In [1]:

```
import pandas as pd
from sklearn.feature_extraction import DictVectorizer
import matplotlib.pyplot as plt
import seaborn as sns
from pandas.plotting import scatter_matrix
```

In [2]:

```
baf = pd.read_csv("baf.csv")
```

In [3]:

```
baf.head()
```

Out[3]:

	age	job	marital	education	default	housing	loan	contact	month	day_
0	56	housemaid	married	basic.4y	no	no	no	telephone	may	
1	57	services	married	high.school	unknown	no	no	telephone	may	
2	37	services	married	high.school	no	yes	no	telephone	may	
3	40	admin.	married	basic.6y	no	no	no	telephone	may	
4	56	services	married	high.school	no	no	yes	telephone	may	

5 rows × 21 columns

In [4]:

```
baf1 = baf.T.to_dict().values()
```

In [5]:

```
vec = DictVectorizer()
```

In [6]:

```
signal_array = vec.fit_transform(baf1).toarray()
```

In [7]:

```
feature_names = vec.get_feature_names()
##splits into numpy matrix
```

In [8]:

```
baff = pd.DataFrame(signal_array,columns=feature_names)
```

In [9]:

```
baff.head()
```

Out[9]:

	age	campaign	cons.conf.idx	cons.price.idx	contact=cellular	contact=telephone	day_
0	56.0	1.0	-36.4	93.994	0.0	1.0	
1	57.0	1.0	-36.4	93.994	0.0	1.0	
2	37.0	1.0	-36.4	93.994	0.0	1.0	
3	40.0	1.0	-36.4	93.994	0.0	1.0	
4	56.0	1.0	-36.4	93.994	0.0	1.0	

5 rows × 65 columns

In [10]:

```
import numpy as np
import matplotlib.pyplot as plt

from sklearn.datasets import make_classification
from sklearn.ensemble import RandomForestClassifier
```

In [11]:

```
X = signal_array[:,:-2]
```

In [12]:

```
X = np.hstack((X[:,:14],X[:,15:]))
```

In [13]:

```
y = signal_array[:,-1]
```

In [16]:

```
print("Using the forest modelling technique")
forest = RandomForestClassifier(n_estimators=250,random_state=0)
```

```
Using the forest modelling technique
```

In [17]:

```
forest.fit(X, y)
```

Out[17]:

```
RandomForestClassifier(bootstrap=True, class_weight=None, criterio
n='gini',
            max_depth=None, max_features='auto', max_leaf_nodes=No
ne,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=250, n_jobs
=None,
            oob_score=False, random_state=0, verbose=0, warm_start
=False)
```

In [18]:

```
importances = forest.feature_importances_
```

In [19]:

```
std = np.std([tree.feature_importances_ for tree in forest.estimators_],axis=0
)
```

In [20]:

```
indices = np.argsort(importances)[::-1]
```

In [21]:

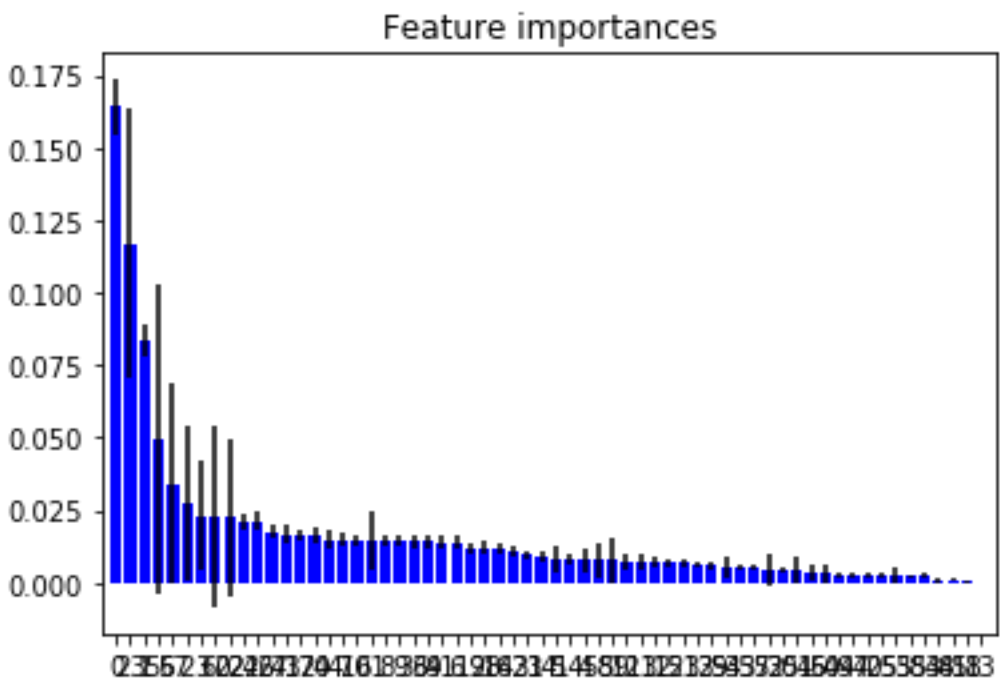
```
print("Feature ranking:")
for f in range(X.shape[1]):
    print("%d. feature %s (%f)" % (f + 1, feature_names[indices[f]], importanc
es[indices[f]]))
```

```
Feature ranking:
1. feature age (0.164047)
2. feature emp.var.rate (0.117021)
3. feature campaign (0.083560)
4. feature month=sep (0.049478)
5. feature nr.employed (0.034052)
6. feature cons.conf.idx (0.027570)
7. feature cons.price.idx (0.023012)
8. feature poutcome=nonexistent (0.022943)
9. feature education=unknown (0.022474)
10. feature euribor3m (0.021194)
11. feature housing=unknown (0.021185)
12. feature housing=yes (0.017653)
13. feature marital=divorced (0.016720)
14. feature education=basic.9y (0.016283)
15. feature education=professional.course (0.016191)
16. feature marital=married (0.014782)
17. feature day_of_week=mon (0.014618)
18. feature day_of_week=wed (0.014473)
```

```
19. feature poutcome=success (0.014427)
20. feature day_of_week=thu (0.014243)
21. feature day_of_week=tue (0.014166)
22. feature job=student (0.014008)
23. feature job=unknown (0.014003)
24. feature loan=unknown (0.013831)
25. feature day_of_week=fri (0.013753)
26. feature education=illiterate (0.011851)
27. feature job=admin. (0.011798)
28. feature education=basic.6y (0.011275)
29. feature loan=yes (0.010415)
30. feature job=housemaid (0.009447)
31. feature job=self-employed (0.009024)
32. feature contact=telephone (0.008300)
33. feature duration (0.008157)
34. feature contact=cellular (0.007694)
35. feature pdays (0.007676)
36. feature poutcome=failure (0.007590)
37. feature default=unknown (0.007252)
38. feature default=no (0.007184)
39. feature job=management (0.007027)
40. feature education=basic.4y (0.006778)
41. feature education=university.degree (0.006760)
42. feature job=retired (0.006212)
43. feature job=blue-collar (0.005778)
44. feature month=nov (0.005462)
45. feature job=services (0.005384)
46. feature job=technician (0.004991)
47. feature month=mar (0.004532)
48. feature job=entrepreneur (0.004431)
49. feature month=jun (0.004220)
50. feature marital=unknown (0.003309)
51. feature month=jul (0.003013)
52. feature month=dec (0.002521)
53. feature month=apr (0.002500)
54. feature loan=no (0.002475)
55. feature housing=no (0.002460)
56. feature month=oct (0.002417)
57. feature job=unemployed (0.002256)
58. feature month=may (0.002140)
59. feature month=aug (0.000844)
60. feature marital=single (0.000843)
61. feature education=high.school (0.000297)
62. feature default=yes (0.000001)
```

