Do Protected Bike Lanes Reduce Accidents Involving Cyclists?

Data Science
Final Project Presentation
Sarah Higgins

Buffered Bike Lane

Bike Lane

Overview

- Analyze Boston's Bike Network Data and Cyclist Accidents Datasets
- Determine if Buffered Bike Lanes decrease number of cyclist accidents than streets with a standard Bike Lane
- Analyze the most frequently taken streets by cyclists around Boston. Determine number of streets with buffered bike lanes.
- If there is a lower number of accidents on Buffered Bike Lane streets, adding Buffered Bike Lanes will help to provide more safety for cyclists especially on those streets most frequently taken.

DataSets

- ***Existing_Bike_Network.csv*** : Dataset with the existing bicycle network in Boston
- Has abbreviated lane type within 'ExisFacil' column

	FID	OBJECTID	STREET_NAM	ROADINVENT	FUNCTIONAL	JURISDICTI	Network	InstallDat	ExisFacil	Road	Divided	TravelLane	OneWay	LTS	PHASE	Shape_Leng
0	1001	8777	Warren Street	4714200	5	2	1	2010	SLM	1	0	2	B	3	2	33.995267
1	1002	8785	Blue Hill Avenue	5175300	2	2	1	2010	SLM	1	1	2	FT	4	0	111.911219
2	1003	8792	Blue Hill Avenue	6282300	2	2	1	2010	BL	1	1	3	FT	3	0	92.776397
3	1004	8794	Blue Hill Avenue	4966300	2	2	1	2010	BL	1	1	2	FT	3	0	93.417217
4	1005	8803	Morton Street	5690800	2	1	1	2013	BL	1	1	2	FT	4	99	36.450628
5	1006	8804	American Legion Highway	6236100	5	2	1	2008	SLM	1	1	2	FT	4	1	77.820774
6	1007	8810	Walnut Avenue	5308200	6	2	1	2011	SLM	1	0	2	B	3	0	76.512560
7	1008	8811	Walnut Avenue	4710200	6	2	1	2011	SLM	1	0	2	B	3	0	124.154736

- ***Bike_facility_Descriptions***: how to read each of the abbreviations of the Existing Bike Network bike path type

	Code	Facility Type	Facility Description	Network Status	Example
0	NaN	NaN	NaN	NaN	NaN
1	ADV	Advisory Lane	On low-volume, narrow roads (< 30' without par...	Pilot Facility	NaN
2	BFBL	Buffered Bike Lane	A 5' min. exclusive lane for bicycle travel, w...	Existing Facility	Seaport Blvd, South Boston
3	PBFBL	Buffered Bike Lane, parking side	A 5' min. exclusive lane for bicycle travel, w...	NaN	NaN
4	BL	Bike Lane	A 5' min. exclusive lane for bicycle travel	Existing Facility	Mass Ave, Back Bay
5	BSBL	Bus Bike Lane	An 11' min. lane for shared bus and bicycle tr...	Existing Facility	Washington St, South End
6	CFBL	Contraflow Bike Lane	On one-way streets, bicyclists may operate in ...	Pilot Facility	NaN
7	CL	Climbing Lane	On roads with steep grades where bicycle lanes...	Existing Facility	Centre St, JP
8	CT	Cycle Track	A physically separated bicycle facility protec...	Existing Facility	Western Ave, Allston
9	NW	Neighborway	Also known as bicycle boulevards, neighborways...	Pilot Facility	NaN
10	PSL	Priority Shared-Lane Markings	On multi-lane streets, (2 or more travel lanes...	Pilot Facility	NaN
11	SLM	Shared-Lane Markings	Where exclusive bicycle lanes are not feasible...	Existing Facility	Huntington Ave, Symphony
12	SRd	Shared Street	A street designed for slow speeds with a singl...	Existing Facility	Washington St, DTX
13	SUP	Shared-Use Path	A phyically separated off-road pathway for sha...	Existing Facility	Charles River Bike Path

- ***cyclists_accidents.csv*** : dataset with crash and collision statistics, last updated December, 2018
- Contains crash statistics on Moving Vehicle, Bike, Pedestrian, etc in mode_type:

	dispatch_ts	mode_type	location_type	street	xstreet1	xstreet2	x_cord	y_cord	lat	long
0	2/28/2019 16:22	ped	Street	OLD COLONY TER	SAVIN HILL AVE	WILLIAM T MORRISSEY BLVD	778755.72	2939231.02	42.312350	-71.046643
1	2/28/2019 16:17	mv	Intersection	NaN	DAVID G MUGAR WAY	PINCKNEY ST	771761.61	2956054.41	42.358769	-71.072310
2	2/28/2019 15:51	ped	Street	TERMINAL RD	TERMINAL A	TERMINAL B	785398.37	2958235.76	42.365351	-71.021114
3	2/28/2019 15:34	mv	Street	RADCLIFFE RD	GREENFIELD RD	RUSKINDALE RD	763248.44	2923046.31	42.268228	-71.104232
4	2/28/2019 14:44	ped	Intersection	NaN	BOYLSTON ST	MASSACHUSETTS AVE	767612.72	2951853.40	42.347298	-71.087736
5	2/28/2019 12:54	mv	Street	WEST ROXBURY PKWY	NEW PARK AVE	COLBERG AVE	752111.01	2928117.46	42.282235	-71.145630
6	2/28/2019 12:23	mv	Street	WASHINGTON ST	COREY RD	EGREMONT RD	753064.51	2950070.06	42.342854	-71.141305

- ***Most_frequently_taken.csv*** : dataset created from data on Boston Bicycle Counts, it shows which streets have more than 10% of its total vehicles are cyclists

	STREET	PERCENTAGE
0	A STREET	10.9
1	BU BRIDGE	12.2
2	COMMONWEALTH AVENUE	15.3
3	COLUMBUS AVENUE	20.9
4	FRANKLIN STREET	43.0
5	LONGFELLOW BRIDGE	20.2
6	LONGWOOD AVENUE	23.1
7	MASSACHUSETTS AVENUE	18.5
8	NORTH HARVARD STREET	15.5
9	WASHINGTON STREET	19.5
10	WESTERN AVENUE	11.4

MORE THAN 10% OF VEHICLES

At the locations listed below, bikes were more than 10% of vehicles during peak hours. The percentages represent the bikes as a percentage of the total number of vehicles counted from 8 – 10 am and 5 – 7 pm. Sites are listed alphabetically.

- A Street north of Iron Street – 10.9%
- BU Bridge north of Commonwealth Avenue – 12.2%
- Columbus Avenue west of Arlington Street – 15.3%
- Columbus Avenue west of Holyoke Street – 16.1%
- Columbus Avenue west of Massachusetts Avenue – 20.9%
- Commonwealth Avenue Eastbound west of Silber Way – 14.6%
- Commonwealth Avenue west of Arlington Street – 10.2%
- Commonwealth Ave. Westbound west of Silber Way – 11.3%
- Franklin Street north of Alcott Street – 43.0%
- Longfellow Bridge Eastbound west of Charles Street – 20.2%
- Longwood Avenue east of Pilgrim Road – 23.1%
- Mass. Ave. Bridge north of Dr. Paul Dudley White Path – 18.5%
- North Harvard Street south of Soldiers Field Road – 15.5%
- Washington Street south of Hayward Place – 19.5%
- Western Avenue east of Hague Street – 11.4%

HONORABLE MENTIONS:

- Brighton Avenue east of St. Lukes Road – 9.6%
- Harvard Avenue north of Commonwealth Avenue – 9.2%

https://www.boston.gov/departments/boston-bikes/bike-data/2017-boston-bicycle-counts

Problem Specification

- **Research Question:**

  Given the number of accidents per these streets that attract more cyclists throughout the day and at peak times, does adding a protected bike lane to the street help lower the number of accidents involving cyclists that take place there?

- Prediction: Yes. Adding Buffered Bike Lanes will result in a safer city for all commuters who are motorists and cyclists. This will also increase the likelyhood of Boston becoming a greener city with less carbon emissions due to more frequent cyclists taking these streets.

Selection of Data

- All Streets With Buffered Bike Lanes

```
bfbl_df = bike_network.loc[bike_network['ExisFacil'] == 'BFBL']
drop_id = bfbl_df.drop(['OBJECTID'], axis=1)
final_bfbl = drop_id.drop_duplicates(['STREET_NAM'])
final_bfbl_df = final_bfbl.rename(index=str, columns={"STREET_NAM": "STREET"})
final_bfbl_df['STREET'] = final_bfbl_df['STREET'].str.upper()
final_bfbl_df
```

	FID	STREET	ROADINVENT	FUNCTIONAL	JURISDICTI	Network	InstallDat	ExisFacil	Road	Divided	TravelLane	OneWay	LTS	PHASE
44	1045	SEAPORT BOULEVARD	6249800	3	2	1	2012	BFBL	1	1	2	FT	3	2
139	1140	SULLIVAN SQUARE	5872200	3	2	1	2014	BFBL	1	0	2	FT	4	2
145	1146	MAIN STREET	5699200	5	2	1	2014	BFBL	1	1	1	FT	1	2
152	1153	COLUMBIA ROAD	4641000	3	1	1	2016	BFBL	1	1	3	FT	3	99
158	1159	OLD COLONY AVENUE	4621100	3	3	1	2016	BFBL	1	1	3	FT	3	99
168	1169	A STREET	5664400	5	2	1	2013	BFBL	1	0	2	B	2	3
184	1185	ALFORD STREET	5196400	3	2	1	2016	BFBL	1	1	2	FT	2	0
208	1209	D STREET	5203800	5	2	1	2013	BFBL	1	0	2	B	2	3
296	1297	AMERICAN LEGION HIGHWAY	6222800	5	2	1	2009	BFBL	1	1	2	FT	2	2
340	1341	SEAVER STREET	5148700	3	2	1	2016	BFBL	1	1	3	FT	3	0
396	1397	MORTON STREET	5106500	2	1	1	2013	BFBL	1	1	2	FT	4	99
450	1451	BROOKLINE AVENUE	6298200	2	2	1	2013	BFBL	1	0	4	B	3	1
599	1600	COMMONWEALTH AVENUE	5230900	3	2	1	2010	BFBL	1	1	1	FT	1	0

Cleaned Buffered Bike Lane Data

- We're only concerned about the street names.

```
# Cleaned Buffered Bike Lane Data:

clean_bfbl = final_bfbl_df[['STREET','ExisFacil']]
clean_bfbl
```

	STREET	ExisFacil
44	SEAPORT BOULEVARD	BFBL
139	SULLIVAN SQUARE	BFBL
145	MAIN STREET	BFBL
152	COLUMBIA ROAD	BFBL
158	OLD COLONY AVENUE	BFBL
168	A STREET	BFBL
184	ALFORD STREET	BFBL
208	D STREET	BFBL
296	AMERICAN LEGION HIGHWAY	BFBL
340	SEAVER STREET	BFBL
396	MORTON STREET	BFBL
450	BROOKLINE AVENUE	BFBL
599	COMMONWEALTH AVENUE	BFBL
654	NORFOLK STREET	BFBL
836	CAMBRIDGE STREET	BFBL
950	ADAMS STREET	BFBL
1212	MOUNTFORT STREET	BFBL
1253	BEACON STREET	BFBL
1852	DORCHESTER AVENUE	BFBL

Selection of Data

- All Streets With Bike Lanes only

```
bl_df = bike_network.loc[bike_network['ExisFacil'] == 'BL']
no_id = bl_df.drop(['OBJECTID'], axis=1)
no_id
final_bl = no_id.drop_duplicates(['STREET_NAM'])
final_bl_df = final_bl.rename(index=str, columns={"STREET_NAM": "STREET"})
final_bl_df['STREET'] = final_bl_df['STREET'].str.upper()
# final_bl_df
```

	FID	STREET	ROADINVENT	FUNCTIONAL	JURISDICTI	Network	InstallDat	ExisFacil	Road	Divided	TravelLane	OneWay	LTS	PHASE
2	1003	BLUE HILL AVENUE	6282300	2	2	1	2010	BL	1	1	3	FT	3	0
4	1005	MORTON STREET	5690800	2	1	1	2013	BL	1	1	2	FT	4	99
9	1010	TREMONT STREET	5780900	5	2	1	2015	BL	1	0	2	B	3	2
13	1014	FORSYTH WAY	5424900	5	2	1	2011	BL	1	1	1	FT	3	0
14	1015	COMMONWEALTH AVENUE	6224600	3	2	1	2009	BL	1	1	2	FT	3	2
25	1026	TALBOT AVENUE	5691000	5	2	1	2010	BL	1	0	2	B	3	0
27	1028	HUMBOLDT AVENUE	4693200	6	2	1	2017	BL	1	0	2	B	3	4
35	1036	FREEPORT STREET	4751100	3	2	1	2013	BL	1	0	2	B	2	0

Cleaned Bike Lane Data

- We're only concerned with the street names again

```
# Cleaned Bike Lane Data:

clean_bl = final_bl_df[['STREET','ExisFacil']]
clean_bl
```

	STREET	ExisFacil
2	BLUE HILL AVENUE	BL
4	MORTON STREET	BL
9	TREMONT STREET	BL
13	FORSYTH WAY	BL
14	COMMONWEALTH AVENUE	BL
25	TALBOT AVENUE	BL
27	HUMBOLDT AVENUE	BL
35	FREEPORT STREET	BL
37	DORCHESTER AVENUE	BL
39	D STREET	BL
41	MAVERICK STREET	BL
46	HEREFORD STREET	BL
47	SEAPORT BOULEVARD	BL
48	MAIN STREET	BL
51	CITY SQUARE	BL
57	DEXTER ROW	BL
59	ADAMS STREET	BL

Lane Totals

```
# obtain totals by getting each dataframe shape:

print('Buffered Bike Lane Total: ')
print(final_bfbl_df.shape)
print('Bike Lane Total: ')
print(final_bl_df.shape)
```

```
Buffered Bike Lane Total:
(19, 16)
Bike Lane Total:
(99, 16)
```

Cyclist Crash Report

- For this project, we are only concerned with the crashes where the mode_type = bike, because this indicates an accident with a cyclist. We also only want to know the street names involved, the street/ intersection type, and the dispatch time.

```
# add a year column for easy indexing later on:
bike_accidents = accidents.loc[accidents['mode_type'] == 'bike']
clean_ba = bike_accidents[['dispatch_ts','mode_type','location_type','street','xstreet1', 'xstreet2']]
clean_ba['year'] = pd.DatetimeIndex(clean_ba['dispatch_ts']).year

# capitalize street column:
clean_bike_accidents = clean_ba.rename(index=str, columns={"street": "STREET"})
```

```
# so the columns line up appropriately with the data above, we need to replace the
# abbreviated street names to the full street names:

columns = [
    'STREET',
    'xstreet1',
    'xstreet2'
]

name_mapping = {
    r'(\s)ST': r'\1STREET',
    r'(\s)AVE': r'\1AVENUE',
    r'(\s)RD': r'\1ROAD',
    r'(\s)PL': r'\1PLACE',
    r'(\s)DR': r'\1DRIVE',
    r'(\s)SQ': r'\1SQUARE'
}

for column in columns:
    for key, val in name_mapping.items():
        clean_bike_accidents[column] = clean_bike_accidents[column].str.replace(key, val)

clean_bike_accidents
```

Cleaned Cyclist Crash Data

	dispatch_ts	mode_type	location_type	STREET	xstreet1	xstreet2	year
8	2/28/2019 9:10	bike	Street	MAIN STREET	WOOD STREET	HATHON SQUARE	2019
26	2/25/2019 10:01	bike	Intersection	NaN	WASHINGTON STREET	NEWCOMB STREET	2019
49	2/22/2019 16:11	bike	Intersection	NaN	HUMBOLDT AVENUE	RUTHVEN STREET	2019
57	2/21/2019 15:21	bike	Intersection	NaN	CHARLES STREET	BEACON STREET	2019
92	2/16/2019 15:37	bike	Street	CENTRE STREET	LAMARTINE STREET	WISE STREET	2019
103	2/15/2019 13:19	bike	Intersection	NaN	PARK DRIVE	BROOKLINE AVENUE	2019
107	2/14/2019 17:09	bike	Intersection	NaN	BEECHCROFT STREET	WASHINGTON STREET	2019
116	2/13/2019 19:06	bike	Street	SECOND AVENUE	FIRST AVENUE	SECOND AVENUE	2019
118	2/13/2019 18:14	bike	Street	SUMMER STREET	LINCOLN STREET	HIGH STREET	2019
144	2/11/2019 17:31	bike	Street	BENNINGTON STREET	ANTRIM STREET	ASHLEY STREET	2019
148	2/11/2019 11:13	bike	Intersection	NaN	DALE STREET	WASHINGTON STREET	2019
199	2/4/2019 19:30	bike	Street	OLD COLONY AVENUE	COLUMBIA ROAD	COLUMBIA ROAD	2019
212	2/2/2019 21:10	bike	Street	HUNTINGTON AVENUE	BELVIDERE STREET	MASSACHUSETTS AVENUE	2019
226	2/1/2019 7:46	bike	Intersection	NaN	PLEASANT STREET	HANCOCK STREET	2019
247	1/30/2019 19:32	bike	Street	BLACKFAN CIR	LONGWOOD AVENUE	AVENUE LOUIS PASTEUR	2019
290	1/25/2019 17:09	bike	Intersection	NaN	MELCHER STREET	A STREET	2019
300	1/24/2019 18:39	bike	Intersection	NaN	BOYLSTON STREET	BURR STREET	2019
316	1/23/2019 0:17	bike	Street	MASSACHUSETTS AVENUE	CLEARWAY STREET	SAINT STREETEPHEN STREET	2019
358	1/17/2019 19:28	bike	Intersection	NaN	MASSACHUSETTS AVENUE	ALBANY STREET	2019

Merged Bike Lane Data and Crash Data

- Now that we have concise working datasets specific to this project, we can merge the datasets

- This merges on the STREET column of bike lane and bike accidents:

```
bl_crashes = pd.merge(clean_bl, clean_bike_accidents)
bl_crashes
```

	STREET	ExisFacil	dispatch_ts	mode_type	location_type	xstreet1	xstreet2	year
0	BLUE HILL AVENUE	BL	12/11/2018 19:11	bike	Street	FAIRBURY STREET	BROOKFORD STREET	2018
1	BLUE HILL AVENUE	BL	11/29/2018 18:14	bike	Street	DONALD ROAD	GREENOCK STREET	2018
2	BLUE HILL AVENUE	BL	2/4/2018 22:56	bike	Street	MORELAND STREET	STAFFORD STREET	2018
3	BLUE HILL AVENUE	BL	9/24/2017 13:26	bike	Street	JULIAN STREET	CLIFFORD STREET	2017
4	BLUE HILL AVENUE	BL	9/9/2017 12:40	bike	Street	GEORGIA STREET	CHENEY STREET	2017
5	BLUE HILL AVENUE	BL	5/18/2017 18:55	bike	Street	RHOADES STREET	MORTON STREET	2017
6	BLUE HILL AVENUE	BL	5/17/2017 4:00	bike	Street	ELLINGTON STREET	COLUMBIA ROAD	2017
7	BLUE HILL AVENUE	BL	12/2/2016 14:04	bike	Street	CLARKWOOD STREET	HOSMER STREET	2016
8	BLUE HILL AVENUE	BL	10/4/2016 18:49	bike	Street	WESTVIEW STREET	HARVARD STREET	2016
9	BLUE HILL AVENUE	BL	12/14/2015 18:26	bike	Street	TENNIS ROAD	ALMONT STREET	2015
10	BLUE HILL AVENUE	BL	11/12/2015 10:12	bike	Street	SEAVER STREET	COLUMBIA ROAD	2015
11	BLUE HILL AVENUE	BL	9/22/2015 17:53	bike	Street	DEVON STREET	STANWOOD STREET	2015
12	BLUE HILL AVENUE	BL	9/9/2015 8:20	bike	Street	BRUNSWICK STREET	DEVON STREET	2015
13	BLUE HILL AVENUE	BL	8/26/2015 19:09	bike	Street	DUDLEY STREET	HUCKINS STREET	2015
14	BLUE HILL AVENUE	BL	5/29/2015 18:40	bike	Street	COLUMBIA ROAD	SEAVER STREET	2015
15	MORTON STREET	BL	6/26/2018 19:58	bike	Street	THEODORE STREET	WILDWOOD STREET	2018
16	MORTON STREET	BL	8/19/2017 1:10	bike	Street	HAVELOCK STREET	BAIRD STREET	2017
17	MORTON STREET	BL	6/27/2016 16:07	bike	Street	CANTERBURY STREET	FOREST HILLS AVENUE	2016
18	TREMONT STREET	BL	10/15/2018 18:04	bike	Street	AVERY STREET	HEAD PLACE	2018
19	TREMONT STREET	BL	9/14/2018 5:35	bike	Street	PARK STREET	WINTER STREET	2018

Merged Buffered Bike Lane Data

- This merges on the STREET column of buffered bike lanes and bike accidents:

```
bfbl_crashes = pd.merge(clean_bfbl, clean_bike_accidents)
bfbl_crashes
```

	STREET	ExisFacil	dispatch_ts	mode_type	location_type	xstreet1	xstreet2	year
0	MAIN STREET	BFBL	2/28/2019 9:10	bike	Street	WOOD STREET	HATHON SQUARE	2019
1	MAIN STREET	BFBL	5/18/2018 8:52	bike	Street	ARMORY STREET	BALDWIN STREET	2018
2	MAIN STREET	BFBL	11/1/2017 16:50	bike	Street	BUNKER HILL STREET	CHARLES STREET	2017
3	MAIN STREET	BFBL	7/17/2017 12:41	bike	Street	ALFORD STREET	BEACHAM STREET	2017
4	MAIN STREET	BFBL	1/20/2017 11:10	bike	Street	WALKER STREET	TIBBETTS TOWN WAY	2017
5	MAIN STREET	BFBL	6/24/2016 14:17	bike	Street	SULLIVAN SQUARE	HOLMES PLACE	2016
6	MAIN STREET	BFBL	9/24/2015 7:57	bike	Street	SULLIVAN STREET	FRANKLIN STREET	2015
7	MAIN STREET	BFBL	9/10/2015 8:16	bike	Street	W SCHOOL STREET	LAWNWOOD PLACE	2015
8	COLUMBIA ROAD	BFBL	9/16/2018 16:31	bike	Street	COLUMBIA ROAD ROTARY	BABE RUTH PARK DRIVE	2018
9	COLUMBIA ROAD	BFBL	8/29/2018 17:38	bike	Street	E COTTAGE STREET	ELDER STREET	2018
10	COLUMBIA ROAD	BFBL	3/4/2018 16:18	bike	Street	GENEVA AVENUE	STANWOOD STREET	2018

Visualization

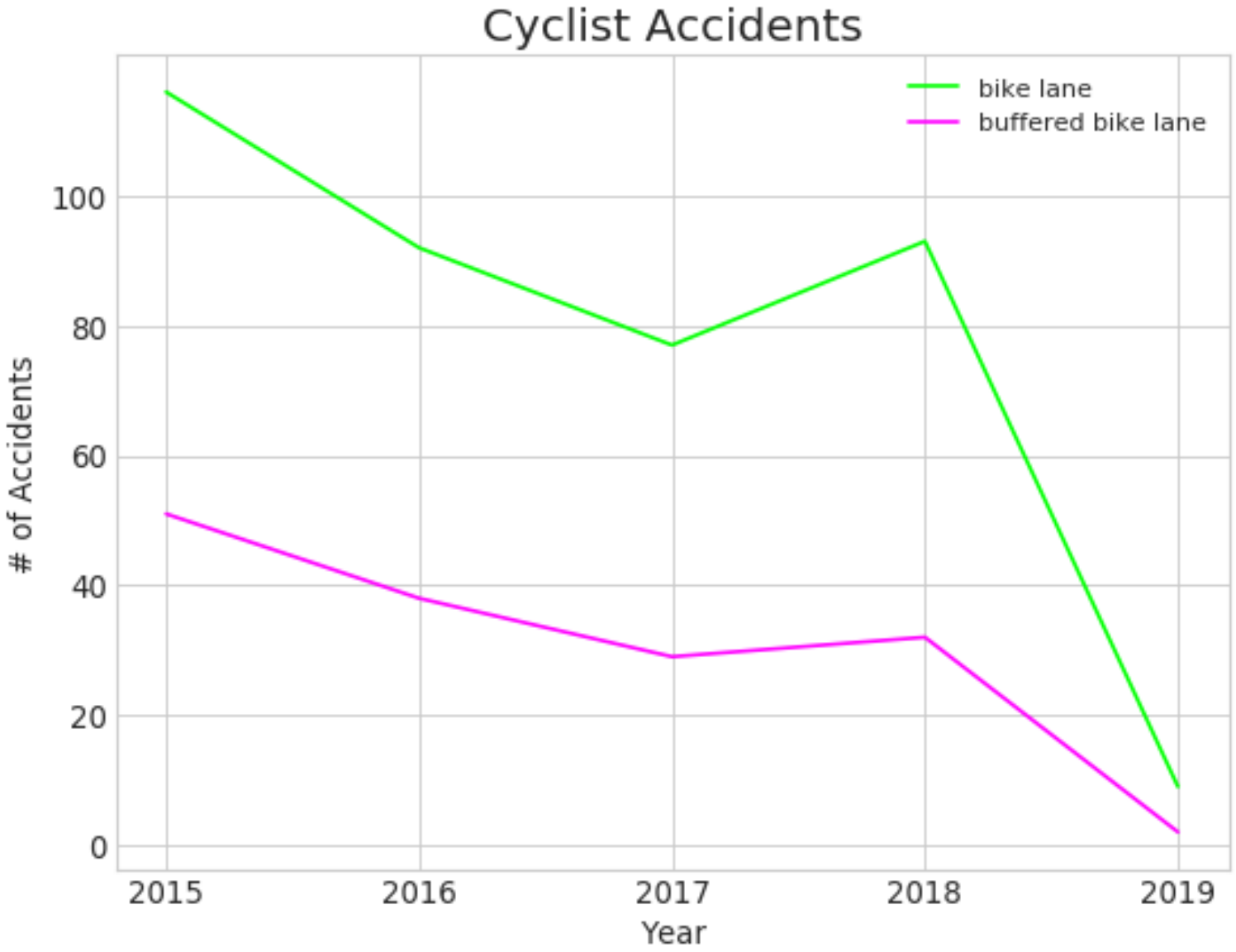
- After all data munging we've done up until now, we have clean and concise datasets we can work with that contains:
  - All Boston streets with bike lanes where accidents have occurred up until 2019
  - All Boston streets with buffered bike lanes where accidents have occurred up until 2019

```
# Bike Lane Data:
bike_lane = bl_crashes['year'].groupby(bl_crashes['year'], sort=True).count()

# # Buffered Bike Lane Data:
buffered_lane = bfbl_crashes['year'].groupby(bfbl_crashes['year'], sort=True).count()
buffered_lane

plt.figure(num=None, figsize=(8, 6), dpi=80, facecolor='w', edgecolor='k')
plt.plot(bike_lane, color='lime', label='bike lane')
plt.plot(buffered_lane, color='magenta', label='buffered bike lane')
plt.legend()
plt.title('Cyclist Accidents', fontsize=18)
plt.ylabel('# of Accidents', fontsize=12)
plt.xlabel('Year', fontsize=12)
plt.xticks(range(2015, 2020, 1), fontsize=12)
plt.yticks(range(0, 120, 20), fontsize=12)
```

Create Line Plot


Cyclist Accidents
bike lane
buffered bike lane
# of Accidents
0
20
40
60
80
100
2015
2016
2017
2018
2019
Year

Create Bar Plot

- Since we already have the data, to create a Bar Plot we can put the data into a Dictionary to be easily plotted:

```
bike_lane
```

```
year
2015    116
2016     92
2017     77
2018     93
2019      9
Name: year, dtype: int64
```

```
buffered_lane
```

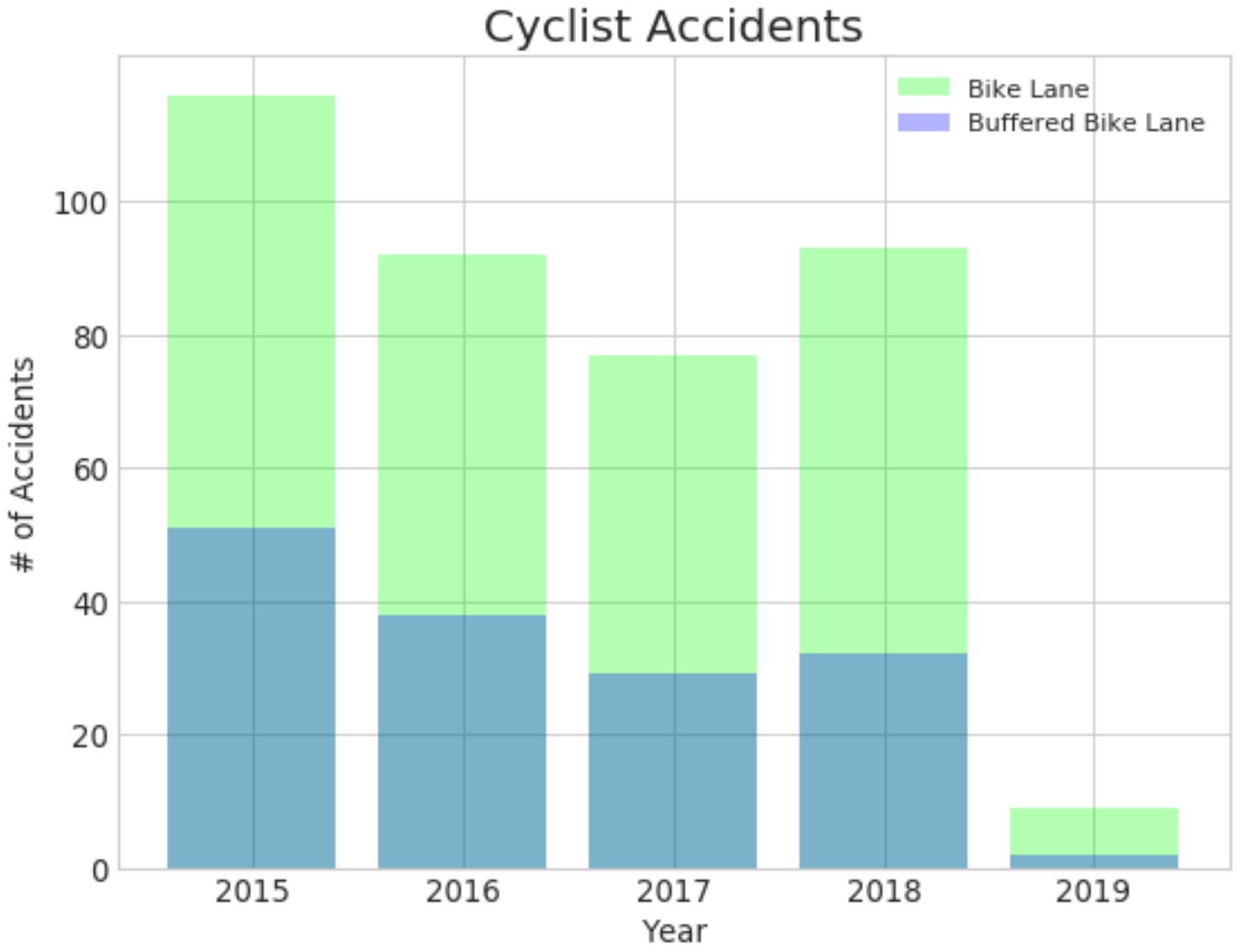
```
year
2015    51
2016    38
2017    29
2018    32
2019     2
Name: year, dtype: int64
```

```
bl_dict = {
    2015: 116,
    2016: 92,
    2017: 77,
    2018: 93,
    2019: 9
}

bfbl_dict = {
    2015: 51,
    2016: 38,
    2017: 29,
    2018: 32,
    2019: 2
}
```

```
plt.figure(num=None, figsize=(8, 6), dpi=80, facecolor='w', edgecolor='k')
plt.bar(bl_dict.keys(), bl_dict.values(), color='lime', alpha = 0.3)
plt.bar(bfbl_dict.keys(), bfbl_dict.values(), color='blue', alpha = 0.3)
plt.title('Cyclist Accidents', fontsize=18)
plt.legend(['Bike Lane', 'Buffered Bike Lane'])
plt.ylabel('# of Accidents', fontsize=12)
plt.xlabel('Year', fontsize=12)
plt.xticks(range(2015, 2020, 1), fontsize=12)
plt.yticks(range(0, 120, 20), fontsize=12)
plt.show()
```

Create Bar Plot


Cyclist Accidents
Bike Lane
Buffered Bike Lane
# of Accidents
0
20
40
60
80
100
2015
2016
2017
2018
2019
Year

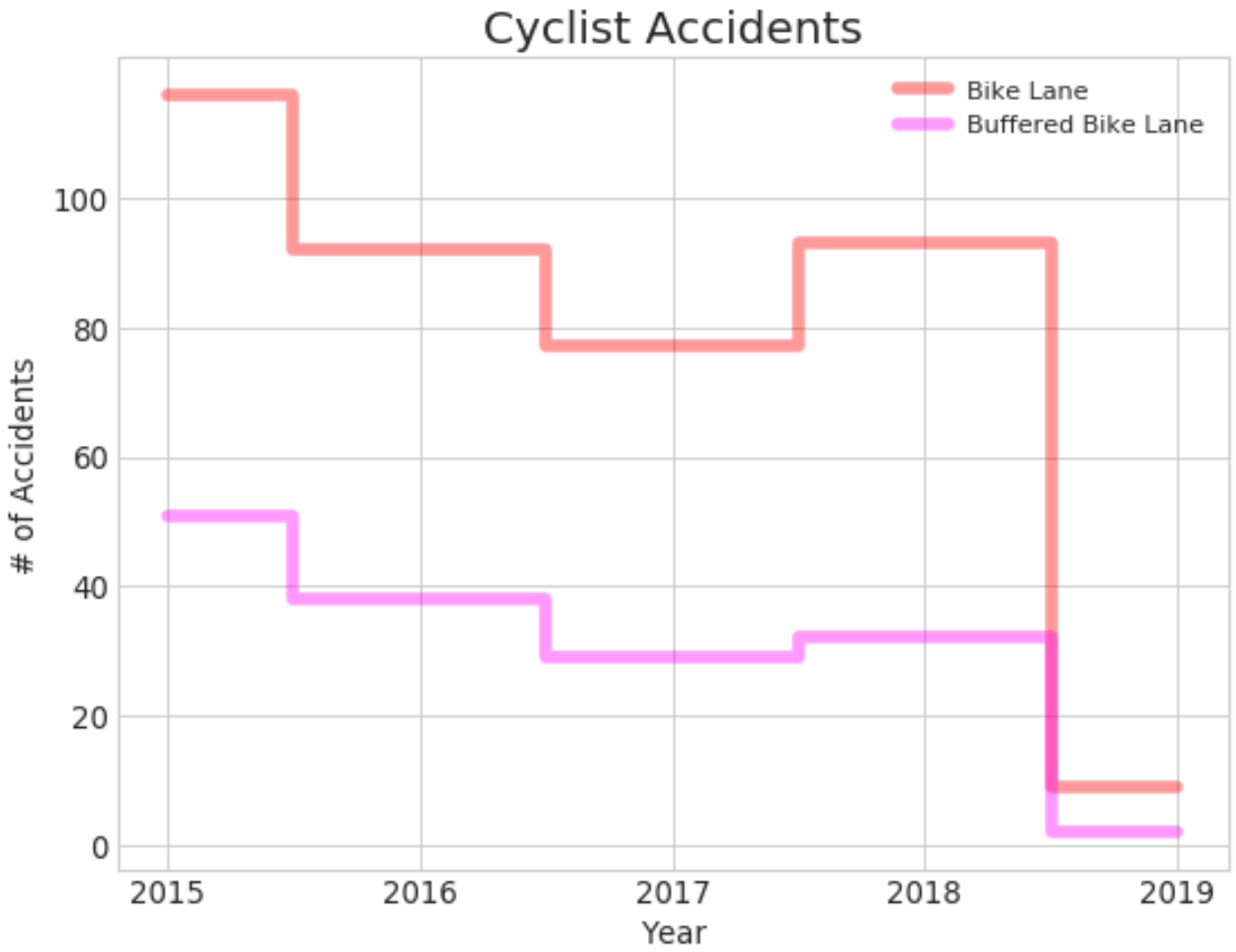
Create Step Plot

- Rather than using dictionaries for Step Plots, we can take the existing data and simply put it into arrays

```
years = [2015, 2016, 2017, 2018, 2019]
bl_accidents = [116, 92, 77, 93, 9]
bfbl_accidents = [51, 38, 29, 32, 2]
```

```
plt.figure(num=None, figsize=(8, 6), dpi=80, facecolor='w', edgecolor='k')
plt.step(years, bl_accidents, where='mid', linewidth=5, color='red', alpha = 0.4)
plt.step(years, bfbl_accidents, where='mid', linewidth=5, color='magenta', alpha = 0.4)
plt.title('Cyclist Accidents', fontsize=18)
plt.legend(['Bike Lane', 'Buffered Bike Lane'])
plt.ylabel('# of Accidents', fontsize=12)
plt.xlabel('Year', fontsize=12)
plt.xticks(range(2015, 2020, 1), fontsize=12)
plt.yticks(range(0, 120, 20), fontsize=12)
plt.show()
```

Create Step Plot


Cyclist Accidents
Bike Lane
Buffered Bike Lane
# of Accidents
0
20
40
60
80
100
2015
2016
2017
2018
2019
Year

Most Frequently Biked Streets

```
# Most taken cycled streets with buffered bike lanes:
most_cycled_bfbl = pd.merge(clean_bfbl, most_cycled, on=['STREET'], how='inner')
most_cycled_bfbl
```

- Let's compare the Buffered Bike Lane dataset now to see if any of those streets are within the Most Frequently Cycled dataset.

	STREET	ExisFacil	PERCENTAGE
0	A STREET	BFBL	10.9
1	COMMONWEALTH AVENUE	BFBL	15.3

Most Frequently Biked Streets

```
# Most taken cycled streets with bike lanes only:
most_cycled_bl = pd.merge(clean_bl, most_cycled, on=['STREET'], how='inner')
most_cycled_bl
```

- And those with bike lanes:

	STREET	ExisFacil	PERCENTAGE
0	COMMONWEALTH AVENUE	BL	15.3
1	MASSACHUSETTS AVENUE	BL	18.5
2	FRANKLIN STREET	BL	43.0
3	COLUMBUS AVENUE	BL	20.9
4	A STREET	BL	10.9
5	NORTH HARVARD STREET	BL	15.5
6	WASHINGTON STREET	BL	19.5
7	LONGFELLOW BRIDGE	BL	20.2
8	WESTERN AVENUE	BL	11.4
9	LONGWOOD AVENUE	BL	23.1

Test the Data

- Our data has different sizes. To get an accurate result for the safety of cyclists, we'll compare on all of the values found for the visualizations: years, and the number of accidents per lane type:

```
np.random.seed(12345678)  #fix random seed to get the same result
years = [2015, 2016, 2017, 2018, 2019]
bl_accidents = [116, 92, 77, 93, 9]
bfbl_accidents = [51, 38, 29, 32, 2]

bl_2015_test = stats.norm.rvs(size=116, loc=0., scale=1)
bfbl_2015_test = stats.norm.rvs(size=51, loc=0.5, scale=1.5)
stats.ks_2samp(rvs1, rvs2)
```

```
Ks_2sampResult(statistic=0.7777777777777778, pvalue=0.13863122857441054)
```

```
bl_2016_test = stats.norm.rvs(size=92, loc=0., scale=1)
bfbl_2016_test = stats.norm.rvs(size=38, loc=0.5, scale=1.5)
stats.ks_2samp(rvs1, rvs2)
```

```
Ks_2sampResult(statistic=0.7777777777777778, pvalue=0.13863122857441054)
```

```
bl_2017_test = stats.norm.rvs(size=77, loc=0., scale=1)
bfbl_2017_test = stats.norm.rvs(size=29, loc=0.5, scale=1.5)
stats.ks_2samp(rvs1, rvs2)
```

```
Ks_2sampResult(statistic=0.7777777777777778, pvalue=0.13863122857441054)
```

```
bl_2018_test = stats.norm.rvs(size=93, loc=0., scale=1)
bfbl_2018_test = stats.norm.rvs(size=32, loc=0.5, scale=1.5)
stats.ks_2samp(rvs1, rvs2)
```

```
Ks_2sampResult(statistic=0.7777777777777778, pvalue=0.13863122857441054)
```

```
bl_2016_test = stats.norm.rvs(size=9, loc=0., scale=1)
bfbl_2016_test = stats.norm.rvs(size=2, loc=0.5, scale=1.5)
stats.ks_2samp(rvs1, rvs2)
```

```
Ks_2sampResult(statistic=0.7777777777777778, pvalue=0.13863122857441054)
```

Test Results

- Our pvalue is greater than .05% for all of our tests,
- We cannot reject our original hypothesis, which means that Buffered Bike Lanes are indeed safer!
- Luckily right now in Boston, there are plans to implement adding Buffered Bike Lanes to all of Commonwealth Avenue and Massachusetts Avenue:
- http://www.bu.edu/today/2017/protected-bike-lanes-commonwealth-ave/

Summary

- Buffered/ Protected Bike Lanes prove to be more effective in reducing the number of cyclist accidents than Bike Lanes alone
- Boston needs to add more Buffered Bike Lanes to its busiest cycled streets to help cyclists feel safer
- More cyclists means less carbon emissions in today's warming climate, so get on your bike!