```
[64]: import hashlib
      import pandahouse
      import swifter
      import scipy.stats as stats
      import numpy as np
      import pandas as pd
      import random
      import matplotlib.pyplot as plt
      import seaborn as sns
```

```
[65]: connection = {
          'host': 'https://clickhouse.lab.karpov.courses',
          'password': 'dpo_python_2020',
          'user': 'student',
          'database': 'simulator'
      }
```

```
[66]: def ab_split(id, salt='exp_mess_1', n_groups=5):
          test_id = str(id) + '-' + str(salt)
          test_id_digest = hashlib.md5(test_id.encode('ascii')).hexdigest()
          test_id_final_int = int(test_id_digest, 16)
          return test_id_final_int % n_groups
```

```
[67]: query_users = """
      SELECT DISTINCT user_id
      FROM simulator_20250520.feed_actions
      WHERE toDate(time) >= '2025-04-25'
        AND toDate(time) <= '2025-05-01'
      """

      users_df = pandahouse.read_clickhouse(query_users, connection=connection)
```

```
[68]: users_df['hash_group'] = users_df['user_id'].swifter.apply(ab_split)
```

Filter…

```
▼ root:
    ascii: false
    bar_format: null
    colour: null
    elapsed: 0.02673935890197754
    initial: 0
    n: 0
    ncols: null
    nrows: null
    postfix: null
    prefix: "Pandas Apply"
    rate: null
    total: 41997
    unit: "it"
    unit_divisor: 1000
    unit_scale: false
```

```
[69]: counts_by_group = users_df.groupby('hash_group')['user_id'].nunique().reset_index()
      print("Число пользователей в каждой hash_group (0-4):")
      print(counts_by_group)
```

```
Число пользователей в каждой hash_group (0-4):
   hash_group  user_id
0           0     8588
1           1     8254
2           2     8397
3           3     8305
4           4     8453
```

```
[70]: query_ctr = """
      SELECT
          user_id,
          SUM(if(action = 'view', 1, 0))   AS views,
          SUM(if(action = 'like', 1, 0))  AS likes,
          CASE
              WHEN SUM(if(action = 'view', 1, 0)) = 0 THEN 0.0
              ELSE toFloat64(SUM(if(action = 'like', 1, 0)))
                   / toFloat64(SUM(if(action = 'view', 1, 0)))
          END AS ctr
      FROM simulator_20250520.feed_actions
      WHERE toDate(time) BETWEEN '2025-04-25' AND '2025-05-01'
      GROUP BY user_id
      """

      ctr_df = pandahouse.read_clickhouse(query_ctr, connection=connection)
```

```
[71]: ctr_df = ctr_df.set_index('user_id')
```

```
[72]: print("\nНесколько строк из ctr_df (user_id, views, likes, ctr):")
      print(ctr_df.head())
```

```

Несколько строк из ctr_df (user_id, views, likes, ctr):
         views  likes       ctr
user_id
13289       32      2  0.062500
121096      57     12  0.210526
5090        14      2  0.142857
129283      80     23  0.287500
4394        54     25  0.462963
```

```
[73]: group2_ids_all = users_df.loc[users_df['hash_group'] == 2, 'user_id'].values
      group3_ids_all = users_df.loc[users_df['hash_group'] == 3, 'user_id'].values
      print(f"\nВсего в группе 2 пользователей: {len(group2_ids_all)}")
      print(f"Всего в группе 3 пользователей: {len(group3_ids_all)}")
```

```

Всего в группе 2 пользователей: 8397
Всего в группе 3 пользователей: 8305
```

```
[74]: n_iterations = 10000
      all_pvalues = []
```

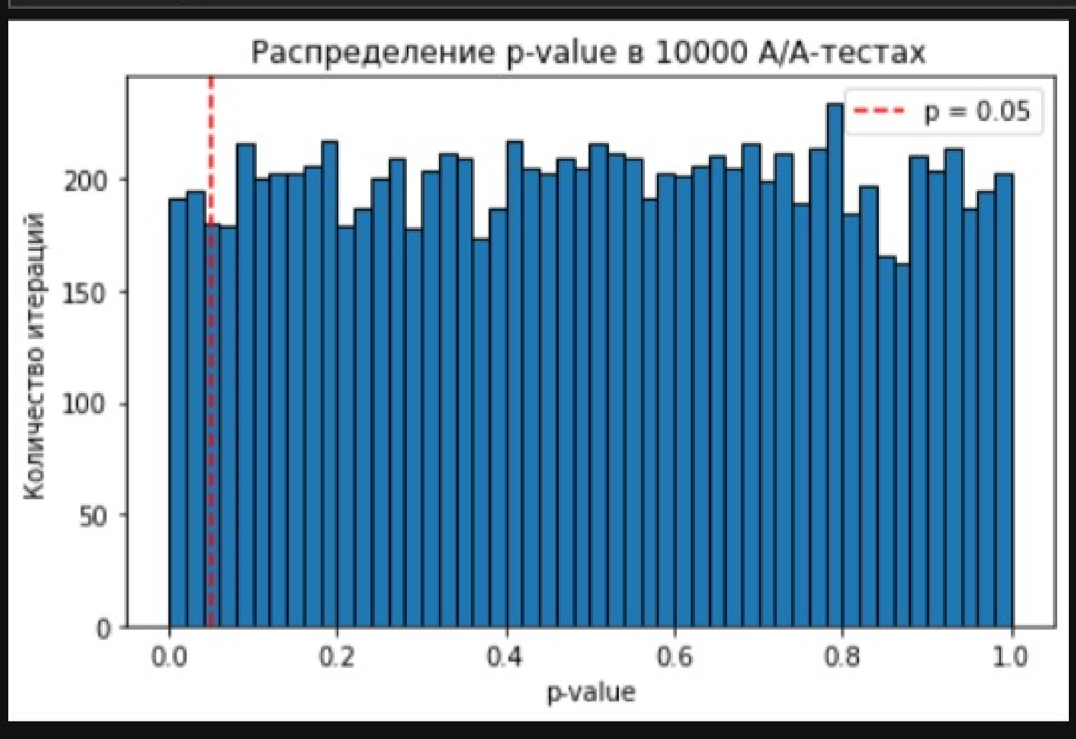
```
[75]: for i in range(n_iterations):
          sampled_2 = np.random.choice(group2_ids_all, size=500, replace=False)
          sampled_3 = np.random.choice(group3_ids_all, size=500, replace=False)
          tmp2 = pd.DataFrame({'user_id': sampled_2})
          tmp3 = pd.DataFrame({'user_id': sampled_3})
          ctr_group2 = (tmp2.join(ctr_df[['ctr']], on='user_id', how='left').fillna(0.0)['ctr'])
          ctr_group3 = (tmp3.join(ctr_df[['ctr']], on='user_id', how='left').fillna(0.0)['ctr'])
          assert len(ctr_group2) == 500
          assert len(ctr_group3) == 500
          t_stat, p_val = stats.ttest_ind(ctr_group2, ctr_group3, equal_var=False)
          all_pvalues.append(p_val)
```

```
[76]: all_pvalues = np.array(all_pvalues)
      share_below_005 = np.mean(all_pvalues < 0.05)
      print(f"\nИз {n_iterations} A/A-тестов доля случаев, когда p-value < 0.05: {share_below_005:.4f}")
```

```

Из 10000 A/A-тестов доля случаев, когда p-value < 0.05: 0.0458
```

```
[79]: plt.figure(figsize=(6, 4))
      plt.hist(all_pvalues, bins=50, edgecolor='k')
      plt.axvline(0.05, color='red', linestyle='--', label='p = 0.05')
      plt.title("Распределение p-value в 10000 A/A-тестах")
      plt.xlabel("p-value")
      plt.ylabel("Количество итераций")
      plt.legend()
      plt.tight_layout()
      plt.show()
```


Распределение p-value в 10000 A/A-тестах
p = 0.05
Количество итераций
p-value