Problem 2756: Query Batching

Problem Information

Difficulty: Hard
Acceptance Rate: 0.00%
Paid Only: No

Problem Description

Batching multiple small queries into a single large query can be a useful optimization. Write a class

QueryBatcher

that implements this functionality.

The constructor should accept two parameters:

An asynchronous function

queryMultiple

which accepts an array of string keys

input

. It will resolve with an array of values that is the same length as the input array. Each index corresponds to the value associated with

input[i]

. You can assume the promise will never reject.

A throttle time in milliseconds

t

.

The class has a single method.

async getValue(key)

. Accepts a single string key and resolves with a single string value. The keys passed to this function should eventually get passed to the

queryMultiple

function.

queryMultiple

should never be called consecutively within

t

milliseconds. The first time

getValue

is called,

queryMultiple

should immediately be called with that single key. If after

t

milliseconds,

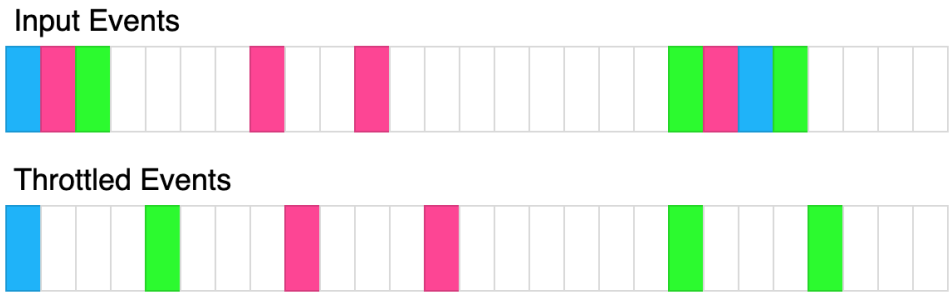
getValue

had been called again, all the passed keys should be passed to

queryMultiple

and ultimately returned. You can assume every key passed to this method is unique.

The following diagram illustrates how the throttling algorithm works. Each rectangle represents 100ms. The throttle time is 400ms.



Example 1:

Input:

queryMultiple = async function(keys) { return keys.map(key => key + '!'); } t = 100 calls = [{"key": "a", "time": 10}, {"key": "b", "time": 20}, {"key": "c", "time": 30}]

Output:

[{"resolved": "a!", "time": 10}, {"resolved": "b!", "time": 110}, {"resolved": "c!", "time": 110}]

Explanation:

const batcher = new QueryBatcher(queryMultiple, 100); setTimeout(() => batcher.getValue('a'), 10); // "a!" at t=10ms setTimeout(() => batcher.getValue('b'), 20); // "b!" at t=110ms setTimeout(() => batcher.getValue('c'), 30); // "c!" at t=110ms

queryMultiple simply adds an "!" to the key At t=10ms, getValue('a') is called, queryMultiple(['a']) is immediately called and the result is immediately returned. At t=20ms, getValue('b') is called but the query is queued At t=30ms, getValue('c') is called but the query is queued. At t=110ms, queryMultiple(['a', 'b']) is called and the results are immediately returned.

Example 2:

Input:

queryMultiple = async function(keys) { await new Promise(res => setTimeout(res, 100)); return keys.map(key => key + '!'); } t = 100 calls = [{"key": "a", "time": 10}, {"key": "b", "time": 20}, {"key": "c", "time": 30}]

Output:

[{"resolved": "a!", "time": 110}, {"resolved": "b!", "time": 210}, {"resolved": "c!", "time": 210}]

Explanation:

This example is the same as example 1 except there is a 100ms delay in queryMultiple. The results are the same except the promises resolve 100ms later.

Example 3:

Input:

queryMultiple = async function(keys) { await new Promise(res => setTimeout(res, keys.length * 100)); return keys.map(key => key + '!'); } t = 100 calls = [{"key": "a", "time": 10}, {"key": "b", "time": 20}, {"key": "c", "time": 30}, {"key": "d", "time": 40}, {"key": "e", "time": 250} {"key": "f", "time": 300}]

Output:

[{"resolved":"a!","time":110}, {"resolved":"e!","time":350}, {"resolved":"b!","time":410}, {"resolved":"c!","time":410}, {"resolved":"d!","time":410}, {"resolved":"f!","time":450}]

Explanation:

queryMultiple(['a']) is called at t=10ms, it is resolved at t=110ms queryMultiple(['b', 'c', 'd']) is called at t=110ms, it is resolved at 410ms queryMultiple(['e']) is called at t=250ms, it is resolved at 350ms queryMultiple(['f']) is called at t=350ms, it is resolved at 450ms

Constraints:

0 <= t <= 1000

0 <= calls.length <= 10

1 <= key.length <= 100

All keys are unique

Code Snippets

JavaScript:

```
/**
* @param {Function} queryMultiple
* @param {number} t
* @return {void}
*/
var QueryBatcher = function(queryMultiple, t) {

};

/**
* @param {string} key
* @return {Promise<string>}
*/
QueryBatcher.prototype.getValue = async function(key) {

};

/**
* async function queryMultiple(keys) {
 * return keys.map(key => key + '!');
* }
*
* const batcher = new QueryBatcher(queryMultiple, 100);
* batcher.getValue('a').then(console.log); // resolves "a!" at t=0ms
* batcher.getValue('b').then(console.log); // resolves "b!" at t=100ms
* batcher.getValue('c').then(console.log); // resolves "c!" at t=100ms
*/
```

TypeScript:

```
type QueryMultiple = (keys: string[]) => Promise<string[]>

class QueryBatcher {

constructor(queryMultiple: QueryMultiple, t: number) {

}

async getValue(key: string): Promise<string> {

}
};

/**
* async function queryMultiple(keys) {
 * return keys.map(key => key + '!');
* }
*
* const batcher = new QueryBatcher(queryMultiple, 100);
* batcher.getValue('a').then(console.log); // resolves "a!" at t=0ms
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*/
```

Solutions

JavaScript Solution:

```
/**
* Problem: Query Batching
* Difficulty: Hard
* Tags: array, string, queue
*
* Approach: Use two pointers or sliding window technique
* Time Complexity: O(n) or O(n log n)
* Space Complexity: O(1) to O(n) depending on approach
*/

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type QueryMultiple = (keys: string[]) => Promise<string[]>

class QueryBatcher {
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constructor(queryMultiple: QueryMultiple, t: number) {

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