Лабораторная работа №3 по курсу "Интеллектуальный анализ данных"

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3.1 Вычисление функций AND, OR и XOR

In [2]:

```
import numpy as np
import pandas as pd
import torch

from torch import nn
from torch import optim

from tqdm import tqdm

import matplotlib.pyplot as plt
import seaborn as sns

sns.set()
```

Поставим задачу нахождения нейронной сети умеющей классифицировать следующий датасет

In [3]:

```
n = 10000
X_train = np.random.rand(n, 2)
y_train = [round(x[0]) ^ round(x[1]) for x in X_train]
```

In [4]:

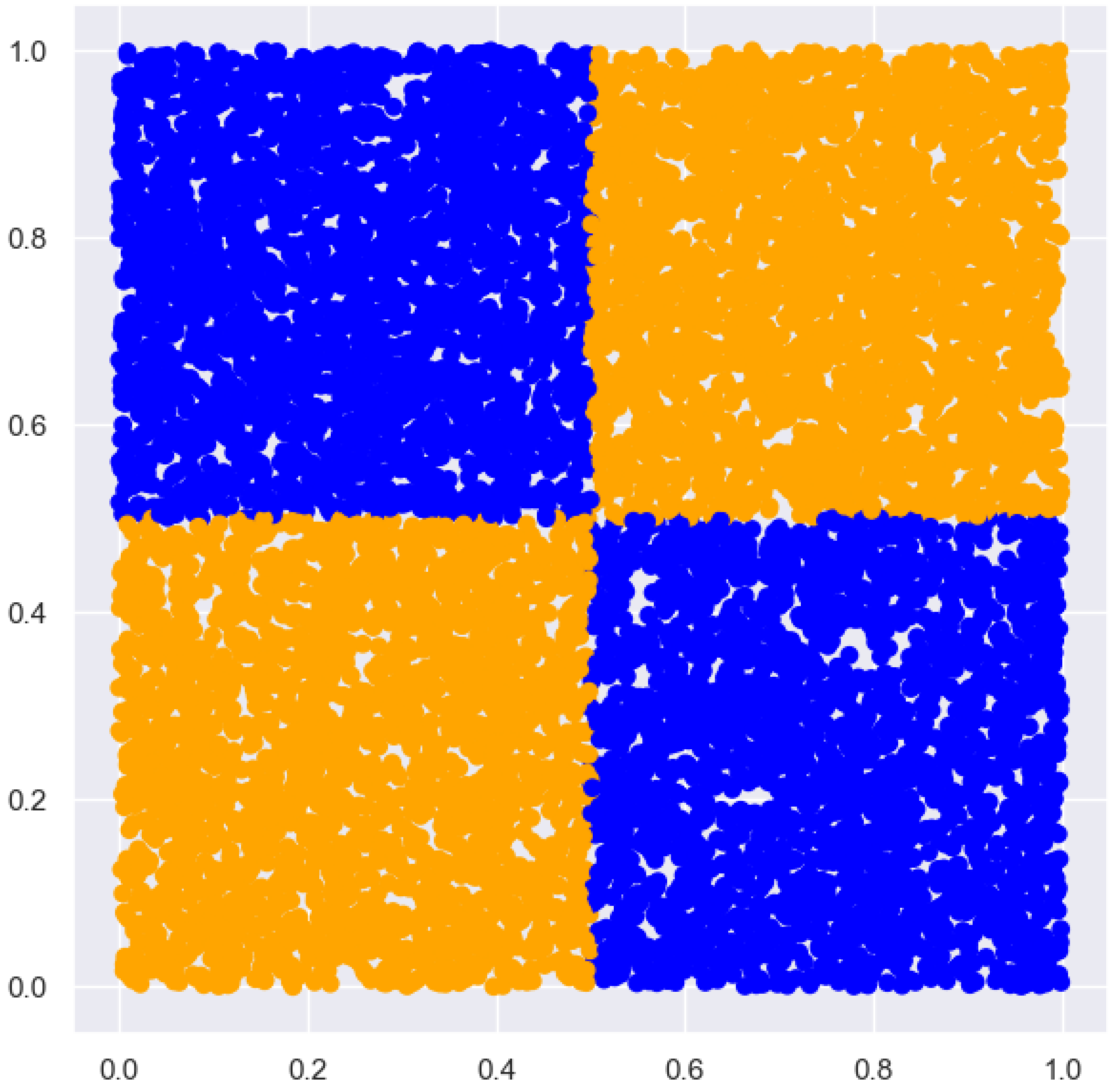
```
color_map = np.vectorize(lambda y: 'orange' if y == 0 else 'blue')
```

In [5]:

```
fig, axs = plt.subplots(figsize=(7, 7))
axs.scatter(X_train[:, 0], X_train[:, 1], c=color_map(y_train))
```

Out[5]:

```
<matplotlib.collections.PathCollection at 0x1262cb40690>
```



Data: numpy array to tensor

In [6]:

```
X_train = torch.FloatTensor(X_train)
y_train = torch.LongTensor(y_train)
```

Модель: 3 линейных слоя, функция активации ReLU

In [7]:

```
model = nn.Sequential(
    nn.Linear(2, 64),
    nn.ReLU(),
    nn.Linear(64, 64),
    nn.ReLU(),
    nn.Linear(64, 2)
)
```

In [8]:

```
optimizer = optim.Adam(model.parameters())
criterion = nn.CrossEntropyLoss()
```

Обучение и визуализация по ходу обучения:

In [9]:

```python
epochs_n = 40

fig, axs = plt.subplots(figsize=(10, 10), ncols=2, nrows=2)

history = []
for epoch in tqdm(range(epochs_n)):
    logits = model(X_train)
    loss = criterion(logits, y_train)
    history.append(loss.item())
    optimizer.zero_grad()
    loss.backward()
    optimizer.step()

    if (epoch + 1) % (epochs_n // 4) == 0:
        print(f'epoch: {epoch + 1},\t loss: {history[-1]}')
        with torch.no_grad():
            n = 200
            X_val = np.random.rand(n, 2)
            y_val = [round(x[0]) ^ round(x[1]) for x in X_val]

            X_val = torch.FloatTensor(X_val)
            y_val = torch.LongTensor(y_val)

            y_pred = torch.sigmoid(model(X_val))

            X_val = X_val.detach().numpy()
            y_val = y_val.detach().numpy()
            y_pred = y_pred.detach().numpy()

            y_pred = np.argmax(y_pred, axis=1)

        i = 0 if (epoch + 1) <= (epochs_n // 2) else 1
        j = 0 if (epoch + 1) % (epochs_n // 2) == (epochs_n // 4) else 1

        axs[i][j].plot([0, 1], [0.5, 0.5])
        axs[i][j].plot([0.5, 0.5], [0, 1])

        axs[i][j].scatter(X_val[:, 0], X_val[:, 1], c=color_map(y_pred))
        axs[i][j].set_title(f'epoch = {epoch + 1}')

plt.legend()
```

```
  0%|          | 0/40 [00:00<?, ?it/s] 45%|████▌     | 18/40 [00:01<00:00, 26.25i
t/s]
epoch: 10,       loss: 0.6720598340034485
 57%|█████▊    | 23/40 [00:01<00:00, 30.27it/s]
epoch: 20,       loss: 0.6524465084075928
100%|██████████| 40/40 [00:01<00:00, 27.34it/s]
No artists with labels found to put in legend.  Note that artists whose label star
t with an underscore are ignored when legend() is called with no argument.
epoch: 30,       loss: 0.6256701350212097
epoch: 40,       loss: 0.5902116298675537
```

Out[9]:

```
<matplotlib.legend.Legend at 0x12630599490>
```

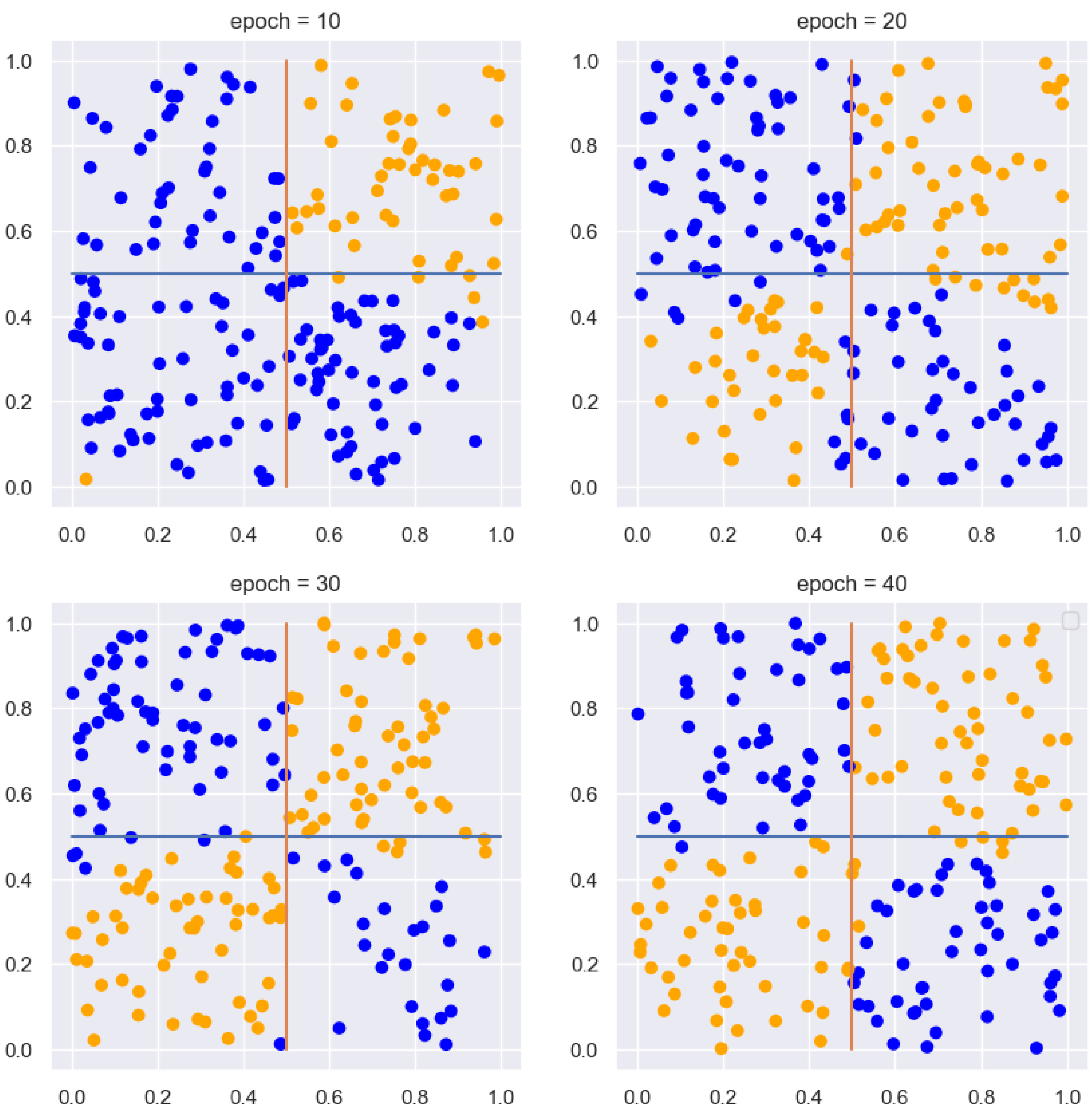
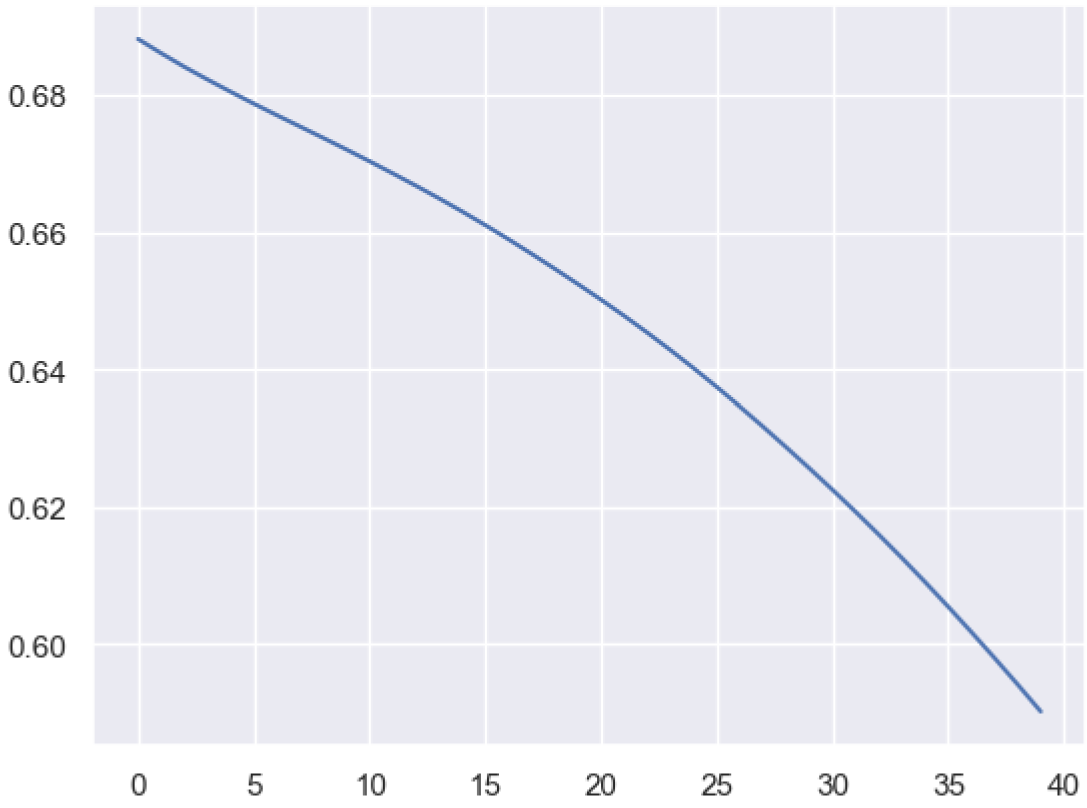


График обучения

```
In [10]: plt.plot(history)
```

```
Out[10]: [<matplotlib.lines.Line2D at 0x126305e7ed0>]
```



3.2 Titanic - Machine Learning from Disaster

In [23]:

```
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report
```

In [50]:

```
df = pd.read_csv('train.csv')
df
```

Out[50]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Ca
0	1	0	3	Braund, Mr. Owen Harris	male	22.0	1	0	A/5 21171	7.2500	N
1	2	1	1	Cumings, Mrs. John Bradley (Florence Briggs Th...	female	38.0	1	0	PC 17599	71.2833	
2	3	1	3	Heikkinen, Miss. Laina	female	26.0	0	0	STON/O2. 3101282	7.9250	N
3	4	1	1	Futrelle, Mrs. Jacques Heath (Lily May Peel)	female	35.0	1	0	113803	53.1000	C
4	5	0	3	Allen, Mr. William Henry	male	35.0	0	0	373450	8.0500	N
...	...	...	...	...	...	...	...	...	...	...	
886	887	0	2	Montvila, Rev. Juozas	male	27.0	0	0	211536	13.0000	N
887	888	1	1	Graham, Miss. Margaret Edith	female	19.0	0	0	112053	30.0000	
888	889	0	3	Johnston, Miss. Catherine Helen "Carrie"	female	NaN	1	2	W./C. 6607	23.4500	N
889	890	1	1	Behr, Mr. Karl Howell	male	26.0	0	0	111369	30.0000	C
890	891	0	3	Dooley, Mr. Patrick	male	32.0	0	0	370376	7.7500	N

891 rows × 12 columns

Предобработка данных:

In [51]:

```
def preprocess_data(df):
    df.drop(['Name', 'Ticket', 'Cabin', 'Embarked'], axis=1, inplace=True)
    df = pd.get_dummies(df)
    mean_age = df['Age'].mean()
    print(mean_age)
    df['Age'].fillna(mean_age, inplace=True)

    return df
```

In [52]:

```
df_new = preprocess_data(df)
df_new
```

```
29.69911764705882
```

Out[52]:

	PassengerId	Survived	Pclass	Age	SibSp	Parch	Fare	Sex_female	Sex_male
0	1	0	3	22.000000	1	0	7.2500	0	1
1	2	1	1	38.000000	1	0	71.2833	1	0
2	3	1	3	26.000000	0	0	7.9250	1	0
3	4	1	1	35.000000	1	0	53.1000	1	0
4	5	0	3	35.000000	0	0	8.0500	0	1
...	...	...	...	...	...	...	...	...	...
886	887	0	2	27.000000	0	0	13.0000	0	1
887	888	1	1	19.000000	0	0	30.0000	1	0
888	889	0	3	29.699118	1	2	23.4500	1	0
889	890	1	1	26.000000	0	0	30.0000	0	1
890	891	0	3	32.000000	0	0	7.7500	0	1

891 rows × 9 columns

In [53]:

```
X_train, X_val, y_train, y_val = train_test_split(df_new.iloc[:, 2:], df_new.iloc[:
```

In [54]:

```
X_train = torch.FloatTensor(X_train.to_numpy())
X_val = torch.FloatTensor(X_val.to_numpy())
y_train = torch.LongTensor(y_train.to_numpy())
y_val = torch.LongTensor(y_val.to_numpy())
```

In [55]:

```
in_features = 7
out_features = 2
```

Модель: 2 линейных слоя по 128 нейронов, функция активации ReLU

In [56]:

```
model = nn.Sequential(
    nn.Linear(in_features, 128),
    nn.ReLU(),
    nn.Linear(128, out_features)
)
```

In [57]:

```
optimizer = optim.Adam(model.parameters())
criterion = nn.CrossEntropyLoss()
```

Обучение:

In [58]:

```
epochs_n = 10000

history = []
for epoch in tqdm(range(epochs_n)):
    logits = model(X_train)
    loss = criterion(logits, y_train)
    history.append(loss.item())
    optimizer.zero_grad()
    loss.backward()
    optimizer.step()
```

```
100%|██████████| 10000/10000 [00:27<00:00, 361.99it/s]
```

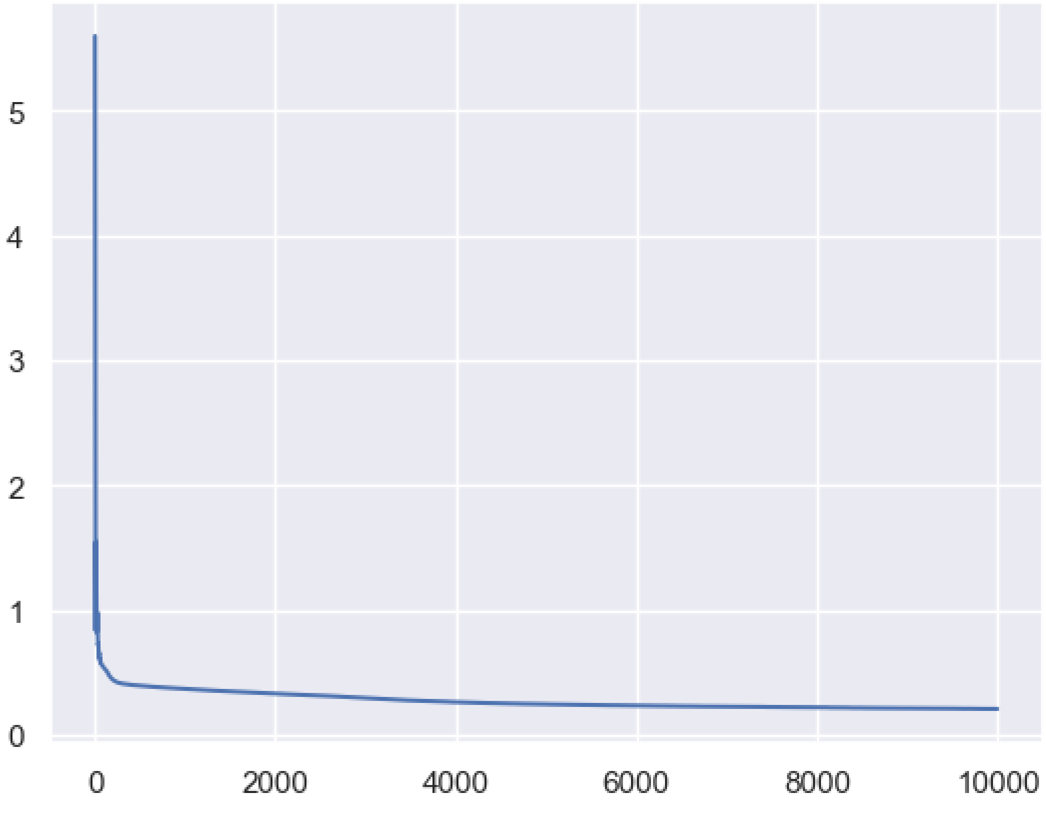
График обучения:

In [59]:

```
plt.plot(history)
```

Out[59]:

```
[<matplotlib.lines.Line2D at 0x126386a0050>]
```



In [60]:

```
y_pred = torch.sigmoid(model(X_val))
y_pred = y_pred.detach().numpy()
y_pred = np.argmax(y_pred, axis=1)

y_val = y_val.detach().numpy()
```

Полученные метрики:

In [61]:

```
print(classification_report(y_val, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.83      0.84      0.83       131
           1       0.77      0.75      0.76        92

    accuracy                           0.80       223
   macro avg       0.80      0.79      0.80       223
weighted avg       0.80      0.80      0.80       223
```