In [22]:

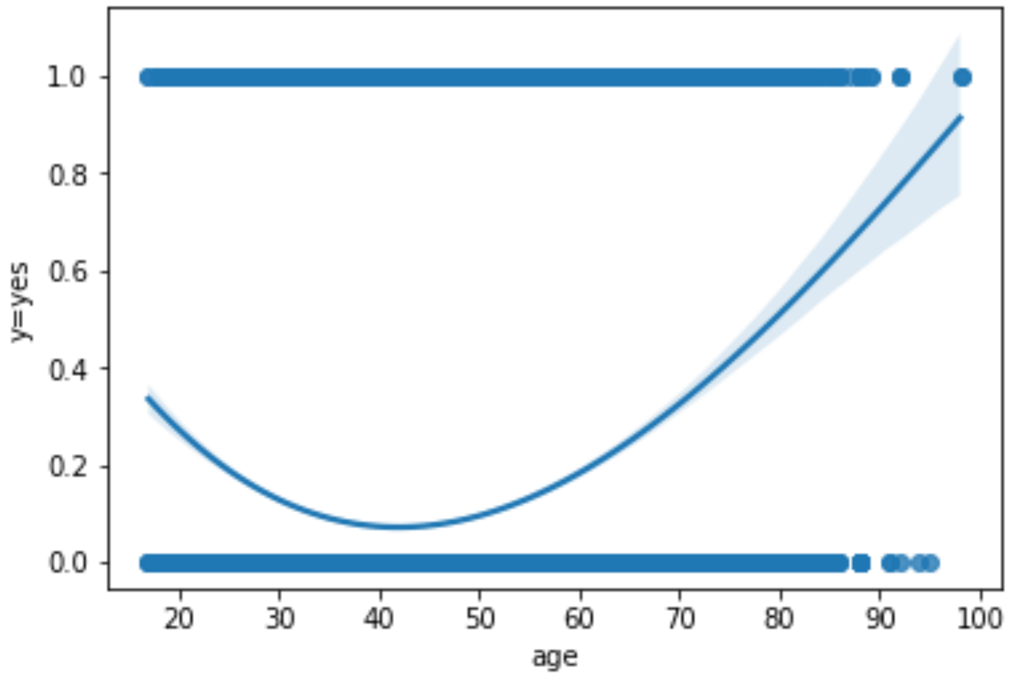
```
plt.figure()
plt.title("Feature importances")
plt.bar(range(X.shape[1]), importances[indices],color="b", yerr=std[indices],
align="center")
plt.xticks(range(X.shape[1]), indices)
plt.xlim([-1, X.shape[1]])
plt.show()
```



In [23]:

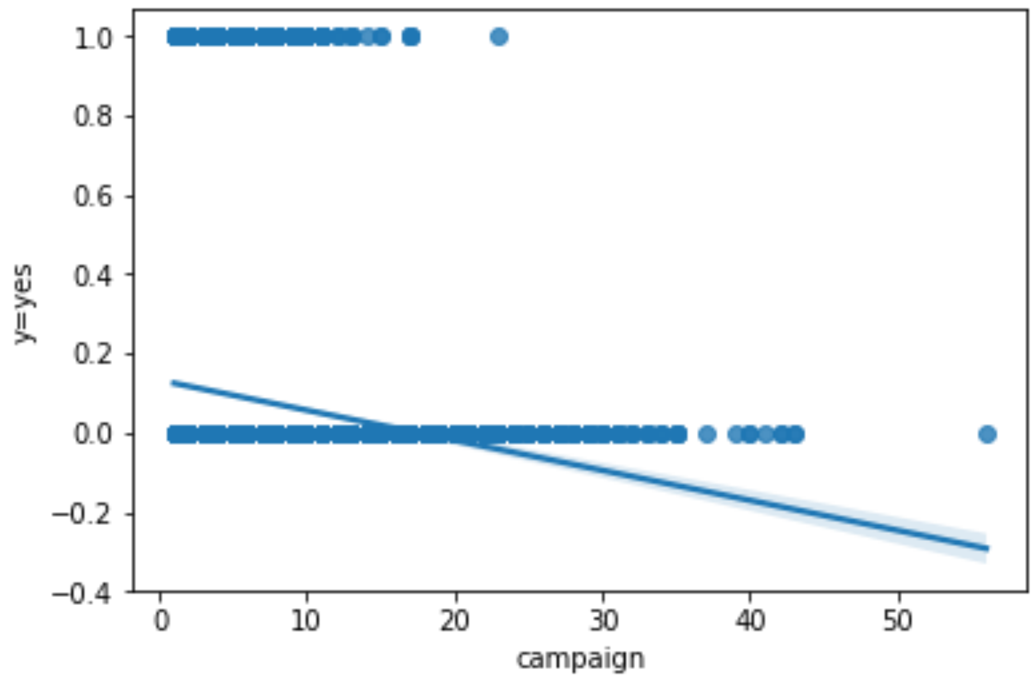
```
ax = sns.regplot(x="age", y="y=yes", order=3, data=baff, truncate=True)
```

```
/anaconda3/lib/python3.7/site-packages/scipy/stats/stats.py:1713:
FutureWarning: Using a non-tuple sequence for multidimensional ind
exing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`.
In the future this will be interpreted as an array index, `arr[np.
array(seq)]`, which will result either in an error or a different
result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sum
val
```



