Proto Seguro Safe Driver Prediction

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In [3]:
```
from IPython.display import display
from PIL import Image
path= "C:/Users/puj83/OneDrive/Portfolio/Porto_Seguro_Claims/ps_logo.jpg"
display(Image.open(path))
```

Link to Dataset:

https://www.kaggle.com/c/porto-seguro-safe-driver-prediction/data (https://www.kaggle.com/c/porto-seguro-safe-driver-prediction/data)

Abstract:

Nothing ruins the thrill of buying a brand new car more quickly than seeing your new insurance bill. The sting's even more painful when you know you're a good driver. It doesn't seem fair that you have to pay so much if you've been cautious on the road for years. Porto Seguro, one of Brazil's largest auto and homeowner insurance companies, completely agrees. Inaccuracies in car insurance company's claim predictions raise the cost of insurance for good drivers and reduce the price for bad ones. In this competition, you're challenged to build a model that predicts the probability that a driver will initiate an auto insurance claim in the next year. While Porto Seguro has used machine learning for the past 20 years, they're looking to Kaggle's machine learning community to explore new, more powerful methods. A more accurate prediction will allow them to further tailor their prices, and hopefully make auto insurance coverage more accessible to more drivers.

Industry:

Insurance

Company Information:

Porto Seguro is the third largest Brazilian insurance company in Brazil, was founded in 1945 and has more than 13,000 employees. The company operates through its subsidiaries in Brazil and in Uruguay. It is headquartered in São Paulo.

The company offers car insurance, residential, health, life, business, consortium also offers auto and homeowners, pension, savings bonds and other financial services. Porto Seguro competes with Bradesco Seguros, BB Seguridade, SulAmérica, Mapfre, Zurich Insurance Group and others insurance and reinsurance companies in Brazil.

Porto Seguro is the leader on the auto and homeowner insurance segments in Brazil and has around 10 million clients all over the different business lines.

Currently the company its owned by the Brazilian billionaire Jayme Garfinkel and the bank Itaú Unibanco, through PSIUPAR (Porto Seguro Itaú Unibanco Participações S.A.). "Since establishing an alliance with the bank Itaú in August 2009, Porto Seguro products have been available at the bank's branches."

https://en.wikipedia.org/wiki/Porto_Seguro_S.A (https://en.wikipedia.org/wiki/Porto_Seguro_S.A).

Use Case:

Predict if a driver will file an insurance claim next year.

Tool:

Python (Jupyter Notebook)

Initial Dataset(s):

train.csv contains the training data, where each row corresponds to a policy holder, and the target columns signifies that a claim was filed.

test.csv contains the test data.

sample_submission.csv is submission file showing the correct format.

Data:

In this competition, you will predict the probability that an auto insurance policy holder files a claim. In the train and test data, features that belong to similar groupings are tagged as such in the feature names (e.g., ind, reg, car, calc). In addition, feature names include the postfix bin to indicate binary features and cat to indicate categorical features. Features without these designations are either continuous or ordinal. Values of -1 indicate that the feature was missing from the observation. The target columns signifies whether or not a claim was filed for that policy holder.

Data Fields:

id

target

ps_ind_01

ps_ind_02_cat

ps_ind_03

ps_ind_04_cat

ps_ind_05_cat

ps_ind_06_bin

ps_ind_07_bin

ps_ind_08_bin

ps_ind_09_bin

ps_ind_10_bin

ps_ind_11_bin

ps_ind_12_bin

ps_ind_13_bin

ps_ind_14

ps_ind_15

ps_ind_16_bin

ps_ind_17_bin

ps_ind_18_bin

ps_reg_01 - ps_reg_03

ps_car_01_cat - ps_car_11_cat

ps_car_11 - ps_car_15

ps_calc_01 - ps_calc_14

ps_calc_15_bin - ps_calc_20_bin

Import Libaries:

In [12]:
```
%matplotlib inline
import pandas as pd # Dataframe manipulation
import numpy as np
import matplotlib.pyplot as plt # Base plotting
import seaborn as sns # Sophisticated plotting (?)
import warnings
# Ignore all warnings - users beware
warnings.filterwarnings("ignore")
```

Import Dataset(s):

In [13]:
```
# Read dataframe into Jupyter
df_train = pd.read_csv('C:/Users/puj83/OneDrive/Portfolio/Porto_Seguro_Claims/train.csv')
df_test = pd.read_csv('C:/Users/puj83/OneDrive/Portfolio/Porto_Seguro_Claims/test.csv')
```

In [14]:
```
df_train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 595212 entries, 0 to 595211
Data columns (total 59 columns):
id                595212 non-null int64
target            595212 non-null int64
ps_ind_01         595212 non-null int64
ps_ind_02_cat     595212 non-null int64
ps_ind_03         595212 non-null int64
ps_ind_04_cat     595212 non-null int64
ps_ind_05_cat     595212 non-null int64
ps_ind_06_bin     595212 non-null int64
ps_ind_07_bin     595212 non-null int64
ps_ind_08_bin     595212 non-null int64
ps_ind_09_bin     595212 non-null int64
ps_ind_10_bin     595212 non-null int64
ps_ind_11_bin     595212 non-null int64
ps_ind_12_bin     595212 non-null int64
ps_ind_13_bin     595212 non-null int64
ps_ind_14         595212 non-null int64
ps_ind_15         595212 non-null int64
ps_ind_16_bin     595212 non-null int64
ps_ind_17_bin     595212 non-null int64
ps_ind_18_bin     595212 non-null int64
ps_reg_01         595212 non-null float64
ps_reg_02         595212 non-null float64
ps_reg_03         595212 non-null float64
ps_car_01_cat     595212 non-null int64
ps_car_02_cat     595212 non-null int64
ps_car_03_cat     595212 non-null int64
ps_car_04_cat     595212 non-null int64
ps_car_05_cat     595212 non-null int64
ps_car_06_cat     595212 non-null int64
ps_car_07_cat     595212 non-null int64
ps_car_08_cat     595212 non-null int64
ps_car_09_cat     595212 non-null int64
ps_car_10_cat     595212 non-null int64
ps_car_11_cat     595212 non-null int64
ps_car_11         595212 non-null int64
ps_car_12         595212 non-null float64
ps_car_13         595212 non-null float64
ps_car_14         595212 non-null float64
ps_car_15         595212 non-null float64
ps_calc_01        595212 non-null float64
ps_calc_02        595212 non-null float64
ps_calc_03        595212 non-null float64
ps_calc_04        595212 non-null int64
ps_calc_05        595212 non-null int64
ps_calc_06        595212 non-null int64
ps_calc_07        595212 non-null int64
ps_calc_08        595212 non-null int64
ps_calc_09        595212 non-null int64
ps_calc_10        595212 non-null int64
ps_calc_11        595212 non-null int64
ps_calc_12        595212 non-null int64
ps_calc_13        595212 non-null int64
ps_calc_14        595212 non-null int64
ps_calc_15_bin    595212 non-null int64
```

```
ps_calc_16_bin    595212 non-null int64
ps_calc_17_bin    595212 non-null int64
ps_calc_18_bin    595212 non-null int64
ps_calc_19_bin    595212 non-null int64
ps_calc_20_bin    595212 non-null int64
dtypes: float64(10), int64(49)
memory usage: 267.9 MB
```

In [15]:
```
# Combine the training and test dataset
df = pd.concat([df_train, df_test])
```

In [16]:
```
df.set_index('id', inplace = True)
df.head(5)
```

Out[16]:

id	ps_calc_01	ps_calc_02	ps_calc_03	ps_calc_04	ps_calc_05	ps_calc_06	ps_calc_07	ps_ca
7	0.6	0.5	0.2	3	1	10	1	
9	0.3	0.1	0.3	2	1	9	5	
13	0.5	0.7	0.1	2	2	9	1	
16	0.6	0.9	0.1	2	4	7	1	
17	0.4	0.6	0.0	2	2	6	3	

5 rows × 58 columns

In [17]:
```
print (df.shape)
print (df_train.shape)
print (df_test.shape)
```

```
(1488028, 58)
(595212, 59)
(892816, 58)
```

In [18]:
```
df.describe()
```

Out[18]:

	ps_calc_01	ps_calc_02	ps_calc_03	ps_calc_04	ps_calc_05	ps_calc_06	
count	1.488028e+06	1.488028e+06	1.488028e+06	1.488028e+06	1.488028e+06	1.488028e+06	1.4
mean	4.496817e-01	4.501073e-01	4.499718e-01	2.371666e+00	1.885551e+00	7.688461e+00	3.(
std	2.872071e-01	2.871817e-01	2.872136e-01	1.117059e+00	1.136029e+00	1.333837e+00	1.4
min	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.(
25%	2.000000e-01	2.000000e-01	2.000000e-01	2.000000e+00	1.000000e+00	7.000000e+00	2.(
50%	4.000000e-01	5.000000e-01	5.000000e-01	2.000000e+00	2.000000e+00	8.000000e+00	3.(
75%	7.000000e-01	7.000000e-01	7.000000e-01	3.000000e+00	3.000000e+00	9.000000e+00	4.(
max	9.000000e-01	9.000000e-01	9.000000e-01	5.000000e+00	6.000000e+00	1.000000e+01	9.(

8 rows × 58 columns

In [19]:
```
(pd.DataFrame(np.sum(df.apply(lambda x: x == -1))
              /len(df))[0][pd.DataFrame(np.sum(df.apply(lambda x: x == -1))/le
n(df))[0] != 0])
```

Out[19]:
```
ps_car_01_cat    1.794321e-04
ps_car_02_cat    6.720304e-06
ps_car_03_cat    6.909426e-01
ps_car_05_cat    4.481838e-01
ps_car_07_cat    1.936792e-02
ps_car_09_cat    9.717559e-04
ps_car_11        4.032182e-06
ps_car_12        6.720304e-07
ps_car_14        7.152083e-02
ps_ind_02_cat    3.514719e-04
ps_ind_04_cat    1.532229e-04
ps_ind_05_cat    9.757209e-03
ps_reg_03        1.810826e-01
Name: 0, dtype: float64
```

In [20]:
```
np.sum(pd.isnull(df))
```

Out[20]:

ps_calc_01	0
ps_calc_02	0
ps_calc_03	0
ps_calc_04	0
ps_calc_05	0
ps_calc_06	0
ps_calc_07	0
ps_calc_08	0
ps_calc_09	0
ps_calc_10	0
ps_calc_11	0
ps_calc_12	0
ps_calc_13	0
ps_calc_14	0
ps_calc_15_bin	0
ps_calc_16_bin	0
ps_calc_17_bin	0
ps_calc_18_bin	0
ps_calc_19_bin	0
ps_calc_20_bin	0
ps_car_01_cat	0
ps_car_02_cat	0
ps_car_03_cat	0
ps_car_04_cat	0
ps_car_05_cat	0
ps_car_06_cat	0
ps_car_07_cat	0
ps_car_08_cat	0
ps_car_09_cat	0
ps_car_10_cat	0
ps_car_11	0
ps_car_11_cat	0
ps_car_12	0
ps_car_13	0
ps_car_14	0
ps_car_15	0
ps_ind_01	0
ps_ind_02_cat	0
ps_ind_03	0
ps_ind_04_cat	0
ps_ind_05_cat	0
ps_ind_06_bin	0
ps_ind_07_bin	0
ps_ind_08_bin	0
ps_ind_09_bin	0
ps_ind_10_bin	0
ps_ind_11_bin	0
ps_ind_12_bin	0
ps_ind_13_bin	0
ps_ind_14	0
ps_ind_15	0
ps_ind_16_bin	0
ps_ind_17_bin	0
ps_ind_18_bin	0
ps_reg_01	0
ps_reg_02	0
ps_reg_03	0

```
target            892816
dtype: int64
```

In [21]:
```
categorical_features = df.columns[df.columns.str.endswith('cat')].tolist()
binary_features = df.columns[df.columns.str.endswith('bin')].tolist()
numeric_features = [feature for feature in df.columns.tolist()
                    if feature not in categorical_features and feature not in
binary_features]
```

In [22]:
```
binary_numeric = binary_features + numeric_features
```

In [23]:
```
df[categorical_features].apply(set)
```

Out[23]:
```
ps_car_01_cat          {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, -1}
ps_car_02_cat                                        {0, 1, -1}
ps_car_03_cat                                        {0, 1, -1}
ps_car_04_cat                        {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}
ps_car_05_cat                                        {0, 1, -1}
ps_car_06_cat    {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13,...
ps_car_07_cat                                        {0, 1, -1}
ps_car_08_cat                                           {0, 1}
ps_car_09_cat                                  {0, 1, 2, 3, 4, -1}
ps_car_10_cat                                        {0, 1, 2}
ps_car_11_cat    {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14...
ps_ind_02_cat                                  {1, 2, 3, 4, -1}
ps_ind_04_cat                                        {0, 1, -1}
ps_ind_05_cat                           {0, 1, 2, 3, 4, 5, 6, -1}
dtype: object
```

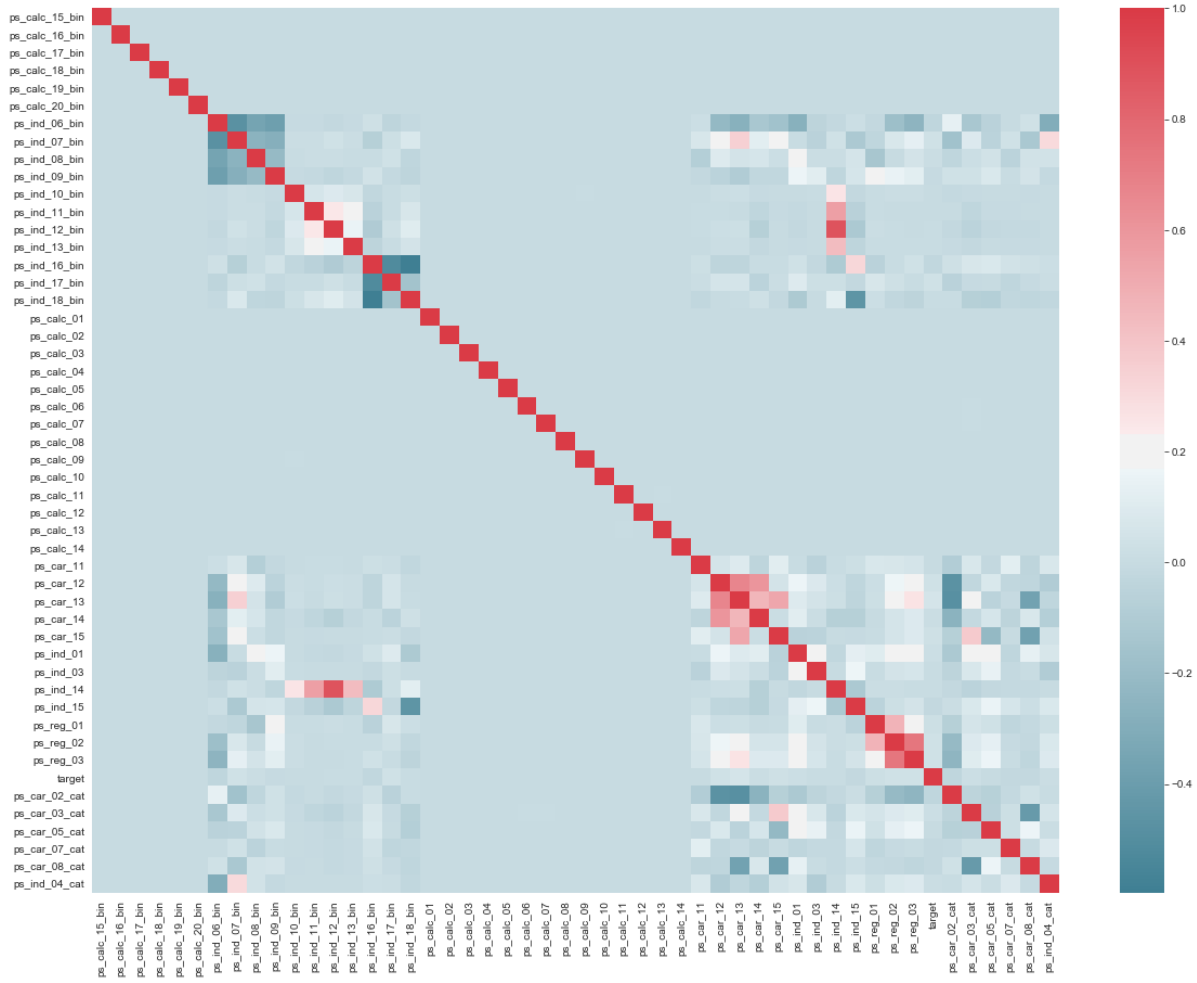
In [24]:
```
for feature in ['ps_car_02_cat', 'ps_car_03_cat', 'ps_car_05_cat', 'ps_car_07_
cat', 'ps_car_08_cat', 'ps_ind_04_cat']:
    binary_numeric.append(feature)
    binary_features.append(feature)
    categorical_features.remove(feature)
```

In [25]:
```
categorical_features
```

Out[25]:
```
['ps_car_01_cat',
 'ps_car_04_cat',
 'ps_car_06_cat',
 'ps_car_09_cat',
 'ps_car_10_cat',
 'ps_car_11_cat',
 'ps_ind_02_cat',
 'ps_ind_05_cat']
```

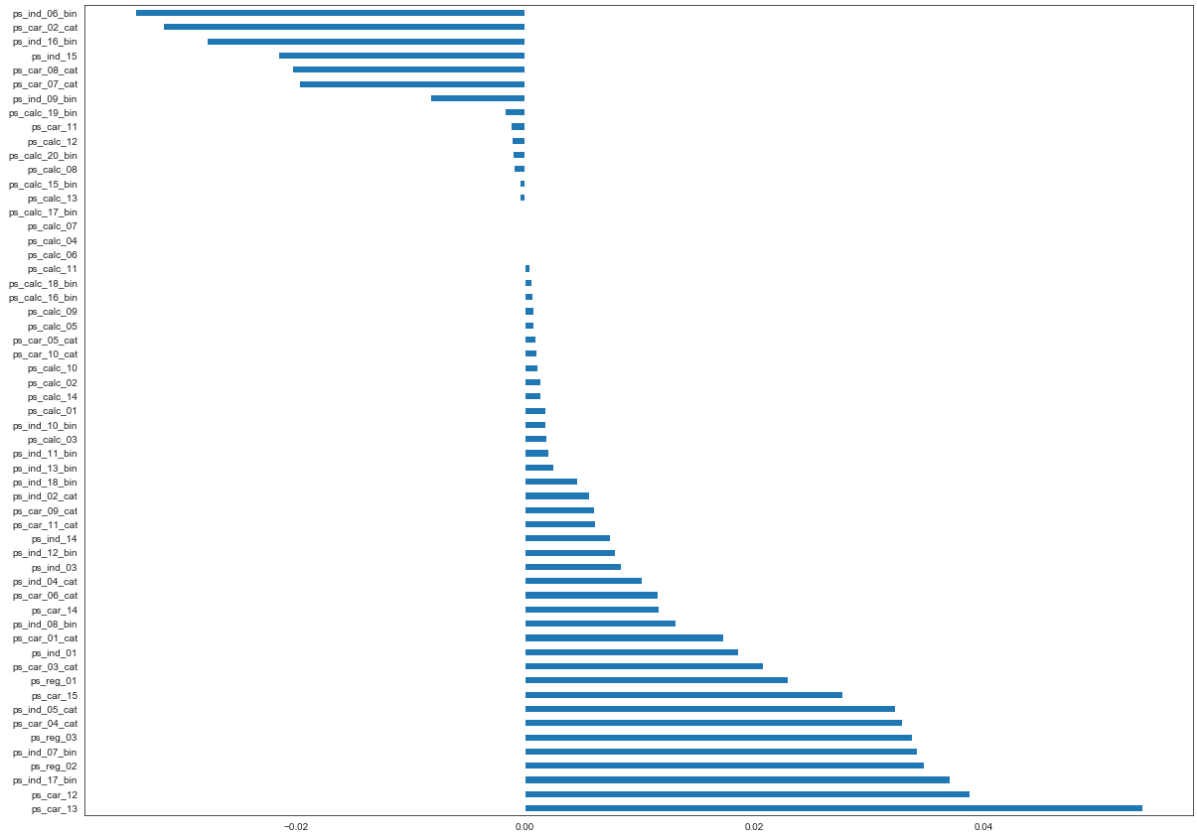
In [26]:
```
df[df == -1] = np.nan
```

In [27]:
```
sns.set_style('white')
cmap = sns.diverging_palette(220, 10, as_cmap=True)

plt.figure(figsize=(20,15))

sns.heatmap(df[binary_numeric].corr(), cmap=cmap)

plt.show()
```



In [28]:
```
plt.figure(figsize=(20, 15))
(df.corr()
     .target
     .drop('target')
     .sort_values(ascending=False)
     .plot
     .barh())
```

Out[28]: <matplotlib.axes._subplots.AxesSubplot at 0x21da642f888>



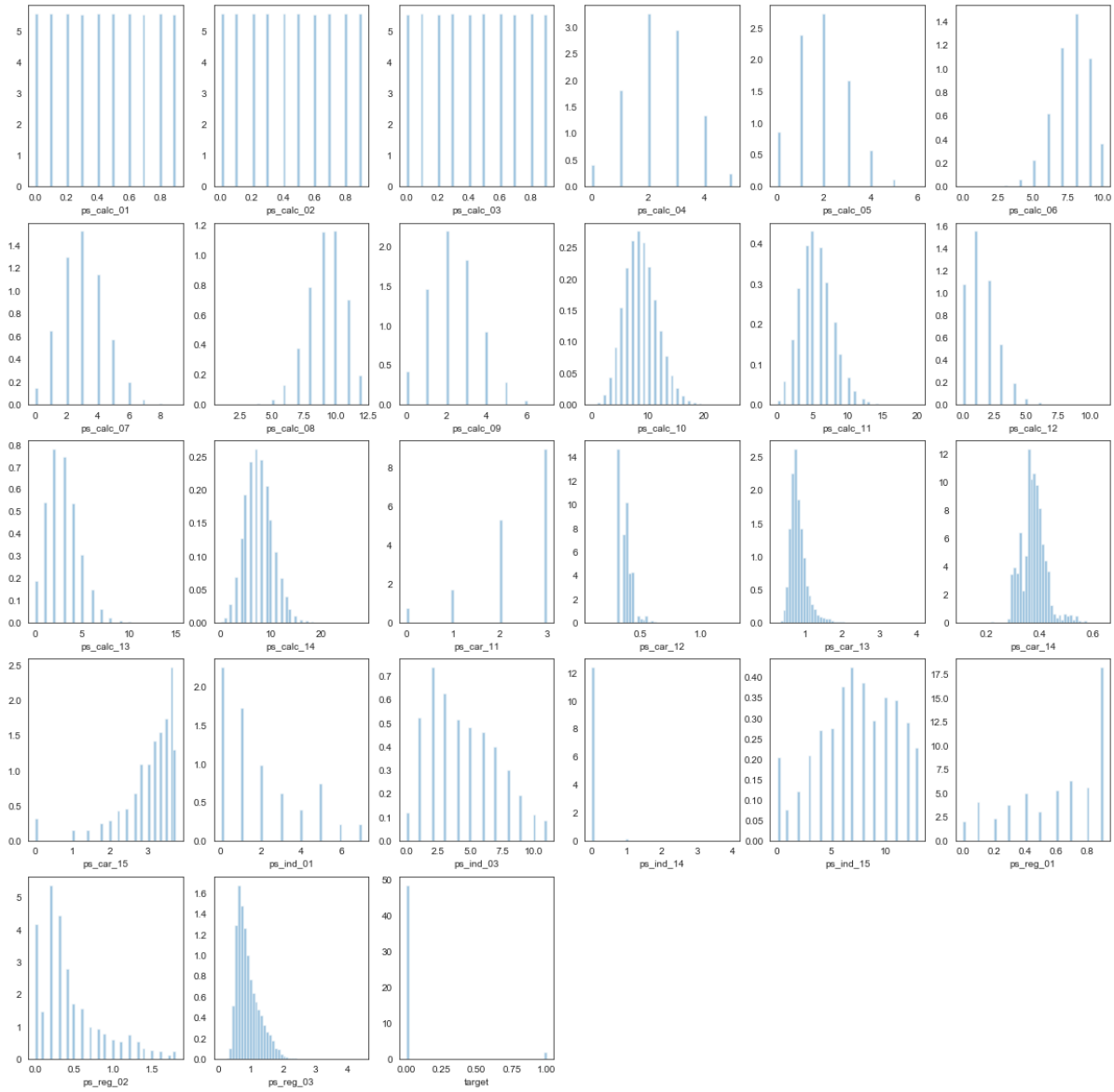
In [29]:
```
len(numeric_features)
```

Out[29]: 27

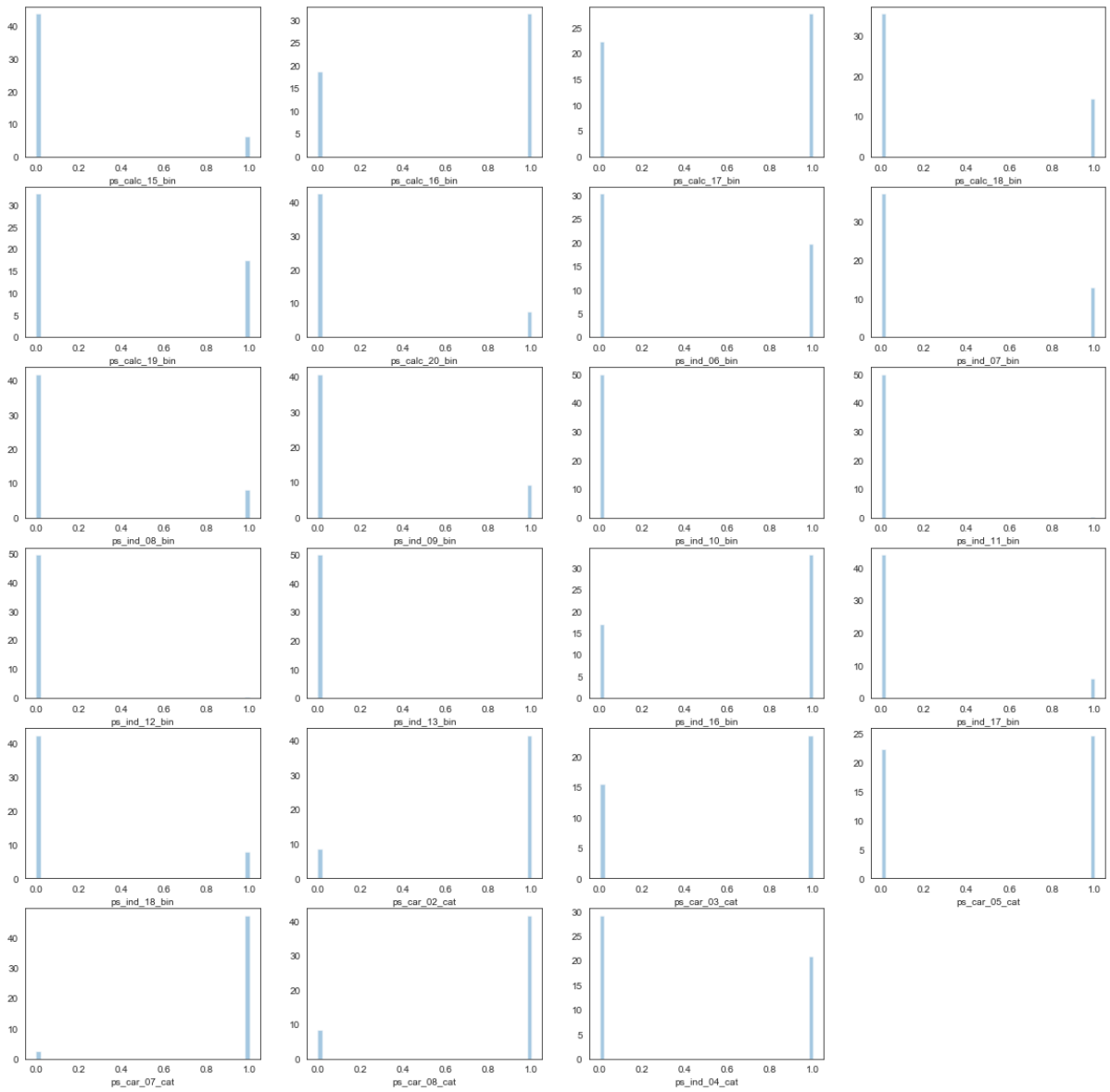
In [30]:
```
len(binary_features)
```

Out[30]: 23

In [31]:
```
plt.figure(figsize=(20,20))
for idx, num_feat in enumerate(numeric_features):
    plt.subplot(5, 6, idx+1)
    sns.distplot(df[num_feat].dropna(), kde = False, norm_hist=True)

plt.show()
```



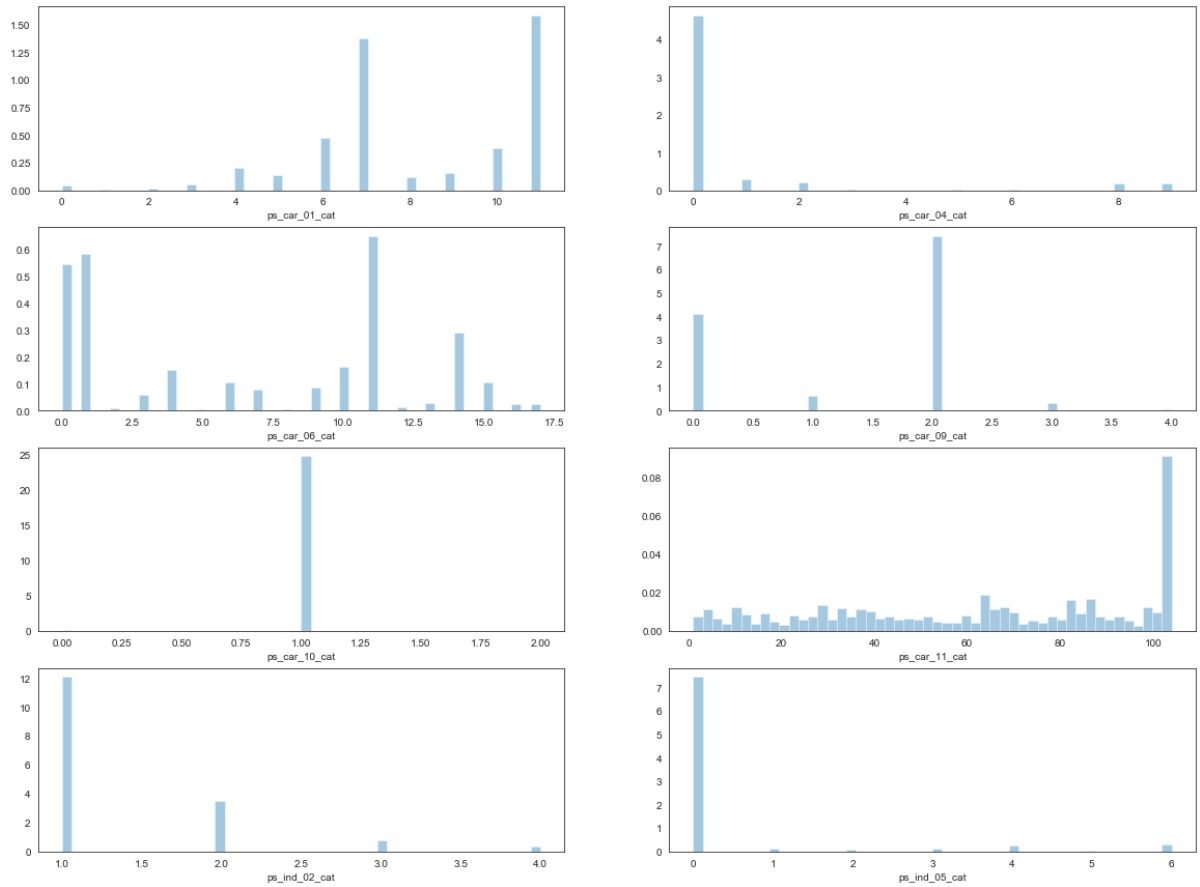
In [32]:
```
plt.figure(figsize=(20,20))
for idx, bin_feat in enumerate(binary_features):
    plt.subplot(6, 4, idx+1)
    sns.distplot(df[bin_feat].dropna(), kde = False, norm_hist=True)

plt.show()
```



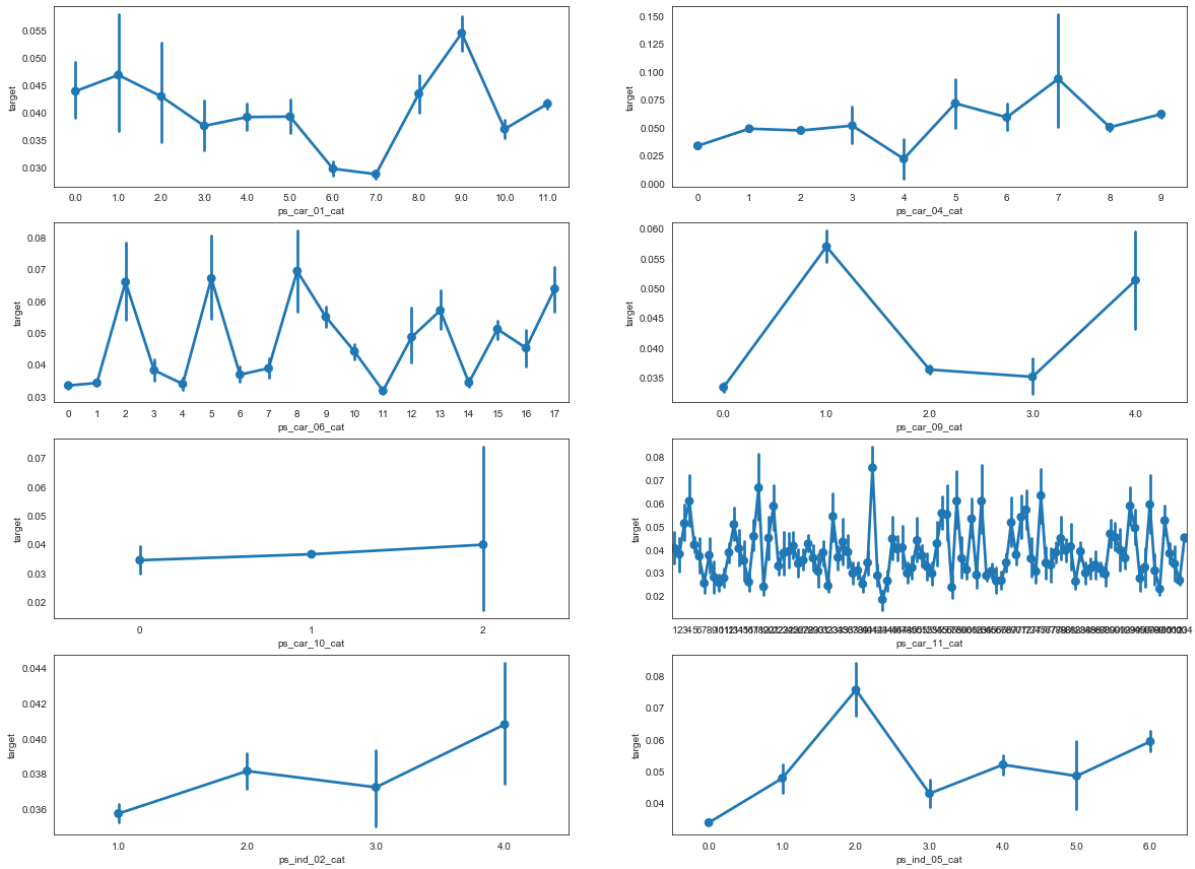
In [33]:
```
len(categorical_features)
```

Out[33]: 8

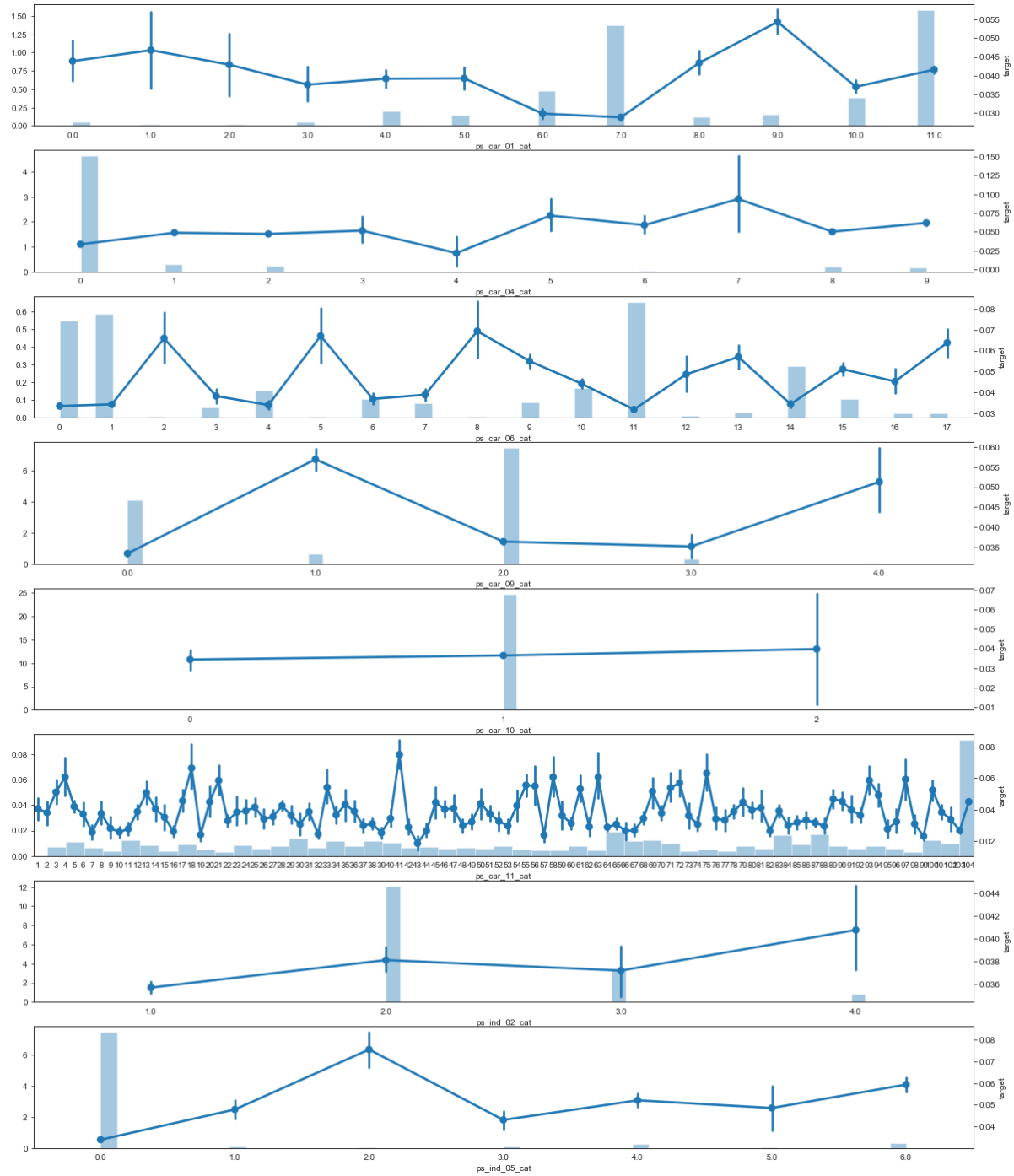
In [34]:
```
plt.figure(figsize=(20,15))

for idx, cat_feat in enumerate(categorical_features):
    plt.subplot(4, 2, idx+1)
    sns.distplot(df[cat_feat].dropna(), kde=False, norm_hist=True)

plt.show()
```



In [35]:
```
plt.figure(figsize=(20,15))

for idx, cat_feat in enumerate(categorical_features):
     plt.subplot(4, 2, idx+1)
     sns.pointplot(x=cat_feat, y='target', data=df.iloc[:df_train.shape[0]])

plt.show()
```



In [36]:
```
fig, axs = plt.subplots(8, 1, figsize=(20, 25))

for ax, cat_feat in zip(axs, categorical_features):
    ax2 = ax.twinx()
    sns.distplot(df[cat_feat].dropna(), kde=False, norm_hist=True, ax = ax)
    sns.pointplot(x=cat_feat, y='target', data=df.iloc[:df_train.shape[0]], a
x=ax2)

plt.show()
```



In [37]:
```
df[df == -1] = np.nan

# Binary and Numeric Features

no_of_features = sum(df[binary_numeric].corr()
                     .target
                     .abs()
                     .drop('target')
                     .sort_values(ascending=False) > 0.005)
no_of_features
```

Out[37]: 23

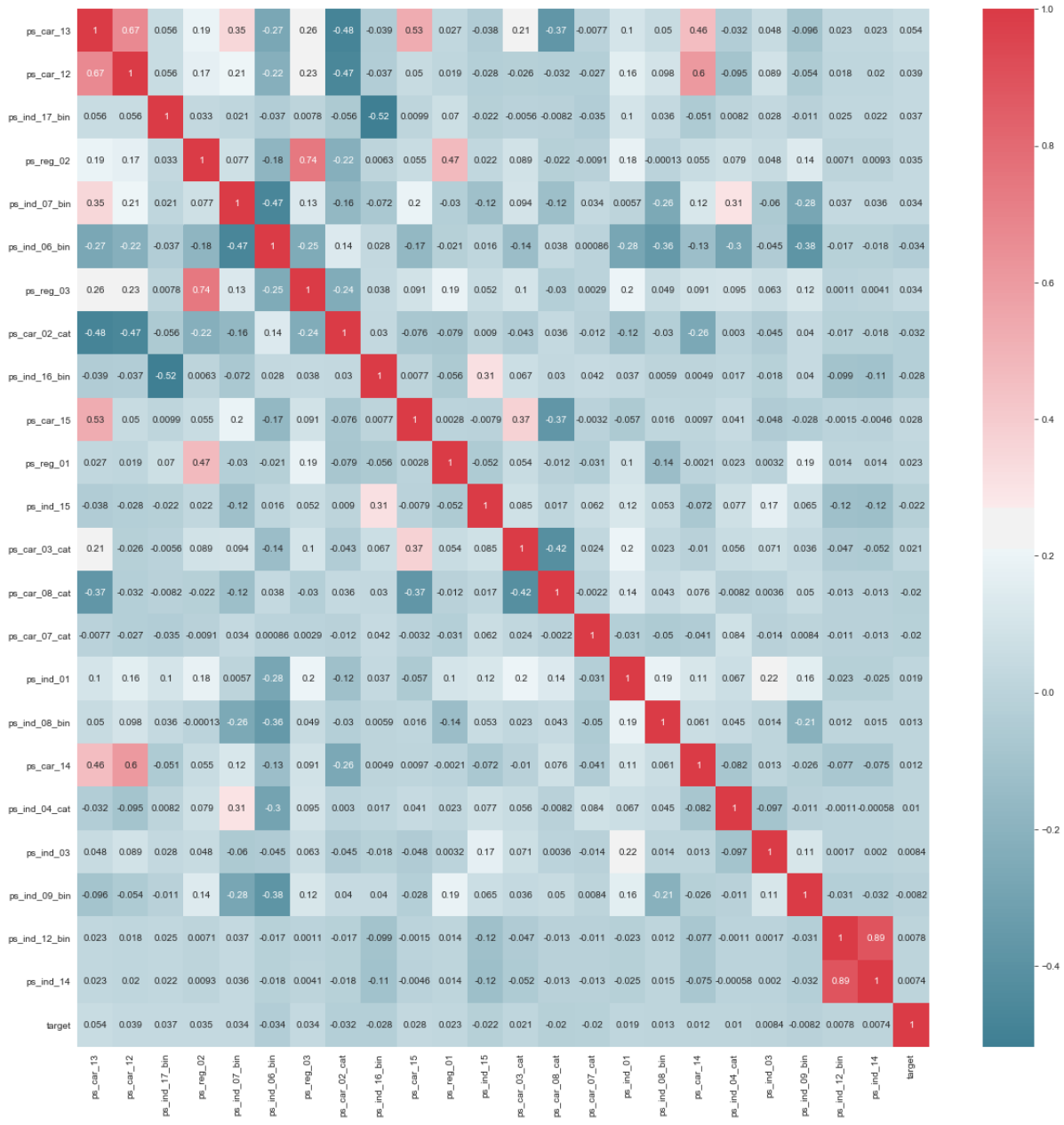
In [38]:
```
bin_num_features = (df[binary_numeric].corr()
                    .target
                    .abs()
                    .drop('target')
                    .sort_values(ascending = False))[:no_of_features].index.to
list()
```

In [39]:
```
cat_features = [feature for feature in df.columns.tolist()
                if (feature not in bin_num_features) and (feature.endswith('ca
t'))]
```

In [40]:
```
df_fs1 = df[bin_num_features + cat_features]

df_fs1['target'] = df.target
bin_num_feat = [column for column in df_fs1.columns
                if column not in cat_features]
```

In [41]:
```
sns.set_style('white')
cmap = sns.diverging_palette(220, 10, as_cmap=True)

plt.figure(figsize=(20, 20))
sns.heatmap(df_fs1[bin_num_feat].iloc[:df_train.shape[0]].corr(), annot = True
, cmap = cmap)
plt.plot()
```

Out[41]: []



In [42]:
```
del df_fs1['ps_ind_14']
```

In [43]:
```
np.sum(df_fs1.isnull())
```

Out[43]:
```
ps_car_13             0
ps_car_12             1
ps_ind_17_bin         0
ps_reg_02             0
ps_ind_07_bin         0
ps_ind_06_bin         0
ps_reg_03        269456
ps_car_02_cat        10
ps_ind_16_bin         0
ps_car_15             0
ps_reg_01             0
ps_ind_15             0
ps_car_03_cat   1028142
ps_car_08_cat         0
ps_car_07_cat     28820
ps_ind_01             0
ps_ind_08_bin         0
ps_car_14        106425
ps_ind_04_cat       228
ps_ind_03             0
ps_ind_09_bin         0
ps_ind_12_bin         0
ps_car_01_cat       267
ps_car_04_cat         0
ps_car_05_cat    666910
ps_car_06_cat         0
ps_car_09_cat      1446
ps_car_10_cat         0
ps_car_11_cat         0
ps_ind_02_cat       523
ps_ind_05_cat     14519
target           892816
dtype: int64
```

In [44]:
```
[feat for feat in df_fs1.columns.tolist()
 if np.sum(pd.isnull(df_fs1[feat])) > (df_fs1.shape[0])*0.20]
```

Out[44]:
```
['ps_car_03_cat', 'ps_car_05_cat', 'target']
```

In [45]:
```
del df_fs1['ps_car_03_cat']
del df_fs1['ps_car_05_cat']
```

In [46]:
```
[feat for feat in df_fs1.columns.tolist()
 if feat.endswith('cat') and ((np.sum(pd.isnull(df_fs1[feat]))) > 0)]
```

Out[46]:
```
['ps_car_02_cat',
 'ps_car_07_cat',
 'ps_ind_04_cat',
 'ps_car_01_cat',
 'ps_car_09_cat',
 'ps_ind_02_cat',
 'ps_ind_05_cat']
```

In [47]:
```
df_fs1.ps_car_02_cat.fillna('-1', inplace = True)
df_fs1.ps_car_07_cat.fillna('-1', inplace = True)
df_fs1.ps_ind_04_cat.fillna('-1', inplace = True)
df_fs1.ps_car_01_cat.fillna('-1', inplace = True)
df_fs1.ps_car_09_cat.fillna('-1', inplace = True)
df_fs1.ps_ind_02_cat.fillna('-1', inplace = True)
df_fs1.ps_ind_05_cat.fillna('-1', inplace = True)
```

In [48]:
```
[feat for feat in df_fs1.columns.tolist()
 if np.sum(pd.isnull(df_fs1[feat])) > 0]
```

Out[48]:
```
['ps_car_12', 'ps_reg_03', 'ps_car_14', 'target']
```

In [49]:
```
df_fs1['ps_car_12'].fillna(df_fs1['ps_car_12'].median(), inplace = True)
df_fs1['ps_reg_03'].fillna(df_fs1['ps_reg_03'].median(), inplace = True)
df_fs1['ps_car_14'].fillna(df_fs1['ps_car_14'].median(), inplace = True)
```

In [50]:
```
np.sum(df_fs1.isnull())
```

Out[50]:
```
ps_car_13            0
ps_car_12            0
ps_ind_17_bin        0
ps_reg_02            0
ps_ind_07_bin        0
ps_ind_06_bin        0
ps_reg_03            0
ps_car_02_cat        0
ps_ind_16_bin        0
ps_car_15            0
ps_reg_01            0
ps_ind_15            0
ps_car_08_cat        0
ps_car_07_cat        0
ps_ind_01            0
ps_ind_08_bin        0
ps_car_14            0
ps_ind_04_cat        0
ps_ind_03            0
ps_ind_09_bin        0
ps_ind_12_bin        0
ps_car_01_cat        0
ps_car_04_cat        0
ps_car_06_cat        0
ps_car_09_cat        0
ps_car_10_cat        0
ps_car_11_cat        0
ps_ind_02_cat        0
ps_ind_05_cat        0
target          892816
dtype: int64
```

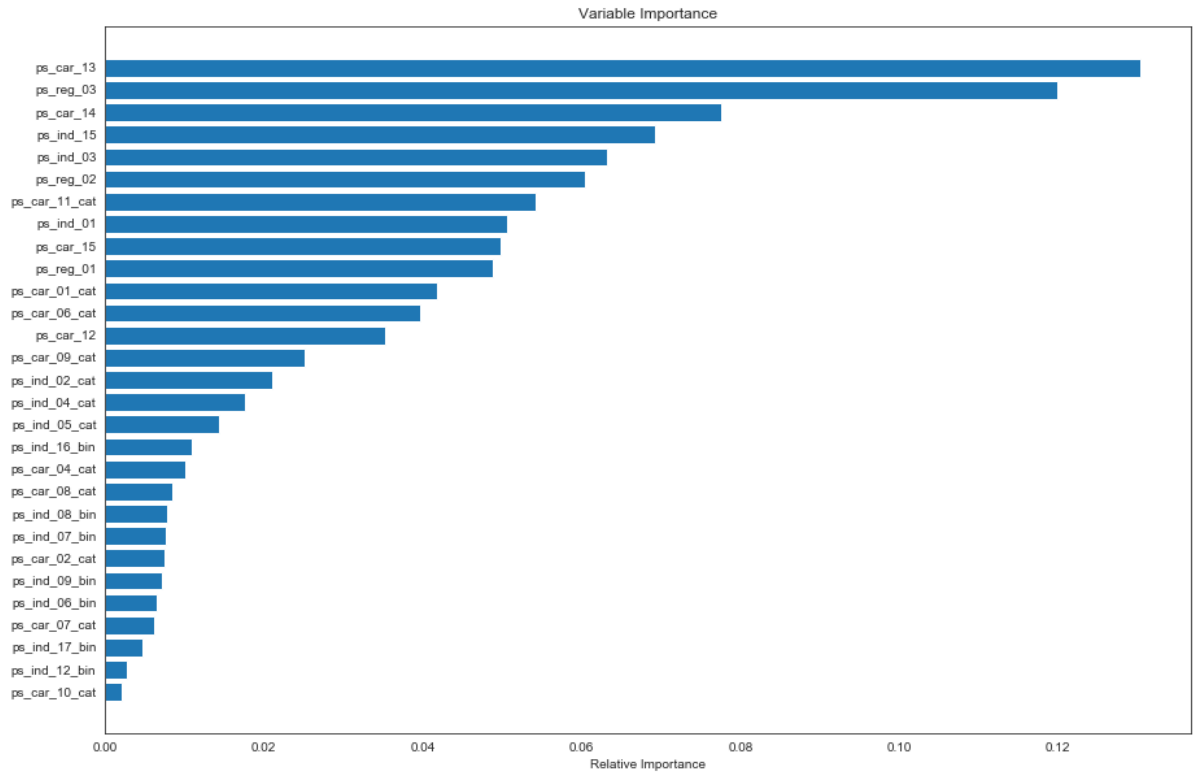
In [51]:
```
features = np.array([feature for feature in df_fs1.columns.tolist()
                     if feature != 'target'])
```

In [52]:
```
random_state = 1212
```

In [53]:
```
idx = df_fs1[df_fs1.target.notnull()].index.tolist()

from sklearn.ensemble import RandomForestClassifier

clf = RandomForestClassifier(50, random_state = random_state)
clf.fit(df_fs1[features].loc[idx], df_fs1.target.loc[idx])
```

Out[53]:
```
RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight=None,
                       criterion='gini', max_depth=None, max_features='auto',
                       max_leaf_nodes=None, max_samples=None,
                       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=50,
                       n_jobs=None, oob_score=False, random_state=1212,
                       verbose=0, warm_start=False)
```

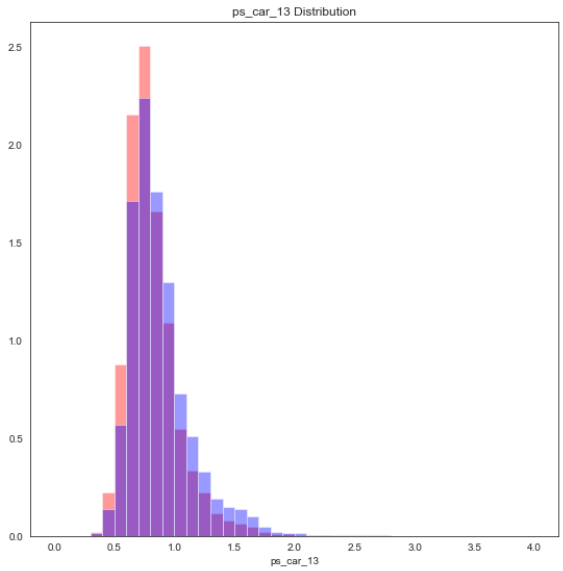
In [54]:
```
importances = clf.feature_importances_
sorted_idx = np.argsort(importances)

plt.figure(figsize=(15, 10))

padding = np.arange(len(features)) + 0.5
plt.barh(padding, importances[sorted_idx], align='center')
plt.yticks(padding, features[sorted_idx])
plt.xlabel("Relative Importance")
plt.title("Variable Importance")

plt.show()
```

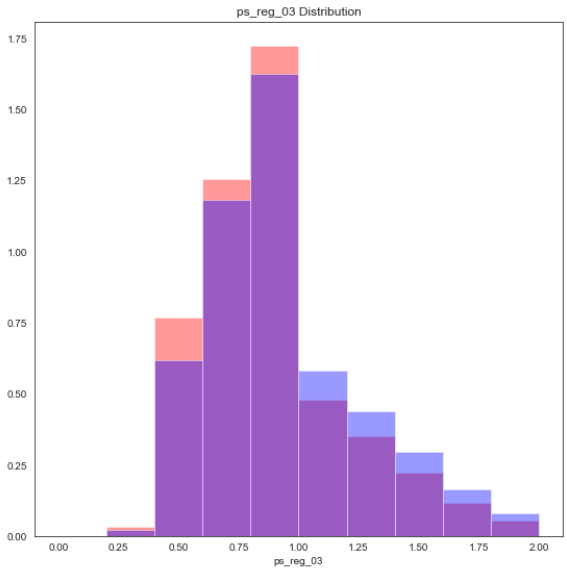


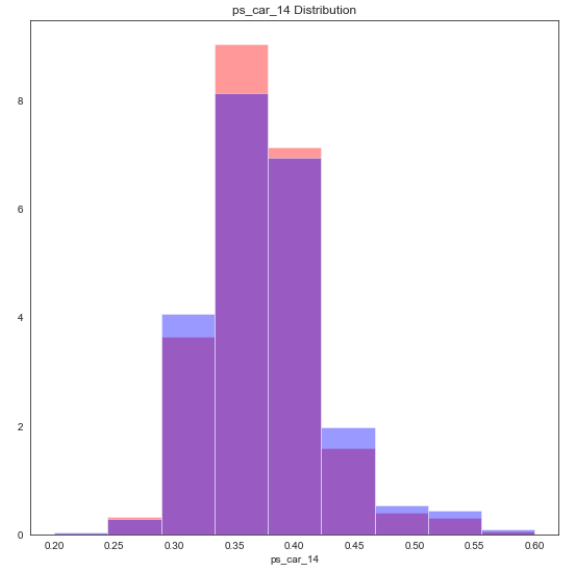
In [55]:
```
combined = df_fs1[features]
combined['target'] = df_train.set_index('id').target
```

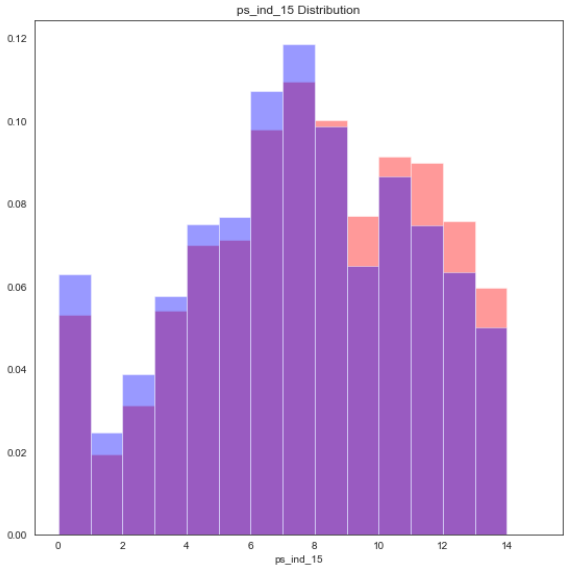
In [56]:
```
plt.figure(figsize=(20,20))

plt.subplot(221)
sns.distplot(combined[combined.target == 0].ps_car_13.dropna(),
             bins = np.linspace(0, 4, 41), kde = False, norm_hist = True, colo
r = 'red')
sns.distplot(combined[combined.target == 1].ps_car_13.dropna(),
             bins = np.linspace(0, 4, 41), kde = False, norm_hist = True, colo
r = 'blue')
plt.title('ps_car_13 Distribution')

plt.subplot(222)
sns.distplot(combined[combined.target == 0].ps_reg_03,
             bins = np.linspace(0, 2, 11), kde = False, norm_hist = True, colo
r = 'red')
sns.distplot(combined[combined.target == 1].ps_reg_03,
             bins = np.linspace(0, 2, 11), kde = False, norm_hist = True, colo
r = 'blue')
plt.title('ps_reg_03 Distribution')

plt.subplot(223)
sns.distplot(combined[combined.target == 0].ps_car_14,
             bins = np.linspace(0.2, 0.6, 10), kde = False, norm_hist = True,
color = 'red')
sns.distplot(combined[combined.target == 1].ps_car_14,
             bins = np.linspace(0.2, 0.6, 10), kde = False, norm_hist = True,
color = 'blue')
plt.title('ps_car_14 Distribution')

plt.subplot(224)
sns.distplot(combined[combined.target == 0].ps_ind_15.dropna(),
             bins = np.linspace(0, 15, 16), kde = False, norm_hist = True, col
or = 'red')
sns.distplot(combined[combined.target == 1].ps_ind_15.dropna(),
             bins = np.linspace(0, 15, 16), kde = False, norm_hist = True, col
or = 'blue')
plt.title('ps_ind_15 Distribution')
```

Out[56]: Text(0.5, 1.0, 'ps_ind_15 Distribution')



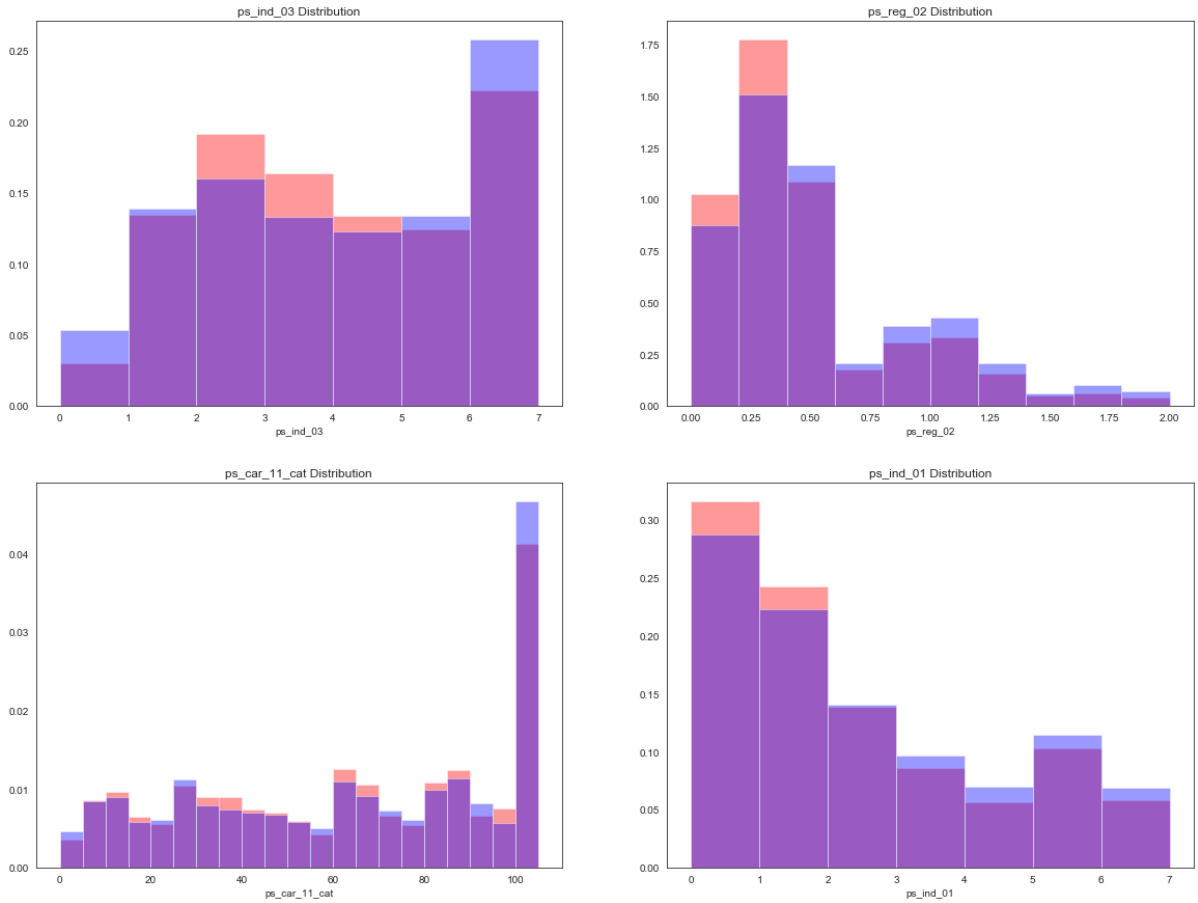






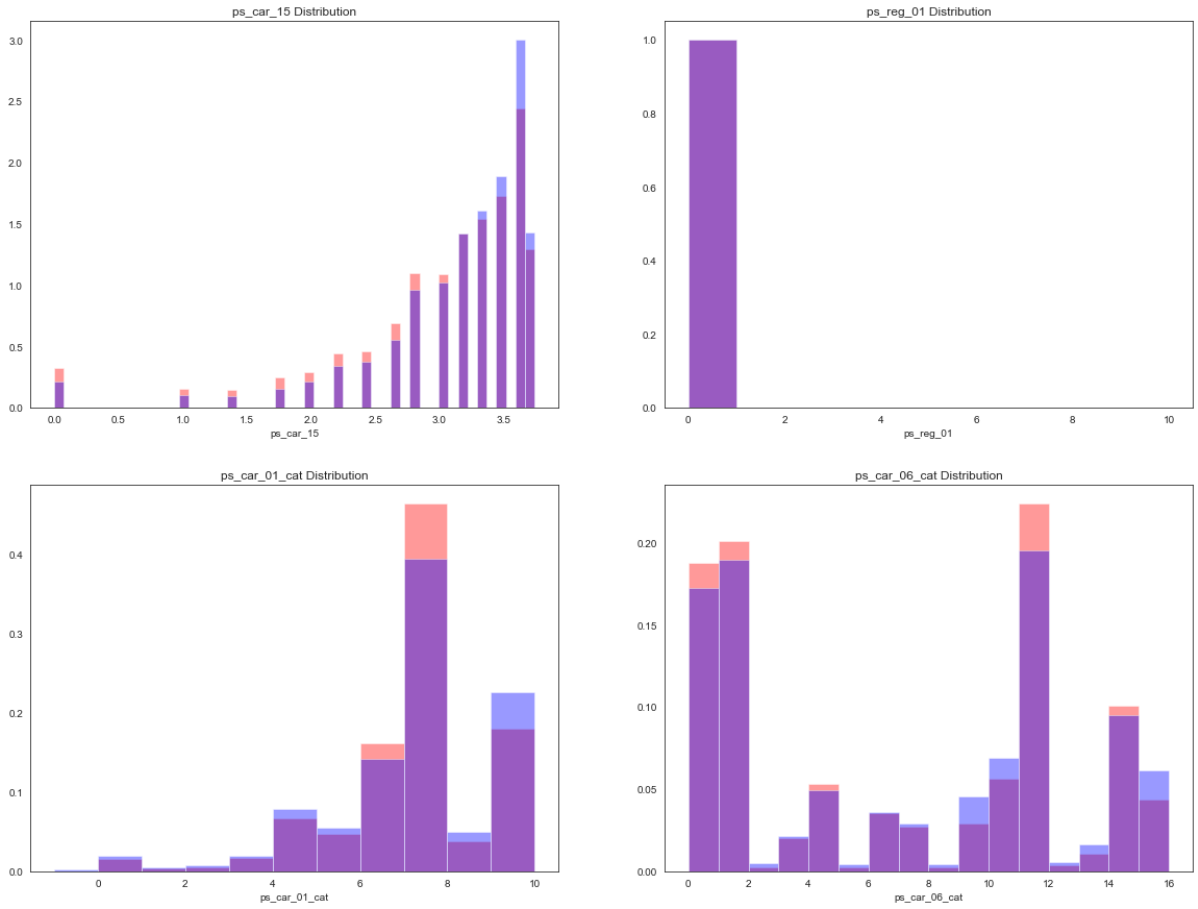
In [57]:
```
plt.figure(figsize=(20,15))

plt.subplot(221)
sns.distplot(combined[combined.target == 0].ps_ind_03.dropna(),
             bins = range(0, 8, 1), kde = False, norm_hist = True, color = 're
d')
sns.distplot(combined[combined.target == 1].ps_ind_03.dropna(),
             bins = range(0, 8, 1), kde = False, norm_hist = True, color = 'bl
ue')
plt.title('ps_ind_03 Distribution')

plt.subplot(222)
sns.distplot(combined[combined.target == 0].ps_reg_02.dropna(),
             bins = np.linspace(0, 2, 11), kde = False, norm_hist = True, colo
r = 'red')
sns.distplot(combined[combined.target == 1].ps_reg_02.dropna(),
             bins = np.linspace(0, 2, 11), kde = False, norm_hist = True, colo
r = 'blue')
plt.title('ps_reg_02 Distribution')

plt.subplot(223)
sns.distplot(combined[combined.target == 0].ps_car_11_cat.dropna(),
             bins = range(0, 110, 5), kde = False, norm_hist = True, color =
'red')
sns.distplot(combined[combined.target == 1].ps_car_11_cat.dropna(),
             bins = range(0, 110, 5), kde = False, norm_hist = True, color =
'blue')
plt.title('ps_car_11_cat Distribution')

plt.subplot(224)
sns.distplot(combined[combined.target == 0].ps_ind_01.dropna(),
             bins = range(0, 8, 1), kde = False, norm_hist = True, color = 're
d')
sns.distplot(combined[combined.target == 1].ps_ind_01.dropna(),
             bins = range(0, 8, 1), kde = False, norm_hist = True, color = 'bl
ue')
plt.title('ps_ind_01 Distribution')
```

Out[57]: Text(0.5, 1.0, 'ps_ind_01 Distribution')

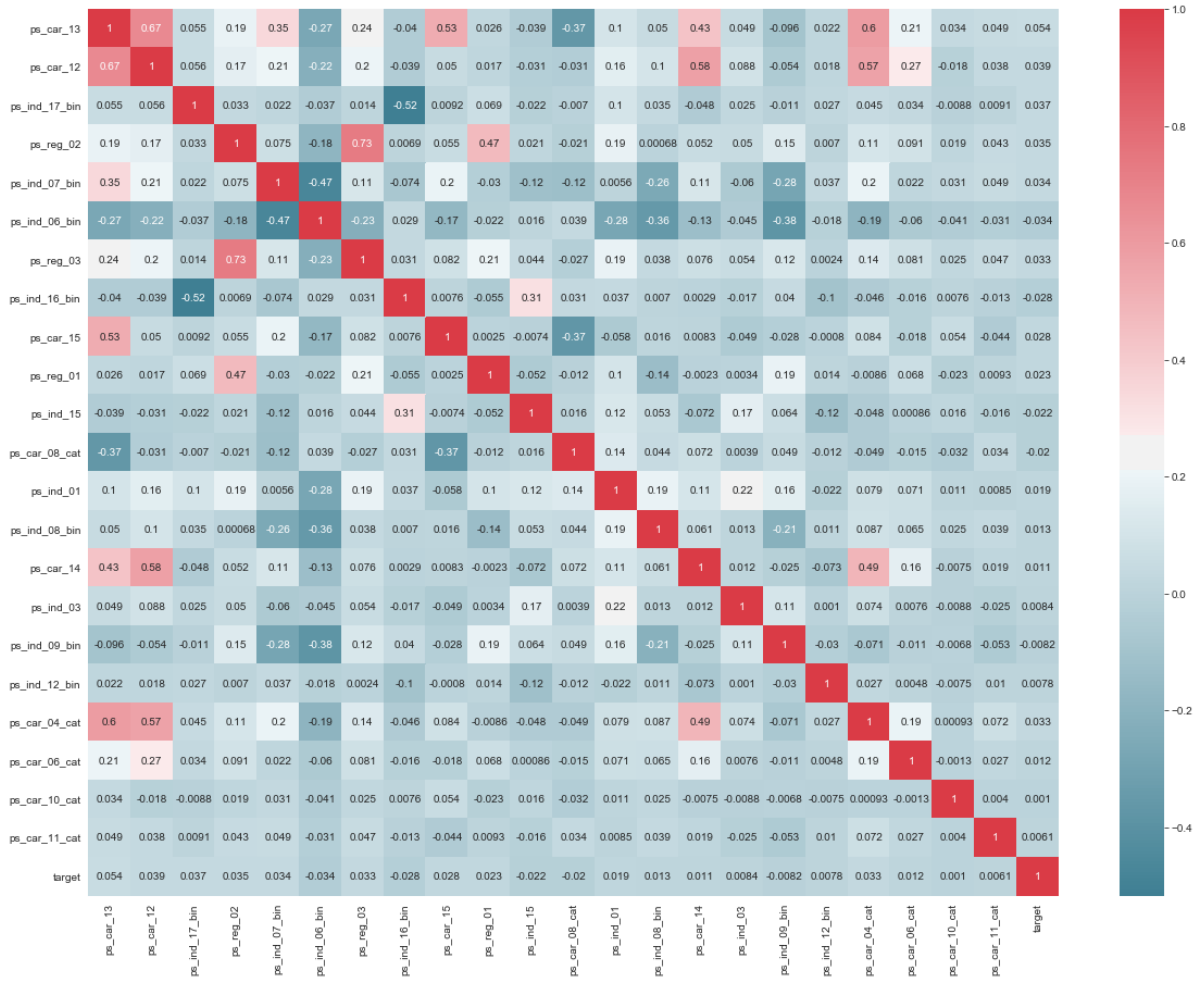


In [74]:
```
plt.figure(figsize=(20,15))

plt.subplot(221)
sns.distplot(combined[combined.target == 0].ps_car_15.dropna(),
             kde = False, norm_hist = True, color = 'red')
sns.distplot(combined[combined.target == 1].ps_car_15.dropna(),
             kde = False, norm_hist = True, color = 'blue')
plt.title('ps_car_15 Distribution')

plt.subplot(222)
sns.distplot(combined[combined.target == 0].ps_reg_01.dropna(),
             bins = range(0, 11, 1), kde = False, norm_hist = True, color = 'r
ed')
sns.distplot(combined[combined.target == 1].ps_reg_01.dropna(),
             bins = range(0, 11, 1), kde = False, norm_hist = True, color = 'b
lue')
plt.title('ps_reg_01 Distribution')

plt.subplot(223)
sns.distplot(combined[combined.target == 0].ps_car_01_cat.dropna(),
             bins = range(-1, 11, 1), kde = False, norm_hist = True, color =
'red')
sns.distplot(combined[combined.target == 1].ps_car_01_cat.dropna(),
             bins = range(-1, 11, 1), kde = False, norm_hist = True, color =
'blue')
plt.title('ps_car_01_cat Distribution')

plt.subplot(224)
sns.distplot(combined[combined.target == 0].ps_car_06_cat.dropna(),
             bins = range(0, 17, 1), kde = False, norm_hist = True, color = 'r
ed')
sns.distplot(combined[combined.target == 1].ps_car_06_cat.dropna(),
             bins = range(0, 17, 1), kde = False, norm_hist = True, color = 'b
lue')
plt.title('ps_car_06_cat Distribution')
```

Out[74]: Text(0.5, 1.0, 'ps_car_06_cat Distribution')



In [75]:
```
combined['target'] = df_train.set_index('id').target

plt.figure(figsize=(20, 15))
sns.heatmap(combined.corr(), annot = True, cmap = cmap)
plt.show()
```



In [76]:
```
ind_var = [feature for feature in combined.columns[sorted_idx][-10:]
           if feature != 'target']
ind_var.reverse()
```

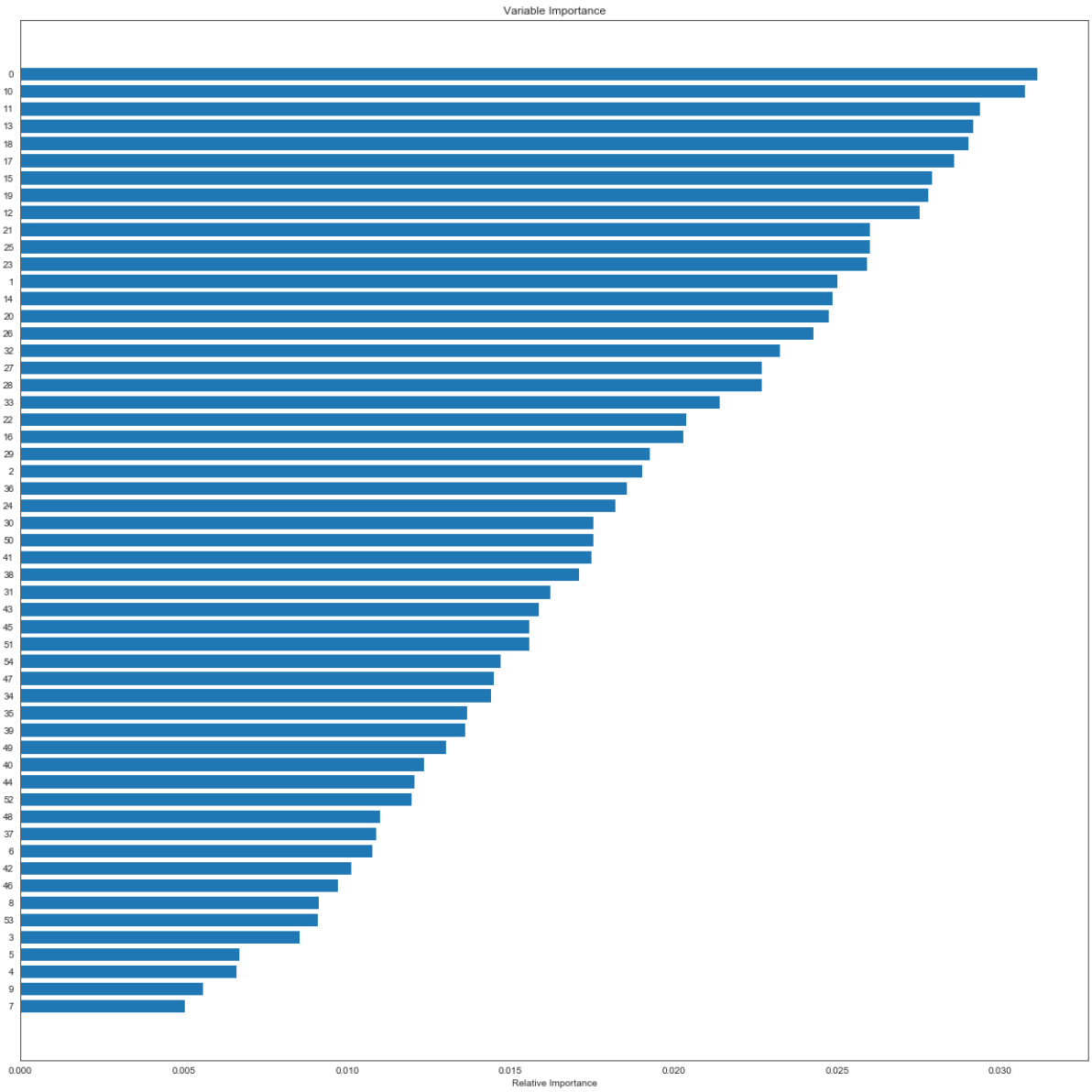
In [77]:
```
from sklearn.preprocessing import PolynomialFeatures

train = combined[pd.notnull(combined.target)][ind_var].reset_index(drop=True)

poly = PolynomialFeatures(interaction_only = True, include_bias = False)

train_interaction = pd.DataFrame(poly.fit_transform(train))
train_interaction['target'] = df_train.target
```

In [78]:
```
features = np.array([feature for feature in train_interaction.columns.tolist()
                     if feature != 'target'])

clf = RandomForestClassifier(50, random_state = random_state)
clf.fit(train_interaction.iloc[:df_train.shape[0]][features],
        train_interaction.iloc[:df_train.shape[0]]['target'])
```

Out[78]:
```
RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight=None,
                       criterion='gini', max_depth=None, max_features='auto',
                       max_leaf_nodes=None, max_samples=None,
                       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=50,
                       n_jobs=None, oob_score=False, random_state=1212,
                       verbose=0, warm_start=False)
```

In [79]:
```
importances = clf.feature_importances_
sorted_idx = np.argsort(importances)

plt.figure(figsize=(15, 10))

plt.figure(figsize=(20, 20))
padding = np.arange(len(features)) + 0.5
plt.barh(padding, importances[sorted_idx], align='center')
plt.yticks(padding, features[sorted_idx])
plt.xlabel("Relative Importance")
plt.title("Variable Importance")

plt.show()
```

```
<Figure size 1080x720 with 0 Axes>
```

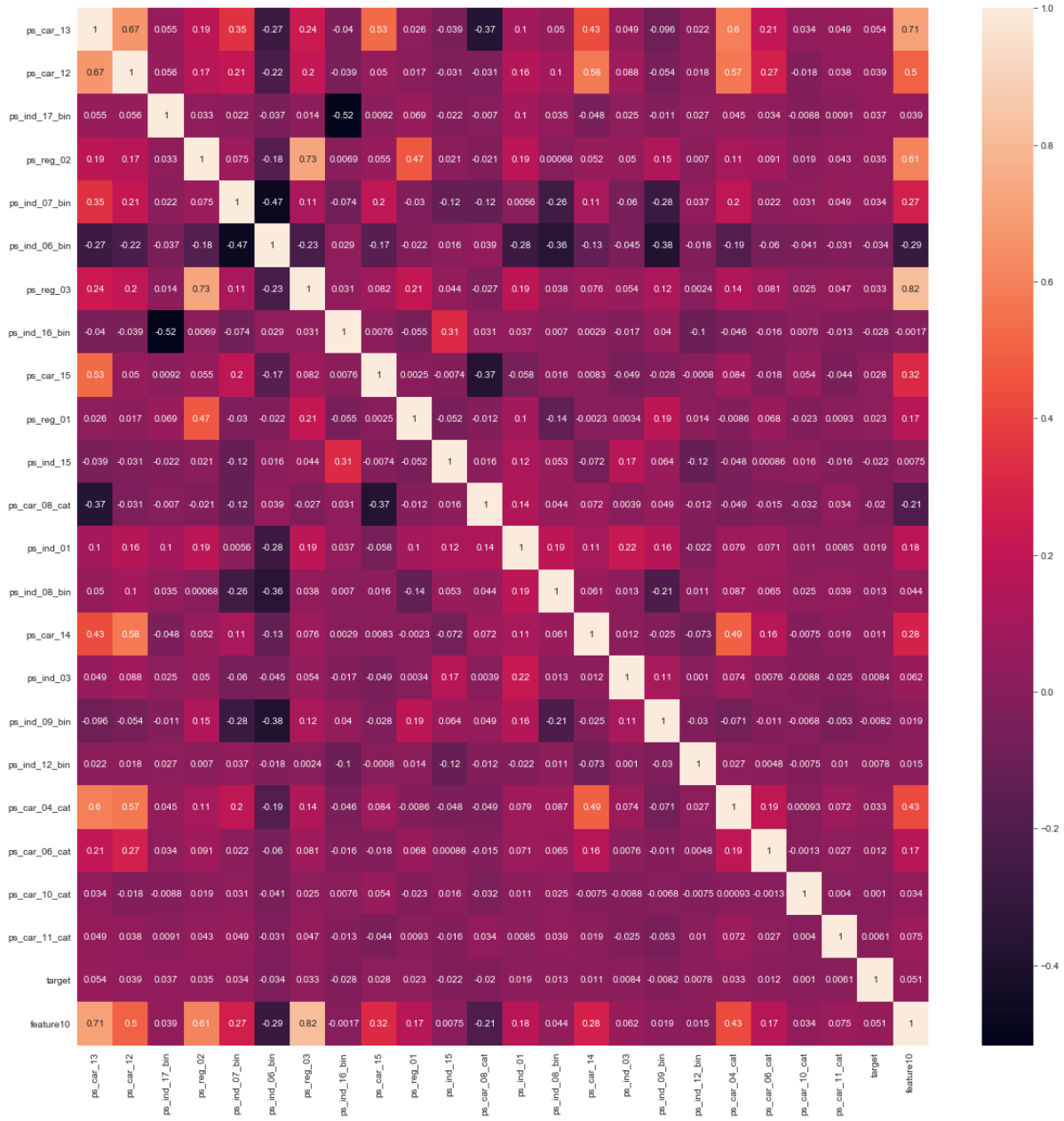


In [80]:
```
[feat for feat in ind_var]
```

Out[80]:
```
['ps_car_13',
 'ps_reg_03',
 'ps_car_14',
 'ps_ind_15',
 'ps_ind_03',
 'ps_reg_02',
 'ps_car_11_cat',
 'ps_ind_01',
 'ps_car_15',
 'ps_reg_01']
```

In [81]:
```
combined['feature10'] = combined['ps_car_13'] * combined['ps_reg_03']
```

In [82]:
```
combined['target'] = df_train.set_index('id').target

plt.figure(figsize=(20, 20))
sns.heatmap(combined.corr(), annot = True)
plt.show()
```

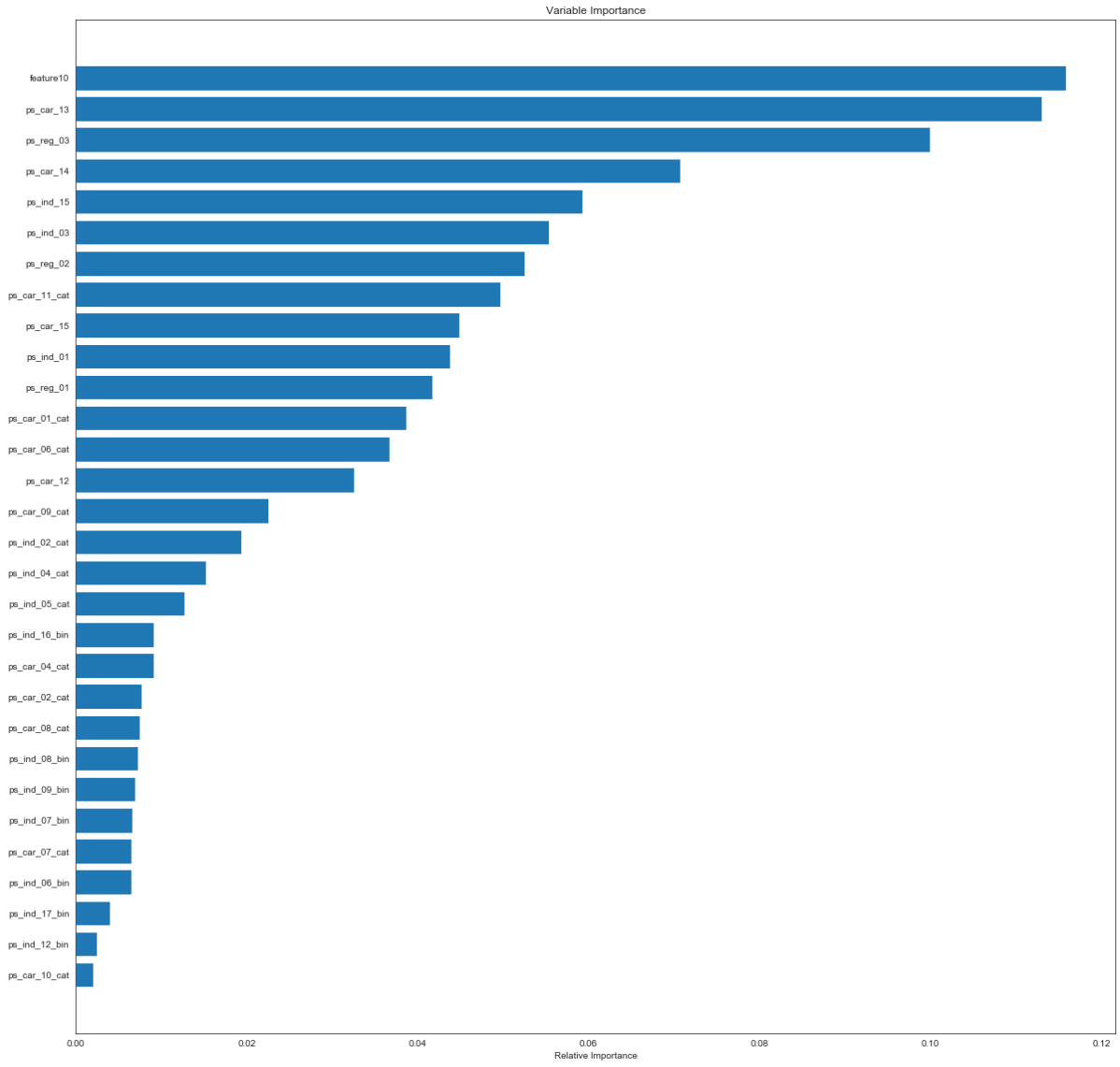


In [83]:
```
features = np.array([feature for feature in combined.columns.tolist()
                     if feature != 'target'])

clf = RandomForestClassifier(50, random_state = random_state)
clf.fit(combined[pd.notnull(combined.target)][features],
        combined[pd.notnull(combined.target)].target)
```

Out[83]:
```
RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight=None,
                       criterion='gini', max_depth=None, max_features='auto',
                       max_leaf_nodes=None, max_samples=None,
                       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=50,
                       n_jobs=None, oob_score=False, random_state=1212,
                       verbose=0, warm_start=False)
```

In [84]:
```
importances = clf.feature_importances_
sorted_idx = np.argsort(importances)

plt.figure(figsize=(15, 10))

plt.figure(figsize=(20, 20))
padding = np.arange(len(features)) + 0.5
plt.barh(padding, importances[sorted_idx], align='center')
plt.yticks(padding, features[sorted_idx])
plt.xlabel("Relative Importance")
plt.title("Variable Importance")

plt.show()
```

```
<Figure size 1080x720 with 0 Axes>
```



In [85]:
```
del combined['target']
```

In [86]:
```
X_train = combined.reset_index(drop = True).iloc[:df_train.shape[0], ]
X_test = combined.reset_index(drop = True).iloc[df_train.shape[0]:, ]
```

In [87]:
```
def gini(actual, pred, cmpcol = 0, sortcol = 1):
    assert( len(actual) == len(pred) )
    all = np.asarray(np.c_[ actual, pred, np.arange(len(actual)) ], dtype=np.f
loat)
    all = all[ np.lexsort((all[:,2], -1*all[:,1])) ]
    totalLosses = all[:,0].sum()
    giniSum = all[:,0].cumsum().sum() / totalLosses

    giniSum -= (len(actual) + 1) / 2.
    return giniSum / len(actual)

def gini_normalized(a, p):
    return gini(a, p) / gini(a, a)

def gini_xgb(preds, dtrain):
    labels = dtrain.get_label()
    gini_score = gini_normalized(labels, preds)
    return 'gini', gini_score
```

In [88]:
```
features = X_train.columns.tolist

X = X_train.values; test = X_test.values

y = df_train.set_index('id').target.values
```

In [89]:
```
params = {
    'objective': 'binary:logistic',
    'min_child_weight': 12.0,
    'max_depth': 5,
    'colsample_bytree': 0.5,
    'subsample': 0.8,
    'eta': 0.025,
    'gamma': 0.8,
    'max_delta_step': 1.5
}
```

In [90]:
```
import xgboost as xgb
from sklearn.model_selection import StratifiedKFold

submission = pd.DataFrame()
submission['id'] = df_test['id'].values
submission['target'] = 0

nrounds=1000
folds = 5
skf = StratifiedKFold(n_splits=folds, random_state=random_state)

for i, (train_index, test_index) in enumerate(skf.split(X, y)):
    int(i+1)

    X_subtrain, X_subtest = X[train_index], X[test_index]
    y_train, y_valid = y[train_index], y[test_index]

    d_subtrain = xgb.DMatrix(X_subtrain, y_train)
    d_subtest = xgb.DMatrix(X_subtest, y_valid)
    d_test = xgb.DMatrix(test)

    watchlist = [(d_subtrain, 'subtrain'), (d_subtest, 'subtest')]

    mdl = xgb.train(params, d_subtrain, nrounds, watchlist, early_stopping_rou
nds=80,
                    feval=gini_xgb, maximize=True, verbose_eval=50)

    # Predict test set based on the best_ntree_limit
    p_test = mdl.predict(d_test, ntree_limit=mdl.best_ntree_limit)

    # Take the average of the prediction via 5 folds to predict for the test s
et
    submission['target'] += p_test/folds
```

```
[0]     subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.00029
subtest-gini:0.00962
Multiple eval metrics have been passed: 'subtest-gini' will be used for early
stopping.

Will train until subtest-gini hasn't improved in 80 rounds.
[50]    subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.26356
subtest-gini:0.25331
[100]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.27193
subtest-gini:0.25643
[150]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.28650
subtest-gini:0.26338
[200]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.30089
subtest-gini:0.27015
[250]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.31509
subtest-gini:0.27595
[300]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.32624
subtest-gini:0.27933
[350]   subtrain-error:0.03644  subtest-error:0.03645   subtrain-gini:0.33491
subtest-gini:0.28077
[400]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.34336
subtest-gini:0.28194
[450]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.34968
subtest-gini:0.28324
[500]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.35577
subtest-gini:0.28371
[550]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.36196
subtest-gini:0.28339
Stopping. Best iteration:
[500]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.35577
subtest-gini:0.28371

[0]     subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:-0.0000
3       subtest-gini:0.01462
Multiple eval metrics have been passed: 'subtest-gini' will be used for early
stopping.

Will train until subtest-gini hasn't improved in 80 rounds.
[50]    subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.26235
subtest-gini:0.24479
[100]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.27280
subtest-gini:0.25146
[150]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.28488
subtest-gini:0.26015
[200]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.29897
subtest-gini:0.26754
[250]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.31356
subtest-gini:0.27331
[300]   subtrain-error:0.03644  subtest-error:0.03645   subtrain-gini:0.32516
subtest-gini:0.27725
[350]   subtrain-error:0.03644  subtest-error:0.03645   subtrain-gini:0.33384
subtest-gini:0.27980
[400]   subtrain-error:0.03644  subtest-error:0.03645   subtrain-gini:0.34170
subtest-gini:0.28136
[450]   subtrain-error:0.03644  subtest-error:0.03645   subtrain-gini:0.34824
subtest-gini:0.28223
[500]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.35492
```

```
subtest-gini:0.28318
[550]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.36138
subtest-gini:0.28377
[600]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.36718
subtest-gini:0.28453
[650]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.37232
subtest-gini:0.28508
[700]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.37763
subtest-gini:0.28505
Stopping. Best iteration:
[643]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.37187
subtest-gini:0.28513

[0]     subtrain-error:0.03645  subtest-error:0.03644   subtrain-gini:0.00107
subtest-gini:-0.00257
Multiple eval metrics have been passed: 'subtest-gini' will be used for early
stopping.

Will train until subtest-gini hasn't improved in 80 rounds.
[50]    subtrain-error:0.03645  subtest-error:0.03644   subtrain-gini:0.27046
subtest-gini:0.25099
[100]   subtrain-error:0.03645  subtest-error:0.03644   subtrain-gini:0.27749
subtest-gini:0.25450
[150]   subtrain-error:0.03645  subtest-error:0.03644   subtrain-gini:0.28743
subtest-gini:0.26176
[200]   subtrain-error:0.03645  subtest-error:0.03644   subtrain-gini:0.30224
subtest-gini:0.26775
[250]   subtrain-error:0.03645  subtest-error:0.03644   subtrain-gini:0.31426
subtest-gini:0.27345
[300]   subtrain-error:0.03645  subtest-error:0.03644   subtrain-gini:0.32511
subtest-gini:0.27770
[350]   subtrain-error:0.03645  subtest-error:0.03644   subtrain-gini:0.33409
subtest-gini:0.27981
[400]   subtrain-error:0.03644  subtest-error:0.03644   subtrain-gini:0.34229
subtest-gini:0.28115
[450]   subtrain-error:0.03644  subtest-error:0.03644   subtrain-gini:0.34926
subtest-gini:0.28171
[500]   subtrain-error:0.03644  subtest-error:0.03645   subtrain-gini:0.35515
subtest-gini:0.28237
[550]   subtrain-error:0.03644  subtest-error:0.03645   subtrain-gini:0.36175
subtest-gini:0.28286
[600]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.36734
subtest-gini:0.28314
[650]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.37261
subtest-gini:0.28337
[700]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.37740
subtest-gini:0.28311
Stopping. Best iteration:
[652]   subtrain-error:0.03643  subtest-error:0.03645   subtrain-gini:0.37280
subtest-gini:0.28340

[0]     subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.00109
subtest-gini:-0.00266
Multiple eval metrics have been passed: 'subtest-gini' will be used for early
stopping.

Will train until subtest-gini hasn't improved in 80 rounds.
```

```
[50]    subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.26736
subtest-gini:0.25055
[100]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.27570
subtest-gini:0.25482
[150]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.28478
subtest-gini:0.26048
[200]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.29898
subtest-gini:0.26949
[250]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.31177
subtest-gini:0.27615
[300]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.32260
subtest-gini:0.28105
[350]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.33180
subtest-gini:0.28445
[400]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.33925
subtest-gini:0.28579
[450]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.34595
subtest-gini:0.28724
[500]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.35212
subtest-gini:0.28768
[550]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.35812
subtest-gini:0.28837
[600]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.36348
subtest-gini:0.28879
[650]   subtrain-error:0.03644  subtest-error:0.03645   subtrain-gini:0.36886
subtest-gini:0.28949
[700]   subtrain-error:0.03644  subtest-error:0.03645   subtrain-gini:0.37394
subtest-gini:0.28935
Stopping. Best iteration:
[665]   subtrain-error:0.03644  subtest-error:0.03645   subtrain-gini:0.37044
subtest-gini:0.28960

[0]     subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.00121
subtest-gini:-0.00452
Multiple eval metrics have been passed: 'subtest-gini' will be used for early
stopping.

Will train until subtest-gini hasn't improved in 80 rounds.
[50]    subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.26843
subtest-gini:0.24453
[100]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.27798
subtest-gini:0.25094
[150]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.28680
subtest-gini:0.25738
[200]   subtrain-error:0.03645  subtest-error:0.03645   subtrain-gini:0.30198
subtest-gini:0.26312
[250]   subtrain-error:0.03644  subtest-error:0.03645   subtrain-gini:0.31534
subtest-gini:0.26865
[300]   subtrain-error:0.03644  subtest-error:0.03646   subtrain-gini:0.32659
subtest-gini:0.27105
[350]   subtrain-error:0.03643  subtest-error:0.03647   subtrain-gini:0.33574
subtest-gini:0.27269
[400]   subtrain-error:0.03643  subtest-error:0.03647   subtrain-gini:0.34385
subtest-gini:0.27348
[450]   subtrain-error:0.03643  subtest-error:0.03647   subtrain-gini:0.35084
subtest-gini:0.27413
[500]   subtrain-error:0.03643  subtest-error:0.03647   subtrain-gini:0.35707
```

```
subtest-gini:0.27436
[550]   subtrain-error:0.03643  subtest-error:0.03647   subtrain-gini:0.36328
subtest-gini:0.27476
[600]   subtrain-error:0.03642  subtest-error:0.03647   subtrain-gini:0.36869
subtest-gini:0.27471
Stopping. Best iteration:
[562]   subtrain-error:0.03642  subtest-error:0.03647   subtrain-gini:0.36472
subtest-gini:0.27492
```

In [ ]:
```
submission.to_csv('C:/Users/puj83/OneDrive/Portfolio/Porto_Seguro_Claims/submission.csv', index=False)
```