In [1]:
```
import pandas as pd
import matplotlib
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns

from sklearn.model_selection import RepeatedKFold, cross_val_score
from sklearn.metrics import mean_absolute_error, mean_squared_error, r2_score
```

In [2]:
```
df = pd.read_csv('clean_dataset.csv', sep=',',index_col=0, header=0)
df.head()
```

Out[2]:

	Latitude	Longitude	Month	Hour	Humidity	AmbientTemp	PolyPwr	Wind.Speed	Visibility	Pre
0	47.11	-122.57	12	11	81.71997	12.86919	0.886940	5	10.0	
1	47.11	-122.57	12	13	96.64917	9.66415	0.901270	0	10.0	
2	47.11	-122.57	12	13	93.61572	15.44983	1.497021	5	10.0	
3	47.11	-122.57	12	12	77.21558	10.36659	0.502979	5	2.0	
4	47.11	-122.57	12	14	54.80347	16.85471	1.883942	3	3.0	

Input/Target Variable Split

In [4]:
```
X = df.drop(['PolyPwr'], axis=1)
X.shape
```

Out[4]:
```
(21045, 14)
```

In [5]:
```
y = df['PolyPwr']
y.shape
```

Out[5]:
```
(21045,)
```

Baseline Regression Models

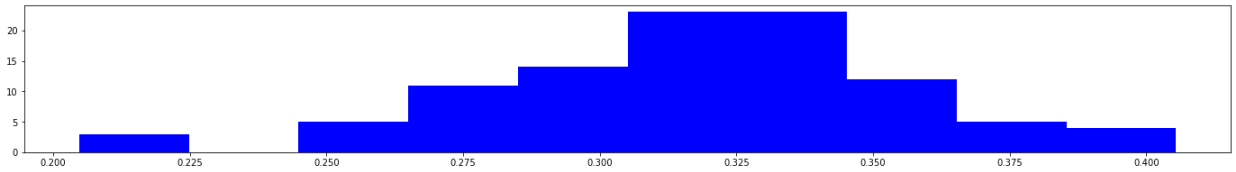
Decision Tree Regression

In [6]:
```
from sklearn.tree import DecisionTreeRegressor

kfoldcv = RepeatedKFold(n_splits=10, n_repeats=10, random_state=12)
power_dt = DecisionTreeRegressor()
dt_scores = cross_val_score(power_dt, X, y, scoring='r2', cv=kfoldcv)

# Runtime = 17s
```

In [7]:
```
dt_scores
```

Out[7]:
```
array([0.31317305, 0.29616485, 0.32629113, 0.32860772, 0.33103677,
       0.39599964, 0.35305671, 0.31358957, 0.30638933, 0.28142008,
       0.27750216, 0.30955522, 0.30787216, 0.3544718 , 0.29217948,
       0.28819343, 0.36264479, 0.35599365, 0.31763987, 0.31663426,
       0.33508131, 0.32058203, 0.30609811, 0.25411402, 0.33067546,
       0.32433377, 0.3588053 , 0.28269884, 0.35073156, 0.32907328,
       0.38771642, 0.29552834, 0.26292906, 0.28218681, 0.29863945,
       0.34597678, 0.32725955, 0.32135628, 0.21336039, 0.34165923,
       0.32176538, 0.36609073, 0.30660808, 0.29834793, 0.3395127 ,
       0.28420336, 0.40541605, 0.219549  , 0.20475598, 0.35447744,
       0.39136191, 0.32492911, 0.31345857, 0.2959595 , 0.33861607,
       0.27462781, 0.31804557, 0.37581803, 0.2637729 , 0.29204455,
       0.34531529, 0.31198103, 0.37797843, 0.25170866, 0.32060701,
       0.29355154, 0.38126963, 0.27603413, 0.3364681 , 0.35762256,
       0.36664655, 0.27754789, 0.3022382 , 0.3277507 , 0.29737609,
       0.29181525, 0.33698338, 0.27766728, 0.3393271 , 0.35130022,
       0.30515528, 0.32228379, 0.34479779, 0.3372244 , 0.35713782,
       0.2968278 , 0.31746437, 0.33669717, 0.30463234, 0.3284078 ,
       0.34501127, 0.27430981, 0.3389814 , 0.32949912, 0.2487396 ,
       0.34493669, 0.3352022 , 0.30812952, 0.31743591, 0.27901677])
```

In [8]:
```
plt.figure(figsize=(24,3))
plt.hist(dt_scores, color='blue')
plt.show()
```



