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            "1          2  15647311    Hill      608  Spain  Female  41  \n",
            "2          3  15619304   Onio      502  France  Female  42  \n",
            "3          4  15701354   Boni      699  France  Female  39  \n",
            "4          5  15737888  Mitchell      850  Spain  Female  43  \n",
            "...      ...      ...      ...      ...      ...      ...      \n",
            "9995      9996  15606229  Obijiaku      771  France  Male  39  \n",
            "9996      9997  15569892  Johnstone      516  France  Male  35  \n",
            "9997      9998  15584532    Liu      709  France  Female  36  \n",
            "9998      9999  15682355  Sabbatini      772  Germany  Male  42  \n",
            "9999     10000  15628319   Walker      792  France  Female  28  \n",
            "\n",
            "  Tenure  Balance  NumOfProducts  HasCrCard  IsActiveMember  \n",
            "0        2    0.00            1      1            1  \n",
            "1        1  83807.86            1      0            1  \n",
            "2        8 159660.80            3      1            0  \n",
            "3        1    0.00            2      0            0  \n",
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"9999 4 130142.79 1 1 0 \n",
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"1 112542.58 0 \n",
"2 113931.57 1 \n",
"3 93826.63 0 \n",
"4 79084.10 0 \n",
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    "\n",
    "#median of CreditScore\n",
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    "\n",
    "# standard deviation of CreditScore\n",
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"35  474\n",
"36  456\n",
"34  447\n",
"   ... \n",
"92   2\n",
"82   1\n",
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"85   1\n",
"83   1\n",
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"4      5  15737888    Mitchell  850    Spain Female  43  \n",
"\n",
"  Tenure  Balance  NumOfProducts  HasCrCard  IsActiveMember  \\\n",
"0      2    0.00          1          1          1  \n",
"1      1 83807.86          1          0          1  \n",
"2      8 159660.80          3          1          0  \n",
"3      1    0.00          2          0          0  \n",
"4      2 125510.82          1          1          1  \n",
"\n",
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"0      101348.88      1  \n",
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"Skew:             -0.072  Prob(JB):          5.43e-19\n",
"Kurtosis:         2.574  Cond. No.          1.56e+05\n",

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\n",
"Notes:\n",
"[1] Standard Errors assume that the covariance matrix of the errors is correctly
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"[2] The condition number is large, 1.56e+05. This might indicate that there are\n",
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"x = df[['Balance']]\n",
\n",
"#add constant to predictor variables\n",
"x = sm.add_constant(x)\n",
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"#fit linear regression model\n",
"model = sm.OLS(y, x).fit()\n",

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"print(model.summary())"
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"### v. Means and Variances Per Group\n",
"### vi. Between-groups Variance and Within-groups Variance for a Variable\n",
"### vii. Between-groups Covariance and Within-groups Covariance for Two Variables\n",
"### viii. Calculating Correlations for Multivariate Data\n",
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"std   2886.89568  7.193619e+04  96.653299   10.487806   2.892174  \n",
"min    1.00000  1.556570e+07  350.000000   18.000000   0.000000  \n",
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```

```

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"\n",
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"\n",
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```

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"    <td>5</td>\n",
"    <td>15737888</td>\n",
"    <td>Mitchell</td>\n",
"    <td>850</td>\n",
"    <td>0</td>\n",
"    <td>43</td>\n",
"    <td>2</td>\n",
"    <td>125510.82</td>\n",
"    <td>1</td>\n",
"    <td>1</td>\n",
"    <td>1</td>\n",
"    <td>79084.10</td>\n",

```

```

"    <td>0</td>\n",
"    <td>0</td>\n",
"    <td>0</td>\n",
"    <td>1</td>\n",
"  </tr>\n",
" </tbody>\n",
"</table>\n",
"</div>"
],
"text/plain": [
"  RowNumber CustomerId Surname CreditScore Gender Age Tenure \\n",
"0      1  15634602 Hargrave      619    0  42    2  \n",
"1      2  15647311 Hill        608    0  41    1  \n",
"2      3  15619304 Onio        502    0  42    8  \n",
"3      4  15701354 Boni        699    0  39    1  \n",
"4      5  15737888 Mitchell    850    0  43    2  \n",
"\n",
"  Balance NumOfProducts HasCrCard IsActiveMember EstimatedSalary \\n",
"0      0.00      1      1      1      101348.88 \n",
"1  83807.86      1      0      1      112542.58 \n",
"2  159660.80      3      1      0      113931.57 \n",
"3      0.00      2      0      0      93826.63 \n",
"4  125510.82      1      1      1      79084.10 \n",
"\n",
"  Exited Geography_France Geography_Germany Geography_Spain \n",
"0      1      1      0      0 \n",
"1      0      0      0      1 \n",
"2      1      1      0      0 \n",
"3      0      1      0      0 \n",
"4      0      0      0      1 "
]
},
"execution_count": 76,
"metadata": {},
"output_type": "execute_result"
}
],
"source": [
"#one hot encoding\n",
"ld1_main=pd.get_dummies(ld1,columns=['Geography'])\n",
"ld1_main.head()"
]
},
{
"cell_type": "markdown",
"id": "3b9f0319",
"metadata": {},
"source": [

```

```

"# 8. Split the data into dependent and independent variables."
]
},
{
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  "metadata": {},
  "outputs": [
    {
      "name": "stdout",
      "output_type": "stream",
      "text": [
        "[[1 15634602 'Hargrave' ... 1 1 101348.88]\n",
        " [2 15647311 'Hill' ... 0 1 112542.58]\n",
        " [3 15619304 'Onio' ... 1 0 113931.57]\n",
        " ... \n",
        " [9998 15584532 'Liu' ... 0 1 42085.58]\n",
        " [9999 15682355 'Sabbatini' ... 1 0 92888.52]\n",
        " [10000 15628319 'Walker' ... 1 0 38190.78]]\n"
      ]
    }
  ],
  "source": [
    "#Splitting the Dataset into the Independent Feature Matrix\n",
    "df=pd.read_csv(\"Churn_Modelling.csv\")\n",
    "X = df.iloc[:, :-1].values\n",
    "print(X)"
  ]
},
{
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  "execution_count": 86,
  "id": "0301a95c",
  "metadata": {},
  "outputs": [
    {
      "name": "stdout",
      "output_type": "stream",
      "text": [
        "[1 0 1 ... 1 1 0]\n"
      ]
    }
  ],
  "source": [
    "#Extracting the Dataset to Get the Dependent Vector\n",
    "Y = df.iloc[:, -1].values\n",
    "print(Y)"
  ]
}

```

```

]
},
{
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  "id": "701a4bee",
  "metadata": {},
  "source": [
    "# 9. Scale the independent variables"
  ]
},
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  "metadata": {},
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          "    vertical-align: middle;\n",
          "  }\n",
          "\n",
          "  .dataframe tbody tr th {\n",
          "    vertical-align: top;\n",
          "  }\n",
          "\n",
          "  .dataframe thead th {\n",
          "    text-align: right;\n",
          "  }\n",
          "</style>\n",
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          "  <thead>\n",
          "    <tr style='text-align: right;'>\n",
          "      <th></th>\n",
          "      <th>Age</th>\n",
          "      <th>Balance</th>\n",
          "      <th>EstimatedSalary</th>\n",
          "    </tr>\n",
          "  </thead>\n",
          "  <tbody>\n",
          "    <tr>\n",
          "      <th>0</th>\n",
          "      <td>42</td>\n",
          "      <td>0.00</td>\n",
          "      <td>101348.88</td>\n",

```

```

" </tr>\n",
" <tr>\n",
"   <th>1</th>\n",
"   <td>41</td>\n",
"   <td>83807.86</td>\n",
"   <td>112542.58</td>\n",
" </tr>\n",
" <tr>\n",
"   <th>2</th>\n",
"   <td>42</td>\n",
"   <td>159660.80</td>\n",
"   <td>113931.57</td>\n",
" </tr>\n",
" <tr>\n",
"   <th>3</th>\n",
"   <td>39</td>\n",
"   <td>0.00</td>\n",
"   <td>93826.63</td>\n",
" </tr>\n",
" <tr>\n",
"   <th>4</th>\n",
"   <td>43</td>\n",
"   <td>125510.82</td>\n",
"   <td>79084.10</td>\n",
" </tr>\n",
" </tbody>\n",
"</table>\n",
"</div>"
],
"text/plain": [
" Age  Balance  EstimatedSalary\n",
"0  42    0.00    101348.88\n",
"1  41  83807.86    112542.58\n",
"2  42 159660.80    113931.57\n",
"3  39    0.00    93826.63\n",
"4  43 125510.82    79084.10"
]
},
"execution_count": 96,
"metadata": {},
"output_type": "execute_result"
}
],
"source": [
"w = df.head()\n",
"q = w[['Age', 'Balance', 'EstimatedSalary']] #splitting the dataset into measureable\n",
"values\n",
"q"

```

```

]
},
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          "       [0.5      , 0.52491194, 0.96014087],\n",
          "       [0.75      , 1.        , 1.        ],\n",
          "       [0.        , 0.        , 0.42305883],\n",
          "       [1.        , 0.78610918, 0.        ]])"
        ]
      },
      "execution_count": 101,
      "metadata": {},
      "output_type": "execute_result"
    }
  ],
  "source": [
    "from sklearn.preprocessing import scale # library for scalling\n",
    "from sklearn.preprocessing import MinMaxScaler\n",
    "mm = MinMaxScaler()\n",
    "\n",
    "x_scaled = mm.fit_transform(q)\n",
    "x_scaled"
  ]
},
{
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  "metadata": {},
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        "text/plain": [
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          "       [-0.29488391,  0.15434425,  0.96285595],\n",
          "       [ 0.44232587,  1.32369179,  1.07074687],\n",
          "       [-1.76930347, -1.13763618, -0.49092058],\n",
          "       [ 1.17953565,  0.79723632, -1.6360585 ]])"
        ]
      },
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      "metadata": {},
      "output_type": "execute_result"
    }
  ],
  "source": [
    "from sklearn.preprocessing import scale # library for scalling\n",
    "from sklearn.preprocessing import MinMaxScaler\n",
    "mm = MinMaxScaler()\n",
    "\n",
    "x_scaled = mm.fit_transform(q)\n",
    "x_scaled"
  ]
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        "text/plain": [
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          "       [-0.29488391,  0.15434425,  0.96285595],\n",
          "       [ 0.44232587,  1.32369179,  1.07074687],\n",
          "       [-1.76930347, -1.13763618, -0.49092058],\n",
          "       [ 1.17953565,  0.79723632, -1.6360585 ]])"
        ]
      },
      "execution_count": 105,
      "metadata": {},
      "output_type": "execute_result"
    }
  ],
  "source": [
    "from sklearn.preprocessing import scale # library for scalling\n",
    "from sklearn.preprocessing import MinMaxScaler\n",
    "mm = MinMaxScaler()\n",
    "\n",
    "x_scaled = mm.fit_transform(q)\n",
    "x_scaled"
  ]
}

```

```

    "execution_count": 103,
    "metadata": {},
    "output_type": "execute_result"
  }
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"source": [
  "from sklearn.preprocessing import StandardScaler\n",
  "sc = StandardScaler()\n",
  "x_ss = sc.fit_transform(q)\n",
  "x_ss"
]
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  "metadata": {},
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          "<style scoped>\n",
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          "    vertical-align: middle;\n",
          "  }\n",
          "\n",
          "  .dataframe tbody tr th {\n",
          "    vertical-align: top;\n",
          "  }\n",
          "\n",
          "  .dataframe thead th {\n",
          "    text-align: right;\n",
          "  }\n",
          "</style>\n",
          "<table border='1' class='dataframe'>\n",
          "  <thead>\n",
          "    <tr style='text-align: right;'>\n",
          "      <th></th>\n",
          "      <th>Age</th>\n",
          "      <th>Balance</th>\n",
          "      <th>EstimatedSalary</th>\n",
          "    </tr>\n",
          "  </thead>\n",
          "  <tbody>\n",
          "    <tr>\n",
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```

```

"    <td>-1.137636</td>\n",
"    <td>0.093376</td>\n",
"  </tr>\n",
"  <tr>\n",
"    <th>1</th>\n",
"    <td>-0.294884</td>\n",
"    <td>0.154344</td>\n",
"    <td>0.962856</td>\n",
"  </tr>\n",
"  <tr>\n",
"    <th>2</th>\n",
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"    <td>1.323692</td>\n",
"    <td>1.070747</td>\n",
"  </tr>\n",
"  <tr>\n",
"    <th>3</th>\n",
"    <td>-1.769303</td>\n",
"    <td>-1.137636</td>\n",
"    <td>-0.490921</td>\n",
"  </tr>\n",
"  <tr>\n",
"    <th>4</th>\n",
"    <td>1.179536</td>\n",
"    <td>0.797236</td>\n",
"    <td>-1.636059</td>\n",
"  </tr>\n",
"</tbody>\n",
"</table>\n",
"</div>"
],
"text/plain": [
"   Age  Balance EstimatedSalary\n",
"0  0.442326 -1.137636      0.093376\n",
"1 -0.294884  0.154344      0.962856\n",
"2  0.442326  1.323692      1.070747\n",
"3 -1.769303 -1.137636     -0.490921\n",
"4  1.179536  0.797236     -1.636059"
]
},
"execution_count": 110,
"metadata": {},
"output_type": "execute_result"
}
],
"source": [
"from sklearn.preprocessing import scale\n",
"X_scaled=pd.DataFrame(scale(q),columns=q.columns)\n",

```



```

"X_scale=X_scaled.head()\n",
"X_scale"
]
},
{
"cell_type": "markdown",
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"# 10. Split the data into training and testing"
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"  .dataframe tbody tr th {\n",
"    vertical-align: top;\n",
"  }\n",
"\n",
"  .dataframe thead th {\n",
"    text-align: right;\n",
"  }\n",
"</style>\n",
"<table border='1' class='dataframe'>\n",
"  <thead>\n",
"    <tr style='text-align: right;'>\n",
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"      <th>Age</th>\n",
"      <th>Balance</th>\n",
"      <th>EstimatedSalary</th>\n",
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"  </thead>\n",
"  <tbody>\n",
"    <tr>\n",
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"      <td>42</td>\n",

```

```

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"    <td>101348.88</td>\n",
"  </tr>\n",
"  <tr>\n",
"    <th>1</th>\n",
"    <td>41</td>\n",
"    <td>83807.86</td>\n",
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"  </tr>\n",
"  <tr>\n",
"    <th>2</th>\n",
"    <td>42</td>\n",
"    <td>159660.80</td>\n",
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"  <tr>\n",
"    <th>3</th>\n",
"    <td>39</td>\n",
"    <td>0.00</td>\n",
"    <td>93826.63</td>\n",
"  </tr>\n",
"  <tr>\n",
"    <th>4</th>\n",
"    <td>43</td>\n",
"    <td>125510.82</td>\n",
"    <td>79084.10</td>\n",
"  </tr>\n",
"  <tr>\n",
"    <th>...</th>\n",
"    <td>...</td>\n",
"    <td>...</td>\n",
"    <td>...</td>\n",
"  </tr>\n",
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"    <th>9995</th>\n",
"    <td>39</td>\n",
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"  <tr>\n",
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"    <td>35</td>\n",
"    <td>57369.61</td>\n",
"    <td>101699.77</td>\n",
"  </tr>\n",
"  <tr>\n",
"    <th>9997</th>\n",
"    <td>36</td>\n",

```

```

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"    <td>42085.58</td>\n",
"  </tr>\n",
"  <tr>\n",
"    <th>9998</th>\n",
"    <td>42</td>\n",
"    <td>75075.31</td>\n",
"    <td>92888.52</td>\n",
"  </tr>\n",
"  <tr>\n",
"    <th>9999</th>\n",
"    <td>28</td>\n",
"    <td>130142.79</td>\n",
"    <td>38190.78</td>\n",
"  </tr>\n",
"</tbody>\n",
"</table>\n",
"<p>10000 rows x 3 columns</p>\n",
"</div>"
],
"text/plain": [
"   Age  Balance  EstimatedSalary\n",
"0    42    0.00    101348.88\n",
"1    41  83807.86    112542.58\n",
"2    42 159660.80    113931.57\n",
"3    39    0.00    93826.63\n",
"4    43 125510.82    79084.10\n",
"...   ...      ...      ... \n",
"9995  39    0.00    96270.64\n",
"9996  35  57369.61    101699.77\n",
"9997  36    0.00    42085.58\n",
"9998  42  75075.31    92888.52\n",
"9999  28 130142.79    38190.78\n",
"\n",
"[10000 rows x 3 columns]"
]
},
"execution_count": 114,
"metadata": {},
"output_type": "execute_result"
}
],
"source": [
"x= df[['Age','Balance','EstimatedSalary']]\n",
"x"
]
},
{

```

```

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"metadata": {
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"outputs": [
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        "1    83807.86\n",
        "2   159660.80\n",
        "3      0.00\n",
        "4   125510.82\n",
        "   ...   \n",
        "9995    0.00\n",
        "9996   57369.61\n",
        "9997    0.00\n",
        "9998   75075.31\n",
        "9999  130142.79\n",
        "Name: Balance, Length: 10000, dtype: float64"
      ]
    },
    "execution_count": 116,
    "metadata": {},
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],
"source": [
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  "y"
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},
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  "metadata": {},
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          "       [ 0.19816383,  0.11735002,  0.21653375],\n",
          "       [ 0.29351742,  1.33305335,  0.2406869 ],\n",
          "       ..., \n",
          "       [-0.27860412, -1.22584767, -1.00864308],\n",

```

```

        "    [ 0.29351742, -0.02260751, -0.12523071],\n",
        "    [-1.04143285, 0.85996499, -1.07636976]]]"
    ]
},
"execution_count": 118,
"metadata": {},
"output_type": "execute_result"
}
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"source": [
"#scaling\n",
"from sklearn.preprocessing import StandardScaler, MinMaxScaler\n",
"sc = StandardScaler()\n",
"x_scaled1 = sc.fit_transform(x)\n",
"x_scaled1"
]
},
{
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"execution_count": 119,
"id": "75315a1e",
"metadata": {},
"outputs": [],
"source": [
"#train and test data\n",
"from sklearn.model_selection import train_test_split\n",
"x_train, x_test, y_train, y_test = train_test_split(x_scaled1, y, test_size = 0.3,
random_state = 0)"
]
},
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"metadata": {},
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"       [ 0.00745665, -1.22584767, -1.39576675],\n",
"       [ 3.53553951,  1.35419118, -1.49965629],\n",
"       ..., \n",
"       [-0.37395771,  1.35890908,  1.41441489],\n",
"       [-0.08789694, -1.22584767,  0.84614739],\n",
"       [ 0.86563897,  0.50630343,  0.32630495]])"
]
}
}
],
},

```

```

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  "metadata": {},
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          "(7000, 3)"
        ]
      },
      "execution_count": 121,
      "metadata": {},
      "output_type": "execute_result"
    }
  ],
  "source": [
    "x_train.shape"
  ],
},
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  "execution_count": 122,
  "id": "38c6ee3a",
  "metadata": {},
  "outputs": [
    {
      "data": {
        "text/plain": [
          "array([[ -0.37395771,  0.87532296,  1.61304597],\n",
          "       [ 0.10281024,  0.42442221,  0.49753166],\n",
          "       [ 0.29351742,  0.30292727, -0.4235611 ],\n",
          "       ..., \n",
          "       [ 0.10281024,  1.46672809,  1.17045451],\n",
          "       [ 2.86806437,  1.25761599, -0.50846777],\n",
          "       [ 0.96099256,  0.19777742, -1.15342685]])"
        ]
      },
    }
  ],
},

```

```

    "execution_count": 122,
    "metadata": {},
    "output_type": "execute_result"
  }
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"source": [
  "x_test"
],
},
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  "id": "655a9540",
  "metadata": {},
  "outputs": [
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          "(3000, 3)"
        ]
      },
      "execution_count": 123,
      "metadata": {},
      "output_type": "execute_result"
    }
  ],
  "source": [
    "x_test.shape"
  ],
},
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          "9031      0.00\n",
          "3691    160979.68\n",
          "202      0.00\n",
          "5625    143262.04\n",
          "    ...    \n",
          "9225    120074.97\n",
          "4859    114440.24\n",
          "3264    161274.05\n",

```

```

    "9845      0.00\n",
    "2732  108076.33\n",
    "Name: Balance, Length: 7000, dtype: float64"
  ]
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        "text/plain": [
          "9394  131101.04\n",
          "898   102967.41\n",
          "2398   95386.82\n",
          "5906  112079.58\n",
          "2343  163034.82\n",
          "    ...   \n",
          "4004      0.00\n",
          "7375   80926.02\n",
          "9307  168001.34\n",
          "8394  154953.94\n",
          "5233   88826.07\n",
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  ]
},
{
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"metadata": {},
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],
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    "language": "python",
    "name": "python3"
  },
  "language_info": {
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      "name": "ipython",
      "version": 3
    },
    "file_extension": ".py",
    "mimetype": "text/x-python",
    "name": "python",
    "nbconvert_exporter": "python",
    "pygments_lexer": "ipython3",
    "version": "3.9.12"
  }
},
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