In [12]:
```
#Importujemo neophodne biblioteke

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as seabornInstance
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn import metrics
%matplotlib inline

from sklearn import preprocessing
from sklearn.preprocessing import Binarizer
from sklearn.preprocessing import LabelEncoder, OneHotEncoder
from sklearn.pipeline import Pipeline, make_union
from sklearn.base import BaseEstimator, TransformerMixin
```

In [13]:
```
#importujemo dataset

cardio = pd.read_csv("cardio_train.csv", sep=";", index_col = "id")
cardio.head()
```

Out[13]:

id	age	gender	height	weight	ap_hi	ap_lo	cholesterol	gluc	smoke	alco	active	cardio
0	18393	2	168	62.0	110	80	1	1	0	0	1	0
1	20228	1	156	85.0	140	90	3	1	0	0	1	1
2	18857	1	165	64.0	130	70	3	1	0	0	0	1
3	17623	2	169	82.0	150	100	1	1	0	0	1	1
4	17474	1	156	56.0	100	60	1	1	0	0	0	0

In [14]:
```
#Opis dataseta - Podaci u kolonama su:
#age - in days, gender: 1 - women, 2 - men, height - cm, weight - kg,
#ap_hi - Systolic blood pressure, ap_lo - Diastolic blood pressure,
#cholesterol - 1: normal, 2: above normal, 3: well above normal,
#gluc - 1: normal, 2: above normal, 3: well above normal
#smoke - whether patient smokes or not
#alco - Binary feature, active - Binary feature
#cardio - Target variable
```

In [15]:
```
#Podešavamo broj decimala u DF
pd.set_option("precision", 2)

#dimenzije
cardio.shape
```

Out[15]: (70000, 12)

In [16]:
```
#provera da li ima nedostajućih podataka

cardio.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 70000 entries, 0 to 99999
Data columns (total 12 columns):
age            70000 non-null int64
gender         70000 non-null int64
height         70000 non-null int64
weight         70000 non-null float64
ap_hi          70000 non-null int64
ap_lo          70000 non-null int64
cholesterol    70000 non-null int64
gluc           70000 non-null int64
smoke          70000 non-null int64
alco           70000 non-null int64
active         70000 non-null int64
cardio         70000 non-null int64
dtypes: float64(1), int64(11)
memory usage: 6.9 MB
```

In [17]:
```
#provera podataka po kolonama

cardio["gender"].values
```

Out[17]:
```
array([2, 1, 1, ..., 2, 1, 1], dtype=int64)
```

In [18]:
```
cardio["height"].values
```

Out[18]:
```
array([168, 156, 165, ..., 183, 163, 170], dtype=int64)
```

In [19]:
```
cardio.describe()
```

Out[19]:

	age	gender	height	weight	ap_hi	ap_lo	cholesterol	gluc	smo
count	70000.00	70000.00	70000.00	70000.00	70000.00	70000.00	70000.00	70000.00	70000
mean	19468.87	1.35	164.36	74.21	128.82	96.63	1.37	1.23	0
std	2467.25	0.48	8.21	14.40	154.01	188.47	0.68	0.57	0
min	10798.00	1.00	55.00	10.00	-150.00	-70.00	1.00	1.00	0
25%	17664.00	1.00	159.00	65.00	120.00	80.00	1.00	1.00	0
50%	19703.00	1.00	165.00	72.00	120.00	80.00	1.00	1.00	0
75%	21327.00	2.00	170.00	82.00	140.00	90.00	2.00	1.00	0
max	23713.00	2.00	250.00	200.00	16020.00	11000.00	3.00	3.00	1

In [20]:
```
#Postoji nekoliko problema u Datasetu koje treba korigovati:
# Kolona age - starost je data u danima, potrebno je konvertovati u godine
# Kolona ap_hi - postoje vrednosti gornjeg krvnog pritiska koje su nemoguće
# Kolona ap_lo - postoje vrednosti gornjeg krvnog pritiska koje su nemoguće
```

In [21]:
```
#Pretvaramo podatke kolonu "age" iz broja dana starosti u godine starosti
starost = cardio["age"]/365
starost = np.floor(starost)
starost = starost.astype(float)
cardio["age"] = starost
cardio.head(3)
```

Out[21]:

id	age	gender	height	weight	ap_hi	ap_lo	cholesterol	gluc	smoke	alco	active	cardio
0	50.0	2	168	62.0	110	80	1	1	0	0	1	0
1	55.0	1	156	85.0	140	90	3	1	0	0	1	1
2	51.0	1	165	64.0	130	70	3	1	0	0	0	1

In [22]:
```
#Kolone ap_hi i ap_lo uređujemo koristeći Inter Quartile Range metod koji ukla
nja
# ekstremne vrednosti - Outliers. Prvo definišemo kontinuirane podatke na koje
# primenjujemo metod. Ostale kolone su definisane

continuous = ["age", "height", "weight", "ap_hi", "ap_lo"]
Q1 = cardio.quantile(0.25)
Q3 = cardio.quantile(0.75)
IQR = Q3 - Q1
print(IQR)
```

```
age            10.0
gender          1.0
height         11.0
weight         17.0
ap_hi          20.0
ap_lo          10.0
cholesterol     1.0
gluc            0.0
smoke           0.0
alco            0.0
active          0.0
cardio          1.0
dtype: float64
```

In [23]:
```
#Uklanjamo Outliers-e odnosno ekstremne podatke

clean = cardio[~((cardio[continuous] < (Q1 - 1.5 * IQR)) | (cardio[continuous]
> (Q3 + 1.5 * IQR))).any(axis = 1)]
clean.shape
```

Out[23]: (62502, 12)

In [24]:
```
#Proveravamo Dataset da li ima ekstremnih vrednosti

clean.describe()
```

Out[24]:

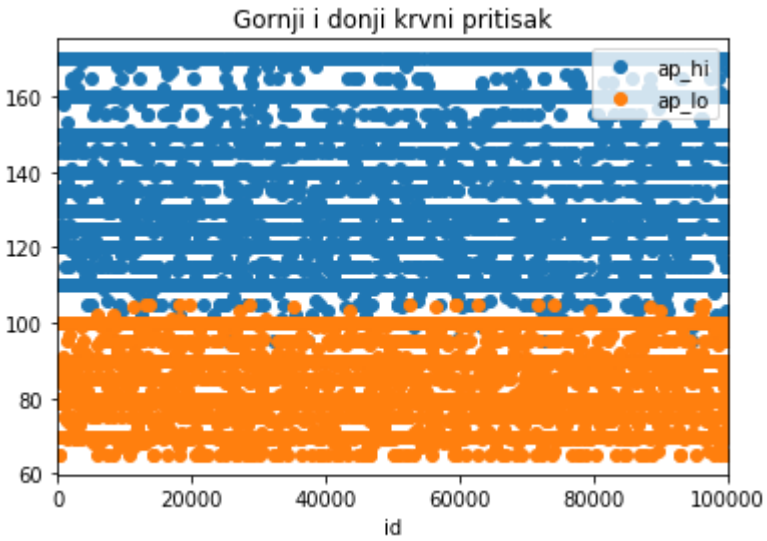
	age	gender	height	weight	ap_hi	ap_lo	cholesterol	gluc	smo
count	62502.00	62502.00	62502.00	62502.00	62502.00	62502.00	62502.00	62502.00	62502
mean	52.91	1.35	164.41	73.18	126.42	81.70	1.36	1.22	0
std	6.74	0.48	7.53	12.27	14.29	7.67	0.68	0.57	0
min	39.00	1.00	143.00	40.00	90.00	65.00	1.00	1.00	0
25%	48.00	1.00	159.00	65.00	120.00	80.00	1.00	1.00	0
50%	54.00	1.00	165.00	72.00	120.00	80.00	1.00	1.00	0
75%	58.00	2.00	170.00	81.00	140.00	90.00	1.00	1.00	0
max	64.00	2.00	186.00	107.00	170.00	105.00	3.00	3.00	1

In [25]:
```
clean.to_csv("cardio_clean.csv")
```

Simple linear regresion

In [26]:
```
#Primena mašinskog učenja korišćenjem linearne regresije. Prvo ćemo koristiti
#linearnu regresiju samo sa dva parametra - Simple Linear Regresion, a potom
# Multiple Linear Regresion

#Simple Linear Regresion
clean.plot( y = ["ap_hi", "ap_lo"], style = "o" )
plt.title("Gornji i donji krvni pritisak")
plt.show()
```



In [27]:
```
#Želimo da na osnovu poznavanja donjeg krvnog pritiska pogodimo gornji krvni p
ritisak, pa
#podešavamo ap_lo da nam bude x atribut, a ap_hi da nam bude lebel

#Prilikom primene fit  metoda javlja nam se value error koji traži da se ispra
vi
# dodavanjem array.reshape(-1, 1)
X = clean["ap_lo"].values.reshape(-1, 1)
y = clean["ap_hi"].values.reshape(-1, 1)
```

In [28]:
```
#Delimo dataset na trening i test skup

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, ran
dom_state = 0)
```

In [29]:
```
regresor = LinearRegression()
regresor.fit(X_train, y_train)
```

Out[29]:
```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None,
         normalize=False)
```

In [30]:
```
#U jednačini linearne regresije y = A*x + B gde je regresor intecept_ = B

print(regresor.intercept_)
```

```
[18.88434357]
```

In [31]:
```
#U jednačini linearne regresije y = A*x + B gde je regresor coef_ (slope) = A

print(regresor.coef_)
```

```
[[1.31610406]]
```

In [32]:
```
#primenjujemo predviđanje gornjeg pritiska na osnovu donjeg

y_pred = regresor.predict(X_test)
y_pred
```

Out[32]:
```
array([[124.1726682 ],
       [137.33370878],
       [124.1726682 ],
       ...,
       [124.1726682 ],
       [150.49474936],
       [124.1726682 ]])
```

In [33]:
```
#rezultate dajemo tabelarno

rezultati_slr = pd.DataFrame({"Stvarni gornji pritisak": y_test.flatten(), "ML gornji pritisak": y_pred.flatten()})
rezultati_slr.head()
```

Out[33]:

	Stvarni gornji pritisak	ML gornji pritisak
0	130	124.17
1	140	137.33
2	120	124.17
3	110	111.01
4	120	124.17

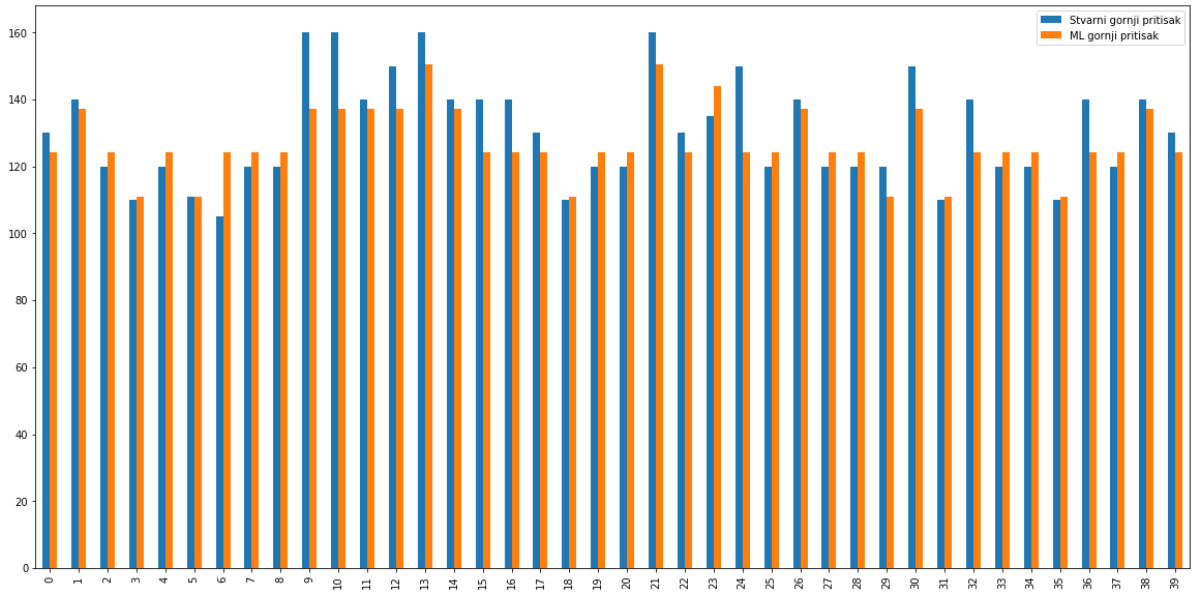
In [34]:
```
rezultati_slr.describe()
```

Out[34]:

	Stvarni gornji pritisak	ML gornji pritisak
count	12501.00	12501.00
mean	126.48	126.42
std	14.31	10.02
min	90.00	104.43
25%	120.00	124.17
50%	120.00	124.17
75%	140.00	137.33
max	170.00	155.76

In [35]:
```
#Grafički prikazujemo tačnost predviđanja za početni deo dataseta

ap_hi1 = rezultati_slr.head(40)
ap_hi1.plot(kind = "bar", figsize = (20, 10))
plt.show()
```



In [36]:
```
#Da utvrdimo veličinu greške

#Prosek greške
mean1 = metrics.mean_absolute_error(y_test, y_pred)
print("Mean Absolute error:", mean1)
```

```
Mean Absolute error: 7.5468982057942124
```

In [37]:
```
#Prosek greške na kvadrat

mse1 = metrics.mean_squared_error(y_test, y_pred)
print("Mean Squared Error:", mse1)
```

```
Mean Squared Error: 105.87729921729378
```

In [38]:
```
#Koren proseka greške na kvadrat

rmse1 = np.sqrt(metrics.mean_squared_error(y_test, y_pred))
print("Root Mean Squared Error", rmse1)
```

```
Root Mean Squared Error 10.289669538779842
```

Multiple Linear Regresion

In [39]:
```
#Delimo dataset na atribute - X i na lebel - y

X = clean[[ "age", "gender", "height", "weight", "ap_lo", "cholesterol", "glu
c",
            "smoke", "alco", "cardio"]].values
y = clean[["ap_hi"]].values
```

In [40]:
```
#Podela dataseta na treninig i test skup

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, ran
dom_state = 0)
```

In [41]:
```
#Kod multiple linearne regresije moramo da nađemo optimalne vrednosti za sve a
tribute
#pomoću koeficijena

regressor = LinearRegression()
regressor.fit(X_train, y_train)
```

Out[41]:
```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None,
         normalize=False)
```

In [42]:
```
y_pred2 = regressor.predict(X_test)
y_pred2
```

Out[42]:
```
array([[120.97182668],
       [137.64063893],
       [129.33142371],
       ...,
       [126.71828928],
       [149.31405477],
       [122.19448719]])
```

In [43]:
```
rezultat2 = pd.DataFrame({"Stvarni gornji pritisak": y_test.flatten(), "ML gor
nji pritisak": y_pred2.flatten()})
rez = rezultat2.head(40)
rez.head()
```

Out[43]:

	Stvarni gornji pritisak	ML gornji pritisak
0	130	120.97
1	140	137.64
2	120	129.33
3	110	108.41
4	120	120.91

In [44]:
```
rezultat2.describe()
```

Out[44]:

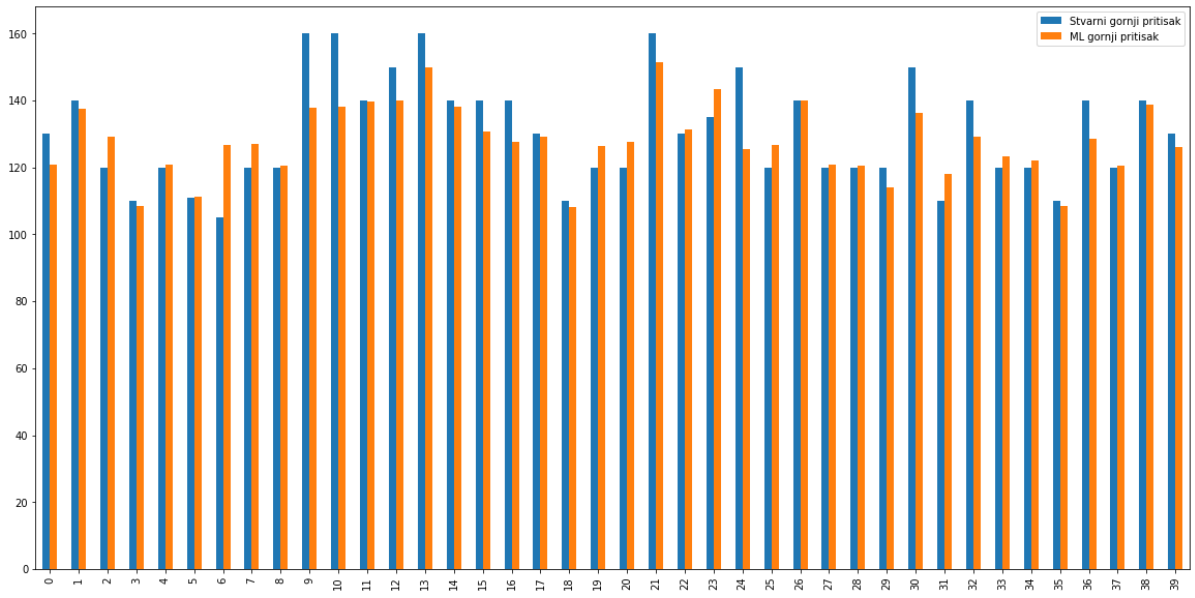
	Stvarni gornji pritisak	ML gornji pritisak
count	12501.00	12501.00
mean	126.48	126.49
std	14.31	10.51
min	90.00	101.34
25%	120.00	120.46
50%	120.00	125.75
75%	140.00	133.73
max	170.00	155.74

In [45]:
```
#Uzimamo podatak o standardnoj devijaciji za Multiple Linear Regression

vrednost2 = rezultat2["ML gornji pritisak"].std()
vrednost2
```

Out[45]:
```
10.507916173751195
```

In [46]:
```
rez.plot(y = ["Stvarni gornji pritisak", "ML gornji pritisak"], kind = "bar",
figsize = (20, 10))
plt.show()
```



In [47]:
```
#Da utvrdimo veličinu greške
#Prosek greške

mean2 = metrics.mean_absolute_error(y_test, y_pred2)
print("Mean Absolute error:", mean2)
```

```
Mean Absolute error: 6.883703189275287
```

In [48]:
```
#Prosek greške na kvadrat

mse2 = metrics.mean_squared_error(y_test, y_pred2)
print("Mean Squared Error:", mse2)
```

```
Mean Squared Error: 94.50978743888389
```

In [129]:
```
#Koren proseka greškw na kvadrat

rmse2 = np.sqrt(metrics.mean_squared_error(y_test, y_pred2))
print("Root Mean Squared Error", rmse2)
```

```
Root Mean Squared Error 10.289669538779842
```

In [ ]:

In [ ]:

In [ ]:

In [ ]: