Habermans survival dataset

- Haberman's survival dataset contains cases from a study that was conducted between 1958 and 1970 at the University of Chicago's Billings Hospital on the survival of patients who had undergone surgery for breast cancer.

In [45]:
```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import numpy as np
import warnings
warnings.filterwarnings("ignore")
```

In [46]:
```
df = pd.read_csv("haberman.csv")
```

In [47]:
```
print(df.shape)
```
```
(305, 4)
```

In [48]:
```
df.columns = ['age','opyear','axil','survive_stat']
```

In [49]:
```
df['survive_stat'] = df['survive_stat'].replace([1],'Survived')
df['survive_stat'] = df['survive_stat'].replace([2],'Not Survived')
```

In [50]:
```
df.head()
```

Out[50]:

	age	opyear	axil	survive_stat
0	30	62	3	Survived
1	30	65	0	Survived
2	31	59	2	Survived
3	31	65	4	Survived
4	33	58	10	Survived

Observation:

- There are 305 rows & 4 columns #### Each row contains:-
  - 'Age': age of pateint at the time of operation
  - 'opyear': Patient's year of operation
  - 'axil': Number of axillary nodes detected
  - 'survive_stat': Survival status of the patient. -1 if patient survived 5 years or longer. -2 if patient died within 5 year.
- 3 Independent variables

Axillary nodes:-

- The axillary lymph nodes or armpit lymph nodes are lymph nodes in the human armpit. Between 20 and 49 in number, they drain lymph vessels from the lateral quadrants of the breast, the superficial lymph vessels from thin walls of the chest and the abdomen above the level of the navel, and the vessels from the upper limb.

In [51]:
```
df["survive_stat"].value_counts()
```

Out[51]:
```
Survived        224
Not Survived     81
Name: survive_stat, dtype: int64
```

In [52]:
```
df.describe()
```

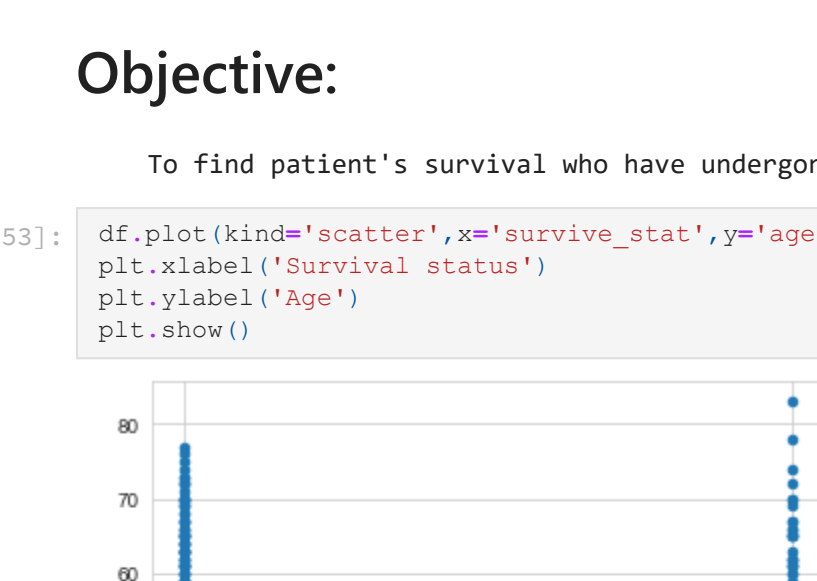
Out[52]:

	age	opyear	axil
count	305.000000	305.000000	305.000000
mean	52.531148	62.849180	4.036066
std	10.744024	3.254078	7.199370
min	30.000000	58.000000	0.000000
25%	44.000000	60.000000	0.000000
50%	52.000000	63.000000	1.000000
75%	61.000000	66.000000	4.000000
max	83.000000	69.000000	52.000000

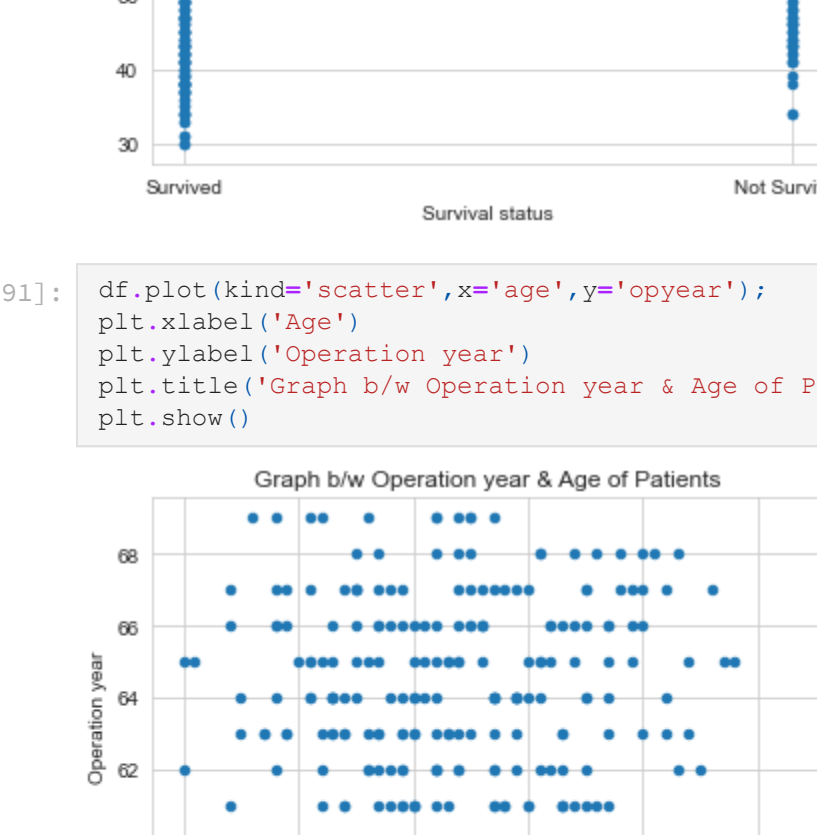
Objective:

To find patient's survival who have undergone through Operation

In [53]:
```
df.plot(kind='scatter',x='survive_stat',y='age');
plt.xlabel('Survival status')
plt.ylabel('Age')
plt.show()
```



In [91]:
```
df.plot(kind='scatter',x='age',y='opyear');
plt.xlabel('Age')
plt.ylabel('Operation year')
plt.title('Graph b/w Operation year & Age of Patients')
plt.show()
```

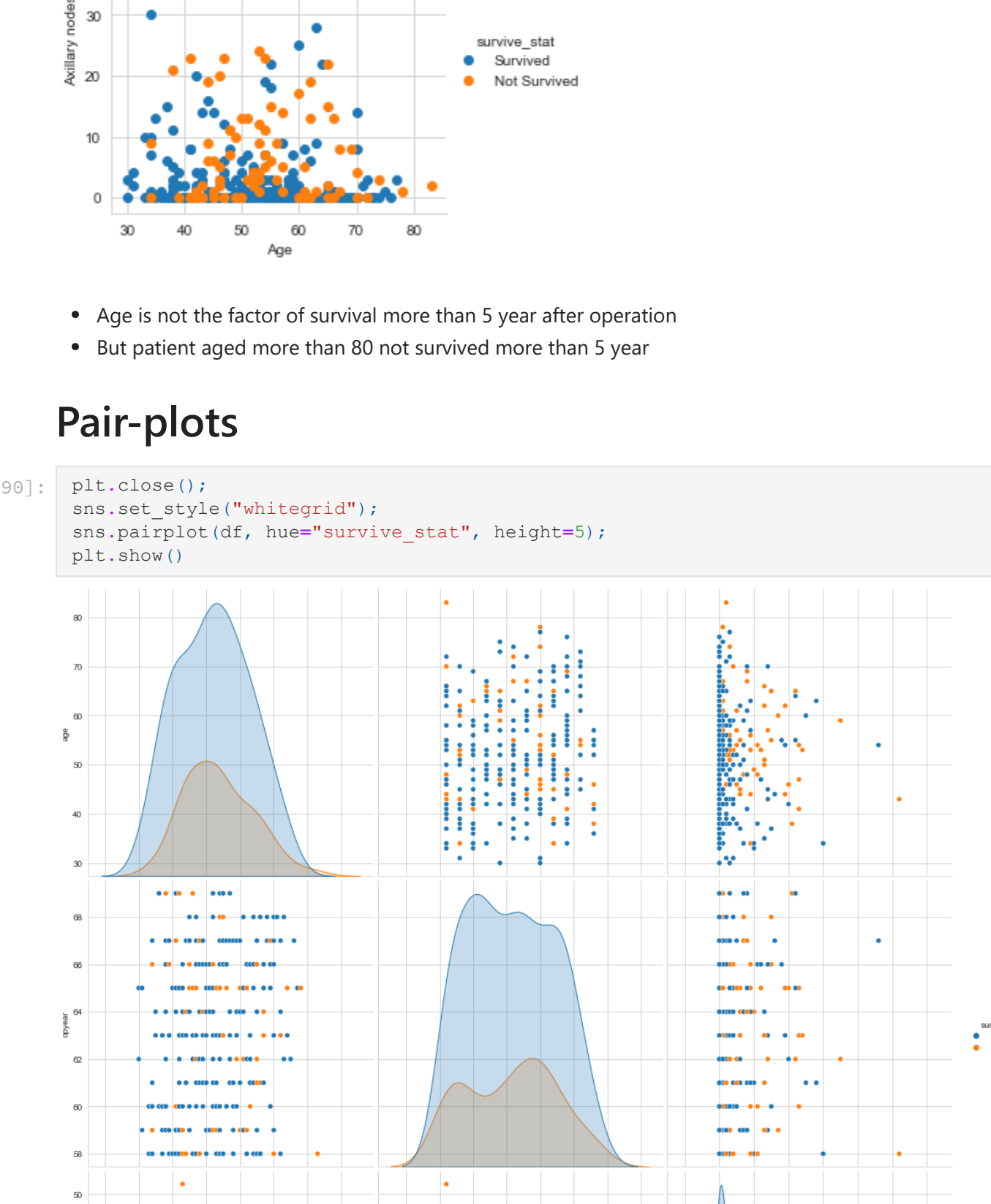


In [55]:
```
sns.set_style("whitegrid");
sns.FacetGrid(df, hue="survive_stat", height=4) \
   .map(plt.scatter, "age", "axil") \
   .add_legend();
plt.xlabel('Age')
plt.ylabel('Axillary nodes')
plt.show();
```

- Age is not the factor of survival more than 5 year after operation
- But patient aged more than 80 not survived more than 5 year

Pair-plots

In [90]:
```
plt.close();
sns.set_style("whitegrid");
sns.pairplot(df, hue="survive_stat", height=5);
plt.show();
```



- There is not any graph which is linearly seperable.

Histogram , PDF

In [57]:
```
df_survived = df.loc[df['survive_stat'] == 'Survived']
df_not_survived = df.loc[df['survive_stat'] == 'Not Survived']
```

In [58]:
```
df_survived.describe()
```

Out[58]:

	age	opyear	axil
count	224.000000	224.000000	224.000000
mean	52.116071	62.857143	2.799107
std	10.937446	3.229231	5.882237
min	30.000000	58.000000	0.000000
25%	43.000000	60.000000	0.000000
50%	52.000000	63.000000	0.000000
75%	60.000000	66.000000	3.000000
max	77.000000	69.000000	46.000000

In [59]:
```
df_not_survived.describe()
```

Out[59]:

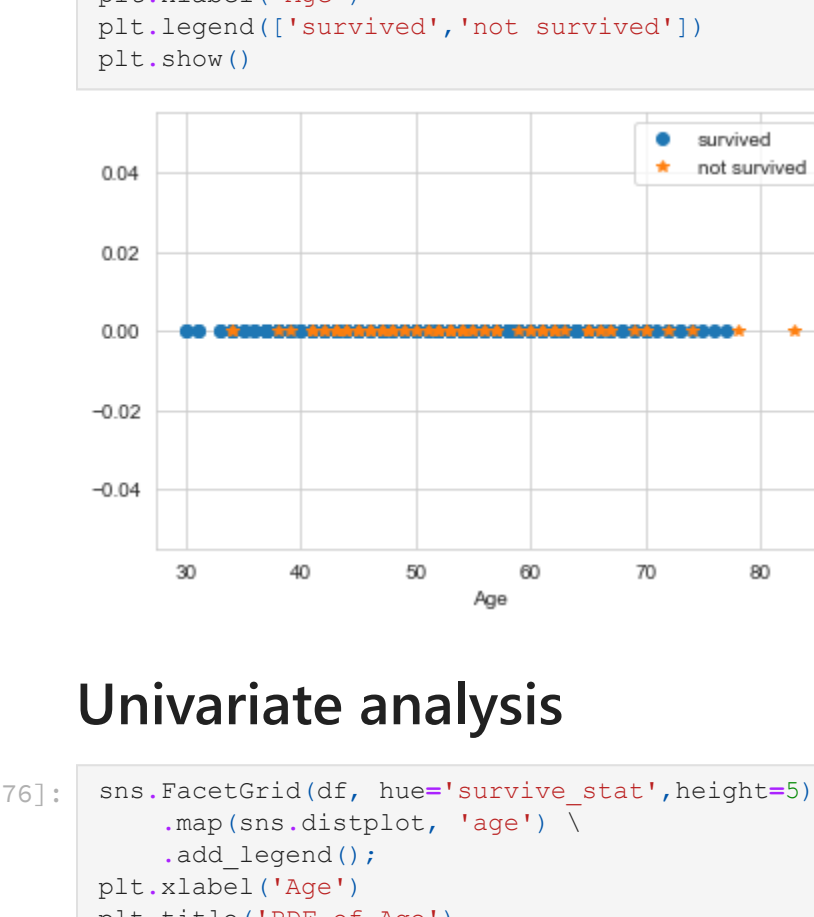
	age	opyear	axil
count	81.000000	81.000000	81.000000
mean	53.679012	62.827160	7.456790
std	10.167137	3.342118	9.185654
min	34.000000	58.000000	0.000000
25%	46.000000	59.000000	1.000000
50%	53.000000	63.000000	4.000000
75%	61.000000	65.000000	11.000000
max	83.000000	69.000000	52.000000

- The 75% patients who survived the operation have axillary nodes less than 3. & 75% patients who didn't survived the operation have less than 11 nodes.
- Mean value of axillary nodes between the survived & Not survived is 4.6

In [60]:
```
plt.plot(df_survived['age'], np.zeros_like(df_survived['age']),'o')
plt.plot(df_not_survived['age'], np.zeros_like(df_not_survived['age']),'*')
plt.xlabel('Age')
plt.legend(['survived','not survived'])
plt.show()
```

