

# Package: seirMFG (via r-universe)

June 9, 2026

**Type** Package

**Title** Mean-Field Game Equilibrium for SEIR Epidemics on Networks

**Version** 0.1.0

**Date** 2026-04-02

**Description** Implements the forward-backward sweep algorithm for computing Nash equilibrium contact policies in SEIR epidemic mean-field games on heterogeneous contact networks, as described in Wang (2026) <[doi:10.5281/zenodo.19381052](https://doi.org/10.5281/zenodo.19381052)>. Supports both heterogeneous networks with arbitrary degree distributions (e.g., truncated Poisson) and homogeneous networks. Computes equilibrium susceptible contact effort, value functions, epidemic trajectories, and the effective reproduction number  $R_t$ .

**License** MIT + file LICENSE

**URL** <https://doi.org/10.5281/zenodo.19381052>

**Encoding** UTF-8

**Depends** R (>= 4.0.0)

**Imports** stats, graphics

**Suggests** ggplot2, testthat (>= 3.0.0)

**Config/testthat/edition** 3

**RoxygenNote** 7.3.1

**NeedsCompilation** no

**Author** Weinan Wang [aut, cre]

**Maintainer** Weinan Wang <[ww@ou.edu](mailto:ww@ou.edu)>

**Repository** <https://wwang-math.r-universe.dev>

**Date/Publication** 2026-04-09 09:44:10 UTC

**RemoteUrl** <https://github.com/cran/seirMFG>

**RemoteRef** HEAD

**RemoteSha** c7a7c259d621668afd086e618fc49aea06efe0ee

## Contents

|                                |           |
|--------------------------------|-----------|
| compute_Rt . . . . .           | 2         |
| make_poisson_network . . . . . | 3         |
| seir_mfg_het . . . . .         | 4         |
| seir_mfg_hom . . . . .         | 5         |
| sir_mfg_het . . . . .          | 7         |
| sir_mfg_hom . . . . .          | 8         |
| <b>Index</b>                   | <b>10</b> |

---

|            |  |
|------------|--|
| compute_Rt | <i>Compute the time-varying effective reproduction number <math>R_t</math></i> |
|------------|--|

---

### Description

Computes  $R_t$  for the heterogeneous-network SEIR-MFG equilibrium using the next-generation spectral radius formula (Theorem 3.6 of Wang, 2026):

$$R_t = \frac{\beta}{\gamma \langle k \rangle} \sum_k k^2 P(k) n_k^{S^*}(t) S_k(t).$$

This scalar formula holds for uncorrelated networks.

### Usage

```
compute_Rt(result, network, gamma = 1)
```

### Arguments

|         |  |
|---------|--|
| result  | A list returned by <a href="#">seir_mfg_het</a> or <a href="#">sir_mfg_het</a> , containing matrices S and nS. |
| network | A list returned by <a href="#">make_poisson_network</a> .  |
| gamma   | Numeric. Recovery rate. Default 1.   |

### Value

A numeric vector of length  $M + 1$  giving  $R_t$  at each time step.

### References

Wang, W. (2026). Learning contact policies for SEIR epidemics on networks: A mean-field game approach. [doi:10.5281/zenodo.19381052](https://doi.org/10.5281/zenodo.19381052).

**Examples**

```
# Simple network setup (fast)
net <- make_poisson_network()

# Full solve then compute Rt (slow)
res <- seir_mfg_het(network = net, sigma = 2, verbose = FALSE)
Rt <- compute_Rt(res, net)
plot(res$t_grid, Rt, type = "l", xlab = "Time", ylab = "Rt")
```

---

make\_poisson\_network *Build a truncated Poisson degree distribution*

---

**Description**

Constructs the degree distribution  $P(k)$  for an uncorrelated Markovian network with a truncated Poisson degree distribution, and computes the transmission rate  $\beta$  required to achieve a target basic reproduction number  $R_0 = \beta \langle k^2 \rangle / (\gamma \langle k \rangle)$ .

**Usage**

```
make_poisson_network(mu = 8, k_max = 25, R0 = 4, gamma = 1)
```

**Arguments**

|       |  |
|-------|--|
| mu    | Numeric. Mean degree of the Poisson distribution. Default 8. |
| k_max | Integer. Maximum degree (truncation point). Default 25.      |
| R0    | Numeric. Target basic reproduction number. Default 4.        |
| gamma | Numeric. Recovery rate. Default 1.                           |

**Value**

A list with components:

**k\_vals** Integer vector of degree values  $1, \dots, k_{max}$ .  
**PK** Numeric vector of probabilities  $P(k)$ , summing to 1.  
**K\_bar** Mean degree  $\langle k \rangle$ .  
**K\_bar2** Second moment  $\langle k^2 \rangle$ .  
**beta** Transmission rate achieving the target  $R_0$ .  
**R0** The target  $R_0$ .

**References**

Wang, W. (2026). Learning contact policies for SEIR epidemics on networks: A mean-field game approach. [doi:10.5281/zenodo.19381052](https://doi.org/10.5281/zenodo.19381052).

**Examples**

```
net <- make_poisson_network(mu = 8, k_max = 25, R0 = 4, gamma = 1)
net$beta # approximately 0.4444
net$K_bar # approximately 8
```

seir\_mfg\_het

*Solve the heterogeneous-network SEIR mean-field game***Description**

Computes the Nash equilibrium contact policy and epidemic trajectory for the SEIR mean-field game on an uncorrelated heterogeneous network using the iterative forward-backward sweep (FBS) algorithm (Section 6.1 of Wang, 2026).

**Usage**

```
seir_mfg_het(network, sigma = 2, gamma = 1, r_I = 50, n_min = 0.1,
             eps = 1, C_E = 0, C_I = 0, S0 = 0.98, E0 = 0.01,
             I0 = 0.01, T_end = 30, dt = 0.05, omega = 0.3,
             tol = 1e-7, max_iter = 2000, verbose = TRUE)
```

**Arguments**

|          |   |
|----------|---|
| network  | A list returned by <a href="#">make_poisson_network</a> .                     |
| sigma    | Numeric. Incubation rate. Default 2.  |
| gamma    | Numeric. Recovery rate. Default 1.  |
| r_I      | Numeric. One-time infection cost. Default 50.                                 |
| n_min    | Numeric. Minimum contact effort in (0,1). Default 0.1.                        |
| eps      | Integer. Isolation cost exponent; $f_k(n) = k^\epsilon(1/n - 1)$ . Default 1. |
| C_E      | Numeric. Health cost in state E. Default 0.                                   |
| C_I      | Numeric. Health cost in state I. Default 0.                                   |
| S0       | Numeric. Initial susceptible fraction. Default 0.98.                          |
| E0       | Numeric. Initial exposed fraction. Default 0.01.                              |
| I0       | Numeric. Initial infectious fraction. Default 0.01.                           |
| T_end    | Numeric. Time horizon. Default 30.  |
| dt       | Numeric. Time step. Default 0.05.   |
| omega    | Numeric. FBS relaxation parameter in (0,1]. Default 0.3.                      |
| tol      | Numeric. Convergence tolerance. Default 1e-7.                                 |
| max_iter | Integer. Maximum FBS iterations. Default 2000.                                |
| verbose  | Logical. Print convergence info. Default TRUE.                                |

**Value**

A list with components:

**S, E, I, R** Matrices of shape  $K \times (M + 1)$ : compartment fractions.

**nS** Matrix of shape  $K \times (M + 1)$ : equilibrium effort  $n_k^{S^*}(t)$ .

**I\_agg** Numeric vector: aggregate infectious fraction  $\sum_k P(k)I_k(t)$ .

**t\_grid** Numeric vector of time points.

**converged** Logical. Whether FBS converged.

**n\_iter** Integer. FBS iterations used.

**References**

Wang, W. (2026). Learning contact policies for SEIR epidemics on networks: A mean-field game approach. [doi:10.5281/zenodo.19381052](https://doi.org/10.5281/zenodo.19381052).

**Examples**

```
# Simple network setup (fast)
net <- make_poisson_network(mu = 8, k_max = 25, R0 = 4)

# Full FBS solve (slow: ~40 iterations x 25 degree classes)
res <- seir_mfg_het(network = net, sigma = 2, verbose = FALSE)
plot(res$t_grid, res$I_agg, type = "l", col = "red",
      xlab = "Time", ylab = "Aggregate I(t)")
```

---

 seir\_mfg\_hom

*Solve the homogeneous-network SEIR mean-field game*


---

**Description**

Computes the Nash equilibrium contact policy and epidemic trajectory for the SEIR mean-field game on a homogeneous network where all nodes have degree  $k$  and the effective per-contact transmission rate  $\beta_k$  is fixed.

**Usage**

```
seir_mfg_hom(k = 8, sigma = 2, beta_k = 4, gamma = 1, r_I = 50,
             n_min = 0.1, eps = 1, C_E = 0, C_I = 0, S0 = 0.98,
             E0 = 0.01, I0 = 0.01, T_end = 30, dt = 0.05,
             omega = 0.3, tol = 1e-7, max_iter = 2000, verbose = TRUE)
```

**Arguments**

|                       |   |
|-----------------------|---|
| <code>k</code>        | Integer. Node degree. Default 8.                            |
| <code>sigma</code>    | Numeric. Incubation rate. Default 2.                        |
| <code>beta_k</code>   | Numeric. Effective transmission rate $\beta k$ . Default 4. |
| <code>gamma</code>    | Numeric. Recovery rate. Default 1.                          |
| <code>r_I</code>      | Numeric. One-time infection cost. Default 50.               |
| <code>n_min</code>    | Numeric. Minimum contact effort. Default 0.1.               |
| <code>eps</code>      | Integer. Isolation cost exponent. Default 1.                |
| <code>C_E</code>      | Numeric. Health cost in state E. Default 0.                 |
| <code>C_I</code>      | Numeric. Health cost in state I. Default 0.                 |
| <code>S0</code>       | Numeric. Initial susceptible fraction. Default 0.98.        |
| <code>E0</code>       | Numeric. Initial exposed fraction. Default 0.01.            |
| <code>I0</code>       | Numeric. Initial infectious fraction. Default 0.01.         |
| <code>T_end</code>    | Numeric. Time horizon. Default 30.                          |
| <code>dt</code>       | Numeric. Time step. Default 0.05.                           |
| <code>omega</code>    | Numeric. FBS relaxation parameter. Default 0.3.             |
| <code>tol</code>      | Numeric. Convergence tolerance. Default 1e-7.               |
| <code>max_iter</code> | Integer. Maximum FBS iterations. Default 2000.              |
| <code>verbose</code>  | Logical. Print convergence info. Default TRUE.              |

**Value**

A list with components:

**S, E, I, R** Numeric vectors of length  $M + 1$ : compartment fractions.

**nS** Numeric vector: equilibrium effort  $n^{S^*}(t)$ .

**t\_grid** Numeric vector of time points.

**converged** Logical.

**n\_iter** Integer. Iterations used.

**References**

Wang, W. (2026). Learning contact policies for SEIR epidemics on networks: A mean-field game approach. [doi:10.5281/zenodo.19381052](https://doi.org/10.5281/zenodo.19381052).

**Examples**

```
# Full FBS solve (slow: ~40 iterations)
res <- seir_mfg_hom(k = 8, sigma = 2, beta_k = 4, verbose = FALSE)
plot(res$t_grid, res$I, type = "l", xlab = "Time", ylab = "I(t)")
lines(res$t_grid, res$nS, col = "red", lty = 2)
legend("topright", c("I(t)", "nS*(t)"),
      col = c("black", "red"), lty = 1:2)
```

sir\_mfg\_het

*Solve the heterogeneous-network SIR mean-field game***Description**

Computes the SIR-MFG Nash equilibrium on an uncorrelated heterogeneous network. This corresponds to the limit  $\sigma \rightarrow \infty$  of [seir\\_mfg\\_het](#) (Lemma 5.7 of Wang, 2026). The initial infectious seed absorbs the exposed compartment:  $I_0^{\text{SIR}} = I_0 + E_0$ .

**Usage**

```
sir_mfg_het(network, gamma = 1, r_I = 50, n_min = 0.1, eps = 1,
            C_I = 0, S0 = 0.98, I0_sir = 0.02, T_end = 30,
            dt = 0.05, omega = 0.3, tol = 1e-7,
            max_iter = 2000, verbose = TRUE)
```

**Arguments**

|          |  |
|----------|--|
| network  | A list returned by <a href="#">make_poisson_network</a> .                  |
| gamma    | Numeric. Recovery rate. Default 1.   |
| r_I      | Numeric. One-time infection cost. Default 50.                              |
| n_min    | Numeric. Minimum contact effort. Default 0.1.                              |
| eps      | Integer. Isolation cost exponent. Default 1.                               |
| C_I      | Numeric. Health cost in state I. Default 0.                                |
| S0       | Numeric. Initial susceptible fraction. Default 0.98.                       |
| I0_sir   | Numeric. Initial infectious fraction (absorbs exposed seed). Default 0.02. |
| T_end    | Numeric. Time horizon. Default 30.   |
| dt       | Numeric. Time step. Default 0.05.  |
| omega    | Numeric. FBS relaxation parameter. Default 0.3.                            |
| tol      | Numeric. Convergence tolerance. Default 1e-7.                              |
| max_iter | Integer. Maximum FBS iterations. Default 2000.                             |
| verbose  | Logical. Print convergence info. Default TRUE.                             |

**Value**

A list with components S, I, R, nS, I\_agg, t\_grid, converged, n\_iter.

**References**

Wang, W. (2026). Learning contact policies for SEIR epidemics on networks: A mean-field game approach. [doi:10.5281/zenodo.19381052](https://doi.org/10.5281/zenodo.19381052).

**Examples**

```
# Simple network setup (fast)
net <- make_poisson_network()

# Full FBS solve (slow)
res <- sir_mfg_het(network = net, verbose = FALSE)
plot(res$t_grid, res$I_agg, type = "l", col = "blue",
      xlab = "Time", ylab = "Aggregate I(t)")
```

---

 sir\_mfg\_hom

*Solve the homogeneous-network SIR mean-field game*


---

**Description**

Computes the SIR-MFG Nash equilibrium on a homogeneous network. The initial infectious seed absorbs the exposed compartment:  $I_0^{\text{SIR}} = I_0 + E_0$ .

**Usage**

```
sir_mfg_hom(k = 8, beta_k = 4, gamma = 1, r_I = 50, n_min = 0.1,
            eps = 1, C_I = 0, S0 = 0.98, I0_sir = 0.02, T_end = 30,
            dt = 0.05, omega = 0.3, tol = 1e-7,
            max_iter = 2000, verbose = TRUE)
```

**Arguments**

|          |   |
|----------|---|
| k        | Integer. Node degree. Default 8.                            |
| beta_k   | Numeric. Effective transmission rate $\beta k$ . Default 4. |
| gamma    | Numeric. Recovery rate. Default 1.                          |
| r_I      | Numeric. One-time infection cost. Default 50.               |
| n_min    | Numeric. Minimum contact effort. Default 0.1.               |
| eps      | Integer. Isolation cost exponent. Default 1.                |
| C_I      | Numeric. Health cost in state I. Default 0.                 |
| S0       | Numeric. Initial susceptible fraction. Default 0.98.        |
| I0_sir   | Numeric. Initial infectious fraction. Default 0.02.         |
| T_end    | Numeric. Time horizon. Default 30.                          |
| dt       | Numeric. Time step. Default 0.05.                           |
| omega    | Numeric. FBS relaxation parameter. Default 0.3.             |
| tol      | Numeric. Convergence tolerance. Default 1e-7.               |
| max_iter | Integer. Maximum FBS iterations. Default 2000.              |
| verbose  | Logical. Print convergence info. Default TRUE.              |

**Value**

A list with components S, I, R, nS, t\_grid, converged, n\_iter.

**References**

Wang, W. (2026). Learning contact policies for SEIR epidemics on networks: A mean-field game approach. [doi:10.5281/zenodo.19381052](https://doi.org/10.5281/zenodo.19381052).

**Examples**

```
# Full FBS solve (slow)
res <- sir_mfg_hom(k = 8, beta_k = 4, verbose = FALSE)
plot(res$t_grid, res$I, type = "l", col = "blue",
      xlab = "Time", ylab = "I(t)")
```

# Index

`compute_Rt`, 2

`make_poisson_network`, 2, 3, 4, 7

`seir_mfg_het`, 2, 4, 7

`seir_mfg_hom`, 5

`sir_mfg_het`, 2, 7

`sir_mfg_hom`, 8