In [19]:
```
dt_meanscore = np.mean(dt_scores)
```

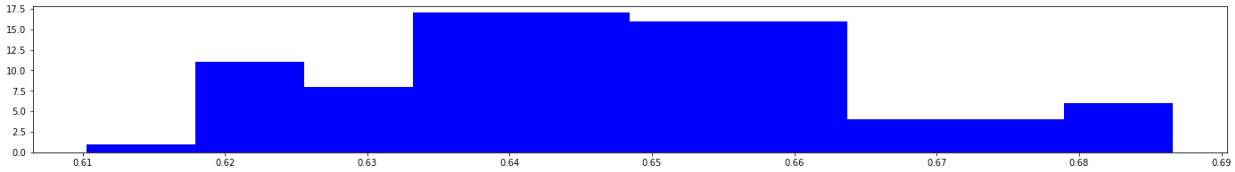
Random Forest Regression

In [9]:
```
from sklearn.ensemble import RandomForestRegressor

power_rf = RandomForestRegressor()
rf_scores = cross_val_score(power_rf, X, y, scoring='r2', cv=kfoldcv)

# Runtime = 19m 9s
```

In [10]:
```
rf_scores
```

Out[10]:
```
array([0.63799286, 0.63877934, 0.64229928, 0.63713272, 0.68438162,
       0.66516719, 0.66290306, 0.6479341 , 0.64381528, 0.61965659,
       0.62452719, 0.65064622, 0.62591033, 0.65342853, 0.62525562,
       0.662832  , 0.65044401, 0.6696666 , 0.64547324, 0.64820079,
       0.65354221, 0.64022097, 0.65743947, 0.61860334, 0.65656049,
       0.65820575, 0.67526673, 0.62248834, 0.67853587, 0.6185326 ,
       0.65659726, 0.64531673, 0.63500108, 0.64500341, 0.62867848,
       0.65184757, 0.67144227, 0.66186489, 0.62451597, 0.64737289,
       0.64606128, 0.64629104, 0.6466135 , 0.66199707, 0.63723692,
       0.64072256, 0.67952133, 0.63169597, 0.61030828, 0.6674166 ,
       0.64934835, 0.63725389, 0.6498257 , 0.63978377, 0.68003858,
       0.640265  , 0.64870395, 0.65401595, 0.6235568 , 0.64110647,
       0.67150319, 0.65780781, 0.64527543, 0.63713499, 0.64470042,
       0.65218336, 0.65427785, 0.63520511, 0.63980228, 0.64872012,
       0.66192974, 0.62637679, 0.62660573, 0.6619016 , 0.63423537,
       0.61861634, 0.65801772, 0.63609149, 0.65837416, 0.68657586,
       0.63786869, 0.64519762, 0.68043441, 0.64670689, 0.63974785,
       0.66035633, 0.65993946, 0.62295851, 0.63242596, 0.66162127,
       0.68104945, 0.6266847 , 0.62637119, 0.65475317, 0.64174613,
       0.65563314, 0.65108273, 0.66445878, 0.62494279, 0.65250389])
```

In [11]:
```
plt.figure(figsize=(24,3))
plt.hist(rf_scores, color='blue')
plt.show()
```

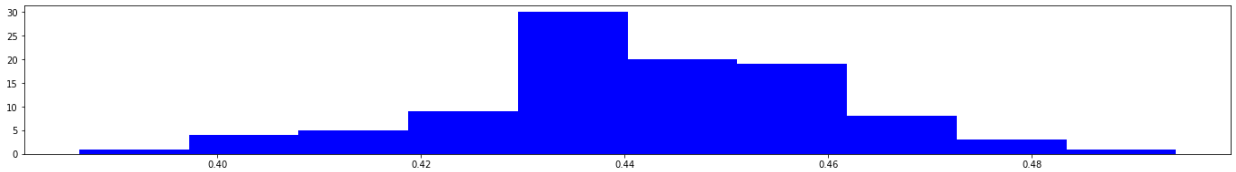


In [18]:
```
rf_meanscore = np.mean(rf_scores)
```

Support Vector Regression

In [12]:
```
from sklearn.svm import SVR

power_svr = SVR()
svr_scores = cross_val_score(power_svr, X, y, scoring='r2', cv=kfoldcv)

# Runtime = 49m 26s
```

In [13]:
```
plt.figure(figsize=(24,3))
plt.hist(svr_scores, color='blue')
plt.show()
```

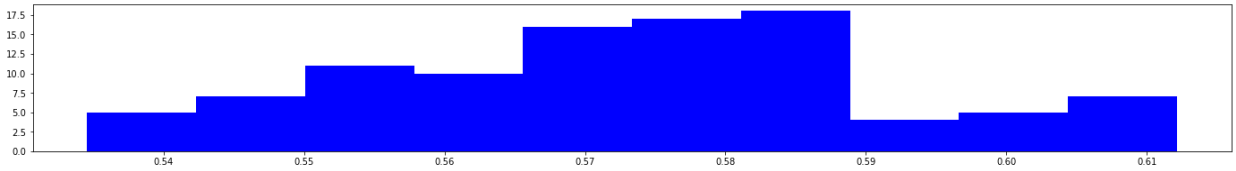


In [42]:
```
svr_meanscore = np.mean(svr_scores)
```

K-Nearest Neighbors Regression

In [14]:
```
from sklearn.neighbors import KNeighborsRegressor

power_knn = KNeighborsRegressor(11)
knn_scores = cross_val_score(power_knn, X, y, scoring='r2', cv=kfoldcv)

# Runtime = 12s
```

In [15]:
```
plt.figure(figsize=(24,3))
plt.hist(knn_scores, color='blue')
plt.show()
```



In [44]:
```
knn_meanscore = np.mean(knn_scores)
```

Hyperparameter Tuning

In [20]:
```
from sklearn.model_selection import GridSearchCV

dtr = DecisionTreeRegressor()
rfr = RandomForestRegressor()
svr = SVR()
knn = KNeighborsRegressor()
```

In [21]:
```
# Decision Tree
dtr_params = {'max_depth':np.arange(1,20), 'max_features':np.arange(1,15), 'min_sample
hyp_dtr = GridSearchCV(dtr, param_grid=dtr_params, cv=5)
hyp_dtr.fit(X, y)
hyp_dtr.best_params_

# Runtime = 16m 28s
```

Out[21]:
```
{'max_depth': 18, 'max_features': 11, 'min_samples_leaf': 85}
```

In [23]:
```
# Random Forest
rfr_params = {'max_features':np.arange(1,15), 'min_samples_leaf':np.arange(5,100,5), '
hyp_rfr = GridSearchCV(rfr, param_grid=rfr_params, cv=2)
hyp_rfr.fit(X, y)
hyp_rfr.best_params_

# Reduced cv from 5 to 2 due to time constraints. Model at first iteration took too lo
# Runtime = ~2h
```

Out[23]:
```
{'max_features': 3, 'min_samples_leaf': 25, 'n_estimators': 50}
```

In [25]:
```
# Support Vector
svr_params = {'C': [0.1, 1, 10, 100, 1000]}
hyp_svr = GridSearchCV(svr, param_grid=svr_params, cv=5)
hyp_svr.fit(X, y)
hyp_svr.best_params_
```

```
# Runtime = ~11m
```

Out[25]:
```
{'C': 1000}
```

In [28]:
```
%%time
# KNN
knn_params = {'n_neighbors':np.arange(1, 50), 'p':[1,2], 'weights': ['uniform', 'dista
hyp_knn = GridSearchCV(knn, param_grid=knn_params, cv=5)
hyp_knn.fit(X, y)
hyp_knn.best_params_

# Runtime = 5m 2s
```

Out[28]:
```
CPU times: total: 4min 52s
Wall time: 5min 2s
{'n_neighbors': 49, 'p': 1, 'weights': 'distance'}
```

New Model Iteration

Decision Tree Regression

In [29]:
```
%%time
from sklearn.tree import DecisionTreeRegressor

kfoldcv = RepeatedKFold(n_splits=10, n_repeats=10, random_state=12)
power_hpdt = DecisionTreeRegressor(max_depth=18, max_features=11, min_samples_leaf=85)
hpdt_scores = cross_val_score(power_hpdt, X, y, scoring='r2', cv=kfoldcv)

# Runtime = 9s
```

Out[29]:
```
CPU times: total: 7.78 s
Wall time: 8.67 s
```

In [30]:
```
hpdt_scores
```

Out[30]:
```
array([0.54690489, 0.57538956, 0.55103817, 0.5588774 , 0.60926131,
       0.5863569 , 0.59359821, 0.56723582, 0.5768021 , 0.56068103,
       0.55602469, 0.57550702, 0.53855351, 0.58615273, 0.53779791,
       0.60981628, 0.58705284, 0.59541134, 0.57432491, 0.57141076,
       0.57741445, 0.57492919, 0.58399438, 0.53596547, 0.59496863,
       0.58293497, 0.61648104, 0.5447341 , 0.59522718, 0.52876994,
       0.5878962 , 0.57797292, 0.56295937, 0.5667976 , 0.55162564,
       0.56753027, 0.60241151, 0.57742693, 0.54805542, 0.56296648,
       0.57635361, 0.56572882, 0.5727193 , 0.56670913, 0.53905042,
       0.57699379, 0.61595015, 0.56273551, 0.54091446, 0.59117269,
       0.56202048, 0.58613951, 0.57824481, 0.56070752, 0.59498296,
       0.57906764, 0.55169617, 0.59780076, 0.52942733, 0.58725211,
       0.58760963, 0.5918085 , 0.57784171, 0.55814354, 0.54887062,
       0.58213886, 0.57484976, 0.55115395, 0.57696781, 0.56336754,
       0.58124993, 0.53496511, 0.55559465, 0.58832893, 0.54588482,
       0.54480517, 0.56743173, 0.56838325, 0.59413368, 0.60986328,
       0.55959618, 0.57408604, 0.59459815, 0.5871277 , 0.54921392,
       0.59910284, 0.57922216, 0.54413381, 0.56217316, 0.57849959,
       0.62458583, 0.5406331 , 0.55449198, 0.58037615, 0.5624434 ,
       0.57984492, 0.5788725 , 0.58772791, 0.53741389, 0.59512772])
```

In [31]:
```
hpdt_meanscore = np.mean(hpdt_scores)
```

Random Forest Regression

In [32]:
```
%%time
from sklearn.ensemble import RandomForestRegressor

power_hprf = RandomForestRegressor(max_features=3, min_samples_leaf=25, n_estimators=5
hprf_scores = cross_val_score(power_hprf, X, y, scoring='r2', cv=kfoldcv)

# Runtime = 1m 20s
```

```
CPU times: total: 1min 18s
Wall time: 1min 20s
```

In [33]:
```
hprf_scores
```

Out[33]:
```
array([0.60339592, 0.61381993, 0.60291894, 0.60398336, 0.64988587,
       0.6251578 , 0.62852248, 0.62053874, 0.61722898, 0.60771145,
       0.60987365, 0.61528445, 0.59552461, 0.63380594, 0.59724119,
       0.64192621, 0.61629235, 0.63351894, 0.61776129, 0.61550602,
       0.62021158, 0.61414791, 0.62662977, 0.58686492, 0.63839064,
       0.62460964, 0.65586936, 0.58712452, 0.6439988 , 0.58687745,
       0.62007121, 0.6367301 , 0.60801821, 0.61464265, 0.5895791 ,
       0.61974491, 0.63619225, 0.63333565, 0.60040486, 0.6159439 ,
       0.62110226, 0.6095211 , 0.61598059, 0.61673766, 0.58481834,
       0.6297167 , 0.64364652, 0.62550095, 0.59371514, 0.63602791,
       0.61299492, 0.62217038, 0.63166083, 0.60248072, 0.65200139,
       0.62351632, 0.60045025, 0.62405302, 0.58311177, 0.62940073,
       0.64169882, 0.6250085 , 0.6083791 , 0.61131932, 0.59750613,
       0.63536922, 0.6166959 , 0.61200969, 0.61780957, 0.6222379 ,
       0.62698767, 0.59853027, 0.59343803, 0.63208011, 0.61196802,
       0.58930392, 0.62850318, 0.61290488, 0.63428677, 0.64584028,
       0.60650337, 0.61091065, 0.64719876, 0.62307705, 0.61708221,
       0.63900182, 0.62411489, 0.58428528, 0.61598876, 0.62720761,
       0.6616562 , 0.58388207, 0.59759972, 0.62615607, 0.61268657,
       0.61944647, 0.62243121, 0.63696706, 0.57971124, 0.63566005])
```

In [34]:
```
hprf_meanscore = np.mean(hprf_scores)
```

Support Vector Regression

In [35]:
```
%%time
from sklearn.svm import SVR

power_hpsvr = SVR(C=1000)
hpsvr_scores = cross_val_score(power_hpsvr, X, y, scoring='r2', cv=kfoldcv)

# Runtime = 52m 10s
```

```
CPU times: total: 51min 27s
Wall time: 52min 10s
```

In [36]:
```
hpsvr_scores
```

Out[36]:
```
array([0.5380166 , 0.54356063, 0.52002238, 0.53470517, 0.57961434,
       0.54785607, 0.55539615, 0.5331653 , 0.54732232, 0.53611036,
       0.55684692, 0.54228791, 0.50748231, 0.56871793, 0.52144811,
       0.56405168, 0.55416578, 0.54084854, 0.5487927 , 0.52934629,
       0.53685362, 0.54892854, 0.55099212, 0.51832278, 0.56275605,
       0.54509777, 0.59074551, 0.51481269, 0.5631091 , 0.49969466,
       0.54333204, 0.56894803, 0.5382789 , 0.53346155, 0.50978759,
       0.55064899, 0.56286286, 0.56227531, 0.53359657, 0.53853568,
       0.53366684, 0.53411297, 0.54833682, 0.53119977, 0.50836319,
       0.55396094, 0.57667048, 0.54737057, 0.53098248, 0.56934955,
       0.5419793 , 0.55028722, 0.56066527, 0.52135186, 0.58351838,
       0.55134767, 0.51397226, 0.55427549, 0.49871997, 0.56024758,
       0.56462267, 0.54060617, 0.54451841, 0.53631251, 0.51919862,
       0.56366119, 0.55078091, 0.54387362, 0.54263757, 0.53232426,
       0.5554109 , 0.53272828, 0.50561958, 0.55273879, 0.53506173,
       0.50999785, 0.55604723, 0.53868602, 0.56538375, 0.58373805,
       0.52596421, 0.53359313, 0.56587936, 0.55507814, 0.54752307,
       0.57414975, 0.55801942, 0.50768406, 0.53520856, 0.53790268,
       0.59344202, 0.50402021, 0.53207781, 0.55016251, 0.54063311,
       0.55271165, 0.54997592, 0.55704246, 0.49003742, 0.57062805])
```

In [37]:
```
hpsvr_meanscore = np.mean(hpsvr_scores)
```

K-Nearest Neighbors Regression

In [38]:
```
%%time
from sklearn.neighbors import KNeighborsRegressor

power_hpknn = KNeighborsRegressor(n_neighbors=49, p=1, weights='distance')
hpknn_scores = cross_val_score(power_hpknn, X, y, scoring='r2', cv=kfoldcv)

# Runtime = 23s
```

```
CPU times: total: 23.2 s
Wall time: 23.3 s
```

In [39]:
```
hpknn_scores
```

Out[39]:
```
array([0.58180517, 0.59064101, 0.58192564, 0.58026763, 0.62193862,
       0.60206674, 0.60357196, 0.5937208 , 0.60308432, 0.59072588,
       0.59009338, 0.59684965, 0.57188313, 0.62055146, 0.57365066,
       0.61073398, 0.59263068, 0.61132304, 0.59337646, 0.59127753,
       0.60614502, 0.58918977, 0.59803358, 0.56527412, 0.6078896 ,
       0.60242304, 0.62920373, 0.56986094, 0.62489694, 0.56824102,
       0.59704262, 0.60956284, 0.5839212 , 0.60059009, 0.57601718,
       0.59555322, 0.61819293, 0.60786533, 0.58407807, 0.59120621,
       0.58628045, 0.59204735, 0.590738  , 0.59767815, 0.56831246,
       0.60400743, 0.62419799, 0.60330076, 0.58129023, 0.61431049,
       0.60324718, 0.60299688, 0.60309275, 0.57935525, 0.63206085,
       0.59324536, 0.57582641, 0.60200368, 0.55625347, 0.60558085,
       0.62529702, 0.60660561, 0.58007456, 0.58827716, 0.58074078,
       0.6016221 , 0.59187432, 0.58867073, 0.59297119, 0.59603578,
       0.61184102, 0.57114206, 0.58037856, 0.61309536, 0.58540876,
       0.56249935, 0.60565682, 0.58629167, 0.60558196, 0.6335821 ,
       0.58742842, 0.58804663, 0.62675013, 0.5976809 , 0.5944745 ,
       0.60353279, 0.60702238, 0.56317513, 0.59224444, 0.60134794,
       0.63187368, 0.55640487, 0.57569322, 0.60077315, 0.60699159,
       0.60359988, 0.5962276 , 0.61107964, 0.5695879 , 0.60954529])
```

In [40]:
```
hpknn_meanscore = np.mean(hpknn_scores)
```

Comparison of Baseline Models and Tuned Models

In [46]:
```
power_compare = pd.DataFrame({
    'Model':['Decision Tree Regression', 'Random Forest Regression', 'Support Vector R
    'Baseline':[dt_meanscore, rf_meanscore, svr_meanscore, knn_meanscore],
    'Hyperparametric Tuned':[hpdt_meanscore, hprf_meanscore, hpsvr_meanscore, hpknn_me
})

power_compare
```

Out[46]:

	Model	Baseline	Hyperparametric Tuned
0	Decision Tree Regression	0.317797	0.572076
1	Random Forest Regression	0.647371	0.618013
2	Support Vector Regression	0.442191	0.543689
3	KNN Regression	0.572612	0.595743

Prediction on test set with best performing model

In [ ]:
```

```