Process dynamics

Process Dynamics (W.L. Luyben)
Approximate description of the battle with a continuous process.
Simulate the processes A, B, C, answer the questions, provide graphs.

1 Battle of Trafalgar (1805)

32 ships led by Admiral Lord Nelson against 38 ships of the line under French Admiral Pierre-Charles Villeneuve. Ship's destruction speed during the battle is proportional to the number of enemy ships, on the average any ship can be destroyed for a half of the day.

1. battle

- Write the equation. Provide solution depending on time $N(t), V(t)$ graphically.

- Who will win? (Victory if number of enemy's vessels $= 0$). How many ships should be in order to win the battle? Try system with the following parameters ($a_{12} = 2.5, a_{21} = 3.8$), answer the questions.

- How big are the losses, how long the battle lasts?

- How can ships' destruction speed change the result?

- What is the process statics (equilibrium point)?

- Is the process stable or not? Calculate the eigenvalues of the system.

- Provide process trajectory in the state space (N, V) and several more with other initial values (in the same graph). Find eigenvalues of the system.

2 Battle of the Atlantic (World War II)

Battle between German submarines (U $= 247$) and British destroyers (D $= 132$). Ship's destruction speed during the battle is proportional to the number of enemy ships, on the average one ship destroys 0.25 of the enemy's ship per week. Germany produces two submarines a week.

- How many destroyers a week to be produced in England in order to achieve victory in the battle?

- Provide the equation to solve $U(t), D(t)$.

3   Battle in space (2200)

Earth (E) has 16 warships Klingon Empire (K) 20 alike (firepower and defence) against a ship. During the modernization of spaceships, half of Earth's ships ($E_1 = \frac{1}{2}E$) increased the firepower in two times compared to K ships, the second half of the warships ($E_2 = \frac{1}{2}E$) has the enhanced defence: damages from K fires decreased by 2 times.

- Provide results of the battle without modernization, how many ships are left?

- Provide results of the battle with modernization, who is the winner?

   Which part of the warships (E_1, E_2) is more likely to survive?

- What happens if E_2 is not able to modernize the ships?