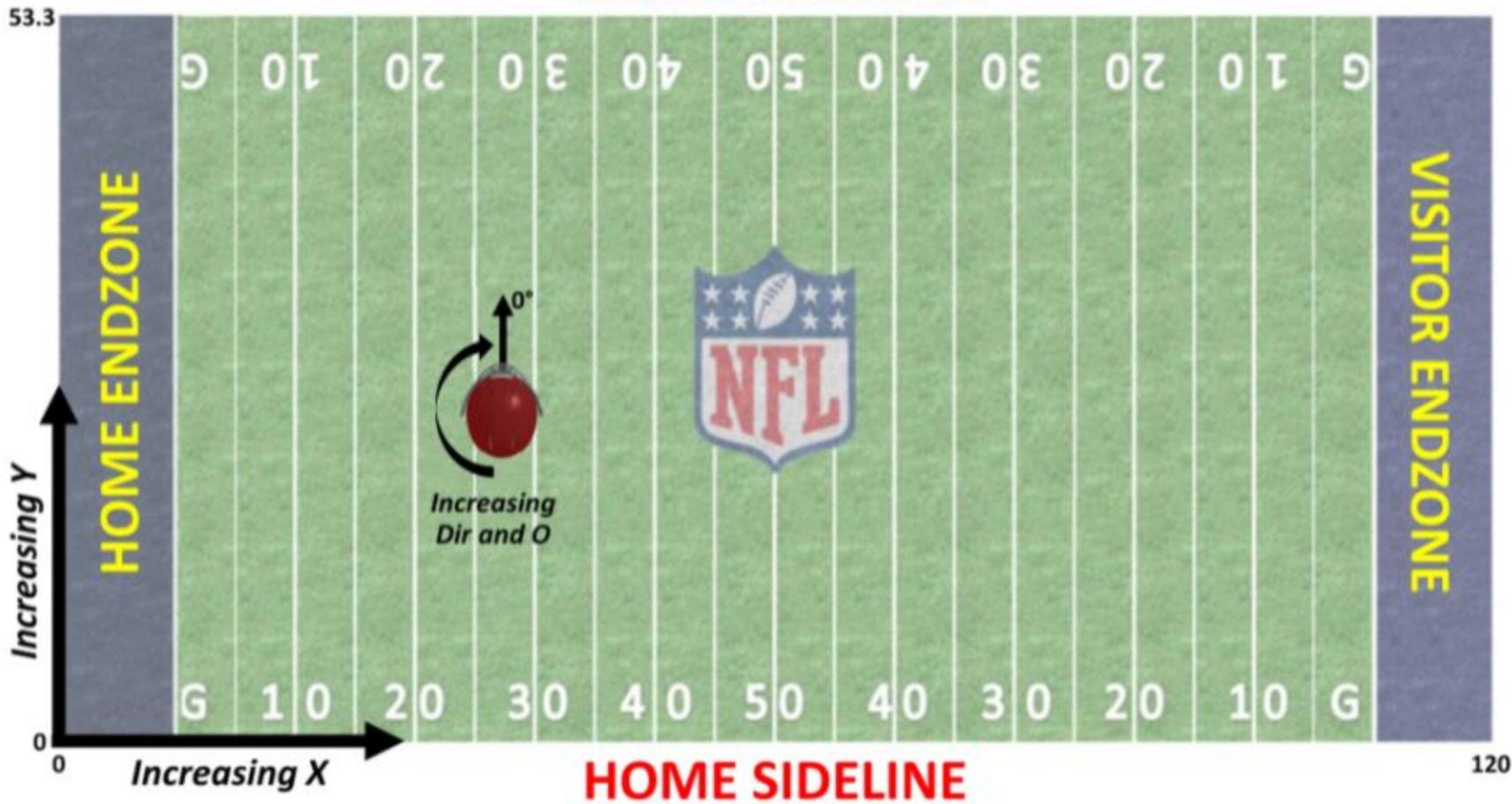
200+

Rows: 1

200 row(s) fetched - 24.535s (+1ms)

D

# VISITOR SIDELINE



tracking 1 ×

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21	2018-09-07 01:07:14.700	98.25	26.63	0.01	0.01	2,018,090,600	75	2

tracking 1 ×

Enter a SQL expression to filter results (use **Ctrl+Space**)

Grid Text Record

	time	x	y	s	a	game_id	play_id	frame
1	2018-09-07 01:07:14.599	91.73	26.67	0	0.01	2,018,090,600	75	1
2	2018-09-07 01:07:14.599	88.89	36.47	0.01	0.01	2,018,090,600	75	1
3	2018-09-07 01:07:14.599	91.35	44.16	0.02	0.03	2,018,090,600	75	1
4	2018-09-07 01:07:14.599	86.31	22.01	0.09	0.42	2,018,090,600	75	1
5	2018-09-07 01:07:14.599	90.78	36.15	0	0	2,018,090,600	75	1
6	2018-09-07 01:07:14.599	73.64	28.7	0.03	0.02	2,018,090,600	75	1
7	2018-09-07 01:07:14.599	98.25	26.63	0.01	0.01	2,018,090,600	75	1
8	2018-09-07 01:07:14.599	86.48	31.12	0.09	0.03	2,018,090,600	75	1
9	2018-09-07 01:07:14.599	82.67	20.53	0.03	0.07	2,018,090,600	75	1
10	2018-09-07 01:07:14.599	84	43.49	0.14	0.05	2,018,090,600	75	1
11	2018-09-07 01:07:14.599	91.29	21.83	0.01	0.02	2,018,090,600	75	1
12	2018-09-07 01:07:14.599	85.63	26.59	0.03	0.04	2,018,090,600	75	1
13	2018-09-07 01:07:14.599	95.13	26.71	0.01	0.01	2,018,090,600	75	1
14	2018-09-07 01:07:14.599	90.11	26.85	0	0	2,018,090,600	75	1
15	2018-09-07 01:07:14.700	91.73	26.67	0	0	2,018,090,600	75	2
16	2018-09-07 01:07:14.700	88.89	36.47	0.01	0.01	2,018,090,600	75	2
17	2018-09-07 01:07:14.700	91.37	4				75	2
18	2018-09-07 01:07:14.700	86.32					75	2
19	2018-09-07 01:07:14.700	90.78	36.15	0	0	2,018,090,600	75	2
20	2018-09-07 01:07:14.700	73.64	28.7	0.03	0.02	2,018,090,600	75	2
21	2018-09-07 01:07:14.700	98.25	26.63	0.01	0.01	2,018,090,600	75	2

tracking 1 ×

select time, x,y,s,a,gameId as game\_id, play\_id, frame  
Enter a SQL expression to filter results (use Ctrl+Space)

Grid Text Record

	time	x	y	s	a	game_id	play_id	frame
1	2018-09-07 01:07:14.599	91.73	26.67	0	0.01	2,018,090,600	75	1
2	2018-09-07 01:07:14.599	88.89	36.47	0.01	0.01	2,018,090,600	75	1
3	2018-09-07 01:07:14.599	91.35	44.16	0.02	0.03	2,018,090,600	75	1
4	2018-09-07 01:07:14.599	86.31	22.01	0.09	0.42	2,018,090,600	75	1
5	2018-09-07 01:07:14.599	90.78	36.15	0	0	2,018,090,600	75	1
6	2018-09-07 01:07:14.599	73.64	28.7	0.03	0.02	2,018,090,600	75	1
7	2018-09-07 01:07:14.599	98.25	26.63	0.01	0.01	2,018,090,600	75	1
8	2018-09-07 01:07:14.599	86.48	31.12	0.09	0.03	2,018,090,600	75	1
9	2018-09-07 01:07:14.599	82.67	20.53	0.03	0.07	2,018,090,600	75	1
10	2018-09-07 01:07:14.599	84	43.49	0.14	0.05	2,018,090,600	75	1
11	2018-09-07 01:07:14.599	91.29	21.83	0.01	0.02	2,018,090,600	75	1
12	2018-09-07 01:07:14.599	85.63	26.59	0.03	0.04	2,018,090,600	75	1
13	2018-09-07 01:07:14.599	95.13	26.71	0.01	0.01	2,018,090,600	75	1
14	2018-09-07 01:07:14.599	90.11	26.85	0	0	2,018,090,600	75	1
15	2018-09-07 01:07:14.700	91.73	26.67	0	0	2,018,090,600	75	2
16	2018-09-07 01:07:14.700	88.89	36.47	0.01	0.01	2,018,090,600	75	2
17	2018-09-07 01:07:14.700	91.37	44.17	0.03	0.03	2,018,090,600	75	2
18	2018-09-07 01:07:14.700	86.32	22	0.1	0.58	2,018,090,600	75	2
19	2018-09-07 01:07:14.700	90.78	36.15	0	0	2,018,090,600	75	2
20	2018-09-07 01:07:14.700	73.64	28.7	0.03	0.02	2,018,090,600	75	2
21	2018-09-07 01:07:14.700	98.25	26.63	0.01	0.01	2,018,090,600	75	2

# Analyze the data

Plot the players' **location** for one moment in time



## Prep code: set game & play ID + get data from DB

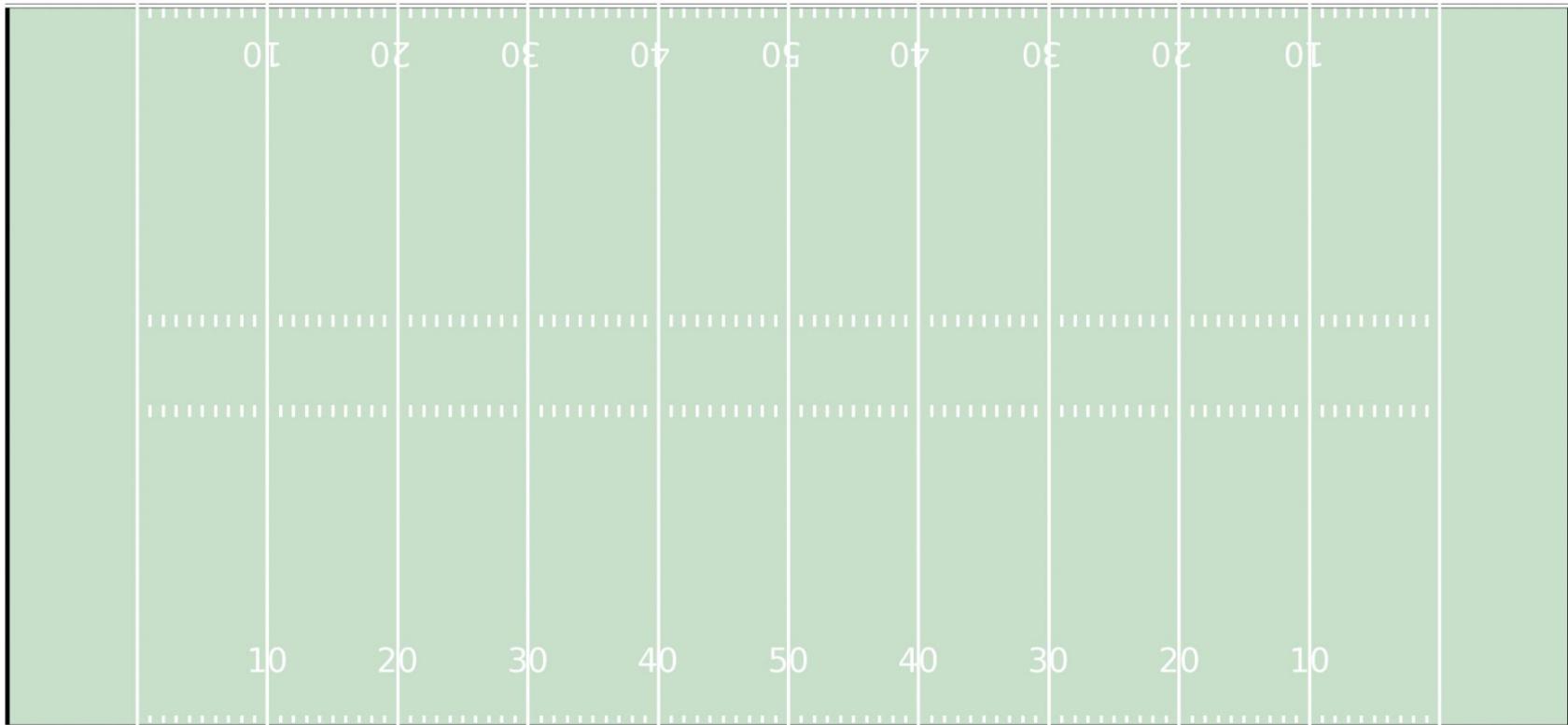
```
# define game_id and play_id input values
gameid=2018111900
playid=4120
d = {}

# get stat overview query information
sql = "select \
|   max(a) as max acc, \
```

First, I need a field

```
def generate_field():
    rect = patches.Rectangle((0, 0), 120, 53.3, linewidth=2,
                           edgecolor='black', facecolor='#1BA821', zorder=0)
    ax.add_patch(rect)

    # plot line numbers
    for a in [10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110]:
        ax.axvline(x=a, color='white')
    # added to set y-axis up for the numbers
    ax.axhline(y=0, color='white')
    ax.axhline(y=53.3, color='white')
```



Next, I need to plot  
the players

```
def draw_play(frame):
    home = tracking.loc[(tracking['frameid'] == frame) & (tracking['team'] == 'home') ]
    away = tracking.loc[(tracking['frameid'] == frame) & (tracking['team'] == 'away') ]
    ball = tracking.loc[(tracking['frameid'] == frame) & (tracking['team'] == 'football') ]

    # visualize positions with scatter plot on our field
    ax.plot(home['x'], home['y'], linestyle='None', marker='o', mfc='#0069D1', mec='#0069D1', label = 'Home team')
    ax.plot(away['x'], away['y'], linestyle='None', marker='o', mfc='#D92F38', mec='#D92F38', label = 'Away team')
    ax.plot(ball['x'], ball['y'], linestyle='None', marker='o', mfc='#E89B00', mec='#E89B00', label = 'Football')

    # query play description and possession team and add them in the title
    ax.set_title("\n".join(wrap('Possession team: {team}\nPlay: {play}'.format(team=play_info[0]['possessionteam'], play=play_info[0]['playdescription'])), 70))

    # plot legend
    ax.legend(loc='upper right')
```

← T select time, x,y,s,a,gameid as game\_id, play\_id, frame from tracking 1 Enter a SQL expression to filter results (use Ctrl+Space)



Grid

Text

Record

Photo

Panels

	time	x	y	s	a	game_id	play_id	frame
1	2018-09-07 01:07:14.599	91.73	26.67	0	0.01	2,018,090,600	75	1
2	2018-09-07 01:07:14.599	88.89	36.47	0.01	0.01	2,018,090,600	75	1
3	2018-09-07 01:07:14.599	91.35	44.16	0.02	0.03	2,018,090,600	75	1
4	2018-09-07 01:07:14.599	86.31	22.01	0.09	0.42	2,018,090,600	75	1
5	2018-09-07 01:07:14.599	90.78	36.15	0	0	2,018,090,600	75	1
6	2018-09-07 01:07:14.599	73.64	28.7	0.03	0.02	2,018,090,600	75	1
7	2018-09-07 01:07:14.599	98.25	26.63	0.01	0.01	2,018,090,600	75	1
8	2018-09-07 01:07:14.599	86.48	22	0.1	0.58	2,018,090,600	75	1
9	2018-09-07 01:07:14.599	82.67	20.53	0.03	0.07	2,018,090,600	75	1
10	2018-09-07 01:07:14.599	84	43.49	0.14	0.05	2,018,090,600	75	1
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13	2018-09-07 01:07:14.599	95.13	26.71	0.01	0.01	2,018,090,600	75	1
14	2018-09-07 01:07:14.599	90.11	26.85	0	0	2,018,090,600	75	1
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17	2018-09-07 01:07:14.700	91.37	44.17	0.03	0.03	2,018,090,600	75	2
18	2018-09-07 01:07:14.700	86.32	22	0.1	0.58	2,018,090,600	75	2
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21	2018-09-07 01:07:14.700	98.25	26.63	0.01	0.01	2,018,090,600	75	2

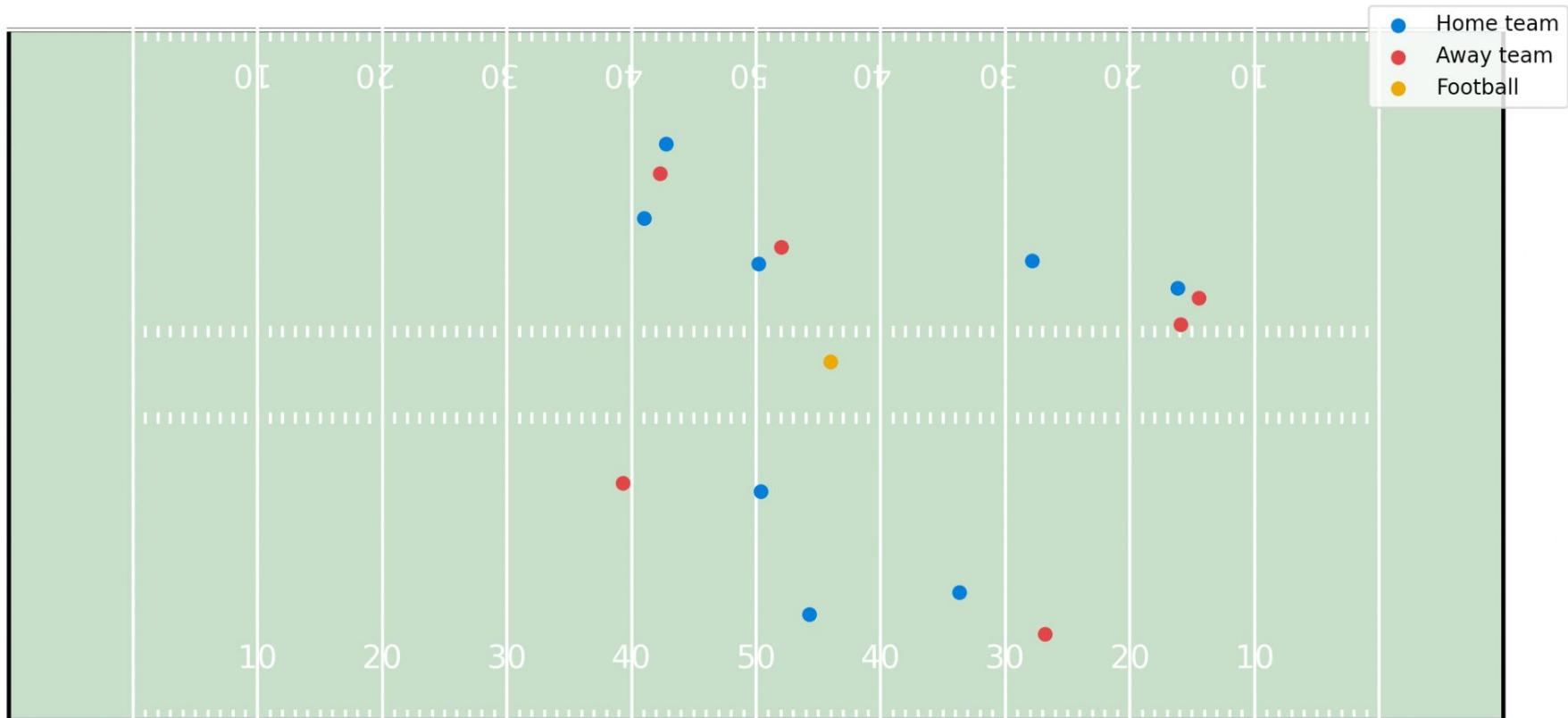
```
def draw_play(frame):
    home = tracking.loc[(tracking['frameid'] == frame) & (tracking['team'] == 'home') ]
    away = tracking.loc[(tracking['frameid'] == frame) & (tracking['team'] == 'away') ]
    ball = tracking.loc[(tracking['frameid'] == frame) & (tracking['team'] == 'football') ]

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    ax.plot(home['x'], home['y'], linestyle='None', marker='o', mfc='#0069D1', mec='#0069D1', label = 'Home team')
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    # plot legend
    ax.legend(loc='upper right')
```

Possession team: KC Play: (12:15) P.Mahomes pass deep middle to T.Hill  
for 73 yards, TOUCHDOWN. PENALTY on KC-T.Hill, Taunting, 15 yards,  
enforced between downs.

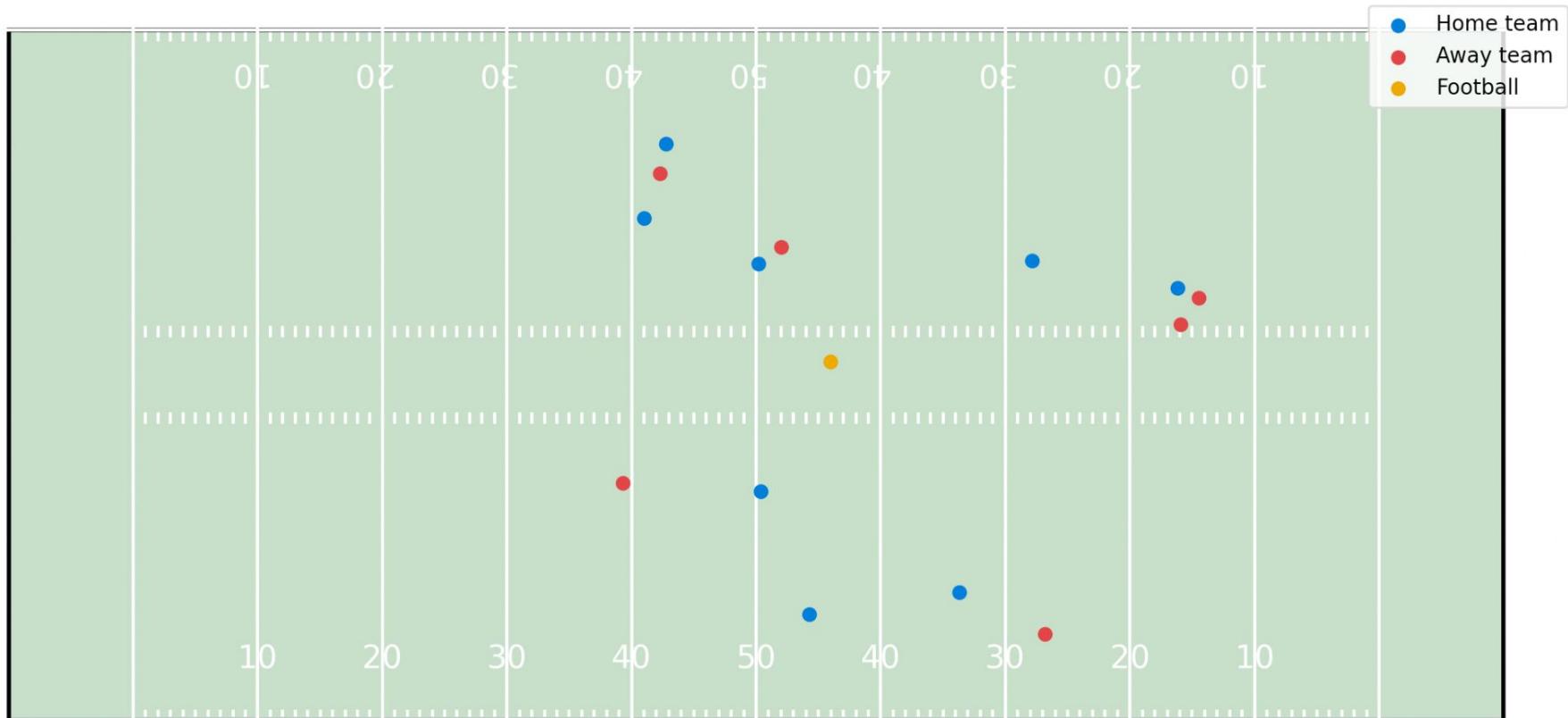




# Functions and their input

```
# plot static graph
fig, ax = plt.subplots(figsize=(14, 6.5))
generate_field()
draw_play(frame=65)
plt.show()
```

Possession team: KC Play: (12:15) P.Mahomes pass deep middle to T.Hill  
for 73 yards, TOUCHDOWN. PENALTY on KC-T.Hill, Taunting, 15 yards,  
enforced between downs.

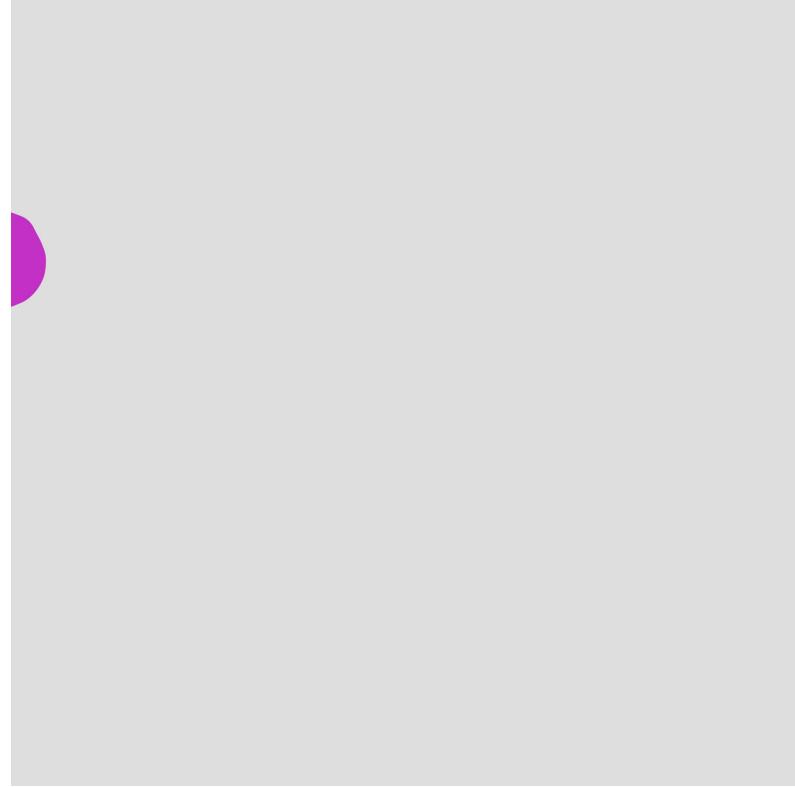


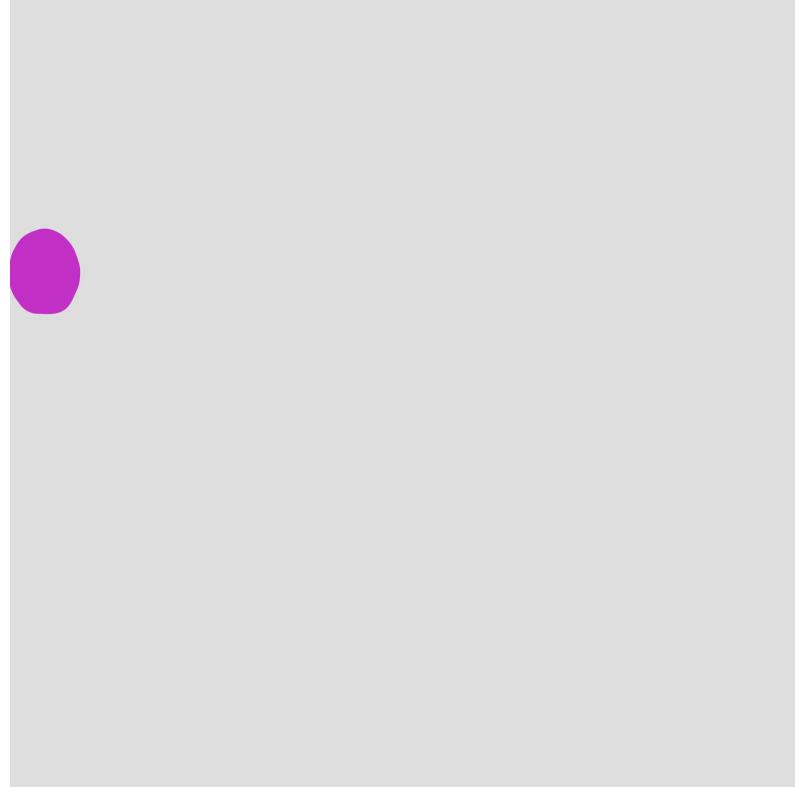
**What if I could animate the  
players' locations on the  
field?**

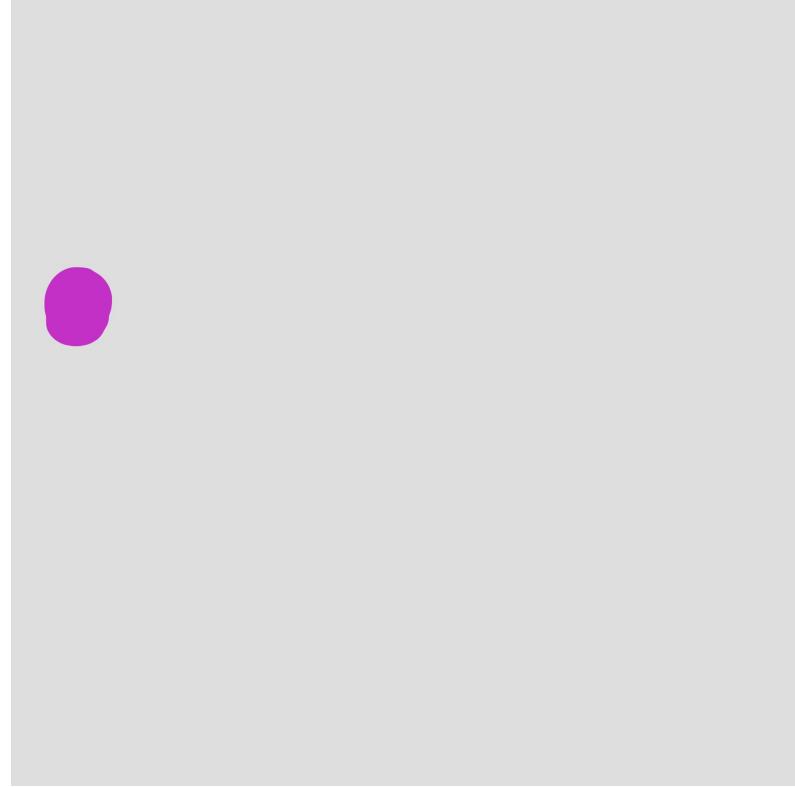
# Where FuncAnimation() comes into play!

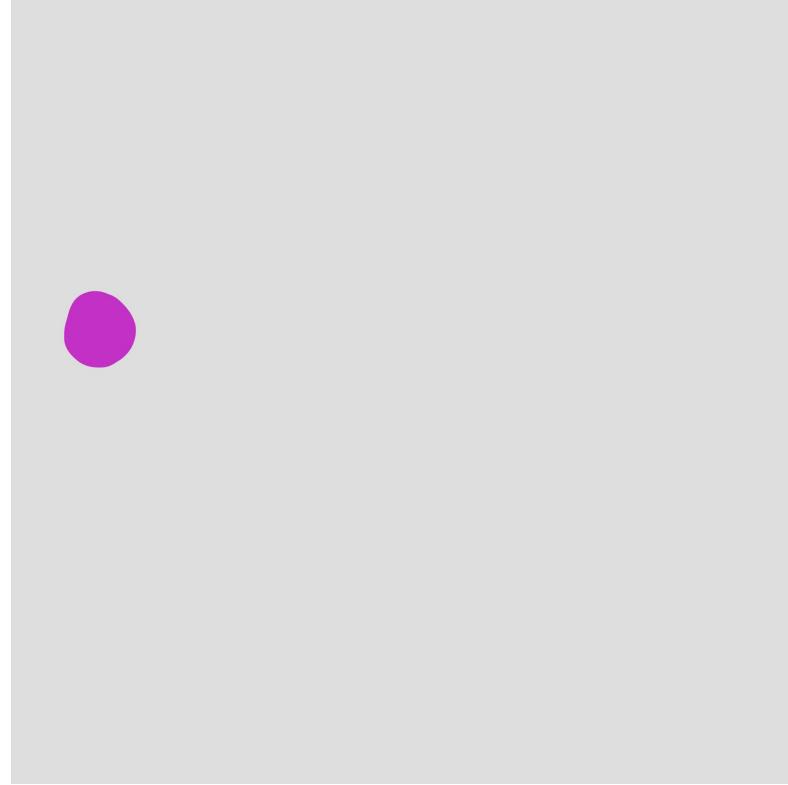
# How do animations work?

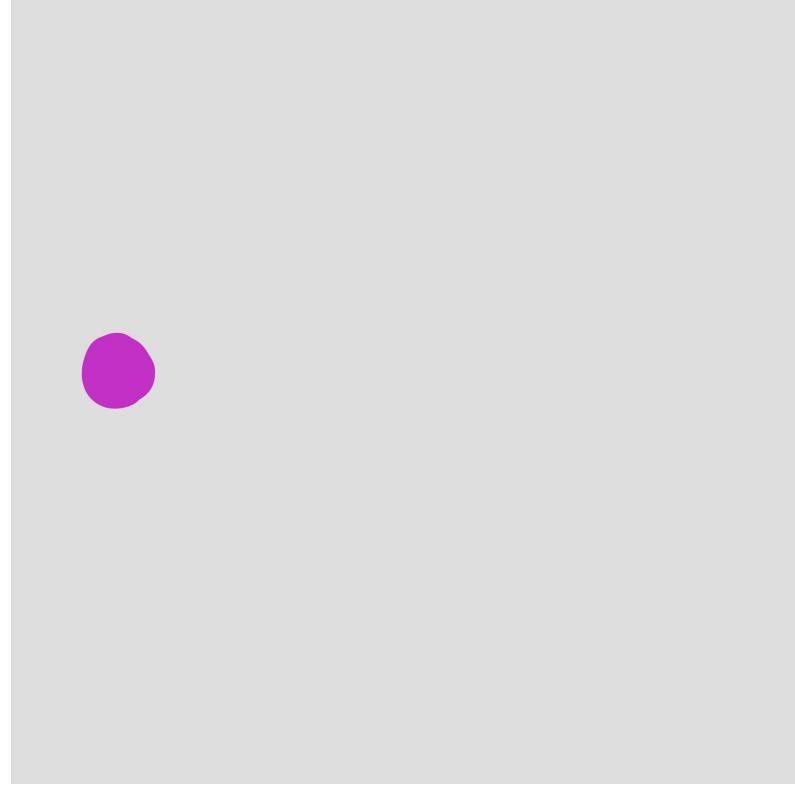
**Let's consider a flipbook**

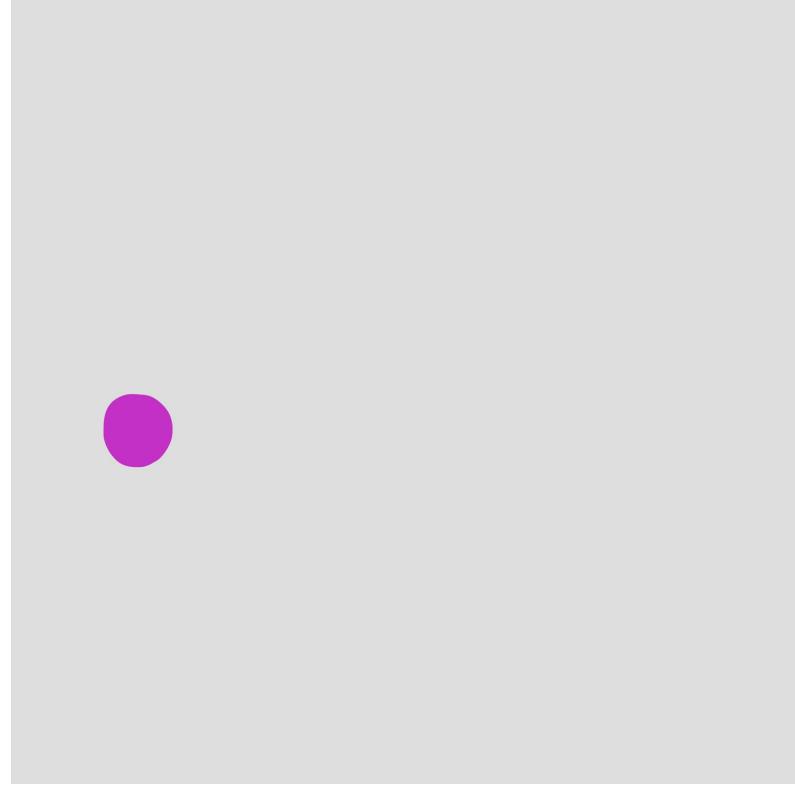


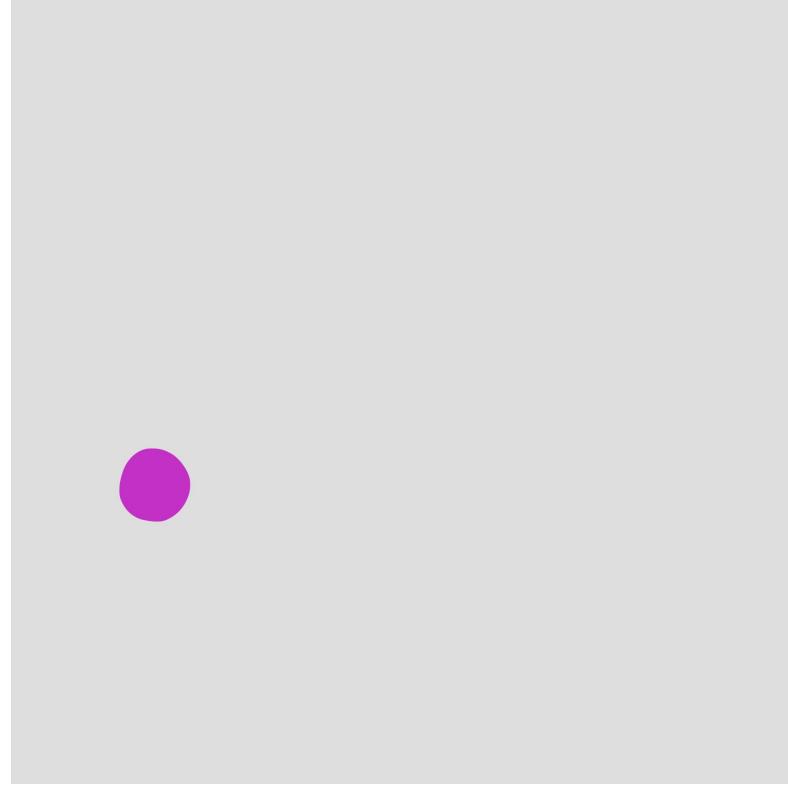


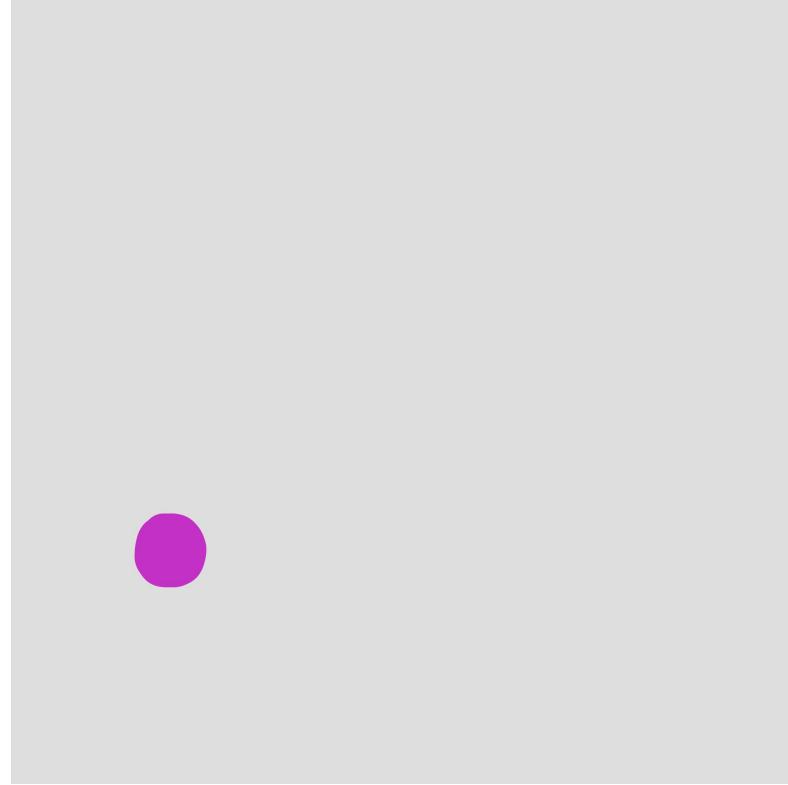






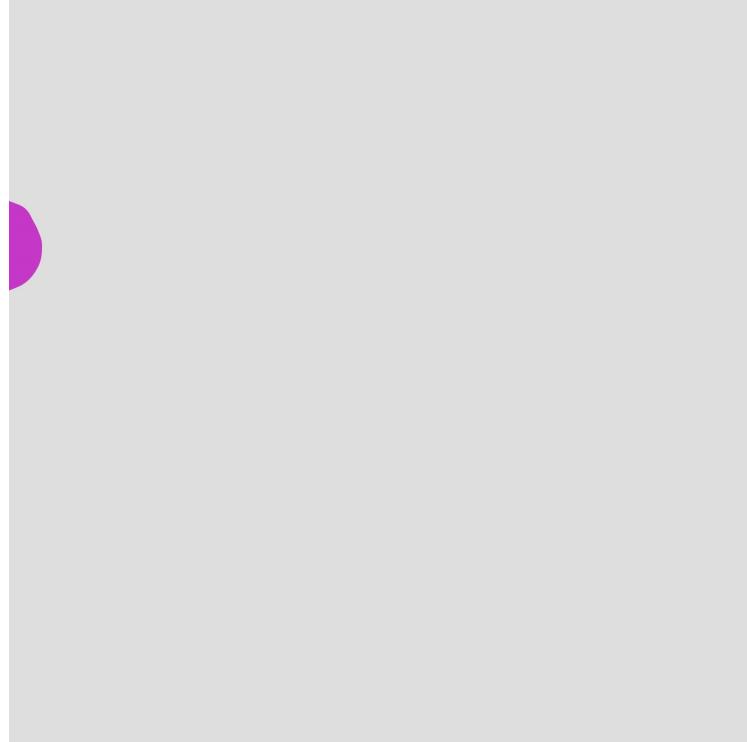








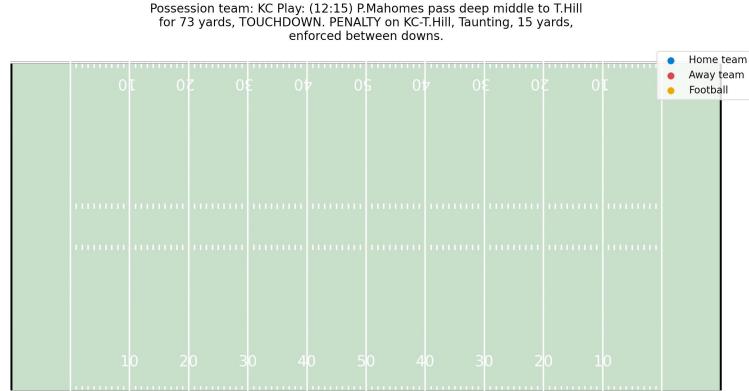
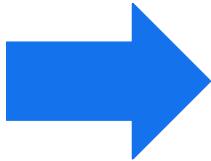
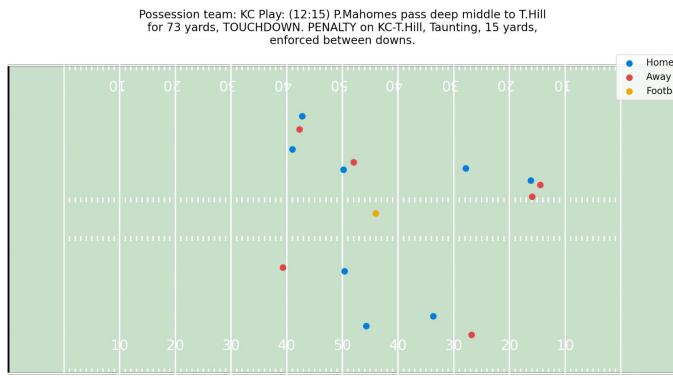
# Series of static images shown in sync



**FuncAnimation() is basically  
a fancy flipbook!**



# FuncAnimation() process



Takes in static graph function

Iterates over the function to animate it



```
FuncAnimation(fig, func, frames=None, init_func=None,  
fargs=None, save_count=None, *,  
cache_frame_data=True, **kwargs)
```



## FuncAnimation(*fig*, *func*)

**Fig:**

matplotlib figure object

**Func:**

a plotting function that funcanimation() can iterate on



# Functions and their input

```
# plot static graph
fig, ax = plt.subplots(figsize=(14, 6.5))
generate_field()
draw_play(frame=65)
plt.show()
```



# Functions and their input

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# plot static graph
fig, ax = plt.subplots(figsize=(14, 6.5))
generate_field()
draw_play frame=65
plt.show()
```

tracking 1 ×

Enter a SQL expression to filter results (use Ctrl+Space)

Grid Text Record

	time	x	y	s	a	game_id	play_id	frame
1	2018-09-07 01:07:14.599	91.73	26.67	0	0.01	2,018,090,600	75	1
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3	2018-09-07 01:07:14.599	91.35	44.16	0.02	0.03	2,018,090,600	75	1
4	2018-09-07 01:07:14.599	86.31	22.01	0.09	0.42	2,018,090,600	75	1
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7	2018-09-07 01:07:14.599	98.25	26.63	0.01	0.01	2,018,090,600	75	1
8	2018-09-07 01:07:14.599	86.48	31.12	0.09	0.03	2,018,090,600	75	1
9	2018-09-07 01:07:14.599	82.67	20.53	0.03	0.07	2,018,090,600	75	1
10	2018-09-07 01:07:14.599	84	43.49	0.14	0.05	2,018,090,600	75	1
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17	2018-09-07 01:07:14.700	91.37	44.17	0.03	0.03	2,018,090,600	75	2
18	2018-09-07 01:07:14.700	86.32	22	0.1	0.58	2,018,090,600	75	2
19	2018-09-07 01:07:14.700	90.78	36.15	0	0	2,018,090,600	75	2
20	2018-09-07 01:07:14.700	73.64	28.7	0.03	0.02	2,018,090,600	75	2
21	2018-09-07 01:07:14.700	98.25	26.63	0.01	0.01	2,018,090,600	75	2

select time, x,y,s,a,gameid as game\_id, play\_id, frame

Enter a SQL expression to filter results (use Ctrl+Space)

Grid	time	x	y	s	a	game_id	play_id	frame
1	2018-09-07 01:07:14.599	91.73	26.67	0	0.01	2,018,090,600	75	1
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3	2018-09-07 01:07:14.599	91.35	44.16	0.02	0.03	2,018,090,600	75	1
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6	2018-09-07 01:07:14.599	73.64	28.7	0.03	0.03	2,018,090,600	75	1
7	2018-09-07 01:07:14.599	98.25	26.63	0.01	0.01	2,018,090,600	75	1
8	2018-09-07 01:07:14.599	86.48	31.9	0.03	0.07	2,018,090,600	75	1
9	2018-09-07 01:07:14.599	82.67	20.53	0.03	0.07	2,018,090,600	75	1
10	2018-09-07 01:07:14.599	84	43.49	0.14	0.05	2,018,090,600	75	1
11	2018-09-07 01:07:14.599	91.29	21.83	0.01	0.02	2,018,090,600	75	1
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21	2018-09-07 01:07:14.700	98.25	26.63	0.01	0.01	2,018,090,600	75	2

tracking 1 ×

Grid Text Record

SQL: `select time, x,y,s,a,game_id as game_id, play_id, frame` Enter a SQL expression to filter results (use `Ctrl+Space`)

Save Cancel Script

200 200+ Rows: 1 200 row(s) fetched - 24.535s (+1ms)

	time	x	y	s	a	game_id	play_id	frame
1	2018-09-07 01:07:14.599	91.73	26.67	0	0.01	2,018,090,600	75	1
2	2018-09-07 01:07:14.599	88.89	36.47	0.01	0.01	2,018,090,600	75	1
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5	2018-09-07 01:07:14.599	90.78	36.15	0	0	2,018,090,600	75	1
6	2018-09-07 01:07:14.599	73.64	28.7	0.03	0.01	2,018,090,600	75	1
7	2018-09-07 01:07:14.599	98.25	26.63	0.01	0.01	2,018,090,600	75	1
8	2018-09-07 01:07:14.599	86.48	31.44	0.01	0.01	2,018,090,600	75	1
9	2018-09-07 01:07:14.599	82.67	20.53	0.03	0.07	2,018,090,600	75	1
10	2018-09-07 01:07:14.599	84	43.49	0.14	0.05	2,018,090,600	75	1
11	2018-09-07 01:07:14.599	91.29	21.83	0.01	0.02	2,018,090,600	75	1
12	2018-09-07 01:07:14.599	85.63	26.59	0.03	0.04	2,018,090,600	75	1
13	2018-09-07 01:07:14.599	95.13	26.71	0.01	0.01	2,018,090,600	75	1
14	2018-09-07 01:07:14.599	90.11	26.85	0	0	2,018,090,600	75	1
15	2018-09-07 01:07:14.700	91.73	26.67	0	0	2,018,090,600	75	2
16	2018-09-07 01:07:14.700	88.89	36.47	0.01	0.01	2,018,090,600	75	2
17	2018-09-07 01:07:14.700	91.37	44.17	0.03	0.03	2,018,090,600	75	2
18	2018-09-07 01:07:14.700	86.32	22	0.1	0.58	2,018,090,600	75	2
19	2018-09-07 01:07:14.700	90.78	36.15	0	0	2,018,090,600	75	2
20	2018-09-07 01:07:14.700	73.64	28.7	0.03	0.02	2,018,090,600	75	2
21	2018-09-07 01:07:14.700	98.25	26.63	0.01	0.01	2,018,090,600	75	2



```
# plot static graph
fig, ax = plt.subplots(figsize=(14, 6.5))
generate_field()
draw_play(frame=65)
plt.show()
```



```
# plot static graph
fig, ax = plt.subplots(figsize=(14, 6.5))
generate_field()
draw_play(frame=65)
plt.show()
```



FuncAnimation(fig, draw\_play(frame))



```
# plot static graph
fig, ax = plt.subplots(figsize=(14, 6.5))
generate_field()
draw_play(frame)
plt.show()
```



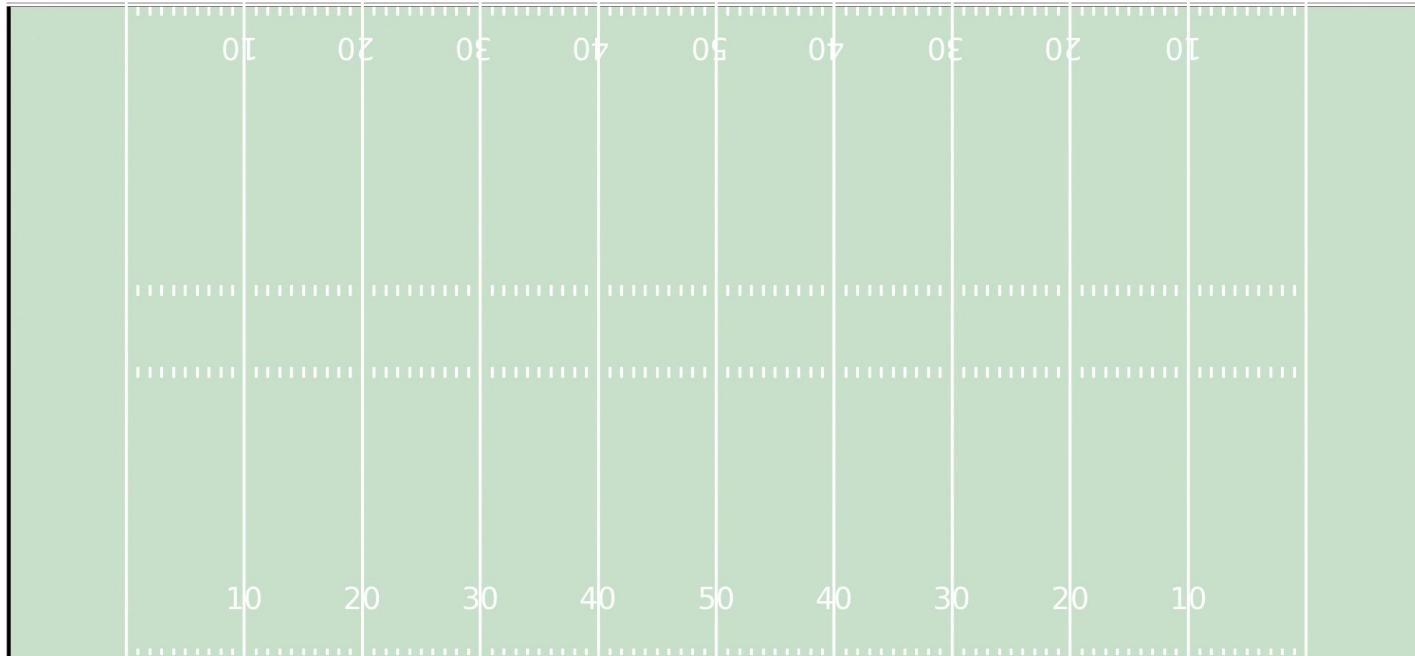
FuncAnimation(**frame**, draw\_play(**frame**))

**Basically yes!**

**But we need to make some  
quick adjustments!**



# Move the legend generation





# Plot vs Set

```
def draw_play(frame):
    home = tracking.loc[(tracking['frameid'] == frame) & (tracking['team'] == 'home') ]
    away = tracking.loc[(tracking['frameid'] == frame) & (tracking['team'] == 'away') ]
    ball = tracking.loc[(tracking['frameid'] == frame) & (tracking['team'] == 'football') ]

    # visualize positions with scatter plot on our field
    ax.plot(home['x'], home['y'], linestyle='None', marker='o', mfc='#0069D1', mec='#0069D1', label = 'Home team')
    ax.plot(away['x'], away['y'], linestyle='None', marker='o', mfc='#D92F38', mec='#D92F38', label = 'Away team')
    ax.plot(ball['x'], ball['y'], linestyle='None', marker='o', mfc='#E89B00', mec='#E89B00', label = 'Football')

    # query play description and possession team and add them in the title
    ax.set_title("\n".join(wrap('Possession team: {team}\nPlay: {play}'.format(team=play_info[0]['possessionteam'],
    play=play_info[0]['playdescription']), 70)))

    # plot legend
    ax.legend(loc='upper right')
```



# Move legend to generate\_field()

```
def draw_play(frame):
    home = tracking.loc[(tracking['frameid'] == frame) & (tracking['team'] == 'home') ]
    away = tracking.loc[(tracking['frameid'] == frame) & (tracking['team'] == 'away') ]
    ball = tracking.loc[(tracking['frameid'] == frame) & (tracking['team'] == 'football') ]

    # visualize positions with scatter plot on our field
    ax.plot(home['x'], home['y'], linestyle='None', marker='o', mfc='#0069D1', mec='#0069D1', label = 'Home team')
    ax.plot(away['x'], away['y'], linestyle='None', marker='o', mfc='#D92F38', mec='#D92F38', label = 'Away team')
    ax.plot(ball['x'], ball['y'], linestyle='None', marker='o', mfc='#E89B00', mec='#E89B00', label = 'Football')

    # query play description and possession team and add them in the title
    ax.set_title("\n".join(wrap('Possession team: {team}\nPlay: {play}'.format(team=play_info[0]['possessionteam'],
    play=play_info[0]['playdescription']), 70)))
```



**Make sure iterative argument is first  
in our plotting function definition**



```
def draw_play(frame):  
    home = tracking.loc[(tracking['f
```

# Let's create our animation!



`FuncAnimation(fig, func, frames=None, init_func=None, fargs=None,  
save_count=None, *, cache_frame_data=True, **kwargs)`

```
# plot static graph
fig, ax = plt.subplots(figsize=(14, 6.5))
generate_field()
draw_play(frame=65)
plt.show()
```



`FuncAnimation(fig, func, frames=None, init_func=None, fargs=None,  
save_count=None, *, cache_frame_data=True, **kwargs)`

```
# plot static graph
fig, ax = plt.subplots(figsize=(14, 6.5))
generate_field()
draw_play(frame=65)
plt.show()

# create animation
anim = FuncAnimation()
```



`FuncAnimation(fig, func, frames=None, init_func=None, fargs=None, save_count=None, *, cache_frame_data=True, **kwargs)`

```
# plot static graph
fig, ax = plt.subplots(figsize=(14, 6.5))
generate_field()
draw_play(frame=65)
plt.show()

# create animation
anim = FuncAnimation(fig, draw_play
```



`FuncAnimation(fig, func, frames=None, init_func=None, fargs=None,  
save_count=None, *, cache_frame_data=True, **kwargs)`

```
# plot static graph
fig, ax = plt.subplots(figsize=(14, 6.5))
generate_field()
draw_play(frame=65)
plt.show()

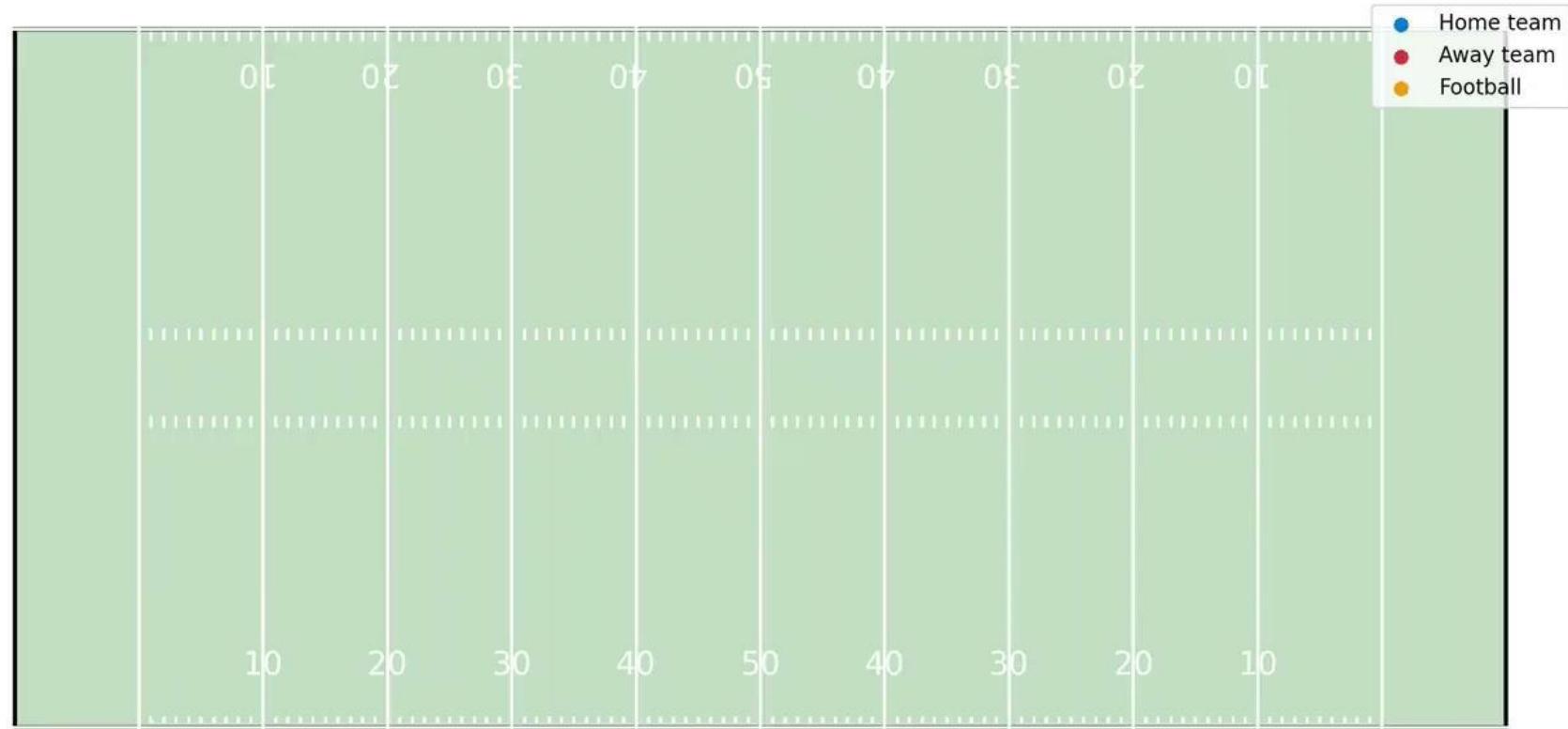
# create animation
anim = FuncAnimation(fig, draw_play, frames=range(1,113))
```

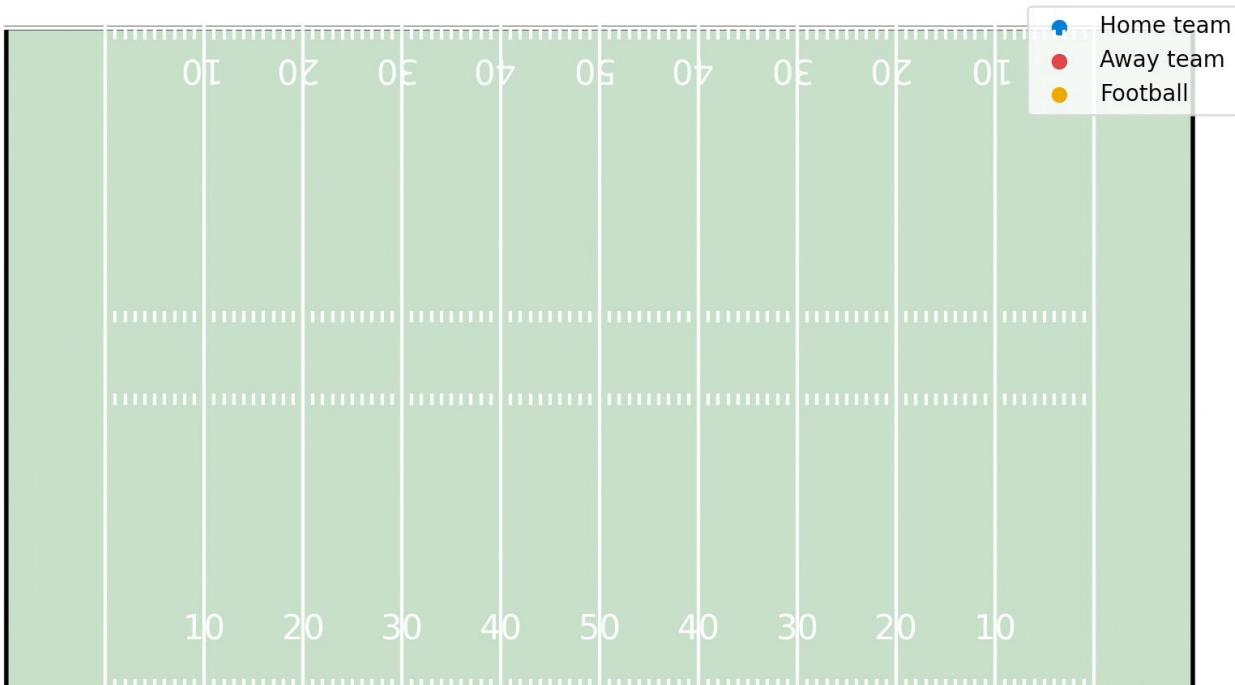


`FuncAnimation(fig, func, frames=None, init_func=None, fargs=None,  
save_count=None, *, cache_frame_data=True, **kwargs)`

```
# plot static graph
fig, ax = plt.subplots(figsize=(14, 6.5))
generate_field()
# draw_play(frame=65)
# plt.show()

# create animation
anim = FuncAnimation(fig, draw_play, frames=range(1,113))
plt.show()
```





Home team  
Away team  
Football

max_acc	max_speed	displayname	jerseynumber
11.3	9.74	Tyreek Hill	10
7.12	5.68	Patrick Mahomes	15
6.91	6.59	Kareem Hunt	27
5.62	8.22	Chris Conley	17
4.68	9.28	Demarcus Robinson	11

max_10_acc	max_10_speed
0.96	0.93

# How can you use animation?

## Animating process

Figure



Iterable plotting function



Animate it!





# Resources

GitHub project: <https://github.com/mirandaauhl/nfl-animation>

NFL Big Data Bowl via Kaggle: <https://www.kaggle.com/c/nfl-big-data-bowl-2021>

NFL tutorial for setting up the data yourself: <https://tsdb.co/nfl-data-tutorial>

Timescale NFL blog post: <https://tsdb.co/nfl-data>

# Happy coding friends