In [24]:

```
ax = sns.regplot(x="campaign", y="y=yes", order=1, data=baff, truncate=True)
```



In [25]:

```
baff.loc[(baff['campaign'] >15) & (baff['y=yes']==1)]
```

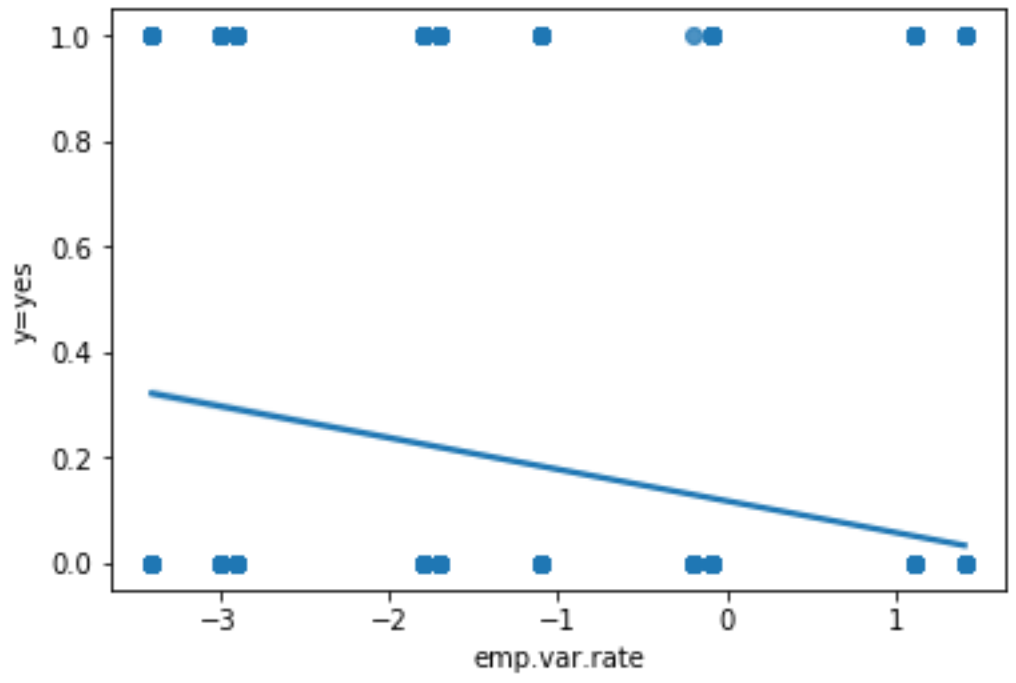
Out[25]:

	age	campaign	cons.conf.idx	cons.price.idx	contact=cellular	contact=telephone
3219	39.0	23.0	-36.4	93.994	0.0	1.0
10162	44.0	17.0	-41.8	94.465	0.0	1.0
17284	59.0	17.0	-42.7	93.918	1.0	0.0
17655	50.0	17.0	-42.7	93.918	0.0	1.0
29980	31.0	17.0	-47.1	93.075	0.0	1.0

5 rows × 65 columns

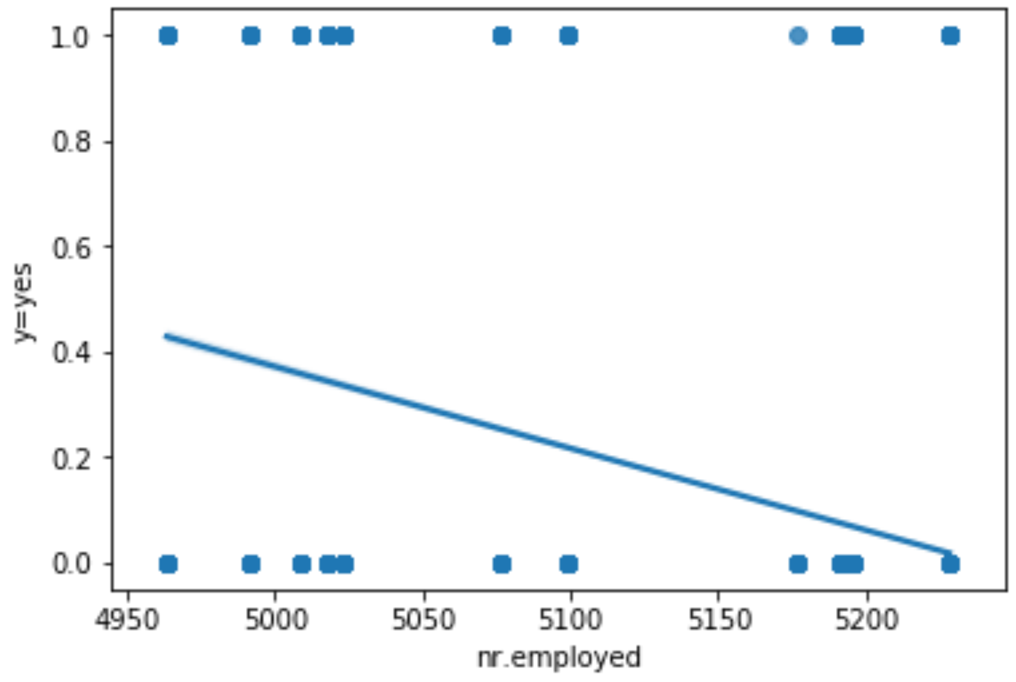
In [26]:

```
ax = sns.regplot(x="emp.var.rate", y="y=yes", order=1, data=baff, truncate=Tru
e)
```



