Visualization_Project_#3

May 10, 2021

1 COVID-19 and Underlying Health Conditions and Comorbidities

1.1 Final Infographic: https://my.visme.co/view/8re9w8op-covid-19-uhc-timeline

Ngone Lo
April 2021

2 Libraries

[31]:
```
# for working with the data
import pandas as pd
import numpy as np
import math


# for visualization
import matplotlib.pyplot as plt
from pylab import rcParams
import matplotlib.colors as mcolors
from mpl_toolkits.mplot3d import Axes3D
from matplotlib.collections import PolyCollection
import seaborn as sb
import plotly.graph_objects as go
from plotly.subplots import make_subplots
import plotly.express as px
```

[32]:
```
# Use pandas to read in the dataset
df = pd.read_csv("TriNetX_Table1.csv",encoding='cp1252')
```

[33]:
```
df
```

[33]:

	PriorCoexistingCondition	AllCOVID-19Patients	%AllCOVID-19Patients
0	Respiratory Diseases	270366	40.7
1	Cardiovascular Diseases	211004	31.7
2	Diabetes	78283	11.8
3	Cancer	41121	6.2
4	Kidney Diseass	33939	5.1

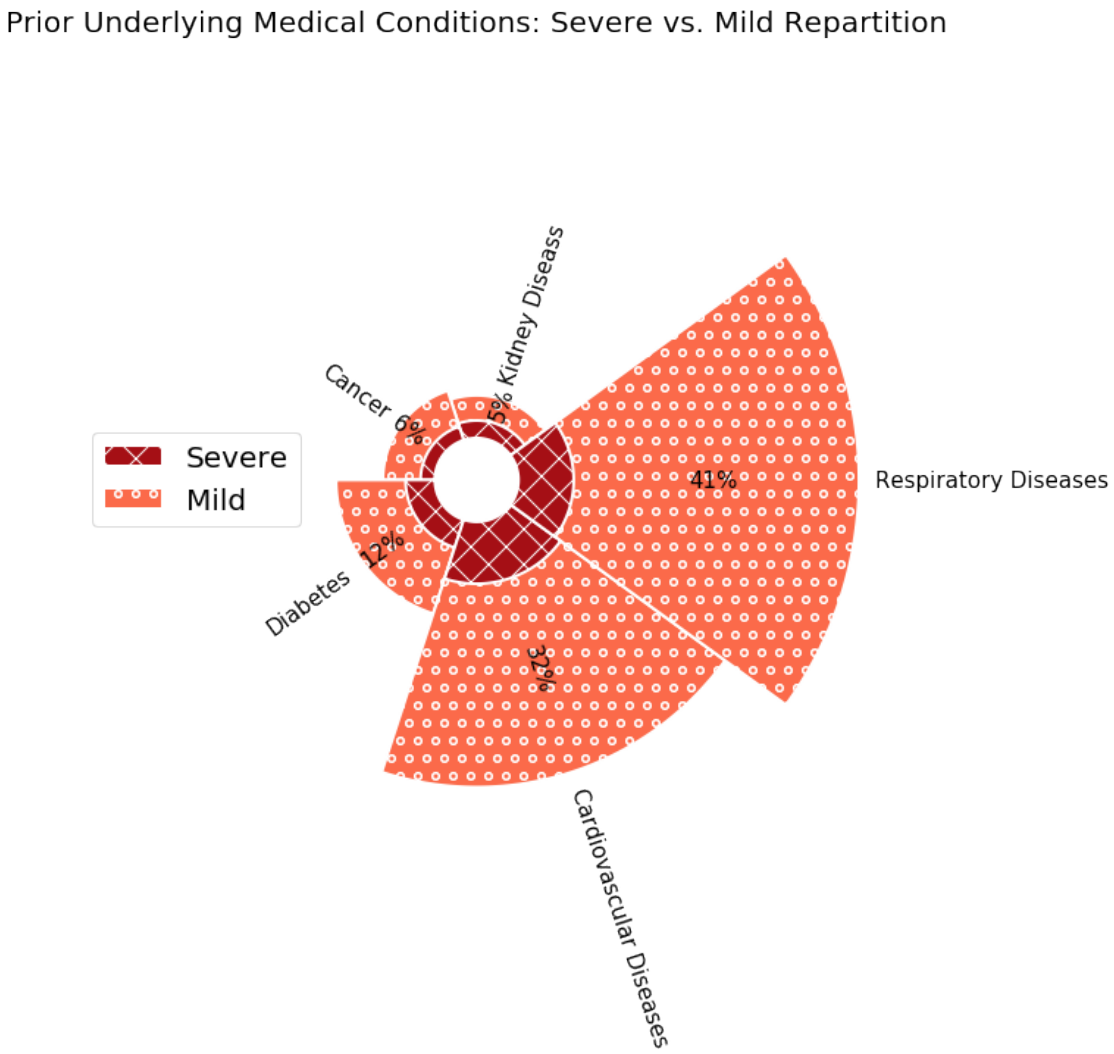
	SevereCOVID-19Patients	%SevereCOVID-19Patients	%AllCOVID-19PatientsSevere
0	43827	48.8	6.6
1	49062	54.6	7.4
2	23428	26.1	3.5
3	11285	12.6	1.7
4	14128	15.7	2.1

3 Part 1 : Visualizing The Underlying Health Conditions

[37]:
```
#circular barplot

# initialize the figure
plt.figure(figsize=(10,10))
ax = plt.subplot(111, polar=True)
plt.axis('off')

# Reorder the dataframe
df = df.sort_values(by=['%AllCOVID-19Patients'])

# Constants = parameters controling the plot layout:
labelPadding = 2
lowerlimit=5

# Compute the width of each bar. In total we have 2*Pi = 360ř
width = 2*np.pi / len(df.index)

# Compute the angle each bar is centered on:
indexes = list(range(1, len(df.index)+1))
angles = [element * width for element in indexes]
angles

heights=df['%AllCOVID-19Patients']

# Draw bars
bars = ax.bar(
    x=angles,
    height=heights,
    width=width,
    bottom=lowerlimit,
    linewidth=2,
    edgecolor="white",
    color="#fb6a4a",
    hatch="o",
    label='Mild'
)
```

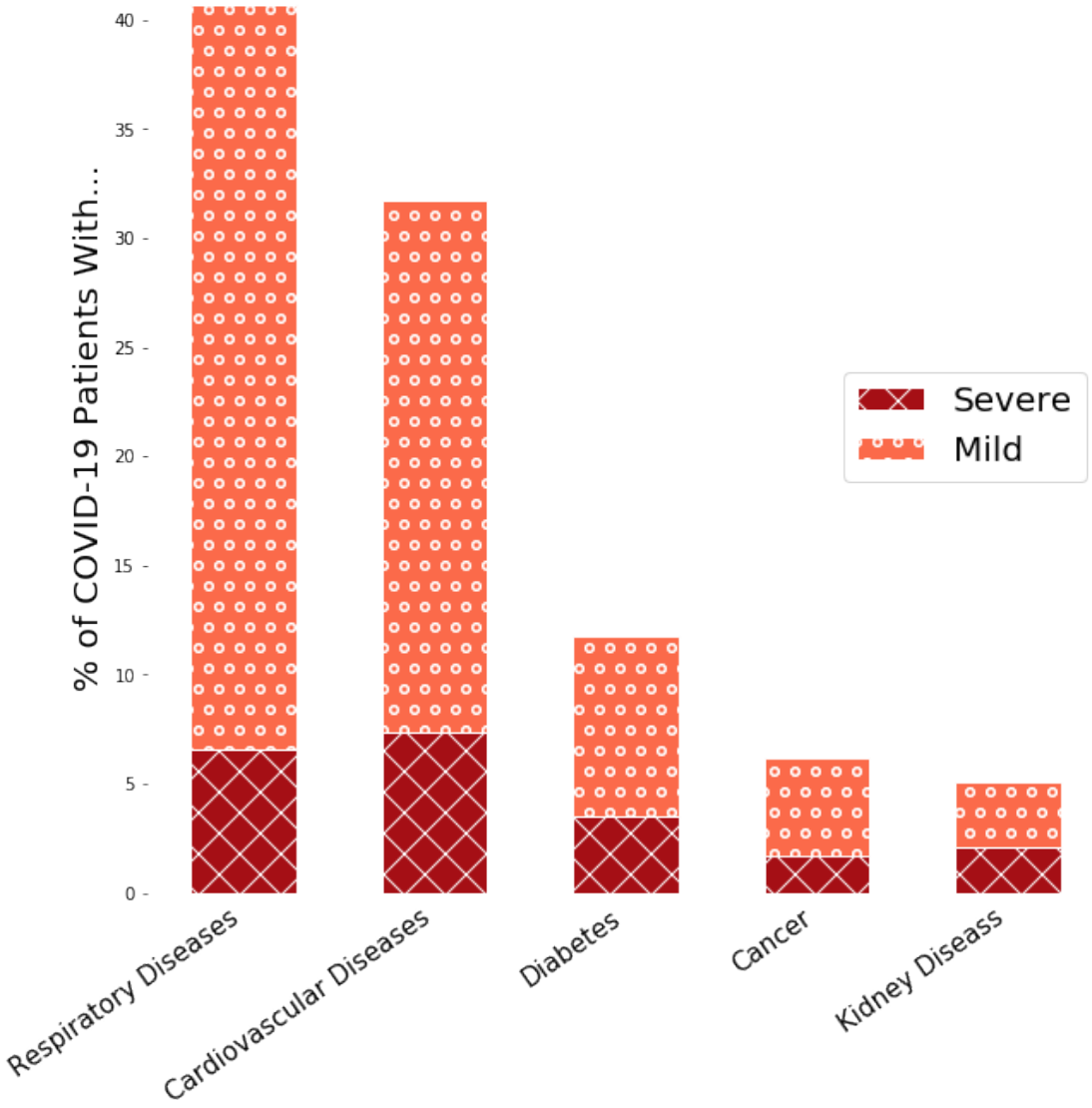
```
# Draw bars
bars2 = ax.bar(
    x=angles,
    height=df['%AllCOVID-19PatientsSevere'],
    width=width,
    bottom=lowerlimit,
    linewidth=2,
    edgecolor="white",
    color="#a50f15",
    hatch="x",
    label='Severe'
)


ax.legend([bars2, bars], ["Severe", "Mild"], loc=6, prop={'size': 20})
ax.set_title("Prior Underlying Medical Conditions: Severe vs. Mild␣
 ↪Repartition", size=20)


# Add labels
for bar, angle, height, label in zip(bars,angles, heights,␣
 ↪df["PriorCoexistingCondition"]):

    # Labels are rotated. Rotation must be specified in degrees :(
    rotation = np.rad2deg(angle)

    # Flip some labels upside down
    alignment = ""
    if angle >= np.pi/2 and angle < 3*np.pi/2:
        alignment = "right"
        rotation = rotation + 180
    else:
        alignment = "left"

    # Finally add the labels
    ax.text(
        x=angle,
        y=bar.get_height() + labelPadding+ lowerlimit,
        s=label,
        size=15,
        ha=alignment,
        va='center',
        rotation=rotation,
        rotation_mode="anchor")
```

```
def autolabel(rects,col):
    """
    Attach a text label above each bar displaying its height
    """
    for bar, angle, height, label in zip(bars,angles, heights,␣
 ↪df["PriorCoexistingCondition"]):

    # Labels are rotated. Rotation must be specified in degrees :(
        rotation = np.rad2deg(angle)

        # Flip some labels upside down
        alignment = ""
        if angle >= np.pi/2 and angle < 3*np.pi/2:
            alignment = "right"
            rotation = rotation + 180
        else:
            alignment = "left"

        # Finally add the labels
        ax.text(
            x=angle,
            y=bar.get_height()*0.5+lowerlimit,
            s=str(round(height))+'%',
            size=15,
            color=col,
            ha=alignment,
            va='center',
            rotation=rotation,
            rotation_mode="anchor")

autolabel(bars, "black")
```



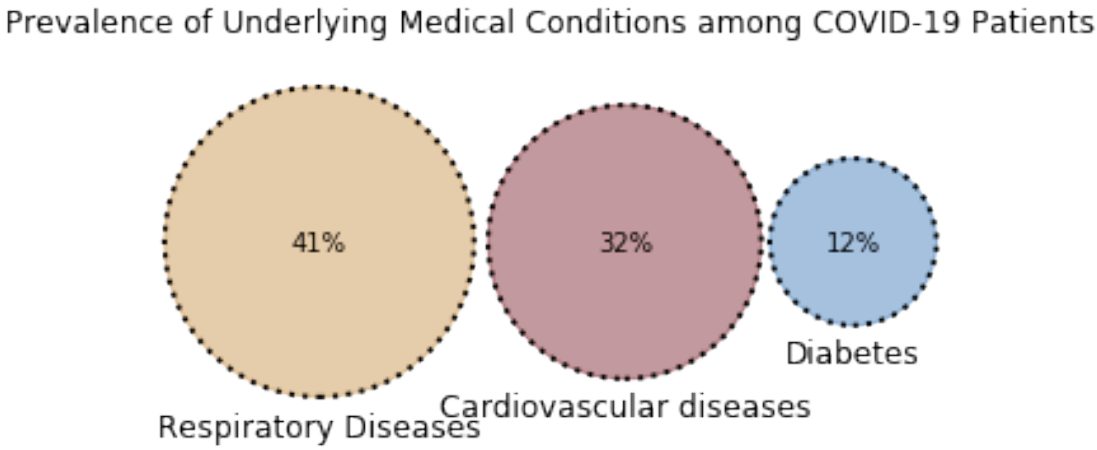
[41]:
```
plt.figure(figsize=(10,10))
ax = plt.subplot(111)

df = df.sort_values(by=['%AllCOVID-19Patients'], ascending=False)

width = 0.55        # the width of the bars: can also be len(x) sequence
#plt.axis('off')
plt.box(False)

prior=df['PriorCoexistingCondition']
mild=df['%AllCOVID-19Patients']
severe=df['%AllCOVID-19PatientsSevere']
```

```
ax.bar(prior, mild, width, label='Mild', color="#fb6a4a", hatch = 'o',␣
 ↪edgecolor="white")
ax.bar(prior, severe, width, label='Severe', color="#a50f15", hatch = 'x',␣
 ↪edgecolor="white")

ax.legend([bars2, bars], ["Severe", "Mild"], loc=7, prop={'size': 20})
ax.xaxis.set_ticks_position('none')
plt.xticks(rotation=35, size=15, horizontalalignment="right")
ax.set_ylabel('% of COVID-19 Patients With...', fontsize=20)




# Hide grid lines
ax.grid(False)


plt.show()
```



[25]:
```
from matplotlib_venn import venn3, venn3_circles

# Make a Basic Venn
v = venn3(subsets=(40.7, 31.7, 0, 11.8, 0, 0, 0), set_labels = ('A', 'B', 'C'))

# Custom it
v.get_patch_by_id('A').set_color('#bf812d')
v.get_patch_by_id('010').set_color('#67000d')
v.get_patch_by_id('001').set_color('#2166ac')

v.get_label_by_id('100').set_text('41%')
v.get_label_by_id('010').set_text('32%')
```

```
v.get_label_by_id('001').set_text('12%')

v.get_label_by_id('A').set_text('Respiratory Diseases')
v.get_label_by_id('B').set_text('Cardiovascular diseases')
v.get_label_by_id('C').set_text('Diabetes')


c = venn3_circles(subsets=(40.7, 31.7, 0, 11.8, 0, 0, 0), linestyle='dotted')


# Add title and annotation
plt.title("Prevalence of Underlying Medical Conditions among COVID-19 Patients")

# Show it
plt.show()
```



4 Part 2 : Visualizing The Symptoms & Diagnosis

[55]:
```
# Use pandas to read in the dataset
df = pd.read_csv("TriNetX_Table2.csv",encoding='cp1252')
```

[56]:
```
df.head()
```

[56]:

	Diagnosis	AllCOVID-19Patients	%AllCOVID-19Patients	\
0	Cough	94259	14.2	
1	Pneumonia	69421	10.4	
2	Shortness of breath	68394	10.3	
3	Fever	60973	9.2	
4	Pain in throat and chest	35051	5.3	

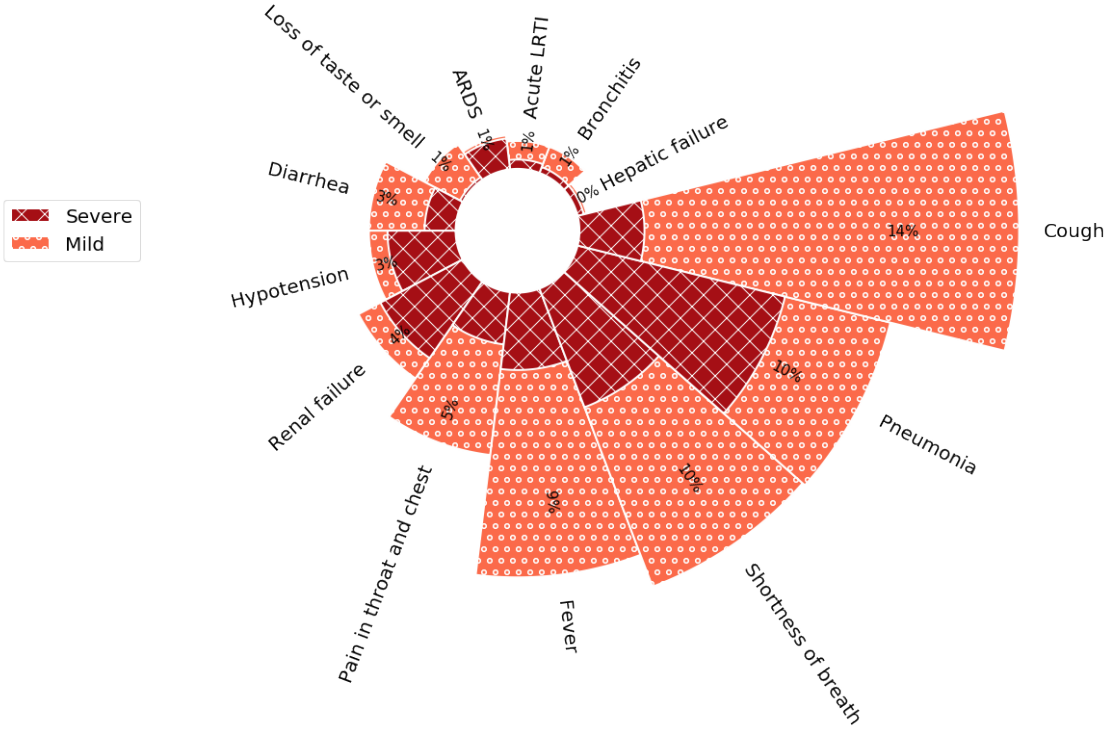
	SevereCOVID-19Patients	%SevereCOVID-19Patients	%AllCOVID-19PatientsSevere

0	13780	15.3	2.1
1	45871	51.0	6.9
2	27272	30.3	4.1
3	16365	18.2	2.5
4	11437	12.7	1.7

[57]:
```
#circular barplot

# initialize the figure
plt.figure(figsize=(20,20))
ax = plt.subplot(111, polar=True)
plt.axis('off')

# Reorder the dataframe
df = df.sort_values(by=['%AllCOVID-19Patients'])

# Constants = parameters controling the plot layout:
labelPadding = 0.8
lowerlimit=2

# Compute the width of each bar. In total we have 2*Pi = 360ř
width = 2*np.pi / len(df.index)

# Compute the angle each bar is centered on:
indexes = list(range(1, len(df.index)+1))
angles = [element * width for element in indexes]
angles

heights=df['%AllCOVID-19Patients']

# Draw bars
bars = ax.bar(
    x=angles,
    height=heights,
    width=width,
    bottom=lowerlimit,
    linewidth=2,
    edgecolor="white",
    color="#fb6a4a",
    hatch="o",
    label='Mild'
)


# Draw bars
bars2 = ax.bar(
    x=angles,
```

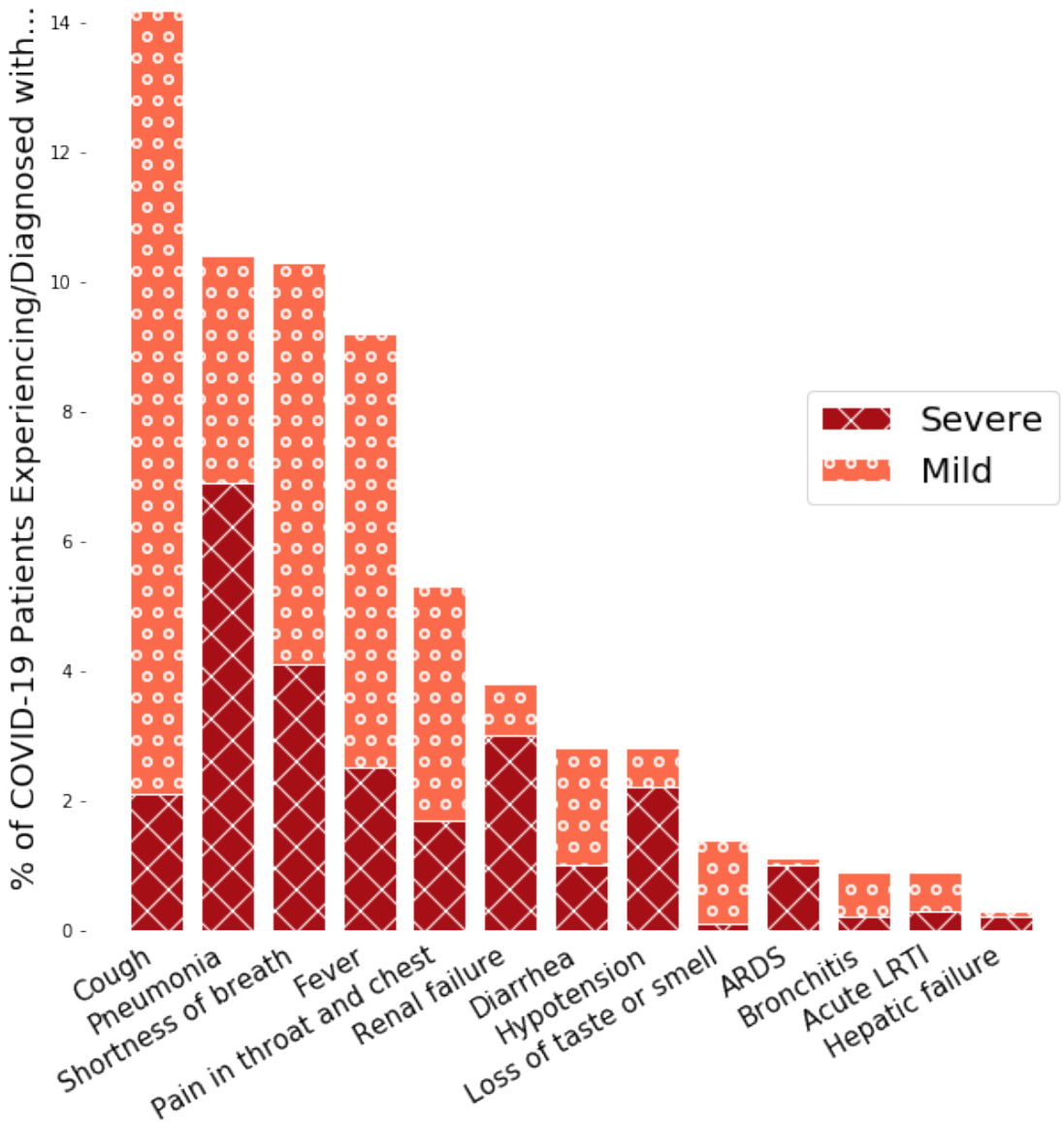
```
    height=df['%AllCOVID-19PatientsSevere'],
    width=width,
    bottom=lowerlimit,
    linewidth=2,
    edgecolor="white",
    color="#a50f15",
    hatch="x",
    label='Severe'
)


ax.legend([bars2, bars], ["Severe", "Mild"], loc=6,prop={'size': 20})
ax.set_title("Symptoms & Diagnosis: Mild vs Severe Repartition", size=25)


# Add labels
for bar, angle, height, label in zip(bars,angles, heights, df["Diagnosis"]):

    # Labels are rotated. Rotation must be specified in degrees :(
    rotation = np.rad2deg(angle)

    # Flip some labels upside down
    alignment = ""
    if angle >= np.pi/2 and angle < 3*np.pi/2:
        alignment = "right"
        rotation = rotation + 180
    else:
        alignment = "left"

    # Finally add the labels
    ax.text(
        x=angle,
        y=bar.get_height() + labelPadding+ lowerlimit,
        s=label,
        size=20,
        ha=alignment,
        va='center',
        rotation=rotation,
        rotation_mode="anchor")



def autolabel(rects,col):
    """
    Attach a text label above each bar displaying its height
    """
    for bar, angle, height, label in zip(bars,angles, heights, df["Diagnosis"]):
```

```
    # Labels are rotated. Rotation must be specified in degrees :(
        rotation = np.rad2deg(angle)

        # Flip some labels upside down
        alignment = ""
        if angle >= np.pi/2 and angle < 3*np.pi/2:
            alignment = "right"
            rotation = rotation + 180
        else:
            alignment = "left"

        # Finally add the labels
        ax.text(
            x=angle,
            y=bar.get_height()*0.7+lowerlimit,
            s=str(round(height))+'%',
            size=15,
            color=col,
            ha=alignment,
            va='center',
            rotation=rotation,
            rotation_mode="anchor")

autolabel(bars, "black")
```



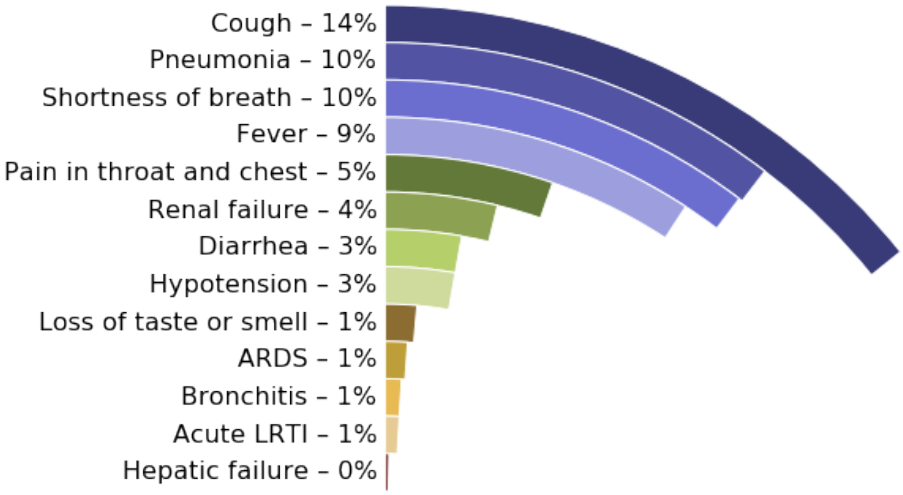
[58]:
```
plt.figure(figsize=(10,10))
ax = plt.subplot(111)

df = df.sort_values(by=['%AllCOVID-19Patients'], ascending=False)

width = 0.75        # the width of the bars: can also be len(x) sequence
#plt.axis('off')
plt.box(False)

prior=df['Diagnosis']
mild=df['%AllCOVID-19Patients']
severe=df['%AllCOVID-19PatientsSevere']
```

```
rect1=ax.bar(prior, mild, width, label='Mild', color="#fb6a4a", hatch = 'o',␣
 ↪edgecolor="white")
rect2=ax.bar(prior, severe, width, label='Severe', color="#a50f15", hatch =␣
 ↪'x', edgecolor="white")

ax.legend([bars2, bars], ["Severe", "Mild"], loc=7, prop={'size': 20})
ax.xaxis.set_ticks_position('none')
plt.xticks(rotation=30, size=15, horizontalalignment="right")
ax.set_ylabel('% of COVID-19 Patients Experiencing/Diagnosed with...',␣
 ↪fontsize=18)
#ax.get_yaxis().set_ticks([])



# Hide grid lines
ax.grid(False)


plt.show()
```



[61]:
```
# initialize the figure
plt.figure(figsize=(10,10))
ax = plt.subplot(111)

cathegories = df['Diagnosis']
percent = df['%AllCOVID-19Patients']

# number of data points
n = len(percent)
# percent of circle to draw for the largest circle
percent_circle = percent.max() / 100
```

```
r = 1.5  # outer radius of the chart
r_inner = 0.4  # inner radius of the chart
# calculate width of each ring
w = (r - r_inner) / n

# create colors along a chosen colormap
#colors = [plt.cm.plasma(i / n) for i in range(n)]
colors = plt.cm.tab20b.colors

# create figure, axis
ax.axis("equal")

#ax.set_title("Comorbidities of Covid-19 Fatalities", size=40)

for i in range(n):
    radius = r - i * w
    ax.pie([percent[i] / percent.max() * percent_circle], radius=radius,␣
 ↪startangle=90,
           counterclock=False,
           colors=[colors[i]],
           labels=[f'{cathegories[i]}  {percent[i]}%'],labeldistance=None,
           wedgeprops={'width': w, 'edgecolor': 'white'})
    ax.text(0, radius - w/2, f'{cathegories[i]}  {int(round(percent[i]))}% ',␣
 ↪ha='right', va='center', size=16)

#plt.legend(loc='upper right', bbox_to_anchor=(0.5, 1.1), prop={'size': 12})
plt.tight_layout()
plt.show()
```



5 Part 3: Visualizing The Comorbidities

[62]:
```
# Use pandas to read in the dataset
df = pd.read_csv("CDC_Table3.csv",encoding='cp1252')
```

[63]:
```
df.head()
```

[63]:

	ComorbiditiesCondition	COVID-19Deaths	%TotalCOVID-19Deaths
0	Influenza and pneumonia	248250	45.7
1	Respiratory failure	203850	37.5
2	Hypertensive diseases	107624	19.8

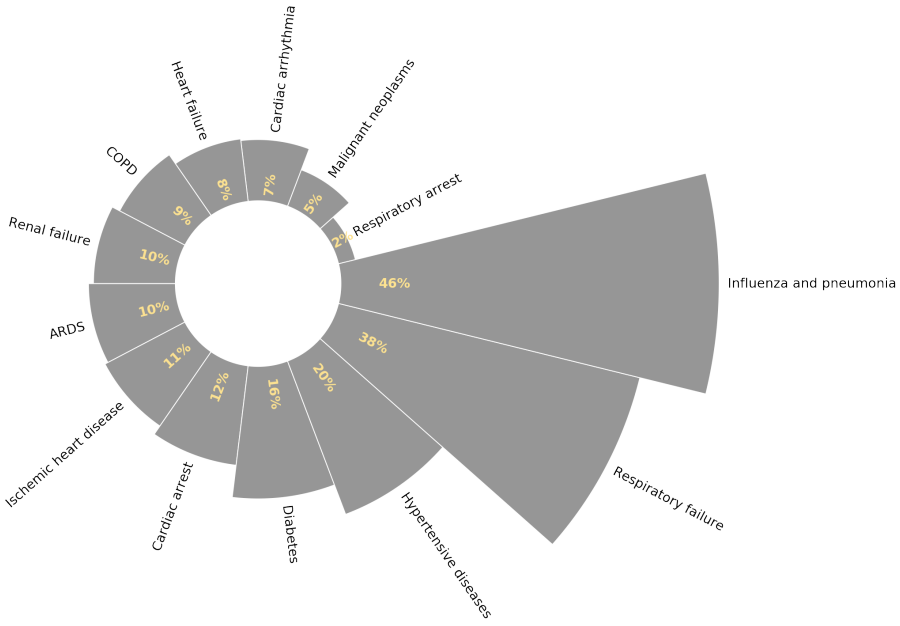
```
3                 Diabetes           87008                 16.0
4           Cardiac arrest           65801                 12.1
```

[67]:
```
#circular barplot

# initialize the figure
plt.figure(figsize=(40,40))
ax = plt.subplot(111, polar=True)
plt.axis('off')

# Reorder the dataframe
df = df.sort_values(by=['%TotalCOVID-19Deaths'])

# Constants = parameters controling the plot layout:
labelPadding = 1
lowerlimit=10

# Compute the width of each bar. In total we have 2*Pi = 360ř
width = 2*np.pi / (len(df.index))

# Compute the angle each bar is centered on:
indexes = list(range(1, len(df.index)+1))
angles = [element * width for element in indexes]
angles

heights=df['%TotalCOVID-19Deaths']

# Draw bars
bars = ax.bar(
    x=angles,
    height=heights,
    width=width,
    bottom=lowerlimit,
    linewidth=2,
    edgecolor="white",
    color="#969696"
)




ax.set_title("Comorbidities of Covid-19 Fatalities", size=50)


# Add labels
```

```
for bar, angle, height, label in zip(bars,angles, heights,␣
 ↪df["ComorbiditiesCondition"]):

    # Labels are rotated. Rotation must be specified in degrees :(
    rotation = np.rad2deg(angle)

    # Flip some labels upside down
    alignment = ""
    if angle >= np.pi/2 and angle < 3*np.pi/2:
        alignment = "right"
        rotation = rotation + 180
    else:
        alignment = "left"

    # Finally add the labels
    ax.text(
        x=angle,
        y=bar.get_height() + labelPadding+ lowerlimit,
        s=label,
        size=30,
        ha=alignment,
        va='center',
        rotation=rotation,
        rotation_mode="anchor")



def autolabel(rects,col):
    """
    Attach a text label above each bar displaying its height
    """
    for bar, angle, height, label in zip(bars,angles, heights,␣
 ↪df["ComorbiditiesCondition"]):

    # Labels are rotated. Rotation must be specified in degrees :(
        rotation = np.rad2deg(angle)

        # Flip some labels upside down
        alignment = ""
        if angle >= np.pi/2 and angle < 3*np.pi/2:
            alignment = "right"
            rotation = rotation + 180
        else:
            alignment = "left"

        # Finally add the labels
        ax.text(
```

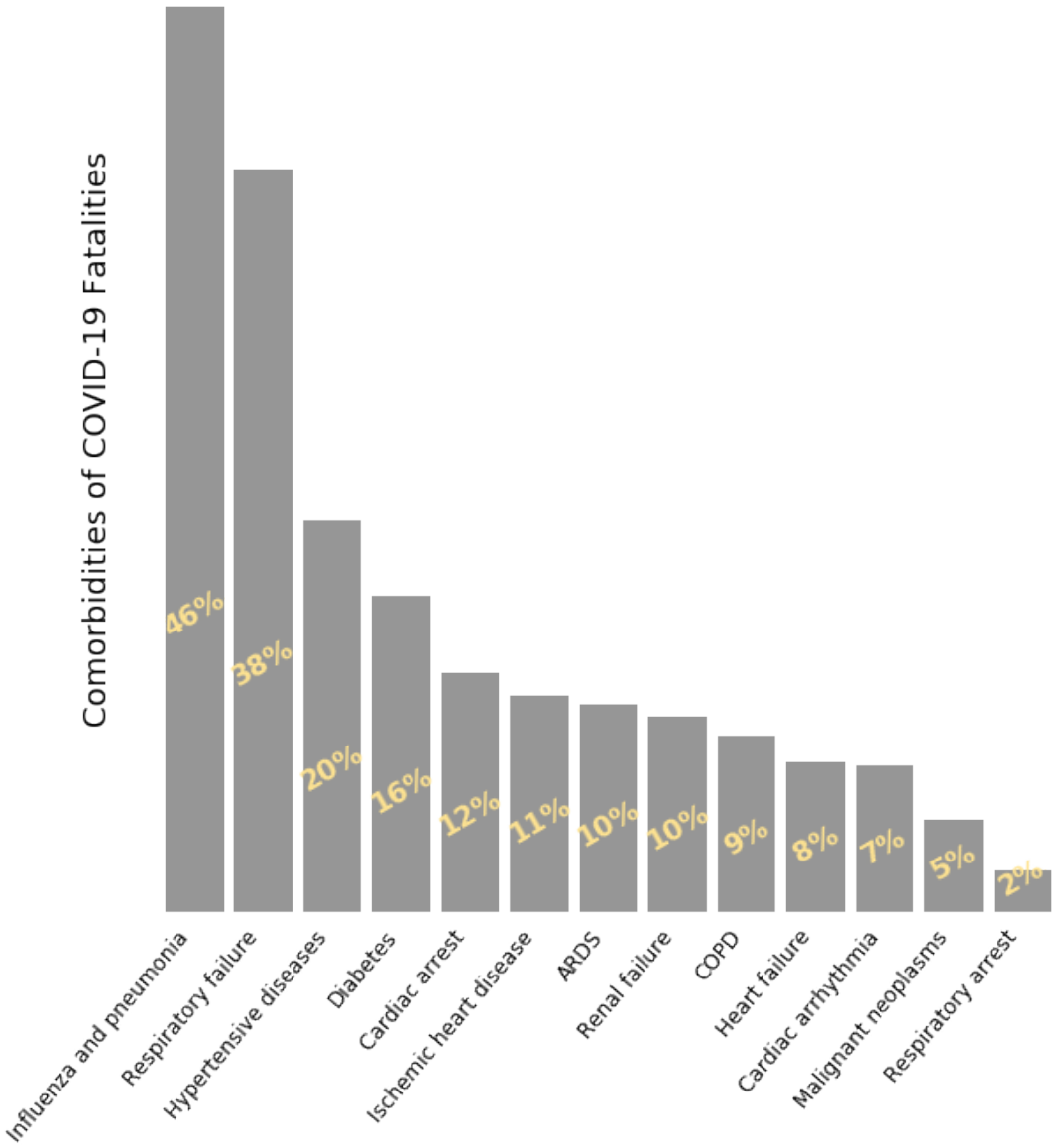
```
            x=angle,
            y=bar.get_height()*0.1+lowerlimit,
            s=str(round(height))+'%',
            size=30,
            ha=alignment,
            va='center',
            color=col,
            weight='bold',
            rotation=rotation,
            rotation_mode="anchor")

autolabel(bars, "#fee391")
```

Comorbidities of Covid-19 Fatalities



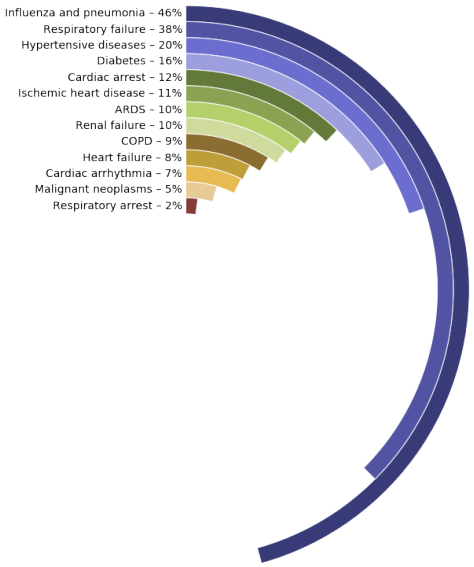
[52]:
```
plt.figure(figsize=(10,10))
ax = plt.subplot(111)
```

```
df = df.sort_values(by=['%TotalCOVID-19Deaths'], ascending=False)

width = 0.85       # the width of the bars: can also be len(x) sequence
#plt.axis('off')
plt.box(False)

prior=df['ComorbiditiesCondition']
mild=df['%TotalCOVID-19Deaths']


rect1=ax.bar(prior, mild, width, color="#969696")


ax.xaxis.set_ticks_position('none')
plt.xticks(rotation=50, size=12, horizontalalignment="right")
ax.set_ylabel('Comorbidities of COVID-19 Fatalities', fontsize=18)
ax.get_yaxis().set_ticks([])


def autolabel(rects,col):
    for rect in rects:
        height = rect.get_height()
        ax.text(rect.get_x() + rect.get_width()/2., 0.3*height,
                str(int(round(height)))+'%',
                ha='center', va='bottom', color=col, weight='bold',␣
 ↪rotation=30, size=16)

autolabel(rect1, "#fee391")


# Hide grid lines
ax.grid(False)


plt.show()
```



[53]:
```
# initialize the figure
plt.figure(figsize=(20,10))
ax = plt.subplot(111)

cathegories = df['ComorbiditiesCondition']
percent = df['%TotalCOVID-19Deaths']

# number of data points
n = len(percent)
# percent of circle to draw for the largest circle
percent_circle = percent.max() / 100
```

```
r = 1.5  # outer radius of the chart
r_inner = 0.4  # inner radius of the chart
# calculate width of each ring
w = (r - r_inner) / n

# create colors along a chosen colormap
#colors = [plt.cm.plasma(i / n) for i in range(n)]
colors = plt.cm.tab20b.colors

# create figure, axis
ax.axis("equal")

#ax.set_title("Comorbidities of Covid-19 Fatalities", size=40)

for i in range(n):
    radius = r - i * w
    ax.pie([percent[i] / percent.max() * percent_circle], radius=radius,␣
 ↪startangle=90,
           counterclock=False,
           colors=[colors[i]],
           labels=[f'{cathegories[i]}  {percent[i]}%'], labeldistance=None,
           wedgeprops={'width': w, 'edgecolor': 'white'})
    ax.text(0, radius - w/2, f'{cathegories[i]}  {int(round(percent[i]))}% ',␣
 ↪ha='right', va='center', size=14)

#plt.legend(loc='upper right', bbox_to_anchor=(0.5, 1.1), prop={'size': 12})
plt.tight_layout()
plt.show()
```

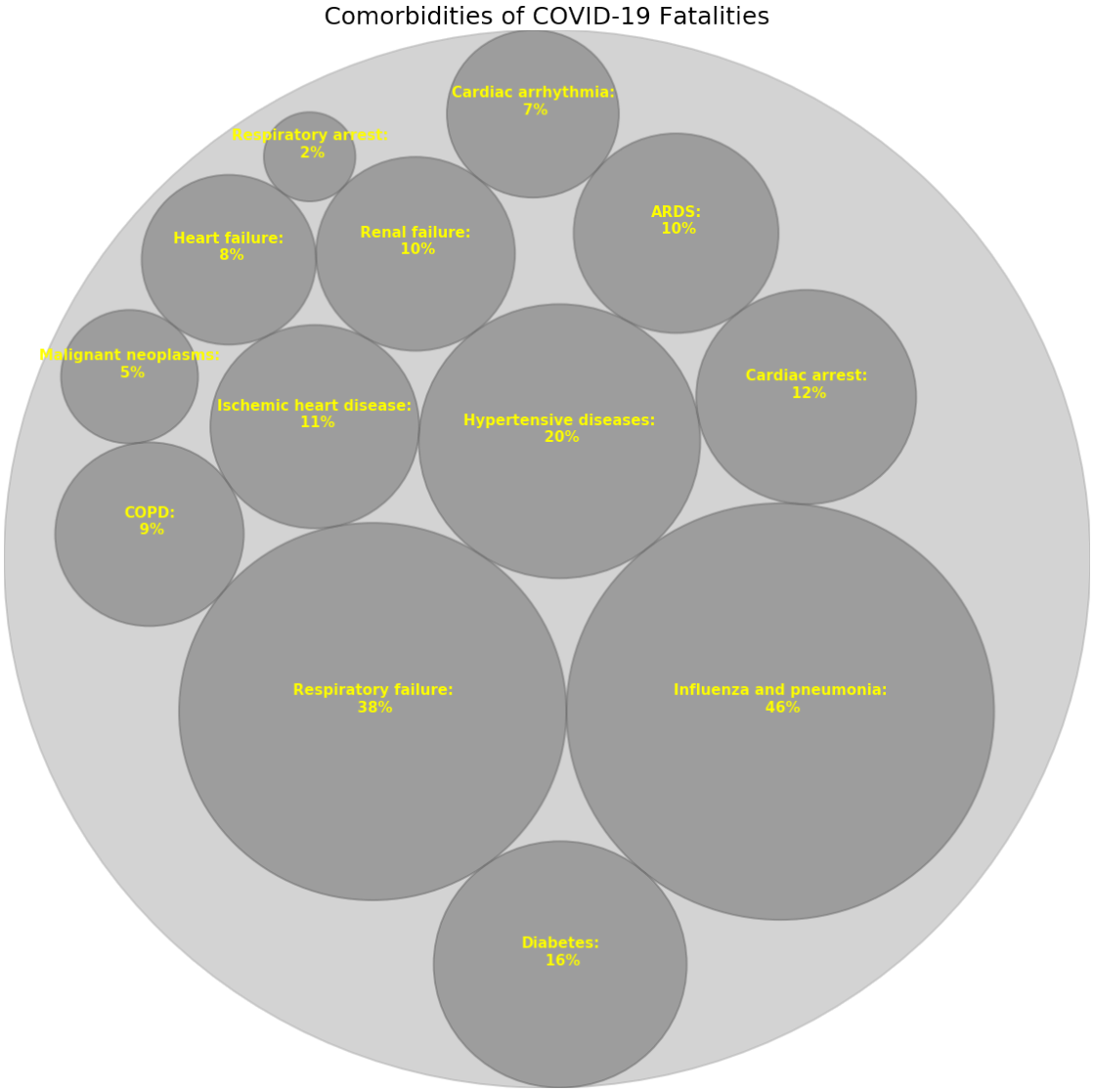


[17]:
```
data = [{'id': 'All COVID-19 Deaths', 'datum': 100,'children' : [
    {'id' : "Influenza and pneumonia", 'datum' : 45.7},
    {'id': 'Respiratory failure', 'datum': 37.5},
    {'id' : "COPD", 'datum' : 8.9},
    {'id' : "ARDS", 'datum' : 10.5},
    {'id': 'Respiratory arrest', 'datum':2.1},
    {'id': 'Hypertensive diseases', 'datum': 19.8},
    {'id': 'Ischemic heart disease', 'datum': 10.9},
    {'id': 'Cardiac arrest', 'datum': 12.1},
    {'id': 'Cardiac arrhythmia', 'datum': 7.4},
    {'id': 'Malignant neoplasms', 'datum': 4.7},
    {'id': 'Heart failure', 'datum': 7.6},
    {'id': 'Diabetes', 'datum': 16},
    {'id': 'Renal failure', 'datum': 9.9}
]}]
```

[18]:
```
# import the circlify library
import circlify

# Compute circle positions thanks to the circlify() function
circles = circlify.circlify(
    data,
    show_enclosure=False,
    target_enclosure=circlify.Circle(x=0, y=0, r=1)
)
```

[66]:
```
# import libraries
import circlify
import matplotlib.pyplot as plt

# Create just a figure and only one subplot
fig, ax = plt.subplots(figsize=(20,20))

# Title
ax.set_title('Comorbidities of COVID-19 Fatalities', size=25)

# Remove axes
ax.axis('off')

# Find axis boundaries
lim = max(
    max(
        abs(circle.x) + circle.r,
        abs(circle.y) + circle.r,
    )
    for circle in circles
)
```

```
plt.xlim(-lim, lim)
plt.ylim(-lim, lim)

# Print circle the highest level:
for circle in circles:
    if circle.level != 1:
        continue
    x, y, r = circle
    ax.add_patch( plt.Circle((x, y), r, alpha=0.5, linewidth=2,␣
 ↪color="darkgray"))

# Print circle and labels for the highest level:
for circle in circles:
    if circle.level != 2:
        continue
    x, y, r = circle
    label = circle.ex["id"]+":\n "+ str(int(round(circle.ex["datum"])))+"%"
    ax.add_patch( plt.Circle((x, y), r, alpha=0.5, linewidth=2,␣
 ↪color="dimgray"))
    plt.annotate(label, (x,y ), ha='center', color="yellow",weight="bold",␣
 ↪size=15)
```



5.1 Final Infographic: https://my.visme.co/view/8re9w8op-covid-19-uhc-timeline

[ ]: