In [39]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split, cross_val_score
import warnings
warnings.filterwarnings('ignore')
from sklearn.preprocessing import OneHotEncoder
from sklearn.compose import make_column_transformer
from sklearn.pipeline import make_pipeline
from sklearn.impute import SimpleImputer
from sklearn.preprocessing import Imputer
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import LinearRegression
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import NearestCentroid
from sklearn.svm import LinearSVC
from sklearn.model_selection import GridSearchCV
```

2.1

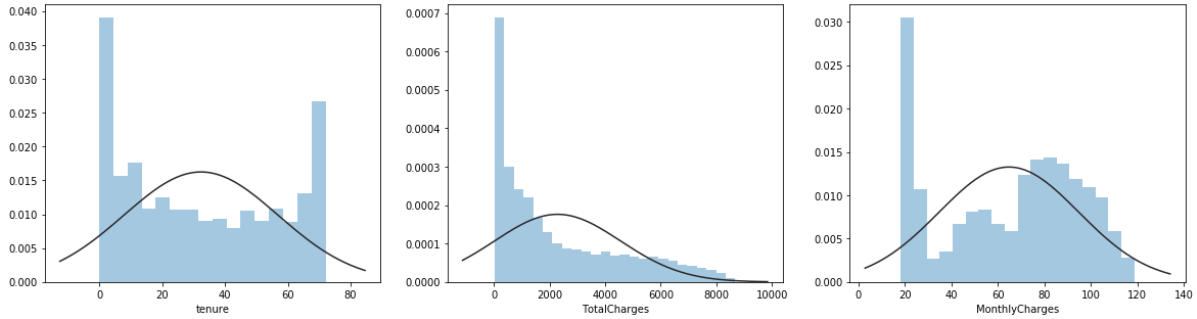
In [28]:
```
df = pd.read_csv("WA_Fn-UseC_-Telco-Customer-Churn.csv", na_values = ' ')
df.sample(5)
```

Out[28]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLin
4520	3506-LCJDC	Male	0	Yes	Yes	1	Yes	
2261	3126-WQMGH	Female	0	Yes	No	49	Yes	\
6469	7945-PRBVF	Male	0	No	No	35	Yes	
1733	1015-OWJKI	Male	0	No	No	1	Yes	
3499	0426-TIRNE	Female	0	No	No	1	Yes	

5 rows × 21 columns

In [35]:
```
import seaborn as sns
from scipy.stats import norm
cont_data = ['tenure', 'TotalCharges', 'MonthlyCharges']
continuous_data = df[cont_data]
target = df['Churn']
fig, ax = plt.subplots(1, 3, figsize=(20, 5))
for col in range(3):
    sns.distplot(continuous_data[cont_data[col]][~pd.isna(continuous_data[cont
_data[col]])],  ax = ax[col], fit=norm, kde=False)
```



2.2

Without StandardScalar

In [40]:
```
x_data = df.iloc[:,df.columns!='Churn']

for i in list(x_data.columns):
    if x_data[i].dtype == 'object':
        x_data[i].fillna('others', inplace = True)
x_data.fillna(x_data.median(), inplace = True)
y_data = df['Churn']
y_data = y_data.map(dict(No=0, Yes=1))

X_train, X_test, y_train, y_test = train_test_split(x_data, y_data)

discrete = X_train.dtypes == 'object'
col_trans = make_column_transformer((OneHotEncoder(handle_unknown='ignore', sp
arse=False), discrete))

Logistic_pipe = make_pipeline(col_trans, LogisticRegression())
Logistic_fin = np.mean(cross_val_score(Logistic_pipe, X_train, y_train, cv=10
))

SVM_pipe = make_pipeline(col_trans, LinearSVC())
SVM_fin = np.mean(cross_val_score(SVM_pipe, X_train, y_train, cv=10))

NN_pipe = make_pipeline(col_trans, NearestCentroid())
NN_fin = np.mean(cross_val_score(NN_pipe, X_train, y_train, cv=10))
```

In [41]:
```
print('Logistic: {:.2f}' .format(Logistic_fin))
print('SVM: {:.2f}'.format(SVM_fin))
print('KNN: {:.2f}'.format(NN_fin))
```

```
Logistic: 0.78
SVM: 0.79
KNN: 0.69
```

With StandardScalar

In [48]:
```
col_trans = make_column_transformer((StandardScaler(), ~discrete), (OneHotEnco
der(handle_unknown='ignore', sparse=False), discrete))
Logistic_pipe = make_pipeline(col_trans, LogisticRegression())
Logistic_fin = np.mean(cross_val_score(Logistic_pipe, X_train, y_train, cv=10
))

SVM_pipe = make_pipeline(col_trans, LinearSVC())
SVM_fin = np.mean(cross_val_score(SVM_pipe, X_train, y_train, cv=10))

NN_pipe = make_pipeline(col_trans, NearestCentroid())
NN_fin = np.mean(cross_val_score(NN_pipe, X_train, y_train, cv=10))
```

In [49]:
```
print('Logistic: {:.2f}' .format(Logistic_fin))
print('SVM: {:.2f}'.format(SVM_fin))
print('KNN: {:.2f}'.format(NN_fin))
```

```
Logistic: 0.81
SVM: 0.81
KNN: 0.73
```

We notice the Standardizing effect improves the scores for all models

2.3

Using Gridsearch

In [50]:
```
Logisticy = {'logisticregression__C': np.logspace(-3, 2, 6)}
SVMy = {'linearsvc__C': np.logspace(-3, 2, 6)}
knny = {'nearestcentroid__shrink_threshold': [None, 0, 0.1, 0.2, 0.3, 0.4, 0.5
, 0.6, 0.7, 0.8, 0.9]}

Logistic_got = GridSearchCV(Logistic_pipe, Logisticy, cv=10)
SVM_got = GridSearchCV(SVM_pipe, SVMy, cv=10)
KNN_got = GridSearchCV(NN_pipe, knny, cv=10)

Logistic_got.fit(X_train, y_train)
SVM_got.fit(X_train, y_train)
KNN_got.fit(X_train, y_train)
```

Out[50]:
```
GridSearchCV(cv=10, error_score='raise-deprecating',
       estimator=Pipeline(memory=None,
     steps=[('columntransformer', ColumnTransformer(n_jobs=None, remainder='d
rop', sparse_threshold=0.3,
         transformer_weights=None,
         transformers=[('standardscaler', StandardScaler(copy=True, with_mean
=True, with_std=True), customerID          False
gender              False
SeniorCitizen...se
dtype: bool)])), ('nearestcentroid', NearestCentroid(metric='euclidean', shri
nk_threshold=None))]),
       fit_params=None, iid='warn', n_jobs=None,
       param_grid={'nearestcentroid__shrink_threshold': [None, 0, 0.1, 0.2,
0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=0)
```

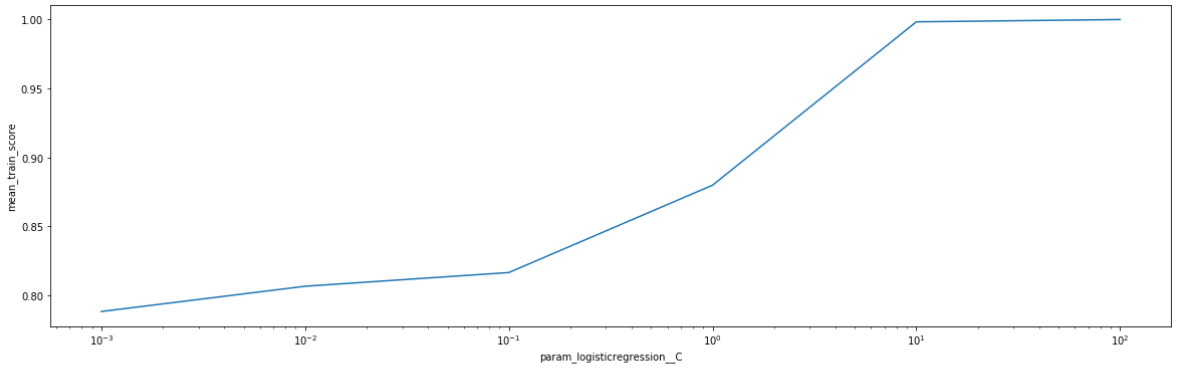
In [51]:
```
print('Logistic: {:.2f}' .format(Logistic_fin))
print('SVM: {:.2f}'.format(SVM_fin))
print('KNN: {:.2f}'.format(NN_fin))
```

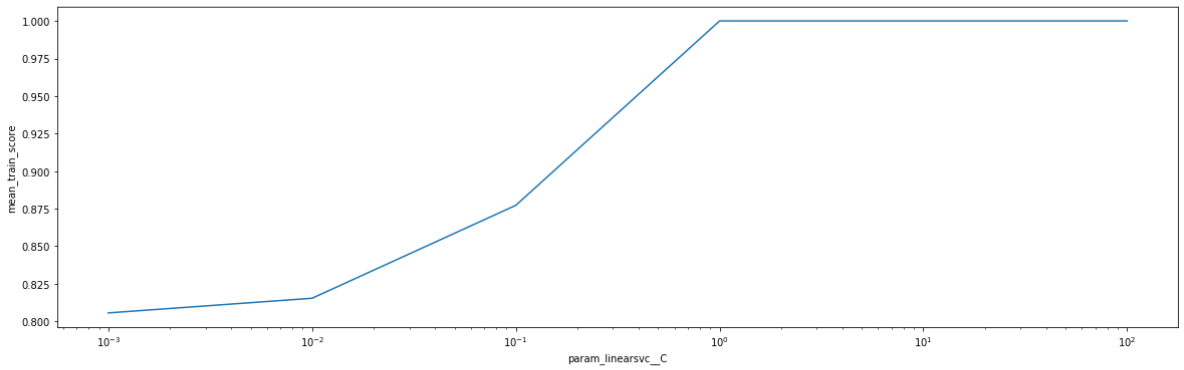
```
Logistic: 0.81
SVM: 0.81
KNN: 0.73
```

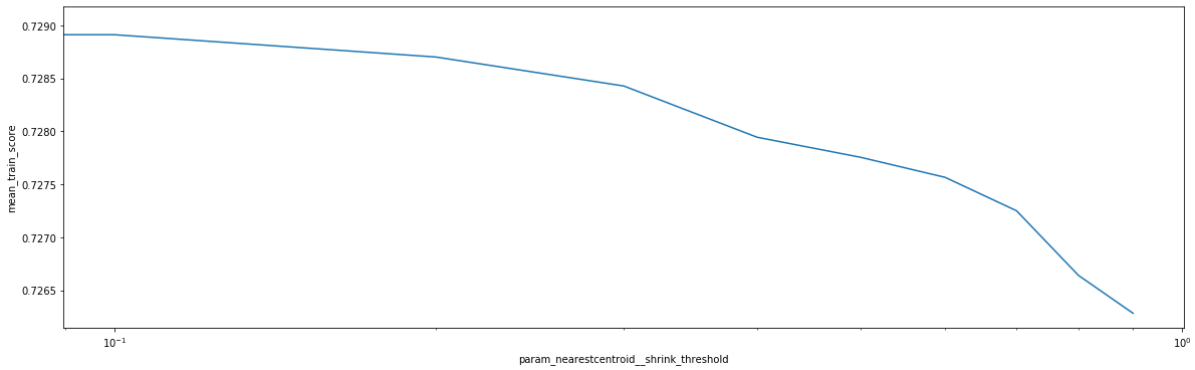
In [52]:
```
fig, ax = plt.subplots(3,1, figsize = (20, 20))
ax[0].plot(list(Logistic_got.cv_results_['param_logisticregression__C']),
        list(Logistic_got.cv_results_['mean_train_score']))
ax[0].set_ylabel('mean_train_score')
ax[0].set_xlabel('param_logisticregression__C')
ax[0].set_xscale("log")

ax[1].plot(list(SVM_got.cv_results_['param_linearsvc__C']),
      list(SVM_got.cv_results_['mean_train_score']))
ax[1].set_ylabel('mean_train_score')
ax[1].set_xlabel('param_linearsvc__C')
ax[1].set_xscale("log")

ax[2].plot(list(KNN_got.cv_results_['param_nearestcentroid__shrink_threshold'
]),
      list(KNN_got.cv_results_['mean_train_score']))
ax[2].set_ylabel('mean_train_score')
ax[2].set_xlabel('param_nearestcentroid__shrink_threshold')
ax[2].set_xscale("log")
```







2.4

With shuffling

In [54]:
```
from sklearn.model_selection import KFold
Logistic_kf = GridSearchCV(Logistic_pipe, Logisticy, cv=KFold(n_splits=3, shuf
fle=True))
Logistic_kf.fit(X_train, y_train)
SVM_kf = GridSearchCV(SVM_pipe, SVMy, cv=KFold(n_splits=3, shuffle=True))
SVM_kf.fit(X_train, y_train)
KNN_kf = GridSearchCV(NN_pipe, knny, cv=KFold(n_splits=3, shuffle=True))
KNN_kf.fit(X_train, y_train)


print('Logistic: {:.2f}'.format(Logistic_kf.best_score_))
print('SVM: {:.2f}'.format(SVM_kf.best_score_))
print('KNN: {:.2f}'.format(KNN_kf.best_score_))
```

```
Logistic: 0.80
SVM: 0.80
KNN: 0.73
```

Params dont change much here, almost same

With random seed

In [55]:
```
Logistic_kfs = GridSearchCV(Logistic_pipe, Logisticy, cv=KFold(n_splits=3, ran
dom_state=7, shuffle=True))
Logistic_kfs.fit(X_train, y_train)
SVM_kfs = GridSearchCV(SVM_pipe, SVMy, cv=KFold(n_splits=3, random_state=7, sh
uffle=True))
SVM_kfs.fit(X_train, y_train)
KNN_kfs = GridSearchCV(NN_pipe, knny, cv=KFold(n_splits=3, random_state=7, shu
ffle=True))
KNN_kfs.fit(X_train, y_train)


print('Logistic: {:.2f}'.format(Logistic_kfs.best_score_))
print('SVM: {:.2f}'.format(SVM_kfs.best_score_))
print('KNN: {:.2f}'.format(KNN_kfs.best_score_))
```

```
Logistic: 0.80
SVM: 0.80
KNN: 0.73
```

Again, not much change!

Changing the random seed of split of data

In [56]:
```
X_train, X_test, y_train, y_test = train_test_split(x_data, y_data, random_sta
te = 1)

Logistic_kfx = GridSearchCV(Logistic_pipe, Logisticy, cv=KFold(n_splits=3, shu
ffle=True))
Logistic_kfx.fit(X_train, y_train)
SVM_kfx = GridSearchCV(SVM_pipe, SVMy, cv=KFold(n_splits=3, shuffle=True))
SVM_kfx.fit(X_train, y_train)
KNN_kfx = GridSearchCV(NN_pipe, knny, cv=KFold(n_splits=3, shuffle=True))
KNN_kfx.fit(X_train, y_train)


print('Logistic: {:.2f}'.format(Logistic_kfx.best_score_))
print('SVM: {:.2f}'.format(SVM_kfx.best_score_))
print('KNN: {:.2f}'.format(KNN_kfx.best_score_))
```

```
Logistic: 0.80
SVM: 0.80
KNN: 0.73
```

This again doesnt change the scores much! This shows us that we have stable models

2.5

In [60]:
```
plt.figure(figsize=(20, 8))
plt.plot(Logistic_got.best_estimator_.named_steps['logisticregression'].coef_[
0], 'o', label='LR')
plt.plot(SVM_got.best_estimator_.named_steps['linearsvc'].coef_[0], 'o', label
='SVM')
plt.legend()
```

Out[60]:
```
<matplotlib.legend.Legend at 0x20900454908>
```