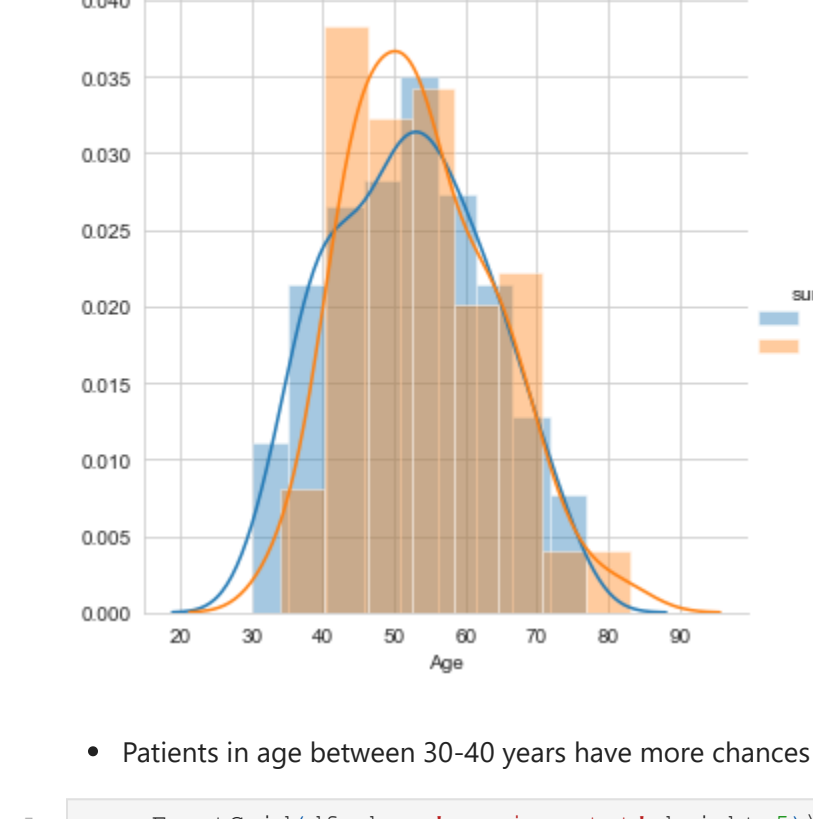
Univariate analysis

In [76]:
```
sns.FacetGrid(df, hue='survive_stat',height=5)\
   .map(sns.distplot, 'age') \
   .add_legend();
plt.xlabel('Age')
plt.title('PDF of Age')
plt.show()
```



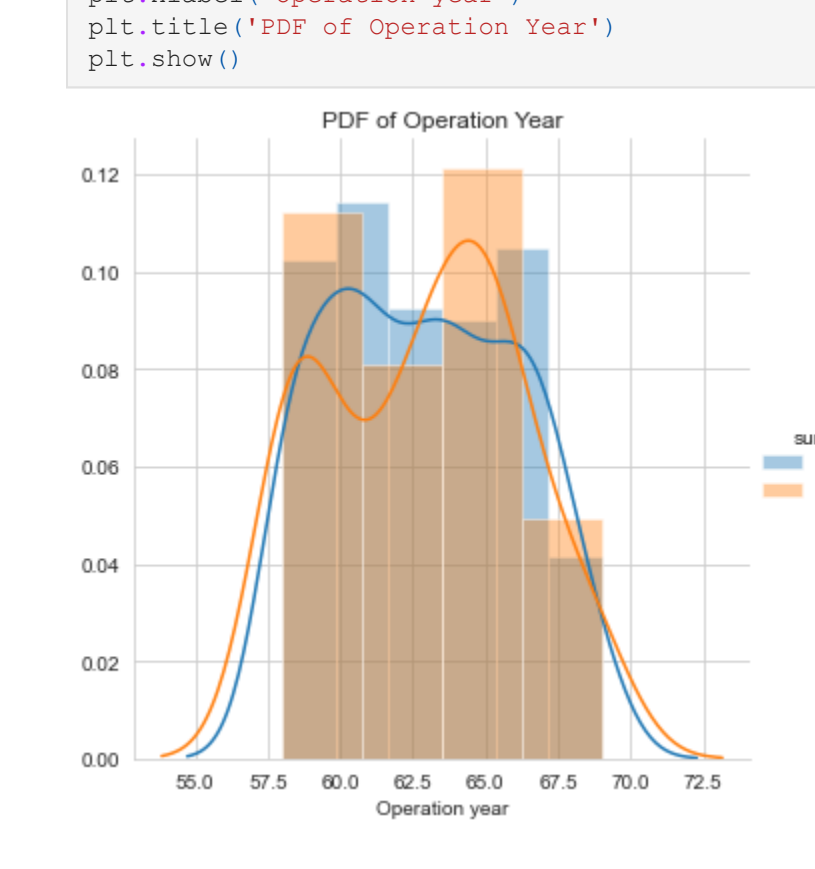
- Patients in age between 30-40 years have more chances of survival

In [77]:
```
sns.FacetGrid(df, hue='survive_stat',height=5)\
   .map(sns.distplot, 'opyear') \
   .add_legend();
plt.xlabel('Operation year')
plt.title('PDF of Operation Year')
plt.show()
```



- Due to excess overlapping no conclusion can be made on the basis of year of Operarion

In [78]:
```
sns.FacetGrid(df, hue='survive_stat',height=5)\
   .map(sns.distplot, 'axil') \
   .add_legend();
plt.xlabel('Axillary nodes')
plt.title('PDF of Axillary nodes')
plt.show()
```

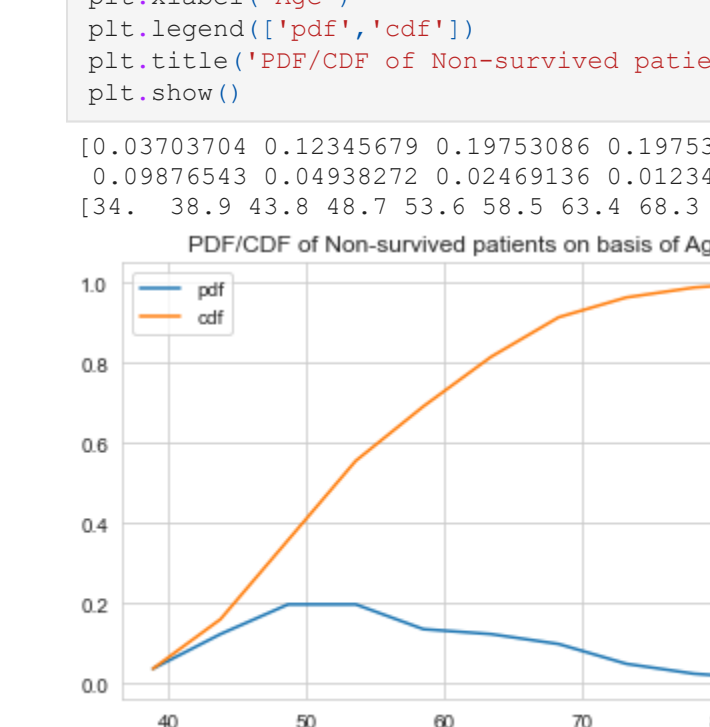


- There is lot of Overlapping so, there not much that can be said but .
- The patients with axillary node less than 2 have more chance of survival.

CDF

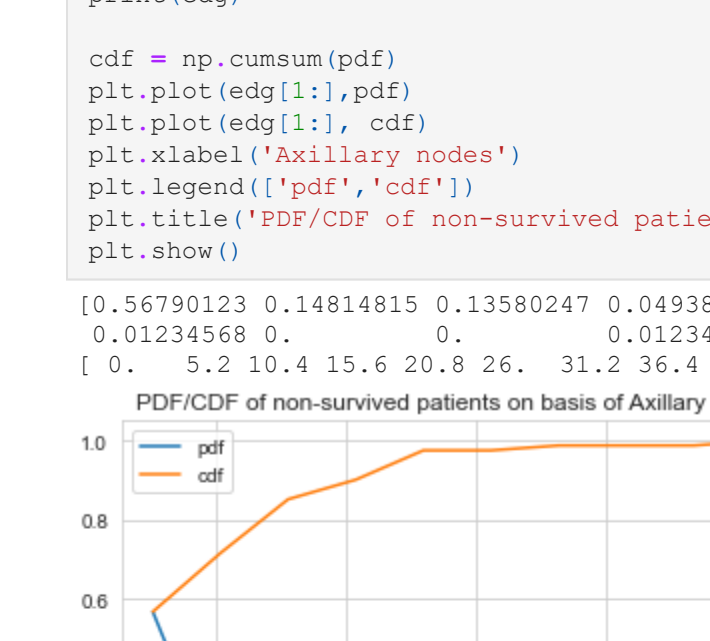
In [79]:
```
counts, edg = np.histogram(df_survived['age'],bins=10,density=True)

pdf = counts/sum(counts)

print(pdf)
print(edg)

cdf = np.cumsum(pdf)
plt.plot(edg[1:],pdf)
plt.plot(edg[1:], cdf)
plt.xlabel('Age')
plt.legend(['pdf','cdf'])
plt.title('PDF/CDF of survived patients on basis of Age')
plt.show()
```

```
[0.04910714 0.10714286 0.125      0.09375    0.16517857 0.16517857
 0.09375    0.11160714 0.0625     0.02678571]
[30.  34.7 39.4 44.1 48.8 53.5 58.2 62.9 67.6 72.3 77. ]
```



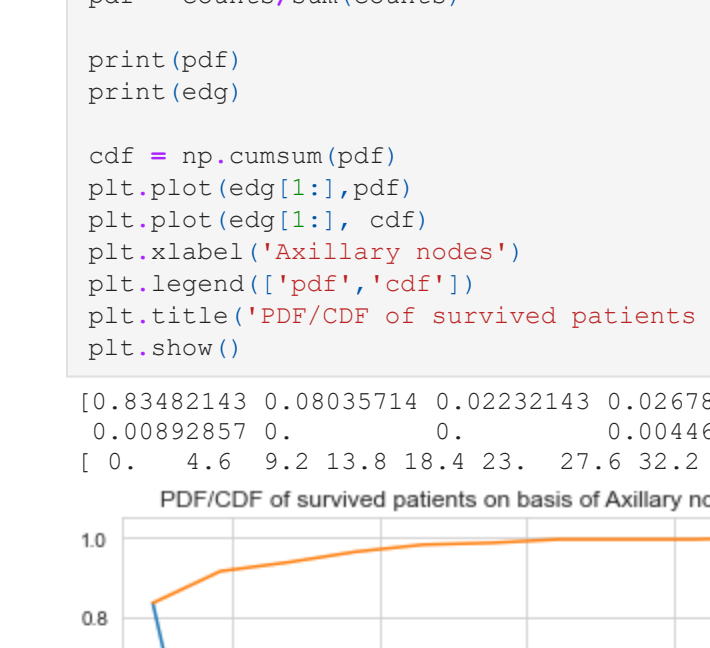
In [80]:
```
counts, edg = np.histogram(df_not_survived['age'],bins=10,density=True)

pdf = counts/sum(counts)

print(pdf)
print(edg)

cdf = np.cumsum(pdf)
plt.plot(edg[1:],pdf)
plt.plot(edg[1:], cdf)
plt.xlabel('Age')
plt.legend(['pdf','cdf'])
plt.title('PDF/CDF of Non-survived patients on basis of Age')
plt.show()
```

```
[0.03703704 0.12345679 0.19753086 0.19753086 0.13580247 0.12345679
 0.09876543 0.04938272 0.02469136 0.01234568]
[34.  38.9 43.8 48.7 53.6 58.5 63.4 68.3 73.2 78.1 83. ]
```



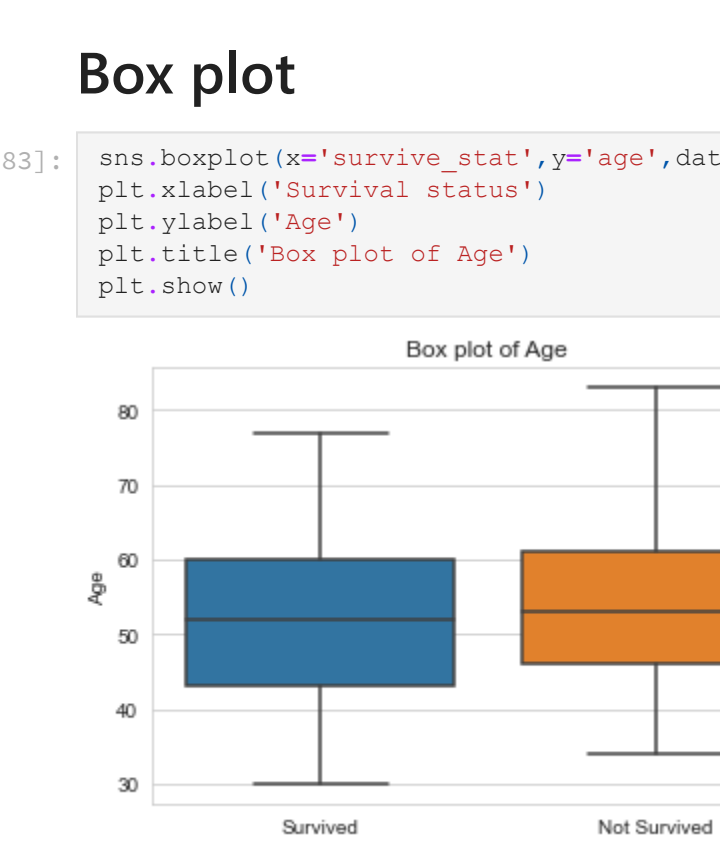
In [81]:
```
counts, edg = np.histogram(df_not_survived['axil'],bins=10,density=True)

pdf = counts/sum(counts)

print(pdf)
print(edg)

cdf = np.cumsum(pdf)
plt.plot(edg[1:],pdf)
plt.plot(edg[1:], cdf)
plt.xlabel('Axillary nodes')
plt.legend(['pdf','cdf'])
plt.title('PDF/CDF of non-survived patients on basis of Axillary nodes')
plt.show()
```

```
[0.56790123 0.14814815 0.13580247 0.04938272 0.07407407 0.
 0.01234568 0.         0.         0.01234568]
[ 0.   5.2 10.4 15.6 20.8 26.  31.2 36.4 41.6 46.8 52. ]
```



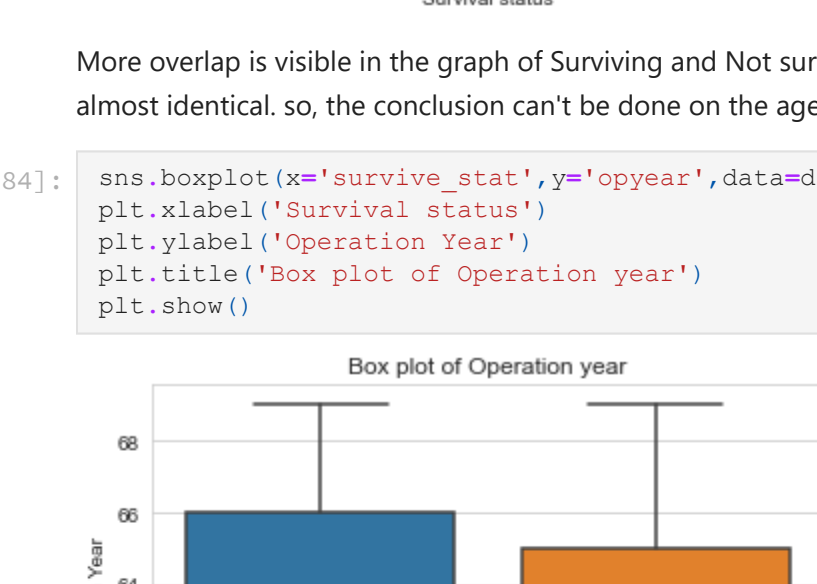
In [82]:
```
counts, edg = np.histogram(df_survived['axil'],bins=10,density=True)

pdf = counts/sum(counts)

print(pdf)
print(edg)

cdf = np.cumsum(pdf)
plt.plot(edg[1:],pdf)
plt.plot(edg[1:], cdf)
plt.xlabel('Axillary nodes')
plt.legend(['pdf','cdf'])
plt.title('PDF/CDF of survived patients on basis of Axillary nodes')
plt.show()
```

```
[0.83482143 0.08035714 0.02232143 0.02678571 0.01785714 0.00446429
 0.00892857 0.         0.         0.00446429]
[ 0.   4.6  9.2 13.8 18.4 23.  27.6 32.2 36.8 41.4 46. ]
```



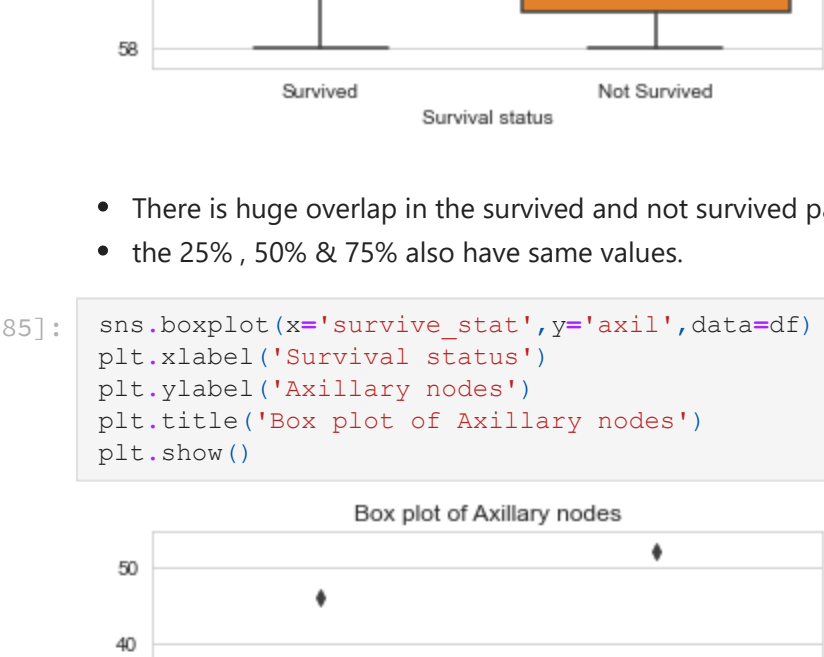
Box plot

In [83]:
```
sns.boxplot(x='survive_stat',y='age',data=df)
plt.xlabel('Survival status')
plt.ylabel('Age')
plt.title('Box plot of Age')
plt.show()
```



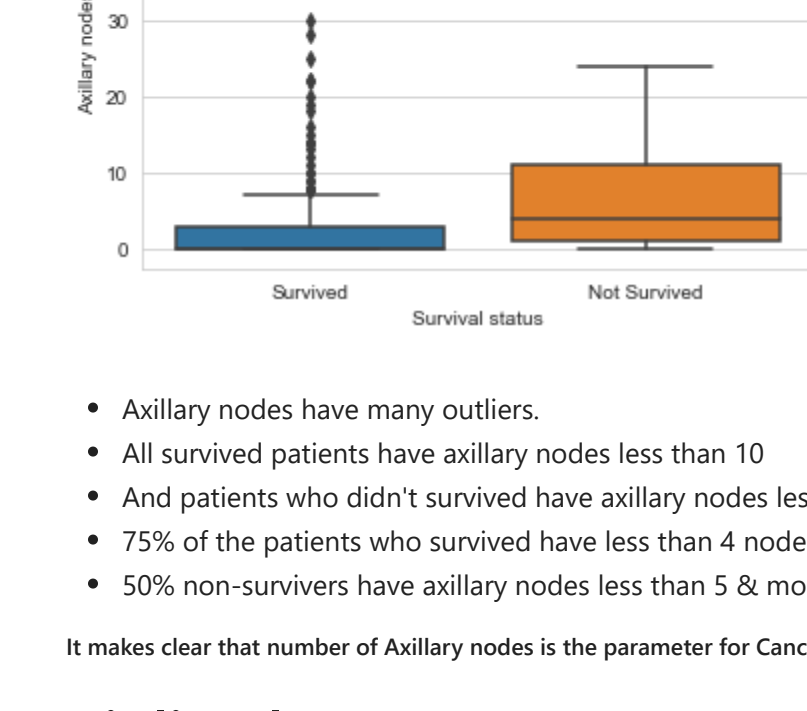
More overlap is visible in the graph of Surviving and Not surviving patients. The 25,50,75 percentile are also almost identical. so, the conclusion can't be done on the age of the patient.

In [84]:
```
sns.boxplot(x='survive_stat',y='opyear',data=df)
plt.xlabel('Survival status')
plt.ylabel('Operation Year')
plt.title('Box plot of Operation year')
plt.show()
```



- There is huge overlap in the survived and not survived patients .
- the 25% , 50% & 75% also have same values.

In [85]:
```
sns.boxplot(x='survive_stat',y='axil',data=df)
plt.xlabel('Survival status')
plt.ylabel('Axillary nodes')
plt.title('Box plot of Axillary nodes')
plt.show()
```

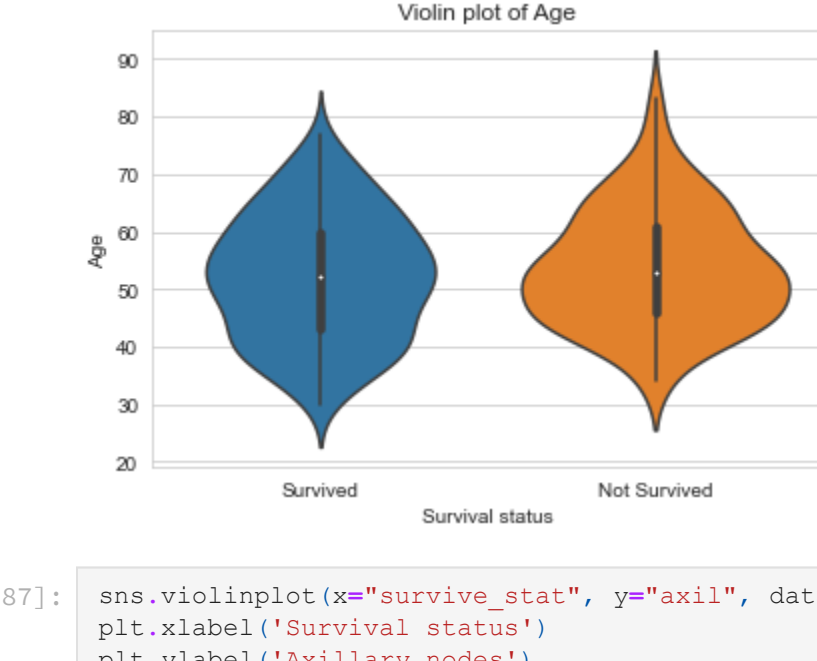


- Axillary nodes have many outliers.
- All survived patients have axillary nodes less than 10
- And patients who didn't survived have axillary nodes less than 24(Apprx.)
- 75% of the patients who survived have less than 4 nodes &
- 50% non-survivers have axillary nodes less than 5 & more than 5

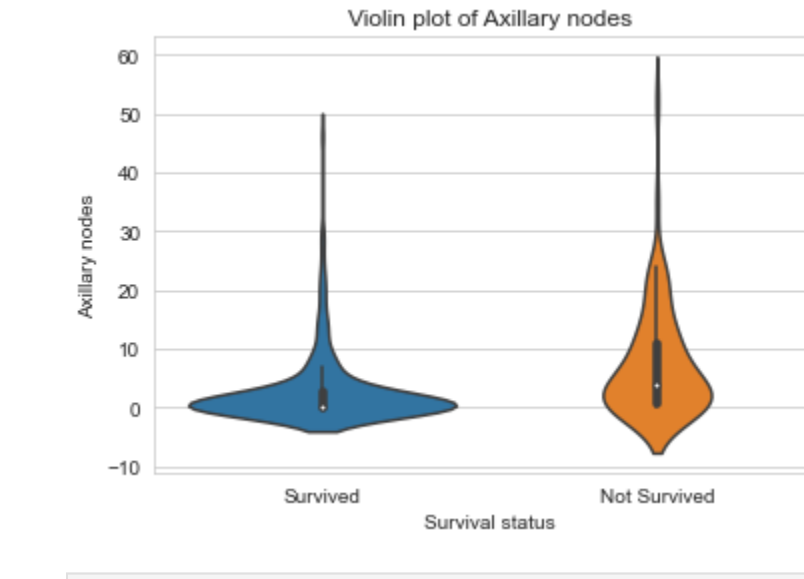
It makes clear that number of Axillary nodes is the parameter for Cancer Survival prediction

Violin plot

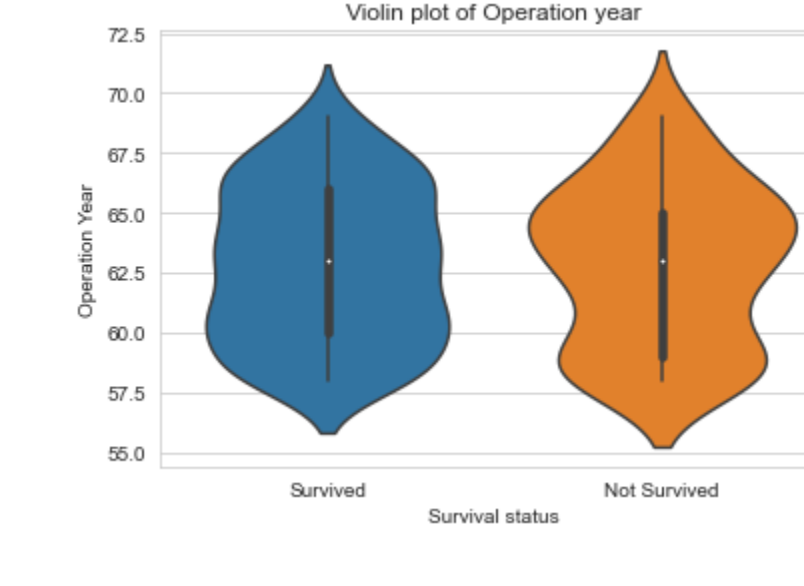
In [86]:
```
sns.violinplot(x="survive_stat", y="age", data=df, size=8)
plt.xlabel('Survival status')
plt.ylabel('Age')
plt.title('Violin plot of Age')
plt.show()
```



In [87]:
```
sns.violinplot(x="survive_stat", y="axil", data=df, size=8)
plt.xlabel('Survival status')
plt.ylabel('Axillary nodes')
plt.title('Violin plot of Axillary nodes')
plt.show()
```



In [88]:
```
sns.violinplot(x="survive_stat", y="opyear", data=df, size=8)
plt.xlabel('Survival status')
plt.ylabel('Operation Year')
plt.title('Violin plot of Operation year')
plt.show()
```



Mean , Stddev..

In [74]:
```
print("Means")
print(np.mean(df_survived['age']))
print(np.mean(df_not_survived['age']))


print("\nStd-dev")
print(np.std(df_survived['age']))
print(np.std(df_not_survived['age']))
```

```
Means
52.11607142857143
53.67901234567901

Std-dev
10.913004640364269
10.10418219303131
```

In [75]:
```
print("Means")
print(np.mean(df_survived['axil']))
print(np.mean(np.append(df_survived['axil'],50)))
print(np.mean(df_not_survived['axil']))


print("\nStd-dev")
print(np.std(df_survived['axil']))
print(np.std(df_not_survived['axil']))
```

```
Means
2.799107142857143
3.008888888888889
7.45679012345679

Std-dev
5.869092706952767
9.128776076761632
```

Conclusion:-

- Age is not the factor for the survival.
- but 80+ year patient not survived after operation
- Patients between the age of 30-40 have more chance of survival
- Axillary nodes have many outliers
- Patients having axillary nodes less 4 have 75% more chances of survival
- Among the 3 features number Axillary nodes is more relevant for the prediction of cancer survival followed by Age & Patient's year of operation.