1. Load the patient data from “patients.csv” file.

In [1]:
```
import pandas as pd
df_load = pd.read_csv("Patients.csv") # load csv file
df_load. head(3)
# as we can see there 2 variables Last Name and Diastolic which need to be removed
```

Out[1]:

	Age	Diastolic	Gender	Height	LastName	Location	SelfAssessedHealthStatus	Smoker	Systolic	Weight
0	38	93	'Male'	71	'Smith'	'County General Hospital'	'Excellent'	1	124	176
1	43	77	'Male'	69	'Johnson'	'VA Hospital'	'Fair'	0	109	163
2	38	83	'Female'	64	'Williams'	'St. Mary's Medical Center'	'Good'	0	125	131

2. Use variables Age, Gender, Height, Weight, Smoker, Location, SelfAssessedHealthStatus to build a linear regression model to predict the systolic blood pressure.

In [2]:
```
#droping the variable Diastolic and Last name
df_drop =  df_load.drop(df_load.columns[[1, 4]], axis=1)
cols = list(df_drop)
cols.insert(6, cols.pop(cols.index('Weight')))
cols.insert(3,cols.pop(cols.index('Weight')))
df1_drop = df_drop.loc[:, cols]
df_patient= pd.DataFrame(df1_drop )
df_patient
```

Out[2]:

	Age	Gender	Height	Weight	Location	SelfAssessedHealthStatus	Smoker	Systolic
0	38	'Male'	71	176	'County General Hospital'	'Excellent'	1	124
1	43	'Male'	69	163	'VA Hospital'	'Fair'	0	109
2	38	'Female'	64	131	'St. Mary's Medical Center'	'Good'	0	125
3	40	'Female'	67	133	'VA Hospital'	'Fair'	0	117
4	49	'Female'	64	119	'County General Hospital'	'Good'	0	122
...	...	...	...	...	...	...	...	...
95	25	'Male'	69	171	'County General Hospital'	'Good'	1	128
96	44	'Male'	69	188	'VA Hospital'	'Good'	1	124
97	49	'Male'	70	186	'County General Hospital'	'Fair'	0	119
98	45	'Male'	68	172	'County General Hospital'	'Good'	1	136
99	48	'Male'	66	177	'County General Hospital'	'Fair'	0	114

100 rows × 8 columns

3. What are the regression coefficients (thetas)?

In [3]:

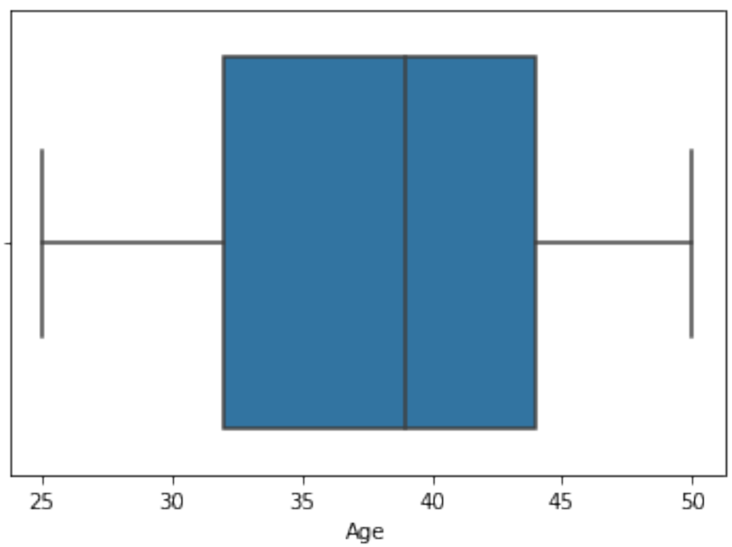
```
# converting categorical variable using one hot encoding
df_patient_dummies = pd.concat([df_patient[['Age','Height','Weight','Smoker','Systolic']],pd.get_dummies(d
df_patient_dummies
cols = list(df_patient_dummies)
# move the column to head of list using index, pop and insert
cols.insert(10, cols.pop(cols.index('Systolic')))
cols
df_patient_new =df_patient_dummies.loc[:, cols]
df_patient_new
```

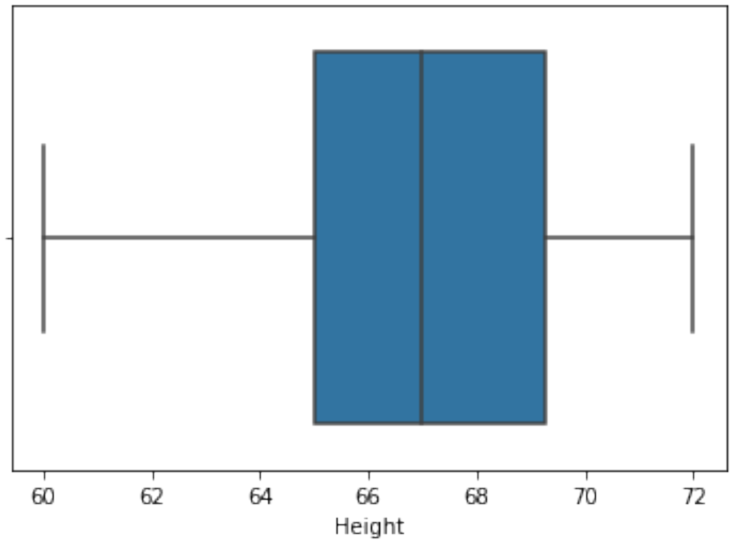
Out[3]:

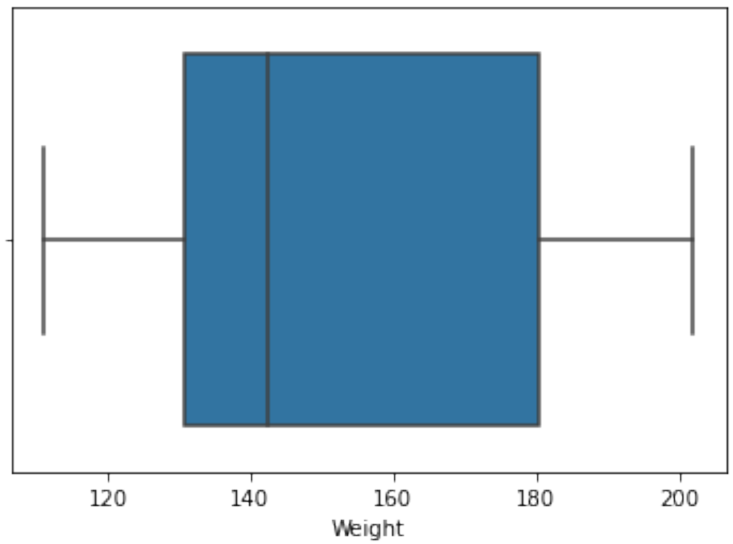
	Age	Height	Weight	Smoker	Gender__'Male'	Location__'St. Mary's Medical Center'	Location__'VA Hospital'	HealthStatus__'Fair'	HealthStatus__'Good'	He
0	38	71	176	1	1	0	0	0	0	
1	43	69	163	0	1	0	1	1	0	
2	38	64	131	0	0	1	0	0	1	
3	40	67	133	0	0	0	1	1	0	
4	49	64	119	0	0	0	0	0	1	
...	...	...	...	...	...	...	...	...	...	
95	25	69	171	1	1	0	0	0	1	
96	44	69	188	1	1	0	1	0	1	
97	49	70	186	0	1	0	0	1	0	
98	45	68	172	1	1	0	0	0	1	
99	48	66	177	0	1	0	0	1	0	

100 rows × 11 columns

In [4]:
```
# determining the outliers in the numerical data (Height, weight,Age )
sorted(df_patient_new)
Q1=df_patient_new.quantile(0.25)
Q3=df_patient_new.quantile(0.75)
IQR=Q3-Q1
#print(IQR)
#print(df_patient < (Q1 - 1.5 * IQR)) |(df_patient> (Q3 + 1.5 * IQR))
%matplotlib inline
import seaborn as sns
import matplotlib.pyplot as plt
#sns.boxplot(data=df_patient_new["Location__'St. Mary's Medical Center'"])

sns.boxplot(x = df_patient_new['Age'])
plt.show()
sns.boxplot(x= df_patient_new['Height'])
plt.show()
sns.boxplot(x= df_patient_new['Weight'])

plt.show()
df_patient_new.describe()
# df_patient < (Q1 - 1.5 * IQR))  also (df_patient> (Q3 + 1.5 * IQR)) so, no outlier found
```




60
62
64
66
68
70
72
Height


120
140
160
180
200
Weight

Out[4]:

	Age	Height	Weight	Smoker	Gender__'Male'	Location__'St. Mary's Medical Center'	Location__'VA Hospital'	HealthStatus__'Fair'	Hea
count	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000	100.00000	
mean	38.280000	67.070000	154.000000	0.340000	0.470000	0.240000	0.370000	0.15000	
std	7.215416	2.836469	26.571421	0.476095	0.501614	0.429235	0.485237	0.35887	
min	25.000000	60.000000	111.000000	0.000000	0.000000	0.000000	0.000000	0.00000	
25%	32.000000	65.000000	130.750000	0.000000	0.000000	0.000000	0.000000	0.00000	
50%	39.000000	67.000000	142.500000	0.000000	0.000000	0.000000	0.000000	0.00000	
75%	44.000000	69.250000	180.250000	1.000000	1.000000	0.000000	1.000000	0.00000	
max	50.000000	72.000000	202.000000	1.000000	1.000000	1.000000	1.000000	1.00000	

In [63]:

```
#scaling the features:
X= df_patient_new.iloc[:,:-1].values
y = df_patient_new.iloc[:,-1].values
model_features = ['Age', 'Height', 'Weight', 'Smoker', "Gender__'Male'","Location__'St. Mary's Medical Cen
                   "Location__'VA Hospital'","HealthStatus__'Fair'" , "HealthStatus__'Good'", "HealthStatu
from sklearn.preprocessing import scale

df_X = pd.DataFrame(X, columns = model_features )
df_numeric =  df_X.drop(df_X.columns[[3, 4,5,6,7,8,9]], axis=1)
df_categorical = df_X.drop(df_X.columns[[0,1,2]], axis=1)
numeric_scale= scale(df_numeric)
print(numeric_scale.mean(axis=0))
print(numeric_scale.std(axis=0))
df_numeric_scale = pd.DataFrame(numeric_scale, columns = ['Age', 'Height', 'Weight'])
X_scale = pd.concat([df_numeric_scale ,df_categorical], axis =1)
#Splitting the data into Training Set and Test Set
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X_scale,y,test_size=0.3)
# Fitting logistic regression on our standardized data set
```

```
from sklearn.linear_model import LinearRegression
model = LinearRegression()
model.fit(X_train, y_train)
# evaluate the model
yhat = model.predict(X_test)

#determining the intercept and theta values, RMSE and R2

from sklearn.metrics import mean_squared_error,r2_score
print('Intercept: \n',  model.intercept_ )

coef_dict = dict(zip(model_features, model.coef_))
df = pd.DataFrame(list(coef_dict.items()),columns = ['Feature','Coef'])
print('Coefficients: \n',  df )
# The mean squared error
print('RMSE: %.2f'  %mean_squared_error(y_test, yhat,squared = False))
#  variance score: 1 is perfect prediction
print('Variance score: %.2f' % r2_score(y_test, yhat))
# The mean squared error
print('MSE: %.2f'  %mean_squared_error(y_test, yhat))
```

```
[-1.57651669e-16  2.45692355e-15 -1.22124533e-17]
[1. 1. 1.]
Intercept:
 121.71734769548412
Coefficients:
                                   Feature      Coef
0                                      Age  1.232660
1                                   Height  1.549090
2                                   Weight -0.475070
3                                   Smoker  9.720256
4                           Gender__'Male' -1.911441
5  Location__'St. Mary's Medical Center' -0.371686
6                 Location__'VA Hospital' -2.801331
7                    HealthStatus__'Fair' -2.258834
8                    HealthStatus__'Good'  0.086496
9                    HealthStatus__'Poor'  1.241223
RMSE: 5.13
Variance score: 0.52
MSE: 26.34
```

4. How do you interpret those numbers?

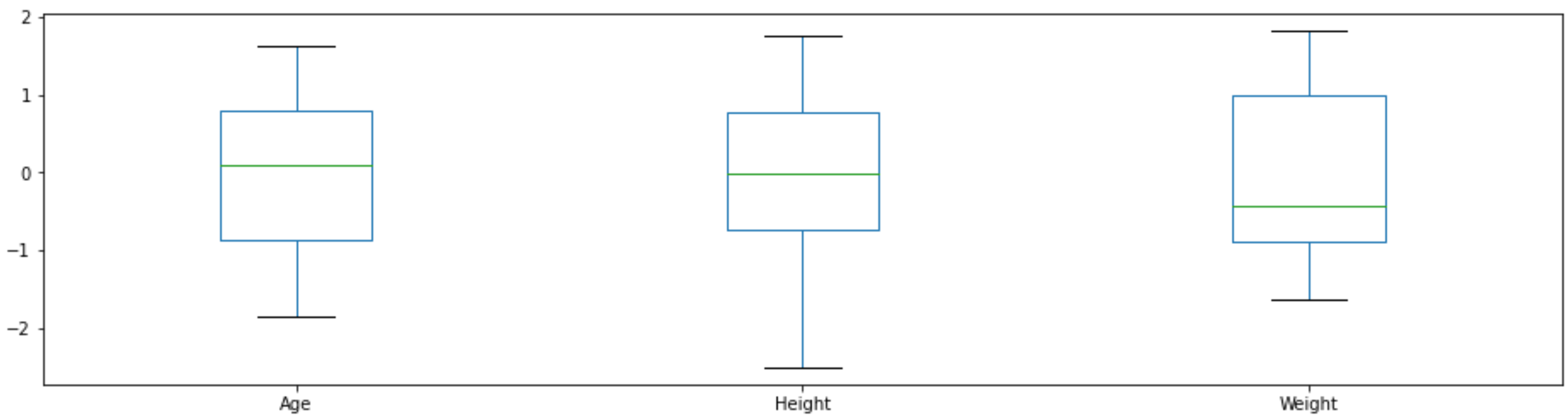
In this dataset the systolic blood pressure range start from 121.71734769548412

1. when the Age increases by 1 standard devation, the systolic blood pressure also increases by 1.232660 2.when weight increases by 1 Standard devation, the systolic blood pressure decreases by 0.475070 3.Increase in the Height by 1 standard devation, result in increase in blood pressure by 1.549090 4.smoker systolic blood pressure is 9.720256 higher with respect to systolic blood pressure of non smoker. 5.male compared to reference group female, blood pressure of male will be 1.911441 lower comapred to the female. 6.Patient from 'St. Mary's Medical Center' location have 0.371686 lower blood pressure with respect to the patient of 'County General Hospital' 7.Patient from 'VA Hospital' location will have 2.801331 lower blood pressure than the patient of County General Hospital. 8.Patient with HealthStatus__'Fair' have 2.258834 lower blood pressure with respect to the patient with excellent health.
2. Patient who say HealthStatus__'Good' have 0.086496 higher blood pressure with respect to the patient with excellent health.
3. Patient with HealthStatus__'Poor' have 1.241223 higher blood pressure with respect to patient with excellent health.

5. If you need to identify one outlier record, which record is a potential outlier? How do you reach this conclusion?

There are no outliers for categorical (dummy)/binary attributes Gender, LastName, Location, SelfAssessment and Smoker are all irrelevant in the search for outliers. Hence, only interested attributes are numeric attributes: Age, Height and Weight. We use box plot to search the outliers.

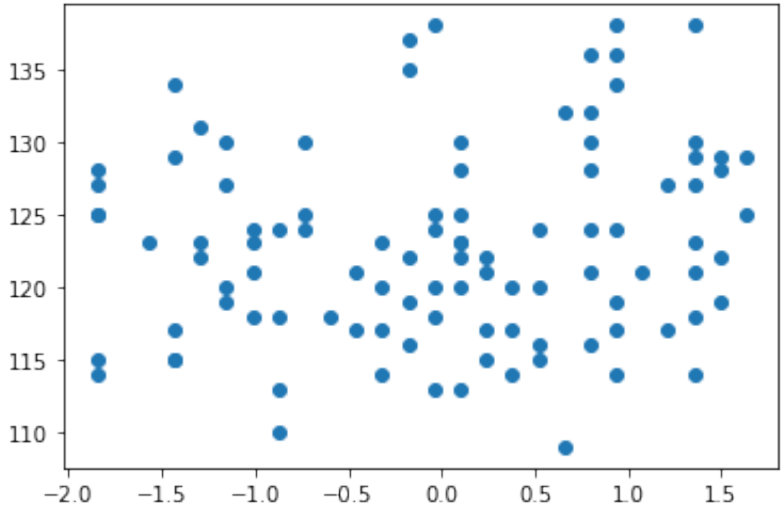
In [64]:
```
#spotting outlier using box plot
X_scale=scale(X)

df_dscale = pd.DataFrame(X_scale, columns = model_features)
df_numeric_scale =  df_dscale.drop(df_dscale.columns[[3, 4,5,6,7,8,9]], axis=1)
df_numeric_scale
import matplotlib.pyplot as plot

#get_ipython().run_line_magic('matplotlib', 'inline')

df_numeric_scale.plot.box(figsize=(16,4))

patientsY = pd.DataFrame(y, columns = ['Systolic'])

#sorted(df_numeric_scale)

#Q1=df_numeric_scale.quantile(0.25)
#Q3=df_numeric_scale.quantile(0.75)
#IQR=Q3-Q1
```



This suggests Height has the largest absolute outlier, which is a minimum. We can now examine this with scatterplots.

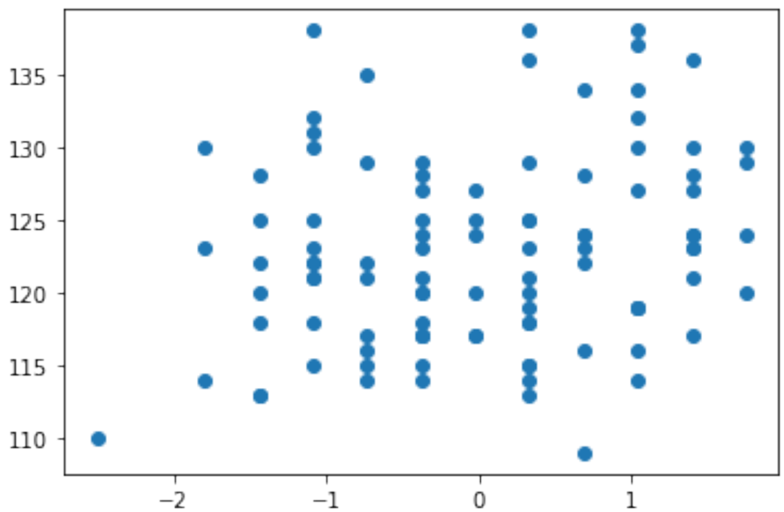
In [65]:
```
plt.scatter(df_numeric_scale['Age'], patientsY)
```

Out[65]: <matplotlib.collections.PathCollection at 0x7fac38763070>



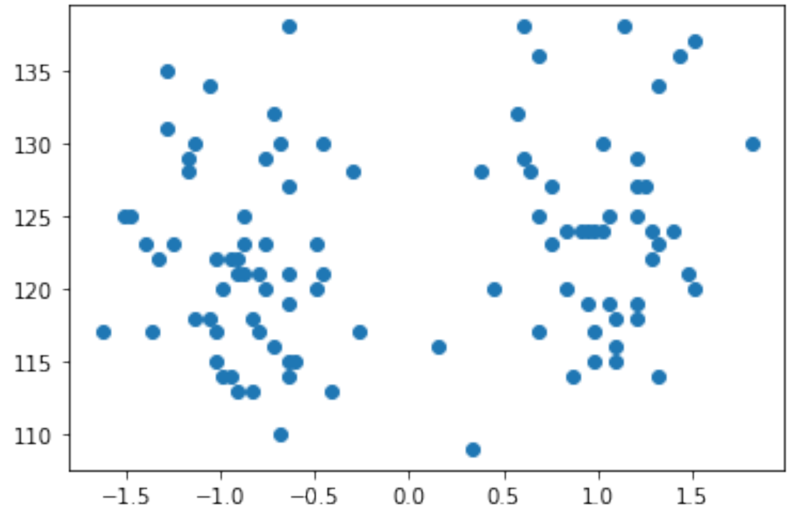
In [66]:
```
plt.scatter(df_numeric_scale['Height'], patientsY)
```

Out[66]: <matplotlib.collections.PathCollection at 0x7fac3a07c0d0>



In [67]:
```
plt.scatter(df_numeric_scale['Weight'], patientsY)
```

Out[67]: <matplotlib.collections.PathCollection at 0x7fac39ed6ca0>



In [68]:
```
print("Min :", df_numeric_scale.min())
print("Max :" , df_numeric_scale.max())
```

```
Min : Age      -1.849776
Height   -2.505093
Weight   -1.626433
dtype: float64
Max : Age       1.632483
Height    1.746833
Weight    1.815553
dtype: float64
```

The single outlier record I identify using a boxplot is the lowest Height value, -2.505

In [ ]: