Exploratory Data Analysis

This notebook reviews the overall dataset, and gives a breakdown of every metric both as a stand-alone metric and also separated by the **deposit** variable.

In [1]:
```
import pandas as pd
import numpy as np

import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:
```
pd.set_option('display.max_columns',None)
```

In [3]:
```
bank_main_df = pd.read_csv('./Dataset_1_Bank Marketing/bank_marketing.csv',delimiter=';')

bank_main_df.head()
```

Out[3]:

	age	job	marital	education	default	balance	housing	loan	contact	day	month	duration	campaign	pdays	previous	pou
0	58.0	management	married	tertiary	no	2143	yes	no	unknown	5	may	261	1	-1	0	unl
1	44.0	technician	single	secondary	no	29	yes	no	unknown	5	may	151	1	-1	0	unl
2	33.0	entrepreneur	married	secondary	no	2	yes	yes	unknown	5	may	76	1	-1	0	unl
3	47.0	blue-collar	married	unknown	no	1506	yes	no	unknown	5	may	92	1	-1	0	unl
4	33.0	unknown	single	unknown	no	1	no	no	NaN	5	may	198	1	-1	0	unl

In [4]:
```
bank_main_df.describe()
```

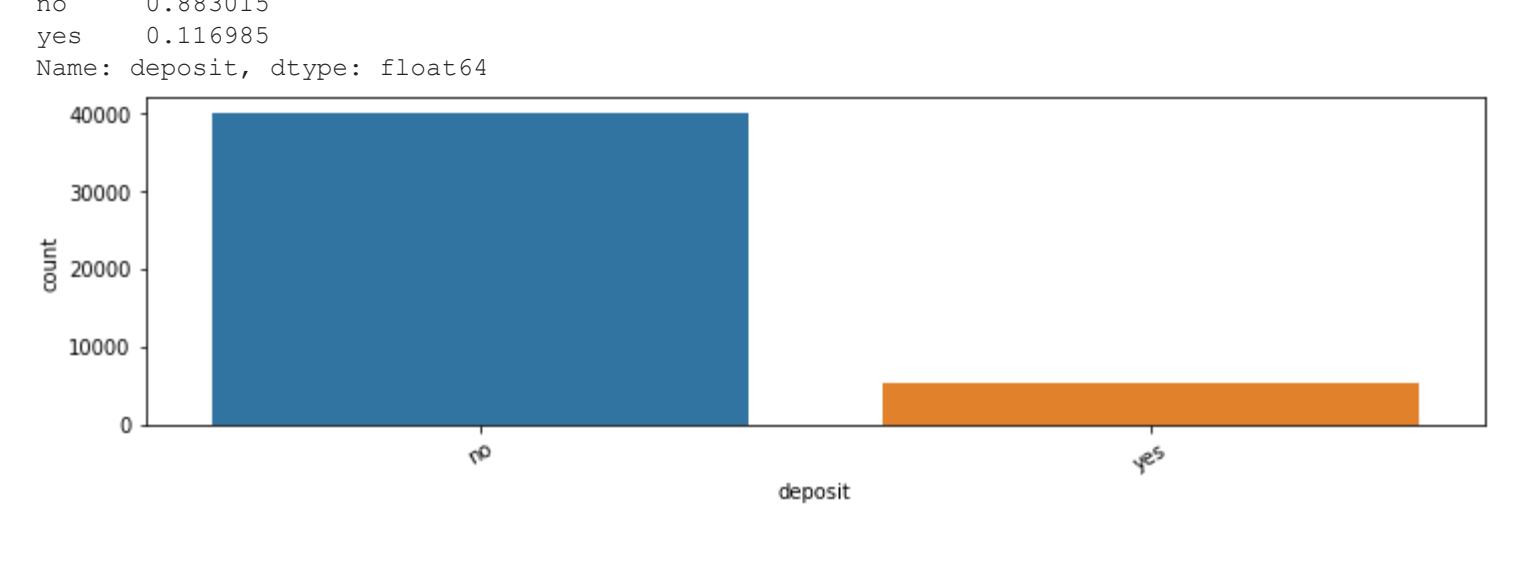
Out[4]:

	age	balance	day	duration	campaign	pdays	previous
count	43872.000000	45211.000000	45211.000000	45211.000000	45211.000000	45211.000000	45211.000000
mean	40.924781	1362.272058	15.806419	258.163080	2.763841	40.197828	0.580323
std	10.610835	3044.765829	8.322476	257.527812	3.098021	100.128746	2.303441
min	18.000000	-8019.000000	1.000000	0.000000	1.000000	-1.000000	0.000000
25%	33.000000	72.000000	8.000000	103.000000	1.000000	-1.000000	0.000000
50%	39.000000	448.000000	16.000000	180.000000	2.000000	-1.000000	0.000000
75%	48.000000	1428.000000	21.000000	319.000000	3.000000	-1.000000	0.000000
max	95.000000	102127.000000	31.000000	4918.000000	63.000000	871.000000	275.000000

deposit

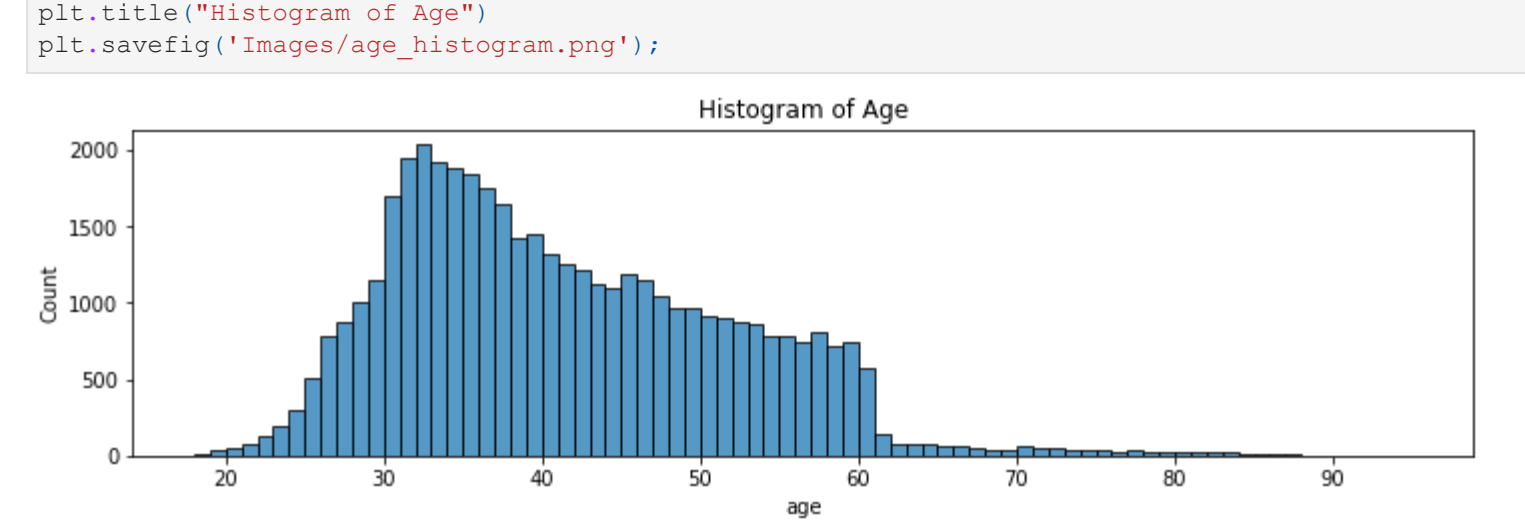
In [5]:
```
print(bank_main_df['deposit'].value_counts(normalize=True))
plt.figure(figsize=(12,3))
sns.countplot(data=bank_main_df,x='deposit')
plt.xticks(rotation=30);
```

```
no     0.883015
yes    0.116985
Name: deposit, dtype: float64
```

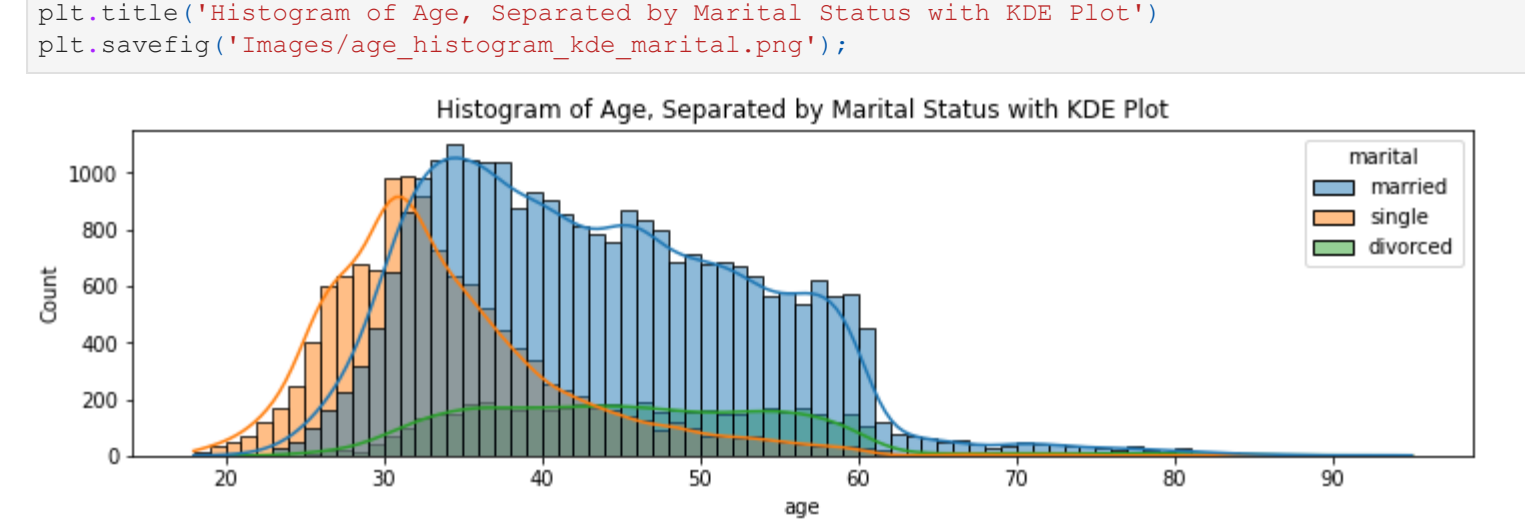


Age

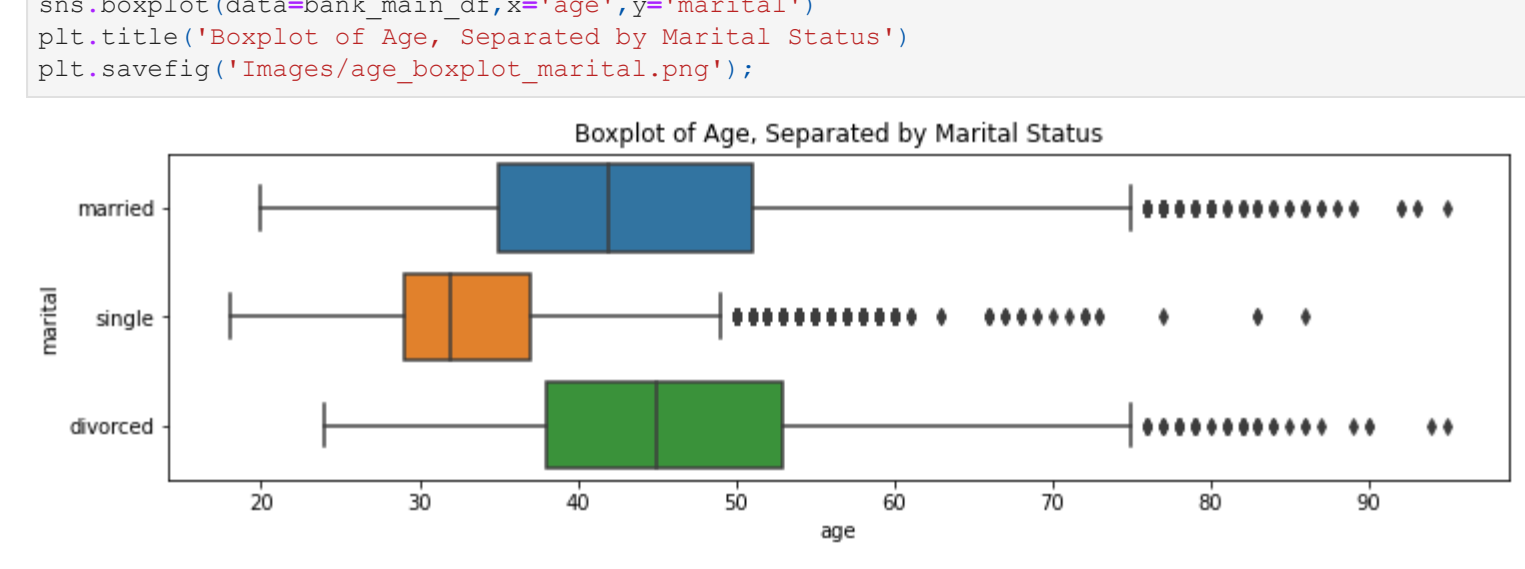
In [6]:
```
#what's with the gaps?
plt.figure(figsize=(12,3))
sns.histplot(data=bank_main_df,x='age',bins=(95-18))
plt.title("Histogram of Age")
plt.savefig('Images/age_histogram.png');
```



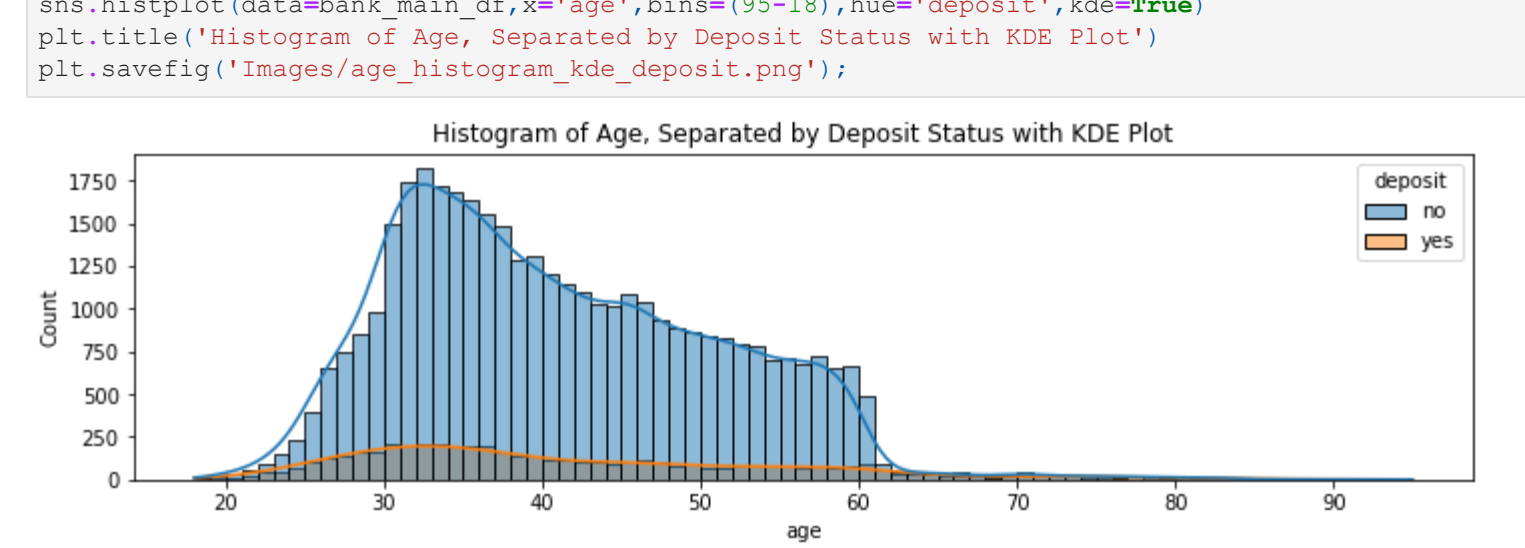
In [7]:
```
plt.figure(figsize=(12,3))
sns.histplot(data=bank_main_df,x='age',bins=(95-18),hue='marital',kde=True)
plt.title('Histogram of Age, Separated by Marital Status with KDE Plot')
plt.savefig('Images/age_histogram_kde_marital.png');
```



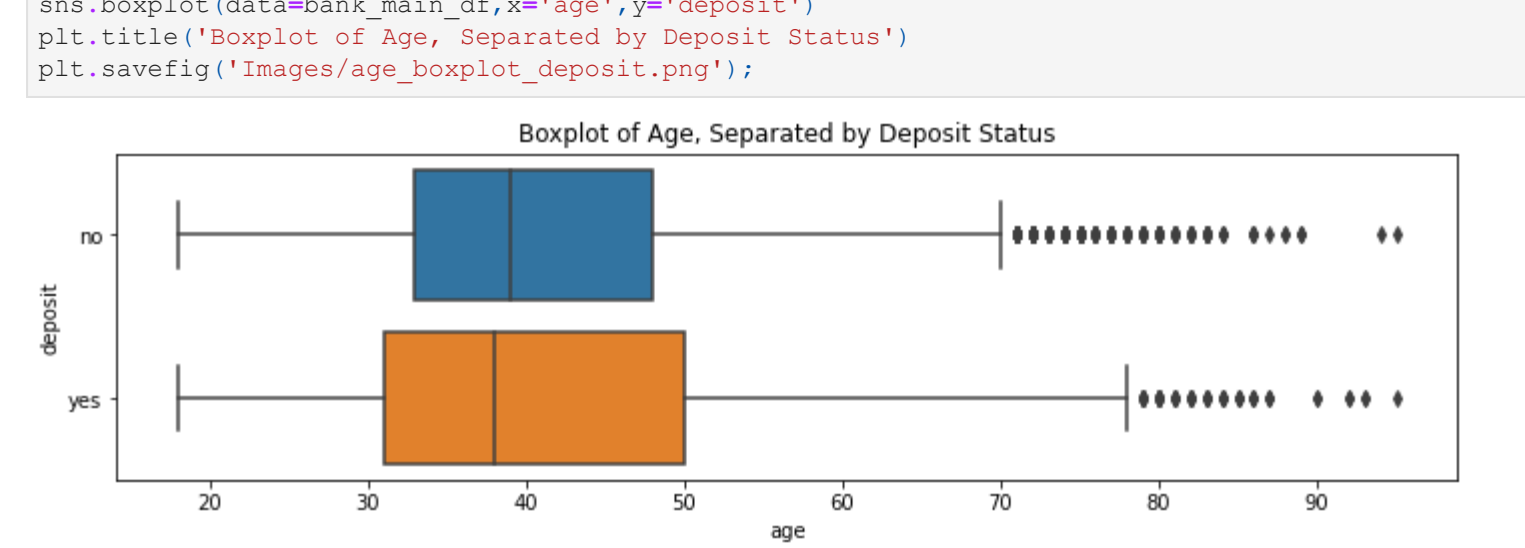
In [8]:
```
plt.figure(figsize=(12,3))
sns.boxplot(data=bank_main_df,x='age',y='marital')
plt.title('Boxplot of Age, Separated by Marital Status')
plt.savefig('Images/age_boxplot_marital.png');
```



In [9]:
```
plt.figure(figsize=(12,3))
sns.histplot(data=bank_main_df,x='age',bins=(95-18),hue='deposit',kde=True)
plt.title('Histogram of Age, Separated by Deposit Status with KDE Plot')
plt.savefig('Images/age_histogram_kde_deposit.png');
```



In [10]:
```
plt.figure(figsize=(12,3))
sns.boxplot(data=bank_main_df,x='age',y='deposit')
plt.title('Boxplot of Age, Separated by Deposit Status')
plt.savefig('Images/age_boxplot_deposit.png');
```



Job

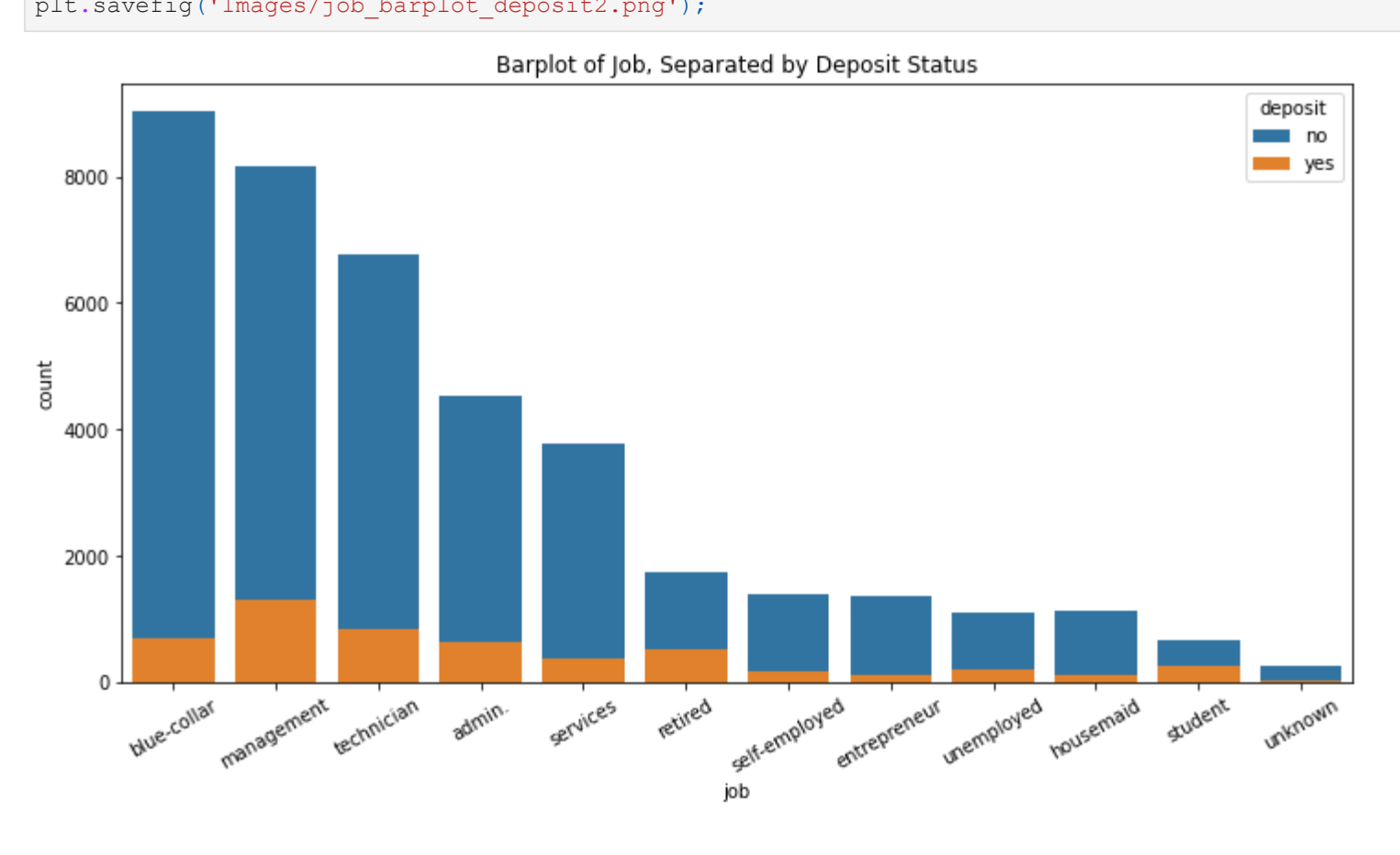
In [11]:
```
print(bank_main_df['job'].value_counts())
print('\n')
pd.DataFrame(np.round(bank_main_df.groupby('job')['deposit'].value_counts(normalize=True),2)).T
```

```
blue-collar      9732
management       9458
technician       7597
admin.           5171
services         4154
retired          2264
self-employed    1579
entrepreneur     1487
unemployed       1303
housemaid        1240
student           938
unknown           288
Name: job, dtype: int64
```

Out[11]:

job	admin.		blue-collar		entrepreneur		housemaid		management		retired		self-employed		services		student		technician		unemployed	
deposit	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
deposit	0.88	0.12	0.93	0.07	0.92	0.08	0.91	0.09	0.86	0.14	0.77	0.23	0.88	0.12	0.91	0.09	0.71	0.29	0.89	0.11	0.84	0.16

In [12]:
```
plt.figure(figsize=(12,6))
sns.countplot(data=bank_main_df,x='job',order=bank_main_df['job'].value_counts().index,hue='deposit',dodge=Fals
plt.xticks(rotation=30)
plt.title('Barplot of Job, Separated by Deposit Status')
plt.savefig('Images/job_barplot_deposit2.png');
```



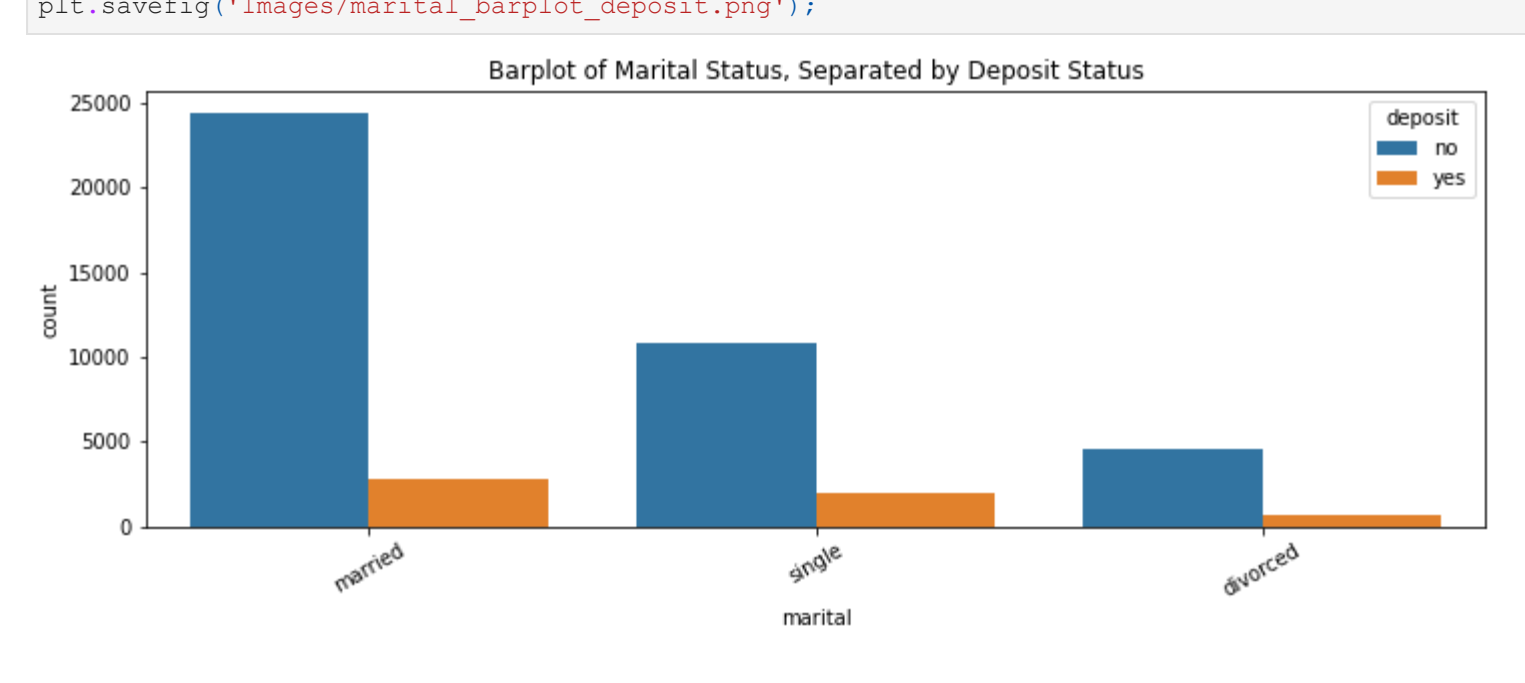
Marital

In [13]:
```
pd.DataFrame(np.round(bank_main_df.groupby('marital')['deposit'].value_counts(normalize=True),2)).T
```

Out[13]:

marital	divorced		married		single	
deposit	no	yes	no	yes	no	yes
deposit	0.88	0.12	0.9	0.1	0.85	0.15

In [14]:
```
plt.figure(figsize=(12,4))
sns.countplot(data=bank_main_df,x='marital',hue='deposit')
plt.xticks(rotation=30)
plt.title('Barplot of Marital Status, Separated by Deposit Status')
plt.savefig('Images/marital_barplot_deposit.png');
```



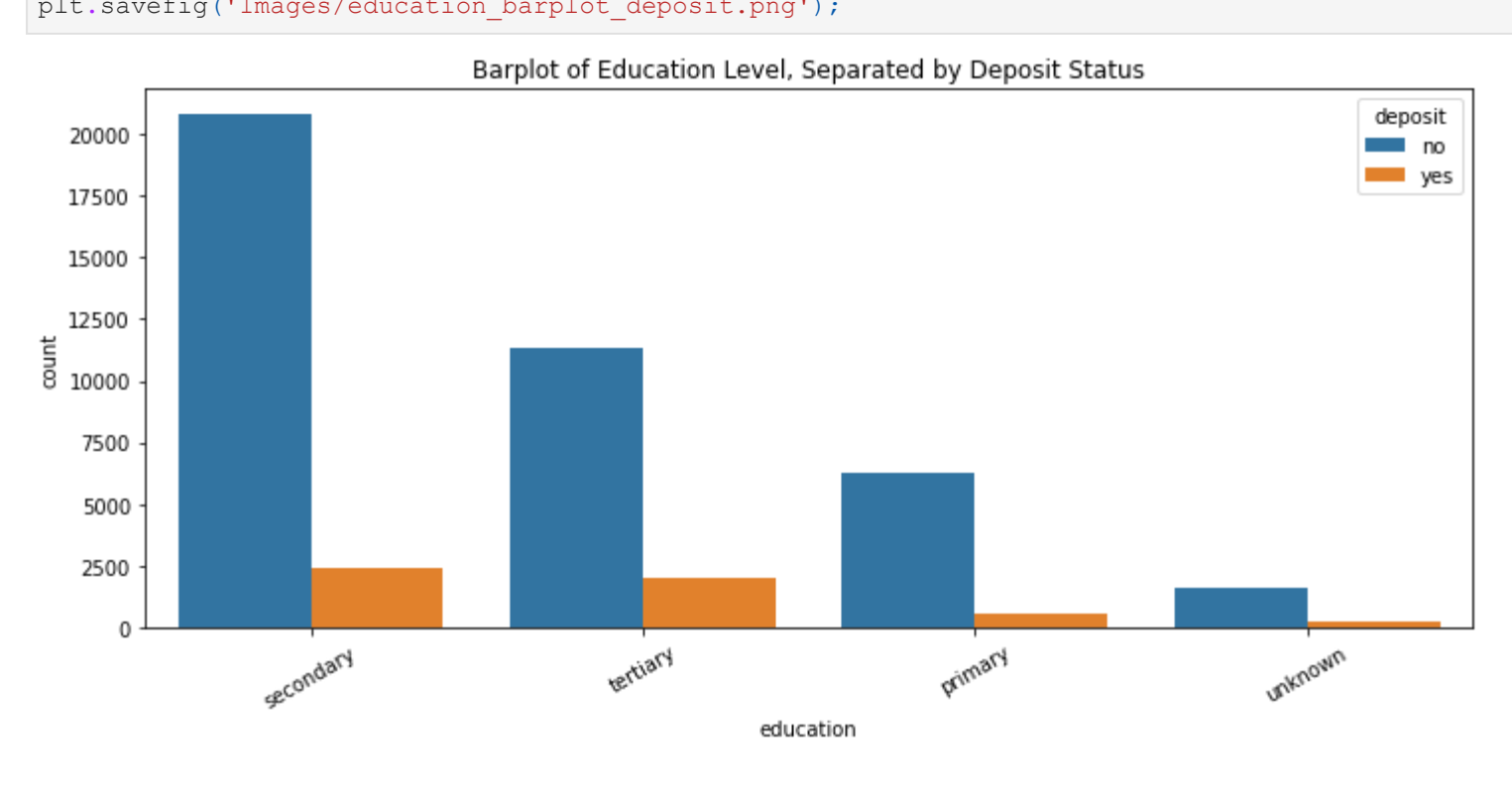
Education

In [15]:
```
pd.DataFrame(np.round(bank_main_df.groupby('education')['deposit'].value_counts(normalize=True),2)).T
```

Out[15]:

education	primary		secondary		tertiary		unknown	
deposit	no	yes	no	yes	no	yes	no	yes
deposit	0.91	0.09	0.89	0.11	0.85	0.15	0.86	0.14

In [16]:
```
plt.figure(figsize=(12,5))
sns.countplot(data=bank_main_df,x='education',order=bank_main_df['education'].value_counts().index,hue='deposit
plt.xticks(rotation=30)
plt.title('Barplot of Education Level, Separated by Deposit Status')
plt.savefig('Images/education_barplot_deposit.png');
```



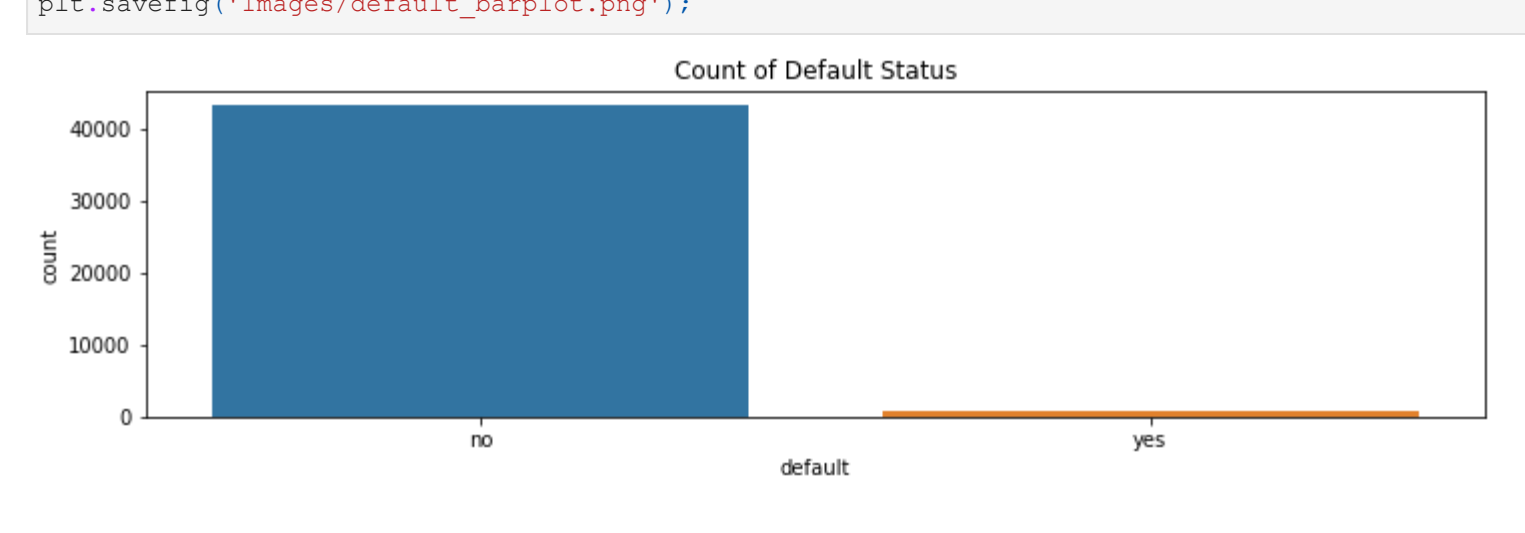
Default

In [17]:
```
pd.DataFrame(np.round(bank_main_df.groupby('default')['deposit'].value_counts(normalize=True),2)).T
```

Out[17]:

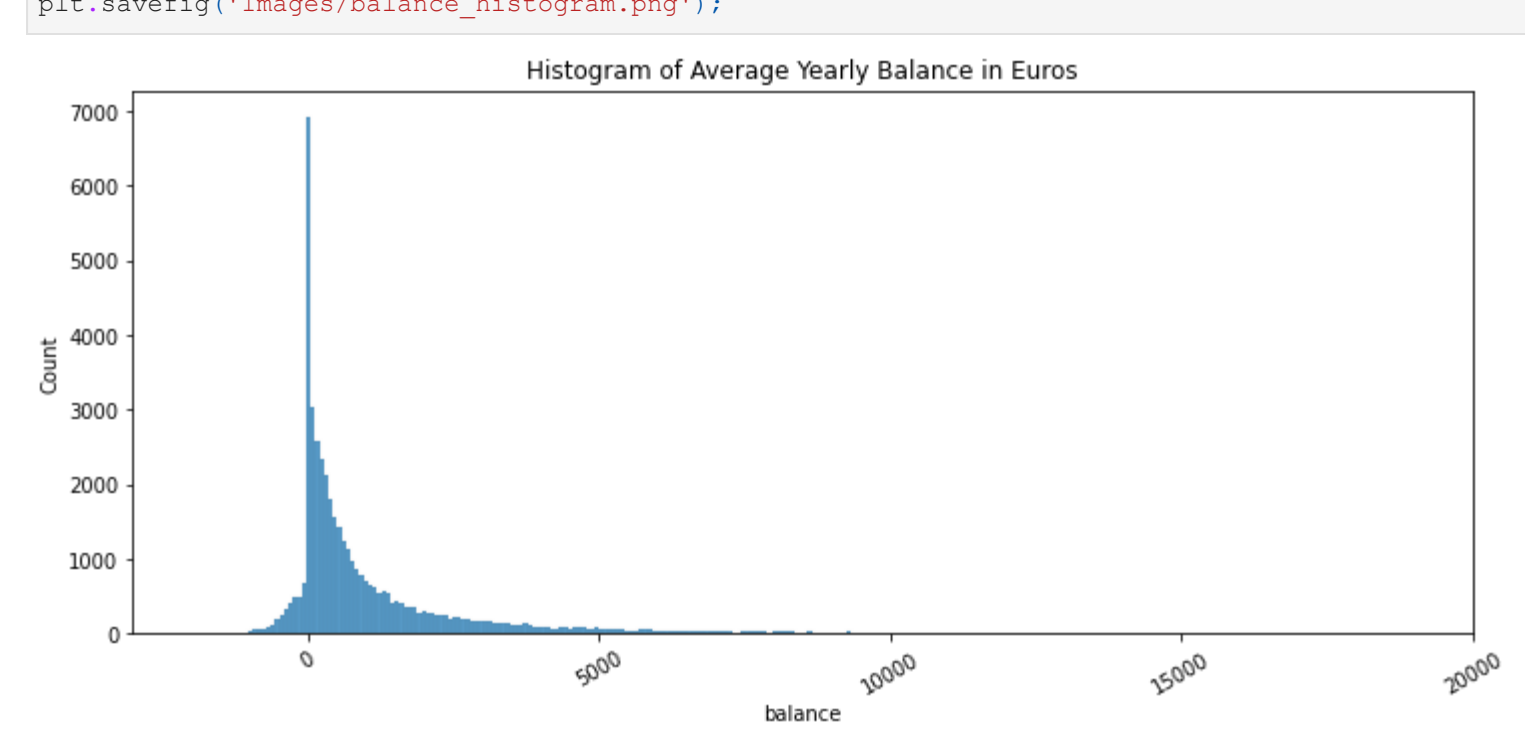
default	no		yes	
deposit	no	yes	no	yes
deposit	0.88	0.12	0.93	0.07

In [18]:
```
plt.figure(figsize=(12,3))
sns.countplot(data=bank_main_df,x='default')
#plt.xticks(rotation=30)
plt.title('Count of Default Status')
plt.savefig('Images/default_barplot.png');
```

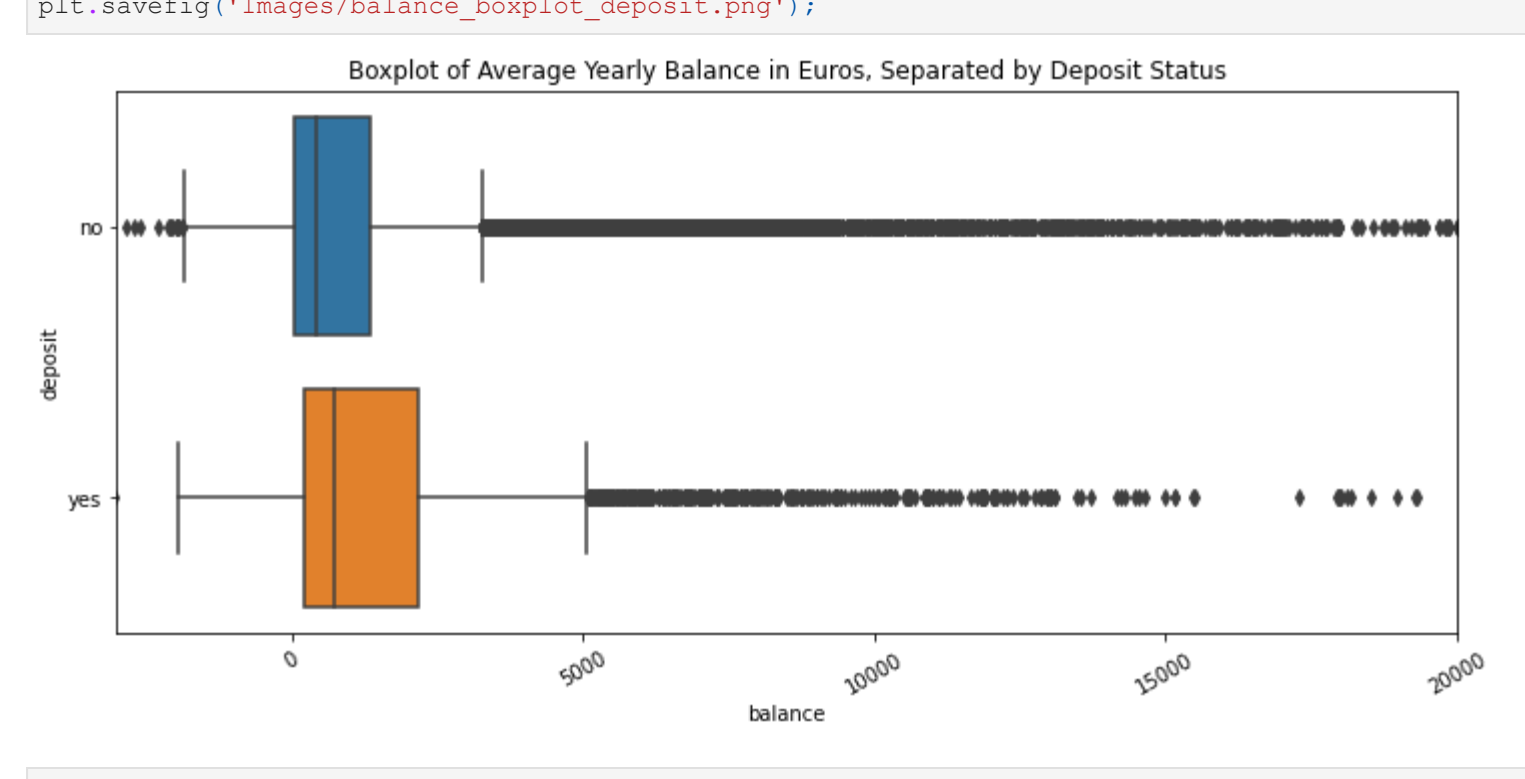


Balance

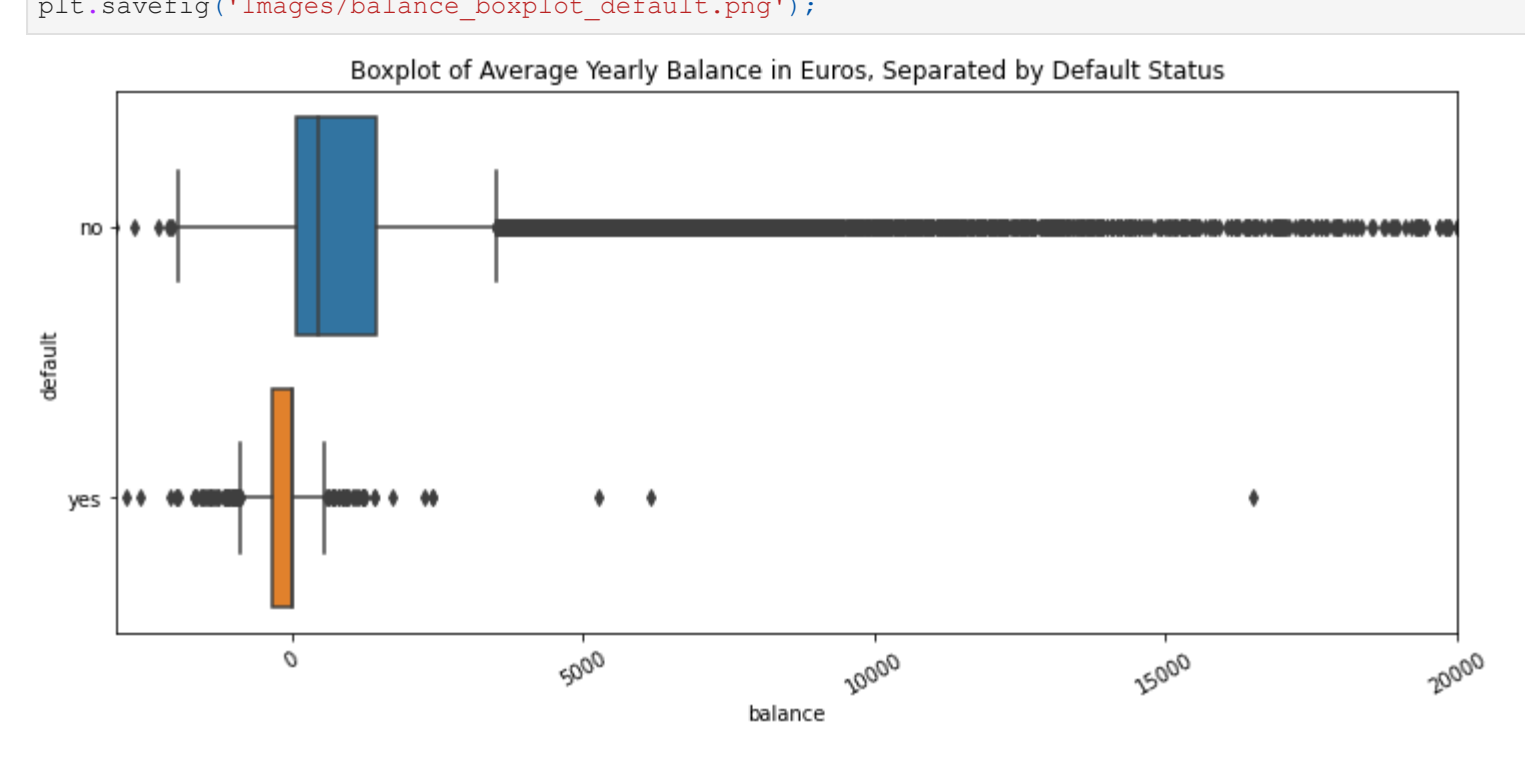
In [19]:
```
#print(bank_main_df['default'].value_counts())
plt.figure(figsize=(12,5))
sns.histplot(data=bank_main_df,x='balance')
plt.xticks(rotation=30)
plt.xlim(-3000,20000)
plt.title('Histogram of Average Yearly Balance in Euros')
plt.savefig('Images/balance_histogram.png');
```



In [20]:
```
#print(bank_main_df['default'].value_counts())
plt.figure(figsize=(12,5))
sns.boxplot(data=bank_main_df,x='balance',y='deposit')
plt.xticks(rotation=30);
plt.xlim(-3000,20000)
plt.title('Boxplot of Average Yearly Balance in Euros, Separated by Deposit Status')
plt.savefig('Images/balance_boxplot_deposit.png');
```



In [21]:
```
#print(bank_main_df['default'].value_counts())
plt.figure(figsize=(12,5))
sns.boxplot(data=bank_main_df,x='balance',y='default')
plt.xticks(rotation=30);
plt.xlim(-3000,20000)
plt.title('Boxplot of Average Yearly Balance in Euros, Separated by Default Status')
plt.savefig('Images/balance_boxplot_default.png');
```



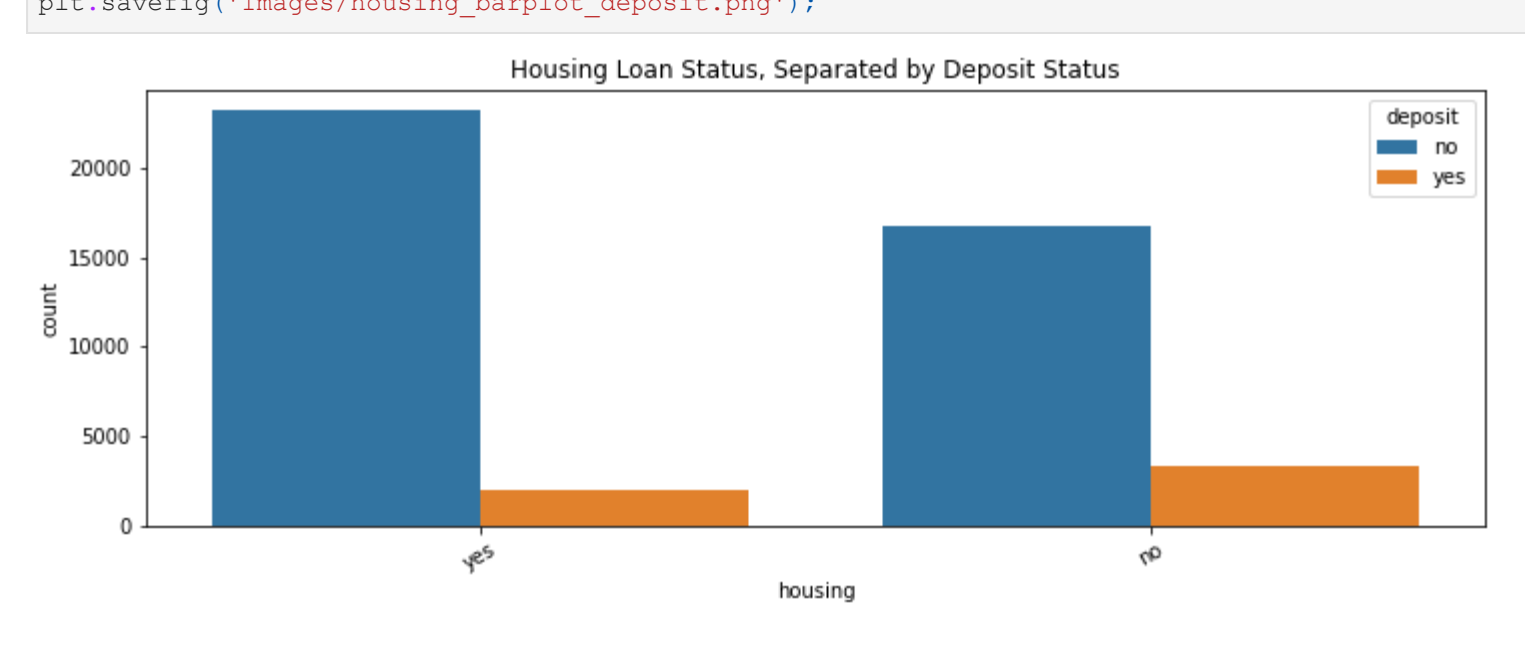
Housing

In [22]:
```
pd.DataFrame(np.round(bank_main_df.groupby('housing')['deposit'].value_counts(normalize=True),2)).T
```

Out[22]:

housing	no		yes	
deposit	no	yes	no	yes
deposit	0.83	0.17	0.92	0.08

In [23]:
```
plt.figure(figsize=(12,4))
sns.countplot(data=bank_main_df,x='housing',hue='deposit')
plt.xticks(rotation=30)
plt.title('Housing Loan Status, Separated by Deposit Status')
plt.savefig('Images/housing_barplot_deposit.png');
```



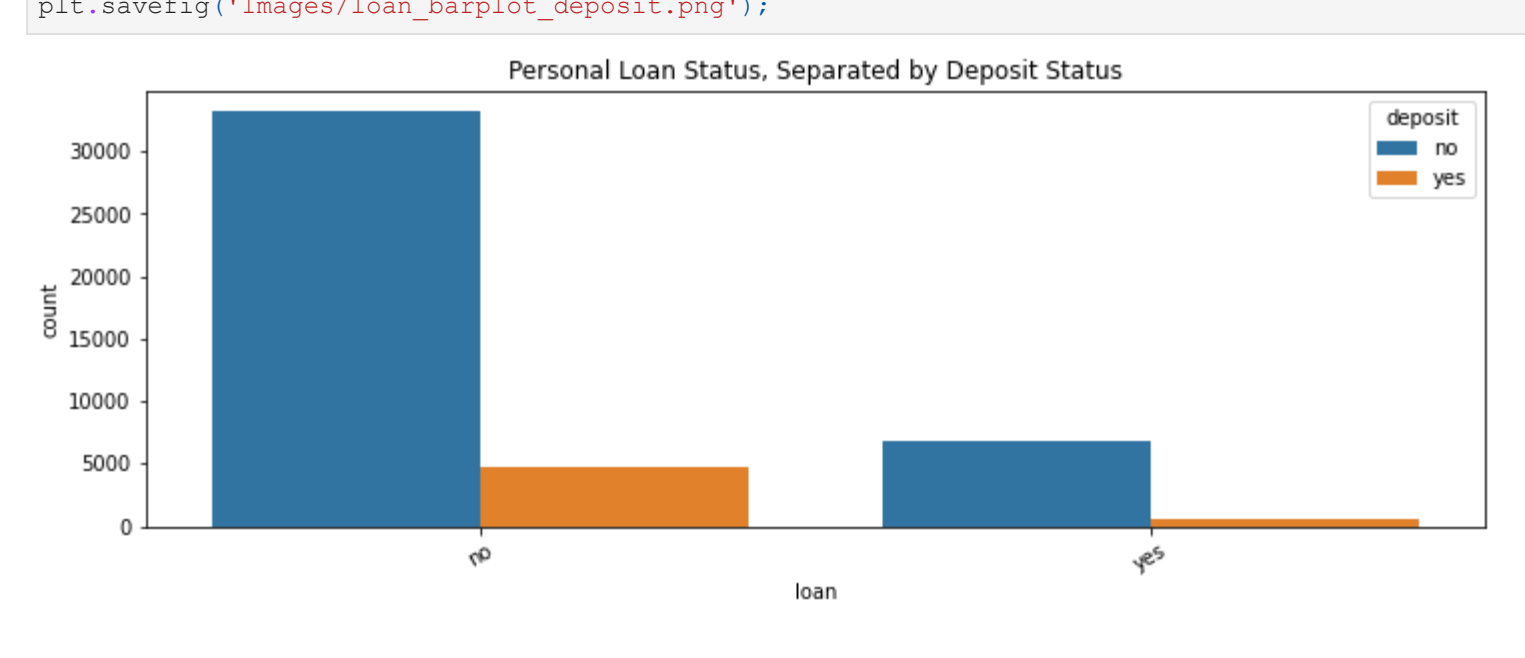
Loan

In [24]:
```
pd.DataFrame(np.round(bank_main_df.groupby('loan')['deposit'].value_counts(normalize=True),2)).T
```

Out[24]:

loan	no		yes	
deposit	no	yes	no	yes
deposit	0.87	0.13	0.93	0.07

In [25]:
```
plt.figure(figsize=(12,4))
sns.countplot(data=bank_main_df,x='loan', hue='deposit')
plt.xticks(rotation=30)
plt.title('Personal Loan Status, Separated by Deposit Status')
plt.savefig('Images/loan_barplot_deposit.png');
```



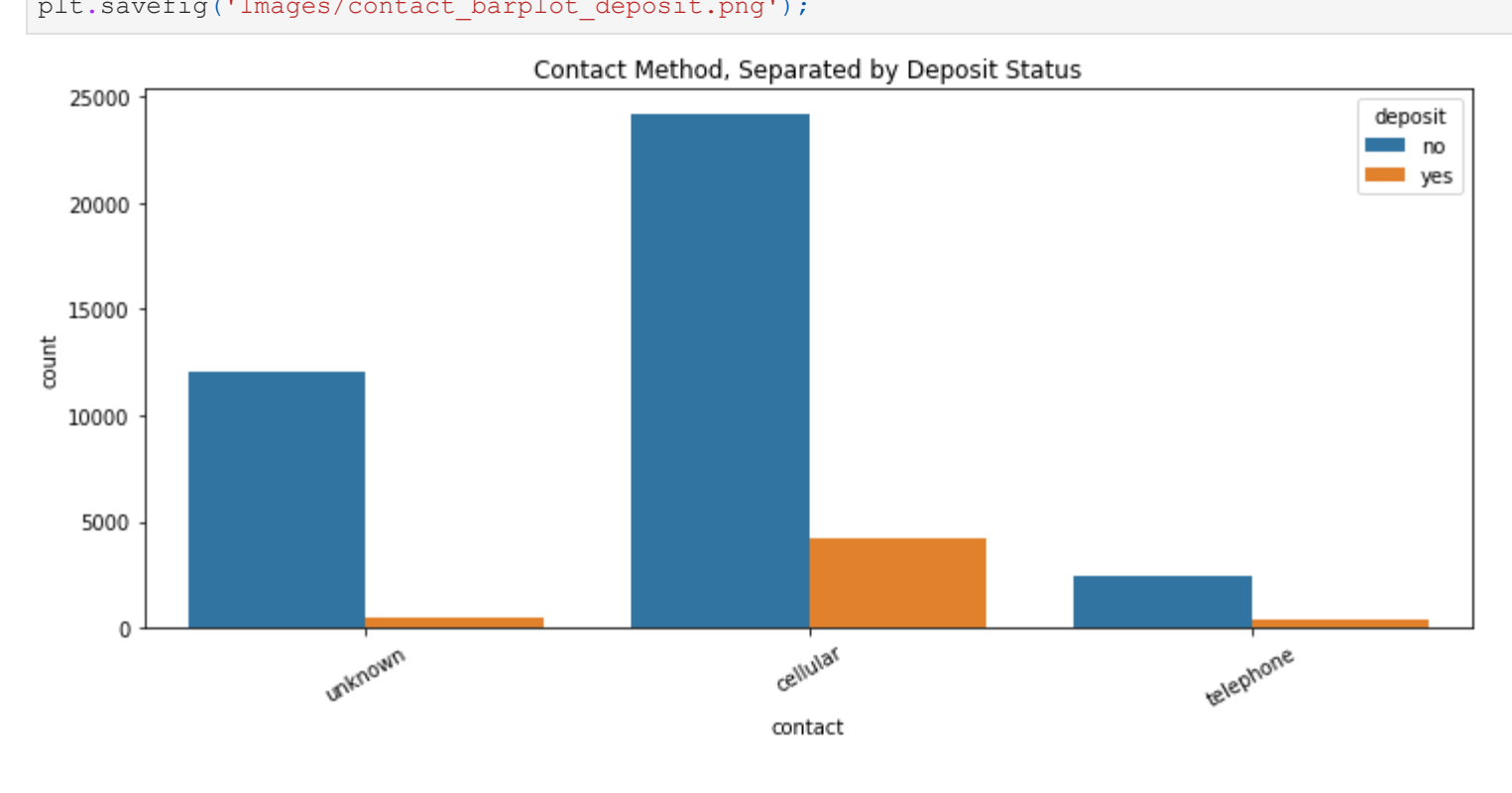
Contact

In [26]:
```
pd.DataFrame(np.round(bank_main_df.groupby('contact')['deposit'].value_counts(normalize=True),2)).T
```

Out[26]:

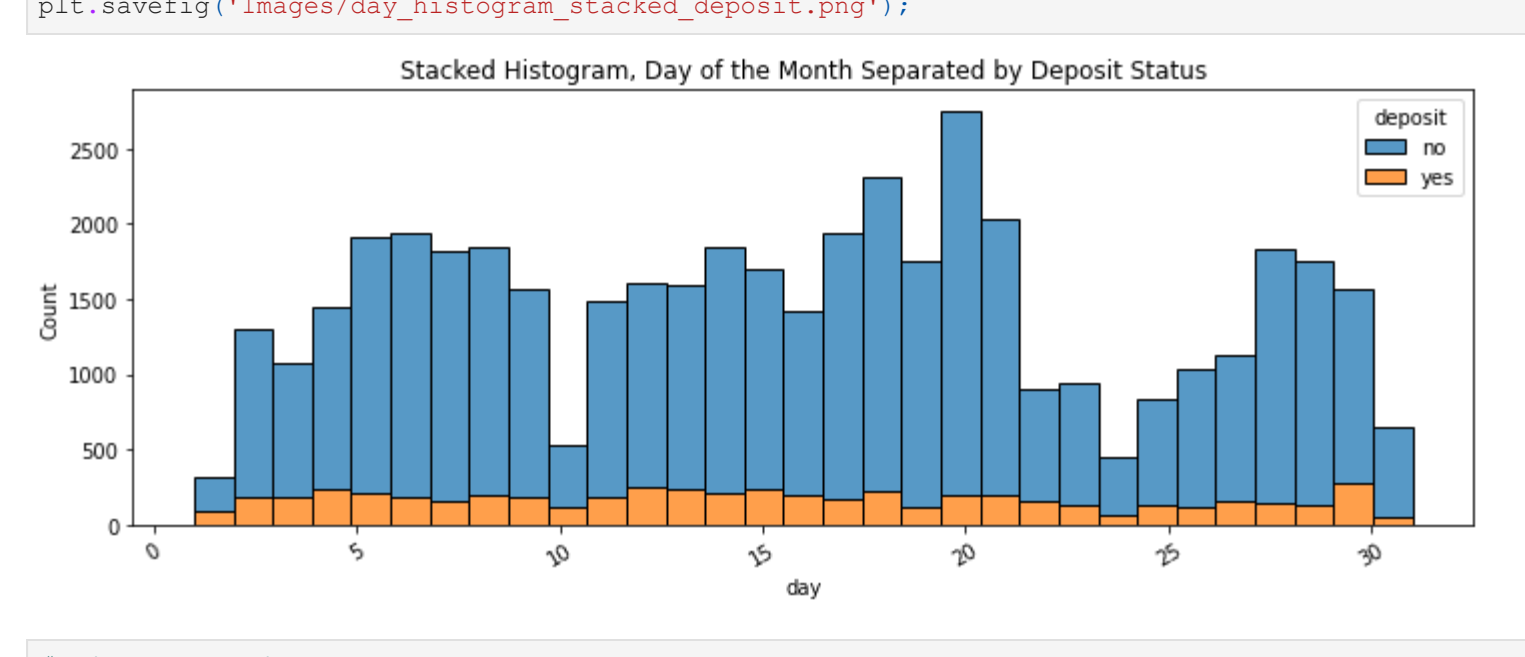
contact	cellular		telephone		unknown	
deposit	no	yes	no	yes	no	yes
deposit	0.85	0.15	0.87	0.13	0.96	0.04

In [27]:
```
plt.figure(figsize=(12,5))
sns.countplot(data=bank_main_df,x='contact',hue='deposit')
plt.xticks(rotation=30)
plt.title('Contact Method, Separated by Deposit Status')
plt.savefig('Images/contact_barplot_deposit.png');
```

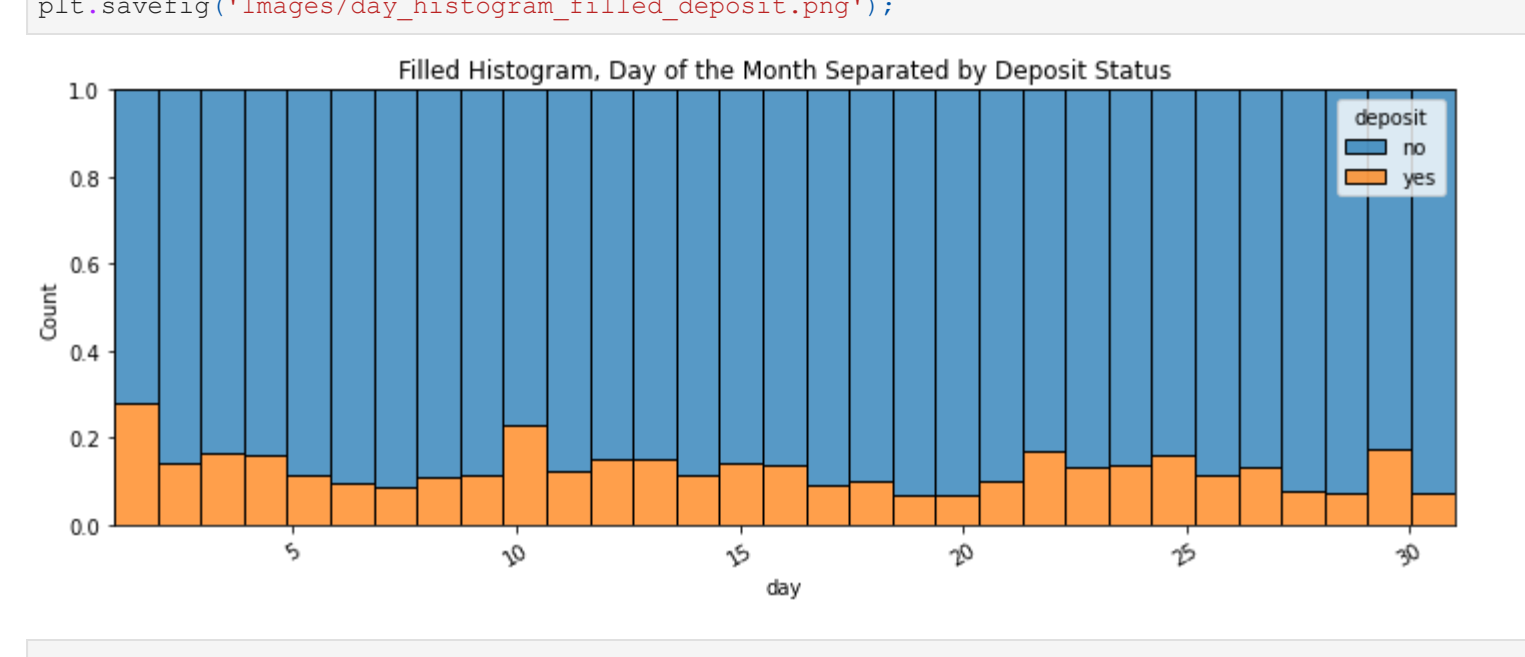


Day

In [28]:
```
#print(bank_main_df['day'].value_counts())
plt.figure(figsize=(12,4))
sns.histplot(data=bank_main_df,x='day',hue='deposit',multiple='stack',bins=31)
plt.xticks(rotation=30)
plt.title('Stacked Histogram, Day of the Month Separated by Deposit Status')
plt.savefig('Images/day_histogram_stacked_deposit.png');
```



In [29]:
```
#print(bank_main_df['day'].value_counts())
plt.figure(figsize=(12,4))
sns.histplot(data=bank_main_df,x='day',hue='deposit',multiple='fill',bins=31)
plt.xticks(rotation=30)
plt.title('Filled Histogram, Day of the Month Separated by Deposit Status')
plt.savefig('Images/day_histogram_filled_deposit.png');
```



In [30]:
```
bank_main_df.groupby('day')['deposit'].value_counts(normalize=True)
```

Out[30]:
```
day  deposit
1    no         0.720497
     yes        0.279503
2    no         0.859242
     yes        0.140758
3    no         0.835032
                  ...
29   yes        0.073926
30   no         0.826948
     yes        0.173052
31   no         0.928460
     yes        0.071540
Name: deposit, Length: 62, dtype: float64
```

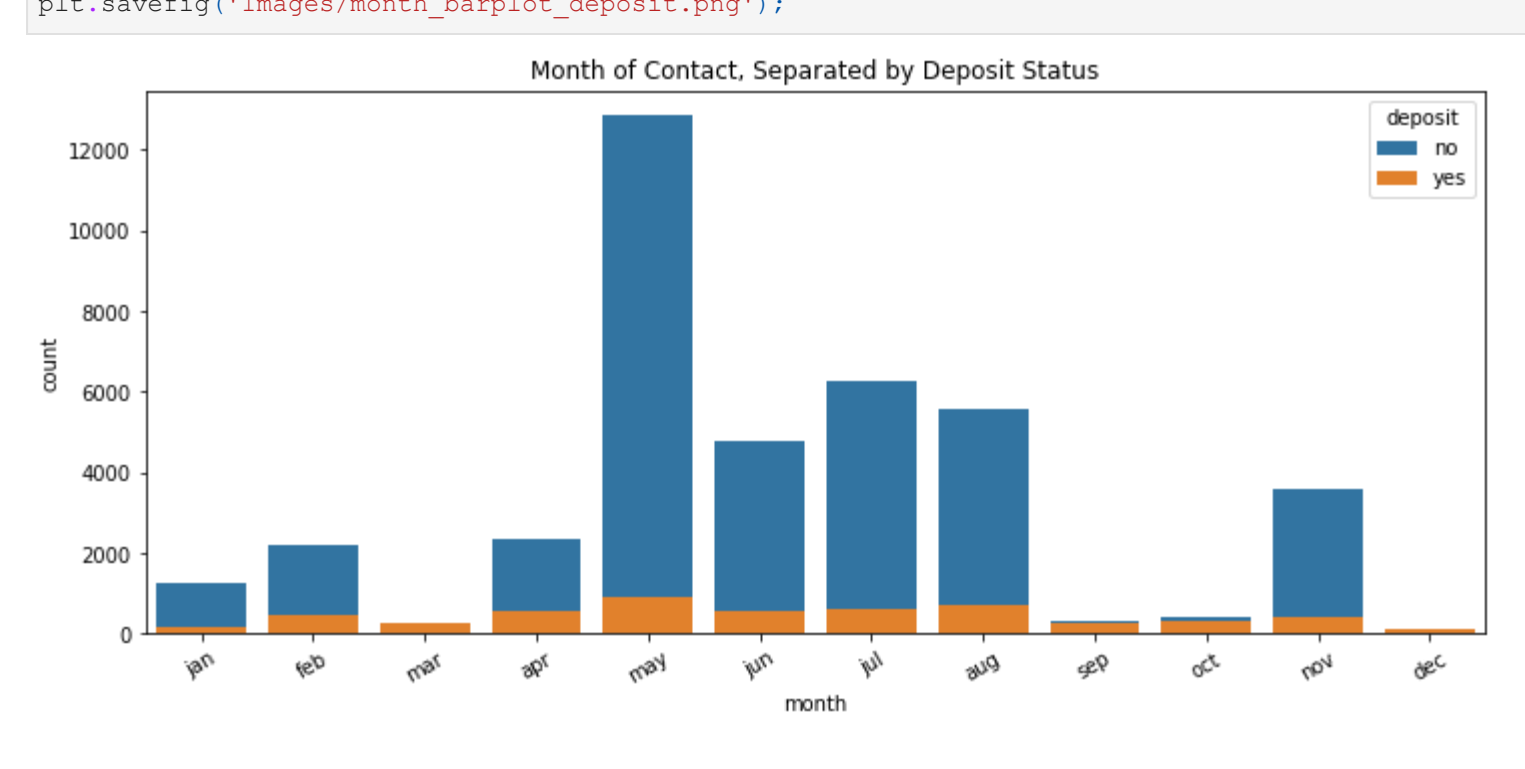
Month

In [31]:
```
pd.DataFrame(np.round(bank_main_df.groupby('month')['deposit'].value_counts(normalize=True),2)).T
```

Out[31]:

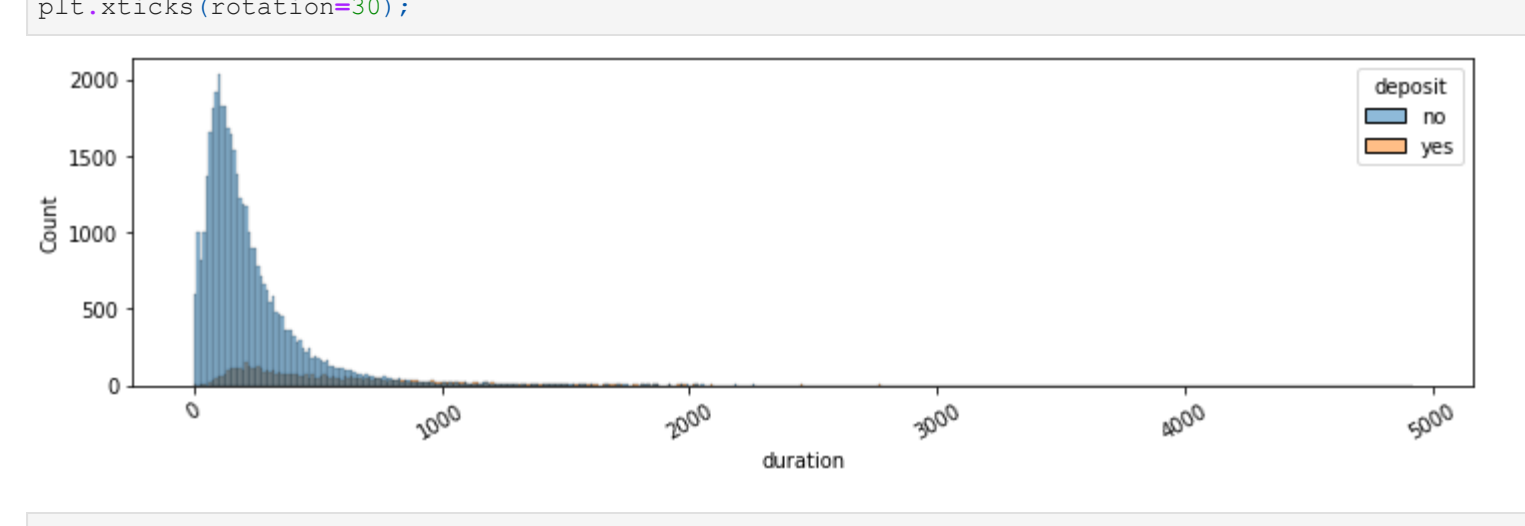
month	apr		aug		dec		feb		jan		jul		jun		mar		may		nov		oct		sep	
deposit	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	yes	no	no	yes	no	yes	no	yes	no	yes
deposit	0.8	0.2	0.89	0.11	0.53	0.47	0.83	0.17	0.9	0.1	0.91	0.09	0.9	0.1	0.52	0.48	0.93	0.07	0.9	0.1	0.56	0.44	0.54	0.46

In [32]:
```
month_list=['jan','feb','mar','apr','may','jun','jul','aug','sep','oct','nov','dec']
plt.figure(figsize=(12,5))
sns.countplot(data=bank_main_df,x='month',order=month_list,hue='deposit',dodge=False)
plt.xticks(rotation=30)
plt.title('Month of Contact, Separated by Deposit Status')
plt.savefig('Images/month_barplot_deposit.png');
```

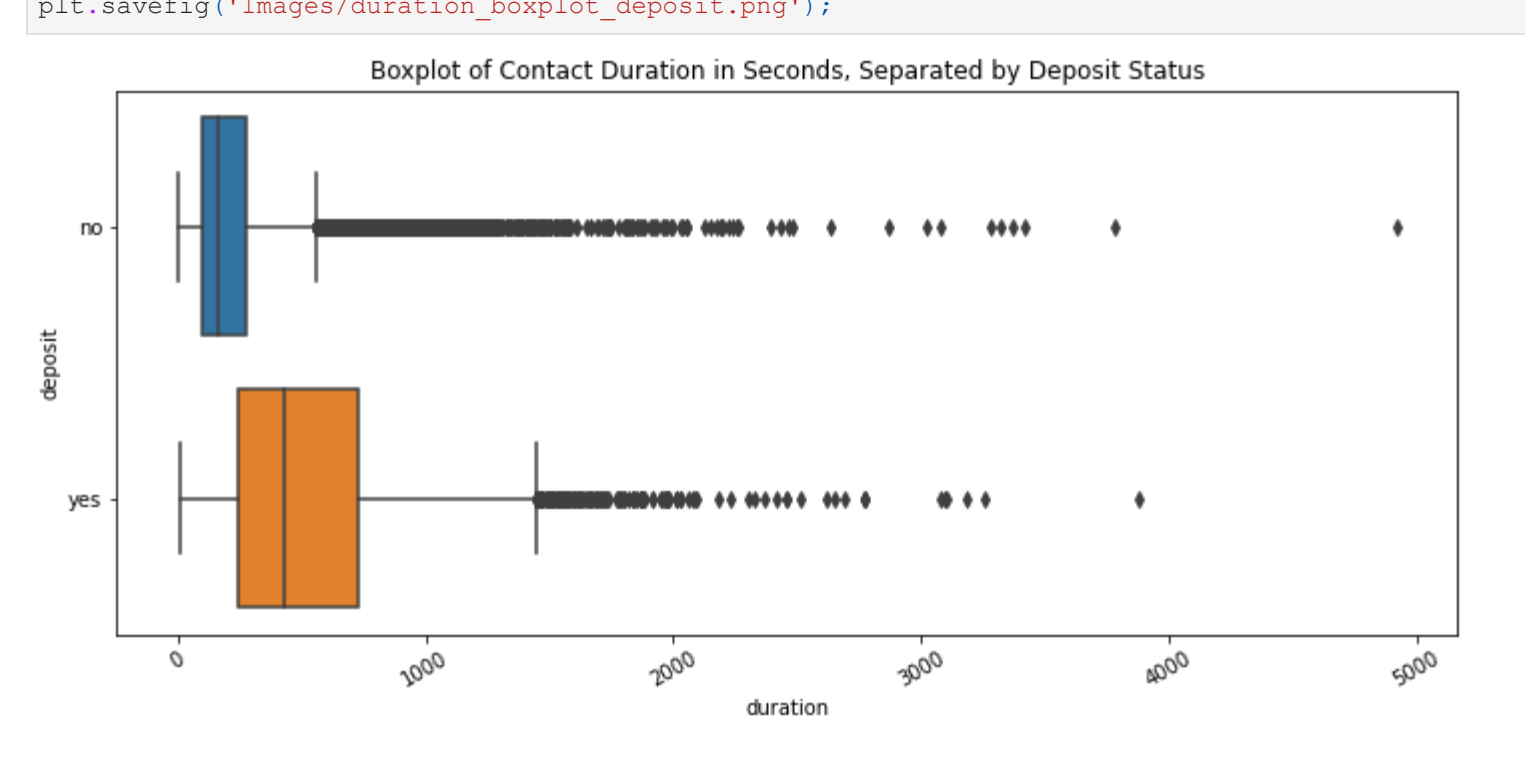


Duration

In [33]:
```
#print(bank_main_df['day'].value_counts())
plt.figure(figsize=(12,3))
sns.histplot(data=bank_main_df,x='duration',hue='deposit',pmax=.5)
plt.xticks(rotation=30);
```



In [34]:
```
#print(bank_main_df['day'].value_counts())
plt.figure(figsize=(12,5))
sns.boxplot(data=bank_main_df,x='duration',y='deposit')
plt.xticks(rotation=30)
plt.title('Boxplot of Contact Duration in Seconds, Separated by Deposit Status')
plt.savefig('Images/duration_boxplot_deposit.png');
```



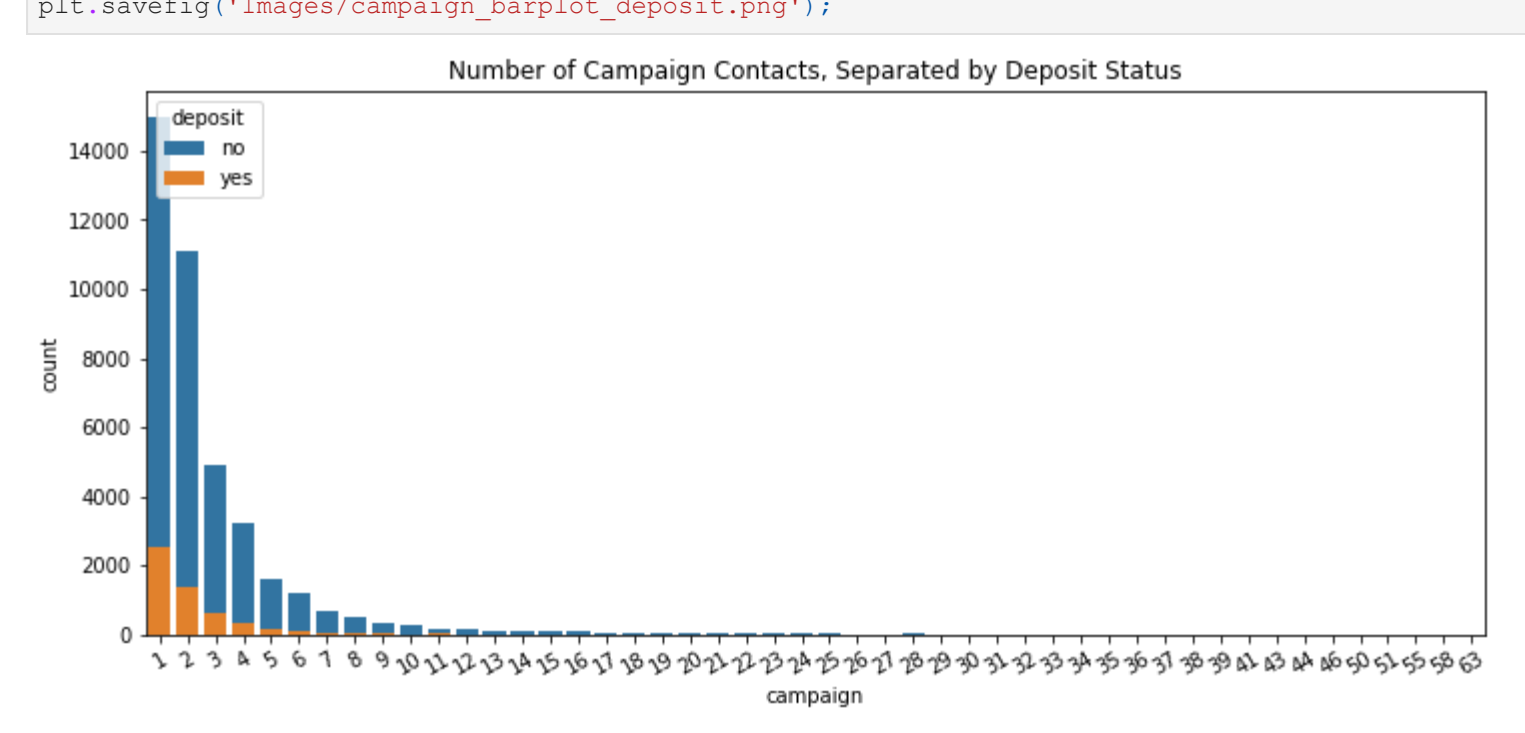
Campaign

In [35]:
```
pd.DataFrame(np.round(bank_main_df.groupby('campaign')['deposit'].value_counts(normalize=True),2)).T
```

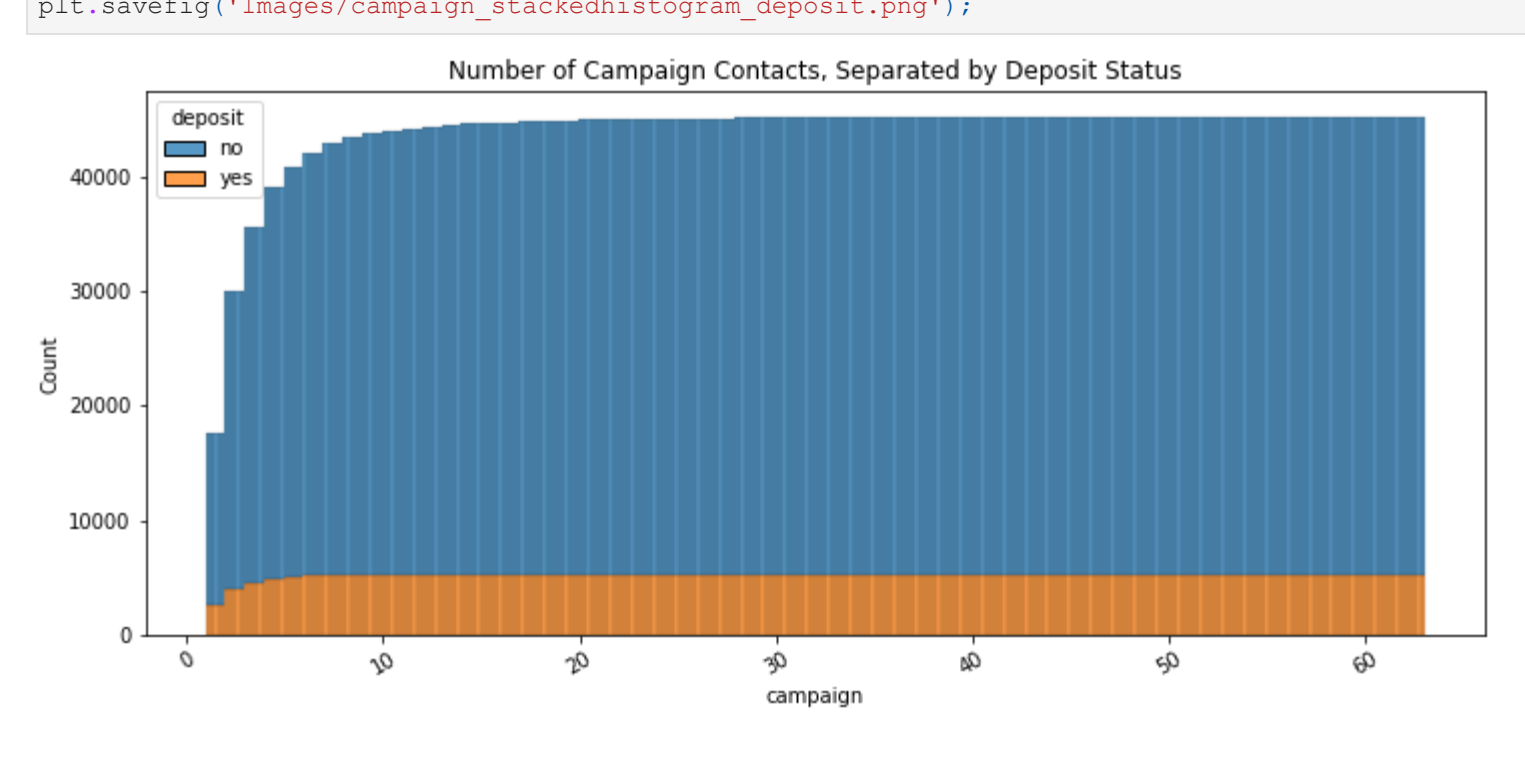
Out[35]:

campaign	1		2		3		4		5		6		7		8		9		10		11		
deposit	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no
deposit	0.85	0.15	0.89	0.11	0.89	0.11	0.91	0.09	0.92	0.08	0.93	0.07	0.94	0.06	0.94	0.06	0.94	0.06	0.95	0.05	0.92	0.08	0.97

In [36]:
```
plt.figure(figsize=(12,5))
sns.countplot(data=bank_main_df,x='campaign', hue='deposit',dodge=False)
plt.xticks(rotation=30)
plt.title('Number of Campaign Contacts, Separated by Deposit Status')
plt.savefig('Images/campaign_barplot_deposit.png');
```

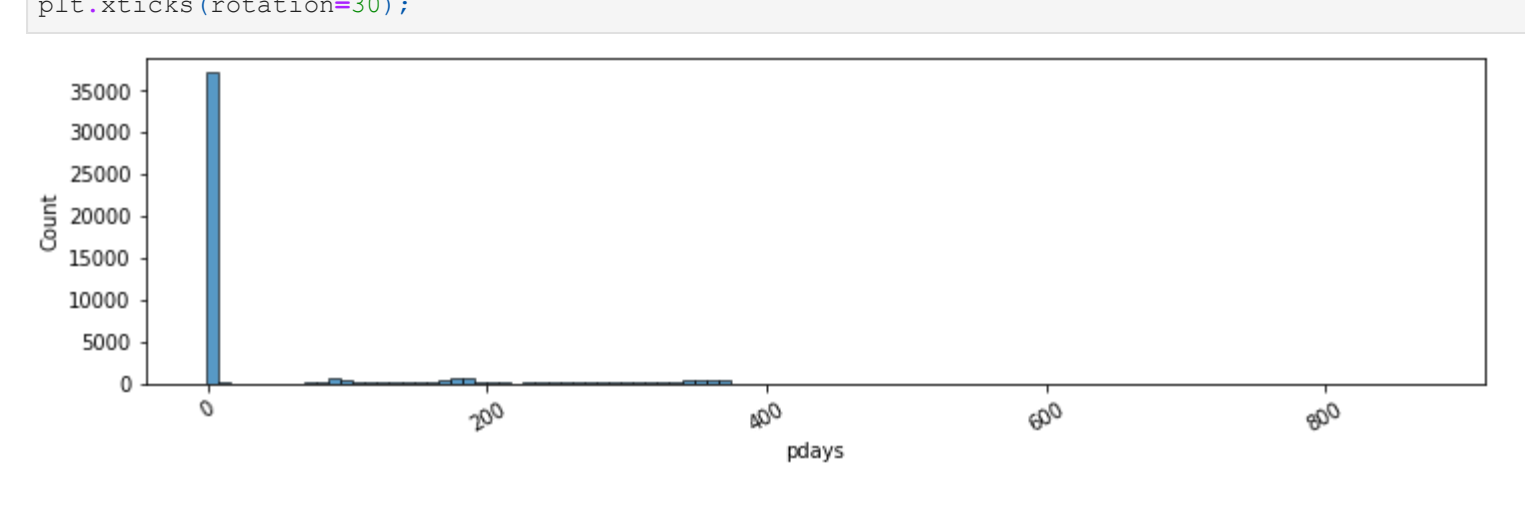


In [37]:
```
plt.figure(figsize=(12,5))
sns.histplot(data=bank_main_df,x='campaign', hue='deposit',cumulative=True,multiple='stack')#,dodge=False)
plt.xticks(rotation=30)
plt.title('Number of Campaign Contacts, Separated by Deposit Status')
plt.savefig('Images/campaign_stackedhistogram_deposit.png');
```



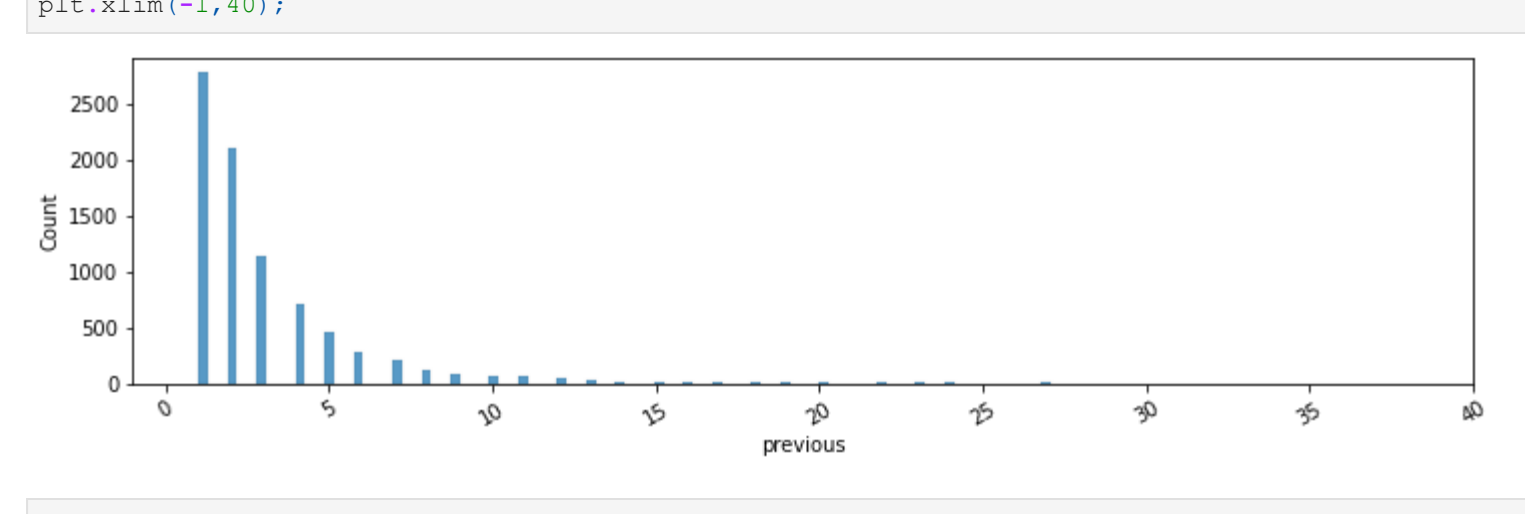
pdays

In [38]:
```
#print(bank_main_df['pdays'].value_counts())
plt.figure(figsize=(12,3))
sns.histplot(data=bank_main_df,x='pdays',bins=100)
plt.xticks(rotation=30);
```

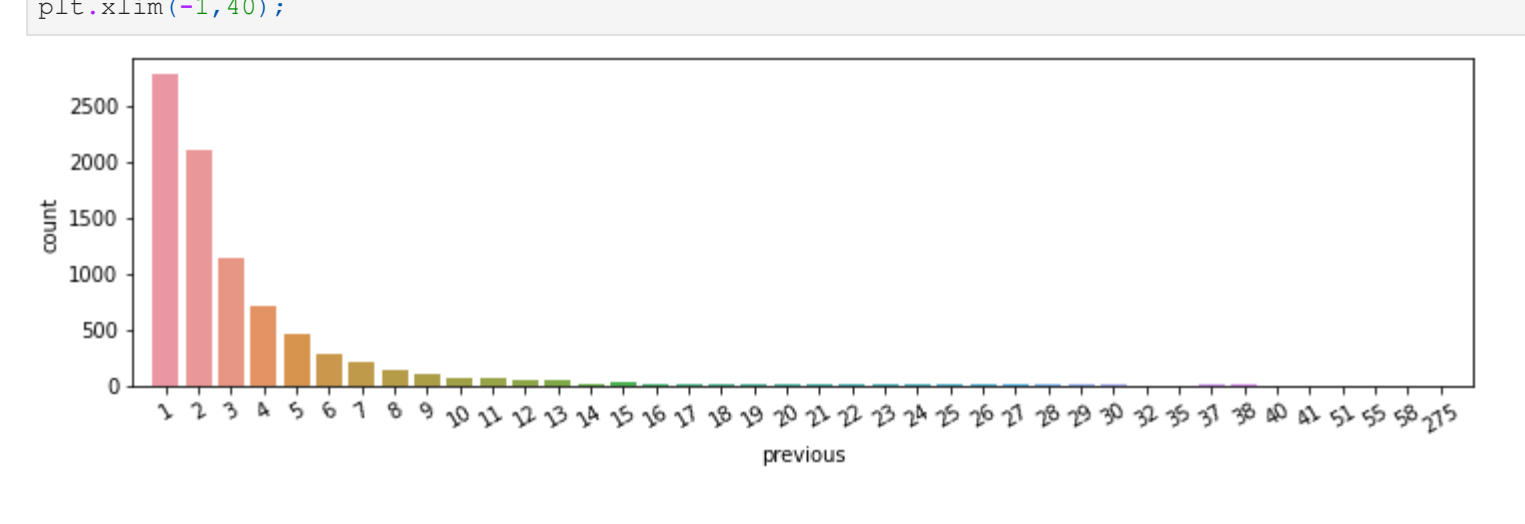


previous

In [39]:
```
#print(bank_main_df['pdays'].value_counts())
plt.figure(figsize=(12,3))
sns.histplot(data=bank_main_df[bank_main_df['previous'] > 0],x='previous')
plt.xticks(rotation=30)
plt.xlim(-1,40);
```



In [40]:
```
#print(bank_main_df['pdays'].value_counts())
plt.figure(figsize=(12,3))
sns.countplot(data=bank_main_df[bank_main_df['previous'] > 0],x='previous')
plt.xticks(rotation=30)
plt.xlim(-1,40);
```



poutcome

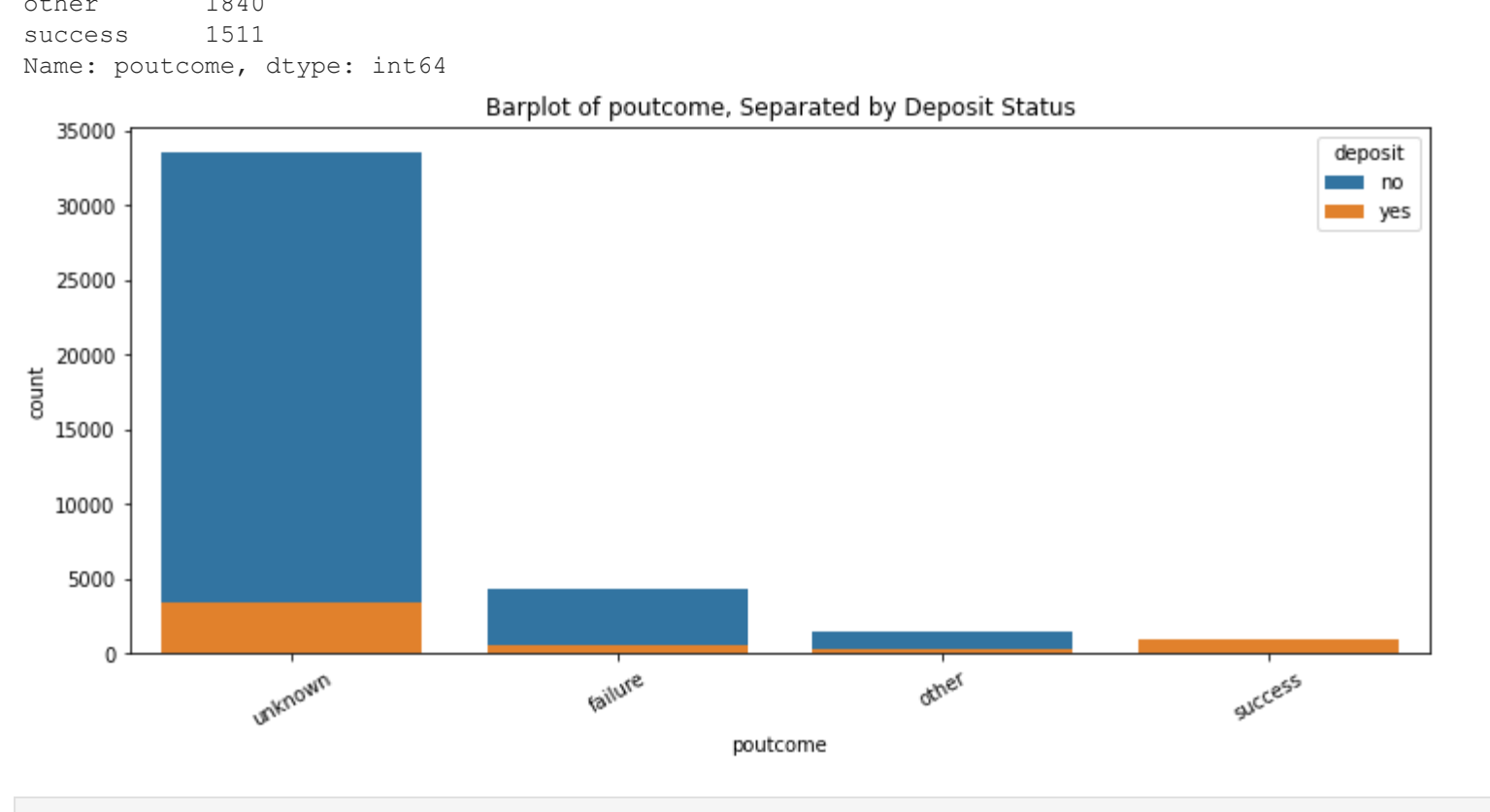
In [41]:
```
pd.DataFrame(np.round(bank_main_df.groupby('poutcome')['deposit'].value_counts(normalize=True),2)).T
```

Out[41]:

poutcome	failure		other		success		unknown	
deposit	no	yes	no	yes	yes	no	no	yes
deposit	0.87	0.13	0.83	0.17	0.65	0.35	0.91	0.09

In [42]:
```
print(bank_main_df['poutcome'].value_counts())
plt.figure(figsize=(12,5))
sns.countplot(data=bank_main_df,x='poutcome',hue='deposit',dodge=False)
plt.xticks(rotation=30)
plt.title('Barplot of poutcome, Separated by Deposit Status')
plt.savefig('Images/poutcome_barplot_deposit.png');
```

```
unknown    36959
failure     4901
other       1840
success     1511
Name: poutcome, dtype: int64
```



In [43]:
```
bank_main_df['deposit'].value_counts(normalize=True)
```

Out[43]:
```
no     0.883015
yes    0.116985
Name: deposit, dtype: float64
```

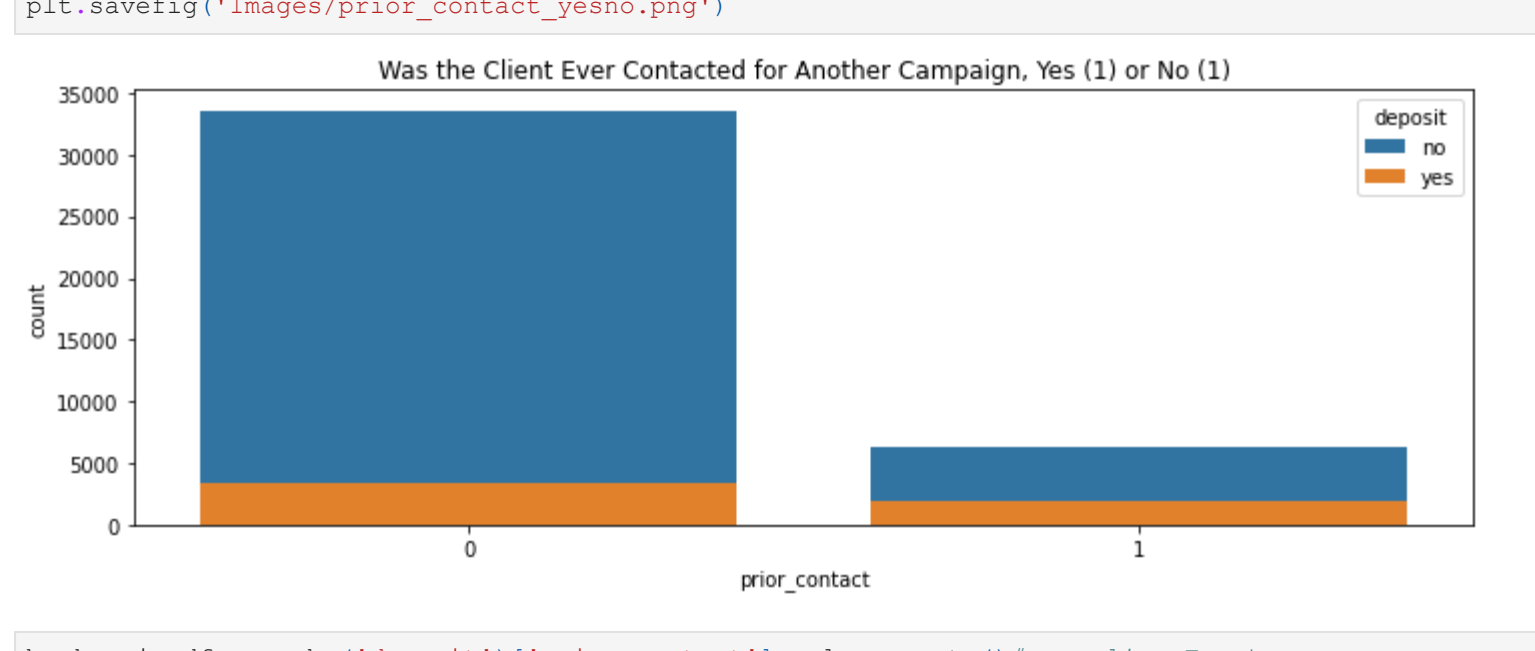
In [ ]:

Creating fields to replace *pdays* and *previous*

In [44]:
```
bank_main_df['prior_contact'] = [ 0 if bank_main_df['pdays'][i] == -1 else 1 for i in range(len(bank_main_df))]
bank_main_df['prior_contact2'] = [ 0 if bank_main_df['previous'][i] == 0 else 1 for i in range(len(bank_main_df
```

Notice that if we separate "never contacted" from "contacted at least once" the numbers are identical for both pdays and previous, as should be expected.

In [45]:
```
plt.figure(figsize=(12,4))
sns.countplot(data=bank_main_df,hue='deposit',x='prior_contact',dodge=False)
plt.title('Was the Client Ever Contacted for Another Campaign, Yes (1) or No (1)')
plt.savefig('Images/prior_contact_yesno.png')
```

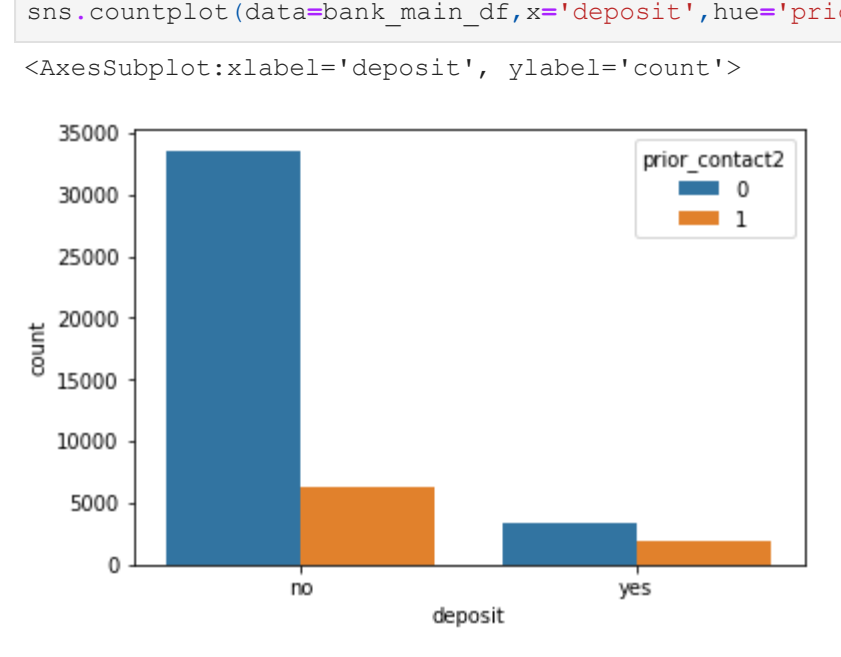


In [46]:
```
bank_main_df.groupby('deposit')['prior_contact'].value_counts()#normalize=True)
```

Out[46]:
```
deposit  prior_contact
no       0                33570
         1                 6352
yes      0                 3384
         1                 1905
Name: prior_contact, dtype: int64
```

In [47]:
```
sns.countplot(data=bank_main_df,x='deposit',hue='prior_contact2')
```

Out[47]:
```
<AxesSubplot:xlabel='deposit', ylabel='count'>
```



In [48]:
```
bank_main_df.groupby('deposit')['prior_contact2'].value_counts()#normalize=True)
```

Out[48]:
```
deposit  prior_contact2
no       0                 33570
         1                  6352
yes      0                  3384
         1                  1905
Name: prior_contact2, dtype: int64
```

In [ ]: