

# *M7116 Maticové populační modely*

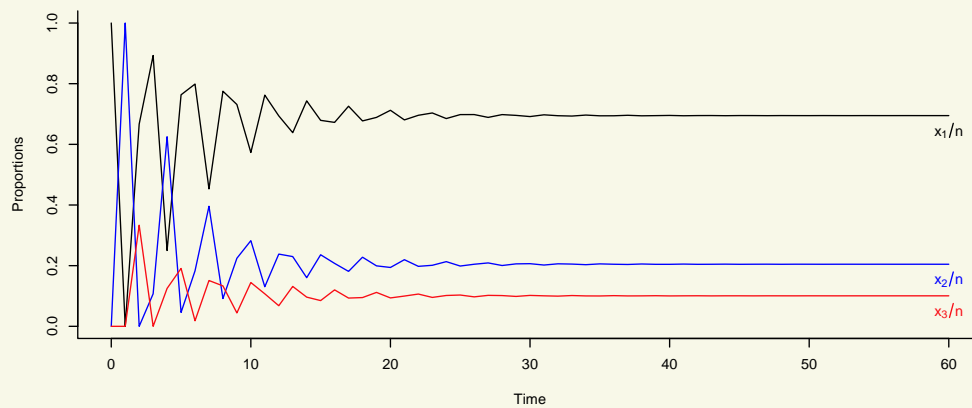
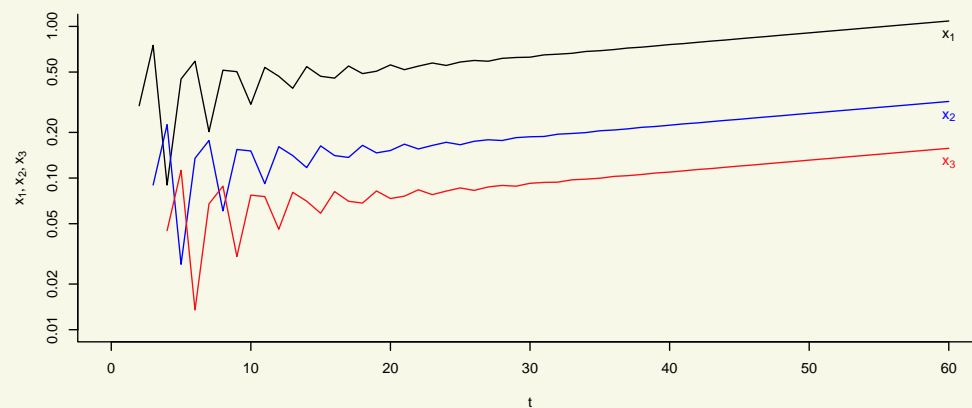
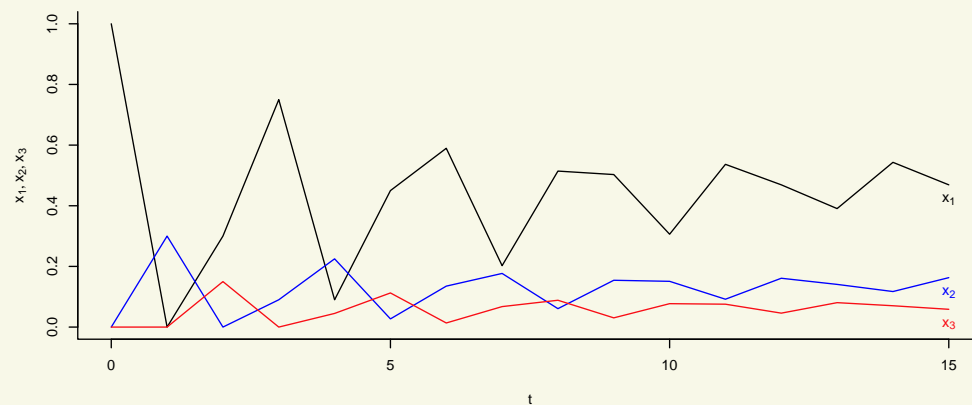
Úvodní příklady

23. 2. 2015

$$\begin{pmatrix} x_1(t+1) \\ x_2(t+1) \\ x_3(t+1) \end{pmatrix} = \begin{pmatrix} 0 & 1 & 5 \\ 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{pmatrix}$$

$$\begin{pmatrix} x_1(0) \\ x_2(0) \\ x_3(0) \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

$$n = x_1 + x_2 + x_3$$



# Vliv počátečních podmínek

$$\begin{pmatrix} x_1(t+1) \\ x_2(t+1) \\ x_3(t+1) \end{pmatrix} = \begin{pmatrix} 0 & 1 & 5 \\ 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{pmatrix}$$

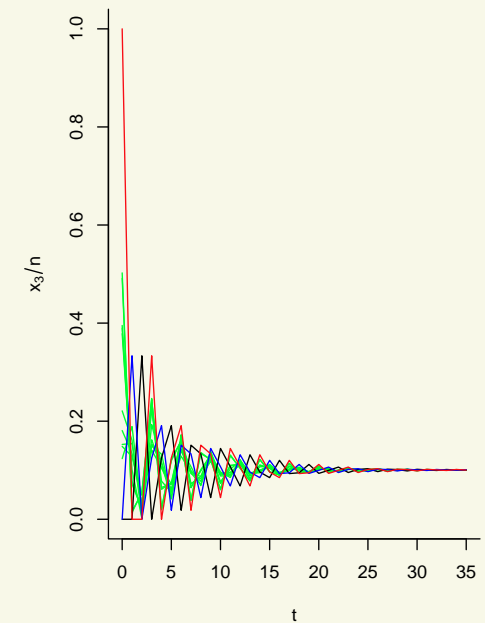
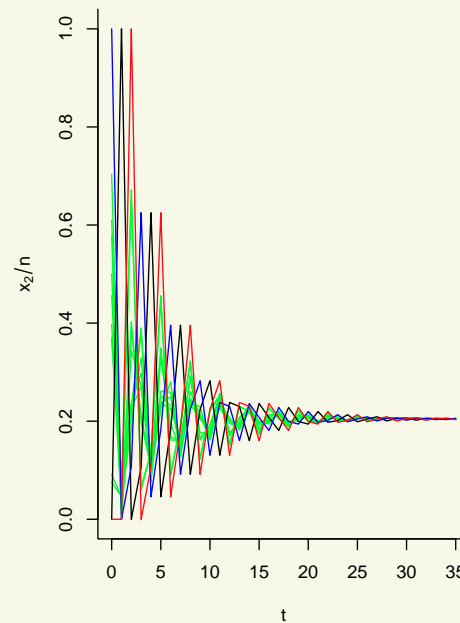
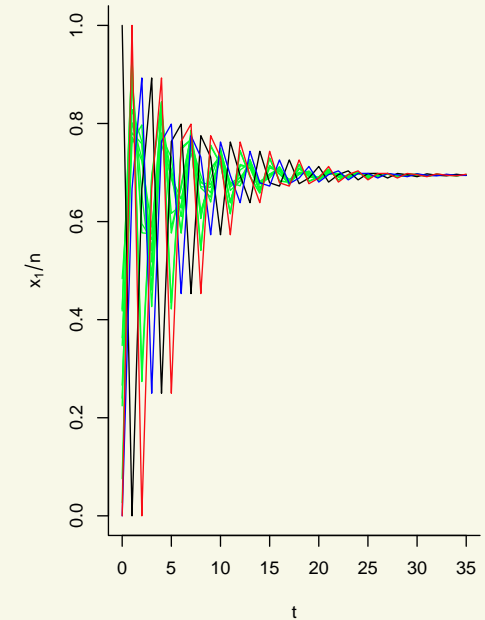
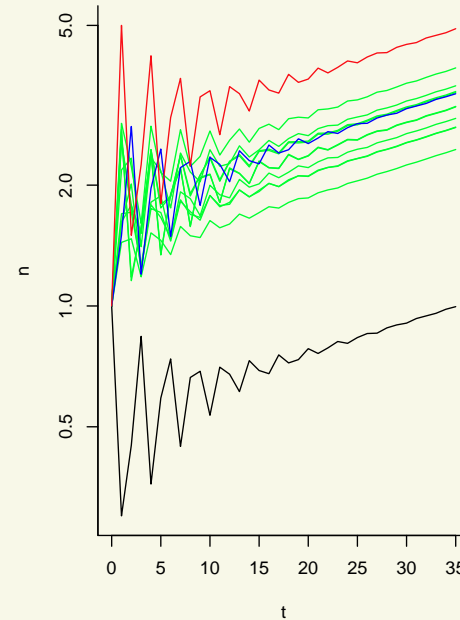
$$\begin{pmatrix} x_1(0) \\ x_2(0) \\ x_3(0) \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}, \quad \begin{pmatrix} x_1(0) \\ x_2(0) \\ x_3(0) \end{pmatrix} = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix},$$

$$\begin{pmatrix} x_1(0) \\ x_2(0) \\ x_3(0) \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}, \quad \begin{pmatrix} x_1(0) \\ x_2(0) \\ x_3(0) \end{pmatrix} = \begin{pmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \end{pmatrix},$$

kde  $\xi_1, \xi_2, \xi_3$  jsou realizace náhodné veličiny takové, že  $\xi_1 + \xi_2 + \xi_3$

Provedeno 10 simulací

$$n = x_1 + x_2 + x_3$$



# Vliv změny prvků matice

$$\begin{pmatrix} x_1(t+1) \\ x_2(t+1) \\ x_3(t+1) \end{pmatrix} = \begin{pmatrix} 0 & F_2 & F_3 \\ P_1 & 0 & 0 \\ 0 & P_2 & 0 \end{pmatrix} \begin{pmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{pmatrix}$$

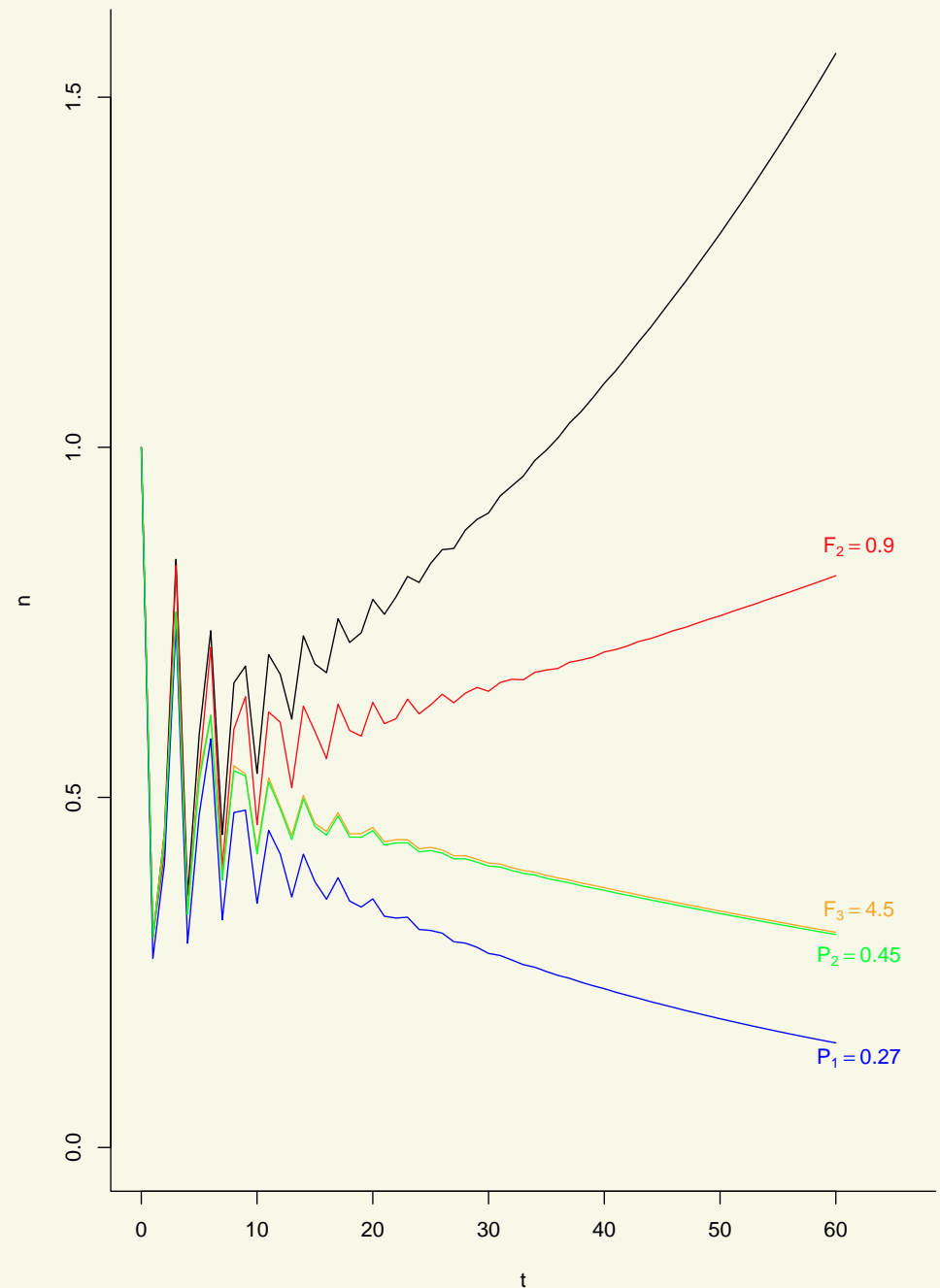
$$\begin{pmatrix} x_1(0) \\ x_2(0) \\ x_3(0) \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

Původní hodnoty:

$$F_2 = 1, F_3 = 5, P_1 = 0.3, P_2 = 0.5$$

V jednotlivých výpočtech vždy zmenšíme právě jeden z parametrů o 10%

$$n = x_1 + x_2 + x_3$$



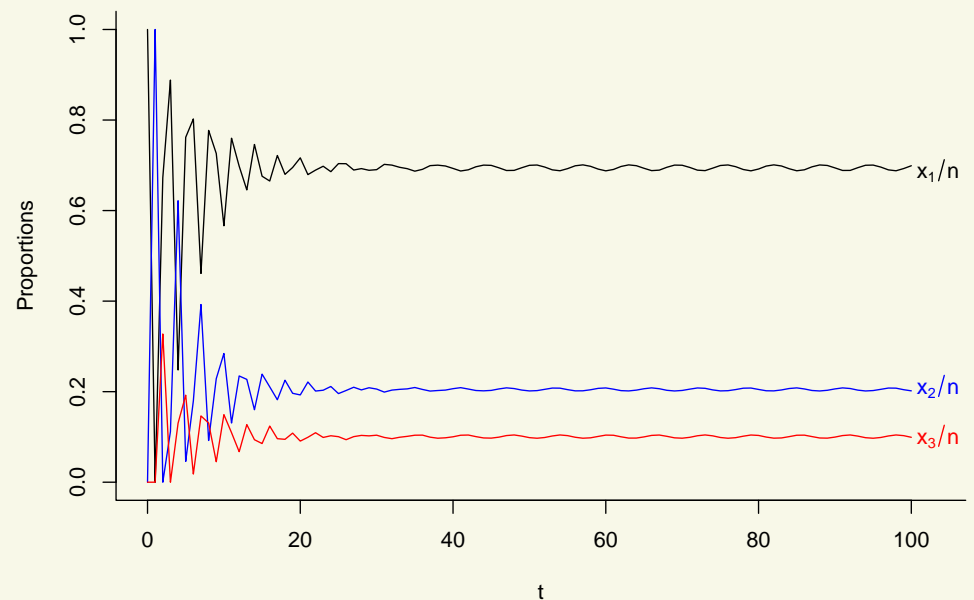
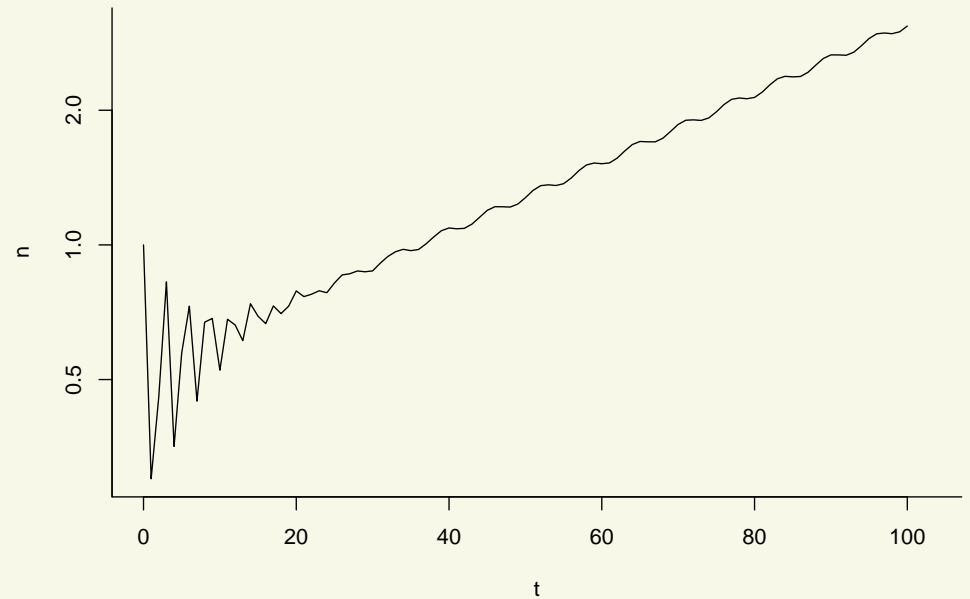
# Vliv kolísání parametrů

$$\begin{pmatrix} x_1(t+1) \\ x_2(t+1) \\ x_3(t+1) \end{pmatrix} = \begin{pmatrix} 0 & h(t) & 5h(t) \\ 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{pmatrix}$$

$$\begin{pmatrix} x_1(0) \\ x_2(0) \\ x_3(0) \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

$$h(t) = 1 + 0.05 \cos(t)$$

$$n = x_1 + x_2 + x_3$$



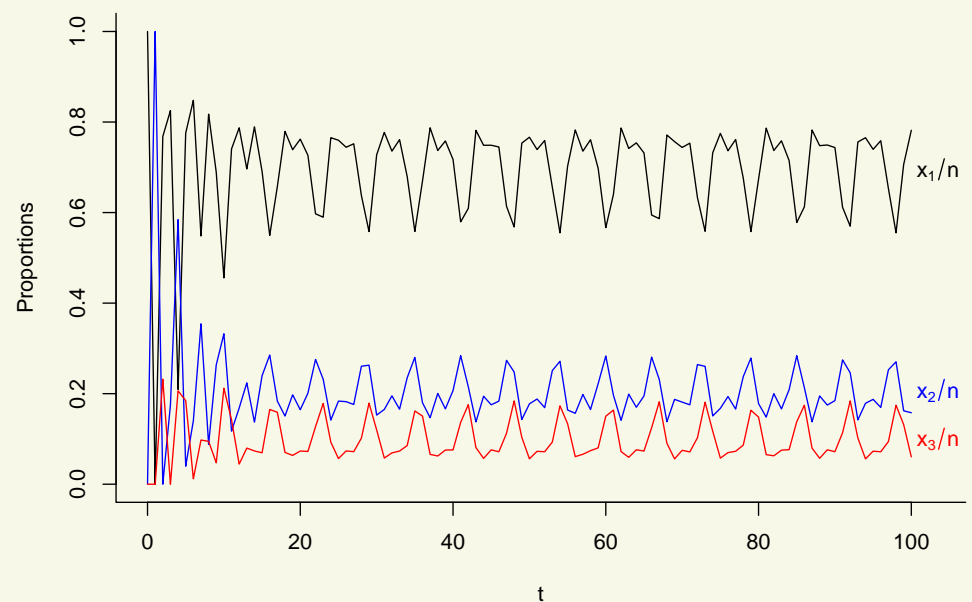
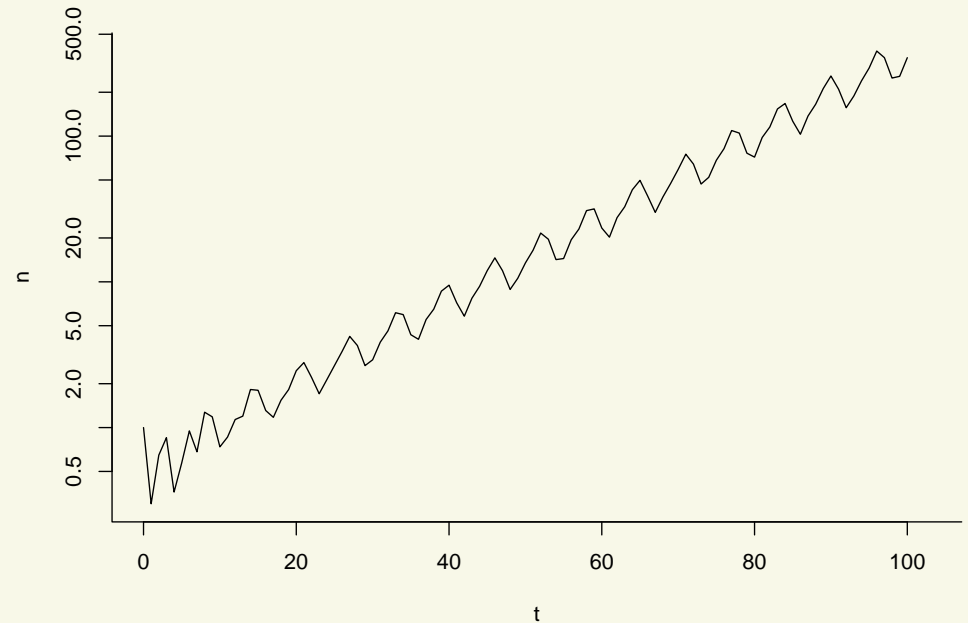
# Vliv kolísání parametrů

$$\begin{pmatrix} x_1(t+1) \\ x_2(t+1) \\ x_3(t+1) \end{pmatrix} = \begin{pmatrix} 0 & h(t) & 5h(t) \\ 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{pmatrix}$$

$$\begin{pmatrix} x_1(0) \\ x_2(0) \\ x_3(0) \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

$$h(t) = 1.25 + 0.75 \cos(t)$$

$$n = x_1 + x_2 + x_3$$



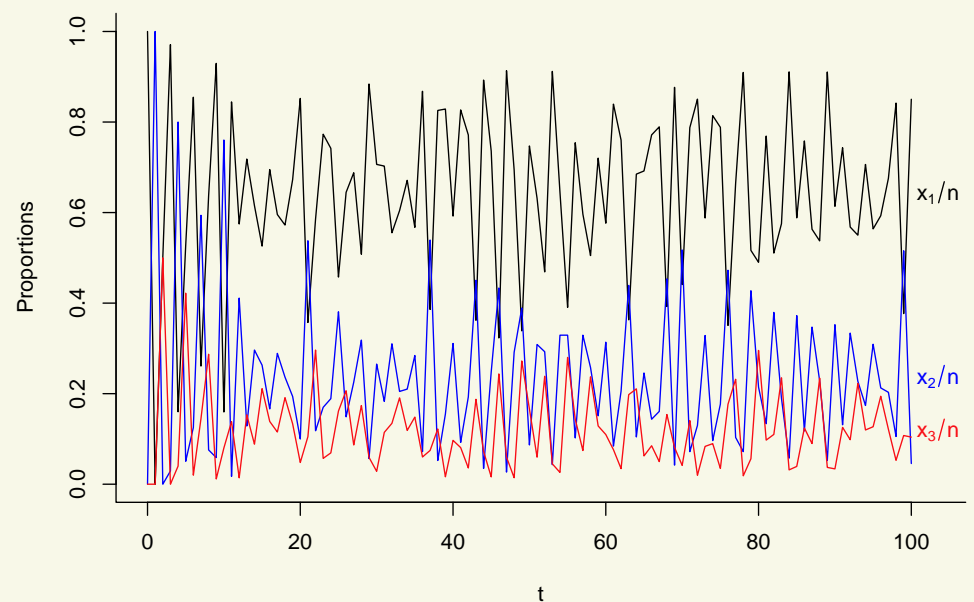
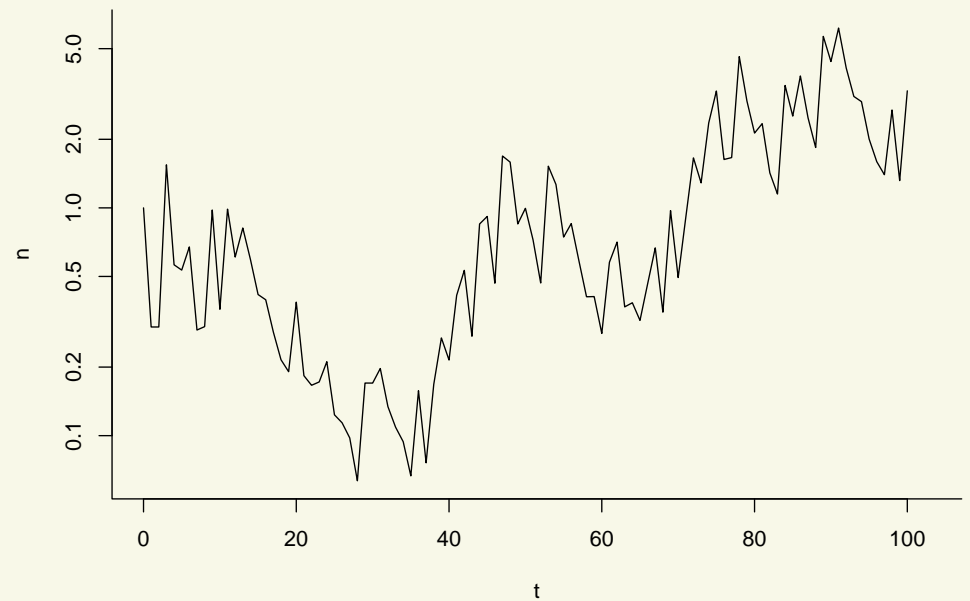
# Vliv náhodnosti

$$\begin{pmatrix} x_1(t+1) \\ x_2(t+1) \\ x_3(t+1) \end{pmatrix} = \begin{pmatrix} 0 & h(t) & 5h(t) \\ 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{pmatrix}$$

$$\begin{pmatrix} x_1(0) \\ x_2(0) \\ x_3(0) \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

$$h(t) = \begin{cases} 2 & \text{s pravděpodobností } \frac{1}{2} \\ 0.5 & \text{s pravděpodobností } \frac{1}{2} \end{cases}$$

$$n = x_1 + x_2 + x_3$$



# Vliv náhodnosti

$$\begin{pmatrix} x_1(t+1) \\ x_2(t+1) \\ x_3(t+1) \end{pmatrix} = \begin{pmatrix} 0 & h(t) & 5h(t) \\ 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{pmatrix} \quad n$$

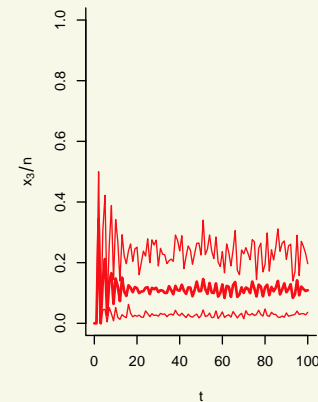
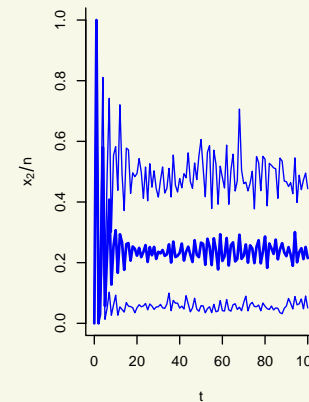
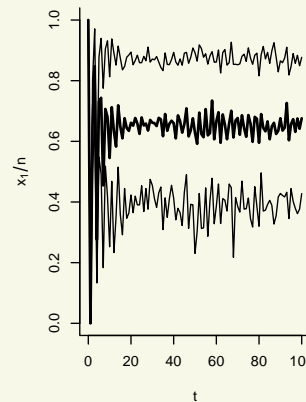
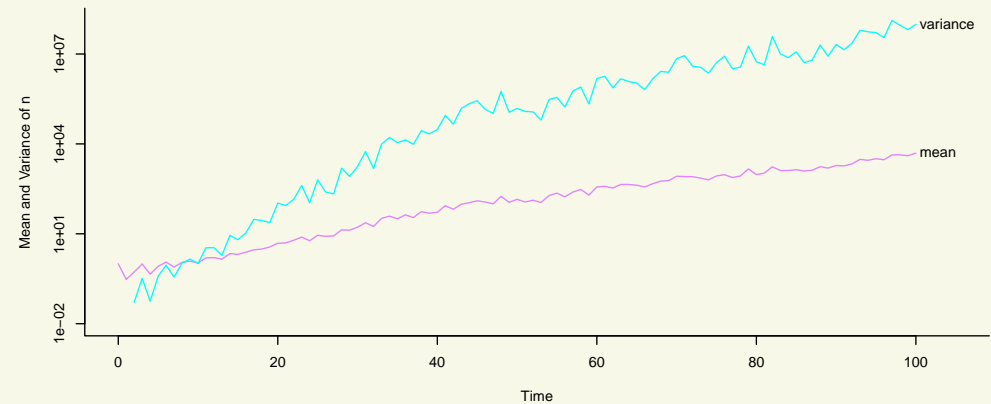
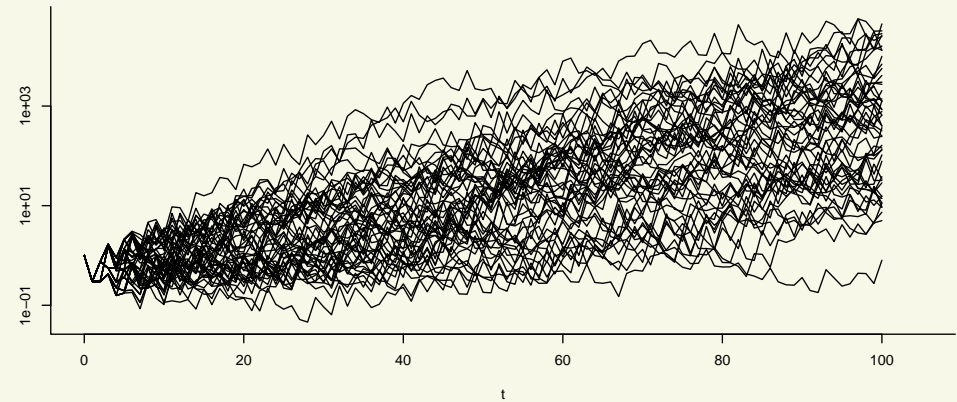
$$\begin{pmatrix} x_1(0) \\ x_2(0) \\ x_3(0) \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

$$h(t) = \begin{cases} 2 & \text{s pravděpodobností } \frac{1}{2} \\ 0.5 & \text{s pravděpodobností } \frac{1}{2} \end{cases}$$

$$n = x_1 + x_2 + x_3$$

Provedeno 50 simulací.

U poměrů jednotlivých složek k jejich součtu jsou zobrazeny výběrové decily a aritmetický průměr.





# Vliv velikosti populace

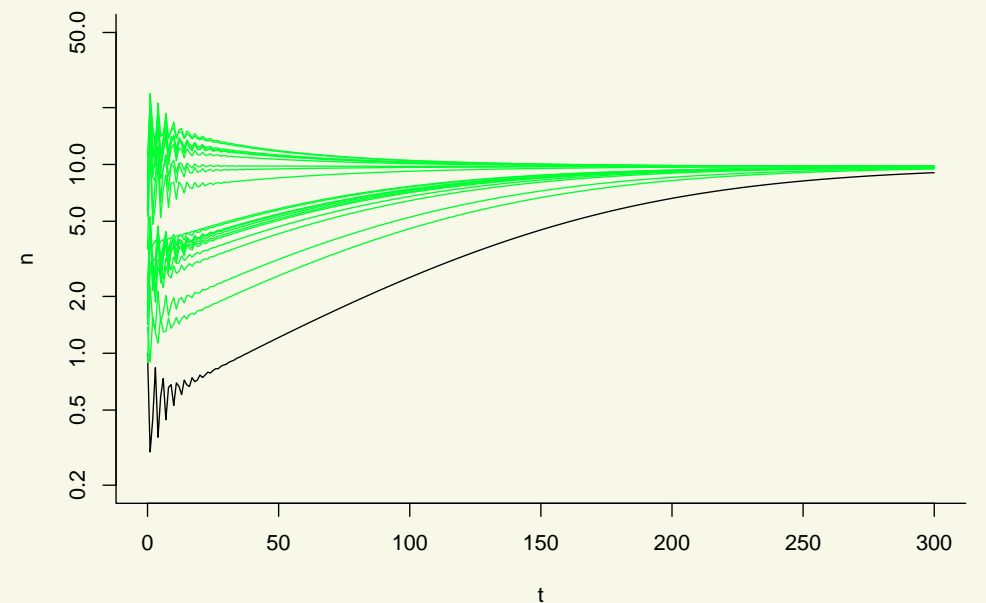
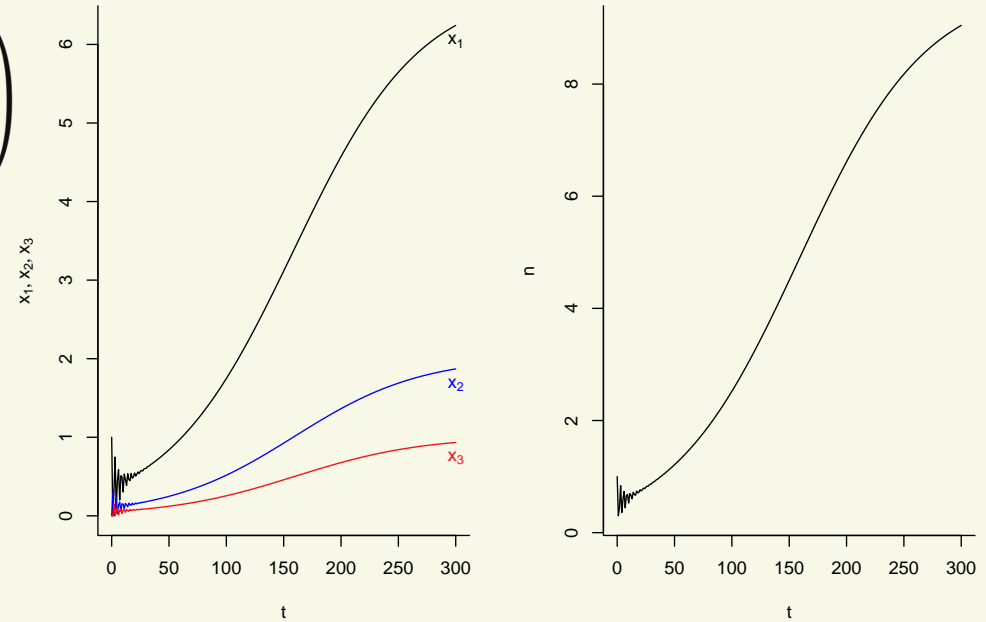
$$\begin{pmatrix} x_1(t+1) \\ x_2(t+1) \\ x_3(t+1) \end{pmatrix} = \begin{pmatrix} 0 & g(n) & 5g(n) \\ 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{pmatrix}$$

$$\begin{pmatrix} x_1(0) \\ x_2(0) \\ x_3(0) \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

$$g(n) = e^{-0.005n}$$

$$n = x_1 + x_2 + x_3$$

Náhodné počáteční hodnoty



# Vliv velikosti populace

$$\begin{pmatrix} x_1(t+1) \\ x_2(t+1) \\ x_3(t+1) \end{pmatrix} = \begin{pmatrix} 0 & g(n) & 5g(n) \\ 0.3 & 0 & 0 \\ 0 & 0.5 & 0 \end{pmatrix} \begin{pmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{pmatrix} \quad c$$

$$\begin{pmatrix} x_1(0) \\ x_2(0) \\ x_3(0) \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

$$g(n) = Re^{-0.005n}$$

$$n = x_1 + x_2 + x_3$$

