Untitled Notebook

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```
import sqlite3
import time
import matplotlib.pyplot as plt
from faker import Faker
import numpy as np
import pandas as pd
from tqdm import tqdm

# 初始化Faker生成测试数据
fake = Faker()
np.random.seed(42)

def generate_data(num_records):
    """生成测试数据集"""
    conn = sqlite3.connect(':memory:')
    cursor = conn.cursor()

    # 创建会话表
    cursor.execute('''
        CREATE TABLE sessions(
            id INTEGER PRIMARY KEY,
            start_time INTEGER,
            end_time INTEGER
        )
    ''')

    # 生成随机会话数据（使用时间戳）
    data = []
    base_time = int(time.time()) - 365*24*3600  # 一年前为基准

    for i in range(num_records):
        start = base_time + np.random.randint(0, 365*24*3600)
        duration = np.random.randint(60, 24*3600)  # 会话持续1分钟到1天
        end = start + duration
        data.append((start, end))

    # 批量插入数据
    cursor.executemany('INSERT INTO sessions(start_time, end_time) VALUES (?, ?)',
data)
    conn.commit()
    return conn

def set_based(conn):
    """基于集合的解决方案"""
    cursor = conn.cursor()
    query = '''
        SELECT MAX(concurrent_count)
        FROM (
            SELECT time,
                (SELECT COUNT(*)
```

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                FROM sessions
              WHERE start_time ⩽ t.time AND end_time ⩾ t.time) AS concurrent_count
            FROM (
                SELECT start_time AS time FROM sessions
                UNION
                SELECT end_time AS time FROM sessions
            ) t
        )
    '''
    start_time = time.time()
    cursor.execute(query)
    result = cursor.fetchone()[0]
    return time.time() - start_time, result

def cursor_based(conn):
    """基于游标的解决方案"""
    cursor = conn.cursor()

    # 获取所有事件点（开始+1，结束-1）
    cursor.execute('''
        SELECT start_time AS time, 1 AS type FROM sessions
        UNION ALL
        SELECT end_time, -1 FROM sessions
        ORDER BY time, type DESC
    ''')

    events = cursor.fetchall()
    current_count = 0
    max_count = 0

    start_time = time.time()
    for event in events:
        current_count += event[1]
        if current_count > max_count:
            max_count = current_count
    return time.time() - start_time, max_count

def window_based(conn):
    """基于窗口函数的解决方案"""
    cursor = conn.cursor()
    query = '''
        SELECT MAX(concurrent_count)
        FROM (
            SELECT SUM(type) OVER (ORDER BY time, type DESC) AS concurrent_count
            FROM (
                SELECT start_time AS time, 1 AS type FROM sessions
                UNION ALL
                SELECT end_time, -1 FROM sessions
            )
        )
    '''
    start_time = time.time()
    cursor.execute(query)
    result = cursor.fetchone()[0]
    return time.time() - start_time, result
```

```
def analyze_performance():
    """性能比较分析"""
    sizes = [100, 500, 1000, 5000, 10000, 20000]
    results = {'Set-based': [], 'Cursor-based': [], 'Window-based': []}

    for size in tqdm(sizes):
        conn = generate_data(size)

        # 每种方法运行3次取平均时间
        set_times = []
        cursor_times = []
        window_times = []

        for _ in range(3):
            t1, _ = set_based(conn)
            t2, _ = cursor_based(conn)
            t3, _ = window_based(conn)
            set_times.append(t1)
            cursor_times.append(t2)
            window_times.append(t3)

        results['Set-based'].append(np.mean(set_times))
        results['Cursor-based'].append(np.mean(cursor_times))
        results['Window-based'].append(np.mean(window_times))
        conn.close()

    # 绘制性能比较图
    plt.figure(figsize=(12, 8))
    for method in results:
        plt.plot(sizes, results[method], 'o-', label=method)

    plt.xscale('log')
    plt.yscale('log')
    plt.xlabel('Dataset Size (log scale)')
    plt.ylabel('Execution Time (seconds, log scale)')
    plt.title('Performance Comparison of Concurrent User Calculation Methods')
    plt.grid(True, which="both", ls="--")
    plt.legend()
    plt.savefig('performance_comparison.png')
    plt.show()

    # 生成报告
    report = pd.DataFrame({
        'Dataset Size': sizes,
        'Set-based (s)': results['Set-based'],
        'Cursor-based (s)': results['Cursor-based'],
        'Window-based (s)': results['Window-based']
    })
    report.to_csv('performance_report.csv', index=False)
    print(report)

if __name__ == "__main__":
[6]:    analyze_performance()
```

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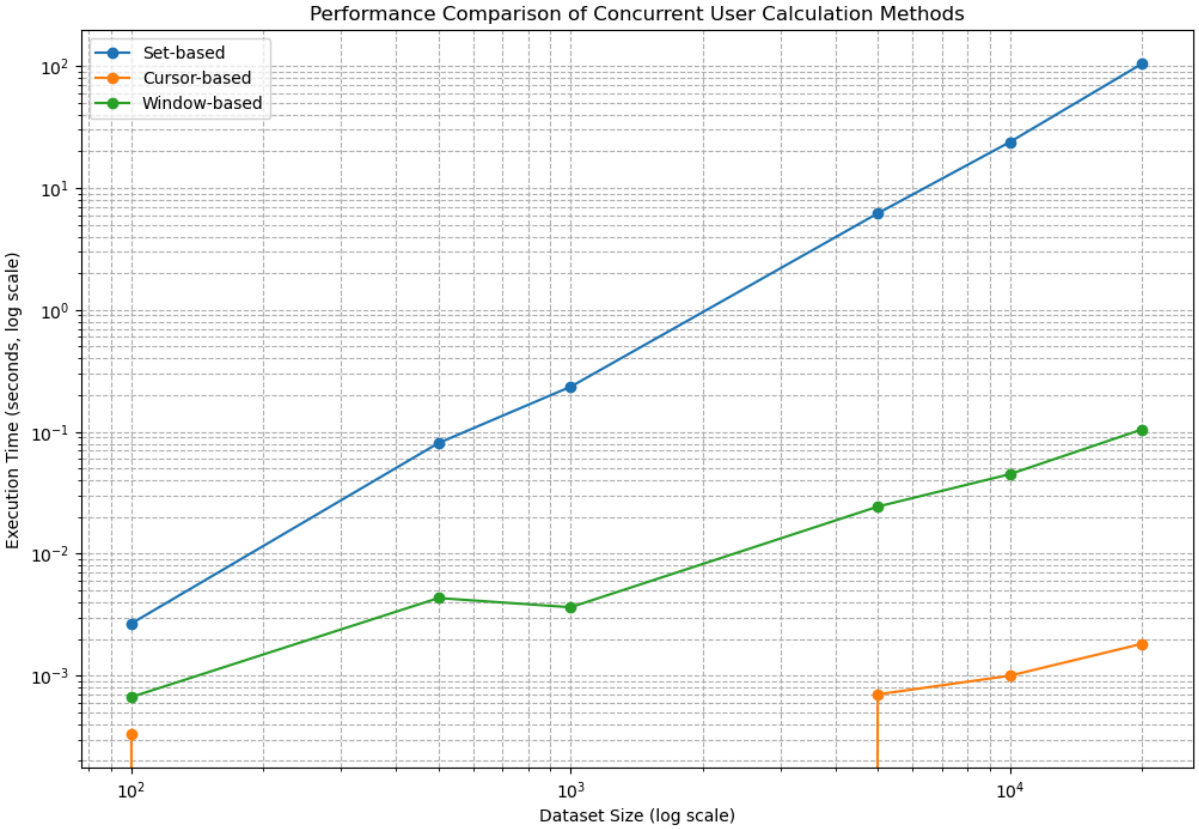

	Dataset Size	Set-based (s)	Cursor-based (s)	Window-based (s)
0	100	0.002678	0.000331	0.000668
1	500	0.080875	0.000000	0.004333
2	1000	0.234507	0.000000	0.003642
3	5000	6.196072	0.000702	0.024360
4	10000	23.853755	0.001000	0.044980
5	20000	104.804647	0.001827	0.104817