

epiworld

0.0-1

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<b>1 Example: 00-hello-world</b>	<b>1</b>
<b>2 Benchmarking</b>	<b>3</b>
<b>3 Contributor Code of Conduct</b>	<b>5</b>
<b>4 epiworld c++ template library</b>	<b>7</b>
4.1 Main features . . . . .	7
4.2 Algorithm . . . . .	7
4.3 Hello world (C++) . . . . .	8
4.4 Surveillance simulation . . . . .	8
4.4.1 Preliminary results . . . . .	9
4.4.2 Cases detected . . . . .	10
<b>5 MIT License</b>	<b>11</b>
<b>6 model1</b>	<b>13</b>
<b>7 EPI Simulator</b>	<b>15</b>
7.1 Disease dynamics . . . . .	15
7.2 Network dynamics . . . . .	15
7.3 Contagion dynamics . . . . .	15
7.4 Time dynamics . . . . .	15
7.5 Updating agent's status . . . . .	16
7.5.1 Other parameters . . . . .	16
<b>8 Contributor Covenant Code of Conduct</b>	<b>17</b>
8.1 Our Pledge . . . . .	17
8.2 Our Standards . . . . .	17
8.3 Enforcement Responsibilities . . . . .	18
8.4 Scope . . . . .	18
8.5 Enforcement . . . . .	18
8.6 Enforcement Guidelines . . . . .	18
8.6.1 1. Correction . . . . .	18
8.6.2 2. Warning . . . . .	18
8.6.3 3. Temporary Ban . . . . .	19
8.6.4 4. Permanent Ban . . . . .	19
8.7 Attribution . . . . .	19
<b>9 MIT License</b>	<b>21</b>
<b>10 epiworld 1.0</b>	<b>23</b>
<b>11 Namespace Index</b>	<b>25</b>
11.1 Namespace List . . . . .	25

<b>12 Hierarchical Index</b>	<b>27</b>
12.1 Class Hierarchy	27
<b>13 Class Index</b>	<b>29</b>
13.1 Class List	29
<b>14 File Index</b>	<b>33</b>
14.1 File List	33
<b>15 Namespace Documentation</b>	<b>35</b>
15.1 epiworld::sampler Namespace Reference	35
15.1.1 Detailed Description	35
15.1.2 Function Documentation	35
15.1.2.1 make_sample_virus_neighbors()	35
15.1.2.2 make_update_susceptible()	36
15.1.2.3 sample_virus_single()	36
15.2 sampler Namespace Reference	38
15.2.1 Detailed Description	38
15.2.2 Function Documentation	38
15.2.2.1 make_sample_virus_neighbors()	38
15.2.2.2 make_update_susceptible()	39
15.2.2.3 sample_virus_single()	39
<b>16 Class Documentation</b>	<b>43</b>
16.1 Action< TSeq > Struct Template Reference	43
16.1.1 Detailed Description	43
16.1.2 Constructor & Destructor Documentation	44
16.1.2.1 Action()	44
16.2 epiworld::Action< TSeq > Struct Template Reference	45
16.2.1 Detailed Description	45
16.2.2 Constructor & Destructor Documentation	45
16.2.2.1 Action()	45
16.3 AdjList Class Reference	46
16.3.1 Constructor & Destructor Documentation	47
16.3.1.1 AdjList()	47
16.3.2 Member Function Documentation	47
16.3.2.1 read_edgelist()	47
16.4 epiworld::AdjList Class Reference	48
16.4.1 Constructor & Destructor Documentation	48
16.4.1.1 AdjList() [1/2]	48
16.4.1.2 AdjList() [2/2]	49
16.4.2 Member Function Documentation	49
16.4.2.1 read_edgelist()	49
16.5 Agent< TSeq > Class Template Reference	50

16.5.1 Detailed Description	52
16.5.2 Member Function Documentation	52
16.5.2.1 operator()()	52
16.6 epiworld::Agent< TSeq > Class Template Reference	53
16.6.1 Detailed Description	55
16.6.2 Member Function Documentation	55
16.6.2.1 operator()()	55
16.7 AgentsSample< TSeq > Class Template Reference	56
16.7.1 Detailed Description	56
16.8 epiworld::AgentsSample< TSeq > Class Template Reference	57
16.8.1 Detailed Description	57
16.9 DataBase< TSeq > Class Template Reference	57
16.9.1 Detailed Description	59
16.9.2 Member Function Documentation	59
16.9.2.1 record_variant()	59
16.9.2.2 reproductive_number()	59
16.9.2.3 transition_probability()	60
16.10 epiworld::DataBase< TSeq > Class Template Reference	60
16.10.1 Detailed Description	62
16.10.2 Member Function Documentation	62
16.10.2.1 get_today_total()	63
16.10.2.2 record_variant() [1/2]	63
16.10.2.3 record_variant() [2/2]	63
16.10.2.4 reproductive_number()	64
16.10.2.5 transition_probability()	64
16.11 Entities< TSeq > Class Template Reference	64
16.11.1 Detailed Description	65
16.12 epiworld::Entities< TSeq > Class Template Reference	65
16.12.1 Detailed Description	65
16.13 Entities_const< TSeq > Class Template Reference	66
16.13.1 Detailed Description	66
16.14 epiworld::Entities_const< TSeq > Class Template Reference	67
16.14.1 Detailed Description	67
16.15 Entity< TSeq > Class Template Reference	67
16.16 epiworld::Entity< TSeq > Class Template Reference	68
16.17 epiworld::LFMCMC< TData > Class Template Reference	69
16.17.1 Detailed Description	70
16.18 LFMCMC< TData > Class Template Reference	70
16.18.1 Detailed Description	71
16.19 epiworld::Model< TSeq > Class Template Reference	71
16.19.1 Detailed Description	79
16.19.2 Member Function Documentation	80

16.19.2.1 add_global_action()	80
16.19.2.2 add_param()	80
16.19.2.3 add_status_susceptible()	81
16.19.2.4 init()	81
16.19.2.5 pop_from_adjlist()	82
16.19.2.6 reset() [1/2]	82
16.19.2.7 reset() [2/2]	83
16.19.2.8 reset_status_codes()	83
16.19.2.9 run_multiple()	83
16.19.2.10 set_agents_data()	84
16.19.2.11 set_backup()	84
16.19.2.12 set_name()	84
16.19.2.13 set_rand_engine()	85
16.19.2.14 set_rewire_fun()	85
16.19.2.15 set_user_data()	85
16.19.2.16 write_data() [1/2]	86
16.19.2.17 write_data() [2/2]	86
16.19.2.18 write_edgelist()	87
16.20 Model< TSeq > Class Template Reference	87
16.20.1 Detailed Description	93
16.20.2 Member Function Documentation	93
16.20.2.1 add_global_action()	93
16.20.2.2 reset()	94
16.20.2.3 run_multiple()	94
16.20.2.4 set_agents_data()	94
16.20.2.5 set_name()	95
16.20.2.6 write_data()	95
16.21 epiworld::epimodels::ModelSEIR< TSeq > Class Template Reference	96
16.21.1 Detailed Description	97
16.21.2 Member Data Documentation	97
16.21.2.1 update_exposed_seir	97
16.21.2.2 update_infected_seir	97
16.22 ModelSEIR< TSeq > Class Template Reference	98
16.22.1 Detailed Description	98
16.22.2 Member Data Documentation	99
16.22.2.1 update_exposed_seir	99
16.22.2.2 update_infected_seir	99
16.23 epiworld::epimodels::ModelSEIRCONN< TSeq > Class Template Reference	100
16.23.1 Constructor & Destructor Documentation	101
16.23.1.1 ModelSEIRCONN()	101
16.24 ModelSEIRCONN< TSeq > Class Template Reference	102
16.24.1 Constructor & Destructor Documentation	103

16.24.1.1 ModelSEIRCONN()	103
16.25 epiworld::epimodels::ModelSIR< TSeq > Class Template Reference	103
16.25.1 Detailed Description	104
16.26 ModelSIR< TSeq > Class Template Reference	105
16.26.1 Detailed Description	106
16.27 epiworld::epimodels::ModelSIRCONN< TSeq > Class Template Reference	106
16.27.1 Constructor & Destructor Documentation	107
16.27.1.1 ModelSIRCONN()	107
16.28 ModelSIRCONN< TSeq > Class Template Reference	108
16.28.1 Constructor & Destructor Documentation	109
16.28.1.1 ModelSIRCONN()	109
16.29 epiworld::epimodels::ModelSIS< TSeq > Class Template Reference	110
16.29.1 Detailed Description	111
16.30 ModelSIS< TSeq > Class Template Reference	112
16.30.1 Detailed Description	113
16.31 epiworld::epimodels::ModelSURV< TSeq > Class Template Reference	113
16.31.1 Constructor & Destructor Documentation	114
16.31.1.1 ModelSURV()	114
16.32 ModelSURV< TSeq > Class Template Reference	115
16.32.1 Constructor & Destructor Documentation	116
16.32.1.1 ModelSURV()	116
16.33 Network< Nettype, Nodetype, Edgetype > Class Template Reference	117
16.34 epiworld::Person< TSeq > Class Template Reference	117
16.35 epiworld::PersonTools< TSeq > Class Template Reference	118
16.35.1 Detailed Description	119
16.36 PersonTools< TSeq > Class Template Reference	119
16.37 epiworld::PersonViruses< TSeq > Class Template Reference	120
16.37.1 Detailed Description	120
16.38 epiworld::Progress Class Reference	120
16.38.1 Detailed Description	121
16.39 Progress Class Reference	121
16.39.1 Detailed Description	121
16.40 epiworld::Queue< TSeq > Class Template Reference	121
16.40.1 Detailed Description	122
16.41 Queue< TSeq > Class Template Reference	122
16.41.1 Detailed Description	122
16.42 epiworld::QueueValues Class Reference	123
16.43 QueueValues Class Reference	123
16.44 RandGraph Class Reference	123
16.45 epiworld::SAMPLETYPE Class Reference	124
16.46 SAMPLETYPE Class Reference	124
16.47 epiworld::Tool< TSeq > Class Template Reference	124

16.47.1 Detailed Description	126
16.47.2 Member Function Documentation	126
16.47.2.1 get_susceptibility_reduction()	126
16.48 Tool< TSeq > Class Template Reference	127
16.48.1 Detailed Description	128
16.49 epiworld::Tools< TSeq > Class Template Reference	128
16.49.1 Detailed Description	128
16.50 Tools< TSeq > Class Template Reference	129
16.50.1 Detailed Description	129
16.51 epiworld::Tools_const< TSeq > Class Template Reference	130
16.51.1 Detailed Description	130
16.52 Tools_const< TSeq > Class Template Reference	130
16.52.1 Detailed Description	131
16.53 epiworld::UserData< TSeq > Class Template Reference	131
16.53.1 Detailed Description	132
16.53.2 Constructor & Destructor Documentation	133
16.53.2.1 UserData()	133
16.54 UserData< TSeq > Class Template Reference	133
16.54.1 Detailed Description	134
16.54.2 Constructor & Destructor Documentation	134
16.54.2.1 UserData()	134
16.55 epiworld::vecHasher< T > Struct Template Reference	135
16.55.1 Detailed Description	135
16.56 vecHasher< T > Struct Template Reference	135
16.56.1 Detailed Description	135
16.57 epiworld::Virus< TSeq > Class Template Reference	136
16.57.1 Detailed Description	138
16.57.2 Member Function Documentation	138
16.57.2.1 get_prob_infecting()	138
16.58 Virus< TSeq > Class Template Reference	139
16.58.1 Detailed Description	140
16.59 epiworld::Viruses< TSeq > Class Template Reference	141
16.59.1 Detailed Description	141
16.60 Viruses< TSeq > Class Template Reference	142
16.60.1 Detailed Description	142
16.61 epiworld::Viruses_const< TSeq > Class Template Reference	142
16.61.1 Detailed Description	143
16.62 Viruses_const< TSeq > Class Template Reference	143
16.62.1 Detailed Description	143
<b>17 File Documentation</b>	<b>145</b>
17.1 include/epiworld/agent-meat-status.hpp File Reference	145



17.1.1 Detailed Description . . . . .	146
<b>Index</b>	<b>147</b>



# Chapter 1

## Example: 00-hello-world

### Output from the program:

Running the model...

```
||||| done.
[epiworld-debug] DEBUGGING ON (compiled with EPI_DEBUG defined)

SIMULATION STUDY
Population size      : 10000
Number of entitites  : 0
Days (duration)     : 100 (of 100)
Number of variants   : 1
Last run elapsed t   : 40.00ms
Rewiring             : off
Virus(es):
- covid 19 (baseline prevalence: 50 seeds)
Tool(s):
- vaccine (baseline prevalence: 50.00%)
- Immunity (covid 19) (originated in the model...)
Model parameters:
(none)
Distribution of the population at time 100:
- (0) Susceptible : 9950 -> 70
- (1) Exposed     : 50 -> 70
- (2) Recovered   : 0 -> 9271
- (3) Removed     : 0 -> 589
Transition Probabilities:
- Susceptible 0.95 0.05 0.00 0.00
- Exposed      0.00 0.85 0.14 0.01
- Recovered    0.00 0.00 1.00 0.00
- Removed      0.00 0.00 0.00 1.00
```



## Chapter 2

# Benchmarking

Here we keep a list of scenarios where we compare epiworld with other ABM simulation engines. Although the comparison is made at the speed level, we also list features of capabilities and main differences between the engines.



## Chapter 3

# Contributor Code of Conduct

As contributors and maintainers of this project, we pledge to respect all people who contribute through reporting issues, posting feature requests, updating documentation, submitting pull requests or patches, and other activities.

We are committed to making participation in this project a harassment-free experience for everyone, regardless of level of experience, gender, gender identity and expression, sexual orientation, disability, personal appearance, body size, race, ethnicity, age, or religion.

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This Code of Conduct is adapted from the Contributor Covenant ( <http://contributor-covenant.org>), version 1.0.0, available at <http://contributor-covenant.org/version/1/0/0/>





## Chapter 4

# epiworld c++ template library

### 4.1 Main features

This C++ template-header-only library provides a general framework for epidemiologic simulation. The main features of the library are:

1. Four key classes: `Model`, `Person`, `Tool`, and `Virus`.
2. The model features a social networks of `Persons`.
3. `Persons` can have multiple `Tools` as a defense system.
4. `Tools` can reduce contagion rate, transmissibility, death rates, and improve recovery rates.
5. `Viruses` can mutate (generating new variants).
6. `Models` can feature multiple states, e.g., `HEALTHY`, `SUSCEPTIBLE`, etc.
7. `Models` can have an arbitrary number of parameters.
8. **REALLY FAST** About 6.5 Million person/day simulations per second.

### 4.2 Algorithm

Setup

- Create viruses.
- Create tools (arbitrary).
- Set model parameters (arbitrary).
- Create global events (e.g., surveillance).
- Set up the population: small world network (default).
- Set up rewiring (optional).
- Set statuses (arbitrary number of them).

## Run

1. Distribute the tool(s) and virus(es)
2. For each t in 1 -> Duration:
  - Update status for susceptible/infected/removed(?)
  - Mutate virus(es) (each individual)
  - Run global actions (e.g., surveillance)
  - Run rewiring algorithm

Along update:

- Contagion events are applied recorded.
- New variants are recorded.
- Optional user data is recorded.

## 4.3 Hello world (C++)

```
#include "include/epiworld/epiworld.hpp"
int main()
{
    // Creating a virus
    epiworld::Virus<> covid19("covid 19");
    covid19.set_infectiousness(.8);

    // Creating a tool
    epiworld::Tool<> vax("vaccine");
    vax.set_contagion_reduction(.95);
    // Creating a model
    epiworld::Model<> model;
    // Adding the tool and virus
    model.add_virus(covid19, .01);
    model.add_tool(vax, .5);
    // Generating a random pop
    model.population_from_adjlist(
        epiworld::rgraph_smallworld(1000, 5, .2)
    );
    // Initializing setting days and seed
    model.init(60, 123123);
    // Running the model
    model.run();
    model.print();
    return;
}
```

## 4.4 Surveillance simulation

- Incubation time of the disease  $\sim \text{Gamma}(3, 1)$
- Duration of the disease  $\sim \text{Gamma}(12, 1)$
- Probability of becoming symptomatic: 0.9
- Prob. of transmission: 1.0.
- Vaccinated population: 25%
- Vaccine efficacy: .9.
- Vaccine reduction on transmission: 0.5.
- Surveillance program of x% of the population at random.
- Individuals who test positive become isolated.

### 4.4.1 Preliminary results

```
# With low surveillance
pop_size <- 20e3
pop_seed <- pop_size * .01
s_levels <- c(0.0001, 0.002)
system(sprintf("./07-surveillance.o %i %i 100 %.04f 2>&1", pop_seed, pop_size, s_levels[1]), intern = TRUE)
|>
cat(sep = "\n")

## Running the model...
##
## | done.
##
##
## SIMULATION STUDY
##
## Population size      : 20000
## Days (duration)     : 200 (of 200)
## Number of variants  : 1
## Last run elapsed t   : 505.00ms
## Rewiring            : off
##
## Virus(es):
## - Covid19 (baseline prevalence: 100 seeds)
## Tool(s):
## - Vaccine (baseline prevalence: 25.00%)
##
## Model parameters:
## - Infect period      : 12.0000
## - Latent period      : 3.0000
## - Prob of symptoms   : 0.7000
## - Prob of transmission : 1.0000
## - Prob. death        : 0.0010
## - Prob. reinfect     : 0.1000
## - Surveillance prob. : 1.0e-04
## - Vax efficacy       : 0.9000
## - Vax redux transmission : 0.5000
##
## Distribution of the population at time 200:
## - Total susceptible (S) : 19900 -> 2106
## - Total recovered (S)   : 0 -> 17369
## - Total latent (I)      : 100 -> 109
## - Total symptomatic (I) : 0 -> 155
## - Total symptomatic isolated (I) : 0 -> 2
## - Total asymptomatic (I) : 0 -> 72
## - Total asymptomatic isolated (I) : 0 -> 0
## - Total removed (R)    : 0 -> 187
##
## (S): Susceptible, (I): Infected, (R): Recovered
##
hist1 <- read.csv("07-surveillance_hist.txt", sep = " ")
surv1 <- read.csv("07-surveillance_user_data.txt", sep = " ")
# With high surveillance
system(sprintf("./07-surveillance.o %i %i 100 %.04f 2>&1", pop_seed, pop_size, s_levels[2]), intern = TRUE)
|>
cat(sep = "\n")

## Running the model...
##
## | done.
##
##
## SIMULATION STUDY
##
## Population size      : 20000
## Days (duration)     : 200 (of 200)
## Number of variants  : 1
## Last run elapsed t   : 530.00ms
## Rewiring            : off
##
## Virus(es):
```

```
## - Covid19 (baseline prevalence: 100 seeds)
## Tool(s):
## - Vaccine (baseline prevalence: 25.00%)
##
## Model parameters:
## - Infect period      : 12.0000
## - Latent period      : 3.0000
## - Prob of symptoms   : 0.7000
## - Prob of transmission : 1.0000
## - Prob. death        : 0.0010
## - Prob. reinfect     : 0.1000
## - Surveillance prob. : 0.0020
## - Vax efficacy       : 0.9000
## - Vax redux transmission : 0.5000
##
## Distribution of the population at time 200:
## - Total susceptible (S)      : 19900 -> 2125
## - Total recovered (S)       : 0 -> 17325
## - Total latent (I)          : 100 -> 109
## - Total symptomatic (I)     : 0 -> 155
## - Total symptomatic isolated (I) : 0 -> 8
## - Total asymptomatic (I)    : 0 -> 76
## - Total asymptomatic isolated (I) : 0 -> 1
## - Total removed (R)        : 0 -> 201
##
## (S): Susceptible, (I): Infected, (R): Recovered
##
hist2 <- read.csv("07-surveillance_hist.txt", sep = " ")
surv2 <- read.csv("07-surveillance_user_data.txt", sep = " ")
hist_comb <- rbind(
  cbind(sim = as.character(s_levels[1]), hist1),
  cbind(sim = as.character(s_levels[2]), hist2)
)
ggplot(hist_comb, aes(x = date, y = counts + 1, colour = status, linetype=sim)) +
  geom_line() +
  # scale_y_log10() +
  labs(y = "Counts (log)")
```

#### 4.4.2 Cases detected

```
survdat <- rbind(
  with(surv1, rbind(
    data.frame(Id = as.character(s_levels[1]), Date = date, Type = "N Sampled", n = nsampled),
    data.frame(Id = as.character(s_levels[1]), Date = date, Type = "N detected", n = ndetected),
    data.frame(Id = as.character(s_levels[1]), Date = date, Type = "N detected Asymp", n =
      ndetected_asymp),
    data.frame(Id = as.character(s_levels[1]), Date = date, Type = "N Asymp", n = nasymptomatic)
  )),
  with(surv2, rbind(
    data.frame(Id = as.character(s_levels[2]), Date = date, Type = "N Sampled", n = nsampled),
    data.frame(Id = as.character(s_levels[2]), Date = date, Type = "N detected", n = ndetected),
    data.frame(Id = as.character(s_levels[2]), Date = date, Type = "N detected Asymp", n =
      ndetected_asymp),
    data.frame(Id = as.character(s_levels[2]), Date = date, Type = "N Asymp", n = nasymptomatic)
  ))
)
ggplot(survdat, aes(x = Date, y = n + 1, colour = Type)) +
  geom_line() +
  facet_wrap(~Id) +
  scale_y_log10() +
  labs(y = "Counts (log)")
```

## Chapter 5

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## Chapter 6

# model1

The dynamics of the simulation process are:

1. Discrete Markov process.

2. The simulation has the following parameters:

a. New variant emergence at rate  $X$ . b. For each variant  $k$ :

- Unvaccinated individuals become sick rate  $C(k)$ ,
- Mortality rate  $D(k)$ ,
- Recovery rate  $H(k)$ ,
- Vaccines have an efficacy rate  $E(v, k)$  and pseudo vaccines (recovered) have efficacy rate  $E(r, k) < E(v, k)$ . In general, the probability of  $i$  acquiring the disease  $k$  from  $j$  will be equal to

```  $P(i \text{ gets the disease from } j \mid \text{their states}) = C(k) * (1 - E(i, k)) * (1 - E(j, k))$  ```

where  $(i, j) \in (u, v, r)$ . Efficacy rate for unvaccinated is zero.

- Vaccinated individuals have a reduced mortality rate  $D(k, v) > D(k)$ , and recovered individuals  $D(k, r) \in (D(k, v), D(k))$
- Vaccinated individuals have an increased recovery rate  $H(k, v) > H(k)$ , whereas recovered's rate  $H(k, r) \in [H(k), H(k, v))$ .

The sum of mortality and recovery rates is less than one since the difference represents no change.

c. Each country vaccinates citizens at rate  $V$  function of  $A$  (availability) and  $B$  (citizens' acceptance rate.) d. In each country  $i$ , the entire population  $N(i)$  distributes between the following states:

- Healthy unvaccinated ( $N(i, t, u)$ ),
- Healthy vaccinated ( $N(i, t, v)$ ),
- Deceased ( $N(i, t, d)$ ),
- Recovered ( $N(i, t, r)$ ),
- Unvaccinated and sick with variant ( $N(i, t, s, k|u)$ )  $k$ ., and
- Vaccinated and sick with variant ( $N(i, t, s, k|v)$ )  $k$ .

Total sick are  $N(i, t, k, s) = \sum(g \in \{u, v\}) N(i, t, k, s|g)$

Globally, we keep track of the prevalence of new variants. Variants can disappear if no more individuals port the variant, i.e., the prevalence rate  $P(k, t) = \sum(i) N(i, s, k)$  equals zero.

d. Vaccines are manufactured at each country at rates  $M(i)$  and uniformly shared with other countries at rate  $S(i)$ . c. Population flows between each country pair  $(i, j)$  at a rate  $F(i, j)$ . Flows between countries do not change Population and are symmetric.

3. The simulation process is as follows:

- (a) Countries are initialized with a total population  $N(i)$ .
- (b) Variant zero initializes at a random location  $i$ , with an initial prevalence  $P(k, t) = N(i, t, k)$ .
- (c) For time  $t$  in  $(0, T)$  do:
  - a. Unvaccinated individuals can become sick of variant  $k$  with probability:  

$$\Pr(h \rightarrow s | i, t, k, u) \sim \sum(g \in \{u, v\}) (N(i, t-1, s, k | g) + \sum(j \neq i) F(i, j) * N(j, t-1, s, k | g)) * C(k) / (N(i) + \sum(j \neq i) N(j))$$
  - b. Vaccinated individuals can become sick of variant  $k$  with probability:  $\Pr(v \rightarrow s | i, t, k, v) \sim \Pr(h \rightarrow s | i, t, k) * (1 - E(v, k))$ .
  - b. Recovered individuals can become sick of variant  $k$  with probability:  $\Pr(v \rightarrow s | i, t, k, r) \sim \Pr(h \rightarrow s | i, t, k) * (1 - E(r, k))$ .
  - c. Sick individuals with variant  $k$  die with probability  $D(k)$  or recover with probability  $H(k)$ , otherwise they stay infected; with the rates depending on their vaccination status  $v$  or  $n$ .
  - d. Unvaccinated individuals vaccinate in country  $i$  with probability  $P(u \rightarrow v) \sim V(A(i, t), B(i))$ .
  - e. The country vaccine supply changes.



## Chapter 7

# EPI Simulator

### 7.1 Disease dynamics

Diseases continuously evolve in time. Changes in their genetic sequence make them more or less resistant to the particular version of the vaccine. Mutations also affect the transmissibility level and mortality rate of the disease. Using this approach allows making vaccination efficacy a function of compatibility between the variant and the vaccine.

When an individual becomes infected, the disease accumulates mutations in the new host. Ultimately, there is no single version of the disease present in the model, but rather an infinite number of them, each slightly different from the other.

### 7.2 Network dynamics

We can assume that the Population is organized in fully connected blocks for the first version of the model. Block sizes and the number of connections between blocks are Poisson random variables. Individuals interact with all the members of their blocks, and bridging individuals allow the disease to move across blocks.

### 7.3 Contagion dynamics

The transmission of the disease will be governed by the number of vaccinated, infected, and recovered within each block. Transmission between blocks will be treated in the same way, although individuals bridging the block will only interact with others within the block and their direct connections across the blocks.

### 7.4 Time dynamics

Time dynamics has two components, how biology evolves and how agents react.

The model develops as a continuous-time Markov process. Each block of individuals takes action at rates  $L(i|N(i))$  function of the local number of infections. This way, if

## 7.5 Updating agent's status

Like most other components, updating agents' states can be personalized. A naive approach allows agents to get infected with a single virus or stay as-is. The probability of this event is conditional on acquiring at most one virus. Since these are independent events, the conditional probability is computed as follows:

$$\begin{aligned} P(\text{Variant } k | \text{at most 1}) &= P(\text{at most 1} | \text{Variant } k) * P(\text{Variant } k) / P(\text{at most 1}) \\ &= P(\text{only variant } k) / P(\text{variant } k) * P(\text{Variant } k) / P(\text{at most 1}) \\ &= P(\text{only variant } k) / P(\text{at most 1}) \end{aligned}$$

Where

$$\begin{aligned} P(\text{only variant } k) &= P(k) * \text{Prod}(m \neq v) (1 - P(m)) \\ P(\text{at most 1}) &= P(\text{None}) + \text{Sum}(v \text{ in variants}) P(v) * \text{Prod}(m \neq v) (1 - P(m)) \\ P(\text{None}) &= \text{Prod}(v \text{ in variants}) (1 - P(v)) \end{aligned}$$

Furthermore, the (Variant, Person) pairs are treated independently.

### 7.5.1 Other parameters

- Who did you get the infection from.
- Omicron is 1.5 more infectious than delta.
- Surveillance:
  - Pull people to be tested at random.
  - Or at symptoms.
  - A mix of the two.
- Define a class for passing extra functions and datasets, for example, testing surveillance.
- Exposed people become infectious after k days.
- [Network](#) changes can be a function of an ERGM. Apply K steps throughout time.
- Add progress bar.

## Chapter 8

# Contributor Covenant Code of Conduct

### 8.1 Our Pledge

We as members, contributors, and leaders pledge to make participation in our community a harassment-free experience for everyone, regardless of age, body size, visible or invisible disability, ethnicity, sex characteristics, gender identity and expression, level of experience, education, socio-economic status, nationality, personal appearance, race, religion, or sexual identity and orientation.

We pledge to act and interact in ways that contribute to an open, welcoming, diverse, inclusive, and healthy community.

### 8.2 Our Standards

Examples of behavior that contributes to a positive environment for our community include:

- Demonstrating empathy and kindness toward other people
- Being respectful of differing opinions, viewpoints, and experiences
- Giving and gracefully accepting constructive feedback
- Accepting responsibility and apologizing to those affected by our mistakes, and learning from the experience
- Focusing on what is best not just for us as individuals, but for the overall community

Examples of unacceptable behavior include:

- The use of sexualized language or imagery, and sexual attention or advances of any kind
- Trolling, insulting or derogatory comments, and personal or political attacks
- Public or private harassment
- Publishing others' private information, such as a physical or email address, without their explicit permission
- Other conduct which could reasonably be considered inappropriate in a professional setting

## 8.3 Enforcement Responsibilities

Community leaders are responsible for clarifying and enforcing our standards of acceptable behavior and will take appropriate and fair corrective action in response to any behavior that they deem inappropriate, threatening, offensive, or harmful.

Community leaders have the right and responsibility to remove, edit, or reject comments, commits, code, wiki edits, issues, and other contributions that are not aligned to this Code of Conduct, and will communicate reasons for moderation decisions when appropriate.

## 8.4 Scope

This Code of Conduct applies within all community spaces, and also applies when an individual is officially representing the community in public spaces. Examples of representing our community include using an official e-mail address, posting via an official social media account, or acting as an appointed representative at an online or offline event.

## 8.5 Enforcement

Instances of abusive, harassing, or otherwise unacceptable behavior may be reported to the community leaders responsible for enforcement at [g.vegayon@gmail.com](mailto:g.vegayon@gmail.com). All complaints will be reviewed and investigated promptly and fairly.

All community leaders are obligated to respect the privacy and security of the reporter of any incident.

## 8.6 Enforcement Guidelines

Community leaders will follow these Community Impact Guidelines in determining the consequences for any action they deem in violation of this Code of Conduct:

### 8.6.1 1. Correction

**Community Impact:** Use of inappropriate language or other behavior deemed unprofessional or unwelcome in the community.

**Consequence:** A private, written warning from community leaders, providing clarity around the nature of the violation and an explanation of why the behavior was inappropriate. A public apology may be requested.

### 8.6.2 2. Warning

**Community Impact:** A violation through a single incident or series of actions.

**Consequence:** A warning with consequences for continued behavior. No interaction with the people involved, including unsolicited interaction with those enforcing the Code of Conduct, for a specified period of time. This includes avoiding interactions in community spaces as well as external channels like social media. Violating these terms may lead to a temporary or permanent ban.

### 8.6.3 3. Temporary Ban

**Community Impact:** A serious violation of community standards, including sustained inappropriate behavior.

**Consequence:** A temporary ban from any sort of interaction or public communication with the community for a specified period of time. No public or private interaction with the people involved, including unsolicited interaction with those enforcing the Code of Conduct, is allowed during this period. Violating these terms may lead to a permanent ban.

### 8.6.4 4. Permanent Ban

**Community Impact:** Demonstrating a pattern of violation of community standards, including sustained inappropriate behavior, harassment of an individual, or aggression toward or disparagement of classes of individuals.

**Consequence:** A permanent ban from any sort of public interaction within the community.

## 8.7 Attribution

This Code of Conduct is adapted from the [Contributor Covenant](https://www.contributor-covenant.org/version/2/0/code_of_conduct.html), version 2.0, available at [https://www.contributor-covenant.org/version/2/0/code\\_of\\_conduct.html](https://www.contributor-covenant.org/version/2/0/code_of_conduct.html).

Community Impact Guidelines were inspired by [Mozilla's code of conduct enforcement ladder](#).

For answers to common questions about this code of conduct, see the FAQ at <https://www.contributor-covenant.org/faq>. Translations are available at <https://www.contributor-covenant.org/translations>.



## Chapter 9

# MIT License

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## Chapter 10

# epiworld 1.0

- Added a NEWS .md file to track changes to the package.



# Chapter 11

## Namespace Index

### 11.1 Namespace List

Here is a list of all documented namespaces with brief descriptions:

<a href="#">epiworld::sampler</a>	Functions for sampling viruses . . . . .	<a href="#">35</a>
<a href="#">sampler</a>	Functions for sampling viruses . . . . .	<a href="#">38</a>



## Chapter 12

# Hierarchical Index

### 12.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

Action< TSeq > . . . . .	43
epiworld::Action< TSeq > . . . . .	45
AdjList . . . . .	46
epiworld::AdjList . . . . .	48
Agent< TSeq > . . . . .	50
epiworld::Agent< TSeq > . . . . .	53
epiworld::Agent< bool > . . . . .	53
AgentsSample< TSeq > . . . . .	56
epiworld::AgentsSample< TSeq > . . . . .	57
DataBase< TSeq > . . . . .	57
epiworld::DataBase< TSeq > . . . . .	60
epiworld::DataBase< bool > . . . . .	60
Entities< TSeq > . . . . .	64
epiworld::Entities< TSeq > . . . . .	65
Entities_const< TSeq > . . . . .	66
epiworld::Entities_const< TSeq > . . . . .	67
Entity< TSeq > . . . . .	67
epiworld::Entity< TSeq > . . . . .	68
epiworld::LFMCMC< TData > . . . . .	69
LFMCMC< TData > . . . . .	70
epiworld::Model< TSeq > . . . . .	71
Model< TSeq > . . . . .	87
epiworld::Model< bool > . . . . .	71
epiworld::Model< EPI_DEFAULT_TSEQ > . . . . .	71
ModelSEIRCONN< TSeq > . . . . .	102
ModelSIRCONN< TSeq > . . . . .	108
ModelSURV< TSeq > . . . . .	115
epiworld::epimodels::ModelSEIRCONN< TSeq > . . . . .	100
epiworld::epimodels::ModelSIRCONN< TSeq > . . . . .	106
epiworld::epimodels::ModelSURV< TSeq > . . . . .	113
epiworld::Model< int > . . . . .	71
ModelSEIR< TSeq > . . . . .	98
ModelSIR< TSeq > . . . . .	105
ModelSIS< TSeq > . . . . .	112
epiworld::epimodels::ModelSEIR< TSeq > . . . . .	96

epiworld::epimodels::ModelSIR< TSeq > . . . . .	103
epiworld::epimodels::ModelSIS< TSeq > . . . . .	110
epiworld::Model< TSeq > . . . . .	71
Network< Nettype, Nodetype, Edgetype > . . . . .	117
epiworld::Person< TSeq > . . . . .	117
epiworld::Person< bool > . . . . .	117
epiworld::PersonTools< TSeq > . . . . .	118
PersonTools< TSeq > . . . . .	119
epiworld::PersonTools< bool > . . . . .	118
epiworld::PersonViruses< TSeq > . . . . .	120
epiworld::PersonViruses< bool > . . . . .	120
epiworld::Progress . . . . .	120
Progress . . . . .	121
epiworld::Queue< TSeq > . . . . .	121
Queue< TSeq > . . . . .	122
epiworld::Queue< bool > . . . . .	121
epiworld::QueueValues . . . . .	123
QueueValues . . . . .	123
RandGraph . . . . .	123
epiworld::SAMPLETYPE . . . . .	124
SAMPLETYPE . . . . .	124
epiworld::Tool< TSeq > . . . . .	124
Tool< TSeq > . . . . .	127
epiworld::Tools< TSeq > . . . . .	128
Tools< TSeq > . . . . .	129
epiworld::Tools_const< TSeq > . . . . .	130
Tools_const< TSeq > . . . . .	130
epiworld::UserData< TSeq > . . . . .	131
UserData< TSeq > . . . . .	133
epiworld::vecHasher< T > . . . . .	135
vecHasher< T > . . . . .	135
epiworld::Virus< TSeq > . . . . .	136
Virus< TSeq > . . . . .	139
epiworld::Viruses< TSeq > . . . . .	141
Viruses< TSeq > . . . . .	142
epiworld::Viruses_const< TSeq > . . . . .	142
Viruses_const< TSeq > . . . . .	143

## Chapter 13

# Class Index

### 13.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

<a href="#">Action&lt; TSeq &gt;</a>	
Action data for update an agent	43
<a href="#">epiworld::Action&lt; TSeq &gt;</a>	
Action data for update an agent	45
<a href="#">AdjList</a>	46
<a href="#">epiworld::AdjList</a>	48
<a href="#">Agent&lt; TSeq &gt;</a>	
Agent (agents)	50
<a href="#">epiworld::Agent&lt; TSeq &gt;</a>	
Agent (agents)	53
<a href="#">AgentsSample&lt; TSeq &gt;</a>	
Sample of agents	56
<a href="#">epiworld::AgentsSample&lt; TSeq &gt;</a>	
Sample of agents	57
<a href="#">DataBase&lt; TSeq &gt;</a>	
Statistical data about the process	57
<a href="#">epiworld::DataBase&lt; TSeq &gt;</a>	
Statistical data about the process	60
<a href="#">Entities&lt; TSeq &gt;</a>	
Set of <a href="#">Entities</a> (useful for building iterators)	64
<a href="#">epiworld::Entities&lt; TSeq &gt;</a>	
Set of <a href="#">Entities</a> (useful for building iterators)	65
<a href="#">Entities_const&lt; TSeq &gt;</a>	
Set of <a href="#">Entities</a> (const) (useful for iterators)	66
<a href="#">epiworld::Entities_const&lt; TSeq &gt;</a>	
Set of <a href="#">Entities</a> (const) (useful for iterators)	67
<a href="#">Entity&lt; TSeq &gt;</a>	67
<a href="#">epiworld::Entity&lt; TSeq &gt;</a>	68
<a href="#">epiworld::LFMCMC&lt; TData &gt;</a>	
Likelihood-Free Markov Chain Monte Carlo	69
<a href="#">LFMCMC&lt; TData &gt;</a>	
Likelihood-Free Markov Chain Monte Carlo	70
<a href="#">epiworld::Model&lt; TSeq &gt;</a>	
Core class of epiworld	71
<a href="#">Model&lt; TSeq &gt;</a>	
Core class of epiworld	87

<a href="#">epiworld::epimodels::ModelSEIR&lt; TSeq &gt;</a>	
Template for a Susceptible-Exposed-Infected-Removed (SEIR) model	96
<a href="#">ModelSEIR&lt; TSeq &gt;</a>	
Template for a Susceptible-Exposed-Infected-Removed (SEIR) model	98
<a href="#">epiworld::epimodels::ModelSEIRCONN&lt; TSeq &gt;</a>	100
<a href="#">ModelSEIRCONN&lt; TSeq &gt;</a>	102
<a href="#">epiworld::epimodels::ModelSIR&lt; TSeq &gt;</a>	
Template for a Susceptible-Infected-Removed (SIR) model	103
<a href="#">ModelSIR&lt; TSeq &gt;</a>	
Template for a Susceptible-Infected-Removed (SIR) model	105
<a href="#">epiworld::epimodels::ModelSIRCONN&lt; TSeq &gt;</a>	106
<a href="#">ModelSIRCONN&lt; TSeq &gt;</a>	108
<a href="#">epiworld::epimodels::ModelSIS&lt; TSeq &gt;</a>	
Template for a Susceptible-Infected-Susceptible (SIS) model	110
<a href="#">ModelSIS&lt; TSeq &gt;</a>	
Template for a Susceptible-Infected-Susceptible (SIS) model	112
<a href="#">epiworld::epimodels::ModelSURV&lt; TSeq &gt;</a>	113
<a href="#">ModelSURV&lt; TSeq &gt;</a>	115
<a href="#">Network&lt; Nettype, Nodetype, Edgetype &gt;</a>	117
<a href="#">epiworld::Person&lt; TSeq &gt;</a>	117
<a href="#">epiworld::PersonTools&lt; TSeq &gt;</a>	
List of tools available for the individual to	118
<a href="#">PersonTools&lt; TSeq &gt;</a>	119
<a href="#">epiworld::PersonViruses&lt; TSeq &gt;</a>	
Set of viruses in host	120
<a href="#">epiworld::Progress</a>	
A simple progress bar	120
<a href="#">Progress</a>	
A simple progress bar	121
<a href="#">epiworld::Queue&lt; TSeq &gt;</a>	
Controls which agents are verified at each step	121
<a href="#">Queue&lt; TSeq &gt;</a>	
Controls which agents are verified at each step	122
<a href="#">epiworld::QueueValues</a>	123
<a href="#">QueueValues</a>	123
<a href="#">RandGraph</a>	123
<a href="#">epiworld::SAMPLETYPE</a>	124
<a href="#">SAMPLETYPE</a>	124
<a href="#">epiworld::Tool&lt; TSeq &gt;</a>	
Tools for defending the agent against the virus	124
<a href="#">Tool&lt; TSeq &gt;</a>	
Tools for defending the agent against the virus	127
<a href="#">epiworld::Tools&lt; TSeq &gt;</a>	
Set of tools (useful for building iterators)	128
<a href="#">Tools&lt; TSeq &gt;</a>	
Set of tools (useful for building iterators)	129
<a href="#">epiworld::Tools_const&lt; TSeq &gt;</a>	
Set of <a href="#">Tools</a> (const) (useful for iterators)	130
<a href="#">Tools_const&lt; TSeq &gt;</a>	
Set of <a href="#">Tools</a> (const) (useful for iterators)	130
<a href="#">epiworld::UserData&lt; TSeq &gt;</a>	
Personalized data by the user	131
<a href="#">UserData&lt; TSeq &gt;</a>	
Personalized data by the user	133
<a href="#">epiworld::vecHasher&lt; T &gt;</a>	
Vector hasher	135
<a href="#">vecHasher&lt; T &gt;</a>	
Vector hasher	135



<a href="#">epiworld::Virus&lt; TSeq &gt;</a>	
<a href="#">Virus</a> . . . . .	136
<a href="#">Virus&lt; TSeq &gt;</a>	
<a href="#">Virus</a> . . . . .	139
<a href="#">epiworld::Viruses&lt; TSeq &gt;</a>	
Set of viruses (useful for building iterators) . . . . .	141
<a href="#">Viruses&lt; TSeq &gt;</a>	
Set of viruses (useful for building iterators) . . . . .	142
<a href="#">epiworld::Viruses_const&lt; TSeq &gt;</a>	
Set of <a href="#">Viruses</a> (const) (useful for iterators) . . . . .	142
<a href="#">Viruses_const&lt; TSeq &gt;</a>	
Set of <a href="#">Viruses</a> (const) (useful for iterators) . . . . .	143



# Chapter 14

## File Index

### 14.1 File List

Here is a list of all documented files with brief descriptions:

<b>epiworld.hpp</b>	??
include/epiworld/ <b>adjlist-bones.hpp</b>	??
include/epiworld/ <b>adjlist-meat.hpp</b>	??
include/epiworld/ <b>agent-actions-meat.hpp</b>	??
include/epiworld/ <b>agent-bones.hpp</b>	??
include/epiworld/ <b>agent-meat-status.hpp</b>	
Sampling functions are getting big, so we keep them in a separate file	145
include/epiworld/ <b>agent-meat-virus-sampling.hpp</b>	??
include/epiworld/ <b>agent-meat.hpp</b>	??
include/epiworld/ <b>agentssample-bones.hpp</b>	??
include/epiworld/ <b>config.hpp</b>	??
include/epiworld/ <b>database-bones.hpp</b>	??
include/epiworld/ <b>database-meat.hpp</b>	??
include/epiworld/ <b>entities-bones.hpp</b>	??
include/epiworld/ <b>entity-bones.hpp</b>	??
include/epiworld/ <b>entity-meat.hpp</b>	??
include/epiworld/ <b>epiworld-macros.hpp</b>	??
include/epiworld/ <b>epiworld.hpp</b>	??
include/epiworld/ <b>misc.hpp</b>	??
include/epiworld/ <b>model-bones.hpp</b>	??
include/epiworld/ <b>model-meat-print.hpp</b>	??
include/epiworld/ <b>model-meat.hpp</b>	??
include/epiworld/ <b>network-bones.hpp</b>	??
include/epiworld/ <b>progress.hpp</b>	??
include/epiworld/ <b>queue-bones.hpp</b>	??
include/epiworld/ <b>randgraph.hpp</b>	??
include/epiworld/ <b>random_graph.hpp</b>	??
include/epiworld/ <b>seq_processing.hpp</b>	??
include/epiworld/ <b>tool-bones.hpp</b>	??
include/epiworld/ <b>tool-meat.hpp</b>	??
include/epiworld/ <b>tools-bones.hpp</b>	??
include/epiworld/ <b>userdata-bones.hpp</b>	??
include/epiworld/ <b>userdata-meat.hpp</b>	??
include/epiworld/ <b>virus-bones.hpp</b>	??
include/epiworld/ <b>virus-meat.hpp</b>	??

include/epiworld/ <b>viruses-bones.hpp</b>	??
include/epiworld/math/ <b>lfmcmc.hpp</b>	??
include/epiworld/math/lfmcmc/ <b>lfmcmc-bones.hpp</b>	??
include/epiworld/math/lfmcmc/ <b>lfmcmc-meat-print.hpp</b>	??
include/epiworld/math/lfmcmc/ <b>lfmcmc-meat.hpp</b>	??
include/epiworld/models/ <b>models.hpp</b>	??
include/epiworld/models/ <b>seir.hpp</b>	??
include/epiworld/models/ <b>seirconnected.hpp</b>	??
include/epiworld/models/ <b>sir.hpp</b>	??
include/epiworld/models/ <b>sirconnected.hpp</b>	??
include/epiworld/models/ <b>sis.hpp</b>	??
include/epiworld/models/ <b>surveillance.hpp</b>	??
rpackage/inst/include/ <b>epiworld.hpp</b>	??
rpackage/inst/include/models/ <b>immune_system.hpp</b>	??
rpackage/inst/include/models/ <b>seirconnected.hpp</b>	??
rpackage/inst/include/models/ <b>sir.hpp</b>	??
rpackage/inst/include/models/ <b>sirconnected.hpp</b>	??
rpackage/inst/include/models/ <b>surveillance.hpp</b>	??
rpackage/src/ <b>epiworld-common.hpp</b>	??
tests/ <b>tests.hpp</b>	??

## Chapter 15

# Namespace Documentation

### 15.1 epiworld::sampler Namespace Reference

Functions for sampling viruses.

#### Functions

- `template<typename TSeq >`  
`std::function< void(Agent< TSeq > *, Model< TSeq > *)> make\_update\_susceptible (std::vector< epiworld_fast_uint > exclude={})`  
*Make a function to sample from neighbors.*
- `template<typename TSeq = int>`  
`std::function< Virus< TSeq > *(Agent< TSeq > *, Model< TSeq > *)> make\_sample\_virus\_neighbors (std::vector< epiworld_fast_uint > exclude={})`  
*Make a function to sample from neighbors.*
- `template<typename TSeq = int>`  
`Virus< TSeq > * sample\_virus\_single (Agent< TSeq > *p, Model< TSeq > *m)`  
*Sample from neighbors pool of viruses (at most one)*

#### 15.1.1 Detailed Description

Functions for sampling viruses.

#### 15.1.2 Function Documentation

##### 15.1.2.1 `make_sample_virus_neighbors()`

```
template<typename TSeq = int>
std::function<Virus<TSeq>*(Agent<TSeq>*,Model<TSeq>*)> epiworld::sampler::make_sample_virus_neighbors (
    std::vector< epiworld_fast_uint > exclude = {} ) [inline]
```

Make a function to sample from neighbors.

This is akin to the function `default_update_susceptible`, with the difference that it will create a function that supports excluding states from the sampling frame. For example, individuals who have acquired a virus can be excluded if in incubation state.

**Template Parameters**

<i>TSeq</i>	
-------------	--

**Parameters**

<i>exclude</i>	unsigned vector of states that need to be excluded from the sampling
----------------	----------------------------------------------------------------------

**Returns**

Virus<TSeq>\* of the selected virus. If none selected (or none available,) returns a nullptr;

**15.1.2.2 make\_update\_susceptible()**

```
template<typename TSeq >
std::function<void (Agent<TSeq>*, Model<TSeq>*)> epiworld::sampler::make_update_susceptible (
    std::vector< epiworld_fast_uint > exclude = {} ) [inline]
```

Make a function to sample from neighbors.

This is akin to the function `default_update_susceptible`, with the difference that it will create a function that supports excluding states from the sampling frame. For example, individuals who have acquired a virus can be excluded if in incubation state.

**Template Parameters**

<i>TSeq</i>	
-------------	--

**Parameters**

<i>exclude</i>	unsigned vector of states that need to be excluded from the sampling
----------------	----------------------------------------------------------------------

**Returns**

Virus<TSeq>\* of the selected virus. If none selected (or none available,) returns a nullptr;

**15.1.2.3 sample\_virus\_single()**

```
template<typename TSeq = int>
Virus<TSeq>* epiworld::sampler::sample_virus_single (
    Agent< TSeq > * p,
    Model< TSeq > * m ) [inline]
```

Sample from neighbors pool of viruses (at most one)

This function samples at most one virus from the pool of viruses from its neighbors. If no virus is selected, the function returns a `nullptr`, otherwise it returns a pointer to the selected virus.

This can be used to build a new update function (EPI\_NEW\_UPDATEFUN.)

## Template Parameters

<i>TSeq</i>	
-------------	--

## Parameters

<i>p</i>	Pointer to person
<i>m</i>	Pointer to the model

## Returns

Virus<TSeq>\* of the selected virus. If none selected (or none available,) returns a nullptr;

## 15.2 sampler Namespace Reference

Functions for sampling viruses.

### Functions

- `template<typename TSeq >`  
`std::function< void(Agent< TSeq > *, Model< TSeq > *)> make\_update\_susceptible (std::vector< epiworld_fast_uint > exclude={})`  
*Make a function to sample from neighbors.*
- `template<typename TSeq = int>`  
`std::function< Virus< TSeq > *(Agent< TSeq > *, Model< TSeq > *)> make\_sample\_virus\_neighbors (std::vector< epiworld_fast_uint > exclude={})`  
*Make a function to sample from neighbors.*
- `template<typename TSeq = int>`  
`Virus< TSeq > * sample\_virus\_single (Agent< TSeq > *p, Model< TSeq > *m)`  
*Sample from neighbors pool of viruses (at most one)*

### 15.2.1 Detailed Description

Functions for sampling viruses.

### 15.2.2 Function Documentation

#### 15.2.2.1 [make\\_sample\\_virus\\_neighbors\(\)](#)

```
template<typename TSeq = int>
std::function<Virus<TSeq>*(Agent<TSeq>*,Model<TSeq>*)> sampler::make_sample_virus_neighbors
(
    std::vector< epiworld_fast_uint > exclude = {} ) [inline]
```

Make a function to sample from neighbors.

This is akin to the function `default_update_susceptible`, with the difference that it will create a function that supports excluding states from the sampling frame. For example, individuals who have acquired a virus can be excluded if in incubation state.



## Template Parameters

<i>TSeq</i>	
-------------	--

## Parameters

<i>exclude</i>	unsigned vector of states that need to be excluded from the sampling
----------------	----------------------------------------------------------------------

## Returns

Virus<TSeq>\* of the selected virus. If none selected (or none available,) returns a nullptr;

## 15.2.2.2 make\_update\_susceptible()

```
template<typename TSeq >
std::function<void (Agent<TSeq>*, Model<TSeq>*)> sampler::make_update_susceptible (
    std::vector< epiworld_fast_uint > exclude = {} ) [inline]
```

Make a function to sample from neighbors.

This is akin to the function `default_update_susceptible`, with the difference that it will create a function that supports excluding states from the sampling frame. For example, individuals who have acquired a virus can be excluded if in incubation state.

## Template Parameters

<i>TSeq</i>	
-------------	--

## Parameters

<i>exclude</i>	unsigned vector of states that need to be excluded from the sampling
----------------	----------------------------------------------------------------------

## Returns

Virus<TSeq>\* of the selected virus. If none selected (or none available,) returns a nullptr;

## 15.2.2.3 sample\_virus\_single()

```
template<typename TSeq = int>
Virus<TSeq>* sampler::sample_virus_single (
    Agent< TSeq > * p,
    Model< TSeq > * m ) [inline]
```

Sample from neighbors pool of viruses (at most one)

This function samples at most one virus from the pool of viruses from its neighbors. If no virus is selected, the function returns a `nullptr`, otherwise it returns a pointer to the selected virus.

This can be used to build a new update function (EPI\_NEW\_UPDATEFUN.)

## Template Parameters

<i>TSeq</i>	
-------------	--

## Parameters

<i>p</i>	Pointer to person
<i>m</i>	Pointer to the model

## Returns

Virus<TSeq>\* of the selected virus. If none selected (or none available,) returns a nullptr;



# Chapter 16

## Class Documentation

### 16.1 Action< TSeq > Struct Template Reference

Action data for update an agent.

```
#include <config.hpp>
```

#### Public Member Functions

- Action (Agent< TSeq > \*agent\_, VirusPtr< TSeq > virus\_, ToolPtr< TSeq > tool\_, Entity< TSeq > \*entity\_, epiworld\_fast\_int new\_status\_, epiworld\_fast\_int queue\_, ActionFun< TSeq > call\_, int idx\_agent←\_, int idx\_object\_)

Construct a new Action object.

#### Public Attributes

- Agent< TSeq > \* agent
- VirusPtr< TSeq > virus
- ToolPtr< TSeq > tool
- Entity< TSeq > \* entity
- epiworld\_fast\_int new\_status
- epiworld\_fast\_int queue
- ActionFun< TSeq > call
- int idx\_agent
- int idx\_object

#### 16.1.1 Detailed Description

```
template<typename TSeq>  
struct Action< TSeq >
```

Action data for update an agent.

## Template Parameters

<i>TSeq</i>	
-------------	--

## 16.1.2 Constructor &amp; Destructor Documentation

## 16.1.2.1 Action()

```
template<typename TSeq >
Action< TSeq >::Action (
    Agent< TSeq > * agent_,
    VirusPtr< TSeq > virus_,
    ToolPtr< TSeq > tool_,
    Entity< TSeq > * entity_,
    epiworld_fast_int new_status_,
    epiworld_fast_int queue_,
    ActionFun< TSeq > call_,
    int idx_agent_,
    int idx_object_ ) [inline]
```

Construct a new [Action](#) object.

All the parameters are rather optional.

## Parameters

<i>agent_</i>	<a href="#">Agent</a> over who the action will happen
<i>virus_</i>	<a href="#">Virus</a> to add
<i>tool_</i>	<a href="#">Tool</a> to add
<i>virus_idx</i>	Index of virus to be removed (if needed)
<i>tool_idx</i>	Index of tool to be removed (if needed)
<i>new_status_↔</i>	Next status
<i>queue_</i>	Efect on the queue
<i>call_</i>	The action call (if needed)
<i>idx_agent_↔</i>	Location of agent in object.
<i>idx_object_↔</i>	Location of object in agent.

The documentation for this struct was generated from the following files:

- include/epiworld/agent-bones.hpp
- include/epiworld/config.hpp

## 16.2 epiworld::Action< TSeq > Struct Template Reference

[Action](#) data for update an agent.

```
#include <epiworld.hpp>
```

### Public Member Functions

- [Action](#) ([Agent](#)< TSeq > \*agent\_, [VirusPtr](#)< TSeq > virus\_, [ToolPtr](#)< TSeq > tool\_, [Entity](#)< TSeq > \*entity\_, epiworld\_fast\_int new\_status\_, epiworld\_fast\_int queue\_, [ActionFun](#)< TSeq > call\_, int idx\_agent\_, int idx\_object\_)  
Construct a new [Action](#) object.

### Public Attributes

- [Agent](#)< TSeq > \* **agent**
- [VirusPtr](#)< TSeq > **virus**
- [ToolPtr](#)< TSeq > **tool**
- [Entity](#)< TSeq > \* **entity**
- epiworld\_fast\_int **new\_status**
- epiworld\_fast\_int **queue**
- [ActionFun](#)< TSeq > **call**
- int **idx\_agent**
- int **idx\_object**

### 16.2.1 Detailed Description

```
template<typename TSeq>
struct epiworld::Action< TSeq >
```

[Action](#) data for update an agent.

Template Parameters

<a href="#">TSeq</a>	
----------------------	--

### 16.2.2 Constructor & Destructor Documentation

#### 16.2.2.1 Action()

```
template<typename TSeq >
epiworld::Action< TSeq >::Action (
    Agent< TSeq > * agent_,
```

```

VirusPtr< TSeq > virus_,
ToolPtr< TSeq > tool_,
Entity< TSeq > * entity_,
epiworld_fast_int new_status_,
epiworld_fast_int queue_,
ActionFun< TSeq > call_,
int idx_agent_,
int idx_object_ ) [inline]

```

Construct a new [Action](#) object.

All the parameters are rather optional.

#### Parameters

<i>agent_</i>	<a href="#">Agent</a> over who the action will happen
<i>virus_</i>	<a href="#">Virus</a> to add
<i>tool_</i>	<a href="#">Tool</a> to add
<i>virus_idx</i>	Index of virus to be removed (if needed)
<i>tool_idx</i>	Index of tool to be removed (if needed)
<i>new_↔ status_</i>	Next status
<i>queue_</i>	Efect on the queue
<i>call_</i>	The action call (if needed)
<i>idx_agent↔ _</i>	Location of agent in object.
<i>idx_object↔ _</i>	Location of object in agent.

The documentation for this struct was generated from the following file:

- epiworld.hpp

## 16.3 AdjList Class Reference

### Public Member Functions

- [AdjList](#) (const std::vector< unsigned int > &source, const std::vector< unsigned int > &target, int size, bool directed)  
*Construct a new Adj List object.*
- void [read\\_edgelist](#) (std::string fn, int size, int skip=0, bool directed=true)  
*Read an edgelist.*
- std::map< unsigned int, unsigned int > **operator()** (unsigned int i) const
- void **print** (unsigned int limit=20u) const
- size\_t [vcount](#) () const  
*Number of vertices/nodes in the network.*
- size\_t [ecount](#) () const  
*Number of edges/arcs/ties in the network.*
- std::vector< std::map< unsigned int, unsigned int > > & **get\_dat** ()
- bool [is\\_directed](#) () const  
*true if the network is directed.*



## 16.3.1 Constructor & Destructor Documentation

### 16.3.1.1 AdjList()

```
AdjList::AdjList (
    const std::vector< unsigned int > & source,
    const std::vector< unsigned int > & target,
    int size,
    bool directed ) [inline]
```

Construct a new Adj List object.

Ids in the network are assume to range from 0 to `size - 1`.

#### Parameters

<i>source</i>	Unsigned int vector with the source
<i>target</i>	Unsigned int vector with the target
<i>size</i>	Number of vertices in the network.
<i>directed</i>	Bool true if the network is directed

## 16.3.2 Member Function Documentation

### 16.3.2.1 read\_edgelist()

```
void AdjList::read_edgelist (
    std::string fn,
    int size,
    int skip = 0,
    bool directed = true ) [inline]
```

Read an edgelist.

Ids in the network are assume to range from 0 to `size - 1`.

#### Parameters

<i>fn</i>	Path to the file
<i>skip</i>	Number of lines to skip (e.g., 1 if there's a header)
<i>directed</i>	true if the network is directed
<i>size</i>	Number of vertices in the network.

The documentation for this class was generated from the following files:

- include/epiworld/adjlist-bones.hpp
- include/epiworld/adjlist-meat.hpp

## 16.4 epiworld::AdjList Class Reference

### Public Member Functions

- [AdjList](#) (const std::vector< unsigned int > &source, const std::vector< unsigned int > &target, int size, bool directed)  
*Construct a new Adj List object.*
- void [read\\_edgelist](#) (std::string fn, int size, int skip=0, bool directed=true)  
*Read an edgelist.*
- std::map< unsigned int, unsigned int > **operator()** (unsigned int i) const
- void **print** (unsigned int limit=20u) const
- size\_t [vcount](#) () const  
*Number of vertices/nodes in the network.*
- size\_t [ecount](#) () const  
*Number of edges/arcs/ties in the network.*
- std::vector< std::map< unsigned int, unsigned int > > & **get\_dat** ()
- bool [is\\_directed](#) () const  
*true if the network is directed.*
- [AdjList](#) (const std::vector< unsigned int > &source, const std::vector< unsigned int > &target, bool directed, int min\_id=-1, int max\_id=-1)  
*Construct a new Adj List object.*
- void **read\_edgelist** (std::string fn, int skip=0, bool directed=true, int min\_id=-1, int max\_id=-1)
- std::map< unsigned int, unsigned int > **operator()** (unsigned int i) const
- void **print** (unsigned int limit=20u) const
- unsigned int **get\_id\_max** () const
- unsigned int **get\_id\_min** () const
- size\_t **vcount** () const
- size\_t **ecount** () const
- std::map< unsigned int, std::map< unsigned int, unsigned int > > & **get\_dat** ()
- bool **is\_directed** () const

### 16.4.1 Constructor & Destructor Documentation

#### 16.4.1.1 AdjList() [1/2]

```
AdjList::AdjList (
    const std::vector< unsigned int > & source,
    const std::vector< unsigned int > & target,
    int size,
    bool directed ) [inline]
```

Construct a new Adj List object.

Ids in the network are assume to range from 0 to `size - 1`.

## Parameters

<i>source</i>	Unsigned int vector with the source
<i>target</i>	Unsigned int vector with the target
<i>size</i>	Number of vertices in the network.
<i>directed</i>	Bool true if the network is directed

## 16.4.1.2 AdjList() [2/2]

```
AdjList::AdjList (
    const std::vector< unsigned int > & source,
    const std::vector< unsigned int > & target,
    bool directed,
    int min_id = -1,
    int max_id = -1 ) [inline]
```

Construct a new Adj List object.

It will create an adjacency list object with `maxid - minid + 1` nodes. If `min_id` and `max_id` are not specified (both `< 0`), then the program will try to figure them out automatically by looking at the range of the observed ids.

## Parameters

<i>source</i>	Unsigned int vector with the source
<i>target</i>	Unsigned int vector with the target
<i>directed</i>	Bool true if the network is directed
<i>min_id</i>	int min id.
<i>max_id</i>	int max id.

## 16.4.2 Member Function Documentation

## 16.4.2.1 read\_edgelist()

```
void AdjList::read_edgelist (
    std::string fn,
    int size,
    int skip = 0,
    bool directed = true ) [inline]
```

Read an edgelist.

Ids in the network are assume to range from 0 to `size - 1`.

## Parameters

<i>fn</i>	Path to the file
<i>skip</i>	Number of lines to skip (e.g., 1 if there's a header)
<i>directed</i>	<code>true</code> if the network is directed
<i>size</i>	Number of vertices in the network.

The documentation for this class was generated from the following file:

- `epiworld.hpp`

## 16.5 Agent< TSeq > Class Template Reference

[Agent](#) (agents)

```
#include <agent-bones.hpp>
```

### Public Member Functions

- **Agent** (const [Agent](#)< TSeq > &p)
- int [get\\_id](#) () const  
*Id of the individual.*
- `std::mt19937` \* **get\_rand\_engine** ()
- [Model](#)< TSeq > \* **get\_model** ()
- [VirusPtr](#)< TSeq > & **get\_virus** (int i)
- [Viruses](#)< TSeq > **get\_viruses** ()
- const [Viruses\\_const](#)< TSeq > **get\_viruses** () const
- `size_t` **get\_n\_viruses** () const noexcept
- [ToolPtr](#)< TSeq > & **get\_tool** (int i)
- [Tools](#)< TSeq > **get\_tools** ()
- const [Tools\\_const](#)< TSeq > **get\_tools** () const
- `size_t` **get\_n\_tools** () const noexcept
- void **mutate\_variant** ()
- void **add\_neighbor** ([Agent](#)< TSeq > \*p, bool check\_source=true, bool check\_target=true)
- `std::vector`< [Agent](#)< TSeq > \* > & **get\_neighbors** ()
- void **change\_status** (`epiworld_fast_uint` new\_status, `epiworld_fast_int` queue=0)
- const `epiworld_fast_uint` & **get\_status** () const
- void **reset** ()
- bool **has\_tool** (unsigned int t) const
- bool **has\_tool** (std::string name) const
- bool **has\_virus** (unsigned int t) const
- bool **has\_virus** (std::string name) const
- void **print** (bool compressed=false) const
- [Entities](#)< TSeq > **get\_entities** ()
- const [Entities\\_const](#)< TSeq > **get\_entities** () const

#### Add/Remove Virus/Tool

*Any of these is ultimately reflected at the end of the iteration.*

*Parameters*

tool	<i>Tool to add</i>
virus	<i>Virus to add</i>
status_new	<i>Status after the change</i>
queue	

- void **add\_tool** (ToolPtr< TSeq > tool, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **add\_tool** ([Tool](#)< TSeq > tool, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **add\_virus** (VirusPtr< TSeq > virus, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **add\_virus** ([Virus](#)< TSeq > virus, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **add\_entity** ([Entity](#)< TSeq > &entity, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_tool** (epiworld\_fast\_uint tool\_idx, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_tool** (ToolPtr< TSeq > &tool, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_virus** (epiworld\_fast\_uint virus\_idx, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_virus** (VirusPtr< TSeq > &virus, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_entity** (epiworld\_fast\_uint entity\_idx, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_entity** ([Entity](#)< TSeq > &entity, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_agent\_by\_virus** (epiworld\_fast\_uint virus\_idx, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)  
*Agent removed by virus.*
- void **rm\_agent\_by\_virus** (VirusPtr< TSeq > &virus, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)  
*Agent removed by virus.*

**Get the rates (multipliers) for the agent***Parameters*

v	<i>A pointer to a virus.</i>
---	------------------------------

*Returns**epiworld\_double*

- epiworld\_double **get\_susceptibility\_reduction** (VirusPtr< TSeq > v)
  - epiworld\_double **get\_transmission\_reduction** (VirusPtr< TSeq > v)
  - epiworld\_double **get\_recovery\_enhancer** (VirusPtr< TSeq > v)
  - epiworld\_double **get\_death\_reduction** (VirusPtr< TSeq > v)
- 
- double & **operator()** (size\_t j)  
*Access the j-th column of the agent.*
  - double & **operator[]** (size\_t j)

## Friends

- class **Model**< TSeq >
- class **Virus**< TSeq >
- class **Viruses**< TSeq >
- class **Viruses\_const**< TSeq >
- class **Tool**< TSeq >
- class **Tools**< TSeq >
- class **Queue**< TSeq >
- class **Entities**< TSeq >
- class **AgentsSample**< TSeq >
- void **default\_add\_virus** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_add\_tool** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_add\_entity** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_rm\_virus** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_rm\_tool** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_rm\_entity** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)

### 16.5.1 Detailed Description

```
template<typename TSeq>
class Agent< TSeq >
```

[Agent](#) (agents)

Template Parameters

<i>TSeq</i>	Sequence type (should match TSeq across the model)
-------------	----------------------------------------------------

### 16.5.2 Member Function Documentation

#### 16.5.2.1 operator()()

```
template<typename TSeq >
double & Agent< TSeq >::operator() (
    size_t j ) [inline]
```

Access the j-th column of the agent.

If an external array has been specified, then these two functions can be used to access additional agent's features not included in the model.

The `operator[]` method is with no boundary check, whereas the `operator()` method checks boundaries. The former can result in a segfault.

## Parameters

<i>j</i>	
----------	--

## Returns

double&amp;

The documentation for this class was generated from the following files:

- include/epiworld/agent-bones.hpp
- include/epiworld/agent-meat.hpp

## 16.6 epiworld::Agent< TSeq > Class Template Reference

[Agent](#) (agents)

```
#include <epiworld.hpp>
```

### Public Member Functions

- **Agent** (const [Agent](#)< TSeq > &p)
- int [get\\_id](#) () const  
*Id of the individual.*
- std::mt19937 \* [get\\_rand\\_engine](#) ()
- [Model](#)< TSeq > \* [get\\_model](#) ()
- VirusPtr< TSeq > & [get\\_virus](#) (int i)
- [Viruses](#)< TSeq > [get\\_viruses](#) ()
- const [Viruses\\_const](#)< TSeq > [get\\_viruses](#) () const
- size\_t [get\\_n\\_viruses](#) () const noexcept
- ToolPtr< TSeq > & [get\\_tool](#) (int i)
- [Tools](#)< TSeq > [get\\_tools](#) ()
- const [Tools\\_const](#)< TSeq > [get\\_tools](#) () const
- size\_t [get\\_n\\_tools](#) () const noexcept
- void [mutate\\_variant](#) ()
- void [add\\_neighbor](#) ([Agent](#)< TSeq > \*p, bool check\_source=true, bool check\_target=true)
- std::vector< [Agent](#)< TSeq > \* > & [get\\_neighbors](#) ()
- void [change\\_status](#) (epiworld\_fast\_uint new\_status, epiworld\_fast\_int queue=0)
- const epiworld\_fast\_uint & [get\\_status](#) () const
- void [reset](#) ()
- bool [has\\_tool](#) (unsigned int t) const
- bool [has\\_tool](#) (std::string name) const
- bool [has\\_virus](#) (unsigned int t) const
- bool [has\\_virus](#) (std::string name) const
- void [print](#) (bool compressed=false) const
- [Entities](#)< TSeq > [get\\_entities](#) ()
- const [Entities\\_const](#)< TSeq > [get\\_entities](#) () const

### Add/Remove Virus/Tool

*Any of these is ultimately reflected at the end of the iteration.*

*Parameters*

tool	<i>Tool to add</i>
virus	<i>Virus to add</i>
status_new	<i>Status after the change</i>
queue	

- void **add\_tool** (ToolPtr< TSeq > tool, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **add\_tool** ([Tool](#)< TSeq > tool, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **add\_virus** (VirusPtr< TSeq > virus, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **add\_virus** ([Virus](#)< TSeq > virus, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **add\_entity** ([Entity](#)< TSeq > &entity, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_tool** (epiworld\_fast\_uint tool\_idx, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_tool** (ToolPtr< TSeq > &tool, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_virus** (epiworld\_fast\_uint virus\_idx, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_virus** (VirusPtr< TSeq > &virus, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_entity** (epiworld\_fast\_uint entity\_idx, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_entity** ([Entity](#)< TSeq > &entity, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)
- void **rm\_agent\_by\_virus** (epiworld\_fast\_uint virus\_idx, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)  
*Agent removed by virus.*
- void **rm\_agent\_by\_virus** (VirusPtr< TSeq > &virus, epiworld\_fast\_int status\_new=-99, epiworld\_fast\_int queue=-99)  
*Agent removed by virus.*

**Get the rates (multipliers) for the agent***Parameters*

v	<i>A pointer to a virus.</i>
---	------------------------------

*Returns*

*epiworld\_double*

- epiworld\_double **get\_susceptibility\_reduction** (VirusPtr< TSeq > v)
  - epiworld\_double **get\_transmission\_reduction** (VirusPtr< TSeq > v)
  - epiworld\_double **get\_recovery\_enhancer** (VirusPtr< TSeq > v)
  - epiworld\_double **get\_death\_reduction** (VirusPtr< TSeq > v)
- 
- double & **operator()** (size\_t j)  
*Access the j-th column of the agent.*
  - double & **operator[]** (size\_t j)



## Friends

- class **Model**< TSeq >
- class **Virus**< TSeq >
- class **Viruses**< TSeq >
- class **Viruses\_const**< TSeq >
- class **Tool**< TSeq >
- class **Tools**< TSeq >
- class **Queue**< TSeq >
- class **Entities**< TSeq >
- class **AgentsSample**< TSeq >
- void **default\_add\_virus** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_add\_tool** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_add\_entity** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_rm\_virus** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_rm\_tool** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_rm\_entity** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)

### 16.6.1 Detailed Description

```
template<typename TSeq>
class epiworld::Agent< TSeq >
```

[Agent](#) (agents)

Template Parameters

<i>TSeq</i>	Sequence type (should match TSeq across the model)
-------------	----------------------------------------------------

### 16.6.2 Member Function Documentation

#### 16.6.2.1 operator()()

```
template<typename TSeq >
double & Agent< TSeq >::operator() (
    size_t j ) [inline]
```

Access the j-th column of the agent.

If an external array has been specified, then these two functions can be used to access additional agent's features not included in the model.

The `operator[]` method is with no boundary check, whereas the `operator()` method checks boundaries. The former can result in a segfault.

## Parameters

<i>j</i>	
----------	--

## Returns

double&

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.7 AgentsSample< TSeq > Class Template Reference

Sample of agents.

```
#include <agentssample-bones.hpp>
```

### Public Member Functions

- [AgentsSample](#) ()=delete  
*Default constructor.*
- [AgentsSample](#) (const [AgentsSample](#)< TSeq > &a)=delete  
*Copy constructor.*
- [AgentsSample](#) ([AgentsSample](#)< TSeq > &&a)=delete  
*Move constructor.*
- **AgentsSample** ([Model](#)< TSeq > &model\_, size\_t n, bool truncate=false)
- **AgentsSample** ([Entity](#)< TSeq > &entity\_, size\_t n, bool truncate=false)
- **AgentsSample** ([Agent](#)< TSeq > &agent\_, size\_t n, bool truncate=false)
- std::vector< [Agent](#)< TSeq > \* >::iterator **begin** ()
- std::vector< [Agent](#)< TSeq > \* >::iterator **end** ()
- [Agent](#)< TSeq > \* **operator[]** (size\_t n)
- [Agent](#)< TSeq > \* **operator()** (size\_t n)
- const size\_t **size** () const noexcept

### 16.7.1 Detailed Description

```
template<typename TSeq>
class AgentsSample< TSeq >
```

Sample of agents.

This class allows sampling agents from Entity<TSeq> and [Model](#)<TSeq>.

#### Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following file:

- include/epiworld/agentssample-bones.hpp

## 16.8 epiworld::AgentsSample< TSeq > Class Template Reference

Sample of agents.

```
#include <epiworld.hpp>
```

### Public Member Functions

- [AgentsSample](#) ()=delete  
*Default constructor.*
- [AgentsSample](#) (const [AgentsSample](#)< TSeq > &a)=delete  
*Copy constructor.*
- [AgentsSample](#) ([AgentsSample](#)< TSeq > &&a)=delete  
*Move constructor.*
- [AgentsSample](#) ([Model](#)< TSeq > &model\_, size\_t n, bool truncate=false)
- [AgentsSample](#) ([Entity](#)< TSeq > &entity\_, size\_t n, bool truncate=false)
- [AgentsSample](#) ([Agent](#)< TSeq > &agent\_, size\_t n, bool truncate=false)
- std::vector< [Agent](#)< TSeq > \* >::iterator **begin** ()
- std::vector< [Agent](#)< TSeq > \* >::iterator **end** ()
- [Agent](#)< TSeq > \* **operator[]** (size\_t n)
- [Agent](#)< TSeq > \* **operator()** (size\_t n)
- const size\_t **size** () const noexcept

### 16.8.1 Detailed Description

```
template<typename TSeq>
class epiworld::AgentsSample< TSeq >
```

Sample of agents.

This class allows sampling agents from Entity<TSeq> and [Model](#)<TSeq>.

Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.9 DataBase< TSeq > Class Template Reference

Statistical data about the process.

```
#include <database-bones.hpp>
```

## Public Member Functions

- **DataBase** ([Model](#)< TSeq > &m)
- void **record\_variant** ([Virus](#)< TSeq > &v)  
*Registering a new variant.*
- void **record\_tool** ([Tool](#)< TSeq > &t)
- void **set\_seq\_hasher** (std::function< std::vector< int >(TSeq)> fun)
- void **set\_model** ([Model](#)< TSeq > &m)
- [Model](#)< TSeq > \* **get\_model** ()
- void **record** ()
- const std::vector< TSeq > & **get\_sequence** () const
- const std::vector< int > & **get\_nexposed** () const
- size\_t **size** () const
- void **write\_data** (std::string fn\_variant\_info, std::string fn\_variant\_hist, std::string fn\_tool\_info, std::string fn\_tool\_hist, std::string fn\_total\_hist, std::string fn\_transmission, std::string fn\_transition, std::string fn\_reproductive\_number) const
- void **record\_transmission** (int i, int j, int variant, int i\_expo\_date)
- size\_t **get\_n\_variants** () const
- size\_t **get\_n\_tools** () const
- void **reset** ()
- void **set\_user\_data** (std::vector< std::string > names)
- void **add\_user\_data** (std::vector< epiworld\_double > x)
- void **add\_user\_data** (unsigned int j, epiworld\_double x)
- [UserData](#)< TSeq > & **get\_user\_data** ()
- std::vector< epiworld\_double > **transition\_probability** (bool print=true) const  
*Calculates the transition probabilities.*

## Get recorded information from the model

### Parameters

what	<i>std::string, The status, e.g., 0, 1, 2, ...</i>
------	----------------------------------------------------

### Returns

*In **get\_today\_total**, the current counts of what.*

*In **get\_today\_variant**, the current counts of what for each variant.*

*In **get\_hist\_total**, the time series of what*

*In **get\_hist\_variant**, the time series of what for each variant.*

*In **get\_hist\_total\_date** and **get\_hist\_variant\_date** the corresponding dates*

- int **get\_today\_total** (std::string what) const
- int **get\_today\_total** (epiworld\_fast\_uint what) const
- void **get\_today\_total** (std::vector< std::string > \*status=nullptr, std::vector< int > \*counts=nullptr) const
- void **get\_today\_variant** (std::vector< std::string > &status, std::vector< int > &id, std::vector< int > &counts) const
- void **get\_hist\_total** (std::vector< int > \*date, std::vector< std::string > \*status, std::vector< int > \*counts) const
- void **get\_hist\_variant** (std::vector< int > &date, std::vector< int > &id, std::vector< std::string > &status, std::vector< int > &counts) const

- MapVec\_type< int, int > [reproductive\\_number](#) () const  
*Computes the reproductive number of each case.*
- void [reproductive\\_number](#) (std::string fn) const

## Friends

- class **Model**< TSeq >
- void **default\_add\_virus** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_add\_tool** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_rm\_virus** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_rm\_tool** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)

## 16.9.1 Detailed Description

```
template<typename TSeq>
class DataBase< TSeq >
```

Statistical data about the process.

### Template Parameters

<i>TSeq</i>	
-------------	--

## 16.9.2 Member Function Documentation

### 16.9.2.1 record\_variant()

```
template<typename TSeq >
void DataBase< TSeq >::record_variant (
    Virus< TSeq > & v ) [inline]
```

Registering a new variant.

### Parameters

<i>v</i>	Pointer to the new variant. Since variants are originated in the agent, the numbers simply move around. From the parent variant to the new variant. And the total number of infected does not change.
----------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

### 16.9.2.2 reproductive\_number()

```
template<typename TSeq >
MapVec_type< int, int > DataBase< TSeq >::reproductive_number [inline]
```

Computes the reproductive number of each case.

By definition, whereas it computes  $R_0$  (basic reproductive number) or  $R_t/R$  (the effective reproductive number) will depend on whether the virus is allowed to circulate naïvely or not, respectively.

#### Parameters

<i>fn</i>	File where to write out the reproductive number.
-----------	--------------------------------------------------

### 16.9.2.3 transition\_probability()

```
template<typename TSeq >
std::vector< epiworld_double > DataBase< TSeq >::transition_probability (
    bool print = true ) const [inline]
```

Calculates the transition probabilities.

#### Returns

std::vector< epiworld\_double >

The documentation for this class was generated from the following files:

- include/epiworld/database-bones.hpp
- include/epiworld/database-meat.hpp

## 16.10 epiworld::DataBase< TSeq > Class Template Reference

Statistical data about the process.

```
#include <epiworld.hpp>
```

### Public Member Functions

- **DataBase** ([Model](#)< TSeq > &m)
- void [record\\_variant](#) ([Virus](#)< TSeq > &v)  
*Registering a new variant.*
- void [record\\_tool](#) ([Tool](#)< TSeq > &t)
- void [set\\_seq\\_hasher](#) (std::function< std::vector< int >(TSeq)> fun)
- void [set\\_model](#) ([Model](#)< TSeq > &m)
- [Model](#)< TSeq > \* [get\\_model](#) ()
- void [record](#) ()
- const std::vector< TSeq > & [get\\_sequence](#) () const
- const std::vector< int > & [get\\_nexposed](#) () const
- size\_t [size](#) () const

- void **write\_data** (std::string fn\_variant\_info, std::string fn\_variant\_hist, std::string fn\_tool\_info, std::string fn\_tool\_hist, std::string fn\_total\_hist, std::string fn\_transmission, std::string fn\_transition, std::string fn\_reproductive\_number) const
- void **record\_transmission** (int i, int j, int variant, int i\_expo\_date)
- size\_t **get\_n\_variants** () const
- size\_t **get\_n\_tools** () const
- void **reset** ()
- void **set\_user\_data** (std::vector< std::string > names)
- void **add\_user\_data** (std::vector< epiworld\_double > x)
- void **add\_user\_data** (unsigned int j, epiworld\_double x)
- [UserData](#)< TSeq > & **get\_user\_data** ()
- std::vector< epiworld\_double > [transition\\_probability](#) (bool print=true) const  
*Calculates the transition probabilities.*
- **DataBase** (int freq=1)
- void [record\\_variant](#) ([Virus](#)< TSeq > \*v)  
*Registering a new variant.*
- void **set\_seq\_hasher** (std::function< std::vector< int >(TSeq)> fun)
- void **set\_model** ([Model](#)< TSeq > &m)
- [Model](#)< TSeq > \* **get\_model** ()
- void **record** ()
- const std::vector< TSeq > & **get\_sequence** () const
- const std::vector< int > & **get\_nexposed** () const
- size\_t **size** () const
- void **up\_exposed** ([Virus](#)< TSeq > \*v, epiworld\_fast\_uint new\_status)
- void **down\_exposed** ([Virus](#)< TSeq > \*v, epiworld\_fast\_uint prev\_status)
- void **state\_change** (epiworld\_fast\_uint prev\_status, epiworld\_fast\_uint new\_status)
- void **record\_transition** (epiworld\_fast\_uint from, epiworld\_fast\_uint to)
- int [get\\_today\\_total](#) (std::string what) const  
*Get recorded information from the model.*
- int **get\_today\_total** (epiworld\_fast\_uint what) const
- void **get\_today\_total** (std::vector< std::string > \*status=nullptr, std::vector< int > \*counts=nullptr) const
- void **get\_today\_variant** (std::vector< std::string > &status, std::vector< int > &id, std::vector< int > &counts) const
- void **get\_hist\_total** (std::vector< int > \*date, std::vector< std::string > \*status, std::vector< int > \*counts) const
- void **get\_hist\_variant** (std::vector< int > &date, std::vector< int > &id, std::vector< std::string > &status, std::vector< int > &counts) const
- void [write\\_data](#) (std::string fn\_variant\_info, std::string fn\_variant\_hist, std::string fn\_total\_hist, std::string fn\_transmission, std::string fn\_transition) const  
*@]*
- void **record\_transmission** (int i, int j, int variant)
- size\_t **get\_nvariants** () const
- void **reset** ()
- void **set\_user\_data** (std::vector< std::string > names)
- void **add\_user\_data** (std::vector< epiworld\_double > x)
- void **add\_user\_data** (unsigned int j, epiworld\_double x)
- [UserData](#)< TSeq > & **get\_user\_data** ()

#### Get recorded information from the model

##### Parameters

what	<i>std::string, The status, e.g., 0, 1, 2, ...</i>
------	----------------------------------------------------

**Returns**

*In `get_today_total`, the current counts of what.*

*In `get_today_variant`, the current counts of what for each variant.*

*In `get_hist_total`, the time series of what*

*In `get_hist_variant`, the time series of what for each variant.*

*In `get_hist_total_date` and `get_hist_variant_date` the corresponding dates*

- int **get\_today\_total** (std::string what) const
  - int **get\_today\_total** (epiworld\_fast\_uint what) const
  - void **get\_today\_total** (std::vector< std::string > \*status=nullptr, std::vector< int > \*counts=nullptr) const
  - void **get\_today\_variant** (std::vector< std::string > &status, std::vector< int > &id, std::vector< int > &counts) const
  - void **get\_hist\_total** (std::vector< int > \*date, std::vector< std::string > \*status, std::vector< int > \*counts) const
  - void **get\_hist\_variant** (std::vector< int > &date, std::vector< int > &id, std::vector< std::string > &status, std::vector< int > &counts) const
- 
- MapVec\_type< int, int > **reproductive\_number** () const  
*Computes the reproductive number of each case.*
  - void **reproductive\_number** (std::string fn) const

**Friends**

- class **Model**< TSeq >
- void **default\_add\_virus** (Action< TSeq > &a, Model< TSeq > \*m)
- void **default\_add\_tool** (Action< TSeq > &a, Model< TSeq > \*m)
- void **default\_rm\_virus** (Action< TSeq > &a, Model< TSeq > \*m)
- void **default\_rm\_tool** (Action< TSeq > &a, Model< TSeq > \*m)

**16.10.1 Detailed Description**

```
template<typename TSeq>
class epiworld::DataBase< TSeq >
```

Statistical data about the process.

**Template Parameters**

<i>TSeq</i>	
-------------	--

**16.10.2 Member Function Documentation**



**16.10.2.1 get\_today\_total()**

```
template<typename TSeq >
int epiworld::DataBase< TSeq >::get_today_total (
    std::string what ) const
```

Get recorded information from the model.

**Parameters**

<i>what</i>	std::string, The status, e.g., 0, 1, 2, ...
-------------	---------------------------------------------

**Returns**

In `get_today_total`, the current counts of `what`.

In `get_today_variant`, the current counts of `what` for each variant.

In `get_hist_total`, the time series of `what`

In `get_hist_variant`, the time series of `what` for each variant.

In `get_hist_total_date` and `get_hist_variant_date` the corresponding dates @[

**16.10.2.2 record\_variant() [1/2]**

```
template<typename TSeq >
void DataBase< TSeq >::record_variant (
    Virus< TSeq > & v ) [inline]
```

Registering a new variant.

**Parameters**

<i>v</i>	Pointer to the new variant. Since variants are originated in the agent, the numbers simply move around. From the parent variant to the new variant. And the total number of infected does not change.
----------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

**16.10.2.3 record\_variant() [2/2]**

```
template<typename TSeq >
void DataBase< TSeq >::record_variant (
    Virus< TSeq > * v ) [inline]
```

Registering a new variant.

**Parameters**

<i>v</i>	Pointer to the new variant. Since variants are originated in the host, the numbers simply move around. From the parent variant to the new variant. And the total number of infected does not change.
----------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

#### 16.10.2.4 reproductive\_number()

```
template<typename TSeq >
MapVec_type< int, int > DataBase< TSeq >::reproductive_number [inline]
```

Computes the reproductive number of each case.

By definition, whereas it computes  $R_0$  (basic reproductive number) or  $R_t/R$  (the effective reproductive number) will depend on whether the virus is allowed to circulate naïvely or not, respectively.

##### Parameters

<i>fn</i>	File where to write out the reproductive number.
-----------	--------------------------------------------------

#### 16.10.2.5 transition\_probability()

```
template<typename TSeq >
std::vector< epiworld_double > DataBase< TSeq >::transition_probability (
    bool print = true ) const [inline]
```

Calculates the transition probabilities.

##### Returns

`std::vector< epiworld_double >`

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.11 Entities< TSeq > Class Template Reference

Set of [Entities](#) (useful for building iterators)

```
#include <entities-bones.hpp>
```

### Public Member Functions

- **Entities** ([Agent](#)< TSeq > &p)
- `std::vector< Entity< TSeq > * >::iterator` **begin** ()
- `std::vector< Entity< TSeq > * >::iterator` **end** ()
- [Entity](#)< TSeq > \*& **operator**() (size\_t i)
- [Entity](#)< TSeq > \*& **operator**[] (size\_t i)
- size\_t **size** () const noexcept

## Friends

- class **Entity**< TSeq >
- class **Agent**< TSeq >

### 16.11.1 Detailed Description

```
template<typename TSeq>
class Entities< TSeq >
```

Set of [Entities](#) (useful for building iterators)

Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following files:

- include/epiworld/agent-bones.hpp
- include/epiworld/entities-bones.hpp

## 16.12 epiworld::Entities< TSeq > Class Template Reference

Set of [Entities](#) (useful for building iterators)

```
#include <epiworld.hpp>
```

## Public Member Functions

- **Entities** ([Agent](#)< TSeq > &p)
- std::vector< [Entity](#)< TSeq > \* >::iterator **begin** ()
- std::vector< [Entity](#)< TSeq > \* >::iterator **end** ()
- [Entity](#)< TSeq > \*& **operator**() (size\_t i)
- [Entity](#)< TSeq > \*& **operator[]** (size\_t i)
- size\_t **size** () const noexcept

## Friends

- class **Entity**< TSeq >
- class **Agent**< TSeq >

### 16.12.1 Detailed Description

```
template<typename TSeq>
class epiworld::Entities< TSeq >
```

Set of [Entities](#) (useful for building iterators)

## Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.13 Entities\_const< TSeq > Class Template Reference

Set of [Entities](#) (const) (useful for iterators)

```
#include <entities-bones.hpp>
```

### Public Member Functions

- **Entities\_const** (const [Agent](#)< TSeq > &p)
- std::vector< [Entity](#)< TSeq > \* >::const\_iterator **begin** ()
- std::vector< [Entity](#)< TSeq > \* >::const\_iterator **end** ()
- const [Entity](#)< TSeq > \*& **operator()** (size\_t i)
- const [Entity](#)< TSeq > \*& **operator[]** (size\_t i)
- size\_t **size** () const noexcept

### Friends

- class **Virus**< TSeq >
- class **Agent**< TSeq >

### 16.13.1 Detailed Description

```
template<typename TSeq>
class Entities_const< TSeq >
```

Set of [Entities](#) (const) (useful for iterators)

## Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following file:

- include/epiworld/entities-bones.hpp

## 16.14 epiworld::Entities\_const< TSeq > Class Template Reference

Set of [Entities](#) (const) (useful for iterators)

```
#include <epiworld.hpp>
```

### Public Member Functions

- **Entities\_const** (const [Agent](#)< TSeq > &p)
- std::vector< [Entity](#)< TSeq > \* >::const\_iterator **begin** ()
- std::vector< [Entity](#)< TSeq > \* >::const\_iterator **end** ()
- const [Entity](#)< TSeq > \*& **operator**() (size\_t i)
- const [Entity](#)< TSeq > \*& **operator**[] (size\_t i)
- size\_t **size** () const noexcept

### Friends

- class **Virus**< TSeq >
- class **Agent**< TSeq >

#### 16.14.1 Detailed Description

```
template<typename TSeq>
class epiworld::Entities_const< TSeq >
```

Set of [Entities](#) (const) (useful for iterators)

Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.15 Entity< TSeq > Class Template Reference

### Public Member Functions

- **Entity** (std::string name)
- void **add\_agent** ([Agent](#)< TSeq > &p)
- void **add\_agent** ([Agent](#)< TSeq > \*p)
- void **rm\_agent** (size\_t idx)
- size\_t **size** () const noexcept
- void **set\_location** (std::vector< epiworld\_double > loc)
- std::vector< epiworld\_double > & **get\_location** ()

- `std::vector< Agent< TSeq > * >::iterator begin ()`
- `std::vector< Agent< TSeq > * >::iterator end ()`
- `std::vector< Agent< TSeq > * >::const_iterator begin () const`
- `std::vector< Agent< TSeq > * >::const_iterator end () const`
- `Agent< TSeq > * operator[] (size_t i)`
- `int get_id () const noexcept`
- `const std::string & get_name () const noexcept`
- `void set_status (epiworld_fast_int init, epiworld_fast_int post)`
- `void set_queue (epiworld_fast_int init, epiworld_fast_int post)`
- `void get_status (epiworld_fast_int *init, epiworld_fast_int *post)`
- `void get_queue (epiworld_fast_int *init, epiworld_fast_int *post)`

## Friends

- `class Agent< TSeq >`
- `class AgentsSample< TSeq >`
- `class Model< TSeq >`
- `void default_add_entity (Action< TSeq > &a, Model< TSeq > *m)`
- `void default_rm_entity (Action< TSeq > &a, Model< TSeq > *m)`

The documentation for this class was generated from the following files:

- `include/epiworld/agent-bones.hpp`
- `include/epiworld/entity-bones.hpp`
- `include/epiworld/entity-meat.hpp`

## 16.16 epiworld::Entity< TSeq > Class Template Reference

### Public Member Functions

- `Entity (std::string name)`
- `void add_agent (Agent< TSeq > &p)`
- `void add_agent (Agent< TSeq > *p)`
- `void rm_agent (size_t idx)`
- `size_t size () const noexcept`
- `void set_location (std::vector< epiworld_double > loc)`
- `std::vector< epiworld_double > & get_location ()`
- `std::vector< Agent< TSeq > * >::iterator begin ()`
- `std::vector< Agent< TSeq > * >::iterator end ()`
- `std::vector< Agent< TSeq > * >::const_iterator begin () const`
- `std::vector< Agent< TSeq > * >::const_iterator end () const`
- `Agent< TSeq > * operator[] (size_t i)`
- `int get_id () const noexcept`
- `const std::string & get_name () const noexcept`
- `void set_status (epiworld_fast_int init, epiworld_fast_int post)`
- `void set_queue (epiworld_fast_int init, epiworld_fast_int post)`
- `void get_status (epiworld_fast_int *init, epiworld_fast_int *post)`
- `void get_queue (epiworld_fast_int *init, epiworld_fast_int *post)`

## Friends

- class **Agent**< TSeq >
- class **AgentsSample**< TSeq >
- class **Model**< TSeq >
- void **default\_add\_entity** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_rm\_entity** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.17 epiworld::LFMCMC< TData > Class Template Reference

Likelihood-Free Markov Chain Monte Carlo.

```
#include <epiworld.hpp>
```

## Public Member Functions

- void **run** (std::vector< epiworld\_double > param\_init, size\_t n\_samples\_, epiworld\_double epsilon\_)
- **LFMCMC** (TData &observed\_data\_)
- void **set\_observed\_data** (TData &observed\_data\_)
- void **set\_proposal\_fun** (LFMCMCProposalFun< TData > fun)
- void **set\_simulation\_fun** (LFMCMCSimFun< TData > fun)
- void **set\_summary\_fun** (LFMCMCSummaryFun< TData > fun)
- void **set\_kernel\_fun** (LFMCMCKernelFun< TData > fun)
- const size\_t **get\_n\_samples** ()
- const size\_t **get\_n\_statistics** ()
- const size\_t **get\_n\_parameters** ()
- const epiworld\_double **get\_epsilon** ()
- const std::vector< epiworld\_double > & **get\_params\_now** ()
- const std::vector< epiworld\_double > & **get\_params\_prev** ()
- const std::vector< epiworld\_double > & **get\_params\_init** ()
- const std::vector< epiworld\_double > & **get\_statistics\_obs** ()
- const std::vector< epiworld\_double > & **get\_statistics\_hist** ()
- const std::vector< bool > & **get\_statistics\_accepted** ()
- const std::vector< epiworld\_double > & **get\_posterior\_if\_prob** ()
- const std::vector< epiworld\_double > & **get\_drawn\_prob** ()
- std::vector< TData > \* **get\_sampled\_data** ()
- void **set\_par\_names** (std::vector< std::string > names)
- void **set\_stats\_names** (std::vector< std::string > names)
- void **print** ()

## Random number generation

### Parameters

eng	
-----	--

- void **set\_rand\_engine** (std::mt19937 &eng)
- std::mt19937 \* **get\_rand\_engine** ()
- void **seed** (unsigned int s)
- void **set\_rand\_gamma** (epiworld\_double alpha, epiworld\_double beta)
- epiworld\_double **runif** ()
- epiworld\_double **rnorm** ()
- epiworld\_double **rgamma** ()
- epiworld\_double **runif** (epiworld\_double lb, epiworld\_double ub)
- epiworld\_double **rnorm** (epiworld\_double mean, epiworld\_double sd)
- epiworld\_double **rgamma** (epiworld\_double alpha, epiworld\_double beta)

### 16.17.1 Detailed Description

```
template<typename TData>
class epiworld::LFMCMC< TData >
```

Likelihood-Free Markov Chain Monte Carlo.

Template Parameters

<i>TData</i>	Type of data that is generated
--------------	--------------------------------

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.18 LFMCMC< TData > Class Template Reference

Likelihood-Free Markov Chain Monte Carlo.

```
#include <lfmcmc-bones.hpp>
```

### Public Member Functions

- void **run** (std::vector< epiworld\_double > param\_init, size\_t n\_samples\_, epiworld\_double epsilon\_)
- **LFMCMC** (TData &observed\_data\_)
- void **set\_observed\_data** (TData &observed\_data\_)
- void **set\_proposal\_fun** (LFMCMCProposalFun< TData > fun)
- void **set\_simulation\_fun** (LFMCMCSimFun< TData > fun)
- void **set\_summary\_fun** (LFMCMCSummaryFun< TData > fun)
- void **set\_kernel\_fun** (LFMCMCKernelFun< TData > fun)
- const size\_t **get\_n\_samples** ()
- const size\_t **get\_n\_statistics** ()
- const size\_t **get\_n\_parameters** ()
- const epiworld\_double **get\_epsilon** ()
- const std::vector< epiworld\_double > & **get\_params\_now** ()
- const std::vector< epiworld\_double > & **get\_params\_prev** ()
- const std::vector< epiworld\_double > & **get\_params\_init** ()
- const std::vector< epiworld\_double > & **get\_statistics\_obs** ()



- const std::vector< epiworld\_double > & **get\_statistics\_hist** ()
- const std::vector< bool > & **get\_statistics\_accepted** ()
- const std::vector< epiworld\_double > & **get\_posterior\_if\_prob** ()
- const std::vector< epiworld\_double > & **get\_drawn\_prob** ()
- std::vector< TData > \* **get\_sampled\_data** ()
- void **set\_par\_names** (std::vector< std::string > names)
- void **set\_stats\_names** (std::vector< std::string > names)
- void **print** ()

### Random number generation

#### Parameters

eng	
-----	--

- void **set\_rand\_engine** (std::mt19937 &eng)
- std::mt19937 \* **get\_rand\_engine** ()
- void **seed** (unsigned int s)
- void **set\_rand\_gamma** (epiworld\_double alpha, epiworld\_double beta)
- epiworld\_double **runif** ()
- epiworld\_double **rnorm** ()
- epiworld\_double **rgamma** ()
- epiworld\_double **runif** (epiworld\_double lb, epiworld\_double ub)
- epiworld\_double **rnorm** (epiworld\_double mean, epiworld\_double sd)
- epiworld\_double **rgamma** (epiworld\_double alpha, epiworld\_double beta)

### 16.18.1 Detailed Description

```
template<typename TData>
class LFMCMC< TData >
```

Likelihood-Free Markov Chain Monte Carlo.

#### Template Parameters

<i>TData</i>	Type of data that is generated
--------------	--------------------------------

The documentation for this class was generated from the following files:

- include/epiworld/math/lfmcmc/lfmcmc-bones.hpp
- include/epiworld/math/lfmcmc/lfmcmc-meat-print.hpp
- include/epiworld/math/lfmcmc/lfmcmc-meat.hpp

## 16.19 epiworld::Model< TSeq > Class Template Reference

Core class of epiworld.

```
#include <epiworld.hpp>
```

## Public Member Functions

- [DataBase](#)< TSeq > & **get\_db** ()
  - epiworld\_double & **operator()** (std::string pname)
  - size\_t **size** () const
  - size\_t **get\_n\_variants** () const
  - size\_t **get\_n\_tools** () const
  - unsigned int **get\_ndays** () const
  - unsigned int **get\_n\_replicates** () const
  - void **set\_ndays** (unsigned int ndays)
  - bool **get\_verbose** () const
  - void **verbose\_off** ()
  - void **verbose\_on** ()
  - int [today](#) () const
- The current time of the model.*
- void [write\\_data](#) (std::string fn\_variant\_info, std::string fn\_variant\_hist, std::string fn\_tool\_info, std::string fn↵  
\_tool\_hist, std::string fn\_total\_hist, std::string fn\_transmission, std::string fn\_transition, std::string fn↵  
reproductive\_number) const
- Wrapper of DataBase::write\_data*
- std::map< std::string, epiworld\_double > & **params** ()
  - void [reset](#) ()
- Reset the model.*
- void **print** () const
  - [Model](#)< TSeq > && **clone** () const
  - void **get\_elapsed** (std::string unit="auto", epiworld\_double \*last\_elapsed=nullptr, epiworld\_double \*total↵  
elapsed=nullptr, std::string \*unit\_abbr=nullptr, bool print=true) const
  - void [add\\_global\\_action](#) (std::function< void([Model](#)< TSeq > \*)> fun, int date=-99)
- Set a global action.*
- void **run\_global\_actions** ()
  - void **clear\_status\_set** ()
  - const std::vector< VirusPtr< TSeq > > & **get\_viruses** () const
  - const std::vector< ToolPtr< TSeq > > & **get\_tools** () const
  - void [set\\_agents\\_data](#) (double \*data\_, size\_t ncols\_)
- Set the agents data object.*
- void [set\\_name](#) (std::string name)
- Set the name object.*
- **Model** (const [Model](#)< TSeq > &m)
  - **Model** ([Model](#)< TSeq > &&m)
  - [Model](#)< TSeq > & **operator=** (const [Model](#)< TSeq > &m)
  - void **clone\_population** (std::vector< [Person](#)< TSeq > > &p, std::map< int, int > &p\_ids, bool &d, [Model](#)< TSeq > \*m=nullptr) const
  - void **clone\_population** (const [Model](#)< TSeq > &m)
  - void [set\\_backup](#) ()
- Set the backup object.*
- void **restore\_backup** ()
  - [DataBase](#)< TSeq > & [get\\_db](#) ()
- @]
- epiworld\_double & **operator()** (std::string pname)
  - size\_t **size** () const
  - void [set\\_rand\\_engine](#) (std::mt19937 &eng)
- Random number generation.*
- std::mt19937 \* **get\_rand\_engine** ()
  - void **seed** (unsigned int s)
  - void **set\_rand\_gamma** (epiworld\_double alpha, epiworld\_double beta)

- epiworld\_double **runif** ()
- epiworld\_double **rnorm** ()
- epiworld\_double **rnorm** (epiworld\_double mean, epiworld\_double sd)
- epiworld\_double **rgamma** ()
- epiworld\_double **rgamma** (epiworld\_double alpha, epiworld\_double beta)
- void **add\_virus** ([Virus](#)< TSeq > v, epiworld\_double preval)
- @]
- void **add\_virus\_n** ([Virus](#)< TSeq > v, unsigned int preval)
- void **add\_tool** ([Tool](#)< TSeq > t, epiworld\_double preval)
- void **add\_tool\_n** ([Tool](#)< TSeq > t, unsigned int preval)
- void **pop\_from\_adjlist** (std::string fn, int skip=0, bool directed=false, int min\_id=-1, int max\_id=-1)
- Accessing population of the model.*
- void **pop\_from\_adjlist** ([AdjList](#) al)
- bool **is\_directed** () const
- std::vector< [Person](#)< TSeq > > \* **get\_population** ()
- void **pop\_from\_random** (unsigned int n=1000, unsigned int k=5, bool d=false, epiworld\_double p=.01)
- void **init** (unsigned int ndays, unsigned int seed)
- @]
- void **update\_status** ()
- void **mutate\_variant** ()
- void **next** ()
- void **run** ()
- void **run\_multiple** (unsigned int nexperiments, std::function< void([Model](#)< TSeq > \*)> fun, bool [reset](#), bool verbose)
- void **record\_variant** ([Virus](#)< TSeq > \*v)
- @]
- int **get\_nvariants** () const
- unsigned int **get\_ndays** () const
- void **set\_ndays** (unsigned int ndays)
- bool **get\_verbose** () const
- void **verbose\_off** ()
- void **verbose\_on** ()
- int **today** () const
- void **set\_rewire\_fun** (std::function< void(std::vector< [Person](#)< TSeq > > \*, [Model](#)< TSeq > \*, epiworld\_double)> fun)
- Rewire the network preserving the degree sequence.*
- void **set\_rewire\_prop** (epiworld\_double prop)
- epiworld\_double **get\_rewire\_prop** () const
- void **rewire** ()
- void **set\_update\_susceptible** (UpdateFun< TSeq > fun)
- @]
- void **set\_update\_exposed** (UpdateFun< TSeq > fun)
- void **set\_update\_removed** (UpdateFun< TSeq > fun)
- void **write\_data** (std::string fn\_variant\_info, std::string fn\_variant\_hist, std::string fn\_total\_hist, std::string fn\_transmission, std::string fn\_transition) const
- Wrapper of DataBase::write\_data*
- void **write\_edgelist** (std::string fn) const
- Export the network data in edgelist form.*
- void **write\_edgelist** (std::vector< unsigned int > &source, std::vector< unsigned int > &target) const
- std::map< std::string, epiworld\_double > & **params** ()
- @]
- void **reset** ()
- Reset the model.*

- void **print** () const
- [Model](#)< TSeq > && **clone** () const
- void [add\\_status\\_susceptible](#) (epiworld\_fast\_uint s, std::string lab)
 

*Adds extra statuses to the model.*
- void **add\_status\_exposed** (epiworld\_fast\_uint s, std::string lab)
- void **add\_status\_removed** (epiworld\_fast\_uint s, std::string lab)
- void **add\_status\_susceptible** (std::string lab)
- void **add\_status\_exposed** (std::string lab)
- void **add\_status\_removed** (std::string lab)
- const std::vector< epiworld\_fast\_uint > & **get\_status\_susceptible** () const
- const std::vector< epiworld\_fast\_uint > & **get\_status\_exposed** () const
- const std::vector< epiworld\_fast\_uint > & **get\_status\_removed** () const
- const std::vector< std::string > & **get\_status\_susceptible\_labels** () const
- const std::vector< std::string > & **get\_status\_exposed\_labels** () const
- const std::vector< std::string > & **get\_status\_removed\_labels** () const
- void **print\_status\_codes** () const
- epiworld\_fast\_uint **get\_default\_susceptible** () const
- epiworld\_fast\_uint **get\_default\_exposed** () const
- epiworld\_fast\_uint **get\_default\_removed** () const
- void [reset\\_status\\_codes](#) (std::vector< epiworld\_fast\_uint > codes, std::vector< std::string > names, bool verbose=true)
- @]
- epiworld\_double [add\\_param](#) (epiworld\_double initial\_val, std::string pname)
 

*Setting and accessing parameters from the model.*
- epiworld\_double **set\_param** (std::string pname)
- epiworld\_double **get\_param** (unsigned int k)
- epiworld\_double **get\_param** (std::string pname)
- epiworld\_double **par** (unsigned int k)
- epiworld\_double **par** (std::string pname)
- void [get\\_elapsed](#) (std::string unit="auto", epiworld\_double \*last\_elapsed=nullptr, epiworld\_double \*total\_↵ elapsed=nullptr, unsigned int \*n\_replicates=nullptr, std::string \*unit\_abbr=nullptr, bool print=true) const
- @]
- void [set\\_user\\_data](#) (std::vector< std::string > names)
 

*Set the user data object.*
- void **add\_user\_data** (unsigned int j, epiworld\_double x)
- void **add\_user\_data** (std::vector< epiworld\_double > x)
- [UserData](#)< TSeq > & **get\_user\_data** ()
- void [add\\_global\\_action](#) (std::function< void([Model](#)< TSeq > \*)> fun, int date)
- @]
- void **run\_global\_actions** ()
- void **clear\_status\_set** ()
- void **toggle\_visited** ()
- void **queuing\_on** ()
- void **queuing\_off** ()
- bool **is\_queuing\_on** () const
- [Queue](#)< TSeq > & **get\_queue** ()

### Set the backup object

*backup* can be used to restore the entire object after a run. This can be useful if the user wishes to have individuals start with the same network from the beginning.

- void **set\_backup** ()
- void **restore\_backup** ()

### Random number generation

## Parameters

eng	<i>Random number generator</i>
s	<i>Seed</i>

- void **set\_rand\_engine** (std::mt19937 &eng)
- std::mt19937 \* **get\_rand\_engine** ()
- void **seed** (unsigned int s)
- void **set\_rand\_norm** (epiworld\_double mean, epiworld\_double sd)
- void **set\_rand\_unif** (epiworld\_double a, epiworld\_double b)
- void **set\_rand\_exp** (epiworld\_double lambda)
- void **set\_rand\_gamma** (epiworld\_double alpha, epiworld\_double beta)
- void **set\_rand\_lognormal** (epiworld\_double mean, epiworld\_double shape)
- epiworld\_double **runif** ()
- epiworld\_double **runif** (epiworld\_double a, epiworld\_double b)
- epiworld\_double **rnorm** ()
- epiworld\_double **rnorm** (epiworld\_double mean, epiworld\_double sd)
- epiworld\_double **rgamma** ()
- epiworld\_double **rgamma** (epiworld\_double alpha, epiworld\_double beta)
- epiworld\_double **rexp** ()
- epiworld\_double **rexp** (epiworld\_double lambda)
- epiworld\_double **rlognormal** ()
- epiworld\_double **rlognormal** (epiworld\_double mean, epiworld\_double shape)

**Add Virus/Tool to the model**

*This is done before the model has been initialized.*

## Parameters

v	<i><a href="#">Virus</a> to be added</i>
t	<i><a href="#">Tool</a> to be added</i>
preval	<i>Initial prevalence (initial state.) It can be specified as a proportion (between zero and one,) or an integer indicating number of individuals.</i>

- void **add\_virus** ([Virus](#)< TSeq > v, epiworld\_double preval)
- void **add\_virus\_n** ([Virus](#)< TSeq > v, unsigned int preval)
- void **add\_virus\_fun** ([Virus](#)< TSeq > v, VirusToAgentFun< TSeq > fun)
- void **add\_tool** ([Tool](#)< TSeq > t, epiworld\_double preval)
- void **add\_tool\_n** ([Tool](#)< TSeq > t, unsigned int preval)
- void **add\_tool\_fun** ([Tool](#)< TSeq > t, ToolToAgentFun< TSeq > fun)
- void **add\_entity** ([Entity](#)< TSeq > e, epiworld\_double preval)
- void **add\_entity\_n** ([Entity](#)< TSeq > e, unsigned int preval)
- void **add\_entity\_fun** ([Entity](#)< TSeq > e, EntityToAgentFun< TSeq > fun)

**Accessing population of the model**

## Parameters

fn	<i>std::string Filename of the edgelist file.</i>
skip	<i>int Number of lines to skip in fn.</i>
directed	<i>bool Whether the graph is directed or not.</i>
size	<i>Size of the network.</i>
al	<i><a href="#">AdjList</a> to read into the model.</i>

- void **agents\_from\_adjlist** (std::string fn, int size, int skip=0, bool directed=false)
- void **agents\_from\_adjlist** ([AdjList](#) al)
- bool **is\_directed** () const
- std::vector< [Agent](#)< TSeq > > \* **get\_agents** ()
- void **agents\_smallworld** (unsigned int n=1000, unsigned int k=5, bool d=false, epiworld\_double p=.01)
- void **agents\_empty\_graph** (unsigned int n=1000)

### Functions to run the model

#### Parameters

seed	<i>Seed to be used for Pseudo-RNG.</i>
ndays	<i>Number of days (steps) of the simulation.</i>
fun	<i>In the case of <code>run_multiple</code>, a function that is called after each experiment.</i>

- void **init** (unsigned int ndays, unsigned int seed)
  - void **update\_status** ()
  - void **mutate\_variant** ()
  - void **next** ()
  - void **run** ()
- Runs the simulation (after initialization)*
- void **run\_multiple** (unsigned int nexperiments, std::function< void(size\_t, [Model](#)< TSeq > \*)> fun=make\_save\_run< TSeq >(), bool **reset**=true, bool verbose=true)

### Rewire the network preserving the degree sequence.

*This implementation assumes an undirected network, thus if  $\{(i,j), (k,l)\} \rightarrow \{(i,l), (k,j)\}$ , the reciprocal is also true, i.e.,  $\{(j,i), (l,k)\} \rightarrow \{(j,k), (l,i)\}$ .*

#### Parameters

proportion	<i>Proportion of ties to be rewired.</i>
------------	------------------------------------------

#### Returns

*A rewired version of the network.*

- void **set\_rewire\_fun** (std::function< void(std::vector< [Agent](#)< TSeq > > \*, [Model](#)< TSeq > \*, epiworld\_double)> fun)
- void **set\_rewire\_prop** (epiworld\_double prop)
- epiworld\_double **get\_rewire\_prop** () const
- void **rewire** ()

### Export the network data in edgelist form

#### Parameters

fn	<i>std::string. File name.</i>
source	<i>Integer vector</i>
target	<i>Integer vector</i>

*When passing the source and target, the function will write the edgelist on those.*

- void **write\_edgelist** (std::string fn) const
- void **write\_edgelist** (std::vector< unsigned int > &source, std::vector< unsigned int > &target) const

### Manage status (states) in the model

The functions `get_status` return the current values for the statuses included in the model.

#### Parameters

lab	<code>std::string</code> Name of the status.
-----	----------------------------------------------

#### Returns

`add_status*` returns nothing.  
`get_status*` returns a vector of pairs with the statuses and their labels.

- void **add\_status** (std::string lab, UpdateFun< TSeq > fun=nullptr)
- const std::vector< std::string > & **get\_status** () const
- const std::vector< UpdateFun< TSeq > > & **get\_status\_fun** () const
- void **print\_status\_codes** () const

### Set the user data object

#### Parameters

names	string vector with the names of the variables.
-------	------------------------------------------------

- void **set\_user\_data** (std::vector< std::string > names)  
     [@]
- void **add\_user\_data** (unsigned int j, epiworld\_double x)
- void **add\_user\_data** (std::vector< epiworld\_double > x)
- `UserData< TSeq >` & **get\_user\_data** ()

### Queuing system

When queuing is on, the model will keep track of which agents are either in risk of exposure or exposed. This then is used at each step to act only on the aforementioned agents.

- void **queuing\_on** ()  
     Activates the queuing system (default.)
- void **queuing\_off** ()  
     Deactivates the queuing system.
- bool **is\_queuing\_on** () const  
     Query if the queuing system is on.
- `Queue< TSeq >` & **get\_queue** ()  
     Retrieve the `Queue` object.

### Get the susceptibility reduction object

#### Parameters

v	
---	--

#### Returns

`epiworld_double`

- void **set\_susceptibility\_reduction\_mixer** (MixerFun< TSeq > fun)
- void **set\_transmission\_reduction\_mixer** (MixerFun< TSeq > fun)
- void **set\_recovery\_enhancer\_mixer** (MixerFun< TSeq > fun)

- void **set\_death\_reduction\_mixer** (MixerFun< TSeq > fun)

## Friends

- class **Agent**< TSeq >
- class **AgentsSample**< TSeq >
- class **DataBase**< TSeq >
- class **Queue**< TSeq >
- class **Person**< TSeq >

## Tool Mixers

These functions combine the effects tools have to deliver a single effect. For example, wearing a mask, been vaccinated, and the immune system combine together to jointly reduce the susceptibility for a given virus.

- std::vector< epiworld\_double > **array\_double\_tmp**
- std::vector< [Virus](#)< TSeq > \* > **array\_virus\_tmp**
- **Model** ()
- **Model** (const [Model](#)< TSeq > &m)
- **Model** ([Model](#)< TSeq > &&m)
- [Model](#)< TSeq > & **operator=** (const [Model](#)< TSeq > &m)
- void **clone\_population** (std::vector< [Agent](#)< TSeq > > &p, bool &d, [Model](#)< TSeq > \*m=nullptr) const
- void **clone\_population** (const [Model](#)< TSeq > &m)

## Setting and accessing parameters from the model

[Tools](#) can incorporate parameters included in the model. Internally, parameters in the tool are stored as pointers to an std::map<> of parameters in the model. Using the `unsigned int` method directly fetches the parameters in the order these were added to the tool. Accessing parameters via the `std::string` method involves searching the parameter directly in the std::map<> member of the model (so it is not recommended.)

The `par()` function members are aliases for `get_param()`.

In the case of the function `read_params`, users can pass a file listing parameters to be included in the model. Each line in the file should have the following structure:

```
[name of parameter 1]: [value in double]
[name of parameter 2]: [value in double]
...
```

The only condition for parameter names is that these do not include a colon.

### Parameters

<i>initial_val</i>	
<i>pname</i>	Name of the parameter to add or to fetch
<i>fn</i>	Path to the file containing parameters

### Returns

The current value of the parameter in the model.



- epiworld\_double \* **p0**
- epiworld\_double \* **p1**
- epiworld\_double \* **p2**
- epiworld\_double \* **p3**
- epiworld\_double \* **p4**
- epiworld\_double \* **p5**
- epiworld\_double \* **p6**
- epiworld\_double \* **p7**
- epiworld\_double \* **p8**
- epiworld\_double \* **p9**
- epiworld\_double \* **p10**
- epiworld\_double \* **p11**
- epiworld\_double \* **p12**
- epiworld\_double \* **p13**
- epiworld\_double \* **p14**
- epiworld\_double \* **p15**
- epiworld\_double \* **p16**
- epiworld\_double \* **p17**
- epiworld\_double \* **p18**
- epiworld\_double \* **p19**
- epiworld\_double \* **p20**
- epiworld\_double \* **p21**
- epiworld\_double \* **p22**
- epiworld\_double \* **p23**
- epiworld\_double \* **p24**
- epiworld\_double \* **p25**
- epiworld\_double \* **p26**
- epiworld\_double \* **p27**
- epiworld\_double \* **p28**
- epiworld\_double \* **p29**
- epiworld\_double \* **p30**
- epiworld\_double \* **p31**
- epiworld\_double \* **p32**
- epiworld\_double \* **p33**
- epiworld\_double \* **p34**
- epiworld\_double \* **p35**
- epiworld\_double \* **p36**
- epiworld\_double \* **p37**
- epiworld\_double \* **p38**
- epiworld\_double \* **p39**
- unsigned int **npar\_used** = 0u
- epiworld\_double **add\_param** (epiworld\_double initial\_val, std::string pname)
- void **read\_params** (std::string fn)
- epiworld\_double **get\_param** (unsigned int k)
- epiworld\_double **get\_param** (std::string pname)
- epiworld\_double **par** (unsigned int k)
- epiworld\_double **par** (std::string pname)

### 16.19.1 Detailed Description

```
template<typename TSeq = bool>
class epiworld::Model< TSeq >
```

Core class of epiworld.

The model class provides the wrapper that puts together [Agent](#), [Virus](#), and [Tools](#).

## Template Parameters

<i>TSeq</i>	Type of sequence. In principle, users can build models in which virus and human sequence is represented as numeric vectors (if needed.)
-------------	-----------------------------------------------------------------------------------------------------------------------------------------

## 16.19.2 Member Function Documentation

### 16.19.2.1 add\_global\_action()

```
template<typename TSeq >
void Model< TSeq >::add_global_action (
    std::function< void(Model< TSeq > *)> fun,
    int date = -99 ) [inline]
```

Set a global action.

## Parameters

<i>fun</i>	A function to be called on the prescribed dates
<i>date</i>	Integer indicating when the function is called (see details)

When date is less than zero, then the function is called at the end of every day. Otherwise, the function will be called only at the end of the indicated date.

### 16.19.2.2 add\_param()

```
template<typename TSeq = bool>
epiworld_double epiworld::Model< TSeq >::add_param (
    epiworld_double initial_val,
    std::string pname )
```

Setting and accessing parameters from the model.

**Tools** can incorporate parameters included in the model. Internally, parameters in the tool are stored as pointers to an `std::map<>` of parameters in the model. Using the `unsigned int` method directly fetches the parameters in the order these were added to the tool. Accessing parameters via the `std::string` method involves searching the parameter directly in the `std::map<>` member of the model (so it is not recommended.)

The function `set_param()` can be used when the parameter already exists in the model.

The `par()` function members are aliases for `get_param()`.

## Parameters

<i>initial_val</i>	
<i>pname</i>	Name of the parameter to add or to fetch

**Returns**

The current value of the parameter in the model. @

**16.19.2.3 add\_status\_susceptible()**

```
template<typename TSeq >
void Model< TSeq >::add_status_susceptible (
    epiworld_fast_uint s,
    std::string lab ) [inline]
```

Adds extra statuses to the model.

Adding values of *s* that are already present in the model will result in an error.

The functions `get_status_*` return the current values for the statuses included in the model.

**Parameters**

<i>s</i>	unsigned int Code of the status
<i>lab</i>	std::string Name of the status.

**Returns**

`add_status*` returns nothing.

`get_status_*` returns a vector of pairs with the statuses and their labels. @

**16.19.2.4 init()**

```
template<typename TSeq = bool>
void epiworld::Model< TSeq >::init (
    unsigned int ndays,
    unsigned int seed )
```

@

Functions to run the model

**Parameters**

<i>seed</i>	Seed to be used for Pseudo-RNG.
<i>ndays</i>	Number of days (steps) of the simulation.
<i>fun</i>	In the case of <code>run_multiple</code> , a function that is called after each experiment. @

### 16.19.2.5 pop\_from\_adjlist()

```
template<typename TSeq >
void Model< TSeq >::pop_from_adjlist (
    std::string fn,
    int skip = 0,
    bool directed = false,
    int min_id = -1,
    int max_id = -1 ) [inline]
```

Accessing population of the model.

#### Parameters

<i>fn</i>	std::string Filename of the edgelist file.
<i>skip</i>	int Number of lines to skip in fn.
<i>directed</i>	bool Whether the graph is directed or not.
<i>min_id</i>	int Minimum id number (if negative, the program will try to guess from the data.)
<i>max_id</i>	int Maximum id number (if negative, the program will try to guess from the data.)
<i>al</i>	<a href="#">AdjList</a> to read into the model. @[

### 16.19.2.6 reset() [1/2]

```
template<typename TSeq >
void Model< TSeq >::reset [inline]
```

Reset the model.

Resetting the model will:

- clear the database
- restore the population (if `set_backup()` was called before)
- re-distribute tools
- re-distribute viruses
- set the date to 0

**16.19.2.7 reset()** [2/2]

```
template<typename TSeq = bool>
void epiworld::Model< TSeq >::reset ( )
```

Reset the model.

Resetting the model will:

- clear the database
- restore the population (if `set_backup()` was called before)
- re-distribute tools
- re-distribute viruses
- set the date to 0

**16.19.2.8 reset\_status\_codes()**

```
template<typename TSeq >
void Model< TSeq >::reset_status_codes (
    std::vector< epiworld_fast_uint > codes,
    std::vector< std::string > names,
    bool verbose = true ) [inline]
```

@]

Reset all the status codes of the model

The default values are those specified in the enum STATUS.

**Parameters**

<i>codes</i>	In the following order: Susceptible, Infected, Removed
<i>names</i>	Names matching the codes
<i>verbose</i>	When <code>true</code> , it will print the new mappings.

**16.19.2.9 run\_multiple()**

```
template<typename TSeq >
void Model< TSeq >::run_multiple (
    unsigned int n_experiments,
    std::function< void(size_t, Model< TSeq > *)> fun = make_save_run<TSeq>(),
    bool reset = true,
    bool verbose = true ) [inline]
```

## Parameters

<i>nexperiments</i>	Multiple runs of the simulation
---------------------	---------------------------------

**16.19.2.10 set\_agents\_data()**

```
template<typename TSeq >
void Model< TSeq >::set_agents_data (
    double * data_,
    size_t ncols_ ) [inline]
```

Set the agents data object.

The data should be an array with the data stored in a column major order, i.e., by column.

## Parameters

<i>data</i> ↔ —	Pointer to the first element of an array of size <code>size() * ncols_</code> .
<i>ncols</i> ↔ —	Number of features included in the data.

**16.19.2.11 set\_backup()**

```
template<typename TSeq = bool>
void epiworld::Model< TSeq >::set_backup ( )
```

Set the backup object.

`backup` can be used to restore the entire object after a run. This can be useful if the user wishes to have individuals start with the same network from the beginning. @[

**16.19.2.12 set\_name()**

```
template<typename TSeq >
void Model< TSeq >::set_name (
    std::string name ) [inline]
```

Set the name object.

## Parameters

<i>name</i>	
-------------	--

**16.19.2.13 set\_rand\_engine()**

```
template<typename TSeq = bool>
void epiworld::Model< TSeq >::set_rand_engine (
    std::mt19937 & eng )
```

Random number generation.

**Parameters**

<i>eng</i>	@[
------------	----

**16.19.2.14 set\_rewire\_fun()**

```
template<typename TSeq >
void Model< TSeq >::set_rewire_fun (
    std::function< void(std::vector< Person< TSeq >> *, Model< TSeq > *, epiworld←
_double)> fun ) [inline]
```

Rewire the network preserving the degree sequence.

This implementation assumes an undirected network, thus if  $\{(i,j), (k,l)\} \rightarrow \{(i,l), (k,j)\}$ , the reciprocal is also true, i.e.,  $\{(j,i), (l,k)\} \rightarrow \{(j,k), (l,i)\}$ .

**Parameters**

<i>proportion</i>	Proportion of ties to be rewired.
-------------------	-----------------------------------

**Returns**

A rewired version of the network. @[

**16.19.2.15 set\_user\_data()**

```
template<typename TSeq = bool>
void epiworld::Model< TSeq >::set_user_data (
    std::vector< std::string > names )
```

Set the user data object.

**Parameters**

<i>names</i>	[@
--------------	----

**16.19.2.16 write\_data() [1/2]**

```
template<typename TSeq >
void Model< TSeq >::write_data (
    std::string fn_variant_info,
    std::string fn_variant_hist,
    std::string fn_tool_info,
    std::string fn_tool_hist,
    std::string fn_total_hist,
    std::string fn_transmission,
    std::string fn_transition,
    std::string fn_reproductive_number ) const [inline]
```

Wrapper of DataBase::write\_data

**Parameters**

<i>fn_variant_info</i>	Filename. Information about the variant.
<i>fn_variant_hist</i>	Filename. History of the variant.
<i>fn_tool_info</i>	Filename. Information about the tool.
<i>fn_tool_hist</i>	Filename. History of the tool.
<i>fn_total_hist</i>	Filename. Aggregated history (status)
<i>fn_transmission</i>	Filename. Transmission history.
<i>fn_transition</i>	Filename. Markov transition history.
<i>fn_reproductive_number</i>	Filename. Case by case reproductive number

**16.19.2.17 write\_data() [2/2]**

```
template<typename TSeq >
void Model< TSeq >::write_data (
    std::string fn_variant_info,
    std::string fn_variant_hist,
    std::string fn_total_hist,
    std::string fn_transmission,
    std::string fn_transition ) const [inline]
```

Wrapper of DataBase::write\_data

**Parameters**

<i>fn_variant_info</i>	Filename. Information about the variant.
<i>fn_variant_hist</i>	Filename. History of the variant.
<i>fn_total_hist</i>	Filename. Aggregated history (status)
<i>fn_transmission</i>	Filename. Transmission history.
<i>fn_transition</i>	Filename. Markov transition history.



**16.19.2.18 write\_edgelist()**

```
template<typename TSeq = bool>
void epiworld::Model< TSeq >::write_edgelist (
    std::string fn ) const
```

Export the network data in edgelist form.

**Parameters**

<i>fn</i>	std::string. File name.
<i>source</i>	Integer vector
<i>target</i>	Integer vector

When passing the source and target, the function will write the edgelist on those. [ @

The documentation for this class was generated from the following file:

- epiworld.hpp

**16.20 Model< TSeq > Class Template Reference**

Core class of epiworld.

```
#include <model-bones.hpp>
```

**Public Member Functions**

- [DataBase](#)< TSeq > & **get\_db** ()
- epiworld\_double & **operator()** (std::string pname)
- size\_t **size** () const
- size\_t **get\_n\_variants** () const
- size\_t **get\_n\_tools** () const
- unsigned int **get\_ndays** () const
- unsigned int **get\_n\_replicates** () const
- void **set\_ndays** (unsigned int ndays)
- bool **get\_verbose** () const
- void **verbose\_off** ()
- void **verbose\_on** ()
- int [today](#) () const
- *The current time of the model.*
- void [write\\_data](#) (std::string fn\_variant\_info, std::string fn\_variant\_hist, std::string fn\_tool\_info, std::string fn\_tool\_hist, std::string fn\_total\_hist, std::string fn\_transmission, std::string fn\_transition, std::string fn\_reproductive\_number) const
- *Wrapper of DataBase::write\_data*
- std::map< std::string, epiworld\_double > & **params** ()
- void [reset](#) ()
- *Reset the model.*
- void **print** () const
- [Model](#)< TSeq > && **clone** () const

- void **get\_elapsed** (std::string unit="auto", epiworld\_double \*last\_elapsed=nullptr, epiworld\_double \*total\_elapsed=nullptr, std::string \*unit\_abbrev=nullptr, bool print=true) const
- void **add\_global\_action** (std::function< void([Model](#)< TSeq > \*)> fun, int date=-99)  
Set a global action.
- void **run\_global\_actions** ()
- void **clear\_status\_set** ()
- const std::vector< VirusPtr< TSeq > > & **get\_viruses** () const
- const std::vector< ToolPtr< TSeq > > & **get\_tools** () const
- void **set\_agents\_data** (double \*data\_, size\_t ncols\_)  
Set the agents data object.
- void **set\_name** (std::string name)  
Set the name object.

### Set the backup object

*backup* can be used to restore the entire object after a run. This can be useful if the user wishes to have individuals start with the same network from the beginning.

- void **set\_backup** ()
- void **restore\_backup** ()

### Random number generation

#### Parameters

eng	Random number generator
s	Seed

- void **set\_rand\_engine** (std::mt19937 &eng)
- std::mt19937 \* **get\_rand\_engine** ()
- void **seed** (unsigned int s)
- void **set\_rand\_norm** (epiworld\_double mean, epiworld\_double sd)
- void **set\_rand\_unif** (epiworld\_double a, epiworld\_double b)
- void **set\_rand\_exp** (epiworld\_double lambda)
- void **set\_rand\_gamma** (epiworld\_double alpha, epiworld\_double beta)
- void **set\_rand\_lognormal** (epiworld\_double mean, epiworld\_double shape)
- epiworld\_double **runif** ()
- epiworld\_double **runif** (epiworld\_double a, epiworld\_double b)
- epiworld\_double **rnorm** ()
- epiworld\_double **rnorm** (epiworld\_double mean, epiworld\_double sd)
- epiworld\_double **rgamma** ()
- epiworld\_double **rgamma** (epiworld\_double alpha, epiworld\_double beta)
- epiworld\_double **rexp** ()
- epiworld\_double **rexp** (epiworld\_double lambda)
- epiworld\_double **rlognormal** ()
- epiworld\_double **rlognormal** (epiworld\_double mean, epiworld\_double shape)

### Add Virus/Tool to the model

This is done before the model has been initialized.

#### Parameters

v	<a href="#">Virus</a> to be added
t	<a href="#">Tool</a> to be added
preval	Initial prevalence (initial state.) It can be specified as a proportion (between zero and one,) or an integer indicating number of individuals.

- void **add\_virus** ([Virus](#)< TSeq > v, epiworld\_double preval)
- void **add\_virus\_n** ([Virus](#)< TSeq > v, unsigned int preval)
- void **add\_virus\_fun** ([Virus](#)< TSeq > v, VirusToAgentFun< TSeq > fun)
- void **add\_tool** ([Tool](#)< TSeq > t, epiworld\_double preval)
- void **add\_tool\_n** ([Tool](#)< TSeq > t, unsigned int preval)
- void **add\_tool\_fun** ([Tool](#)< TSeq > t, ToolToAgentFun< TSeq > fun)
- void **add\_entity** ([Entity](#)< TSeq > e, epiworld\_double preval)
- void **add\_entity\_n** ([Entity](#)< TSeq > e, unsigned int preval)
- void **add\_entity\_fun** ([Entity](#)< TSeq > e, EntityToAgentFun< TSeq > fun)

### Accessing population of the model

#### Parameters

fn	<i>std::string Filename of the edgelist file.</i>
skip	<i>int Number of lines to skip in <i>fn</i>.</i>
directed	<i>bool Whether the graph is directed or not.</i>
size	<i>Size of the network.</i>
al	<i><a href="#">AdjList</a> to read into the model.</i>

- void **agents\_from\_adjlist** (std::string fn, int size, int skip=0, bool directed=false)
- void **agents\_from\_adjlist** ([AdjList](#) al)
- bool **is\_directed** () const
- std::vector< [Agent](#)< TSeq > > \* **get\_agents** ()
- void **agents\_smallworld** (unsigned int n=1000, unsigned int k=5, bool d=false, epiworld\_double p=.01)
- void **agents\_empty\_graph** (unsigned int n=1000)

### Functions to run the model

#### Parameters

seed	<i>Seed to be used for Pseudo-RNG.</i>
ndays	<i>Number of days (steps) of the simulation.</i>
fun	<i>In the case of <i>run_multiple</i>, a function that is called after each experiment.</i>

- void **init** (unsigned int ndays, unsigned int seed)
- void **update\_status** ()
- void **mutate\_variant** ()
- void **next** ()
- void **run** ()
- *Runs the simulation (after initialization)*
- void **run\_multiple** (unsigned int nexperiments, std::function< void(size\_t, [Model](#)< TSeq > \*)> fun=make\_save\_run< TSeq >(), bool **reset**=true, bool verbose=true)

### Rewire the network preserving the degree sequence.

*This implementation assumes an undirected network, thus if  $\{(i,j), (k,l)\} \rightarrow \{(i,l), (k,j)\}$ , the reciprocal is also true, i.e.,  $\{(j,i), (l,k)\} \rightarrow \{(j,k), (l,i)\}$ .*

#### Parameters

proportion	<i>Proportion of ties to be rewired.</i>
------------	------------------------------------------

### Returns

*A rewired version of the network.*

- void **set\_rewire\_fun** (std::function< void(std::vector< [Agent](#)< TSeq >> \*, [Model](#)< TSeq > \*, epiworld\_double)> fun)
- void **set\_rewire\_prop** (epiworld\_double prop)
- epiworld\_double **get\_rewire\_prop** () const
- void **rewire** ()

### Export the network data in edgelist form

#### Parameters

fn	<i>std::string. File name.</i>
source	<i>Integer vector</i>
target	<i>Integer vector</i>

*When passing the source and target, the function will write the edgelist on those.*

- void **write\_edgelist** (std::string fn) const
- void **write\_edgelist** (std::vector< unsigned int > &source, std::vector< unsigned int > &target) const

### Manage status (states) in the model

*The functions `get_status` return the current values for the statuses included in the model.*

#### Parameters

lab	<i>std::string Name of the status.</i>
-----	----------------------------------------

### Returns

*add\_status\* returns nothing.*

*get\_status\_\* returns a vector of pairs with the statuses and their labels.*

- void **add\_status** (std::string lab, UpdateFun< TSeq > fun=nullptr)
- const std::vector< std::string > & **get\_status** () const
- const std::vector< UpdateFun< TSeq > > & **get\_status\_fun** () const
- void **print\_status\_codes** () const

### Set the user data object

#### Parameters

names	<i>string vector with the names of the variables.</i>
-------	-------------------------------------------------------

- void **set\_user\_data** (std::vector< std::string > names)
- void **add\_user\_data** (unsigned int j, epiworld\_double x)
- void **add\_user\_data** (std::vector< epiworld\_double > x)
- [UserData](#)< TSeq > & **get\_user\_data** ()

### Queuing system

*When queueing is on, the model will keep track of which agents are either in risk of exposure or exposed. This then is used at each step to act only on the aforementioned agents.*

- void [queuing\\_on](#) ()  
*Activates the queuing system (default.)*
- void [queuing\\_off](#) ()  
*Deactivates the queuing system.*
- bool [is\\_queuing\\_on](#) () const  
*Query if the queuing system is on.*
- [Queue](#)< TSeq > & [get\\_queue](#) ()  
*Retrieve the [Queue](#) object.*

### Get the susceptibility reduction object

#### Parameters

v	
---	--

#### Returns

*epiworld\_double*

- void **set\_susceptibility\_reduction\_mixer** (MixerFun< TSeq > fun)
- void **set\_transmission\_reduction\_mixer** (MixerFun< TSeq > fun)
- void **set\_recovery\_enhancer\_mixer** (MixerFun< TSeq > fun)
- void **set\_death\_reduction\_mixer** (MixerFun< TSeq > fun)

### Friends

- class **Agent**< TSeq >
- class **AgentsSample**< TSeq >
- class **DataBase**< TSeq >
- class **Queue**< TSeq >

### Tool Mixers

These functions combine the effects tools have to deliver a single effect. For example, wearing a mask, been vaccinated, and the immune system combine together to jointly reduce the susceptibility for a given virus.

- std::vector< epiworld\_double > **array\_double\_tmp**
- std::vector< [Virus](#)< TSeq > \* > **array\_virus\_tmp**
- **Model** ()
- **Model** (const [Model](#)< TSeq > &m)
- **Model** ([Model](#)< TSeq > &&m)
- [Model](#)< TSeq > & **operator=** (const [Model](#)< TSeq > &m)
- void **clone\_population** (std::vector< [Agent](#)< TSeq > > &p, bool &d, [Model](#)< TSeq > \*m=nullptr) const
- void **clone\_population** (const [Model](#)< TSeq > &m)

## Setting and accessing parameters from the model

[Tools](#) can incorporate parameters included in the model. Internally, parameters in the tool are stored as pointers to an `std::map<>` of parameters in the model. Using the `unsigned int` method directly fetches the parameters in the order these were added to the tool. Accessing parameters via the `std::string` method involves searching the parameter directly in the `std::map<>` member of the model (so it is not recommended.)

The `par()` function members are aliases for `get_param()`.

In the case of the function `read_params`, users can pass a file listing parameters to be included in the model. Each line in the file should have the following structure:

```
[name of parameter 1]: [value in double]
[name of parameter 2]: [value in double]
...
```

The only condition for parameter names is that these do not include a colon.

### Parameters

<i>initial_val</i>	
<i>pname</i>	Name of the parameter to add or to fetch
<i>fn</i>	Path to the file containing parameters

### Returns

The current value of the parameter in the model.

- `epiworld_double * p0`
- `epiworld_double * p1`
- `epiworld_double * p2`
- `epiworld_double * p3`
- `epiworld_double * p4`
- `epiworld_double * p5`
- `epiworld_double * p6`
- `epiworld_double * p7`
- `epiworld_double * p8`
- `epiworld_double * p9`
- `epiworld_double * p10`
- `epiworld_double * p11`
- `epiworld_double * p12`
- `epiworld_double * p13`
- `epiworld_double * p14`
- `epiworld_double * p15`
- `epiworld_double * p16`
- `epiworld_double * p17`
- `epiworld_double * p18`
- `epiworld_double * p19`
- `epiworld_double * p20`
- `epiworld_double * p21`
- `epiworld_double * p22`
- `epiworld_double * p23`
- `epiworld_double * p24`
- `epiworld_double * p25`
- `epiworld_double * p26`

- `epiworld_double * p27`
- `epiworld_double * p28`
- `epiworld_double * p29`
- `epiworld_double * p30`
- `epiworld_double * p31`
- `epiworld_double * p32`
- `epiworld_double * p33`
- `epiworld_double * p34`
- `epiworld_double * p35`
- `epiworld_double * p36`
- `epiworld_double * p37`
- `epiworld_double * p38`
- `epiworld_double * p39`
- `unsigned int npar_used = 0u`
- `epiworld_double add_param (epiworld_double initial_val, std::string pname)`
- `void read_params (std::string fn)`
- `epiworld_double get_param (unsigned int k)`
- `epiworld_double get_param (std::string pname)`
- `epiworld_double par (unsigned int k)`
- `epiworld_double par (std::string pname)`

### 16.20.1 Detailed Description

```
template<typename TSeq>
class Model< TSeq >
```

Core class of epiworld.

The model class provides the wrapper that puts together [Agent](#), [Virus](#), and [Tools](#).

#### Template Parameters

<i>TSeq</i>	Type of sequence. In principle, users can build models in which virus and human sequence is represented as numeric vectors (if needed.)
-------------	-----------------------------------------------------------------------------------------------------------------------------------------

### 16.20.2 Member Function Documentation

#### 16.20.2.1 add\_global\_action()

```
template<typename TSeq >
void Model< TSeq >::add_global_action (
    std::function< void(Model< TSeq > *)> fun,
    int date = -99 )
```

Set a global action.

## Parameters

<i>fun</i>	A function to be called on the prescribed dates
<i>date</i>	Integer indicating when the function is called (see details)

When date is less than zero, then the function is called at the end of every day. Otherwise, the function will be called only at the end of the indicated date.

**16.20.2.2 reset()**

```
template<typename TSeq >
void Model< TSeq >::reset ( )
```

Reset the model.

Resetting the model will:

- clear the database
- restore the population (if `set_backup()` was called before)
- re-distribute tools
- re-distribute viruses
- set the date to 0

**16.20.2.3 run\_multiple()**

```
template<typename TSeq >
void Model< TSeq >::run_multiple (
    unsigned int n_experiments,
    std::function< void(size_t, Model< TSeq > *)> fun = make_save_run< TSeq >(),
    bool reset = true,
    bool verbose = true )
```

## Parameters

<i>n_experiments</i>	Multiple runs of the simulation
----------------------	---------------------------------

**16.20.2.4 set\_agents\_data()**

```
template<typename TSeq >
void Model< TSeq >::set_agents_data (
    double * data_,
    size_t n_cols_ )
```



Set the agents data object.

The data should be an array with the data stored in a column major order, i.e., by column.

#### Parameters

<i>data</i> ↔ _	Pointer to the first element of an array of size <code>size() * ncols_</code> .
<i>ncols</i> ↔ _	Number of features included in the data.

#### 16.20.2.5 set\_name()

```
template<typename TSeq >
void Model< TSeq >::set_name (
    std::string name )
```

Set the name object.

#### Parameters

<i>name</i>	
-------------	--

#### 16.20.2.6 write\_data()

```
template<typename TSeq >
void Model< TSeq >::write_data (
    std::string fn_variant_info,
    std::string fn_variant_hist,
    std::string fn_tool_info,
    std::string fn_tool_hist,
    std::string fn_total_hist,
    std::string fn_transmission,
    std::string fn_transition,
    std::string fn_reproductive_number ) const
```

Wrapper of `DataBase::write_data`

#### Parameters

<i>fn_variant_info</i>	Filename. Information about the variant.
<i>fn_variant_hist</i>	Filename. History of the variant.
<i>fn_tool_info</i>	Filename. Information about the tool.
<i>fn_tool_hist</i>	Filename. History of the tool.
<i>fn_total_hist</i>	Filename. Aggregated history (status)
<i>fn_transmission</i>	Filename. Transmission history.
<i>fn_transition</i>	Filename. Markov transition history.
<i>fn_reproductive_number</i>	Filename. Case by case reproductive number

The documentation for this class was generated from the following files:

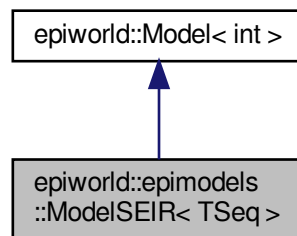
- include/epiworld/agent-bones.hpp
- include/epiworld/model-bones.hpp

## 16.21 epiworld::epimodels::ModelSEIR< TSeq > Class Template Reference

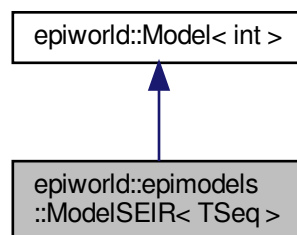
Template for a Susceptible-Exposed-Infected-Removed (SEIR) model.

```
#include <epiworld.hpp>
```

Inheritance diagram for epiworld::epimodels::ModelSEIR< TSeq >:



Collaboration diagram for epiworld::epimodels::ModelSEIR< TSeq >:



### Public Member Functions

- **ModelSEIR** ([ModelSEIR](#)< TSeq > &model, std::string vname, epiworld\_double prevalence, epiworld\_double infectiousness, epiworld\_double incubation\_days, epiworld\_double recovery)
- **ModelSEIR** (std::string vname, epiworld\_double prevalence, epiworld\_double infectiousness, epiworld\_double incubation\_days, epiworld\_double recovery)

## Public Attributes

- epiworld::UpdateFun< TSeq > **update\_exposed\_seir**
- epiworld::UpdateFun< TSeq > **update\_infected\_seir**

### 16.21.1 Detailed Description

```
template<typename TSeq = int>
class epiworld::epimodels::ModelSEIR< TSeq >
```

Template for a Susceptible-Exposed-Infected-Removed (SEIR) model.

#### Parameters

<i>model</i>	A <a href="#">Model&lt;TSeq&gt;</a> object where to set up the SIR.
<i>vname</i>	std::string Name of the virus
<i>initial_prevalence</i>	epiworld_double Initial prevalence
<i>initial_effacy</i>	epiworld_double Initial susceptibility_reduction of the immune system
<i>initial_recovery</i>	epiworld_double Initial recovery rate of the immune system

### 16.21.2 Member Data Documentation

#### 16.21.2.1 update\_exposed\_seir

```
template<typename TSeq = int>
epiworld::UpdateFun<TSeq> epiworld::epimodels::ModelSEIR< TSeq >::update\_exposed\_seir
```

##### Initial value:

```
= [] (
    epiworld::Agent<TSeq> * p,
    epiworld::Model<TSeq> * m
) -> void {
    if (m->runif() < 1.0/(*m->p1))
        p->change_status(ModelSEIR<TSeq>::INFECTED);
    return;
}
```

#### 16.21.2.2 update\_infected\_seir

```
template<typename TSeq = int>
epiworld::UpdateFun<TSeq> epiworld::epimodels::ModelSEIR< TSeq >::update\_infected\_seir
```

##### Initial value:

```
= [] (
    epiworld::Agent<TSeq> * p,
    epiworld::Model<TSeq> * m
) -> void {
    if (m->runif() < (*m->p2))
        p->rm_virus(0);
    return;
}
```

The documentation for this class was generated from the following file:

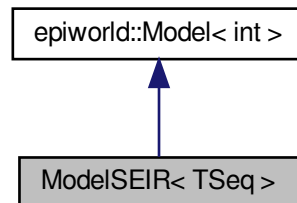
- epiworld.hpp

## 16.22 ModelSEIR< TSeq > Class Template Reference

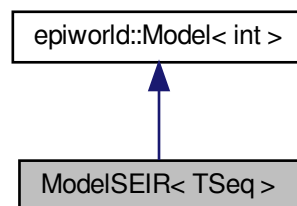
Template for a Susceptible-Exposed-Infected-Removed (SEIR) model.

```
#include <seir.hpp>
```

Inheritance diagram for ModelSEIR< TSeq >:



Collaboration diagram for ModelSEIR< TSeq >:



### Public Member Functions

- **ModelSEIR** ([ModelSEIR](#)< TSeq > &model, std::string vname, epiworld\_double prevalence, epiworld\_double infectiousness, epiworld\_double incubation\_days, epiworld\_double recovery)
- **ModelSEIR** (std::string vname, epiworld\_double prevalence, epiworld\_double infectiousness, epiworld\_double incubation\_days, epiworld\_double recovery)

### Public Attributes

- epiworld::UpdateFun< TSeq > **update\_exposed\_seir**
- epiworld::UpdateFun< TSeq > **update\_infected\_seir**

### 16.22.1 Detailed Description

```
template<typename TSeq = int>
class ModelSEIR< TSeq >
```

Template for a Susceptible-Exposed-Infected-Removed (SEIR) model.

## Parameters

<i>model</i>	A <a href="#">Model&lt;TSeq&gt;</a> object where to set up the SIR.
<i>vname</i>	std::string Name of the virus
<i>initial_prevalence</i>	epiworld_double Initial prevalence
<i>initial_efficacy</i>	epiworld_double Initial susceptibility_reduction of the immune system
<i>initial_recovery</i>	epiworld_double Initial recovery rate of the immune system

## 16.22.2 Member Data Documentation

## 16.22.2.1 update\_exposed\_seir

```
template<typename TSeq = int>
epiworld::UpdateFun<TSeq> ModelSEIR< TSeq >::update_exposed_seir
```

## Initial value:

```
= [] (
    epiworld::Agent<TSeq> * p,
    epiworld::Model<TSeq> * m
) -> void {
    if (m->runif() < 1.0/(*m->p1))
        p->change_status(ModelSEIR<TSeq>::INFECTED);
    return;
}
```

## 16.22.2.2 update\_infected\_seir

```
template<typename TSeq = int>
epiworld::UpdateFun<TSeq> ModelSEIR< TSeq >::update_infected_seir
```

## Initial value:

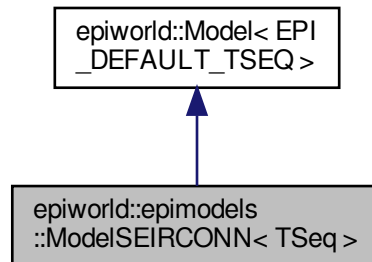
```
= [] (
    epiworld::Agent<TSeq> * p,
    epiworld::Model<TSeq> * m
) -> void {
    if (m->runif() < (*m->p2))
        p->rm_virus(0);
    return;
}
```

The documentation for this class was generated from the following file:

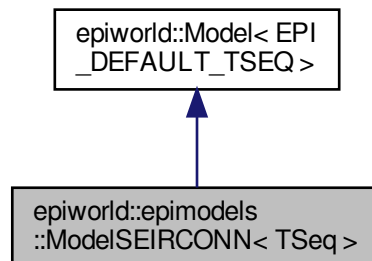
- include/epiworld/models/seir.hpp

## 16.23 epiworld::epimodels::ModelSEIRCONN< TSeq > Class Template Reference

Inheritance diagram for epiworld::epimodels::ModelSEIRCONN< TSeq >:



Collaboration diagram for epiworld::epimodels::ModelSEIRCONN< TSeq >:



### Public Member Functions

- [ModelSEIRCONN](#) ([ModelSEIRCONN](#)< TSeq > &model, std::string vname, unsigned int n, epiworld\_double prevalence, epiworld\_double reproductive\_number, epiworld\_double prob\_transmission, epiworld\_double incubation\_days, epiworld\_double prob\_recovery)  
*Template for a Susceptible-Exposed-Infected-Removed (SEIR) model.*
- **ModelSEIRCONN** (std::string vname, unsigned int n, epiworld\_double prevalence, epiworld\_double reproductive\_number, epiworld\_double prob\_transmission, epiworld\_double incubation\_days, epiworld\_double prob\_recovery)

## Public Attributes

- `std::vector< epiworld::Agent<> * > tracked_agents_infected = {}`
- `std::vector< epiworld::Agent<> * > tracked_agents_infected_next = {}`
- `bool tracked_started = false`
- `int tracked_ninfected = 0`
- `int tracked_ninfected_next = 0`

## 16.23.1 Constructor & Destructor Documentation

### 16.23.1.1 ModelSEIRCONN()

```
template<typename TSeq >
ModelSEIRCONN< TSeq >::ModelSEIRCONN (
    ModelSEIRCONN< TSeq > & model,
    std::string vname,
    unsigned int n,
    epiworld_double prevalence,
    epiworld_double reproductive_number,
    epiworld_double probab_transmission,
    epiworld_double incubation_days,
    epiworld_double probab_recovery ) [inline]
```

Template for a Susceptible-Exposed-Infected-Removed (SEIR) model.

#### Parameters

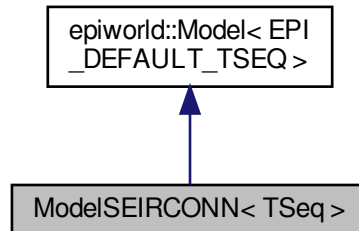
<i>model</i>	A <a href="#">Model&lt;TSeq&gt;</a> object where to set up the SIR.
<i>vname</i>	std::string Name of the virus
<i>prevalence</i>	Initial prevalence (proportion)
<i>reproductive_number</i>	Reproductive number (beta)
<i>probab_transmission</i>	Probability of transmission
<i>probab_recovery</i>	Probability of recovery

The documentation for this class was generated from the following file:

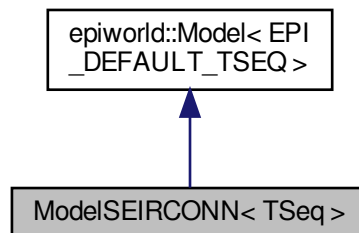
- epiworld.hpp

## 16.24 ModelSEIRCONN< TSeq > Class Template Reference

Inheritance diagram for ModelSEIRCONN< TSeq >:



Collaboration diagram for ModelSEIRCONN< TSeq >:



### Public Member Functions

- [ModelSEIRCONN](#) ([ModelSEIRCONN](#)< TSeq > &model, std::string vname, unsigned int n, epiworld\_double prevalence, epiworld\_double reproductive\_number, epiworld\_double prob\_transmission, epiworld\_double incubation\_days, epiworld\_double prob\_recovery)  
*Template for a Susceptible-Exposed-Infected-Removed (SEIR) model.*
- **ModelSEIRCONN** (std::string vname, unsigned int n, epiworld\_double prevalence, epiworld\_double reproductive\_number, epiworld\_double prob\_transmission, epiworld\_double incubation\_days, epiworld\_double prob\_recovery)

### Public Attributes

- std::vector< [epiworld::Agent](#)<> \* > **tracked\_agents\_infected** = {}
- std::vector< [epiworld::Agent](#)<> \* > **tracked\_agents\_infected\_next** = {}
- bool **tracked\_started** = false
- int **tracked\_ninfected** = 0
- int **tracked\_ninfected\_next** = 0



## 16.24.1 Constructor & Destructor Documentation

### 16.24.1.1 ModelSEIRCONN()

```
template<typename TSeq >
ModelSEIRCONN< TSeq >::ModelSEIRCONN (
    ModelSEIRCONN< TSeq > & model,
    std::string vname,
    unsigned int n,
    epiworld_double prevalence,
    epiworld_double reproductive_number,
    epiworld_double prob_transmission,
    epiworld_double incubation_days,
    epiworld_double prob_recovery ) [inline]
```

Template for a Susceptible-Exposed-Infected-Removed (SEIR) model.

#### Parameters

<i>model</i>	A <a href="#">Model&lt;TSeq&gt;</a> object where to set up the SIR.
<i>vname</i>	std::string Name of the virus
<i>prevalence</i>	Initial prevalence (proportion)
<i>reproductive_number</i>	Reproductive number (beta)
<i>prob_transmission</i>	Probability of transmission
<i>prob_recovery</i>	Probability of recovery

The documentation for this class was generated from the following file:

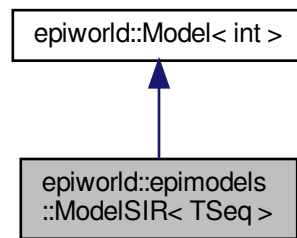
- include/epiworld/models/seirconnected.hpp

## 16.25 epiworld::epimodels::ModelSIR< TSeq > Class Template Reference

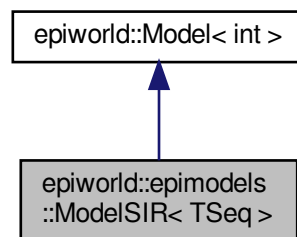
Template for a Susceptible-Infected-Removed (SIR) model.

```
#include <epiworld.hpp>
```

Inheritance diagram for `epiworld::epimodels::ModelSIR< TSeq >`:



Collaboration diagram for `epiworld::epimodels::ModelSIR< TSeq >`:



## Public Member Functions

- **ModelSIR** ([ModelSIR](#)< TSeq > &model, std::string vname, epiworld\_double prevalence, epiworld\_double infectiousness, epiworld\_double recovery)
- **ModelSIR** (std::string vname, epiworld\_double prevalence, epiworld\_double infectiousness, epiworld\_double recovery)

## Additional Inherited Members

### 16.25.1 Detailed Description

```

template<typename TSeq = int>
class epiworld::epimodels::ModelSIR< TSeq >

```

Template for a Susceptible-Infected-Removed (SIR) model.

## Parameters

<i>model</i>	A <a href="#">Model&lt;TSeq&gt;</a> object where to set up the SIR.
<i>vname</i>	std::string Name of the virus
<i>initial_prevalence</i>	epiworld_double Initial prevalence
<i>initial_efficacy</i>	epiworld_double Initial susceptibility_reduction of the immune system
<i>initial_recovery</i>	epiworld_double Initial recovery rate of the immune system

The documentation for this class was generated from the following file:

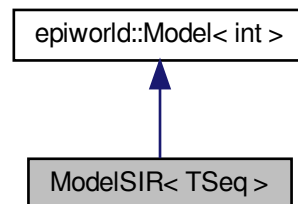
- epiworld.hpp

## 16.26 ModelSIR< TSeq > Class Template Reference

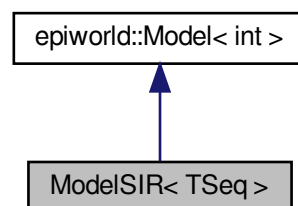
Template for a Susceptible-Infected-Removed (SIR) model.

```
#include <sir.hpp>
```

Inheritance diagram for ModelSIR< TSeq >:



Collaboration diagram for ModelSIR< TSeq >:



## Public Member Functions

- **ModelSIR** ([ModelSIR](#)< TSeq > &model, std::string vname, epiworld\_double prevalence, epiworld\_double infectiousness, epiworld\_double recovery)
- **ModelSIR** (std::string vname, epiworld\_double prevalence, epiworld\_double infectiousness, epiworld\_double recovery)

## Additional Inherited Members

### 16.26.1 Detailed Description

```
template<typename TSeq = int>
class ModelSIR< TSeq >
```

Template for a Susceptible-Infected-Removed (SIR) model.

#### Parameters

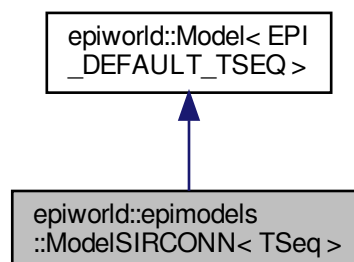
<i>model</i>	A <a href="#">Model</a> <TSeq> object where to set up the SIR.
<i>vname</i>	std::string Name of the virus
<i>initial_prevalence</i>	epiworld_double Initial prevalence
<i>initial_effacy</i>	epiworld_double Initial susceptibility_reduction of the immune system
<i>initial_recovery</i>	epiworld_double Initial recovery rate of the immune system

The documentation for this class was generated from the following file:

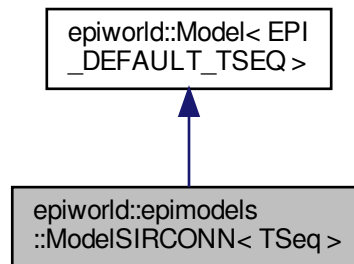
- include/epiworld/models/sir.hpp

## 16.27 epiworld::epimodels::ModelSIRCONN< TSeq > Class Template Reference

Inheritance diagram for epiworld::epimodels::ModelSIRCONN< TSeq >:



Collaboration diagram for epiworld::epimodels::ModelSIRCONN< TSeq >:



## Public Member Functions

- [ModelSIRCONN](#) ([ModelSIRCONN](#)< TSeq > &model, std::string vname, unsigned int n, epiworld\_double prevalence, epiworld\_double reproductive\_number, epiworld\_double prob\_transmission, epiworld\_double prob\_recovery)

*Template for a Susceptible-Infected-Removed (SIR) model.*

- **ModelSIRCONN** (std::string vname, unsigned int n, epiworld\_double prevalence, epiworld\_double reproductive\_number, epiworld\_double prob\_transmission, epiworld\_double prob\_recovery)

## Public Attributes

- std::vector< [epiworld::Agent](#)< TSeq > \* > **tracked\_agents\_infected** = {}
- std::vector< [epiworld::Agent](#)< TSeq > \* > **tracked\_agents\_infected\_next** = {}
- bool **tracked\_started** = false
- int **tracked\_ninfected** = 0
- int **tracked\_ninfected\_next** = 0
- epiworld\_double **tracked\_current\_infect\_prob** = 0.0

## 16.27.1 Constructor & Destructor Documentation

### 16.27.1.1 ModelSIRCONN()

```

template<typename TSeq >
ModelSIRCONN< TSeq >::ModelSIRCONN (
    ModelSIRCONN< TSeq > & model,
    std::string vname,
    unsigned int n,
    epiworld_double prevalence,
    epiworld_double reproductive_number,
    epiworld_double prob_transmission,
    epiworld_double prob_recovery ) [inline]
  
```

Template for a Susceptible-Infected-Removed (SIR) model.

## Parameters

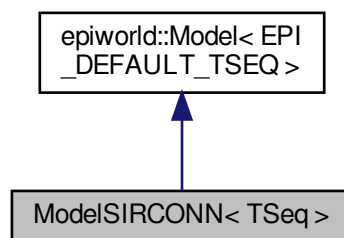
<i>model</i>	A <a href="#">Model&lt;TSeq&gt;</a> object where to set up the SIR.
<i>vname</i>	std::string Name of the virus
<i>prevalence</i>	Initial prevalence (proportion)
<i>reproductive_number</i>	Reproductive number (beta)
<i>prob_transmission</i>	Probability of transmission
<i>prob_recovery</i>	Probability of recovery

The documentation for this class was generated from the following file:

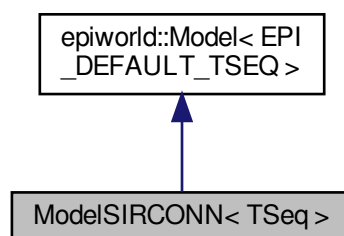
- epiworld.hpp

## 16.28 ModelSIRCONN< TSeq > Class Template Reference

Inheritance diagram for ModelSIRCONN< TSeq >:



Collaboration diagram for ModelSIRCONN< TSeq >:



## Public Member Functions

- [ModelSIRCONN](#) ([ModelSIRCONN](#)< TSeq > &model, std::string vname, unsigned int n, epiworld\_double prevalence, epiworld\_double reproductive\_number, epiworld\_double prob\_transmission, epiworld\_double prob\_recovery)

*Template for a Susceptible-Infected-Removed (SIR) model.*

- **ModelSIRCONN** (std::string vname, unsigned int n, epiworld\_double prevalence, epiworld\_double reproductive\_number, epiworld\_double prob\_transmission, epiworld\_double prob\_recovery)

## Public Attributes

- std::vector< [epiworld::Agent](#)< TSeq > \* > **tracked\_agents\_infected** = {}
- std::vector< [epiworld::Agent](#)< TSeq > \* > **tracked\_agents\_infected\_next** = {}
- bool **tracked\_started** = false
- int **tracked\_ninfected** = 0
- int **tracked\_ninfected\_next** = 0
- epiworld\_double **tracked\_current\_infect\_prob** = 0.0

## 16.28.1 Constructor & Destructor Documentation

### 16.28.1.1 ModelSIRCONN()

```
template<typename TSeq >
ModelSIRCONN< TSeq >::ModelSIRCONN (
    ModelSIRCONN< TSeq > & model,
    std::string vname,
    unsigned int n,
    epiworld_double prevalence,
    epiworld_double reproductive_number,
    epiworld_double prob_transmission,
    epiworld_double prob_recovery ) [inline]
```

Template for a Susceptible-Infected-Removed (SIR) model.

#### Parameters

<i>model</i>	A <a href="#">Model&lt;TSeq&gt;</a> object where to set up the SIR.
<i>vname</i>	std::string Name of the virus
<i>prevalence</i>	Initial prevalence (proportion)
<i>reproductive_number</i>	Reproductive number (beta)
<i>prob_transmission</i>	Probability of transmission
<i>prob_recovery</i>	Probability of recovery

The documentation for this class was generated from the following file:

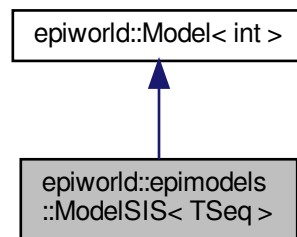
- include/epiworld/models/sirconnected.hpp

## 16.29 epiworld::epimodels::ModelSIS< TSeq > Class Template Reference

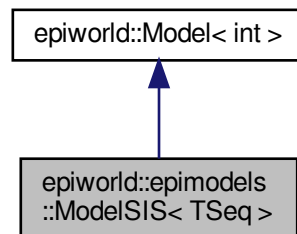
Template for a Susceptible-Infected-Susceptible (SIS) model.

```
#include <epiworld.hpp>
```

Inheritance diagram for epiworld::epimodels::ModelSIS< TSeq >:



Collaboration diagram for epiworld::epimodels::ModelSIS< TSeq >:



### Public Member Functions

- **ModelSIS** ([ModelSIS](#)< TSeq > &model, std::string vname, epiworld\_double prevalence, epiworld\_double infectiousness, epiworld\_double recovery)
- **ModelSIS** (std::string vname, epiworld\_double prevalence, epiworld\_double infectiousness, epiworld\_double recovery)



## Additional Inherited Members

### 16.29.1 Detailed Description

```
template<typename TSeq = int>  
class epiworld::epimodels::ModelSIS< TSeq >
```

Template for a Susceptible-Infected-Susceptible (SIS) model.

## Parameters

<i>vname</i>	std::string Name of the virus
<i>initial_prevalence</i>	epiworld_double Initial prevalence
<i>initial_efficacy</i>	epiworld_double Initial susceptibility_reduction of the immune system
<i>initial_recovery</i>	epiworld_double Initial recovery rate of the immune system

The documentation for this class was generated from the following file:

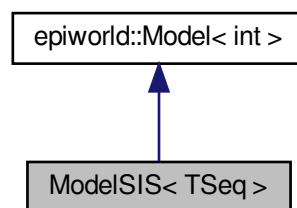
- epiworld.hpp

## 16.30 ModelSIS< TSeq > Class Template Reference

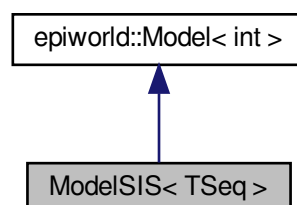
Template for a Susceptible-Infected-Susceptible (SIS) model.

```
#include <sis.hpp>
```

Inheritance diagram for ModelSIS< TSeq >:



Collaboration diagram for ModelSIS< TSeq >:



## Public Member Functions

- **ModelSIS** ([ModelSIS](#)< TSeq > &model, std::string vname, epiworld\_double prevalence, epiworld\_double infectiousness, epiworld\_double recovery)
- **ModelSIS** (std::string vname, epiworld\_double prevalence, epiworld\_double infectiousness, epiworld\_double recovery)

## Additional Inherited Members

### 16.30.1 Detailed Description

```
template<typename TSeq = int>
class ModelSIS< TSeq >
```

Template for a Susceptible-Infected-Susceptible (SIS) model.

#### Parameters

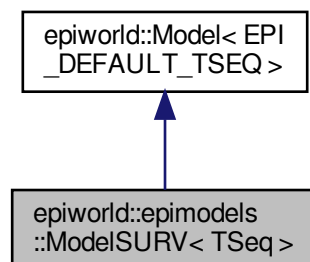
<i>vname</i>	std::string Name of the virus
<i>initial_prevalence</i>	epiworld_double Initial prevalence
<i>initial_efficacy</i>	epiworld_double Initial susceptibility_reduction of the immune system
<i>initial_recovery</i>	epiworld_double Initial recovery rate of the immune system

The documentation for this class was generated from the following file:

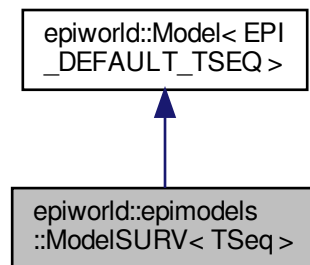
- include/epiworld/models/sis.hpp

## 16.31 epiworld::epimodels::ModelSURV< TSeq > Class Template Reference

Inheritance diagram for epiworld::epimodels::ModelSURV< TSeq >:



Collaboration diagram for `epiworld::epimodels::ModelSURV< TSeq >`:



## Public Member Functions

- [ModelSURV](#) ([ModelSURV](#)< TSeq > &model, std::string vname, unsigned int prevalence=50, epiworld\_double efficacy\_vax=0.9, epiworld\_double latent\_period=3u, epiworld\_double infect\_period=6u, epiworld\_double prob\_symptoms=0.6, epiworld\_double prop\_vaccinated=0.25, epiworld\_double prop\_vax\_redux\_transm=0.5, epiworld\_double prop\_vax\_redux\_infect=0.5, epiworld\_double surveillance\_prob=0.001, epiworld\_double prob\_transmission=1.0, epiworld\_double prob\_death=0.001, epiworld\_double prob\_noreinfect=0.9)
- *Template for a Susceptible-Infected-Removed (SIR) model.*
- **ModelSURV** (std::string vname, unsigned int prevalence=50, epiworld\_double efficacy\_vax=0.9, epiworld\_double latent\_period=3u, epiworld\_double infect\_period=6u, epiworld\_double prob\_symptoms=0.6, epiworld\_double prop\_vaccinated=0.25, epiworld\_double prop\_vax\_redux\_transm=0.5, epiworld\_double prop\_vax\_redux\_infect=0.5, epiworld\_double surveillance\_prob=0.001, epiworld\_double prob\_transmission=1.0, epiworld\_double prob\_death=0.001, epiworld\_double prob\_noreinfect=0.9)

## Additional Inherited Members

### 16.31.1 Constructor & Destructor Documentation

#### 16.31.1.1 ModelSURV()

```

template<typename TSeq >
ModelSURV< TSeq >::ModelSURV (
    ModelSURV< TSeq > & model,
    std::string vname,
    unsigned int prevalence = 50,
    epiworld_double efficacy_vax = 0.9,
    epiworld_double latent_period = 3u,
    epiworld_double infect_period = 6u,
    epiworld_double prob_symptoms = 0.6,
    epiworld_double prop_vaccinated = 0.25,

```

```

epiworld_double prop_vax_redux_transm = 0.5,
epiworld_double prop_vax_redux_infect = 0.5,
epiworld_double surveillance_prob = 0.001,
epiworld_double prob_transmission = 1.0,
epiworld_double prob_death = 0.001,
epiworld_double prob_noreinfect = 0.9 ) [inline]

```

Template for a Susceptible-Infected-Removed (SIR) model.

#### Parameters

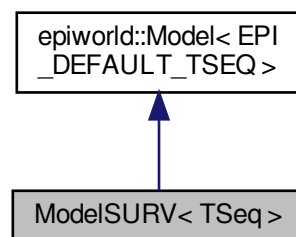
<i>model</i>	A <a href="#">Model&lt;TSeq&gt;</a> object where to set up the SIR.
<i>vname</i>	std::string Name of the virus
<i>initial_prevalence</i>	epiworld_double Initial prevalence
<i>initial_susceptibility_reduction</i>	epiworld_double Initial susceptibility_reduction of the immune system
<i>initial_recovery</i>	epiworld_double Initial recovery rate of the immune system

The documentation for this class was generated from the following file:

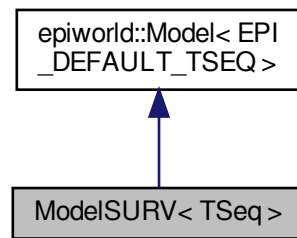
- epiworld.hpp

## 16.32 ModelSURV< TSeq > Class Template Reference

Inheritance diagram for ModelSURV< TSeq >:



Collaboration diagram for ModelSURV< TSeq >:



## Public Member Functions

- [ModelSURV](#) ([ModelSURV](#)< TSeq > &model, std::string vname, unsigned int prevalence=50, epiworld\_double efficacy\_vax=0.9, epiworld\_double latent\_period=3u, epiworld\_double infect\_period=6u, epiworld\_double prob\_symptoms=0.6, epiworld\_double prop\_vaccinated=0.25, epiworld\_double prop\_vax\_redux\_transm=0.5, epiworld\_double prop\_vax\_redux\_infect=0.5, epiworld\_double surveillance\_prob=0.001, epiworld\_double prob\_transmission=1.0, epiworld\_double prob\_death=0.001, epiworld\_double prob\_noreinfect=0.9)

*Template for a Susceptible-Infected-Removed (SIR) model.*

- **ModelSURV** (std::string vname, unsigned int prevalence=50, epiworld\_double efficacy\_vax=0.9, epiworld\_double latent\_period=3u, epiworld\_double infect\_period=6u, epiworld\_double prob\_symptoms=0.6, epiworld\_double prop\_vaccinated=0.25, epiworld\_double prop\_vax\_redux\_transm=0.5, epiworld\_double prop\_vax\_redux\_infect=0.5, epiworld\_double surveillance\_prob=0.001, epiworld\_double prob\_transmission=1.0, epiworld\_double prob\_death=0.001, epiworld\_double prob\_noreinfect=0.9)

## Additional Inherited Members

### 16.32.1 Constructor & Destructor Documentation

#### 16.32.1.1 ModelSURV()

```

template<typename TSeq >
ModelSURV< TSeq >::ModelSURV (
    ModelSURV< TSeq > & model,
    std::string vname,
    unsigned int prevalence = 50,
    epiworld_double efficacy_vax = 0.9,
    epiworld_double latent_period = 3u,
    epiworld_double infect_period = 6u,
    epiworld_double prob_symptoms = 0.6,
    epiworld_double prop_vaccinated = 0.25,
    epiworld_double prop_vax_redux_transm = 0.5,

```

```

epiworld_double prop_vax_redux_infect = 0.5,
epiworld_double surveillance_prob = 0.001,
epiworld_double prob_transmission = 1.0,
epiworld_double prob_death = 0.001,
epiworld_double prob_noreinfect = 0.9 ) [inline]

```

Template for a Susceptible-Infected-Removed (SIR) model.

#### Parameters

<i>model</i>	A <a href="#">Model&lt;TSeq&gt;</a> object where to set up the SIR.
<i>vname</i>	std::string Name of the virus
<i>initial_prevalence</i>	epiworld_double Initial prevalence
<i>initial_susceptibility_reduction</i>	epiworld_double Initial susceptibility_reduction of the immune system
<i>initial_recovery</i>	epiworld_double Initial recovery rate of the immune system

The documentation for this class was generated from the following file:

- include/epiworld/models/surveillance.hpp

## 16.33 Network< Nettype, Nodetype, Edgetype > Class Template Reference

### Public Member Functions

- **NType** ()
- Edgetype **operator()** (int i, int j)
- bool **is\_directed** () const
- size\_t **vcount** () const
- size\_t **ecount** () const
- void **add\_edge** (int i, int j)
- void **rm\_edge** (int i, int j)

The documentation for this class was generated from the following file:

- include/epiworld/network-bones.hpp

## 16.34 epiworld::Person< TSeq > Class Template Reference

### Public Member Functions

- void **init** (epiworld\_fast\_uint baseline\_status)
- void **add\_tool** (int d, [Tool< TSeq >](#) tool)
- void **add\_virus** ([Virus< TSeq >](#) \*virus)
- void **rm\_virus** ([Virus< TSeq >](#) \*virus)
- epiworld\_double **get\_susceptibility\_reduction** ([Virus< TSeq >](#) \*v)
- epiworld\_double **get\_transmission\_reduction** ([Virus< TSeq >](#) \*v)

- epiworld\_double **get\_recovery\_enhancer** ([Virus](#)< TSeq > \*v)
- epiworld\_double **get\_death\_reduction** ([Virus](#)< TSeq > \*v)
- int **get\_id** () const
- unsigned int **get\_index** () const
- std::mt19937 \* **get\_rand\_engine** ()
- [Model](#)< TSeq > \* **get\_model** ()
- [Virus](#)< TSeq > & **get\_virus** (int i)
- [PersonViruses](#)< TSeq > & **get\_viruses** ()
- [Tool](#)< TSeq > & **get\_tool** (int i)
- [PersonTools](#)< TSeq > & **get\_tools** ()
- void **mutate\_variant** ()
- void **add\_neighbor** ([Person](#)< TSeq > \*p, bool check\_source=true, bool check\_target=true)
- std::vector< [Person](#)< TSeq > \* > & **get\_neighbors** ()
- void **update\_status** ()
- const epiworld\_fast\_uint & **get\_status** () const
- void **reset** ()
- void **set\_update\_susceptible** (UpdateFun< TSeq > fun)
- void **set\_update\_exposed** (UpdateFun< TSeq > fun)
- void **set\_update\_removed** (UpdateFun< TSeq > fun)
- bool **has\_tool** (unsigned int t) const
- bool **has\_tool** (std::string name) const
- bool **has\_virus** (unsigned int t) const
- bool **has\_virus** (std::string name) const
- bool **visited** () const
- void **toggle\_visited** ()

## Friends

- class **Model**< TSeq >
- class **Tool**< TSeq >
- class **Queue**< TSeq >

The documentation for this class was generated from the following file:

- rpackage/inst/include/epiworld.hpp

## 16.35 epiworld::PersonTools< TSeq > Class Template Reference

List of tools available for the individual to.

```
#include <epiworld.hpp>
```



## Public Member Functions

- void `add_tool` (int date, `Tool`< TSeq > tool)  
@]
- `epiworld_double` `get_susceptibility_reduction` (`Virus`< TSeq > \*v)
- `epiworld_double` `get_transmission_reduction` (`Virus`< TSeq > \*v)
- `epiworld_double` `get_recovery_enhancer` (`Virus`< TSeq > \*v)
- `epiworld_double` `get_death_reduction` (`Virus`< TSeq > \*v)
- void `set_susceptibility_reduction_mixer` (`MixerFun`< TSeq > fun)
- void `set_transmission_reduction_mixer` (`MixerFun`< TSeq > fun)
- void `set_recovery_enhancer_mixer` (`MixerFun`< TSeq > fun)
- void `set_death_reduction_mixer` (`MixerFun`< TSeq > fun)
- `size_t` `size` () const
- `Tool`< TSeq > & `operator()` (int i)
- `Person`< TSeq > \* `get_person` ()
- `Model`< TSeq > \* `get_model` ()
- void `reset` ()
- bool `has_tool` (unsigned int t) const
- bool `has_tool` (std::string name) const

## Friends

- class `Person`< TSeq >
- class `Model`< TSeq >

### 16.35.1 Detailed Description

```
template<typename TSeq = bool>
class epiworld::PersonTools< TSeq >
```

List of tools available for the individual to.

#### Template Parameters

<code>TSeq</code>	
-------------------	--

The documentation for this class was generated from the following file:

- `epiworld.hpp`

## 16.36 PersonTools< TSeq > Class Template Reference

The documentation for this class was generated from the following file:

- `include/epiworld/config.hpp`

## 16.37 epiworld::PersonViruses< TSeq > Class Template Reference

Set of viruses in host.

```
#include <epiworld.hpp>
```

### Public Member Functions

- void **add\_virus** (epiworld\_fast\_uint new\_status, [Virus](#)< TSeq > v)
- size\_t **size** () const
- int **size\_active** () const
- [Virus](#)< TSeq > & **operator()** (int i)
- void **mutate** ()
- void **reset** ()
- void **deactivate** ([Virus](#)< TSeq > &v)
- [Person](#)< TSeq > \* **get\_host** ()
- bool **has\_virus** (unsigned int v) const
- bool **has\_virus** (std::string vname) const

### Friends

- class [Person](#)< TSeq >
- class [Model](#)< TSeq >

### 16.37.1 Detailed Description

```
template<typename TSeq = bool>
class epiworld::PersonViruses< TSeq >
```

Set of viruses in host.

#### Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following file:

- rpackage/inst/include/epiworld.hpp

## 16.38 epiworld::Progress Class Reference

A simple progress bar.

```
#include <epiworld.hpp>
```

## Public Member Functions

- **Progress** (int n\_, int width\_)
- void **start** ()
- void **next** ()
- void **end** ()
- **Progress** (int n\_, int width\_)
- void **start** ()
- void **next** ()
- void **end** ()

### 16.38.1 Detailed Description

A simple progress bar.

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.39 Progress Class Reference

A simple progress bar.

```
#include <progress.hpp>
```

## Public Member Functions

- **Progress** (int n\_, int width\_)
- void **start** ()
- void **next** ()
- void **end** ()

### 16.39.1 Detailed Description

A simple progress bar.

The documentation for this class was generated from the following file:

- include/epiworld/progress.hpp

## 16.40 epiworld::Queue< TSeq > Class Template Reference

Controls which agents are verified at each step.

```
#include <epiworld.hpp>
```

## Public Member Functions

- void **operator+=** ([Agent](#)< TSeq > \*p)
- void **operator-=** ([Agent](#)< TSeq > \*p)
- epiworld\_fast\_int & **operator[]** (unsigned int i)
- void **set\_model** ([Model](#)< TSeq > \*m)
- void **operator+=** ([Person](#)< TSeq > \*p)
- void **operator-=** ([Person](#)< TSeq > \*p)
- epiworld\_fast\_int **operator[]** (unsigned int i) const
- void **set\_model** ([Model](#)< TSeq > \*m)
- void **update** ()

### 16.40.1 Detailed Description

```
template<typename TSeq>
class epiworld::Queue< TSeq >
```

Controls which agents are verified at each step.

The idea is that only agents who are either in an infected state or have an infected neighbor should be checked. Otherwise it makes no sense (no chance to recover or capture the disease).

Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.41 Queue< TSeq > Class Template Reference

Controls which agents are verified at each step.

```
#include <queue-bones.hpp>
```

## Public Member Functions

- void **operator+=** ([Agent](#)< TSeq > \*p)
- void **operator-=** ([Agent](#)< TSeq > \*p)
- epiworld\_fast\_int & **operator[]** (unsigned int i)
- void **set\_model** ([Model](#)< TSeq > \*m)

### 16.41.1 Detailed Description

```
template<typename TSeq>
class Queue< TSeq >
```

Controls which agents are verified at each step.

The idea is that only agents who are either in an infected state or have an infected neighbor should be checked. Otherwise it makes no sense (no chance to recover or capture the disease).

## Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following files:

- include/epiworld/agent-bones.hpp
- include/epiworld/queue-bones.hpp

## 16.42 epiworld::QueueValues Class Reference

### Static Public Attributes

- static const int **NoOne** = 0
- static const int **OnlySelf** = 1
- static const int **Everyone** = 2

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.43 QueueValues Class Reference

### Static Public Attributes

- static const int **NoOne** = 0
- static const int **OnlySelf** = 1
- static const int **Everyone** = 2

The documentation for this class was generated from the following file:

- include/epiworld/epiworld-macros.hpp

## 16.44 RandGraph Class Reference

### Public Member Functions

- **RandGraph** (int N\_)
- void **init** (int s)
- void **set\_rand\_engine** (std::mt19937 &e)
- epiworld\_double **runif** ()

The documentation for this class was generated from the following file:

- include/epiworld/random\_graph.hpp

## 16.45 epiworld::SAMPLETYPE Class Reference

### Static Public Attributes

- static const int **MODEL** = 0
- static const int **ENTITY** = 1
- static const int **AGENT** = 2

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.46 SAMPLETYPE Class Reference

### Static Public Attributes

- static const int **MODEL** = 0
- static const int **ENTITY** = 1
- static const int **AGENT** = 2

The documentation for this class was generated from the following file:

- include/epiworld/agentssample-bones.hpp

## 16.47 epiworld::Tool< TSeq > Class Template Reference

[Tools](#) for defending the agent against the virus.

```
#include <epiworld.hpp>
```

### Public Member Functions

- **Tool** (std::string name="unknown tool")
- void **set\_sequence** (TSeq d)
- void **set\_sequence\_unique** (TSeq d)
- void **set\_sequence** (std::shared\_ptr< TSeq > d)
- std::shared\_ptr< TSeq > **get\_sequence** ()
- TSeq & **get\_sequence\_unique** ()
- void **set\_name** (std::string name)
- std::string **get\_name** () const
- [Agent](#)< TSeq > \* **get\_agent** ()
- int **get\_id** () const
- void **set\_id** (int id)
- void **set\_date** (int d)
- int **get\_date** () const
- void **set\_status** (epiworld\_fast\_int init, epiworld\_fast\_int post)
- void **set\_queue** (epiworld\_fast\_int init, epiworld\_fast\_int post)

- void **get\_status** (epiworld\_fast\_int \*init, epiworld\_fast\_int \*post)
- void **get\_queue** (epiworld\_fast\_int \*init, epiworld\_fast\_int \*post)
- **Tool** (std::string name="unknown tool")
- void **set\_sequence** (TSeq d)
- void **set\_sequence\_unique** (TSeq d)
- void **set\_sequence** (std::shared\_ptr< TSeq > d)
- std::shared\_ptr< TSeq > **get\_sequence** ()
- TSeq & **get\_sequence\_unique** ()
- epiworld\_double **get\_susceptibility\_reduction** (Virus< TSeq > \*v)  
*Get and set the tool functions.*
- epiworld\_double **get\_transmission\_reduction** (Virus< TSeq > \*v)
- epiworld\_double **get\_recovery\_enhancer** (Virus< TSeq > \*v)
- epiworld\_double **get\_death\_reduction** (Virus< TSeq > \*v)
- void **set\_susceptibility\_reduction\_fun** (ToolFun< TSeq > fun)
- void **set\_transmission\_reduction\_fun** (ToolFun< TSeq > fun)
- void **set\_recovery\_enhancer\_fun** (ToolFun< TSeq > fun)
- void **set\_death\_reduction\_fun** (ToolFun< TSeq > fun)
- void **set\_susceptibility\_reduction** (epiworld\_double \*prob)
- void **set\_transmission\_reduction** (epiworld\_double \*prob)
- void **set\_recovery\_enhancer** (epiworld\_double \*prob)
- void **set\_death\_reduction** (epiworld\_double \*prob)
- void **set\_susceptibility\_reduction** (epiworld\_double prob)
- void **set\_transmission\_reduction** (epiworld\_double prob)
- void **set\_recovery\_enhancer** (epiworld\_double prob)
- void **set\_death\_reduction** (epiworld\_double prob)
- void **set\_name** (std::string name)
- @]
- std::string **get\_name** () const
- Person< TSeq > \* **get\_person** ()
- unsigned int **get\_id** () const

### Get and set the tool functions

#### Parameters

v	<i>The virus over which to operate</i>
fun	<i>the function to be used</i>

#### Returns

*epiworld\_double*

- epiworld\_double **get\_susceptibility\_reduction** (VirusPtr< TSeq > v)
- epiworld\_double **get\_transmission\_reduction** (VirusPtr< TSeq > v)
- epiworld\_double **get\_recovery\_enhancer** (VirusPtr< TSeq > v)
- epiworld\_double **get\_death\_reduction** (VirusPtr< TSeq > v)
- void **set\_susceptibility\_reduction\_fun** (ToolFun< TSeq > fun)
- void **set\_transmission\_reduction\_fun** (ToolFun< TSeq > fun)
- void **set\_recovery\_enhancer\_fun** (ToolFun< TSeq > fun)
- void **set\_death\_reduction\_fun** (ToolFun< TSeq > fun)
- void **set\_susceptibility\_reduction** (epiworld\_double \*prob)
- void **set\_transmission\_reduction** (epiworld\_double \*prob)
- void **set\_recovery\_enhancer** (epiworld\_double \*prob)
- void **set\_death\_reduction** (epiworld\_double \*prob)
- void **set\_susceptibility\_reduction** (epiworld\_double prob)
- void **set\_transmission\_reduction** (epiworld\_double prob)
- void **set\_recovery\_enhancer** (epiworld\_double prob)
- void **set\_death\_reduction** (epiworld\_double prob)

## Friends

- class **Agent**< TSeq >
- class **Model**< TSeq >
- class **PersonTools**< TSeq >
- class **Person**< TSeq >
- void **default\_add\_tool** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_rm\_tool** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)

### 16.47.1 Detailed Description

```
template<typename TSeq = bool>
class epiworld::Tool< TSeq >
```

[Tools](#) for defending the agent against the virus.

[Tools](#) for defending the host against the virus.

#### Template Parameters

<i>TSeq</i>	Type of sequence
-------------	------------------

### 16.47.2 Member Function Documentation

#### 16.47.2.1 get\_susceptibility\_reduction()

```
template<typename TSeq >
epiworld_double Tool< TSeq >::get_susceptibility_reduction (
    Virus< TSeq > * v ) [inline]
```

Get and set the tool functions.

#### Parameters

<i>v</i>	The virus over which to operate
<i>fun</i>	the function to be used

#### Returns

epiworld\_double @[]

The documentation for this class was generated from the following file:

- epiworld.hpp



## 16.48 Tool< TSeq > Class Template Reference

Tools for defending the agent against the virus.

```
#include <tool-bones.hpp>
```

### Public Member Functions

- **Tool** (std::string name="unknown tool")
- void **set\_sequence** (TSeq d)
- void **set\_sequence\_unique** (TSeq d)
- void **set\_sequence** (std::shared\_ptr< TSeq > d)
- std::shared\_ptr< TSeq > **get\_sequence** ()
- TSeq & **get\_sequence\_unique** ()
- void **set\_name** (std::string name)
- std::string **get\_name** () const
- [Agent](#)< TSeq > \* **get\_agent** ()
- int **get\_id** () const
- void **set\_id** (int id)
- void **set\_date** (int d)
- int **get\_date** () const
- void **set\_status** (epiworld\_fast\_int init, epiworld\_fast\_int post)
- void **set\_queue** (epiworld\_fast\_int init, epiworld\_fast\_int post)
- void **get\_status** (epiworld\_fast\_int \*init, epiworld\_fast\_int \*post)
- void **get\_queue** (epiworld\_fast\_int \*init, epiworld\_fast\_int \*post)

### Get and set the tool functions

#### Parameters

v	<i>The virus over which to operate</i>
fun	<i>the function to be used</i>

#### Returns

*epiworld\_double*

- epiworld\_double **get\_susceptibility\_reduction** (VirusPtr< TSeq > v)
- epiworld\_double **get\_transmission\_reduction** (VirusPtr< TSeq > v)
- epiworld\_double **get\_recovery\_enhancer** (VirusPtr< TSeq > v)
- epiworld\_double **get\_death\_reduction** (VirusPtr< TSeq > v)
- void **set\_susceptibility\_reduction\_fun** (ToolFun< TSeq > fun)
- void **set\_transmission\_reduction\_fun** (ToolFun< TSeq > fun)
- void **set\_recovery\_enhancer\_fun** (ToolFun< TSeq > fun)
- void **set\_death\_reduction\_fun** (ToolFun< TSeq > fun)
- void **set\_susceptibility\_reduction** (epiworld\_double \*prob)
- void **set\_transmission\_reduction** (epiworld\_double \*prob)
- void **set\_recovery\_enhancer** (epiworld\_double \*prob)
- void **set\_death\_reduction** (epiworld\_double \*prob)
- void **set\_susceptibility\_reduction** (epiworld\_double prob)
- void **set\_transmission\_reduction** (epiworld\_double prob)
- void **set\_recovery\_enhancer** (epiworld\_double prob)
- void **set\_death\_reduction** (epiworld\_double prob)

## Friends

- class **Agent**< TSeq >
- class **Model**< TSeq >
- void **default\_add\_tool** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_rm\_tool** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)

### 16.48.1 Detailed Description

```
template<typename TSeq>
class Tool< TSeq >
```

[Tools](#) for defending the agent against the virus.

#### Template Parameters

<i>TSeq</i>	Type of sequence
-------------	------------------

The documentation for this class was generated from the following files:

- include/epiworld/agent-bones.hpp
- include/epiworld/tool-bones.hpp
- include/epiworld/tool-meat.hpp

## 16.49 epiworld::Tools< TSeq > Class Template Reference

Set of tools (useful for building iterators)

```
#include <epiworld.hpp>
```

### Public Member Functions

- **Tools** ([Agent](#)< TSeq > &p)
- std::vector< ToolPtr< TSeq > >::iterator **begin** ()
- std::vector< ToolPtr< TSeq > >::iterator **end** ()
- ToolPtr< TSeq > & **operator**() (size\_t i)
- ToolPtr< TSeq > & **operator[]** (size\_t i)
- size\_t **size** () const noexcept

## Friends

- class **Tool**< TSeq >
- class **Agent**< TSeq >

### 16.49.1 Detailed Description

```
template<typename TSeq>
class epiworld::Tools< TSeq >
```

Set of tools (useful for building iterators)

## Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.50 Tools< TSeq > Class Template Reference

Set of tools (useful for building iterators)

```
#include <tools-bones.hpp>
```

### Public Member Functions

- **Tools** ([Agent](#)< TSeq > &p)
- std::vector< ToolPtr< TSeq > >::iterator **begin** ()
- std::vector< ToolPtr< TSeq > >::iterator **end** ()
- ToolPtr< TSeq > & **operator()** (size\_t i)
- ToolPtr< TSeq > & **operator[]** (size\_t i)
- size\_t **size** () const noexcept

### Friends

- class **Tool**< TSeq >
- class **Agent**< TSeq >

### 16.50.1 Detailed Description

```
template<typename TSeq>
class Tools< TSeq >
```

Set of tools (useful for building iterators)

## Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following files:

- include/epiworld/agent-bones.hpp
- include/epiworld/tools-bones.hpp

## 16.51 epiworld::Tools\_const< TSeq > Class Template Reference

Set of [Tools](#) (const) (useful for iterators)

```
#include <epiworld.hpp>
```

### Public Member Functions

- **Tools\_const** (const [Agent](#)< TSeq > &p)
- std::vector< ToolPtr< TSeq > >::const\_iterator **begin** ()
- std::vector< ToolPtr< TSeq > >::const\_iterator **end** ()
- const ToolPtr< TSeq > & **operator**() (size\_t i)
- const ToolPtr< TSeq > & **operator**[] (size\_t i)
- size\_t **size** () const noexcept

### Friends

- class **Tool**< TSeq >
- class **Agent**< TSeq >

### 16.51.1 Detailed Description

```
template<typename TSeq>
class epiworld::Tools_const< TSeq >
```

Set of [Tools](#) (const) (useful for iterators)

Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.52 Tools\_const< TSeq > Class Template Reference

Set of [Tools](#) (const) (useful for iterators)

```
#include <tools-bones.hpp>
```

### Public Member Functions

- **Tools\_const** (const [Agent](#)< TSeq > &p)
- std::vector< ToolPtr< TSeq > >::const\_iterator **begin** ()
- std::vector< ToolPtr< TSeq > >::const\_iterator **end** ()
- const ToolPtr< TSeq > & **operator**() (size\_t i)
- const ToolPtr< TSeq > & **operator**[] (size\_t i)
- size\_t **size** () const noexcept

## Friends

- class **Tool**< TSeq >
- class **Agent**< TSeq >

### 16.52.1 Detailed Description

```
template<typename TSeq>
class Tools_const< TSeq >
```

Set of [Tools](#) (const) (useful for iterators)

#### Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following files:

- include/epiworld/agent-bones.hpp
- include/epiworld/tools-bones.hpp

## 16.53 epiworld::UserData< TSeq > Class Template Reference

Personalized data by the user.

```
#include <epiworld.hpp>
```

### Public Member Functions

- **UserData** ([Model](#)< TSeq > &m)
- **UserData** (std::vector< std::string > names)
 

*Construct a new User Data object.*
- std::vector< std::string > & **get\_names** ()
- std::vector< int > & **get\_dates** ()
- std::vector< epiworld\_double > & **get\_data** ()
- void **get\_all** (std::vector< std::string > \*names=nullptr, std::vector< int > \*date=nullptr, std::vector< epiworld\_double > \*data=nullptr)
- unsigned int **nrow** () const
- unsigned int **ncol** () const
- void **write** (std::string fn)
- void **print** () const
- **UserData** (std::vector< std::string > names)
- void **add** (std::vector< epiworld\_double > x)
- void **add** (unsigned int j, epiworld\_double x)
- epiworld\_double & **operator()** (unsigned int i, unsigned int j)
- epiworld\_double & **operator()** (unsigned int i, std::string name)
- std::vector< std::string > & **get\_names** ()
- std::vector< int > & **get\_dates** ()

- `std::vector< epiworld_double > &get_data ()`
- `void get_all (std::vector< std::string > *names=nullptr, std::vector< int > *date=nullptr, std::vector< epiworld_double > *data=nullptr)`
- `unsigned int nrow () const`
- `unsigned int ncol () const`
- `void write (std::string fn)`
- `void print () const`

### Append data

#### Parameters

x	A vector of length <code>ncol ()</code> (if vector), otherwise a <code>epiworld_double</code> .
j	Index of the data point, from 0 to <code>ncol () - 1</code> .

- `void add (std::vector< epiworld_double > x)`
- `void add (unsigned int j, epiworld_double x)`

### Access data

#### Parameters

i	Row (0 through <code>ndays - 1</code> .)
j	Column (0 through <code>ncols ()</code> ).

#### Returns

`epiworld_double&`

- `epiworld_double &operator() (unsigned int i, unsigned int j)`
- `epiworld_double &operator() (unsigned int i, std::string name)`

## Friends

- `class Model< TSeq >`
- `class DataBase< TSeq >`

## 16.53.1 Detailed Description

```
template<typename TSeq>
class epiworld::UserData< TSeq >
```

Personalized data by the user.

#### Template Parameters

<code>TSeq</code>	
-------------------	--

## 16.53.2 Constructor & Destructor Documentation

### 16.53.2.1 UserData()

```
template<typename TSeq >
UserData< TSeq >::UserData (
    std::vector< std::string > names ) [inline]
```

Construct a new User Data object.

#### Parameters

<i>names</i>	A vector of names. The length of the vector sets the number of columns to record.
--------------	-----------------------------------------------------------------------------------

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.54 UserData< TSeq > Class Template Reference

Personalized data by the user.

```
#include <userdata-bones.hpp>
```

### Public Member Functions

- **UserData** ([Model](#)< TSeq > &m)
- [UserData](#) (std::vector< std::string > names)  
*Construct a new User Data object.*
- std::vector< std::string > & **get\_names** ()
- std::vector< int > & **get\_dates** ()
- std::vector< epiworld\_double > & **get\_data** ()
- void **get\_all** (std::vector< std::string > \*names=nullptr, std::vector< int > \*date=nullptr, std::vector< epiworld\_double > \*data=nullptr)
- unsigned int **nrow** () const
- unsigned int **ncol** () const
- void **write** (std::string fn)
- void **print** () const

#### Append data

#### Parameters

<i>x</i>	A vector of length <i>ncol</i> () (if vector), otherwise a <i>epiworld_double</i> .
<i>j</i>	Index of the data point, from 0 to <i>ncol</i> () - 1.

- void **add** (std::vector< epiworld\_double > x)
- void **add** (unsigned int j, epiworld\_double x)

### Access data

#### Parameters

i	Row (0 through <i>ndays</i> - 1.)
j	Column (0 through <i>ncols</i> ()).

#### Returns

*epiworld\_double*&

- *epiworld\_double* & **operator()** (unsigned int i, unsigned int j)
- *epiworld\_double* & **operator()** (unsigned int i, std::string name)

### Friends

- class **Model**< TSeq >
- class **DataBase**< TSeq >

## 16.54.1 Detailed Description

```
template<typename TSeq>
class UserData< TSeq >
```

Personalized data by the user.

#### Template Parameters

<i>TSeq</i>	
-------------	--

## 16.54.2 Constructor & Destructor Documentation

### 16.54.2.1 UserData()

```
template<typename TSeq >
UserData< TSeq >::UserData (
    std::vector< std::string > names ) [inline]
```

Construct a new User Data object.

#### Parameters

<i>names</i>	A vector of names. The length of the vector sets the number of columns to record.
--------------	-----------------------------------------------------------------------------------



The documentation for this class was generated from the following files:

- include/epiworld/database-bones.hpp
- include/epiworld/userdata-bones.hpp
- include/epiworld/userdata-meat.hpp

## 16.55 epiworld::vecHasher< T > Struct Template Reference

Vector hasher.

```
#include <epiworld.hpp>
```

### Public Member Functions

- `std::size_t operator() (std::vector< T > const &dat) const` noexcept
- `std::size_t operator() (std::vector< T > const &dat) const` noexcept

#### 16.55.1 Detailed Description

```
template<typename T>
struct epiworld::vecHasher< T >
```

Vector hasher.

Template Parameters

<i>T</i>	
----------	--

The documentation for this struct was generated from the following file:

- epiworld.hpp

## 16.56 vecHasher< T > Struct Template Reference

Vector hasher.

```
#include <misc.hpp>
```

### Public Member Functions

- `std::size_t operator() (std::vector< T > const &dat) const` noexcept

#### 16.56.1 Detailed Description

```
template<typename T>
struct vecHasher< T >
```

Vector hasher.

## Template Parameters

<i>T</i>	
----------	--

The documentation for this struct was generated from the following file:

- include/epiworld/misc.hpp

## 16.57 epiworld::Virus< TSeq > Class Template Reference

[Virus.](#)

```
#include <epiworld.hpp>
```

### Public Member Functions

- **Virus** (std::string name="unknown virus")
- void **mutate** ()
- void **set\_mutation** (MutFun< TSeq > fun)
- const TSeq \* **get\_sequence** ()
- void **set\_sequence** (TSeq sequence)
- [Agent](#)< TSeq > \* **get\_agent** ()
- void **set\_agent** ([Agent](#)< TSeq > \*p, epiworld\_fast\_uint idx)
- [Model](#)< TSeq > \* **get\_model** ()
- void **set\_date** (int d)
- int **get\_date** () const
- void **set\_id** (int idx)
- int **get\_id** () const
- void **set\_name** (std::string name)
- std::string **get\_name** () const
- std::vector< epiworld\_double > & **get\_data** ()
- **Virus** (std::string name="unknown virus")
- void **mutate** ()
- void **set\_mutation** (MutFun< TSeq > fun)
- const TSeq \* **get\_sequence** ()
- void **set\_sequence** (TSeq sequence)
- [Person](#)< TSeq > \* **get\_host** ()
- [Model](#)< TSeq > \* **get\_model** ()
- void **set\_date** (int d)
- int **get\_date** () const
- void **set\_id** (int idx)
- int **get\_id** () const
- bool **is\_active** () const
- void **deactivate** ()
- epiworld\_double **get\_prob\_infecting** ()
- *Get and set the tool functions.*
- epiworld\_double **get\_prob\_recovery** ()
- epiworld\_double **get\_prob\_death** ()
- void **post\_recovery** ()
- void **set\_post\_recovery** (PostRecoveryFun< TSeq > fun)

- void **set\_post\_immunity** (epiworld\_double prob)
  - void **set\_post\_immunity** (epiworld\_double \*prob)
  - void **set\_prob\_infecting\_fun** (VirusFun< TSeq > fun)
  - void **set\_prob\_recovery\_fun** (VirusFun< TSeq > fun)
  - void **set\_prob\_death\_fun** (VirusFun< TSeq > fun)
  - void **set\_prob\_infecting** (epiworld\_double \*prob)
  - void **set\_prob\_recovery** (epiworld\_double \*prob)
  - void **set\_prob\_death** (epiworld\_double \*prob)
  - void **set\_prob\_infecting** (epiworld\_double prob)
  - void **set\_prob\_recovery** (epiworld\_double prob)
  - void **set\_prob\_death** (epiworld\_double prob)
  - void **set\_name** (std::string name)
- @]
- std::string **get\_name** () const
  - std::vector< epiworld\_double > & **get\_data** ()

### Get and set the tool functions

#### Parameters

v	<i>The virus over which to operate</i>
fun	<i>the function to be used</i>

#### Returns

*epiworld\_double*

- epiworld\_double **get\_prob\_infecting** ()
- epiworld\_double **get\_prob\_recovery** ()
- epiworld\_double **get\_prob\_death** ()
- void **post\_recovery** ()
- void **set\_post\_recovery** (PostRecoveryFun< TSeq > fun)
- void **set\_post\_immunity** (epiworld\_double prob)
- void **set\_post\_immunity** (epiworld\_double \*prob)
- void **set\_prob\_infecting\_fun** (VirusFun< TSeq > fun)
- void **set\_prob\_recovery\_fun** (VirusFun< TSeq > fun)
- void **set\_prob\_death\_fun** (VirusFun< TSeq > fun)
- void **set\_prob\_infecting** (epiworld\_double \*prob)
- void **set\_prob\_recovery** (epiworld\_double \*prob)
- void **set\_prob\_death** (epiworld\_double \*prob)
- void **set\_prob\_infecting** (epiworld\_double prob)
- void **set\_prob\_recovery** (epiworld\_double prob)
- void **set\_prob\_death** (epiworld\_double prob)

### Get and set the status and queue

After applied, viruses can change the status and affect the queue of agents. These function sets the default values, which are retrieved when adding or removing a virus does not specify a change in status or in queue.

#### Parameters

init	<i>After the virus/tool is added to the agent.</i>
end	<i>After the virus/tool is removed.</i>
removed	<i>After the agent (<a href="#">Agent</a>) is removed.</i>

- void **set\_status** (epiworld\_fast\_int init, epiworld\_fast\_int end, epiworld\_fast\_int removed=-99)

- void **set\_queue** (epiworld\_fast\_int init, epiworld\_fast\_int end, epiworld\_fast\_int removed=-99)
- void **get\_status** (epiworld\_fast\_int \*init, epiworld\_fast\_int \*end, epiworld\_fast\_int \*removed=-99)
- void **get\_queue** (epiworld\_fast\_int \*init, epiworld\_fast\_int \*end, epiworld\_fast\_int \*removed=-99)

## Friends

- class **Agent**< TSeq >
- class **Model**< TSeq >
- class **DataBase**< TSeq >
- class **Person**< TSeq >
- class **PersonViruses**< TSeq >
- void **default\_add\_virus** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- void **default\_rm\_virus** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)

### 16.57.1 Detailed Description

```
template<typename TSeq = bool>
class epiworld::Virus< TSeq >
```

[Virus](#).

Template Parameters

<i>TSeq</i>	
-------------	--

Raw transmissibility of a virus should be a function of its genetic sequence. Nonetheless, transmissibility can be reduced as a result of having one or more tools to fight the virus. Because of this, transmissibility should be a function of the agent.

Template Parameters

<i>TSeq</i>	
-------------	--

Raw transmissibility of a virus should be a function of its genetic sequence. Nonetheless, transmissibility can be reduced as a result of having one or more tools to fight the virus. Because of this, transmissibility should be a function of the host.

### 16.57.2 Member Function Documentation

#### 16.57.2.1 get\_prob\_infecting()

```
template<typename TSeq = bool>
epiworld_double epiworld::Virus< TSeq >::get_prob_infecting ( )
```

Get and set the tool functions.

**Parameters**

<i>v</i>	The virus over which to operate
<i>fun</i>	the function to be used

**Returns**

epiworld\_double @[]

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.58 Virus< TSeq > Class Template Reference

[Virus.](#)

```
#include <virus-bones.hpp>
```

**Public Member Functions**

- **Virus** (std::string name="unknown virus")
- void **mutate** ()
- void **set\_mutation** (MutFun< TSeq > fun)
- const TSeq \* **get\_sequence** ()
- void **set\_sequence** (TSeq sequence)
- [Agent](#)< TSeq > \* **get\_agent** ()
- void **set\_agent** ([Agent](#)< TSeq > \*p, epiworld\_fast\_uint idx)
- [Model](#)< TSeq > \* **get\_model** ()
- void **set\_date** (int d)
- int **get\_date** () const
- void **set\_id** (int idx)
- int **get\_id** () const
- void **set\_name** (std::string name)
- std::string **get\_name** () const
- std::vector< epiworld\_double > & **get\_data** ()

**Get and set the tool functions****Parameters**

<i>v</i>	<i>The virus over which to operate</i>
<i>fun</i>	<i>the function to be used</i>

**Returns**

epiworld\_double

- epiworld\_double **get\_prob\_infecting** ()

- `epiworld_double` **get\_prob\_recovery** ()
- `epiworld_double` **get\_prob\_death** ()
- `void` **post\_recovery** ()
- `void` **set\_post\_recovery** (PostRecoveryFun< TSeq > fun)
- `void` **set\_post\_immunity** (epiworld\_double prob)
- `void` **set\_post\_immunity** (epiworld\_double \*prob)
- `void` **set\_prob\_infecting\_fun** (VirusFun< TSeq > fun)
- `void` **set\_prob\_recovery\_fun** (VirusFun< TSeq > fun)
- `void` **set\_prob\_death\_fun** (VirusFun< TSeq > fun)
- `void` **set\_prob\_infecting** (epiworld\_double \*prob)
- `void` **set\_prob\_recovery** (epiworld\_double \*prob)
- `void` **set\_prob\_death** (epiworld\_double \*prob)
- `void` **set\_prob\_infecting** (epiworld\_double prob)
- `void` **set\_prob\_recovery** (epiworld\_double prob)
- `void` **set\_prob\_death** (epiworld\_double prob)

### Get and set the status and queue

After applied, viruses can change the status and affect the queue of agents. These function sets the default values, which are retrieved when adding or removing a virus does not specify a change in status or in queue.

#### Parameters

init	After the virus/tool is added to the agent.
end	After the virus/tool is removed.
removed	After the agent ( <a href="#">Agent</a> ) is removed.

- `void` **set\_status** (epiworld\_fast\_int init, epiworld\_fast\_int end, epiworld\_fast\_int removed=-99)
- `void` **set\_queue** (epiworld\_fast\_int init, epiworld\_fast\_int end, epiworld\_fast\_int removed=-99)
- `void` **get\_status** (epiworld\_fast\_int \*init, epiworld\_fast\_int \*end, epiworld\_fast\_int \*removed=-99)
- `void` **get\_queue** (epiworld\_fast\_int \*init, epiworld\_fast\_int \*end, epiworld\_fast\_int \*removed=-99)

### Friends

- `class` **Agent**< TSeq >
- `class` **Model**< TSeq >
- `class` **DataBase**< TSeq >
- `void` **default\_add\_virus** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)
- `void` **default\_rm\_virus** ([Action](#)< TSeq > &a, [Model](#)< TSeq > \*m)

## 16.58.1 Detailed Description

```
template<typename TSeq>
class Virus< TSeq >
```

[Virus](#).

#### Template Parameters

<i>TSeq</i>	
-------------	--

Raw transmissibility of a virus should be a function of its genetic sequence. Nonetheless, transmissibility can be

reduced as a result of having one or more tools to fight the virus. Because of this, transmissibility should be a function of the agent.

The documentation for this class was generated from the following files:

- include/epiworld/agent-bones.hpp
- include/epiworld/virus-bones.hpp
- include/epiworld/virus-meat.hpp

## 16.59 epiworld::Viruses< TSeq > Class Template Reference

Set of viruses (useful for building iterators)

```
#include <epiworld.hpp>
```

### Public Member Functions

- **Viruses** ([Agent](#)< TSeq > &p)
- std::vector< VIRUSPTR >::iterator **begin** ()
- std::vector< VIRUSPTR >::iterator **end** ()
- VIRUSPTR & **operator()** (size\_t i)
- VIRUSPTR & **operator[]** (size\_t i)
- size\_t **size** () const noexcept

### Friends

- class **Virus**< TSeq >
- class **Agent**< TSeq >

### 16.59.1 Detailed Description

```
template<typename TSeq>
class epiworld::Viruses< TSeq >
```

Set of viruses (useful for building iterators)

#### Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.60 Viruses< TSeq > Class Template Reference

Set of viruses (useful for building iterators)

```
#include <viruses-bones.hpp>
```

### Public Member Functions

- **Viruses** ([Agent](#)< TSeq > &p)
- std::vector< VIRUSPTR >::iterator **begin** ()
- std::vector< VIRUSPTR >::iterator **end** ()
- VIRUSPTR & **operator()** (size\_t i)
- VIRUSPTR & **operator[]** (size\_t i)
- size\_t **size** () const noexcept

### Friends

- class **Virus**< TSeq >
- class **Agent**< TSeq >

### 16.60.1 Detailed Description

```
template<typename TSeq>
class Viruses< TSeq >
```

Set of viruses (useful for building iterators)

Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following files:

- include/epiworld/agent-bones.hpp
- include/epiworld/viruses-bones.hpp

## 16.61 epiworld::Viruses\_const< TSeq > Class Template Reference

Set of [Viruses](#) (const) (useful for iterators)

```
#include <epiworld.hpp>
```

### Public Member Functions

- **Viruses\_const** (const [Agent](#)< TSeq > &p)
- std::vector< VIRUSPTR >::const\_iterator **begin** ()
- std::vector< VIRUSPTR >::const\_iterator **end** ()
- const VIRUSPTR & **operator()** (size\_t i)
- const VIRUSPTR & **operator[]** (size\_t i)
- size\_t **size** () const noexcept



## Friends

- class **Virus**< TSeq >
- class **Agent**< TSeq >

### 16.61.1 Detailed Description

```
template<typename TSeq>
class epiworld::Viruses_const< TSeq >
```

Set of [Viruses](#) (const) (useful for iterators)

#### Template Parameters

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following file:

- epiworld.hpp

## 16.62 Viruses\_const< TSeq > Class Template Reference

Set of [Viruses](#) (const) (useful for iterators)

```
#include <viruses-bones.hpp>
```

## Public Member Functions

- **Viruses\_const** (const [Agent](#)< TSeq > &p)
- std::vector< VIRUSPTR >::const\_iterator **begin** ()
- std::vector< VIRUSPTR >::const\_iterator **end** ()
- const VIRUSPTR & **operator**() (size\_t i)
- const VIRUSPTR & **operator**[] (size\_t i)
- size\_t **size** () const noexcept

## Friends

- class **Virus**< TSeq >
- class **Agent**< TSeq >

### 16.62.1 Detailed Description

```
template<typename TSeq>
class Viruses_const< TSeq >
```

Set of [Viruses](#) (const) (useful for iterators)

**Template Parameters**

<i>TSeq</i>	
-------------	--

The documentation for this class was generated from the following files:

- include/epiworld/agent-bones.hpp
- include/epiworld/viruses-bones.hpp

## Chapter 17

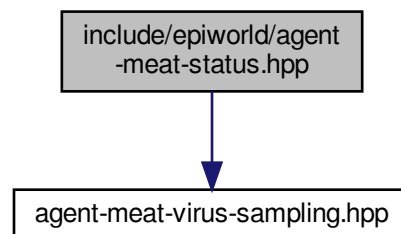
# File Documentation

### 17.1 include/epiworld/agent-meat-status.hpp File Reference

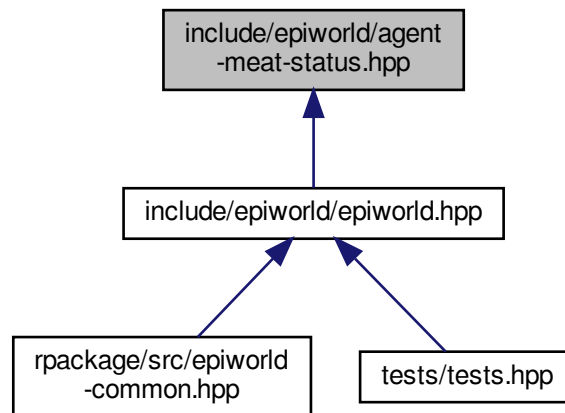
Sampling functions are getting big, so we keep them in a separate file.

```
#include "agent-meat-virus-sampling.hpp"
```

Include dependency graph for agent-meat-status.hpp:



This graph shows which files directly or indirectly include this file:



## Functions

- `template<typename TSeq = EPI_DEFAULT_TSEQ>`  
`void default_update_susceptible (Agent< TSeq > *p, Model< TSeq > *m)`
- `template<typename TSeq = EPI_DEFAULT_TSEQ>`  
`void default_update_exposed (Agent< TSeq > *p, Model< TSeq > *m)`

### 17.1.1 Detailed Description

Sampling functions are getting big, so we keep them in a separate file.

#### Author

George G. Vega Yon (g.vegayon en gmail)

#### Version

0.1

#### Date

2022-06-15

#### Copyright

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# Index

Action  
  Action< TSeq >, 44  
  epiworld::Action< TSeq >, 45  
Action< TSeq >, 43  
  Action, 44  
add\_global\_action  
  epiworld::Model< TSeq >, 80  
  Model< TSeq >, 93  
add\_param  
  epiworld::Model< TSeq >, 80  
add\_status\_susceptible  
  epiworld::Model< TSeq >, 81  
AdjList, 46  
  AdjList, 47  
  epiworld::AdjList, 48, 49  
  read\_edgelist, 47  
Agent< TSeq >, 50  
  operator(), 52  
AgentsSample< TSeq >, 56  
  
DataBase< TSeq >, 57  
  record\_variant, 59  
  reproductive\_number, 59  
  transition\_probability, 60  
  
Entities< TSeq >, 64  
Entities\_const< TSeq >, 66  
Entity< TSeq >, 67  
epiworld::Action< TSeq >, 45  
  Action, 45  
epiworld::AdjList, 48  
  AdjList, 48, 49  
  read\_edgelist, 49  
epiworld::Agent< TSeq >, 53  
  operator(), 55  
epiworld::AgentsSample< TSeq >, 57  
epiworld::DataBase< TSeq >, 60  
  get\_today\_total, 62  
  record\_variant, 63  
  reproductive\_number, 64  
  transition\_probability, 64  
epiworld::Entities< TSeq >, 65  
epiworld::Entities\_const< TSeq >, 67  
epiworld::Entity< TSeq >, 68  
epiworld::epimodels::ModelSEIR< TSeq >, 96  
  update\_exposed\_seir, 97  
  update\_infected\_seir, 97  
epiworld::epimodels::ModelSEIRCONN< TSeq >, 100  
  ModelSEIRCONN, 101  
epiworld::epimodels::ModelSIR< TSeq >, 103  
epiworld::epimodels::ModelSIRCONN< TSeq >, 106  
  ModelSIRCONN, 107  
epiworld::epimodels::ModelSIS< TSeq >, 110  
epiworld::epimodels::ModelSURV< TSeq >, 113  
  ModelSURV, 114  
epiworld::LFMCMC< TData >, 69  
epiworld::Model< TSeq >, 71  
  add\_global\_action, 80  
  add\_param, 80  
  add\_status\_susceptible, 81  
  init, 81  
  pop\_from\_adjlist, 81  
  reset, 82  
  reset\_status\_codes, 83  
  run\_multiple, 83  
  set\_agents\_data, 84  
  set\_backup, 84  
  set\_name, 84  
  set\_rand\_engine, 84  
  set\_rewire\_fun, 85  
  set\_user\_data, 85  
  write\_data, 85, 86  
  write\_edgelist, 86  
epiworld::Person< TSeq >, 117  
epiworld::PersonTools< TSeq >, 118  
epiworld::PersonViruses< TSeq >, 120  
epiworld::Progress, 120  
epiworld::Queue< TSeq >, 121  
epiworld::QueueValues, 123  
epiworld::sampler, 35  
  make\_sample\_virus\_neighbors, 35  
  make\_update\_susceptible, 36  
  sample\_virus\_single, 36  
epiworld::SAMPLETYPE, 124  
epiworld::Tool< TSeq >, 124  
  get\_susceptibility\_reduction, 126  
epiworld::Tools< TSeq >, 128  
epiworld::Tools\_const< TSeq >, 130  
epiworld::UserData< TSeq >, 131  
  UserData, 133  
epiworld::vechHasher< T >, 135  
epiworld::Virus< TSeq >, 136  
  get\_prob\_infecting, 138  
epiworld::Viruses< TSeq >, 141  
epiworld::Viruses\_const< TSeq >, 142  
  
get\_prob\_infecting  
  epiworld::Virus< TSeq >, 138  
get\_susceptibility\_reduction  
  epiworld::Tool< TSeq >, 126

get\_today\_total  
     epiworld::DataBase< TSeq >, 62

include/epiworld/agent-meat-status.hpp, 145

init  
     epiworld::Model< TSeq >, 81

LFMCMC< TData >, 70

make\_sample\_virus\_neighbors  
     epiworld::sampler, 35  
     sampler, 38

make\_update\_susceptible  
     epiworld::sampler, 36  
     sampler, 39

Model< TSeq >, 87  
     add\_global\_action, 93  
     reset, 94  
     run\_multiple, 94  
     set\_agents\_data, 94  
     set\_name, 95  
     write\_data, 95

ModelSEIR< TSeq >, 98  
     update\_exposed\_seir, 99  
     update\_infected\_seir, 99

ModelSEIRCONN  
     epiworld::epimodels::ModelSEIRCONN< TSeq >, 101  
     ModelSEIRCONN< TSeq >, 103

ModelSEIRCONN< TSeq >, 102  
     ModelSEIRCONN, 103

ModelSIR< TSeq >, 105

ModelSIRCONN  
     epiworld::epimodels::ModelSIRCONN< TSeq >, 107  
     ModelSIRCONN< TSeq >, 109

ModelSIRCONN< TSeq >, 108  
     ModelSIRCONN, 109

ModelSIS< TSeq >, 112

ModelSURV  
     epiworld::epimodels::ModelSURV< TSeq >, 114  
     ModelSURV< TSeq >, 116

ModelSURV< TSeq >, 115  
     ModelSURV, 116

Network< Nettype, Nodetype, Edgetype >, 117

operator()  
     Agent< TSeq >, 52  
     epiworld::Agent< TSeq >, 55

PersonTools< TSeq >, 119

pop\_from\_adjlist  
     epiworld::Model< TSeq >, 81

Progress, 121

Queue< TSeq >, 122

QueueValues, 123

RandGraph, 123

read\_edgelist  
     AdjList, 47  
     epiworld::AdjList, 49

record\_variant  
     DataBase< TSeq >, 59  
     epiworld::DataBase< TSeq >, 63

reproductive\_number  
     DataBase< TSeq >, 59  
     epiworld::DataBase< TSeq >, 64

reset  
     epiworld::Model< TSeq >, 82  
     Model< TSeq >, 94

reset\_status\_codes  
     epiworld::Model< TSeq >, 83

run\_multiple  
     epiworld::Model< TSeq >, 83  
     Model< TSeq >, 94

sample\_virus\_single  
     epiworld::sampler, 36  
     sampler, 39

sampler, 38  
     make\_sample\_virus\_neighbors, 38  
     make\_update\_susceptible, 39  
     sample\_virus\_single, 39

SAMPLETYPE, 124

set\_agents\_data  
     epiworld::Model< TSeq >, 84  
     Model< TSeq >, 94

set\_backup  
     epiworld::Model< TSeq >, 84

set\_name  
     epiworld::Model< TSeq >, 84  
     Model< TSeq >, 95

set\_rand\_engine  
     epiworld::Model< TSeq >, 84

set\_rewire\_fun  
     epiworld::Model< TSeq >, 85

set\_user\_data  
     epiworld::Model< TSeq >, 85

Tool< TSeq >, 127

Tools< TSeq >, 129

Tools\_const< TSeq >, 130

transition\_probability  
     DataBase< TSeq >, 60  
     epiworld::DataBase< TSeq >, 64

update\_exposed\_seir  
     epiworld::epimodels::ModelSEIR< TSeq >, 97  
     ModelSEIR< TSeq >, 99

update\_infected\_seir  
     epiworld::epimodels::ModelSEIR< TSeq >, 97  
     ModelSEIR< TSeq >, 99

UserData  
     epiworld::UserData< TSeq >, 133  
     UserData< TSeq >, 134

UserData< TSeq >, 133  
     UserData, 134

vecHasher< T >, [135](#)  
Virus< TSeq >, [139](#)  
Viruses< TSeq >, [142](#)  
Viruses\_const< TSeq >, [143](#)  
  
write\_data  
    epiworld::Model< TSeq >, [85](#), [86](#)  
    Model< TSeq >, [95](#)  
write\_edgelist  
    epiworld::Model< TSeq >, [86](#)