Set - 7 : Modelling strategic conflict between nations

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CS302, Modelling and Simulation

In this lab, we model and visualize the war-waging potential of two rival countries. This potential is influenced by several factors, including the war readiness of the opposing country, the level of grievance felt towards the rival, and the cost of armament. These parameters collectively determine the war-waging potential of each country.

I. EQUATIONS

Strategic conflict between two nations is captured by the coupled equations

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

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

For Mutual disarmament without grievance,

$$g = h = 0$$

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

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

For Mutual disarmament with grievance,

$$g, h \neq 0$$

$$y(0) = x(0) = 0$$

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

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

For Unilateral disarmament,

$$y(0) = 0, x(0) \neq 0$$

$$\dot{y} = lx + h \tag{7}$$

For Arms race

$$g = h = 0$$

$$\alpha = \beta = 0$$

$$\dot{x} = ky \tag{1}$$

$$\dot{y} = lx \tag{2}$$

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II. RESULTS

A. Mutual disarmament without grievance

Fig. 1 shows the Disarmament of countries x and y, without grievance with respect to time.

FIG. 1: Here, x(0) = 7, y(0) = 8, α= 3, β= 5, k = 0.8, l = 2, g = 0, h = 0 and Δ t = 0.002 units.

Fig. 2 shows the Disarmament of countries x and y, without grievance with respect to time, taking logarithmic scale on y-axis.

FIG. 2: Here, x(0) = 7, y(0) = 8, α = 3, β = 5, k = 0.8, l = 2, g = 0, h = 0 and Δ t= 0.002 units

Fig. 3 shows the Disarmament of countries y vs x, without grievance.

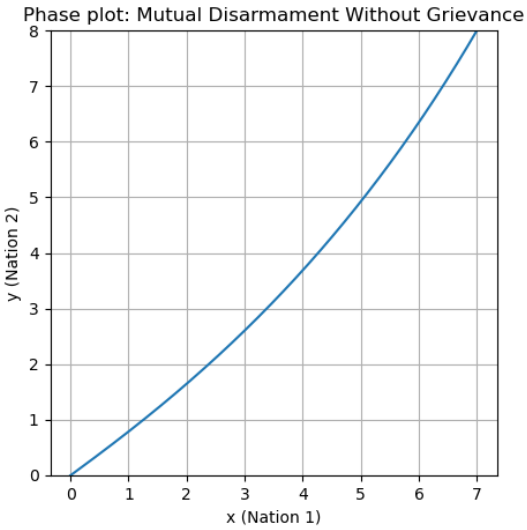

FIG. 3: Here, x(0) = 7, y(0) = 8, $\alpha = 3$, $\beta = 5$, k = 0.8, l = 2, g = 0, h = 0 and Δ t= 0.002 units.

B. Mutual disarmament with grievance

Fig. 4 shows the Disarmament of countries x and y, with grievance with respect to time.

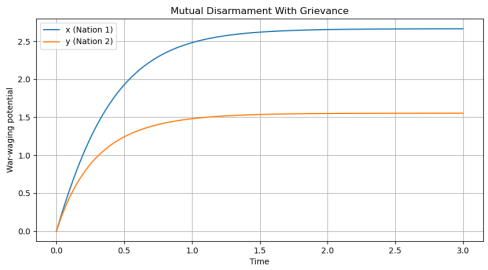

FIG. 4: Here, x(0) = 0, y(0) = 0, $\alpha = 4$, $\beta = 5$, k = 3, l = 0.85, g = 6, h = 5.5 and Δ t= 0.001 units.

Fig. 5 shows the Disarmament of countries y vs x, with grievance.

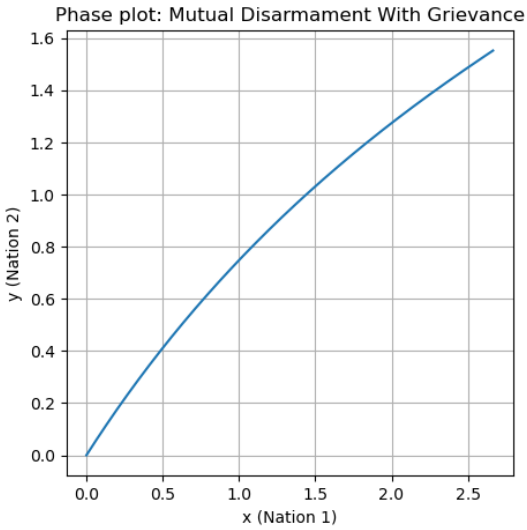

FIG. 5: Here, x(0) = 0, y(0) = 0, $\alpha = 4$, $\beta = 5$, k = 3, l = 0.85, g = 6, h = 5.5 and Δ t= 0.001 units.

C. Unilateral disarmament

Fig. 6 shows the Unilateral Disarmament of country y with respect to time.

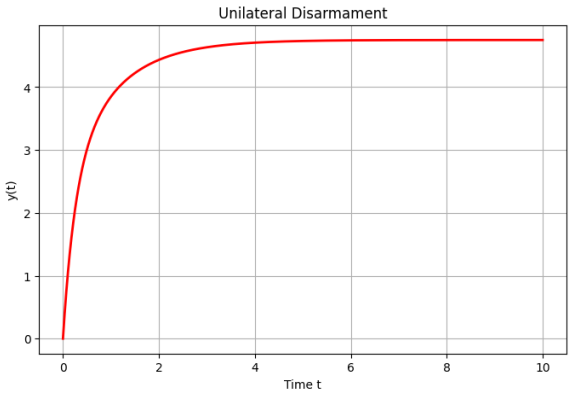

FIG. 6: Here, x(0) = 7, y(0) = 0, $\alpha = 3$, $\beta = 2$, k = 2, l = 1, g = 4, h = 5 and Δ t= 0.001 units.

D. Arms race

Fig. 7 shows the Arms Race of countries x and y, with respect to time.

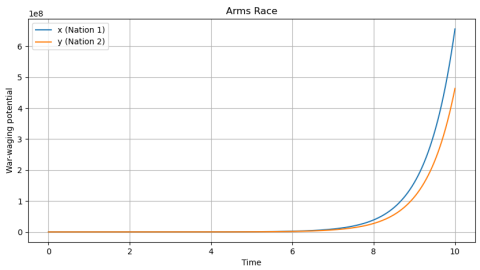

FIG. 7: Here, x(0) = 250, y(0) = 500, $\alpha = 0$, $\beta = 0$, k = 2, l = 1, g = 0, h = 0 and Δ t= 0.001 units.

Fig. 8 shows the Arms Race of countries x and y, with respect to time, taking logarithmic scale on y-axis.

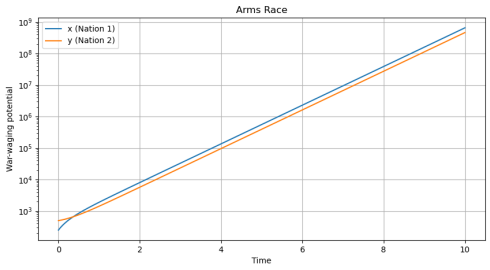

FIG. 8: Here, x(0) = 250, y(0) = 500, $\alpha = 0$, $\beta = 0$, k = 2, l = 1, g = 0, h = 0 and Δ t= 0.001 units.

Fig. 9 shows the Arms Race of countries y vs x.

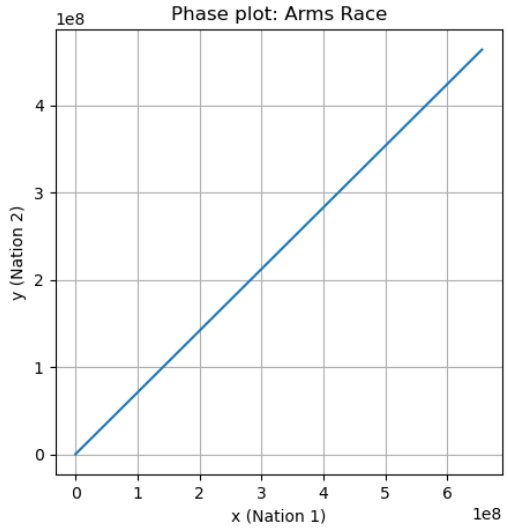

FIG. 9: Here, x(0) = 250, y(0) = 500, $\alpha = 0$, $\beta = 0$, k = 2, l = 1, g = 0, h = 0 and Δ t= 0.001 units.

III. CONCLUSIONS

- **Effect of Grievance on War-Waging Potential:** In the absence of grievance, a country's war-waging potential declines exponentially over time. However, when grievance is present, the war-waging potential increases linearly.

- **Impact of War-Readiness Factor on War-Waging Potential:** Our findings indicate that a rival country's war-readiness factor triggers an exponential rise in war-waging potential, regardless of any existing grievance between the nations.

- **Relationship Between Armament and Rival's Armament:** We observe a linear relationship between a country's armament and that of its rival. As one nation's armament increases, its rival's armament also increases correspondingly.