Problem 1242: Web Crawler Multithreaded

Problem Information

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

Problem Description

Given a URL

startUrl

and an interface

HtmlParser

, implement

a Multi-threaded web crawler

to crawl all links that are under the

same hostname

as

startUrl

.

Return all URLs obtained by your web crawler in

any

order.

Your crawler should:

Start from the page:

startUrl

Call

HtmlParser.getUrls(url)

to get all URLs from a webpage of a given URL.

Do not crawl the same link twice.

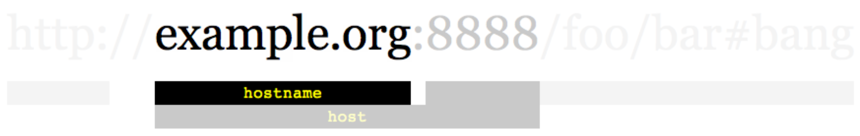
Explore only the links that are under the

same hostname

as

startUrl

.



As shown in the example URL above, the hostname is

example.org

. For simplicity's sake, you may assume all URLs use

HTTP protocol

without any

port

specified. For example, the URLs

http://leetcode.com/problems

and

http://leetcode.com/contest

are under the same hostname, while URLs

http://example.org/test

and

http://example.com/abc

are not under the same hostname.

The

HtmlParser

interface is defined as such:

interface HtmlParser { // Return a list of all urls from a webpage of given

url

. // This is a blocking call, that means it will do HTTP request and return when this request is finished. public List<String> getUrls(String url); }

Note that

getUrls(String url)

simulates performing an HTTP request. You can treat it as a blocking function call that waits for an HTTP request to finish. It is guaranteed that

getUrls(String url)

will return the URLs within

15ms.

Single-threaded solutions will exceed the time limit so, can your multi-threaded web crawler do better?

Below are two examples explaining the functionality of the problem. For custom testing purposes, you'll have three variables

urls

,

edges

and

startUrl

. Notice that you will only have access to

startUrl

in your code, while

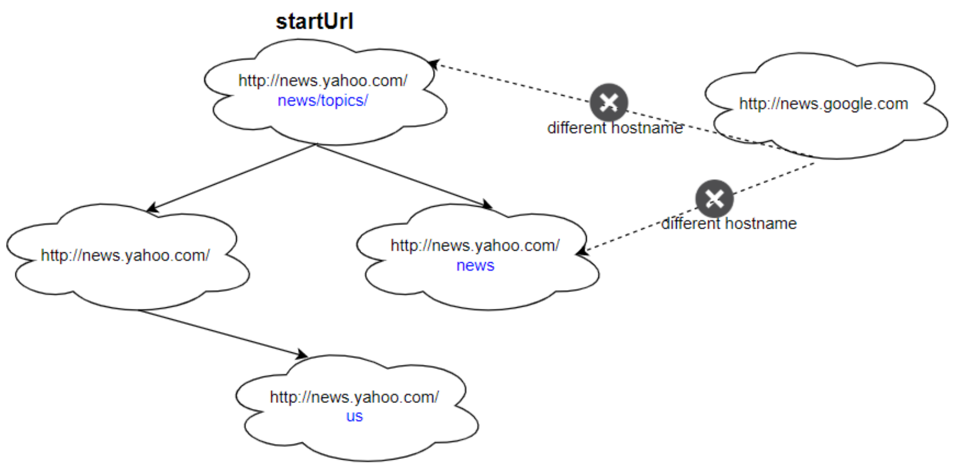
urls

and

edges

are not directly accessible to you in code.

Example 1:



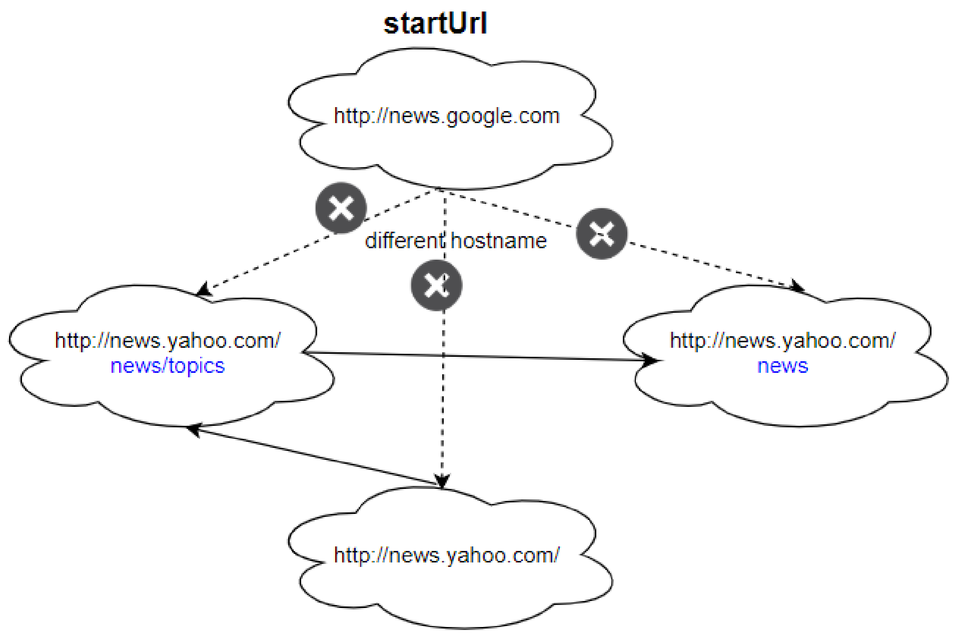
Input:

urls = ["http://news.yahoo.com", "http://news.yahoo.com/news", "http://news.yahoo.com/news/topics/", "http://news.google.com", "http://news.yahoo.com/us"] edges = [[2,0],[2,1],[3,2],[3,1],[0,4]] startUrl = "http://news.yahoo.com/news/topics/"

Output:

["http://news.yahoo.com", "http://news.yahoo.com/news", "http://news.yahoo.com/news/topics/", "http://news.yahoo.com/us"]

Example 2:



Input:

urls = ["http://news.yahoo.com", "http://news.yahoo.com/news", "http://news.yahoo.com/news/topics/", "http://news.google.com"] edges = [[0,2],[2,1],[3,2],[3,1],[3,0]] startUrl = "http://news.google.com"

Output:

["http://news.google.com"]

Explanation:

The startUrl links to all other pages that do not share the same hostname.

Constraints:

1 <= urls.length <= 1000

1 <= urls[i].length <= 300

startUrl

is one of the

urls

.

Hostname label must be from

1

to

63

characters long, including the dots, may contain only the ASCII letters from

'a'

to

'z'

, digits from

'0'

to

'9'

and the hyphen-minus character (

'-'

).

The hostname may not start or end with the hyphen-minus character ('-').

See:

https://en.wikipedia.org/wiki/Hostname#Restrictions_on_valid_hostnames

You may assume there're no duplicates in the URL library.

Follow up:

Assume we have 10,000 nodes and 1 billion URLs to crawl. We will deploy the same software onto each node. The software can know about all the nodes. We have to minimize communication between machines and make sure each node does equal amount of work. How would your web crawler design change?

What if one node fails or does not work?

How do you know when the crawler is done?

Code Snippets

C++:

```
/**
* // This is the HtmlParser's API interface.
* // You should not implement it, or speculate about its implementation
* class HtmlParser {
* public:
* vector<string> getUrls(string url);
* };
*/
class Solution {
public:
vector<string> crawl(string startUrl, HtmlParser htmlParser) {

}
};
```

Java:

```
/**
* // This is the HtmlParser's API interface.
* // You should not implement it, or speculate about its implementation
* interface HtmlParser {
* public List<String> getUrls(String url) {}
* }
```

```
*/
class Solution {
public List<String> crawl(String startUrl, HtmlParser htmlParser) {

}
}
```

Python3:

```
# """
# This is HtmlParser's API interface.
# You should not implement it, or speculate about its implementation
# """
#class HtmlParser(object):
# def getUrls(self, url):
# """
# :type url: str
# :rtype List[str]
# """

class Solution:
def crawl(self, startUrl: str, htmlParser: 'HtmlParser') -> List[str]:
```

Python:

```
# """
# This is HtmlParser's API interface.
# You should not implement it, or speculate about its implementation
# """
#class HtmlParser(object):
# def getUrls(self, url):
# """
# :type url: str
# :rtype List[str]
# """

class Solution(object):
def crawl(self, startUrl, htmlParser):
"""
:type startUrl: str
:type htmlParser: HtmlParser
:rtype: List[str]
```

```
"""
```

C#:

```
/**
* // This is the HtmlParser's API interface.
* // You should not implement it, or speculate about its implementation
* class HtmlParser {
* public List<String> GetUrls(String url) {}
* }
*/
class Solution {
public IList<string> Crawl(string startUrl, HtmlParser htmlParser) {

}
}
```

Go:

```
import (
"math/rand"
"time"
)



/*
This is HtmlParser's API interface.
You should not implement it, or speculate about its implementation
type HtmlParser struct {
maps map[string]int
imaps map[int]string
a map[int][]int
}
*/
func crawl(startUrl string, htmlParser *HtmlParser) []string {

}
```

Solutions

C++ Solution:

```
/*
* Problem: Web Crawler Multithreaded
* Difficulty: Medium
* Tags: string, search
*
* Approach: String manipulation with hash map or two pointers
* Time Complexity: O(n) or O(n log n)
* Space Complexity: O(1) to O(n) depending on approach
*/

/**
* // This is the HtmlParser's API interface.
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vector<string> crawl(string startUrl, HtmlParser htmlParser) {

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Java Solution:

```
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* Difficulty: Medium
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/**
* // This is the HtmlParser's API interface.
* // You should not implement it, or speculate about its implementation
* interface HtmlParser {
```

```
* public List<String> getUrls(String url) {}
* }
*/
class Solution {
public List<String> crawl(String startUrl, HtmlParser htmlParser) {

}
}
```

Python3 Solution:

```
"""
Problem: Web Crawler Multithreaded
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# You should not implement it, or speculate about its implementation
# """
#class HtmlParser(object):
# def getUrls(self, url):
# """
# :type url: str
# :rtype List[str]
# """

class Solution:
def crawl(self, startUrl: str, htmlParser: 'HtmlParser') -> List[str]:
# TODO: Implement optimized solution
pass
```

Python Solution:

```
# """
# This is HtmlParser's API interface.
# You should not implement it, or speculate about its implementation
# """
#class HtmlParser(object):
# def getUrls(self, url):
# """
# :type url: str
# :rtype List[str]
# """

class Solution(object):
def crawl(self, startUrl, htmlParser):
"""
:type startUrl: str
:type htmlParser: HtmlParser
:rtype: List[str]
"""
```

C# Solution:

```
/*
* Problem: Web Crawler Multithreaded
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class Solution {
public IList<string> Crawl(string startUrl, HtmlParser htmlParser) {

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```

Go Solution:

```
// Problem: Web Crawler Multithreaded
// Difficulty: Medium
// Tags: string, search
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