DQN: 2constraint Optimal control

Boyeon Kim

Department of Mathematics, School of Mathematics and Computing
Mathematics
Yonsei University

January 13, 2023

SLIAR Optimal control

- GAOL : 2-constraint optimal control
- Method : DQN

SLIAR Model

- SLIAR Model Equations and structure.

$$\begin{cases} S' &= -\beta(1-\sigma)S\Lambda - \nu S \\ L' &= \beta(1-\sigma)S\Lambda - \kappa L \\ I' &= p\kappa L - \alpha I - \tau I \\ A' &= (1-p)\kappa L - \eta A \end{cases} \qquad \text{with } \Lambda = \epsilon L + (1-q)I + \delta A$$

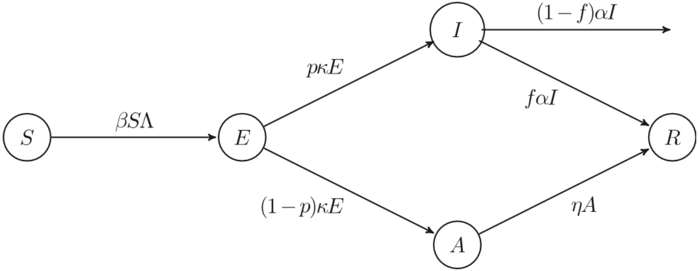


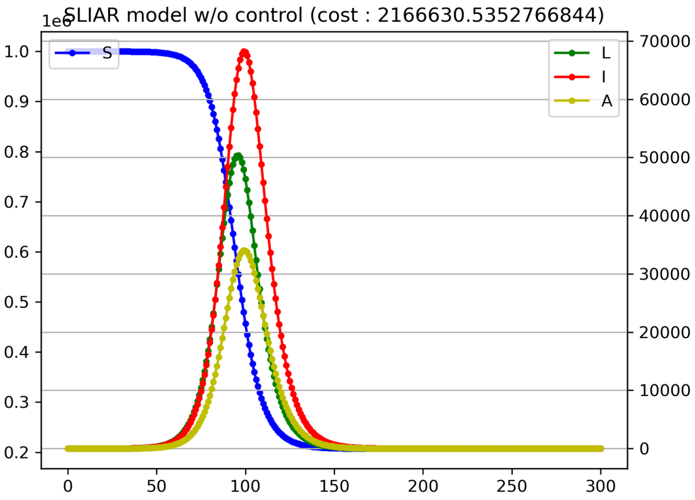
Fig. 1. SEIAR epidemic model.

SLIAR model parameters

```
Start: 0
End: 300

S0: 1000000
L0: 0
I0: 1
A0: 0

Reproduction number
: 1.9847
```

```
beta: 7.26582E-07
sigma: 0
kappa: 0.526
alpha: 0.244
tau: 0
p: 0.667
eta: 0.244
epsilon: 0
q: 0.5
delta: 1

P: 1
Q: 1
R: 0
W: 0
```

SLIAR w/o constrol



SLIAR optimal control

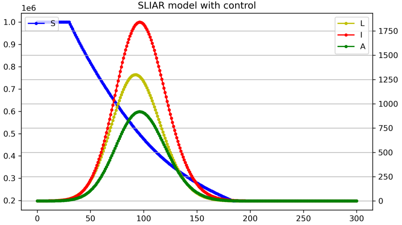
$$\min_{u \in \mathcal{U}_{ad}} \int_0^T PI(t) + Q\nu^2(t) + R\tau^2(t) + W\sigma^2(t)dt$$

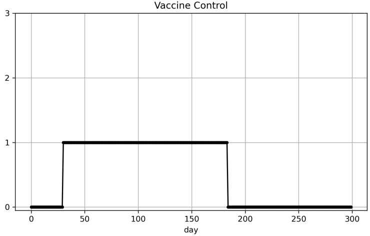
subject to

$$\begin{cases} S' &= -\beta(1-\sigma)S\Lambda - \nu S \\ L' &= \beta(1-\sigma)S\Lambda - \kappa L \\ I' &= p\kappa L - \alpha I - \tau I \\ A' &= (1-p)\kappa L - \eta A \end{cases} \qquad with \quad \Lambda = \epsilon L + (1-q)I + \delta A$$

SLIAR optimal control

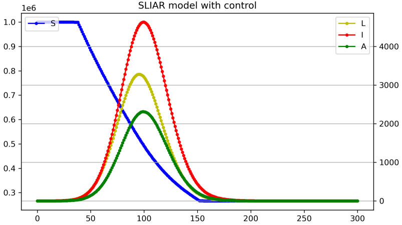
- $\min_{u \in \mathcal{U}_{ad}} \int_0^T PI(t) + Q\nu^2(t) + R\tau^2(t) + W\sigma^2(t)dt$
- Method : DQN
- P = 1, Q = 1E6, R = 1E6, $\nu_{max} = 0.01$, $\tau_{max} = 0.05$,iteration : 2000

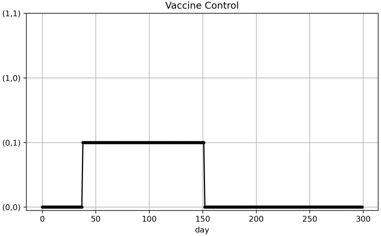




SLIAR optimal control

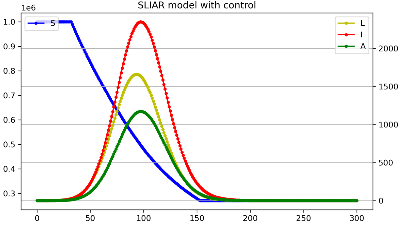
- $\min_{u \in \mathcal{U}_{ad}} \int_0^T PI(t) + Q\nu^2(t) + R\tau^2(t) + W\sigma^2(t)dt$
- Method : DQN
- P = 1, Q = 1E6, R = 1E6, $\nu_{max} = 0.01$, $\tau_{max} = 0.05$,iteration : 5000

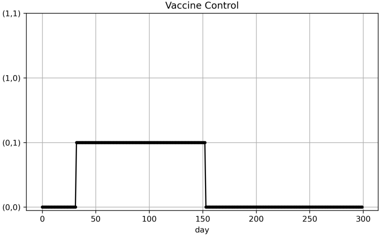




SLIAR optimal control

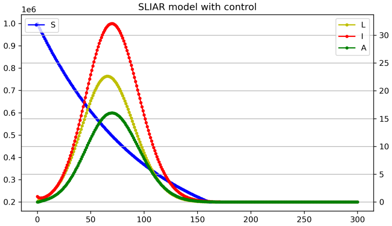
- $\min_{u \in \mathcal{U}_{ad}} \int_0^T PI(t) + Q\nu^2(t) + R\tau^2(t) + W\sigma^2(t)dt$
- Method : DQN
- P = 1, Q = 1E6, R = 1E6, $\nu_{max} = 0.01$, $\tau_{max} = 0.05$,iteration : 7000

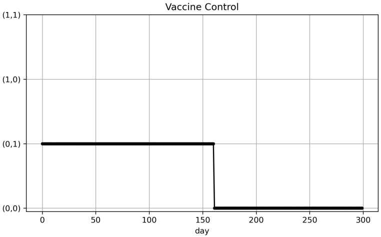




SLIAR optimal control

- $\min_{u \in \mathcal{U}_{ad}} \int_0^T PI(t) + Q\nu^2(t) + R\tau^2(t) + W\sigma^2(t)dt$
- Method : DQN
- P = 1, Q = 1E6, R = 1E6, $\nu_{max} = 0.01$, $\tau_{max} = 0.05$,iteration : 10000





Another result of DQN

- $\min_{u \in \mathcal{U}_{ad}} \int_0^T PI(t) + Q\nu^2(t) + R\tau^2(t) + W\sigma^2(t) dt$
- Method : DQN
- P = 1, Q = 1e6, $\nu_max = 0.01$, iteration : 10,000