# Reinforcement Learning Seminar

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# SEIAR Optimal control

- Goal1 : DQN
- Goal2 : PPO

# Mathematical models

- The influenza model : SEIAR model
- J.Kim et.al.,*Constrained optimal control applied to vaccination for influenza*,2016

$$
\begin{aligned}
S'(t) &= -\beta S(t)\Lambda(t) - \psi\nu(t)S(t) \\
E'(t) &= \beta S(t)\Lambda(t) - \kappa E(t) \\
I'(t) &= p\kappa E(t) - \alpha I(t) - \tau I(t) \\
A'(t) &= (1-p)\kappa E(t) - \eta A(t) \\
R'(t) &= f\alpha I(t) + \tau I(t) + \eta A(t) + \psi\nu(t)S(t)
\end{aligned}
$$

with $\Lambda(t) = \epsilon E(t) + (1-q)I(t) + \delta A(t)$

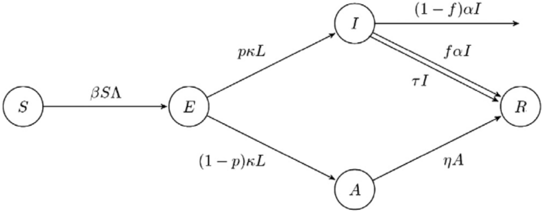


**Fig. 1.** Flow chart for the SEIAR model.

# SEIAR model parameters

| Parameter | Description | value |
|---|---|---|
| $\epsilon$ | Infectivity reduction factor for the exposed | 0 |
| $q$ | Contact reduction by isolation | 0.5 |
| $\delta$ | Infectivity reduction factor for the asymptomatic | 0.5 |
| $p$ | Fraction of developing symptoms | 0.667 |
| $\kappa$ | Transition rate for the exposed | 0.7143 / day |
| $f$ | Complement to fatality rate (1 - fatality rate) | 0.999 |
| $\alpha$ | Recovery rate for the (symptomatic) infective | 0.1667 /day |
| $\eta$ | Recovery rate for the asymptomatic | 0.1667 / day |
| $\tau$ | Antiviral treatment rate | 0 / day |
| $\psi$ | Efficacy of vaccination | 70% |
| $\beta$ | Transmission rate | 6.3346e-08 |
| $R_0$ | Basic Reproduction number | 1.9 |

- $S0 = 5e07, \quad E0 = 0, \quad I0 = 1, \quad A0 = 0, \quad R0 = 0$

# Goal in paper

- The goal is to **minimize the number of people who becom infected** at a **minimal efforts of vaccination**.
- The objective functional is given by

$$J(\nu) = \int_0^T PI(t) + Q\nu^2(t)dt$$

with $0 \leq \nu(t) \leq 1$ , $\nu(t)S(t) \leq \nu_{max}$, $\int_0^T \nu(t)S(t) \leq \nu_{total}$