Set - 7 :Modelling strategic conflict between nations

Shail Patel (202201297)* and Divyakumar Tandel (202201469)†
Dhirubhai Ambani Institute of Information & Communication Technology, Gandhinagar, Gujarat 382007, India
CS302, Modelling and Simulation

I. MODEL

Richardson's mathematical model of conflict between nations:
Strategic conflict between two nations is captured by the coupled equations,

$$\dot{x} = ky + g - \alpha x \tag{1}$$

$$\dot{y} = lx + h - \beta y \tag{2}$$

where $k, g, \alpha, l, h, \beta > 0$.

Mutual disarmament without grievance, g = h = 0. The strategic conflict between two nations is captured by the coupled equations,

$$\dot{x} = ky - \alpha x \tag{3}$$

$$\dot{y} = lx - \beta y \tag{4}$$

Under the condition of $\alpha\beta > kl$.

Mutual disarmament with grievance, g, h != 0 Strategic conflict between two nations is captured by the coupled equations, with initial values of x(0) = y(0) = 0,

$$\dot{x} = g \tag{5}$$

$$\dot{y} = h \tag{6}$$

where $g, h > 0$.

Unilateral disarmament, Strategic conflict between two nations is captured by the coupled equations,with y(0) = 0 and x(0) != 0.

$$\dot{x} = g - \alpha x \tag{7}$$

$$\dot{y} = lx + h \tag{8}$$

where $g, \alpha, l, h > 0$.

Arms race, Strategic conflict between two nations is captured by the coupled equations,with $\alpha = \beta = g = h = 0$.

$$\dot{x} = ky \tag{9}$$

$$\dot{y} = lx \tag{10}$$

where $k, l > 0$.

II. MUTUAL DISARMAMENT WITHOUT GRIEVANCE, G = H = 0

A. Results

Fig. 1 shows the war potential of the nations in time.

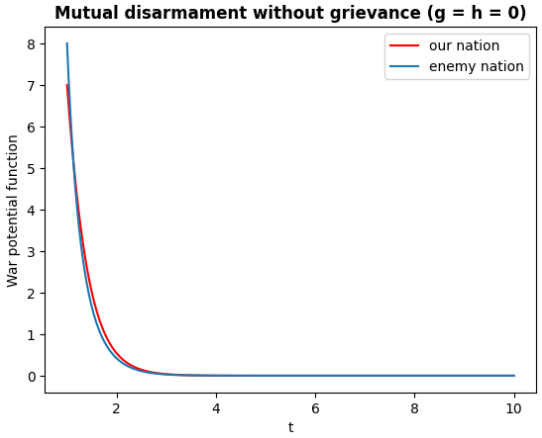

FIG. 1: Here x(0)=7, y(0)=8,α = 3 ,k=0.8, β = 5, Δt = 0.0001$unit.$, l=2.

Fig. 2 shows the war potential of nations in time with logaritmic y scale.

*Electronic address: 202201297@daiict.ac.in
†Electronic address: 202201469@daiict.ac.in

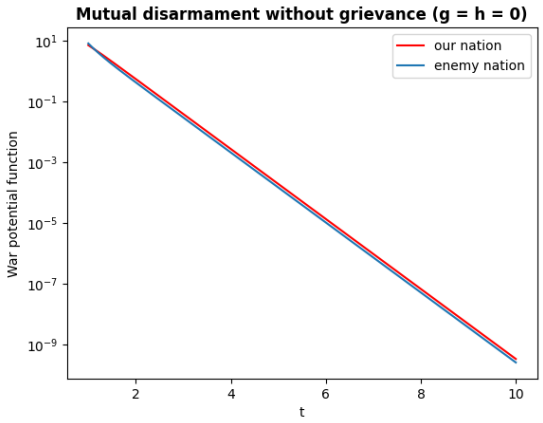

FIG. 2: Here x(0)=7, y(0)=8,α = 3 ,k=0.8, β = 5, Δt = 0.0001*unit.* , l=2.

Fig. 3 shows the war potential of enemy nation with respect to war potential of our nation.

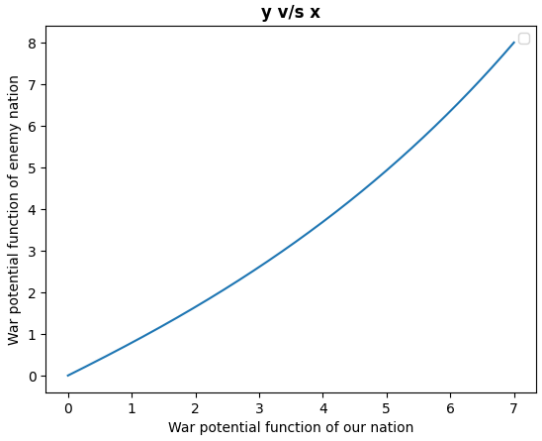

FIG. 3: Here x(0)=7, y(0)=8,α = 3 ,k=0.8, β = 5, Δt = 0.0001*unit.* , l=2.

III. MUTUAL DISARMAMENT WITH GRIEVANCE, G, H != 0

A. Results

Fig. 4 shows the war potential of the nations in time.

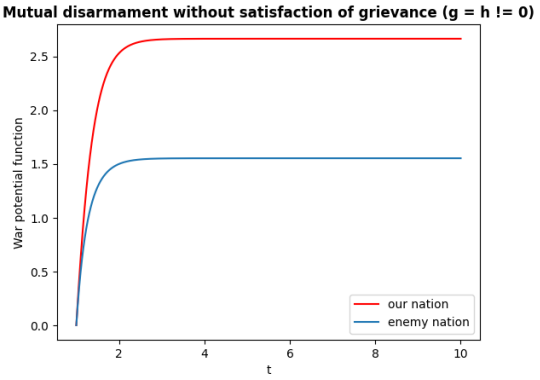

FIG. 4: Here x(0)=0, y(0)=0,α = 4 ,k=3, β = 5, Δt = 0.0001*unit.* , l=0.85,g=6,h=5.5.

Fig. 5 shows the war potential of enemy nation with respect to war pontential of our nation.

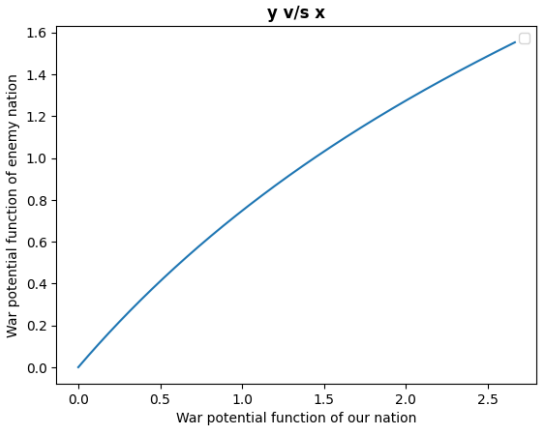

FIG. 5: Here x(0)=0, y(0)=0,α = 4 ,k=3, β = 5, Δt = 0.0001*unit.* , l=0.85,g=6,h=5.5.

IV. UNILATERAL DISARMAMENT

A. Results

Fig. 6 shows the war potential of the enemy nation with respect to time.

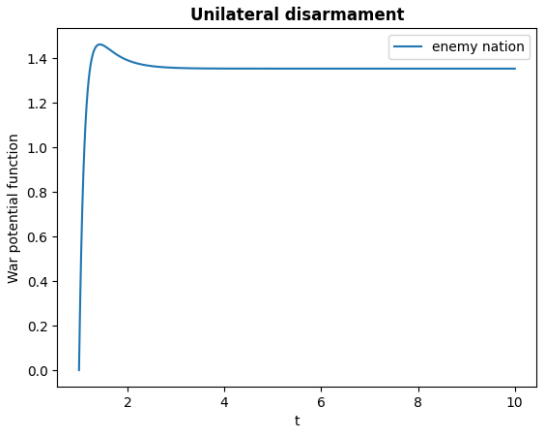

FIG. 6: Here x(0)=4, y(0)=0,$\alpha = 3$,k=2, $\beta = 7$, l=2 , g=4 , h=5, $\Delta t = 0.0001 unit$..

V. ARMS RACE

A. Results

Fig. 7 shows the war potential of the nations in time.

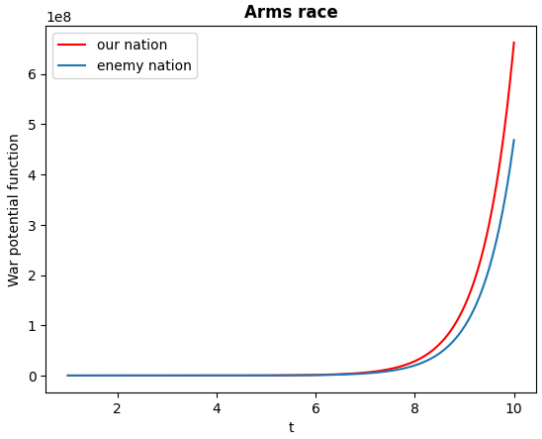

FIG. 7: Here x(0)=250, y(0)=500,$\alpha = 0$,k=2, $\beta = 0$, l=1 , g=0 , h=0, $\Delta t = 0.0001 unit$..

Fig. 8 shows war potential of nations wrt time with logarithmic y scale.

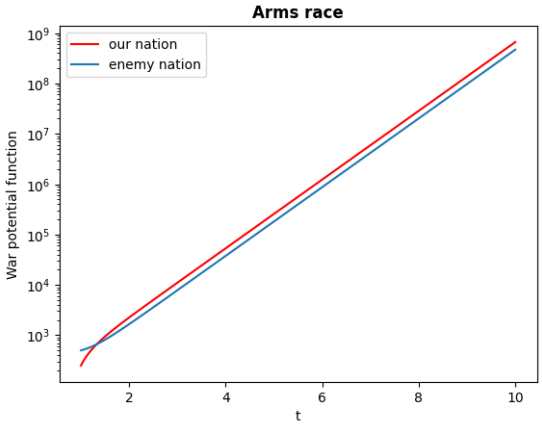

FIG. 8: Here x(0)=250, y(0)=500,$\alpha = 0$,k=2, $\beta = 0$, l=1 , g=0 , h=0, $\Delta t = 0.0001 unit$..

Fig. 9 shows the war potential of the enemy nation with respect to the war potential of our nation.

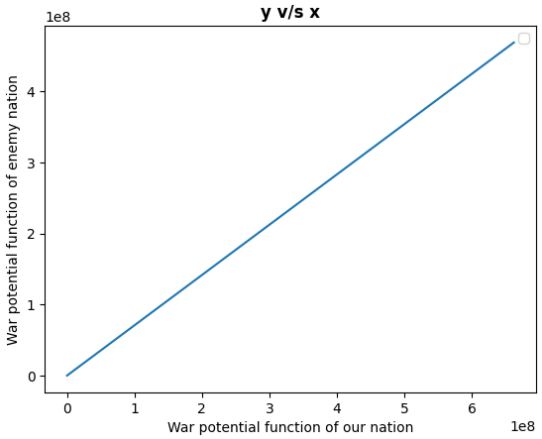

FIG. 9: Here x(0)=250, y(0)=500,$\alpha = 0$,k=2, $\beta = 0$, l=1 , g=0 , h=0, $\Delta t = 0.0001 unit$..

VI. SALIENT FEATURES:

1. For mutual disarmament without grievance, if $\alpha\ \beta > kl$ and the initial values are zero, then peace prevails all the time.

2. For arms race, whenever x grows y tend to grow with it and same happens for x.

3. For unilateral diarmanent , the nation whose initial value of weaponary is zero grows with the time.