Laboratory "**Modeling and Simulation of Dynamic Systems**"
Institute of the Theory of Electrical Engineering, Measurement and Information Systems, WUT

Exercise No 6C

# DYNAMICS OF THE CHANGE OF POPULATION

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## 1. The aim of experiments

Learning the dynamics of the change of population of the groups of individuals competeing with each other in the same region.

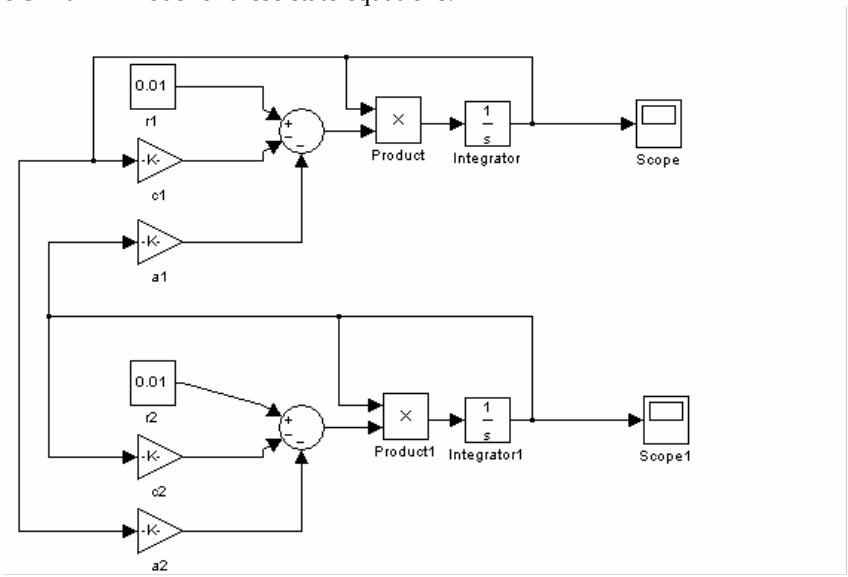
## 2. Dynamic model

Two groups of individuals $x_1$ i $x_2$ occupy the same region competing to the resources of food. Assume that this resource is sufficient to support the population of *K* individuals. Let r is the relative growth of population for the unit of time and $c = \frac{r}{K}$. Assuming that the increase of one population results into decrease of the other, with the proportionality coefficient *a*, the state space equations describing the dynamics of the process are as follows

$$\frac{dx_1}{dt} = (r_1 - c_1 x_1 - a_1 x_2) x_1$$

$$\frac{dx_2}{dt} = (r_2 - c_2 x_2 - a_2 x_1) x_2$$

Fig. 1 presents the Simulink model of these state equations.




Rys. 2 Simulink model of the dynamics of the change of two populations

## 3. Program of numerical experiments

The experiments will explore the change of both populations with time for two cases:

- both groups of species occupy different regions and don't interfere with each other ($a_1$=$a_2$=0)
- the groups live in the same area and compete for the resources of food ($a_1$ and $a_2$ are different from zero).

Use **in** the experiments the Simulink model written in the file **populacja.mdl**. In your experiments simulate the following cases.

1. **No interaction between two populations ($a_1$=$a_2$=0):**
   - Equal initial conditions of both populations at different values of r and K.
   - Non-equal initial conditions of both populations at different values of r and K.

2. **Interaction of two populations ($a_1 \neq 0$, $a_2 \neq 0$):**
    - Equal values of $a_1$ and $a_2$ (for example 1E-7), set $K_1=K_2=50000$ and $r_1=r_1=0.001$ and equal initial conditions (for example $x_1=x_2=10000$).
    - Equal values of $a_1$ and $a_2$ (for example 1E-7), set K=50000 and $r_1= 0.001$, $r_2=0.0012$ and equal initial conditions (for example $x_1=x_2=10000$).
    - Equal values of $a_1$ and $a_2$ (for example 1E-7), set K=50000 and $r_1= 0.001$, $r_2=0.0012$ and different initial conditions (for example $x_1 =1100$ and $x_2=400$).
    - Equal values of $a_1$ and $a_2$ (for example 1E-7), set K=50000 and $r_1= 0.001$, $r_2=0.0012$ and different initial conditions (for example $x_1 =1100$ and $x_2=4000$).
    - Non-equal (but close) values of $a_1$ and $a_2$ (for example 1E-7, 1.05E-7), set K=50000 and $r_1= 0.001$, $r_2=0.001$ and different initial conditions (for example $x_1 =1100$ and $x_2=1400$).
    - Non-equal (but close) values of $a_1$ and $a_2$ (for example 1E-7, 1.05E-7), set K=50000 and $r_1= 0.001$, $r_2=0.001$ and different initial conditions (for example $x_1 =1100$ and $x_2=1200$).