In [1]:

```
# Start Python Imports
import math, time, random, datetime

# Data Manipulation
import numpy as np
import pandas as pd

# Visualization
import matplotlib.pyplot as plt
import missingno
import seaborn as sns
plt.style.use('seaborn-whitegrid')

import warnings
warnings.filterwarnings('ignore')

# Import train & test data
train = pd.read_csv('./Data/train.csv')
test = pd.read_csv('./Data/test.csv')
```

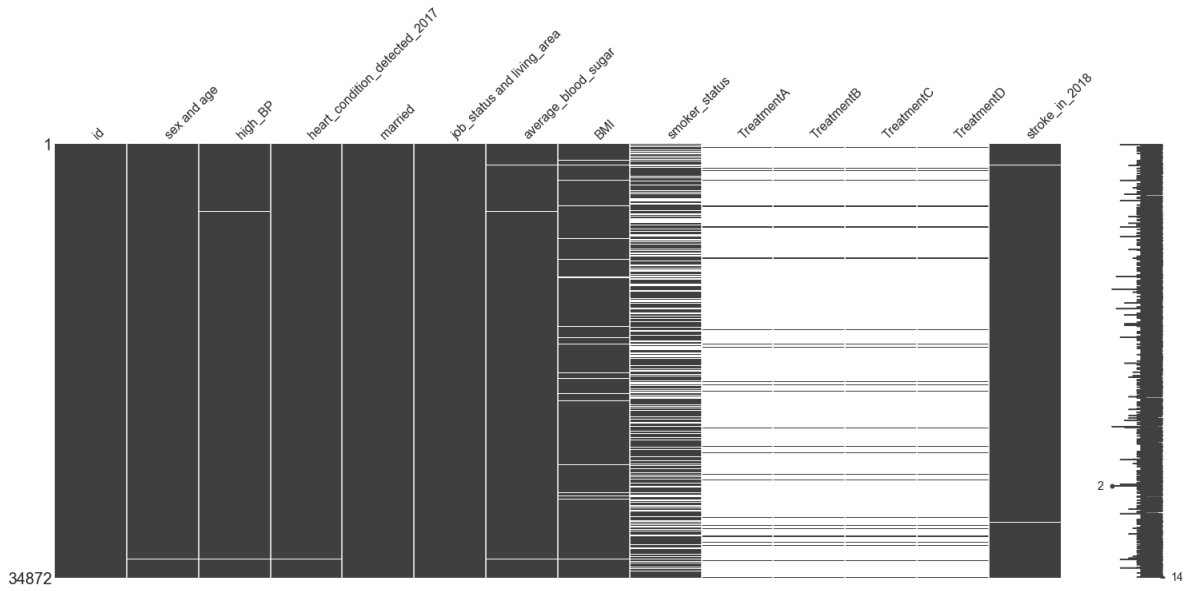
In [5]:

```
all_is_null = zip(train.isnull(), train.isnull().sum())
for is_null in all_is_null:
    if is_null[1] > 0:
        print(f'{is_null[0]}: {is_null[1]}')
print()
print(f'Total: {len(train)}')

missingno.matrix(train)
```

```
sex and age: 37
high_BP: 47
heart_condition_detected_2017: 50
married: 15
job_status and living_area: 31
average_blood_sugar: 61
BMI: 1204
smoker_status: 10640
TreatmentA: 33217
TreatmentB: 33217
TreatmentC: 33217
TreatmentD: 33217
stroke_in_2018: 34

Total: 34872
```

Out[5]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x801170>
```



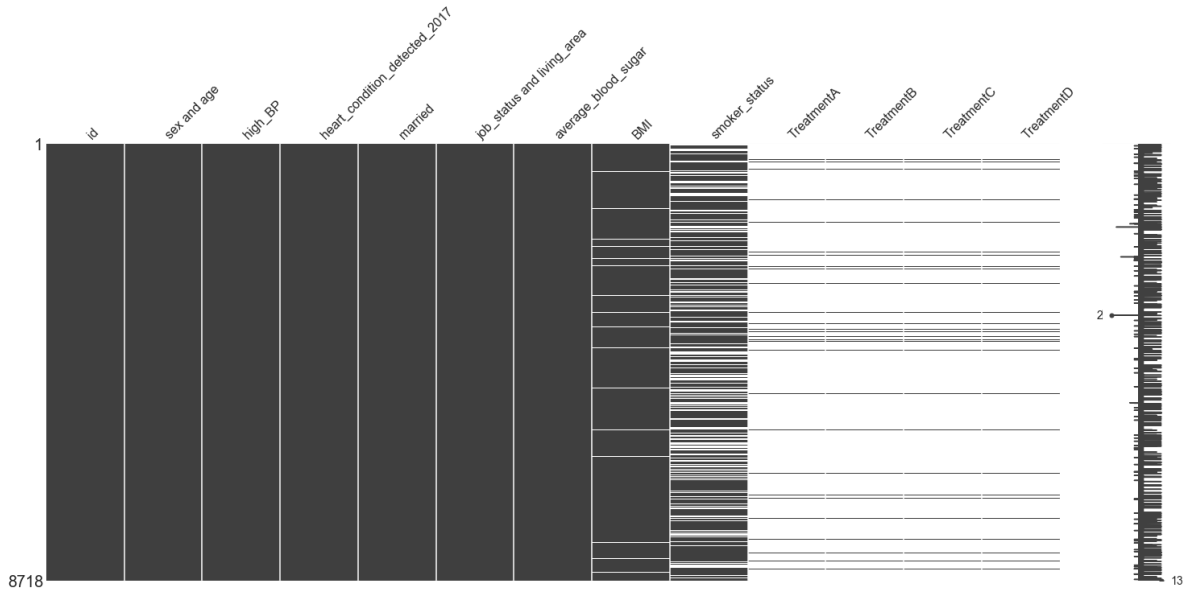
In [6]:

```
all_is_null = zip(test.isnull(), test.isnull().sum())
for is_null in all_is_null:
    if is_null[1] > 0:
        print(f'{is_null[0]}: {is_null[1]}')
print()
print(f'Total: {len(train)}')

missingno.matrix(test)
```

```
sex and age: 10
high_BP: 11
heart_condition_detected_2017: 5
married: 2
job_status and living_area: 10
average_blood_sugar: 11
BMI: 302
smoker_status: 2697
TreatmentA: 8302
TreatmentB: 8302
TreatmentC: 8302
TreatmentD: 8302

Total: 34872
```

Out[6]:

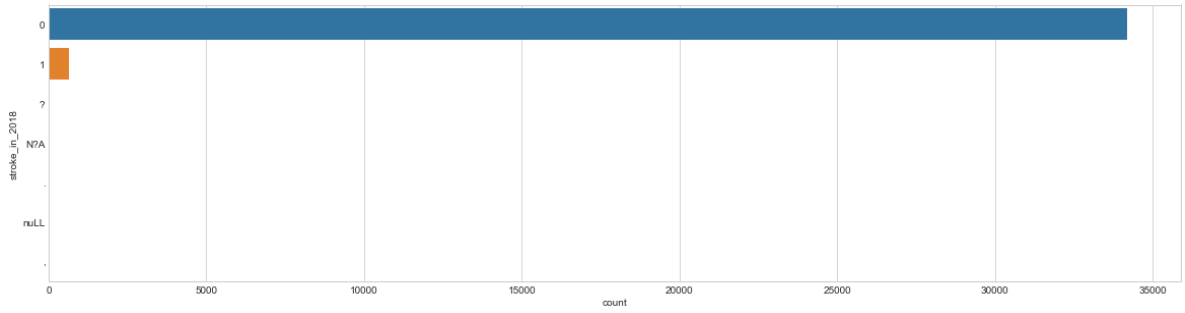
```
<matplotlib.axes._subplots.AxesSubplot at 0x857b50>
```



In [13]:

```
total_stroke = train[train['stroke_in_2018'] == '1']['stroke_in_2018'].count()
total_samples = train['stroke_in_2018'].count()
print('Training data')
print(f'Total people who had strokes: {total_stroke}')
print(f'Fraction of people who had strokes: {1 - (total_stroke / total_samples)}')
print()

print('Test data')
print(f'Fraction of people who had strokes: 0.98480 (approx. from submission)')
print()

fig = plt.figure(figsize=(20,5))
sns.countplot(y='stroke_in_2018', data=train);
print(train.stroke_in_2018.value_counts())
```

```
Training data
Total people who had strokes: 652
Fraction of people who had strokes: 0.9812848039497101

Test data
Fraction of people who had strokes: 0.98480 (approx. from submission)

0       34179
1         652
.           3
?           1
,           1
nuLL        1
N?A         1
Name: stroke_in_2018, dtype: int64
```



In [14]:

```
from word2number import w2n
def getGender(x):
    return 1 if x.lower() == 'm' else (0 if x.lower() == 'f' else (2 if x.lower() == 'other

def splitAgeGender(x, ret_age=True):
    if not x or str(x) == 'nan':
        return ''

    parts = str(x).replace(',', ' ').split()
    age = gender = ''
    if ret_age:
        try:
            age = w2n.word_to_num(parts[0])
        except ValueError:
            try:
                age = float(parts[0])
            except ValueError:
                pass
        if not age and len(parts) > 1:
            try:
                age = w2n.word_to_num(parts[1])
            except ValueError:
                try:
                    age = float(parts[1])
                except ValueError:
                    pass
        return age
    else:
        gender = getGender(parts[0])
        if gender == '' and len(parts) > 1:
            gender = getGender(parts[1])
        return gender

def discreteAge(x):
    if not x:
        return 0
    return int(x // 5) + 1

# Added - Job and location
def split_job_livivng(line, job = True):
    if not line or str(line) == 'nan':
        return 'AAA'

    part_1, part_2 = line.split('?')[:2:]
    if job:
        if 'gov' in part_1.lower() or 'gov' in part_2.lower():
            part_1 = 'GOVERNMENT'
        elif 'pri' in part_1.lower() or 'pri' in part_2.lower():
            part_1 = 'PRIVATE'
        elif 'bus' in part_1.lower() or 'bus' in part_2.lower() or 'biz' in part_1.lower()
            part_1 = 'BUSINESS'
        elif 'parent' in part_1.lower() or 'parent' in part_2.lower():
            part_1 = 'PARENTAL_LEAVE'
        elif 'unemp' in part_1.lower() or 'unemp' in part_2.lower():
            part_1 = 'UNEMPLOYED'
        else:
            part_1 = 'AAA'
        return part_1
```

```
    else:
        if 'city' in part_1.lower() or 'city' in part_2.lower():
            part_2 = 'CITY'
        elif 'remo' in part_1.lower() or 'remo' in part_2.lower():
            part_2 = 'REMOTE'
        elif part_1 == 'c' or part_2 == 'c':
            part_2 = 'CITY'
        elif part_1 == 'r' or part_2 == 'r':
            part_2 = 'REMOTE'
        else:
            part_2 = 'AAA'
        return part_2

def getSmokeStatus(x):
    x = str(x).lower()
    x = ''.join([i for i in x if i.isalpha()])
    return 1 if 'non' in x else (2 if 'quit' in x else (3 if 'active' in x else 0))

def fixBmi(x):
    x = str(x)
    if x == 'nan' or x == '?' or x == '.':
        x = 0

    return float(x)

def discreteBmi(x):
    if x < 0.5:
        return 0
    elif x < 18.5:
        return 1
    elif x < 25:
        return 2
    elif x < 30:
        return 3
    elif x < 35:
        return 4
    elif x < 40:
        return 5
    return 6

def discreteBloodSugar(x):
    if x < 70:
        return 1
    elif x < 120:
        return 2
    elif x < 200:
        return 3
    elif x < 280:
        return 3
    return 4

def cleanBinary(x, flip=False):
    val = x
    try:
        val = int(x)
        if flip:
            val = 1 if val == 1 else 0
        else:
            val = 0 if val == 0 else 1
    except ValueError:
        val = ''
```

```
    return val

def checkTreated(x):
    if str(x['TreatmentA']) == 'nan':
        return 0
    return 1 if (x['TreatmentA'] == 1 or x['TreatmentB'] == 1 or x['TreatmentC'] == 1 or x[

def bmiMean(x, m):
    if x > 0.5:
        return x
    return m
```

In [23]:

```
def createCleanedData(test_type):
    if test_type == 'test':
        old_df = test
    else:
        old_df = train

    new_df = pd.DataFrame(old_df)

    new_df['sex'] = old_df['sex and age'].apply(lambda x: splitAgeGender(x, False))
    new_df['age'] = old_df['sex and age'].apply(lambda x: splitAgeGender(x, True))

    new_df['age_2'] = old_df['age'].apply(lambda x: discreteAge(x))

    new_df['job'] = old_df['job_status and living_area'].apply(lambda x: split_job_livivng(
    new_df['location'] = old_df['job_status and living_area'].apply(lambda x: split_job_liv

    from sklearn.preprocessing import LabelEncoder
    encoder = LabelEncoder()

    new_df['job_encoded'] = encoder.fit_transform(new_df['job'])
    new_df['location_encoded'] = encoder.fit_transform(new_df['location'])

    new_df['smoker_status_2'] = old_df['smoker_status'].apply(getSmokeStatus)

    new_df['BMI'] = old_df['BMI'].apply(fixBmi)
    new_df['BMI_2'] = new_df['BMI'].apply(discreteBmi)

    if 'stroke_in_2018' in new_df:
        new_df_2 = new_df[new_df['stroke_in_2018'].isin(['1', '0'])]
    else:
        new_df_2 = new_df

    new_df_2['average_blood_sugar_2'] = new_df_2['average_blood_sugar'].apply(discreteBlooc
    new_df_2['high_BP_2'] = new_df_2['high_BP'].apply(cleanBinary)
    new_df_2['heart_condition_detected_2017_2'] = new_df_2['heart_condition_detected_2017']
    new_df_2['married_2'] = new_df_2['married'].apply(cleanBinary)
    new_df_2['TreatmentD_2'] = new_df_2['TreatmentD'].apply(cleanBinary)
    new_df_2['treated'] = new_df_2.apply(lambda row: checkTreated(row), axis=1)

    new_df_3 = new_df_2.replace('', np.nan, regex=True)

    BMI_mean = new_df_3['BMI'].mean()
    new_df_3['BMI_3'] = new_df_3['BMI'].apply(lambda x: bmiMean(x, BMI_mean))

    new_df_3['sex'].fillna(0, inplace=True)
    new_df_3['age'].fillna(new_df_3['age'].mean(), inplace=True)
    new_df_3['high_BP_2'].fillna(0, inplace=True)
    new_df_3['heart_condition_detected_2017_2'].fillna(0, inplace=True)

    new_df_3['average_blood_sugar'].fillna(new_df_3['average_blood_sugar'].mean(), inplace=
    new_df_3['married_2'].fillna(1, inplace=True)
    new_df_3['TreatmentA'].fillna(0, inplace=True)
    new_df_3['TreatmentB'].fillna(0, inplace=True)
    new_df_3['TreatmentC'].fillna(0, inplace=True)
    new_df_3['TreatmentD_2'].fillna(0, inplace=True)

    new_df_3.to_csv(f'./Data/{test_type}_cleaned.csv')
    return new_df_3
```

In [24]:

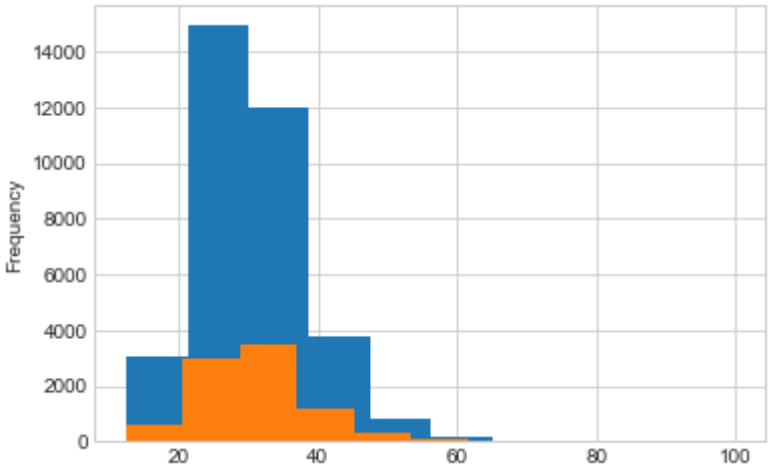
```
train_clean = createCleanedData('train')
test_clean = createCleanedData('test')
```

In [27]:

```
train_clean.BMI_3.plot.hist()
test_clean.BMI_3.plot.hist()
```

Out[27]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x148e3db0>
```

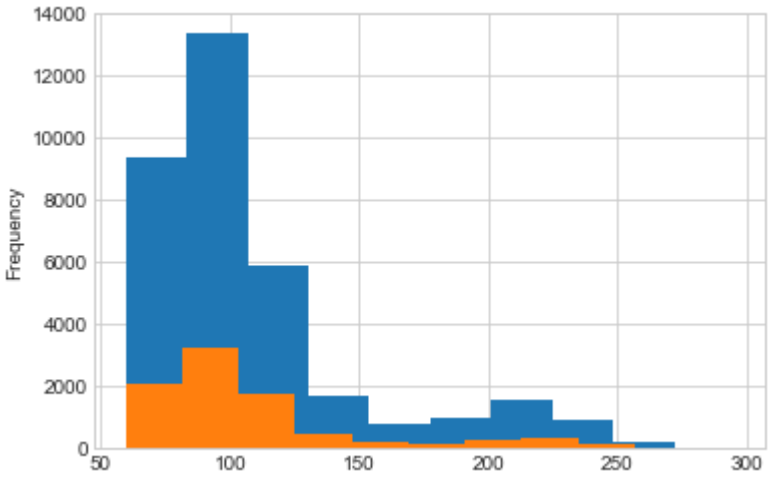


In [28]:

```
train_clean.average_blood_sugar.plot.hist()
test_clean.average_blood_sugar.plot.hist()
```

Out[28]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x14882e70>
```

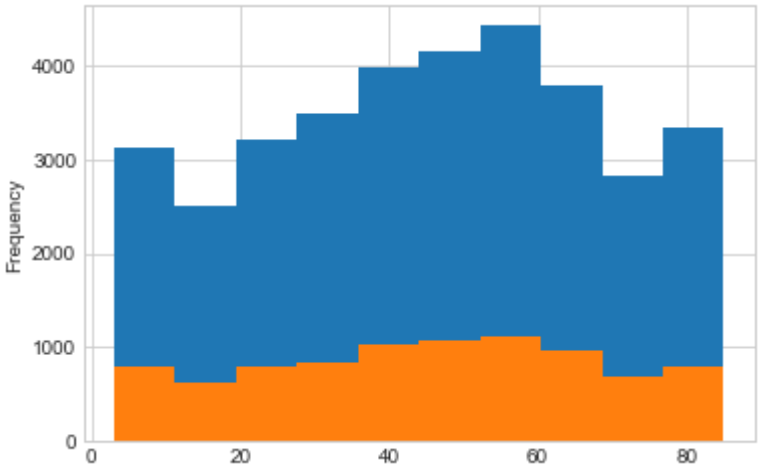


In [29]:

```
train_clean.age.plot.hist()
test_clean.age.plot.hist()
```

Out[29]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x15009610>
```

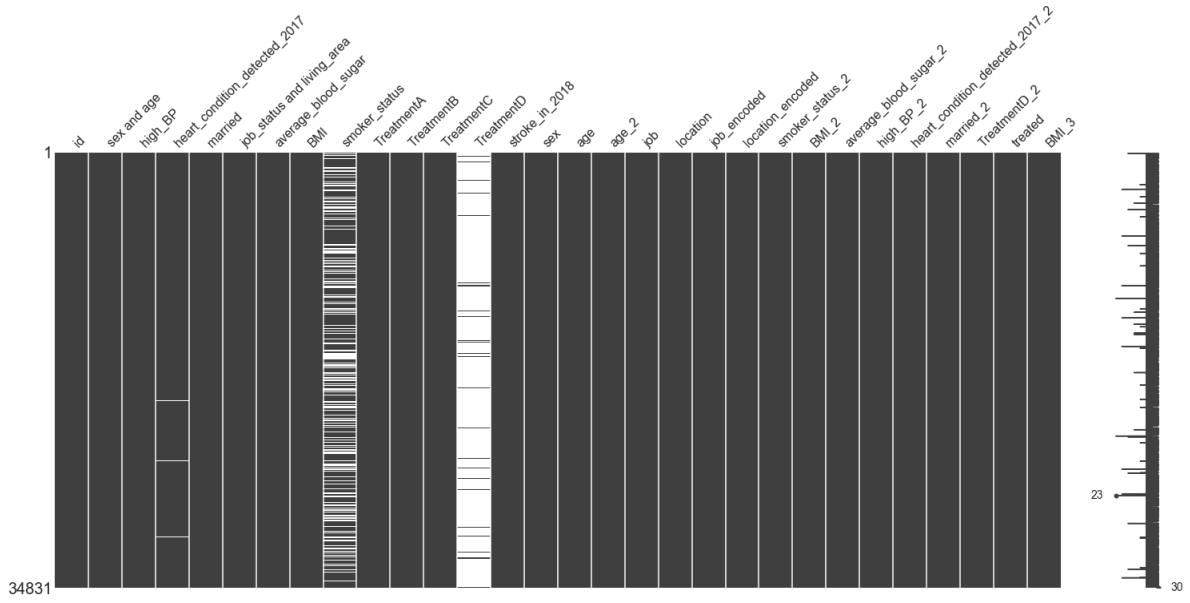


In [31]:

```
missingno.matrix(train_clean)
```

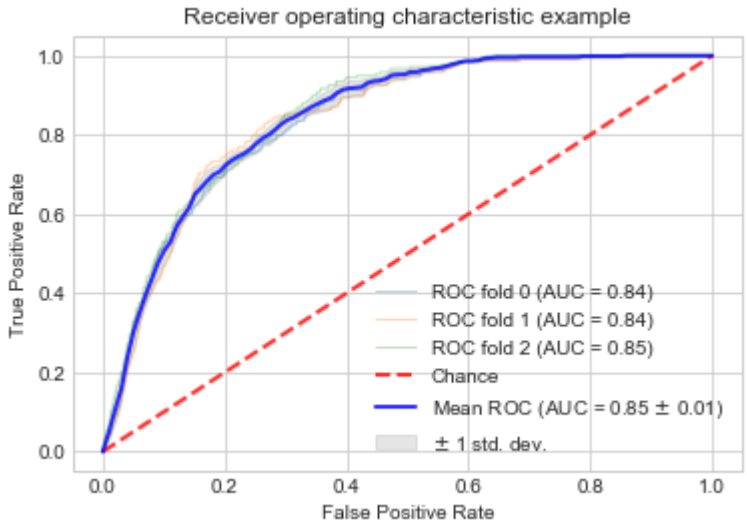
Out[31]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x4d32cf0>
```



In [49]:

```
from sklearn import svm, datasets
from sklearn.linear_model import LinearRegression, LogisticRegressionCV
from sklearn.metrics import roc_curve, auc
from scipy import interp
from sklearn.model_selection import StratifiedKFold

train_clean_2 = pd.read_csv('./Data/train_cleaned.csv')
x_train = train_clean_2[['sex', 'age', 'high_BP_2', 'heart_condition_detected_2017_2', 'mar
y_train = train_clean_2[['stroke_in_2018']].copy()

# Run classifier with cross-validation and plot ROC curves
cv = StratifiedKFold(n_splits=3)
classifier = LogisticRegressionCV()

tprs = []
aucs = []
mean_fpr = np.linspace(0, 1, 100)

i = 0
for train, test in cv.split(x_train, y_train):
    probas_ = classifier.fit(x_train.iloc[train], y_train.iloc[train]).predict_proba(x_trai
    # Compute ROC curve and area the curve
    fpr, tpr, thresholds = roc_curve(y_train.iloc[test], probas_[:, 1])
    tprs.append(interp(mean_fpr, fpr, tpr))
    tprs[-1][0] = 0.0
    roc_auc = auc(fpr, tpr)
    aucs.append(roc_auc)
    plt.plot(fpr, tpr, lw=1, alpha=0.3,
             label='ROC fold %d (AUC = %0.2f)' % (i, roc_auc))

    i += 1
plt.plot([0, 1], [0, 1], linestyle='--', lw=2, color='r',
         label='Chance', alpha=.8)

mean_tpr = np.mean(tprs, axis=0)
mean_tpr[-1] = 1.0
mean_auc = auc(mean_fpr, mean_tpr)
std_auc = np.std(aucs)
plt.plot(mean_fpr, mean_tpr, color='b',
         label=r'Mean ROC (AUC = %0.2f $\pm$ %0.2f)' % (mean_auc, std_auc),
         lw=2, alpha=.8)

std_tpr = np.std(tprs, axis=0)
tprs_upper = np.minimum(mean_tpr + std_tpr, 1)
tprs_lower = np.maximum(mean_tpr - std_tpr, 0)
plt.fill_between(mean_fpr, tprs_lower, tprs_upper, color='grey', alpha=.2,
                 label=r'$\pm$ 1 std. dev.')

plt.xlim([-0.05, 1.05])
plt.ylim([-0.05, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic example')
plt.legend(loc="lower right")
plt.show()
```

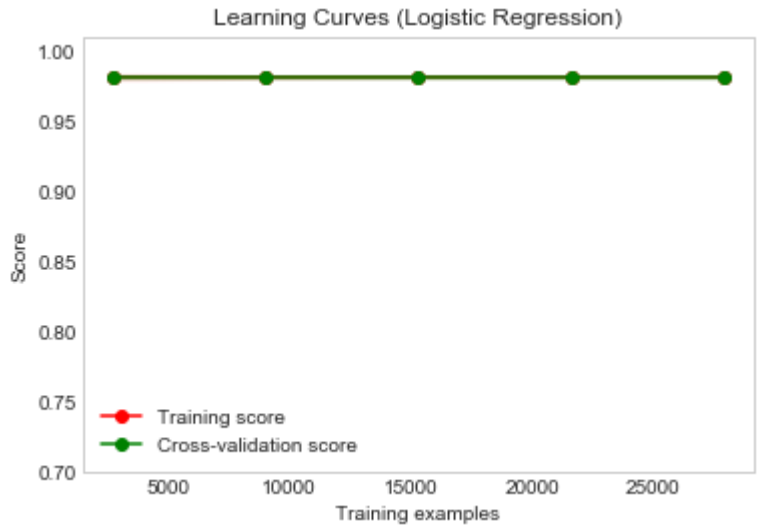

Receiver operating characteristic example
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
ROC fold 0 (AUC = 0.84)
ROC fold 1 (AUC = 0.84)
ROC fold 2 (AUC = 0.85)
Chance
Mean ROC (AUC = 0.85 ± 0.01)
± 1 std. dev.

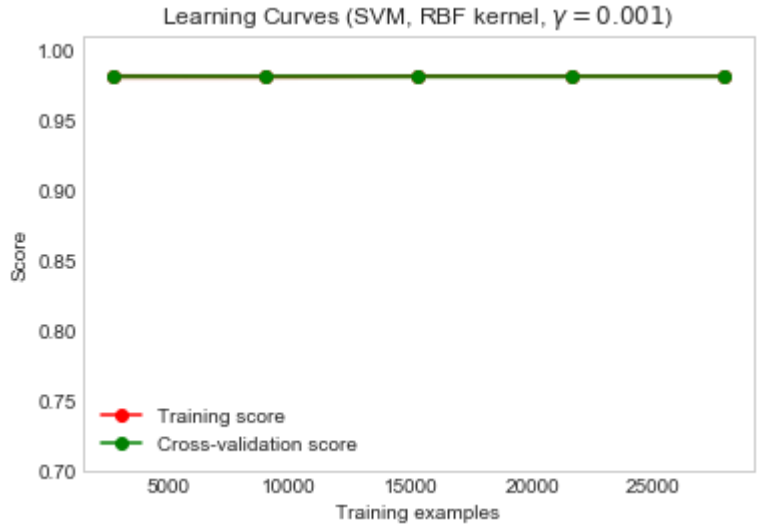
In [51]:

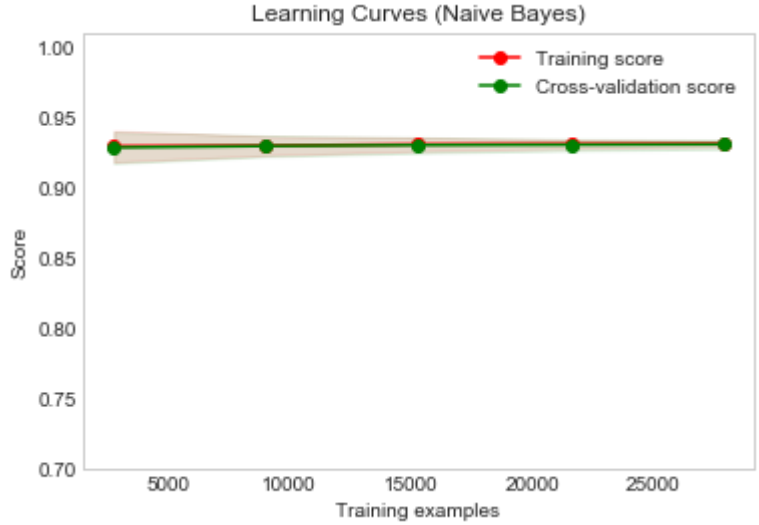
```
# Learning Curve for Bias analysis
import numpy as np
import matplotlib.pyplot as plt
from sklearn.naive_bayes import GaussianNB
from sklearn.svm import SVC
from sklearn.datasets import load_digits
from sklearn.model_selection import learning_curve
from sklearn.model_selection import ShuffleSplit
from sklearn.tree import DecisionTreeClassifier
from sklearn import tree
from sklearn.neighbors import KNeighborsClassifier


def plot_learning_curve(estimator, title, X, y, ylim=None, cv=None,
                        n_jobs=None, train_sizes=np.linspace(.1, 1.0, 5)):

    plt.figure()
    plt.title(title)
    if ylim is not None:
        plt.ylim(*ylim)
    plt.xlabel("Training examples")
    plt.ylabel("Score")
    train_sizes, train_scores, test_scores = learning_curve(
        estimator, X, y, cv=cv, n_jobs=n_jobs, train_sizes=train_sizes)
    train_scores_mean = np.mean(train_scores, axis=1)
    train_scores_std = np.std(train_scores, axis=1)
    test_scores_mean = np.mean(test_scores, axis=1)
    test_scores_std = np.std(test_scores, axis=1)
    plt.grid()

    plt.fill_between(train_sizes, train_scores_mean - train_scores_std,
                     train_scores_mean + train_scores_std, alpha=0.1,
                     color="r")
    plt.fill_between(train_sizes, test_scores_mean - test_scores_std,
                     test_scores_mean + test_scores_std, alpha=0.1, color="g")
    plt.plot(train_sizes, train_scores_mean, 'o-', color="r",
             label="Training score")
    plt.plot(train_sizes, test_scores_mean, 'o-', color="g",
             label="Cross-validation score")

    plt.legend(loc="best")
    return plt


X, y = x_train, y_train

# Logistic
title = "Learning Curves (Logistic Regression)"
# Cross validation with 100 iterations to get smoother mean test and train
# score curves, each time with 20% data randomly selected as a validation set.
cv = ShuffleSplit(n_splits=100, test_size=0.2, random_state=0)
estimator = LogisticRegressionCV(cv=5, random_state=0, multi_class='ovr')
plot_learning_curve(estimator, title, X, y, ylim=(0.7, 1.01), cv=cv, n_jobs=4)
print('Logistic Done...')

# SVM
title = r"Learning Curves (SVM, RBF kernel, $\gamma=0.001$)"
# SVC is more expensive so we do a lower number of CV iterations:
cv = ShuffleSplit(n_splits=10, test_size=0.2, random_state=0)
```

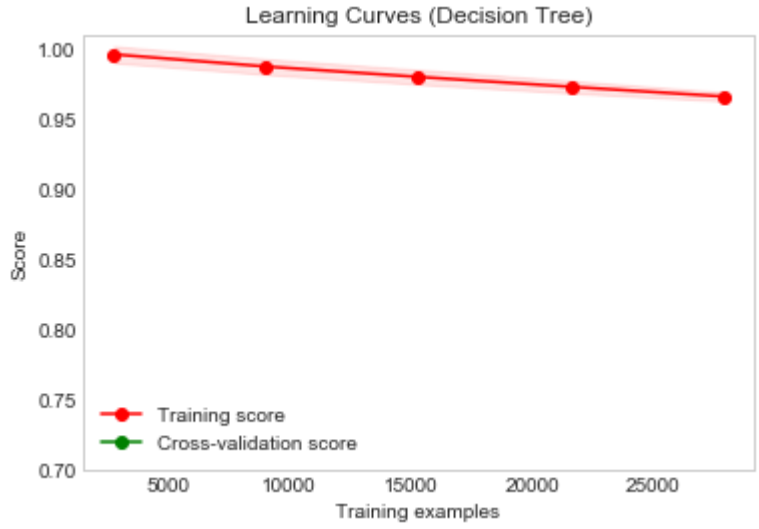
```
estimator = SVC(gamma=0.001)
plot_learning_curve(estimator, title, X, y, (0.7, 1.01), cv=cv, n_jobs=4)
print('SVM Done...')

# Naive Bayse
title = "Learning Curves (Naive Bayes)"
# Cross validation with 100 iterations to get smoother mean test and train
# score curves, each time with 20% data randomly selected as a validation set.
cv = ShuffleSplit(n_splits=100, test_size=0.2, random_state=0)
estimator = GaussianNB()
plot_learning_curve(estimator, title, X, y, ylim=(0.7, 1.01), cv=cv, n_jobs=4)
print('Naive Bayes Done...')

# Decision Tree
title = "Learning Curves (Decision Tree)"
# Cross validation with 100 iterations to get smoother mean test and train
# score curves, each time with 20% data randomly selected as a validation set.
cv = ShuffleSplit(n_splits=100, test_size=0.2, random_state=0)
estimator = tree.DecisionTreeRegressor()
plot_learning_curve(estimator, title, X, y, ylim=(0.7, 1.01), cv=cv, n_jobs=4)
print('DT Done...')


# KNN
title = "Learning Curves (KNN)"
# Cross validation with 100 iterations to get smoother mean test and train
# score curves, each time with 20% data randomly selected as a validation set.
cv = ShuffleSplit(n_splits=100, test_size=0.2, random_state=0)
estimator = KNeighborsClassifier(n_neighbors=10)
plot_learning_curve(estimator, title, X, y, ylim=(0.7, 1.01), cv=cv, n_jobs=4)
print('KNN Done...')
```

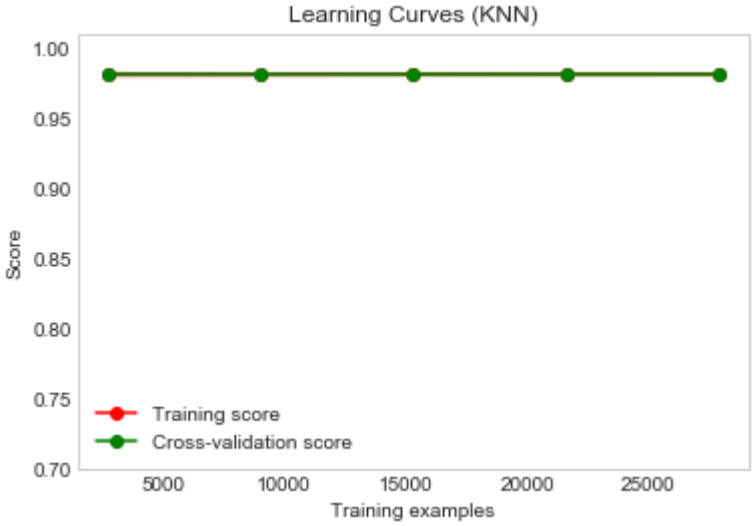
```
Logistic Done...
SVM Done...
Naive Bayes Done...
DT Done...
KNN Done...
```




Learning Curves (SVM, RBF kernel, $\gamma = 0.001$)
Score
Training examples
Training score
Cross-validation score
1.00
0.95
0.90
0.85
0.80
0.75
0.70
5000
10000
15000
20000
25000


Learning Curves (Naive Bayes)
Score
Training examples
Training score
Cross-validation score
1.00
0.95
0.90
0.85
0.80
0.75
0.70
5000
10000
15000
20000
25000


Learning Curves (Decision Tree)
Score
Training examples
Training score
Cross-validation score
1.00
0.95
0.90
0.85
0.80
0.75
0.70
5000
10000
15000
20000
25000


Learning Curves (KNN)
1.00
0.95
0.90
0.85
0.80
0.75
0.70
Score
Training score
Cross-validation score
5000
10000
15000
20000
25000
Training examples

In [52]:

```
# Now resample the data
import imblearn

data = pd.read_csv('./Data/train_cleaned.csv')

np.random.seed(seed=1)
mask = np.random.rand(data.shape[0]) < 0.7
train = data[mask]
test = data[~mask]

train.to_csv('./Data/train_clean_split.csv')
test.to_csv('./Data/test_clean_split.csv')

used_features = ['age', 'high_BP_2', 'average_blood_sugar', 'BMI_3', 'TreatmentA', 'Treatme
#used_features = ['sex', 'age', 'high_BP_2', 'heart_condition_detected_2017_2', 'married_2'

x_train = train[used_features].copy()
y_train = train[['stroke_in_2018']].copy()
train.describe()
```

```
Using TensorFlow backend.
```

Out[52]:

	Unnamed: 0	id	average_blood_sugar	BMI	TreatmentA	Treatme
count	24389.000000	24389.000000	24389.000000	24389.000000	24389.000000	24389.000
mean	17444.176309	21656.621305	109.173065	29.848866	0.008692	0.014
std	10090.457572	12536.501093	43.255927	9.514981	0.092829	0.118
min	0.000000	3.000000	59.600000	0.000000	0.000000	0.000
25%	8656.000000	10791.000000	81.930000	25.000000	0.000000	0.000
50%	17449.000000	21661.000000	96.250000	29.800000	0.000000	0.000
75%	26197.000000	32546.000000	116.750000	35.000000	0.000000	0.000
max	34871.000000	43399.000000	295.650000	99.900000	1.000000	1.000

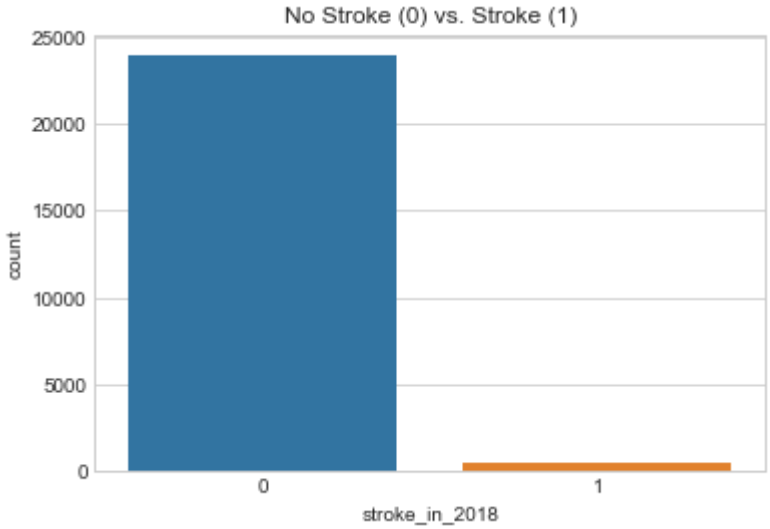
8 rows × 22 columns

In [53]:

```
sns.countplot('stroke_in_2018', data = train)
plt.title('No Stroke (0) vs. Stroke (1)')
```

Out[53]:

```
Text(0.5,1,'No Stroke (0) vs. Stroke (1)')
```



In [56]:

```
from imblearn.over_sampling import SMOTE
from imblearn.under_sampling import RandomUnderSampler

# random oversampling
ros = RandomUnderSampler(random_state=0)
#x_resampled, y_resampled = ros.fit_resample(x_train, y_train)

# applying SMOTE to our data and checking the class counts
x_resampled, y_resampled = SMOTE().fit_resample(x_train, y_train)
print(f'Total size of resampled data: {len(x_resampled)}')
```

```
Total size of resampled data: 47832
```

In [57]:

```
from ModelsTest import runTests
runTests(x_resampled, y_resampled, test_type='cv', data_used=1)
```

```
      Model        |       Time       | Accuracy (train) | Accuracy (test)
-------------------------------------------------------------------------
  Decision Tree    |      0.942       |      100.0       |      96.36
   Gaussian NB     |      0.223       |      69.55       |      69.54
  Multinomial NB   |      0.146       |      70.36       |      70.36
  LogRegression    |      0.845       |       79.5       |      79.49
Nearest Neighbors  |      2.452       |       94.2       |       91.9
```

In [59]:

```
from sklearn.linear_model import LogisticRegressionCV
from sklearn.tree import DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn import svm
from sklearn import metrics

x_test = test[used_features].copy()
y_test = test[['stroke_in_2018']].copy()

def run_model(algo_name):
    algos = {'lr': LogisticRegressionCV(class_weight='balanced', scoring='roc_auc', max_ite
             'svm': svm.SVC(), 'dt': DecisionTreeClassifier(max_depth=5, min_samples_split=
    algo = algos[algo_name]
    algo.fit(x_resampled, y_resampled)
    pred_train_lr = algo.predict(x_resampled)
    print('Accuracy for train: ' + str(round(metrics.accuracy_score(y_resampled, pred_train
    print('Confusion matrix for train:')
    print(metrics.confusion_matrix(y_resampled, pred_train_lr))
    print()

    pred_test_lr = algo.predict(x_test)
    print('Accuracy for test: ' + str(round(metrics.accuracy_score(y_test, pred_test_lr) *
    print('Confusion matrix for test:')
    print(metrics.confusion_matrix(y_test, pred_test_lr))
    print('F1 score for test: ' + str(metrics.f1_score(y_test, pred_test_lr, average='binar
    fpr, tpr, thresholds = metrics.roc_curve(y_test, pred_test_lr)
    print('AUC score for test: ' + str(metrics.auc(fpr, tpr)))
    print()
    return algo

print('Logistic regression')
lr_fit = run_model('lr')
#print('K-Nearest Neighbors')
#run_model('knn')
#print('SVM')
#run_model('svm')
print('Decisition Tree')
dt_fit = run_model('dt')
```

```
Logistic regression
Accuracy for train: 79.51
Confusion matrix for train:
[[18305  5611]
 [ 4191 19725]]

Accuracy for test: 76.27
Confusion matrix for test:
[[7829 2434]
 [  44  135]]
F1 score for test: 0.09825327510917031
AUC score for test: 0.7585136605596826

Decisition Tree
Accuracy for train: 83.59
Confusion matrix for train:
[[19713  4203]
 [ 3647 20269]]
```

```
Accuracy for test: 82.28
Confusion matrix for test:
[[8487 1776]
 [  74  105]]
F1 score for test: 0.10194174757281553
AUC score for test: 0.7067716813176583
```

In [61]:

```
import xgboost as xgb

xgb2 = xgb.XGBClassifier(
 learning_rate =0.5,
 n_estimators=100,
 max_depth=8,
 min_child_weight=3,
 gamma=5,
 subsample=0.8,
 colsample_bytree=0.8,
 objective= 'binary:logistic',
 nthread=4,
 scale_pos_weight=2,
 seed=27)

train_model7 = xgb2.fit(x_resampled, y_resampled)
pred7 = train_model7.predict(x_test.to_numpy())
print("Accuracy for model XGBoost train: %.2f" % (metrics.accuracy_score(y_test, pred7) * 1
print(metrics.confusion_matrix(y_test, pred7))
print('F1 Score for XGBoost test: ' + str(metrics.f1_score(y_test, pred7, average='binary')
fpr, tpr, thresholds = metrics.roc_curve(y_test, pred7)
print('AUC score for XGBoost test: ' + str(metrics.auc(fpr, tpr)))
```

```
Accuracy for model XGBoost train: 97.00
[[10105   158]
 [  155    24]]
F1 Score for XGBoost test: 0.1329639889196676
AUC score for XGBoost test: 0.5593415518239029
```

In [62]:

```
test_data = pd.read_csv('./Data/test_cleaned.csv')
x_test_final = test_data[used_features].copy()

pred_f = lr_fit.predict(x_test_final.to_numpy())
print(pred_f.mean())
```

```
0.2384721266345492
```

In [63]:

```
output = test_data[['id']]
output['stroke_in_2018'] = pd.DataFrame(pred_f)
```

In [64]:

```
print(output)
output.to_csv('./Data/final.csv')
```

```
         id  stroke_in_2018
0     33327               0
1       839               0
2     11127               0
3     20768               0
4     37774               0
5      4283               1
6     13832               1
7      4579               0
8     26781               1
9     17196               0
10     2514               0
11    19277               1
12    17398               0
13    31096               0
14    20650               0
15     3184               0
16    25947               1
17     5128               1
18    23326               0
19    30751               0
20     2813               0
21    15246               1
22     2554               0
23    11821               0
24    36075               0
25    22637               0
26    30739               0
27     5329               0
28    41161               0
29    30743               0
...     ...             ...
8688  14277               0
8689  21603               0
8690  14473               0
8691  22513               0
8692  42215               0
8693  14740               1
8694  31252               0
8695   8166               0
8696  19964               0
8697  28849               0
8698  27013               0
8699  37724               1
8700  12513               1
8701  14401               0
8702  15130               0
8703  31955               0
8704  25036               0
8705   2857               1
8706   6480               0
8707  40291               0
8708  19138               0
8709   9266               1
8710  26713               0
8711  42238               0
```

```
8712  28993              0
8713  29622              1
8714  34519              0
8715   3938              0
8716   3252              1
8717  10499              0

[8718 rows x 2 columns]
```

In [ ]: