Implementation of Survival Of The Fittest

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Abstract

Dynamic Programming is a very efficient type of algorithm for solving problems that have overlapping subproblems.This problem can be solved by a DP approach.

Keywords

Dynamic Programming; Archer; Pike Men; knights; Probability

I. Problem Statement

There exists 3 units in an arena namely archers,pikemen and knights.Archers can kill pikemen,pikemen can kill knights and knights can kill archers.Only these three combinations can result in the death of any unit.The problem at hand is to find the probability of survival of each of the three units given a archers , p pikemen and k knights exist.

II. Implementation

To solve this problem we use a dynamic programming approach.It involves a 4 Dimensional array DP Table.

The implementation provides us with certain functionality :

- solve(a,p,k) : Returns the probability of each of the units survival.
- APK(a,p,k):Calculates the probability of survival of each of the units and returns a vector consisting of all the probabilities.

III. Analysis

Initially there are A archers,P pikemen and K knights.It is known that only archers can kill pikemen,pikemen can kill knights and knights can kill archers.Therefore at each fight each individual on the arena can end up meeting 3 people in the arena.Our goal is to find the probability that the individual survives his fight.Based on the facts we can make a few inferences -:

- Number of archers is 0 : Then a pikemen can never be killed.In that case the probability that a pikemen survives is 100%
- Number of pikemen is 0 : Then a knight can never be killed.In that case the probability that a knight survives is 100%
- Number of knights is 0 : Then an archer can never be killed.In that case the probability that an archer survives is 100%.

The probability of any particular unit surviving is - :

Let a be archer,p be pikemen and k be knights.

Total number of ways in which all units can meet each other is (a * p + p * k + k * a).The probability of archer surviving depends on which unit meets which unit in a dual.

Probability of archer surviving after a particular dual is

$$Total\ possible\ duals\ (T) = (a * p + p * k + k * a)$$

$$Probabaility_{a->p}(a,p,k) = (a*p) * Probabaility_{a->p}(a,p-1,k)/T$$

$$Probabaility_{p->k}(a,p,k) = (a*p) * Probabaility_{p->k}(a,p,k-1)/T$$

$$Probabaility_{k->a}(a,p,k) = (a*p) * Probabaility_{k->a}(a-1,p,k)/T$$

$$Probability_{archer} = Probabaility_{a->p}(a,p,k) + Probabaility_{p->k}(a,p,k) + Probabaility_{k->a}(a,p,k)$$

Similarly the probability of knights as well as pikemen surviving is calculated.

IV. Results

The DP table is a 4 dimensional DP table.The probability of survival of each of archers,knights and pikemen is calculated to 9 digits of precision.