

RABIN-KARP ALGORITHM IN ALGORITHMS

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Abstract. The algorithm is rarely used to match a single pattern, but has significant theoretical significance and is very effective in finding the matches of multiple patterns of the same length. for a text of length n and a pattern of length m , its average and best execution time is $O(n)$ with a correctly selected hash function (see below), but in the worst case it has an $O(nm)$ efficiency, one of the reasons why it is not so widely used. For applications where incorrect positives can be tolerated in search, i.e. applications where some instances of a pattern being found may not actually match the pattern, the Rabin-Karp algorithm works in guaranteed $O(n)$ time and with an appropriate choice of random selection.

Introduction. To perform, the P0 process is selected first. The duration of its processor crack is greater than the value of the time quantum, and therefore the process is performed until the quantum expiration, that is, within 4 time units. After that, it is placed at the end of the queue of ready-to-do processes, which takes the appearance of P1, p2, p0. The next P1 process begins to be executed. Its execution time corresponds to the size of the allocated Quantum, so it continues until the process is complete. Now the turn of the processes in the finished state consists of two P2, p0 processes. The processor is reserved for the p2 process.

Rabin-Karp algorithm

Material from Wikipedia - free encyclopedia

The Rabin-Karp algorithm is a row search algorithm that uses hashing to search for a pattern, i.e. a bottom row, in text. It was developed in 1987 by Michael Rabin and Richard Karp .

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Since the number of lines we are looking for, k , is so large, traditional one-line search algorithms become inefficient.

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Substring ceiling search and competing algorithms

The main task of the algorithm is to find a string of length m in a text of length n , which is called a pattern. One of the simplest algorithms for this task is looking for a bottom line in all possible places:

1 function NaiveSearch (string $s[1..n]$, string $sub[1..m]$).

1 for 1 to $n-m+1$ for 2

3 for j from 1 to m

4 if $s[i+j-1] \neq sub[j]$

5 proceed to the next iteration of the outer cycle

6 return i

7 return not found

This algorithm is y in many practical cases

Load matching algorithms

Medial

Sooner or later, web applications will exceed the autonomy of one server. Companies must record both their identity or or other acquisition. To do this, they place their applications on multiple servers and put a load balance in front of it to

distribute incoming requests. To cope with the workload, companies working on a web application may require thousands of servers.

In the Ush post, we will consider ways to distribute single load balancer HTTP requests to multiple servers. We start from the bottom and move on to modern algorithms for cleaning loads.

Visualization of the problem

Let's start from the very beginning: requests are sent to one server with one balance. Queries ask (RPS) per second

To perform, the P0 process is selected first. The duration of its processor crack is greater than the value of the time quantum, and therefore the process is performed until the quantum expiration, that is, within 4 time units. After that, it is placed at the end of the queue of ready-to-do processes, which takes the appearance of P1, p2, p0. The next P1 process begins to be executed. Its execution time corresponds to the size of the allocated Quantum, so it continues until the process is complete. Now the turn of the processes in the finished state consists of two P2, p0 processes. The processor is reserved for the p2 process. The allocated processor is completed by the time it runs out, and the next Quanta are allocated for processing p0 - the only one that has not finished its work at the moment. the waiting time for the P0 process (the number of characters "G" in the corresponding line) is 5 time units, for the P1 process - 4 time units, for the P2 process - 8 time units.

Rabin-Karp algorithm methods

The original algorithm proposed by Miller was deterministic and consisted of checking all $\{ \displaystyle 70 \ln(m)^{2} \}$. Miller's algorithm is guaranteed to recognize prime and composite numbers, provided that the generalized Riemann hypothesis is satisfied. The Miller-Rabin algorithm does not depend on the validity of the generalized Riemann hypothesis, but is probabilistic

Тест Миллера - Рабина

- ▶ Пусть n — нечётное число больше 1. Число $m - 1$ однозначно представляется в виде $m - 1 = 2^s \cdot t$, где t нечётно. Целое число a , $1 < a < m$, называется **свидетелем простоты** числа m , если выполняется одно из условий:

$$a^t = 1 \pmod{m}$$

- ▶ Или существует целое число k , $0 \leq k < s$, такое, что

$$a^{2^k t} = m - 1 \pmod{m}$$

- ▶ **Теорема Рабина** утверждает, что составное нечётное число m имеет не более $\phi(m) / 4$ различных свидетелей простоты.

Another noteworthy algorithm for text search is the Rabin-Karp algorithm, which is based on the hashing method. I will try to explain in detail how it works.

Let us have the following text: FINDINAHAYSTACKNEEDLEINA
 Pattern: NEEDLE

a hash number is generated based on characters from 0 to M-1 in the pattern. Here, M is the number of characters in the pattern.

in each [i..N-1] cycle, a hash number is generated for i to M + i - 1 characters in the text. Here, N is the number of characters in the text

If the pattern hash and the text substring hash are equal to each other, the pattern is found in the text.

One of the fastest and easiest ways to generate a hash number is to take the code of each character of the pattern, add them together, and divide it by a large prime number, leaving a remainder. In Javascript, this is done as follows

```
const primeNumber = 997 // prime number
const pattern = "NEEDLE" // search term
const hash = pattern.split("").map(char => char.charCodeAt()).join("") %
primeNumber
// hash number for pattern is 769
INDINAHAYSTACKNEEDLEINA
FINDIN // 5 != 769
INDINA // 877 != 769
```

```

NDINAH // 105 != 769
DINAHA // 259 != 769
INAHAY // 541 != 769
NAHAYS // 414 != 769
AHAYST // 271 != 769
HAYSTA // 963 != 769
AYSTAC // 805 != 769
YSTACK // 535 != 769
STACKN // 507 != 769
TACKNE // 178 != 769
ACKNEE // 98 != 769
CKNEED // 615 != 769
KNEEDL // 317 != 769
NEEDLE // 769 == 769
    
```

A very simple and ingenious method!

Discussion

The hash generation method above may run slower due to the use of split() and join() methods. Therefore, we will perform hash generation using the proven method - Horner's method. The general formula is as follows::

$$xi = (ti * RM-1 + ti+1 * RM-2 + \dots + ti+M-1 * R0) \% Q$$

Bu yerda:

xi – matndagi [i..M + i – 1] substring uchun hash soni.

ti – str.charCodeAtAt(i) – matn/pattern belgisining ASCII jadvalidagi raqami.

R – radix soni. ASCII uchun 128 yoki 256.

M – patterndagi belgilar soni.

Q – tub son.

The probability of a collision in a hash function depends on how big the prime number Q is. For example, if the number Q is greater than M * N2, the probability of collision is equal to 1/N. So we have generated the hash number of the pattern. Now it generates a hash number from each i to M + i - 1 substrings in the text and compares it to the hash number of the pattern. Hash is generated in the same way for both substring and pattern

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