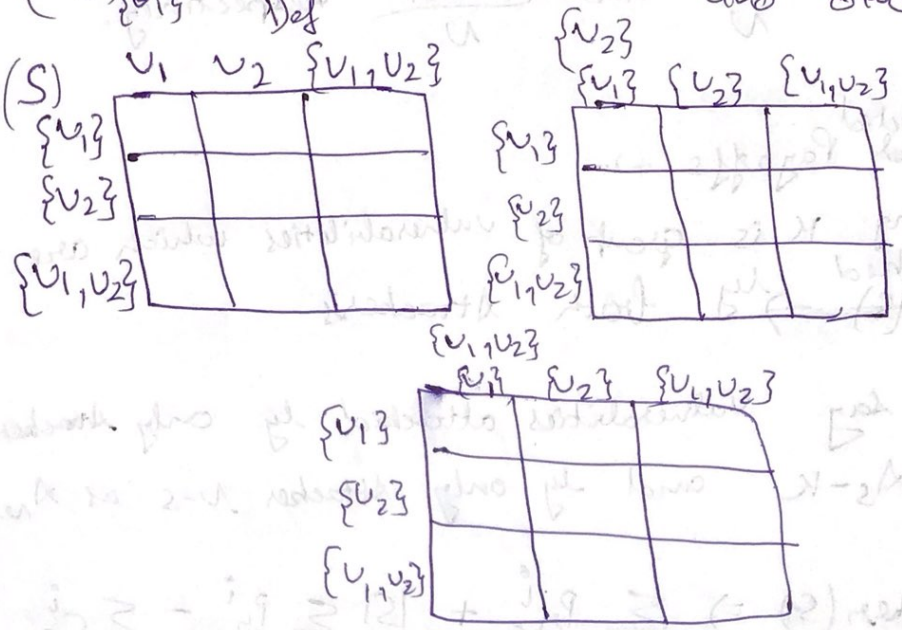
Consider 2 attacker group and one Defender and 2 vulnerabilities. one attacker group is S and other V-S



These above all are cases in all of these will have 3 tupled value.

C_A^v = Cost of attacking a vulnerability v by attacker A.

C_{Def}^v = Cost of defending a vulnerability v by Defender Def

Pr_A^v = Profit of attacker A after attack on vulnerability

I_A^v = Impact of exploitation of vulnerability on Defender by attacker

Pr_{Def}^v = Profit of Defender D after patching vulnerability v.

Now Consider Attacke S is using some strategy A_S and Attacker V-S using a strategy A_{V-S} and Defender is using a strategy D.

we are assuming the Attacker S and Attacker N-S are attacking a same vulnerability with probability $\frac{|S|}{N}$ and $\frac{|N-S|}{N}$ respectively.

Now Expected Payoffs →

Assuming K is group of vulnerabilities which are attacked by both Attackers.

let's say vulnerabilities attacked by only Attacker S as $A_S - K$ and by only Attacker $N-S$ as A_{N-S}

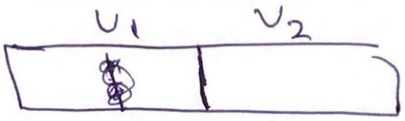
$$\text{Attacker}(S) \Rightarrow \sum_{i=A_S-K} Pr_S^i + \frac{|S|}{N} \sum_{i \in K} Pr_S^i - \sum_{i=A_S} C_S^i$$

$$\text{Attacker}(N-S) \Rightarrow \sum_{i=A_{N-S}-K} Pr_{N-S}^i + \frac{|N-S|}{N} \sum_{i=K} Pr_{N-S}^i - \sum_{i=A_{N-S}} C_{N-S}^i$$

$$\text{Defender}(Def) \Rightarrow \sum_{(i=1)} Pr_{Def}^i - \sum_{i=1} C_{Def}^i + \left(\sum_{i=\ell} I_A^i\right) P_A^i$$

where ℓ is the group of vulnerabilities which are attacked by Attackers that weren't patched by Defender (Def) and I_A^i A represents Attacker group which attacked that particular i^{th} vulnerability and P_A^i represents the probability of attacking a vulnerability i by Attacker A if that vulnerability i is attacked by more than one Attacker

A matrix



a random variable $R \rightarrow (0, 1)$

if $R \leq \frac{|S|}{N}$ where $|S| < N$

then $V_1 = S$ else $V_1 = N - S$

we will consider strategies for both groups

ex ⇒ $S \Rightarrow \{V_1, V_2\}$

$N - S \Rightarrow \{V_2\}$

now for V_2 we will use the above process but V_1 will be filled with S beforehand.

After calculating payoff matrix, we will use Approximation or Nash equilibrium this Algo is described below ⇒)

Step1 ⇒ Calculate Payoffs using the given formulas

Step2 ⇒ use Nash equilibrium or Approximation method to ~~represent~~ find equilibrium states

Step3 ⇒ use Shapely value or any other metric to divide payoffs among the groups.