Set - 7 :Modelling strategic conflict between nations

Natansh Shah (202201445)* and Tirth Modi (202201513)†
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 $k, g, \alpha, l, h, \beta > 0$.

i) Mutual disarmament without grievance, g = h = 0. 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 $\alpha\beta > kl$.

ii) Mutual disarmament with grievance, g, h $\neq$ 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 $g, h > 0$.

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

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

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

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

iv) 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 war potential of nations wrt time.

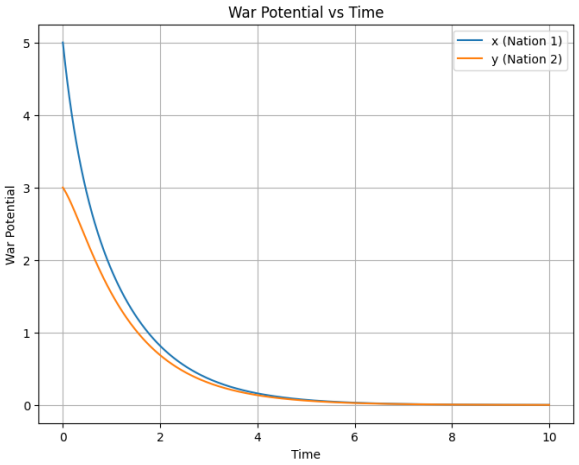

FIG. 1: Here x(0)=5, y(0)=3,α = 3 ,k=2, β = 2, Δt = 0.0001*unit.* , l=1.

Fig. 2 shows war potential of nations wrt time with logarithmic y scale.

*Electronic address: 202201445@daiict.ac.in
†Electronic address: 202201513@daiict.ac.in

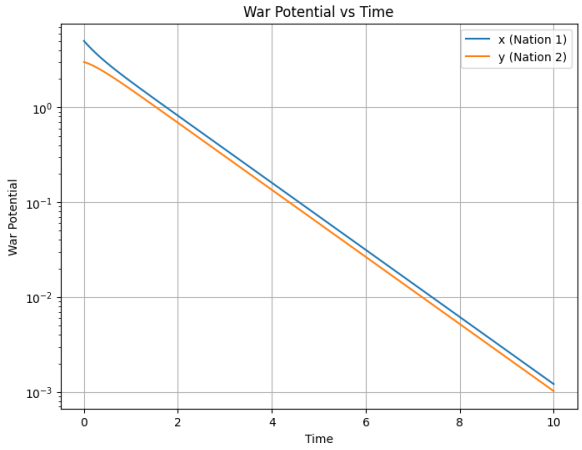

FIG. 2: Here x(0)=5, y(0)=3,$\alpha = 3$,k=2, $\beta = 2$, l=1, $\Delta t = 0.0001 unit.$.

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

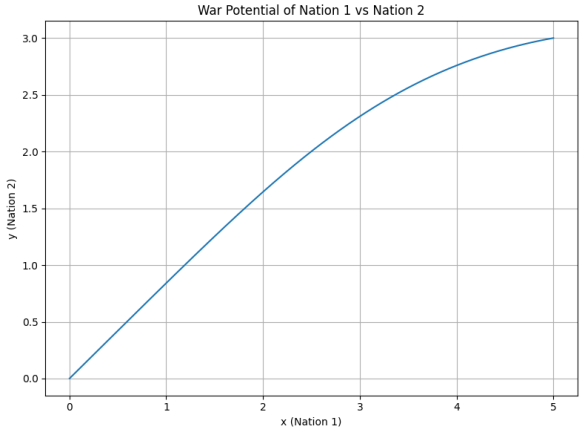

FIG. 3: Here x(0)=5, y(0)=3,$\alpha = 3$,k=2, $\beta = 2$, l=1, $\Delta t = 0.0001 unit.$.

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

A. Results

Fig. 4 shows war potential of nations wrt time.

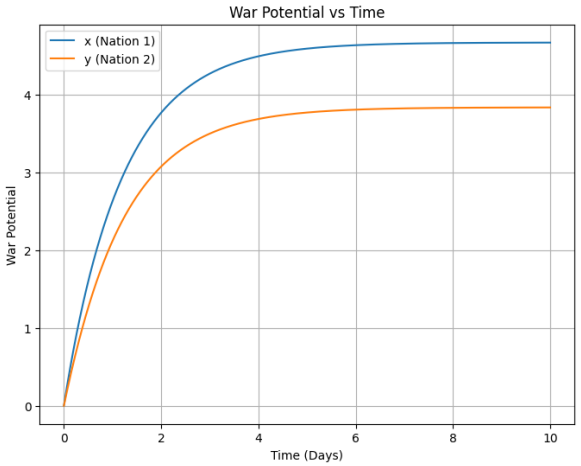

FIG. 4: here x(0)=0, y(0)=0, g=4, h=3 $\alpha = 2.5$,k=2, $\beta = 2$, l=1, $\Delta t = 0.0001 unit.$.

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

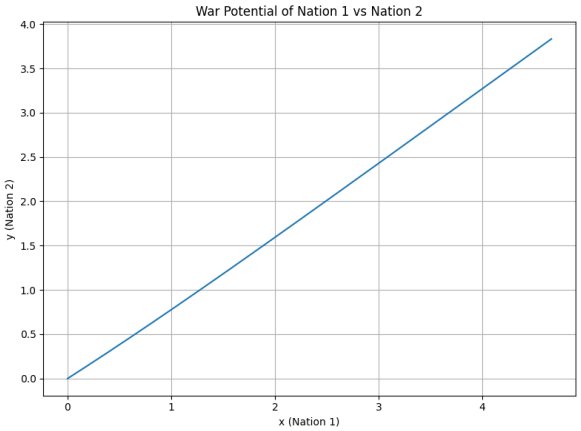

FIG. 5: Here g=3, h=4 ,x(0)=0 , y(0)=0, $\Delta t = 0.0001 unit.$.

IV. UNILATERAL DISARMAMENT

A. Results

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

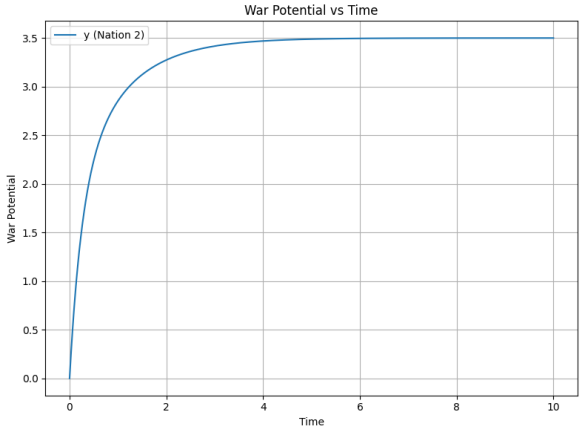

FIG. 6: Here x(0)=3, y(0)=0,$\alpha = 2$,k=1, $\beta = 3$, l=2 , g=4 , h=3, $\Delta t = 0.0001 unit$..

V. ARMS RACE

A. Results

Fig. 7 shows war potential of nations wrt time.

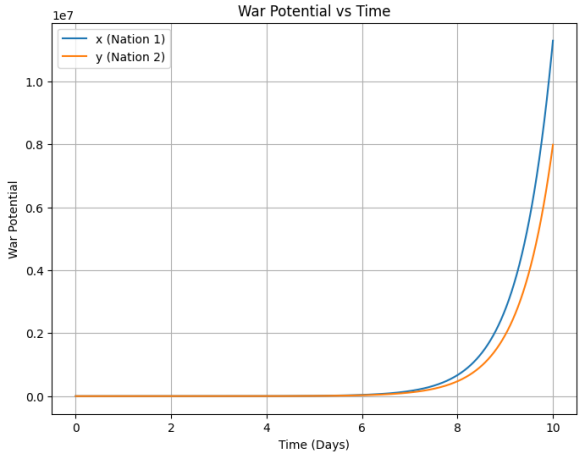

FIG. 7: Here x(0)=5, y(0)=8 , k=2 , l=1, $\Delta t = 0.0001 unit$..

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

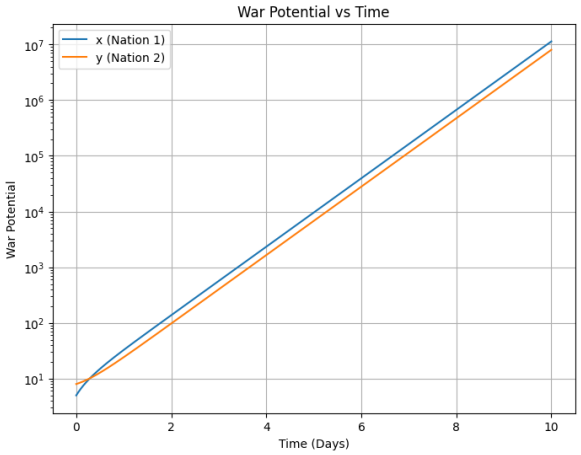

FIG. 8: Here x(0)=5, y(0)=8 , k=2 , l=1, $\Delta t = 0.0001 unit$..

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

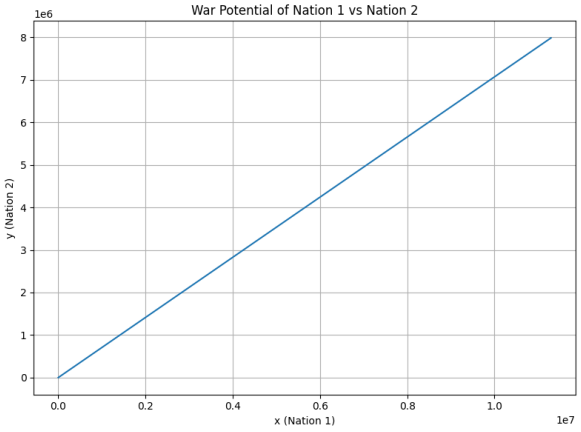

FIG. 9: Here x(0)=5, y(0)=8 , k=2 , l=1, $\Delta t = 0.0001 unit$..