A simple mathematical model of the Coastguards

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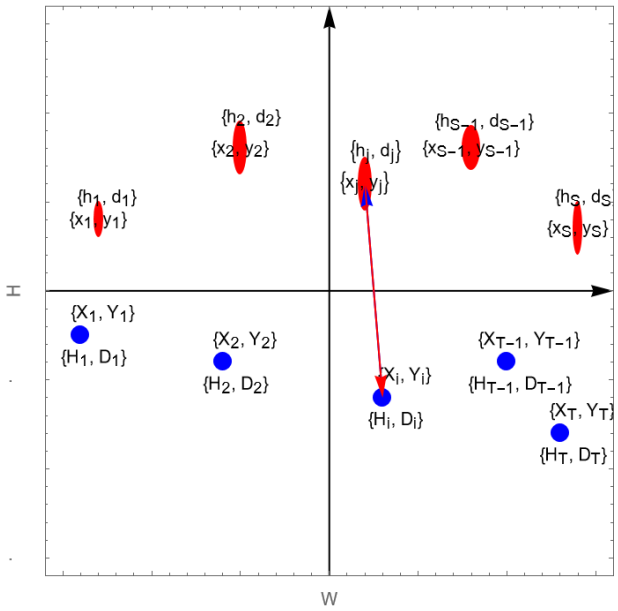
Abstract

In this paper, I describe a simple mathematical model of the Coastguards.
The paper ends with "The End"

Introduction

The Coastguards in any nation are responsible for defending the coasts of the nation.
In this paper, I describe a simple mathematical model of the Coastguards.

The mathematics of the Coastguards



The **area of contention** is from $x = -\frac{W}{2}$ to $x = \frac{W}{2}$ and $y = -\frac{H}{2}$ to $y = \frac{H}{2}$.
T **allied cannons** are positioned at (X_i, Y_i) where $1 \leq i \leq T$ and every $Y_i \leq 0$
Each cannon has **hit-points** H and can fire missiles that cause **damage** D to any ship.
Each cannon is destroyed whenever the total damage to the cannon where equals or is greater than the hit-points of the cannon.
s **enemy ships** are positioned at (x_j, y_j) where $1 \leq j \leq s$ and every $y_j \geq 0$
Each ship has hit-points h and can fire missiles that cause damage d to any cannon.
Each ship is destroyed whenever the total damage to the ship
equals or is greater than the hit-points of the ship.

Therefore, we obtain **the missile equations**:

$$M = \lceil \frac{h}{D} \rceil$$

$$m = \lceil \frac{H}{d} \rceil$$

where
M is the number of missiles to be fired by cannon(s) to destroy a ship.
m is the number of missiles to be fired by ship(s) to destroy a cannon.

We also have the following equations:
The total hit-points equations:

$$P = TH$$

$$p = sh$$

where
P is the total hit-points of all cannons.
p is the total hit-points of all ships.
The total missiles equations:

$$N = sM$$

$$n = Tm$$

where
N is the total missiles fired from all cannons.
n is the total missiles fired from all ships.
The total damage equations:

$$\Delta = ND$$

$$\delta = nd$$

where
Δ is the total damage caused by all cannons to all ships.
δ is the total damage caused by all ships to all cannons.

Working backwards to solve for the win of the Coastguards

For the Coastguards to win, we must have

$$(\Delta > \delta) \wedge (P > \delta)$$

i.e.,

$$(ND > nd) \wedge (TH > nd)$$

i.e.,

$$(sMD > Tmd) \wedge (TH > Tmd)$$

i.e.,

$$(s\lceil \frac{h}{D} \rceil D > T\lceil \frac{H}{d} \rceil d) \wedge (T(H - \lceil \frac{H}{d} \rceil d) > 0)$$

The End