mu mu

$\underbrace{\text{num řeš}}_{u} = \text{ode}(\text{fcn}, x_0, t_{span})$

$\dot{x} = \boxed{F}(x, u, \dots)$

$\dot{x} = \boxed{Ax + bu}$

$\boxed{\text{integrál} = \text{stará h.} + \text{změna} * \Delta T}$

$\dot{x} = F(x, u)$

$\text{ode}(\text{fnc}, x_0, ts)$

out = difrov(t, x, u)

~~u = konst~~

$u = \text{fcn}(t, \Delta T, \cancel{\text{stav}}, x, \dots)$ $u = \sin(t\omega)$

$\text{out} = Ax + bu$

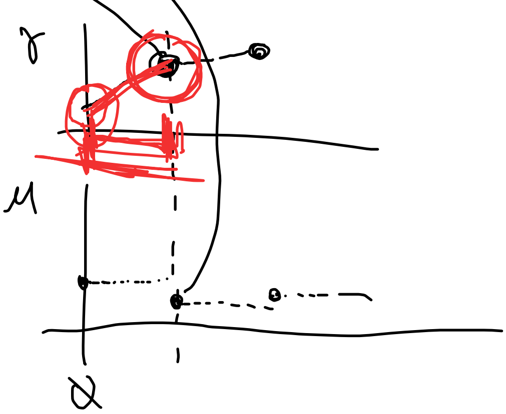
init y_0 u_0

cyklus:

$u = ?$

$y = \text{ode}(\dots\dots, u)$

čas	idx	y_log	u_log
0	0	y_0	u_0
5	1		
10	2		
15	3		
20	4		



cyklus

zač...

1.) ? $y[idx]$

$y[idx]$ = senzor ... čítanie

alebo

$y[idx]$ = ode(... $\boxed{u[idx-1]}$)

$\boxed{\begin{matrix} y[idx-1] \\ y[idx] \end{matrix}}$

koniec

2.) ? $\boxed{u[idx]}$ ← dané z tab

← výpočet ... PID

→ send ...

$$y(k) = -a_1 y(k-1) + b_1 u(k-1)$$

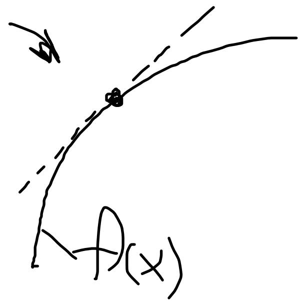
$$u(k) = ? \quad y(k)$$

$$\ddot{\varphi} = -\frac{\beta}{ml^2}\dot{\varphi} - \frac{g}{l}\sin(\varphi) + \frac{1}{ml^2}u$$

$$\dot{x} = Ax + bu$$

$$\dot{x} = F(x, u)$$

$$\underbrace{\begin{aligned} \dot{x}_1 &= x_2 \\ \dot{x}_2 &= -\frac{\beta}{ml^2}x_2 - \frac{g}{l}\sin(x_1) + \frac{1}{ml^2}u \end{aligned}}_{x}$$



$$\dot{x} = F(x, u)$$

$F(x)$

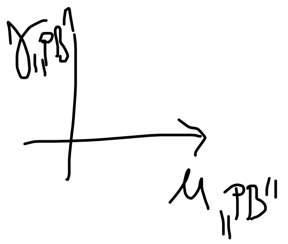
prevod ch.:

$$0 = F(x, u)$$

$$0 = x_{2PB}$$

$$0 = -\frac{g}{l}\sin(x_{1PB}) + \frac{1}{ml^2}u_{PB}$$

$$\theta_{PB} = x_{1PB}$$



$$\sin(\theta_{PB}) = \frac{1}{mlg}u_{PB}$$

$$\theta_{PB} = \arcsin\left(u_{PB}\frac{1}{mlg}\right)$$

$$[u_{PB}, \theta_{PB}]$$

$$\dot{x} = F(x, u)$$

$$\Delta x \quad \Delta y \quad \Delta u$$

$$\boxed{x = x_{PB} + \Delta x} \quad \boxed{\dot{x} = 0 + \Delta\dot{x}}$$

$$y = y_{PB} + \Delta y$$

$$u = u_{PB} + \Delta u$$

$$\underbrace{\frac{d}{dt}\left(x_{PB} + \Delta x\right)}_{\Delta\dot{x}} = F\left(x_{PB} + \Delta x,\; u_{PB} + \Delta u\right)$$

$$\Delta\dot{x} \approx \underbrace{\cancel{F(x_{PB}, u_{PB})}}_{=0} + \underbrace{\left.\frac{\partial F}{\partial x}\right|_{x = x_{PB}} \cdot (x - x_{PB})}_{\Delta x} + \underbrace{\left.\frac{\partial F}{\partial u}\right|_{u = u_{PB}} \cdot (u - u_{PB})}_{\Delta u}$$

$$F(x, u) = \begin{bmatrix} F_1(x,u) \\ F_2(x,u) \end{bmatrix} = \begin{bmatrix} x_2 \\ -\frac{B}{ml^2} x_2 - \frac{g}{l}\sin(x_1) + \frac{1}{ml^2} u \end{bmatrix}$$

$$\frac{\partial F}{\partial x} = \begin{bmatrix} \frac{\partial F_1}{\partial x_1} & \frac{\partial F_1}{\partial x_2} \\ \frac{\partial F_2}{\partial x_1} & \frac{\partial F_2}{\partial x_2} \end{bmatrix} = \left.\begin{bmatrix} 0 & 1 \\ -\frac{g}{l}\cos(\underbrace{x_1}_{y_{PB}}) & -\frac{B}{ml^2} \end{bmatrix}\right|_{x = x_{PB}}$$

$$\frac{\partial F}{\partial u} = \begin{bmatrix} \frac{\partial F_1}{\partial u} \\ \frac{\partial F_2}{\partial u} \end{bmatrix} = \begin{bmatrix} 0 \\ \frac{1}{ml^2} \end{bmatrix}$$

$$\Delta \dot{x} = \underbrace{\begin{bmatrix} 0 & 1 \\ \boxed{-\frac{g}{\ell}\overset{\cos}{\cancel{\sin}}(\theta_{pm})} & -\frac{3}{m\ell^2} \end{bmatrix}}_{A} \begin{bmatrix} \Delta x_1 \\ \Delta x_2 \end{bmatrix} + \underbrace{\begin{bmatrix} 0 \\ \frac{1}{m\ell^2} \end{bmatrix}}_{b} \Delta u$$

$$\Delta y = \underbrace{\begin{bmatrix} 1 & 0 \end{bmatrix}}_{C} \begin{bmatrix} \Delta x_1 \\ \Delta x_2 \end{bmatrix}$$