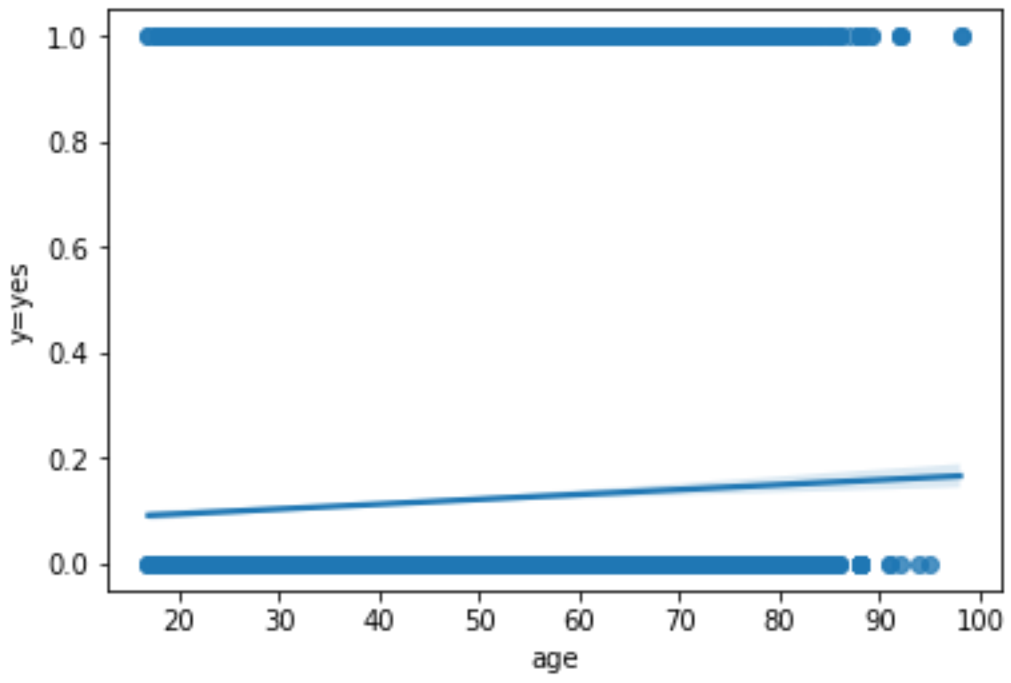
In [27]:

```
ax = sns.regplot(x="nr.employed", y="y=yes", order=1, data=baff, truncate=True
)
```



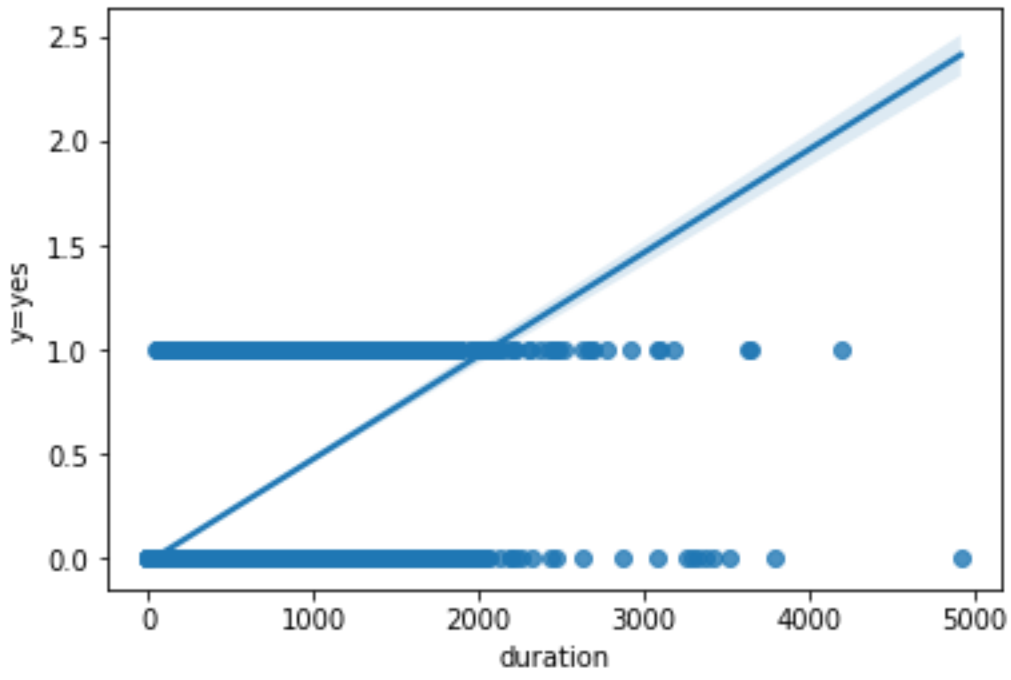
In [28]:

```
ax = sns.regplot(x="age", y="y=yes", order=1, data=baff, truncate=True)
```



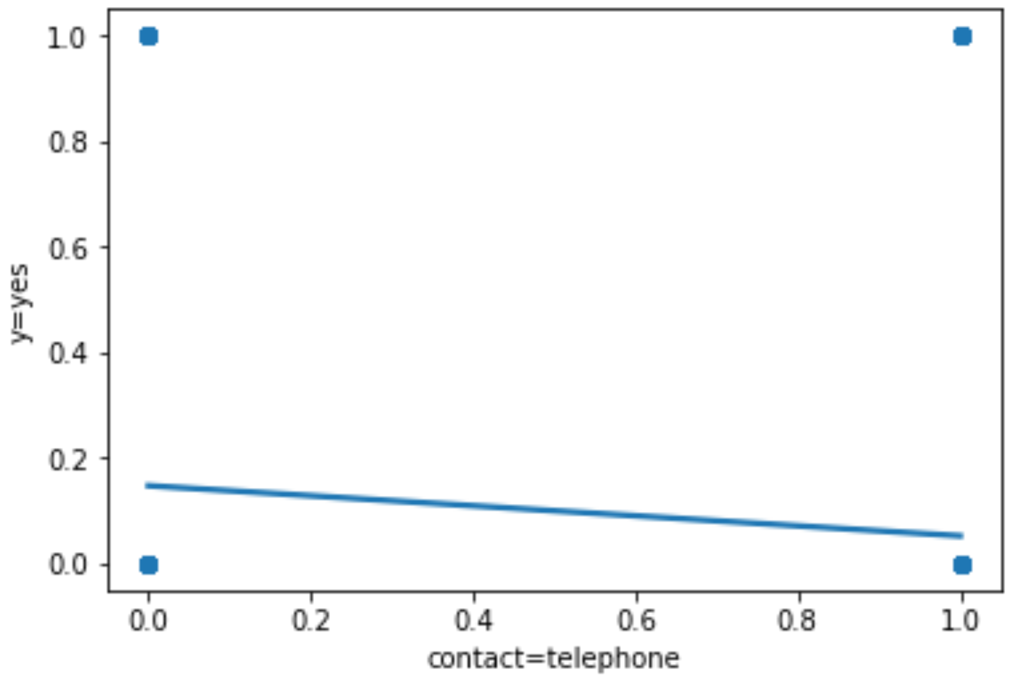
In [29]:

```
ax = sns.regplot(x="duration", y="y=yes", order=1, data=baff, truncate=True)
```



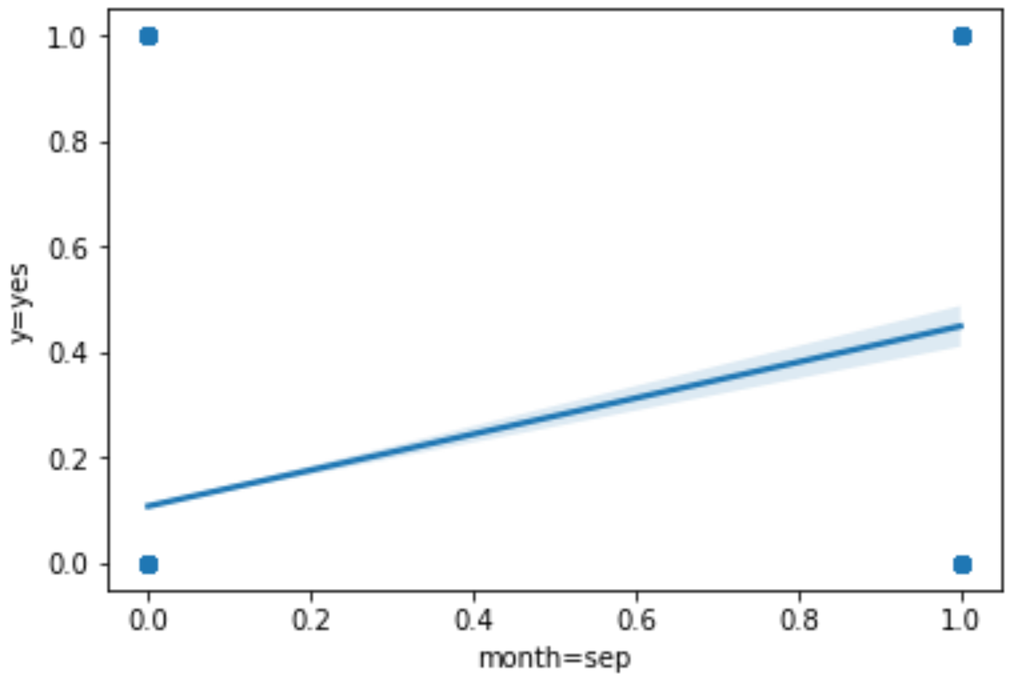
In [30]:

```
ax = sns.regplot(x="contact=telephone", y="y=yes", order=1, data=baff, truncat
e=True)
```



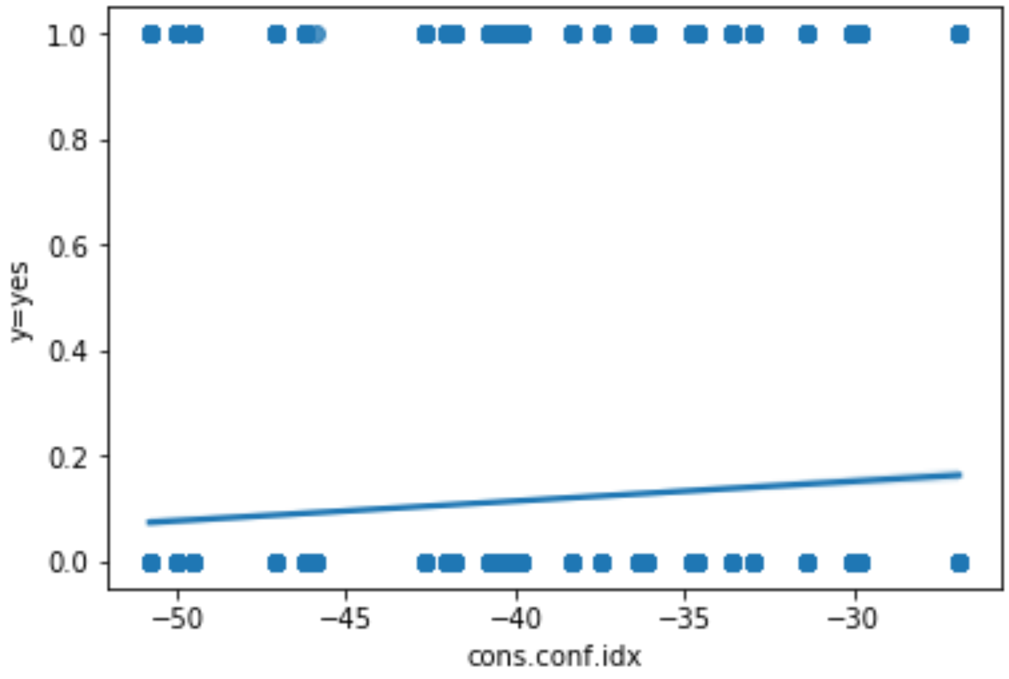
In [31]:

```
ax = sns.regplot(x="month=sep", y="y=yes", order=1, data=baff, truncate=True)
```



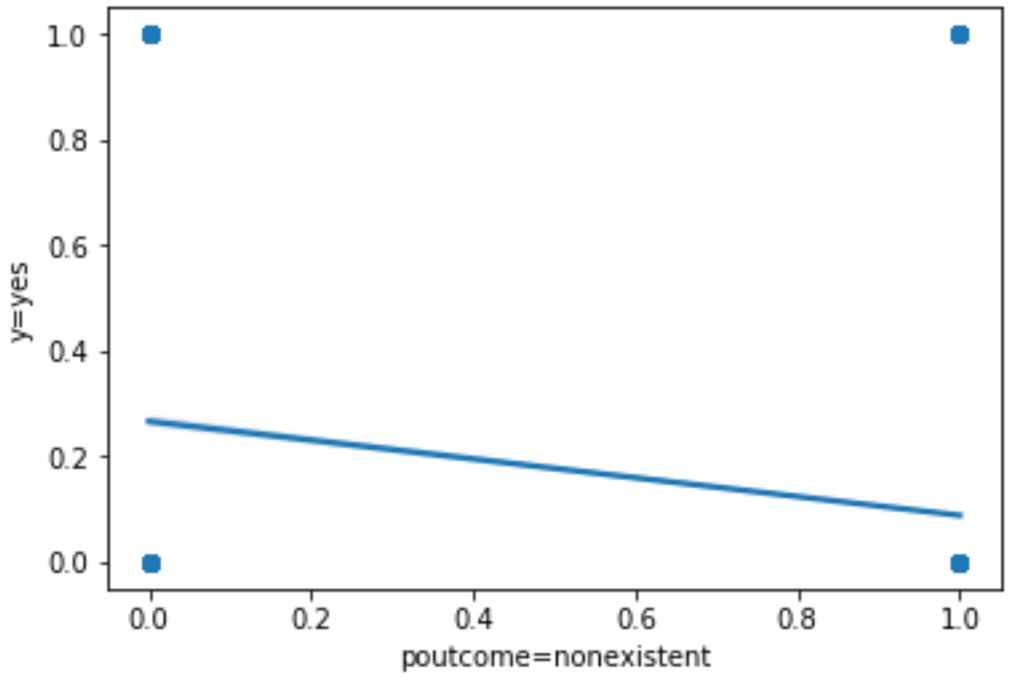
In [32]:

```
ax = sns.regplot(x="cons.conf.idx", y="y=yes", order=1, data=baff, truncate=True)
```



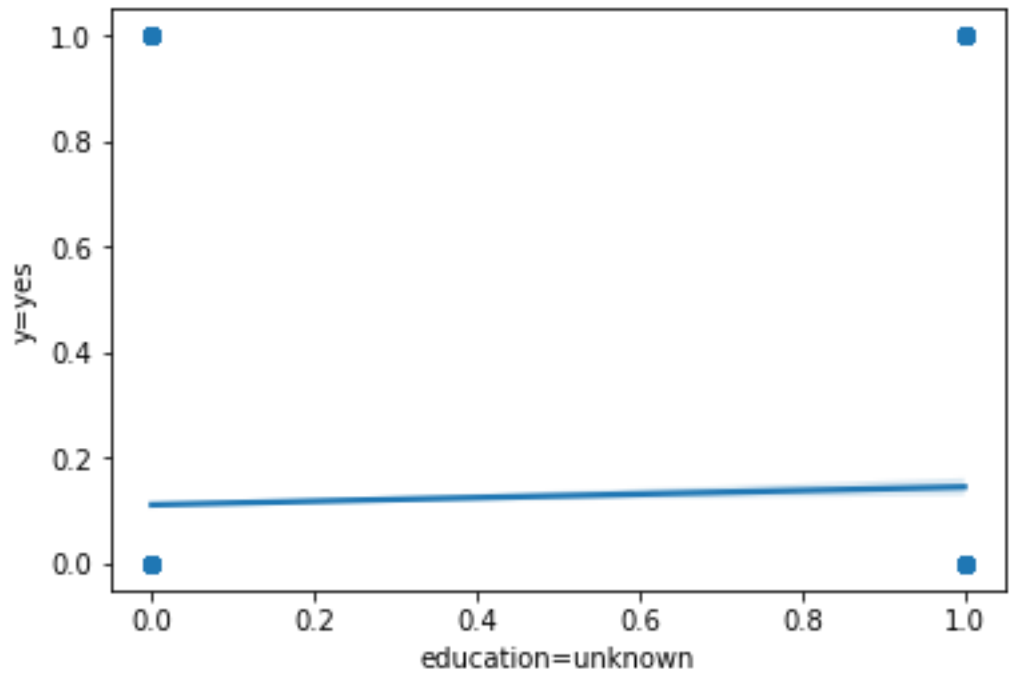
In [33]:

```
ax = sns.regplot(x="poutcome=nonexistent", y="y=yes", order=1, data=baff, truncate=True)
```



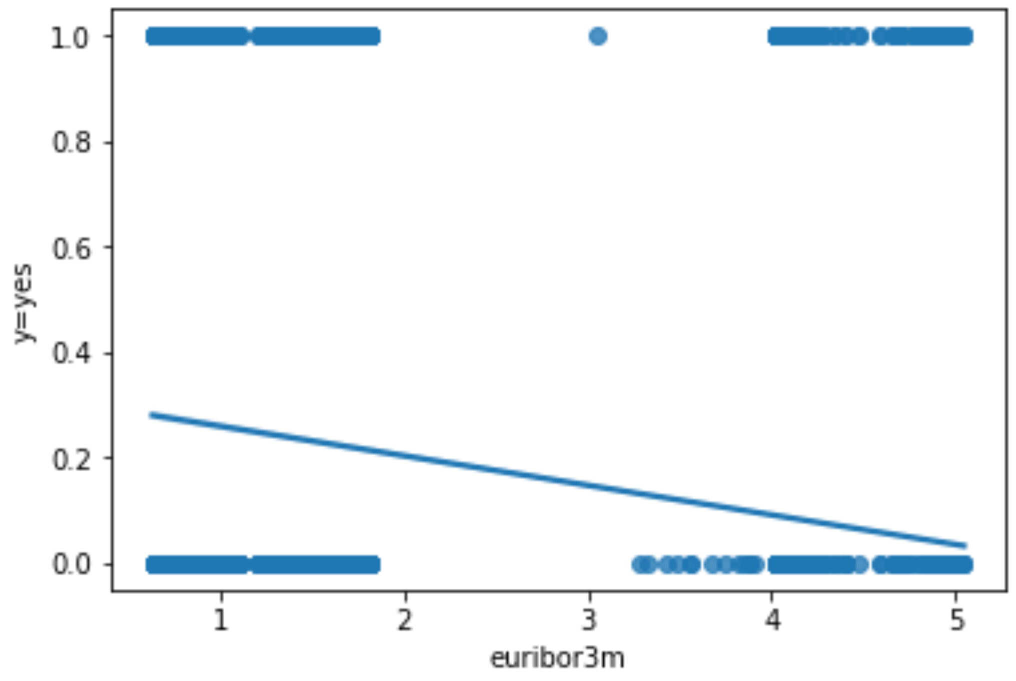
In [34]:

```
ax = sns.regplot(x="education=unknown", y="y=yes", order=1, data=baff, truncat
e=True)
```



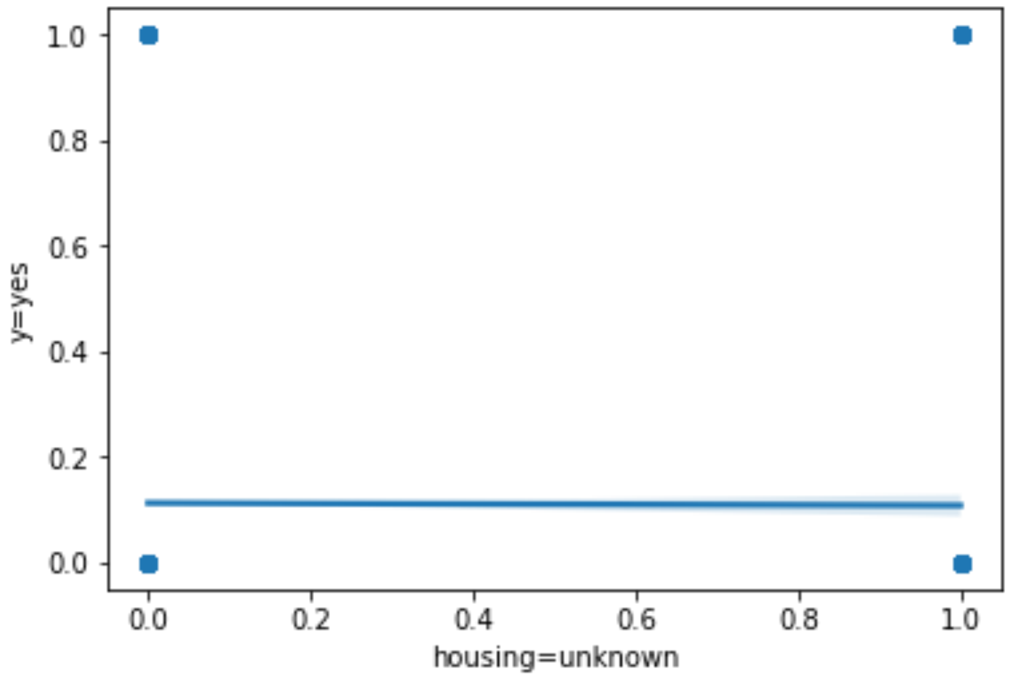
In [35]:

```
ax = sns.regplot(x="euribor3m", y="y=yes", order=1, data=baff, truncate=True)
```



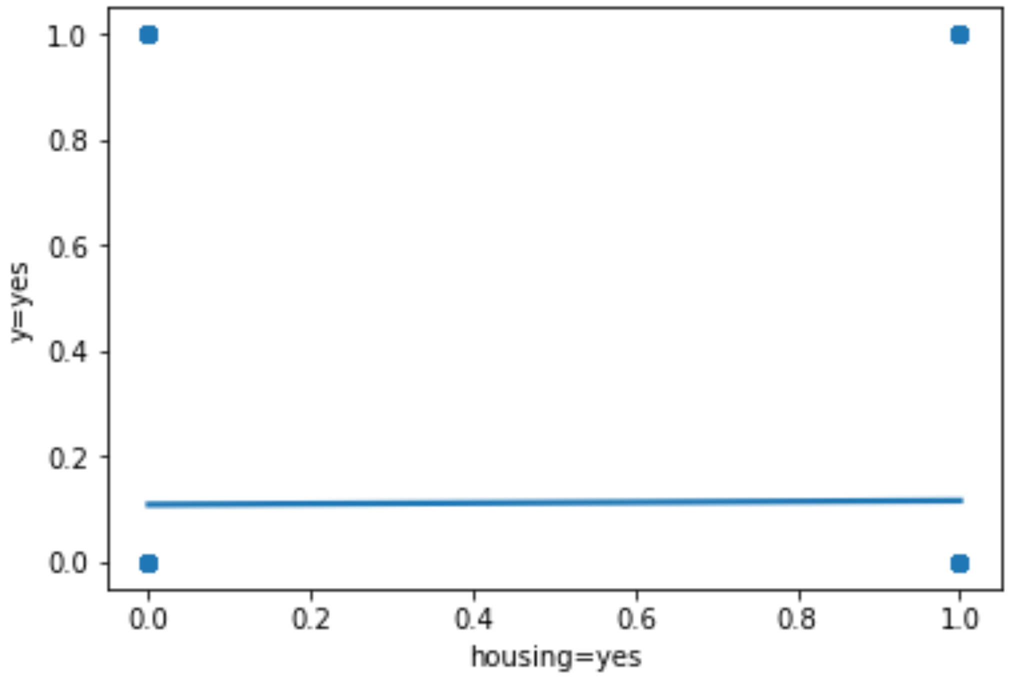
In [36]:

```
ax = sns.regplot(x="housing=unknown", y="y=yes", order=1, data=baff, truncate=
True)
```



In [37]:

```
ax = sns.regplot(x="housing=yes", y="y=yes", order=1, data=baff, truncate=True
)
```



In [38]:

```
print("Conversion ratio:")
sum(baff['y=yes'])/sum(baff['campaign'])
```

```
Conversion ratio:
```

Out[38]:

```
0.043875408967982296
```

In [39]:

```
print("Efficiancy on every additional call:")
print ("Nth Call \t Efficiency")
for i in range(1,30):
    goo = sum(baff.loc[baff['campaign']==i]['y=yes']) / float(baff.loc[baff['c
ampaign'] >= i].shape[0])
    print (str((i))+" \t\t "+str(goo))
```

```
Efficiancy on every additional call:
Nth Call         Efficiency
1                0.05584150723511702
2                0.0514312409751254
3                0.04423551171393342
4                0.0326129666011787 8
5                0.024077046548956663
6                0.022156573116691284
7                0.015793848711554447
8                0.009566685424873381
9                0.012345679012345678
10               0.010968921389396709
11               0.01380897583429229
12               0.004335260115606936
13               0.007054673721340388
14               0.002105263157894737
15               0.0049261083743842365
16               0.0
17               0.013157894736842105
18               0.0
19               0.0
20               0.0
21               0.0
22               0.0
23               0.008620689655172414
24               0.0
25               0.0
26               0.0
27               0.0
28               0.0
29               0.0
```

In [40]:

```
print(" We see that any call after the 6th call is not needed beacuse it has a
conversion ratio of less than 1.6%")
```

```
 We see that any call after the 6th call is not needed beacuse it
has a conversion ratio of less than 1.6%
```

In [41]:

```
print("For age upto 30")
print ("Nth Call \t Efficiency")
for i in range(1,30):
    num = float(baff[(baff['age'] <= 30) & (baff['campaign']==i) & (baff['y=ye
s']==1)].shape[0])
    den = 1+float(baff[(baff['age'] <= 30) & (baff['campaign'] >= i)].shape[0]
)
    print (str((i))+" \t\t "+str(num/den))
```

```
For age upto 30
Nth Call         Efficiency
1                0.07502708559046588
2                0.07100309745055992
3                0.06274509803921569
4                0.04447739065974796
5                0.03882352941176471
6                0.02058319039451115
7                0.030805687203791468
8                0.006493506493506494
9                0.012875536480686695
10               0.005376344086021506
11               0.013888888888888888
12               0.0
13               0.010869565217391304
14               0.0
15               0.014705882352941176
16               0.0
17               0.0
18               0.0
19               0.0
20               0.0
21               0.0
22               0.0
23               0.0
24               0.0
25               0.0
26               0.0
27               0.0
28               0.0
29               0.0
```

In [42]:

```
print("For age between 30-40")
print ("Nth Call \t Efficiency")
for i in range(1,30):
    num = float(baff[(baff['age'] <= 40) & (baff['age'] > 30) & (baff['campaig
n']==i) & (baff['y=yes']==1)].shape[0])
    den = 1+float(baff[(baff['age'] <= 40) & (baff['age'] > 30) & (baff['campa
ign'] >= i)].shape[0])
    print (str((i))+" \t\t "+str(num/den))
```

```
For age between 30-40
Nth Call         Efficiency
1                0.04882216526302942
2                0.042643923240938165
3                0.04005444293214078
4                0.028093645484949834
5                0.02048131080389145
6                0.024279210925644917
7                0.007494646680942184
8                0.008746355685131196
9                0.011538461538461539
10               0.011990407673860911
11               0.015015015015015015
12               0.0076045627376425855
13               0.009523809523809525
14               0.0
15               0.0
16               0.0
17               0.009259259259259259
18               0.0
19               0.0
20               0.0
21               0.0
22               0.0
23               0.02040816326530612
24               0.0
25               0.0
26               0.0
27               0.0
28               0.0
29               0.0
```

```
In [43]:
```

```
print("For age between 40-50")
print ("Nth Call \t Efficiency")
for i in range(1,30):
    num = float(baff[(baff['age'] <= 50) & (baff['age'] > 40) & (baff['campaig
n']==i) & (baff['y=yes']==1)].shape[0])
    den = 1+float(baff[(baff['age'] <= 50) & (baff['age'] > 40) & (baff['campa
ign'] >= i)].shape[0])
    print (str((i))+" \t\t "+str(num/den))
```

```
For age between 40-50
Nth Call         Efficiency
1                0.03925397910360316
2                0.036345108695652176
3                0.03047676523838262
4                0.027820710973724884
5                0.020737327188940093
6                0.016853932584269662
7                0.008012820512820512
8                0.008368200836820083
9                0.005333333333333333
10               0.013888888888888888
11               0.017316017316017316
12               0.005434782608695652
13               0.006622516556291391
14               0.007936507936507936
15               0.0
16               0.0
17               0.023529411764705882
18               0.0
19               0.0
20               0.0
21               0.0
22               0.0
23               0.0
24               0.0
25               0.0
26               0.0
27               0.0
28               0.0
29               0.0
```

In [44]:

```
print("For age between 50-60")
print ( "Nth Call \t Efficiency")
for i in range(1,30):
    num = float(baff[(baff['age'] <= 60) & (baff['age'] > 50) & (baff['campaig
n']==i) & (baff['y=yes']==1)].shape[0])
    den = 1+float(baff[(baff['age'] <= 60) & (baff['age'] > 50) & (baff['campa
ign'] >= i)].shape[0])
    print (str((i))+" \t\t "+str(num/den))
```

```
For age between 50-60
Nth Call         Efficiency
1                0.050709615691277306
2                0.05120481927710843
3                0.040806293018682396
4                0.024681528662420384
5                0.016766467065868262
6                0.02120141342756184
7                0.022004889975550123
8                0.013559322033898305
9                0.024489795918367346
10               0.009900990099009901
11               0.0
12               0.0
13               0.0
14               0.0
15               0.011363636363636364
16               0.0
17               0.016129032258064516
18               0.0
19               0.0
20               0.0
21               0.0
22               0.0
23               0.0
24               0.0
25               0.0
26               0.0
27               0.0
28               0.0
29               0.0
```

In [45]:

```
print("For age above 60")
print ("Nth Call \t Efficiency")
for i in range(1,30):
    num = float(baff[(baff['age'] > 60) & (baff['campaign']==i) & (baff['y=yes
']==1)].shape[0])
    den = float(baff[(baff['age'] > 60) & (baff['campaign'] >= i)].shape[0])+1
    print (str((i))+" \t\t "+str(num/den))
```

```
For age above 60
Nth Call         Efficiency
1                0.24807903402854006
2                0.25806451612903225
3                0.20512820512820512
4                0.19230769230769232
5                0.12244897959183673
6                0.12121212121212122
7                0.18181818181818182
8                0.06666666666666667
9                0.0
10               0.0
11               0.16666666666666666
12               0.0
13               0.0
14               0.0
15               0.0
16               0.0
17               0.0
18               0.0
19               0.0
20               0.0
21               0.0
22               0.0
23               0.0
24               0.0
25               0.0
26               0.0
27               0.0
28               0.0
29               0.0
```

In [46]:

```
total_calls = sum(baff['campaign'])
print(total_calls)
```

```
105754.0
```

In [47]:

```
extra_calls = sum(baff[baff['campaign']>6]['campaign']) - 6*baff[baff['campaig
n']>6].shape[0]
print(extra_calls)
```

```
12040.0
```

In [48]:

```
reduction=100*extra_calls/total_calls
print(reduction)
```

```
11.384912154622993
```

In [49]:

```
total_sales=float(baff[baff['y=yes']==1].shape[0])
print(total_sales)
```

```
4640.0
```

In [50]:

```
less_costly_sales=float(baff[(baff['campaign'] <= 6) & (baff['y=yes']==1)].sha
pe[0])
print(less_costly_sales)
```

```
4529.0
```

In [51]:

```
sales_percent=100*less_costly_sales/total_sales
print(sales_percent)
```

```
97.60775862068965
```

In [52]:

```
print("CONCLUSION: A reduction of about 11.39% in marketing cost could be achi
eved while maintaining 97.6% sales if any person is called a max of 6 times.")
```

```
CONCLUSION: A reduction of about 11.39% in marketing cost could be
achieved while maintaining 97.6% sales if any person is called a m
ax of 6 times.
```

In [ ]:

```

```