Crack A Hack

Dream-play and the String Game

Course: ALGORITHMIC PROBLEM SOLVING

Course code: 17ECSE309

by:

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1. Introduction

Game theory is a tool used to analyze strategic behavior by taking into account how participants expect others to behave. Game theory is used to find the optimal outcome from a set of choices by analyzing the costs and benefits to each independent party as they compete with each other.

2. Example

Prisoners' Dilemma.

In this scenario, two people are arrested for stealing a car. They will each serve 2 years in prison for their crime.

The case is air-tight, but the police have reason to suspect that the two prisoners are also responsible for a recent string of high-profile bank robberies. Each prisoner is placed in a separate cell. Each is told he is suspected of being a bank robber and questioned separately regarding the robberies. The prisoners cannot communicate with each other.

The prisoners are told that a) if they both confess to the robberies, they'll each serve 3 years for the robberies and the car theft, and b) if only one confesses to the robbery and the other does not, the one who confesses will be rewarded with a 1 year sentence while the other will be punished with a 10 year sentence.

In the game, the prisoners have only two possible actions: confess to the bank robbery, or deny having participated in the bank robbery.

Since there are two players, each with two different strategies, there are four outcomes that are possible:

Prisoner 2

	Confess	Deny
Confess	Both prisoners serve 3 years in prison	Prisoner 2 serves 10 years, Prisoner 1 serves 1 year
Deny	Prisoner 1 serves 10 years, Prisoner 2 serves 1 year	Both prisoners serve 2 years in prison

Prisoner 1

The best option for both prisoners is to deny committing the robberies and face 2 years in prison for the car theft. But because neither can be guaranteed that the other won't confess, the most likely outcome is that both prisoners will hedge their bets and confess to the robberies -- effectively taking the 10 year sentence off the table and replacing it with the 3 year sentence.

3. HackerRank Question link

[Dreamplay and the String Game: Used](#)

4. Code (in C++)

```cpp
#include<bits/stdc++.h>

using namespace std;

string s, p;

bool F(int x)

{

    if(x < 0 || x + p.length() > s.length())

        return false;

    for(int i = 0; i < p.length(); i++)

        if(s[i + x] != p[i])

            return false;

    return true;

}

int main()

{

    int t;

    cin >> t;

    while(t--)

    {

        cin >> s;

        cin >> p;

        int n = s.length(), m = p.length(), k = n - m;

        if(k < 0)
```

```cpp
        {
            cout << "Steven\n";

            continue;
        }
        if(k&1)
        {
            if(F(k/2 - 1) && F(k/2 + 1))

                cout << "Amanda\n";

            else

                cout << "Steven\n";
        }
        else
        {
            if(F(k / 2) || (F(k/2 - 1) && F(k/2 + 1)))

                cout << "Amanda\n";

            else

                cout << "Steven\n";
        }
    }
    return 0;

}
```

5. Explanation

Let K = |S| - |P|, and let F(x) be *true* if P appears as a substring of S starting exactly at position x, and *false* otherwise.

If K < 0

In this case, Steven wins.

If K >= 0 and K is odd

In this case, Amanda wins if **F(K-1/2)** and **F(K+1/2)** are both true, and Steven wins otherwise.

If K >= 0 and K is even

In this case, Amanda wins if **F(K/2)** is true or both **F(K/2 -1)** and **F(K/2 + 1)** are true, and Steven wins otherwise.

6. Time Complexity

The time complexity of the above code is O(|S| + |P|), where S is length of string given and P is the length of the substring to match.

7. Applications

- Elections
- Auctions
- Wars
- Arms races
- Oligopolies (when a small number of companies dominate a market)
- Certain aspects of animal behavior
- The evolution of social norms
- And of course, games (the ones played for entertainment)

8. References

- https://en.wikipedia.org/wiki/Game_theory
- https://en.wikibooks.org/wiki/Introduction_to_Game_Theory
- http://www.investinganswers.com/financial-dictionary/economics/game-theory-2160
- https://www.quora.com/What-are-some-real-world-examples-of-game-theory

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