In [222]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

from scipy import stats
from scipy.stats import norm
from scipy.stats import t
from numpy.random import seed
```

In [223]:
```
df = pd.read_csv('DATA/insurance2.csv')
df.head()
```

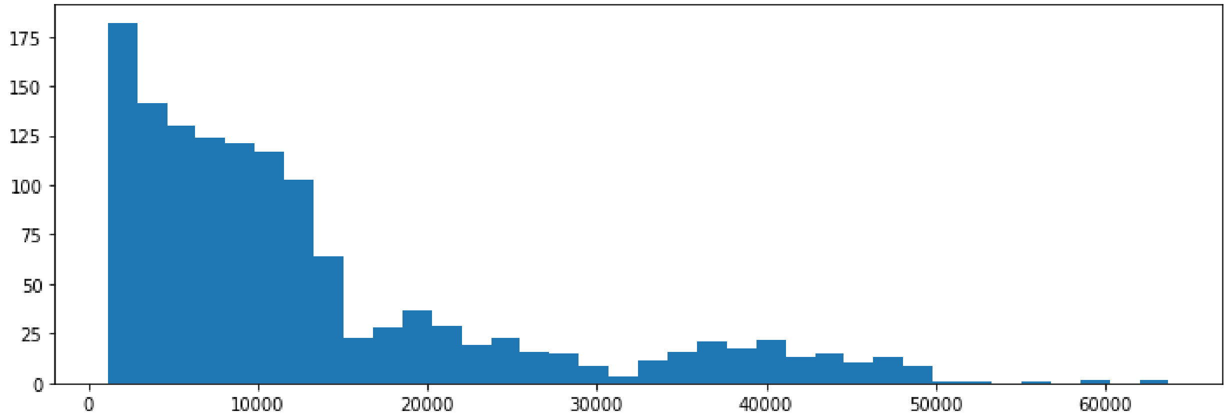
Out[223]:

| | age | sex | bmi | children | smoker | region | charges | insuranceclaim |
|---|---|---|---|---|---|---|---|---|
| **0** | 19 | 0 | 27.900 | 0 | 1 | 3 | 16884.92400 | 1 |
| **1** | 18 | 1 | 33.770 | 1 | 0 | 2 | 1725.55230 | 1 |
| **2** | 28 | 1 | 33.000 | 3 | 0 | 2 | 4449.46200 | 0 |
| **3** | 33 | 1 | 22.705 | 0 | 0 | 1 | 21984.47061 | 0 |
| **4** | 32 | 1 | 28.880 | 0 | 0 | 1 | 3866.85520 | 1 |

In [224]:
```
df.columns
```

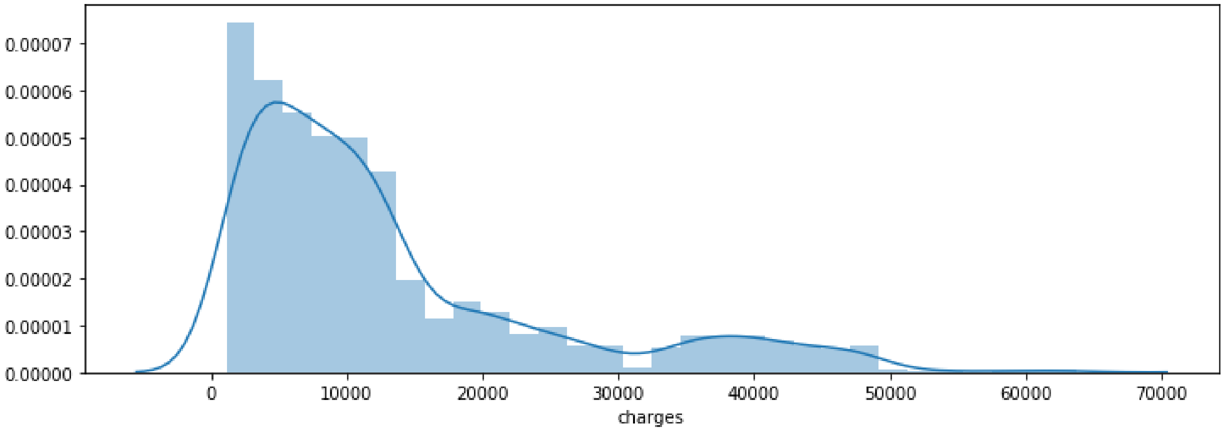
Out[224]:
```
Index(['age', 'sex', 'bmi', 'children', 'smoker', 'region', 'charges',
       'insuranceclaim'],
      dtype='object')
```

In [225]:
```
plt.figure(figsize=(12,4))
df['charges'].hist(bins=36)
plt.grid()
plt.show()
```



In [226]:
```
import seaborn as sns
```

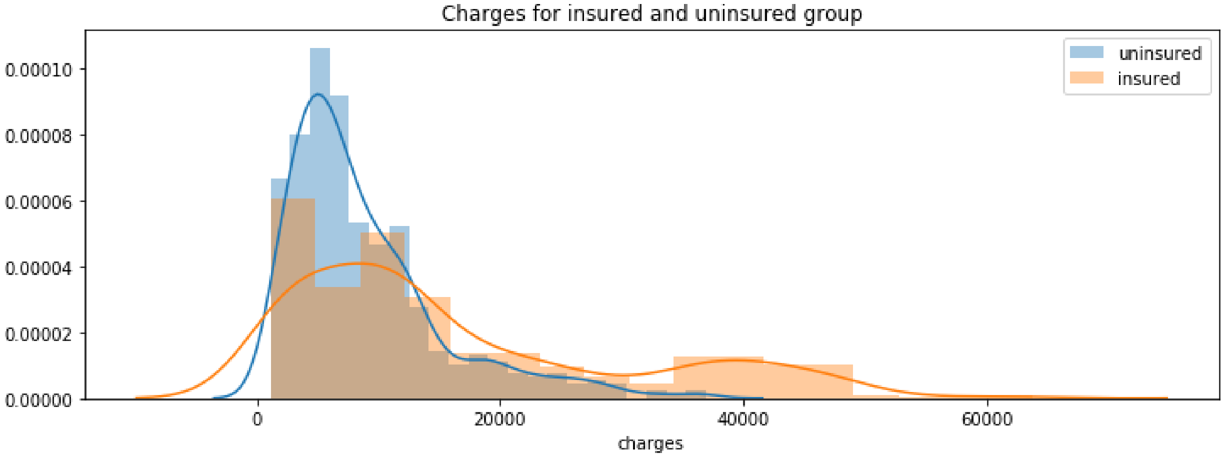
```
In [227]: plt.figure(figsize=(12,4))
          sns.distplot(df["charges"])
          plt.show()
```



```
In [228]: df[df['insuranceclaim']==1]['charges'].head()
```

```
Out[228]: 0     16884.9240
          1      1725.5523
          4      3866.8552
          6      8240.5896
          10     2721.3208
          Name: charges, dtype: float64
```

```
In [229]: plt.figure(figsize=(12,4))
          sns.distplot(df[df['insuranceclaim']==0]['charges'], label='uninsured')
          sns.distplot(df[df['insuranceclaim']==1]['charges'], label='insured')
          plt.title(" Charges for insured and uninsured group ")
          plt.legend()
          plt.show()
```



## Compare two groups statistically

```
In [230]: df[df['insuranceclaim']==1]['charges'].mean(), df[df['insuranceclaim']==0][
```

```
Out[230]: (16423.928276537663, 8821.421892306294)
```

```
In [231]: df[df['insuranceclaim']==1]['charges'].std(), df[df['insuranceclaim']==0]['
```

```
Out[231]: (14045.928418802127, 6446.510126811736)
```

By comparing the mean and std of the above two groups, we see they are not same

```
In [232]: [t,p] = stats.ttest_ind(df[df['insuranceclaim']==1]['charges'], df[df['insur
          t, p
```

```
Out[232]: (11.893299030876712, 4.461230231620717e-31)
```

The probability that the two groups are same is null

The pooled standard deviation

```
In [233]: s_1 = df[df['insuranceclaim']==1]['charges'].std()
          n_1 = len(df[df['insuranceclaim']==1]['charges'])
          s_1, v_1
```

```
Out[233]: (14045.928418802127, 197288105.14611322)
```

```
In [234]: s_0 = df[df['insuranceclaim']==0]['charges'].std()
          n_0 = len(df[df['insuranceclaim']==0]['charges'])
          s_0, n_0
```

```
Out[234]: (6446.510126811736, 555)
```

```
In [235]: s_p = np.sqrt( ((n_1-1)*s_1**2+(n_0-1)*s_0**2)/(n_1+n_0-2) )
          s_p
```

```
Out[235]: 11520.034268775256
```

```
In [236]: t_p = ( df[df['insuranceclaim']==1]['charges'].mean() - df[df['insurancecla

          t_p, t
```

```
Out[236]: (11.89329903087671, 11.893299030876712)
```

So the t value calculated here by standard subroutine and by alternative approach is same

Now the p-value can be calculated as p_value = 2*(1 - t.cdf(t_stat, df=total_dof))

```
In [237]: print(" p = p_value = 2*(1 - t.cdf(t_stat, df=total_dof)) " )

           p = p_value = 2*(1 - t.cdf(t_stat, df=total_dof))
```

In [238]:
```
p_1 = 0
p_1
```

Out[238]:
```
0
```

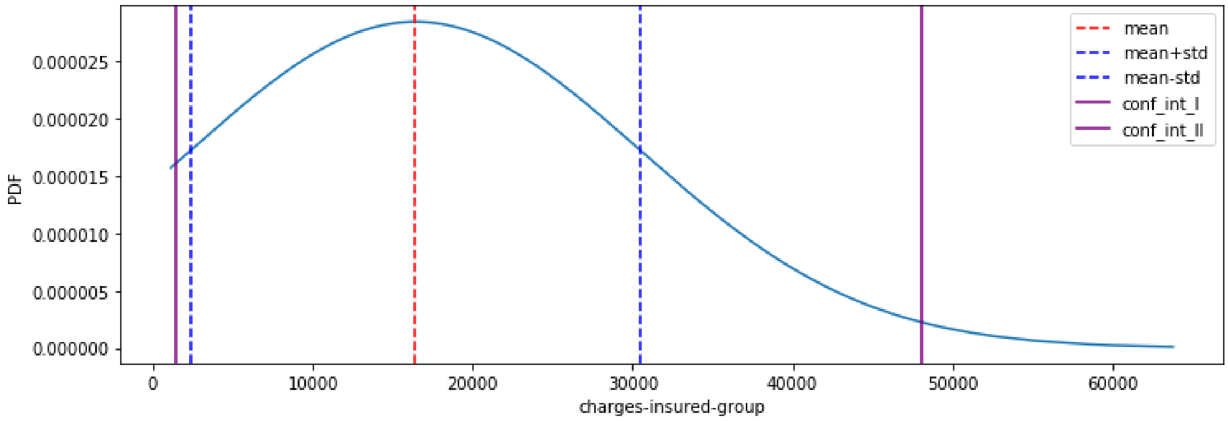
# Z score

In [239]:
```
x = np.sort(df[df['insuranceclaim']==1]['charges'])
x_bar = np.mean(x)
x_sigma = np.std(x)
x_bar, x_sigma
```

Out[239]:
```
(16423.928276537674, 14036.956250260417)
```

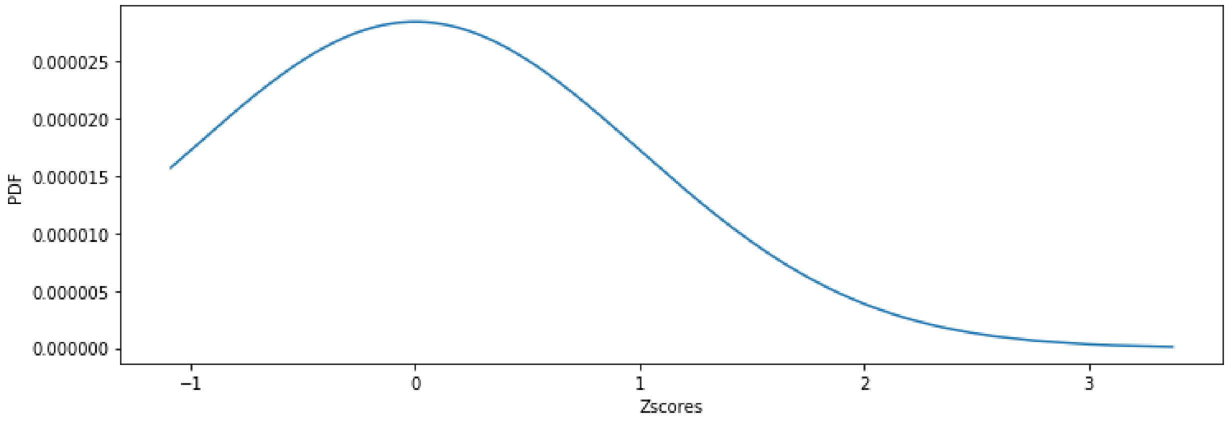
In [240]:
```
x_pdf = norm.pdf(x, loc=x_bar, scale=x_sigma)
c_int = 96
conf_int = np.percentile(x, [(100-c_int)/2,c_int+(100-c_int)/2])
conf_int[0]

x_zscore = stats.zscore(x)
```

In [241]:
```
plt.figure(figsize=(12,4))
plt.plot(x, x_pdf)
plt.axvline(x_bar, color='red', linestyle='--', label='mean')
plt.axvline(x_bar+x_sigma, color='blue', linestyle='--', label='mean+std')
plt.axvline(x_bar-x_sigma, color='blue', linestyle='--', label='mean-std')

plt.axvline(conf_int[0], color='purple', linestyle='-', label='conf_int_I')
plt.axvline(conf_int[1], color='purple', linestyle='-', label='conf_int_II'

plt.xlabel('charges-insured-group')
plt.ylabel('PDF')

plt.legend()
plt.show()
```



In [242]:

```
plt.figure(figsize=(12,4))
x_zscore = stats.zscore(x)
plt.plot(x_zscore, x_pdf)

plt.xlabel('Zscores')
plt.ylabel('PDF')
plt.show()
```



In [ ]:

In [ ]:

In [ ]: