Multi-agent simulation of trust in vaccination

Project presentation

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Internship funded by CNRS MODCOV19
Supervised by Carole ADAM (LIG) and Didier GEAORGES (GIPSA-lab)
With the help of Pierrick TRANOUEZ (Litis, Université Rouen Normandie)

Masters defence - 1st of September 2022

Vaccine hesitancy

Influencing factors:

- Complacency
- Fear of needles
- Lack of proper scientific background
- Distrust of public authorities
- Deaths from vaccine-preventable diseases

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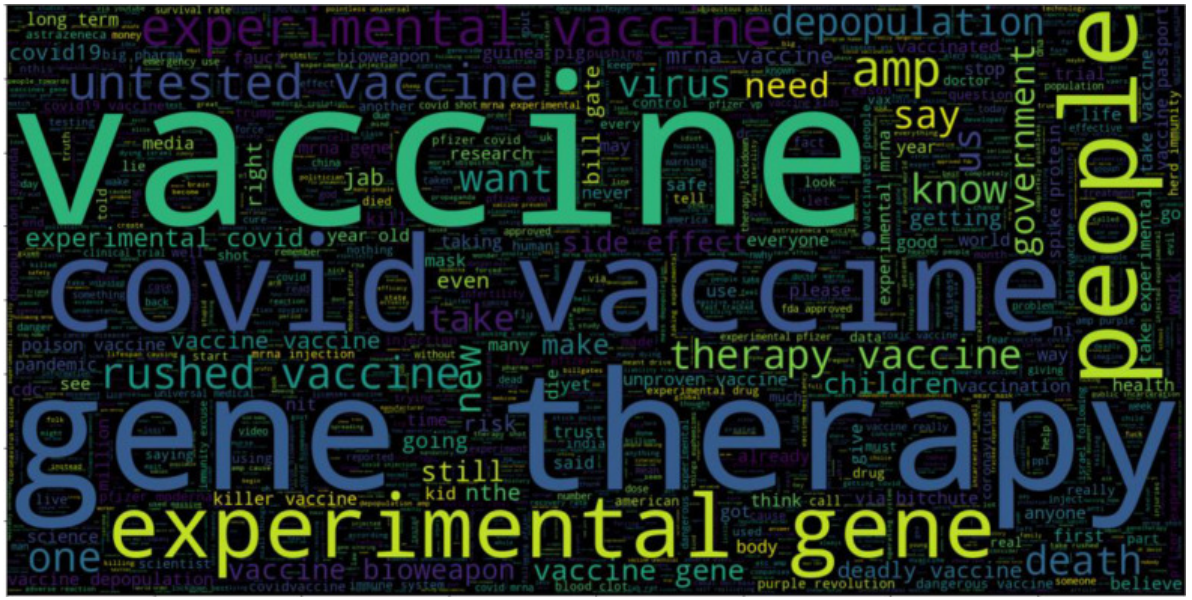
COVID-19 vaccine additional influencing factors:

- Early vaccine roll-out
- "New" vaccine technology

Misleading information and misinterpretation

[1]



[2]

Word cloud visualization for vaccine misinformation tweets

[1] https://twitter.com/BFMTV/status/1471539246985060360

[2] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8648668/

Problem

Misleading information and misinterpretation of information

- Decrease in the population's trust

Effects of the decrease

- Lower trust in vaccines and institutions
- Lower vaccination rates

Goal

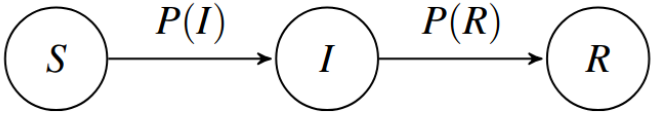
Educational simulation

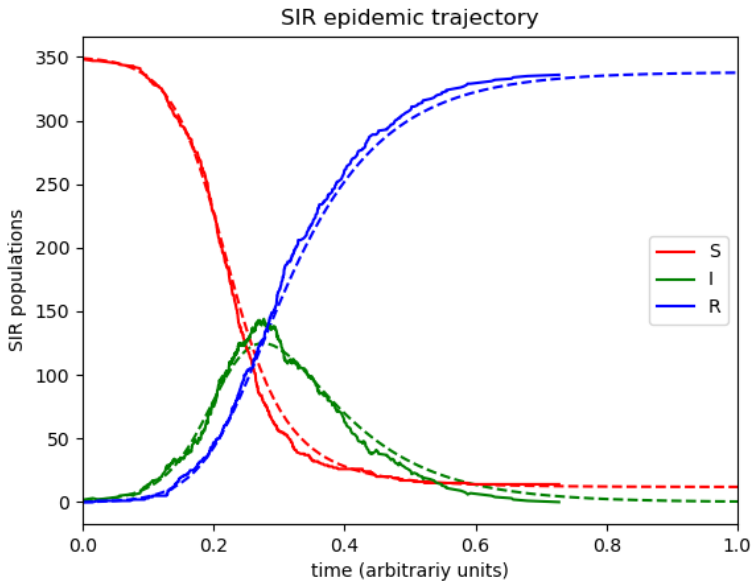
- Agent-based simulations on vaccine effectiveness
- Public trust in vaccines
- Computer Science, Psychology, and Epidemiology

In the continuity of CoVprehension

GRETSI'22 presentation by Pierrick TRANOUEZ

Epidemic simulations - Mathematical models

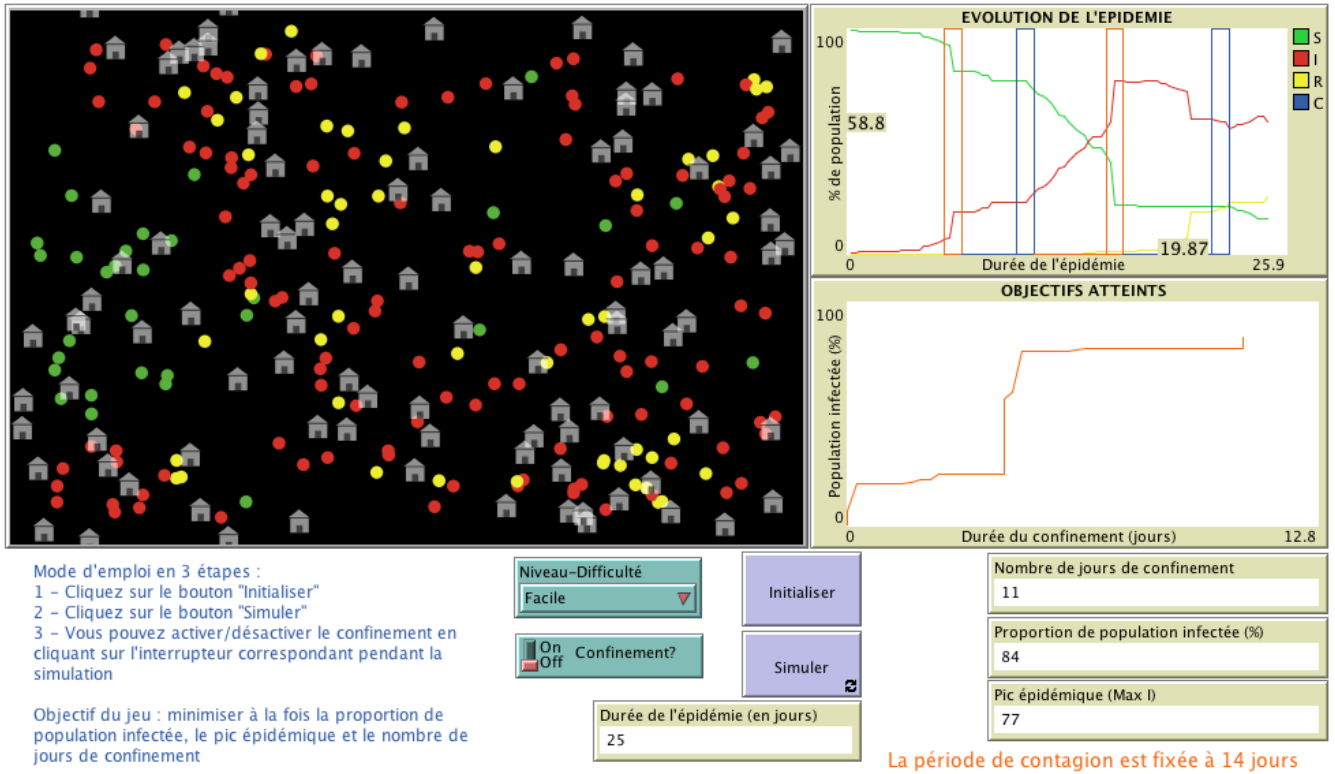




[3]

[3] https://en.wikipedia.org/wiki/Compartmental_models_in_epidemiology

Epidemic simulations - Agent-based models (ABM)



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[4] https://covprehension.org/2020/03/30/q6.html

Epidemic simulations

Mathematical models

- Homogeneous
- Macro-level model
- Macro-level analysis

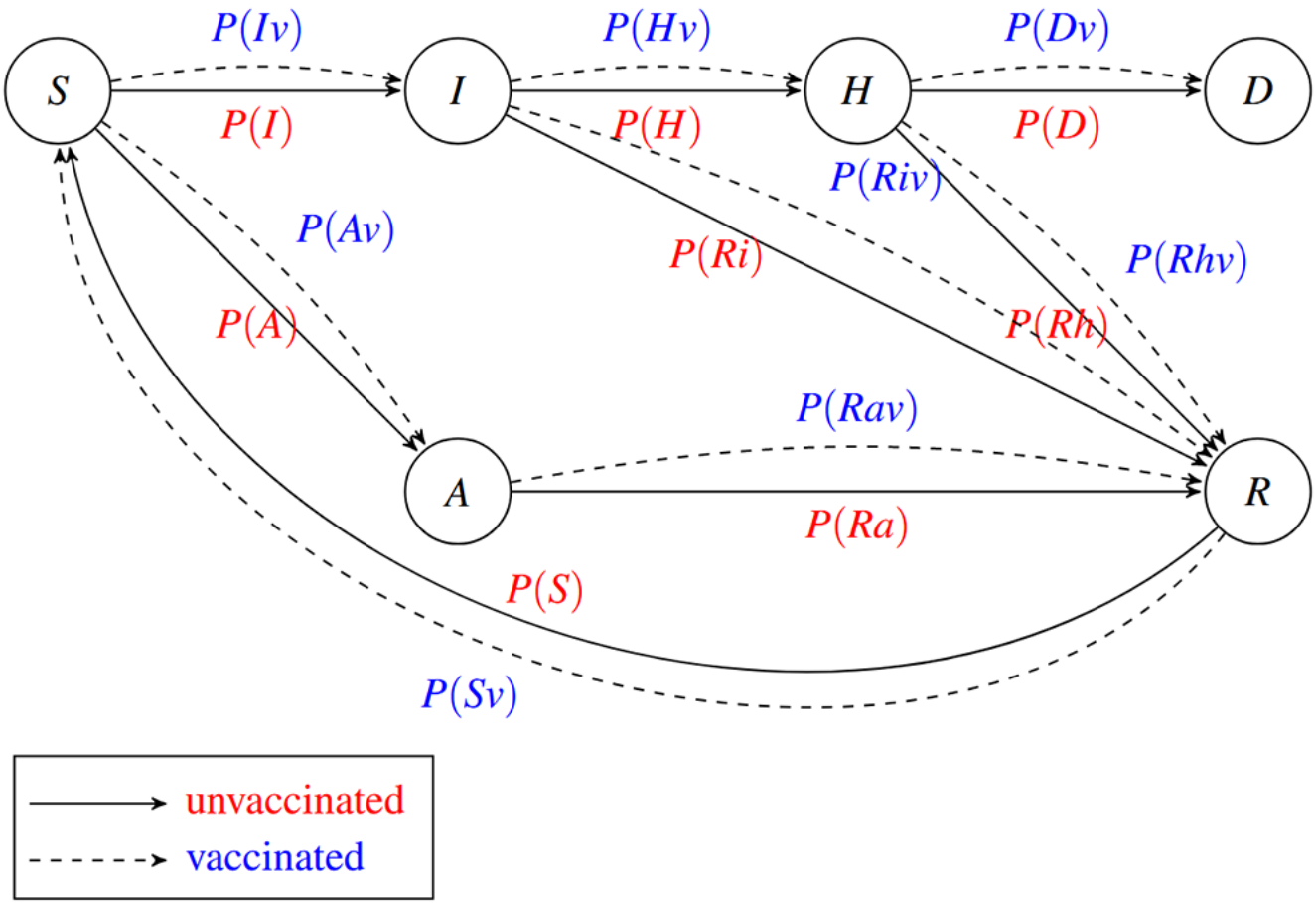
Agent-based models

- Heterogeneous
- Micro-level model
- Micro & Macro-level analysis

Agent attributes

- Epidemiological state
- Vaccine status (boolean)
- Trust level (float: 0.0 - 1.0)
- Misinterpretation status (boolean)

Epidemiological model



S: Susceptible; I: Symptomatic; A: Asymptomatic; H: Hospitalised; R: Recovered; D: Deceased

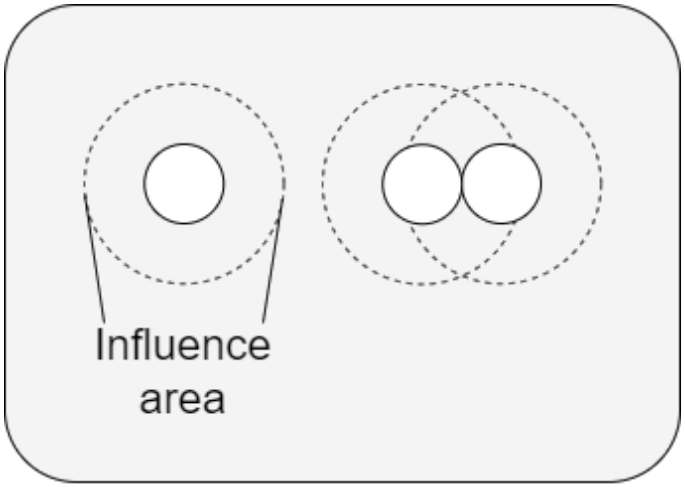
Agent behaviour

- Move randomly
- Hospitalised are put apart
- Susceptible, Asymptomatic & Recovered visit hospitalised
- Uninfected get vaccinated based on their trust level

Three influence over trust:

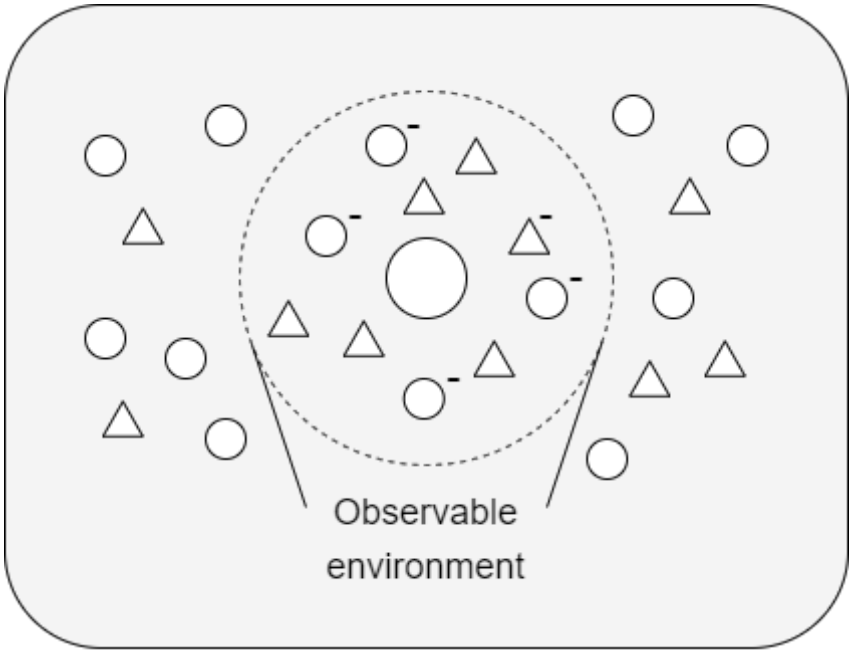
- Interpersonal
- Observational
- Institutional

Interpersonal influence



Agent A's trust level	**Agent B's trust level**	**Resulting influence**
0.9	0.5	High influence of A over B
0.9	0.8	Mutual confirmation
0.9	0.3	A less influenced than B
0.9	0.1	Influence almost cancelled out

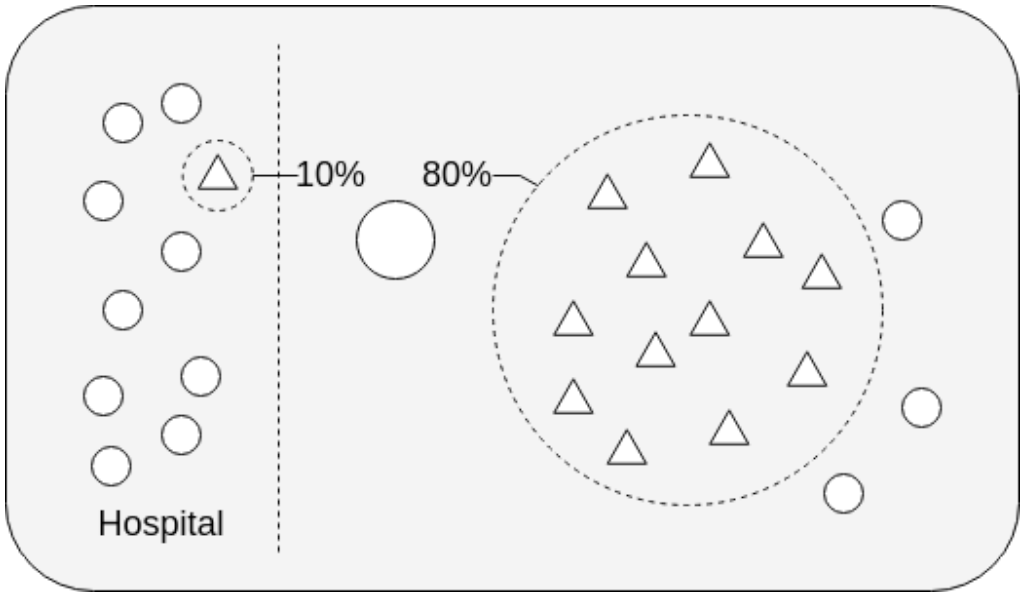
Observational influence



Agent's observation	**Resulting influence**
Vaccinated and not infected	Small increase in observer's trust
Vaccinated and infected	Decrease in observer's trust

Negative information have more impact than positive information

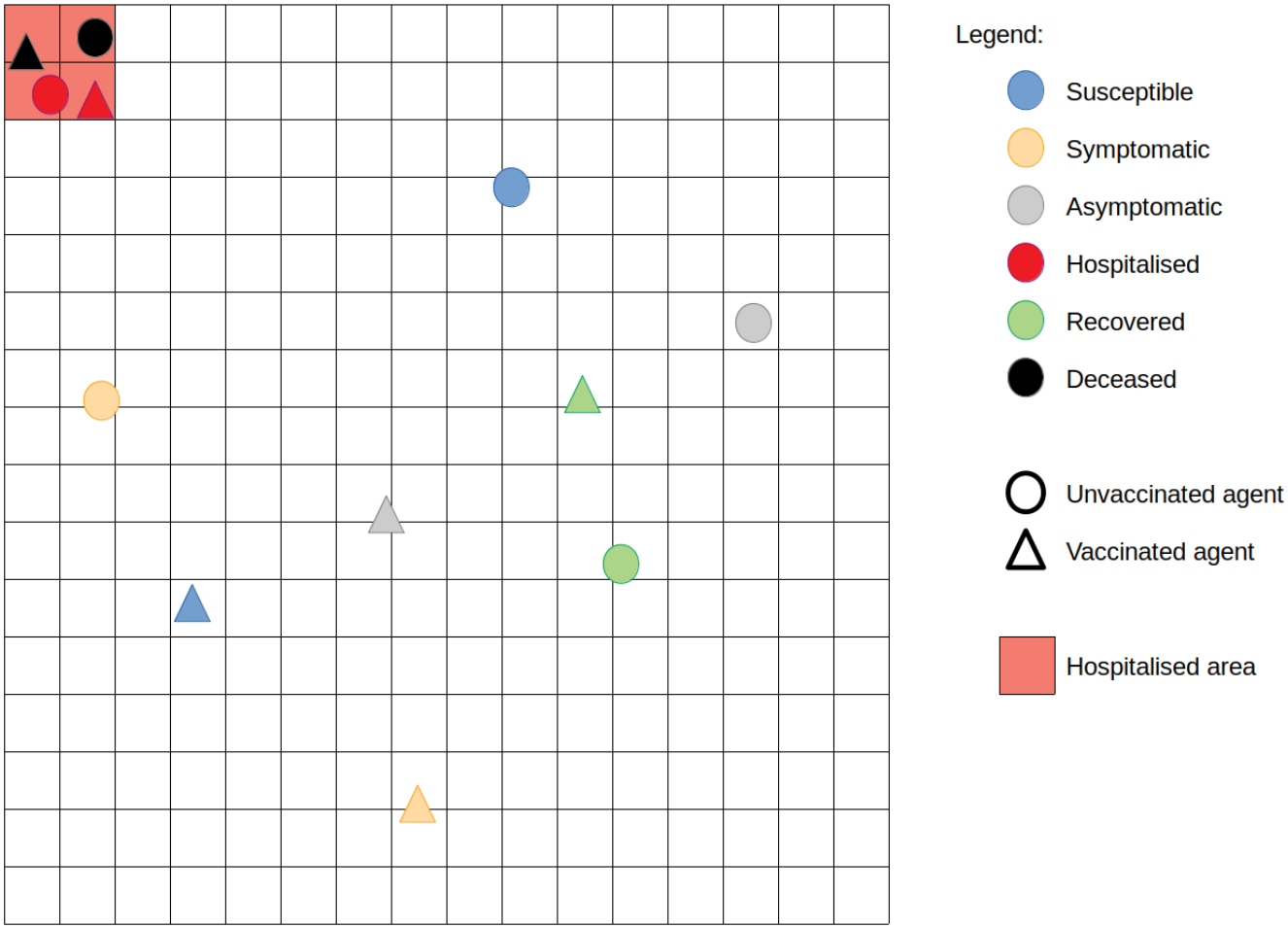
Institutional influence and misinterpretation



Details

- NetLogo
- ∼800 lines
- Based on CoVprehension's Q17
- Available on GitHub
- Runnable on NetLogo Web

Simulation environment



Environment details

- 2000 agents
- Agents initialised unvaccinated
- Agents initialised as Susceptible
- One agent initialised as Symptomatic
- Trust initialised randomly following custom law similar to a skew normal distribution

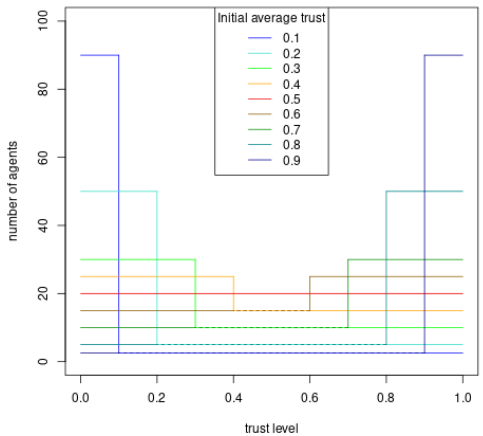


Figure 1: Output of the algorithm used in the initialisation of the population's average trust.

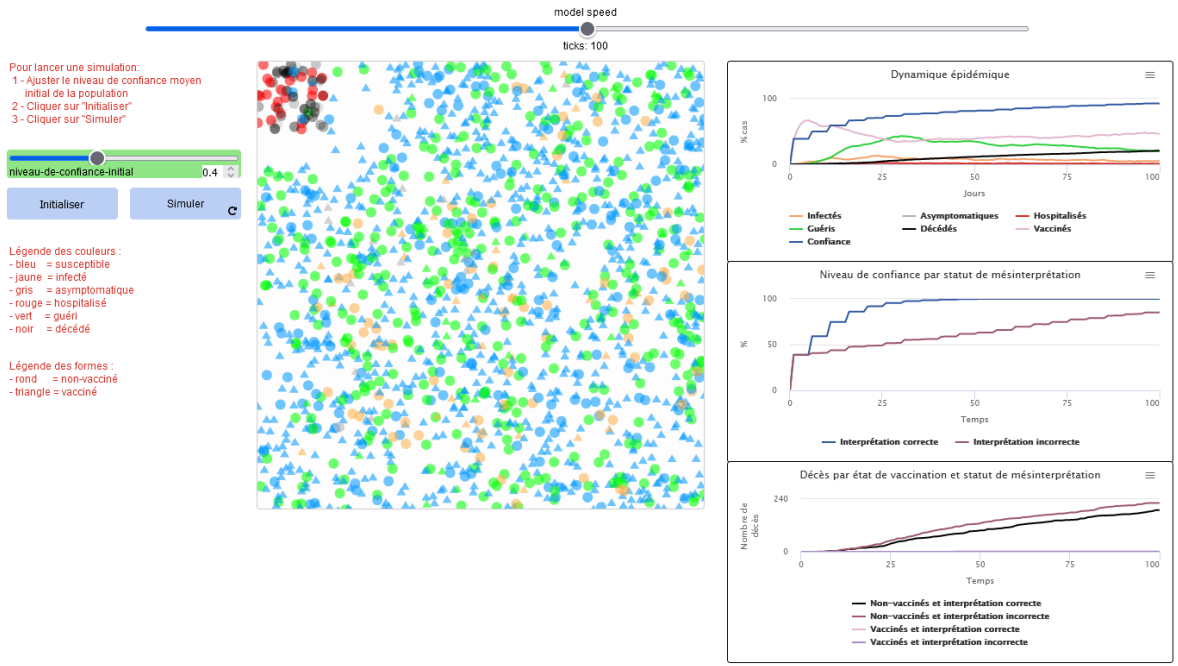
Inputs & Outputs

Input:

- Population average initial trust (0.1 - 0.9)

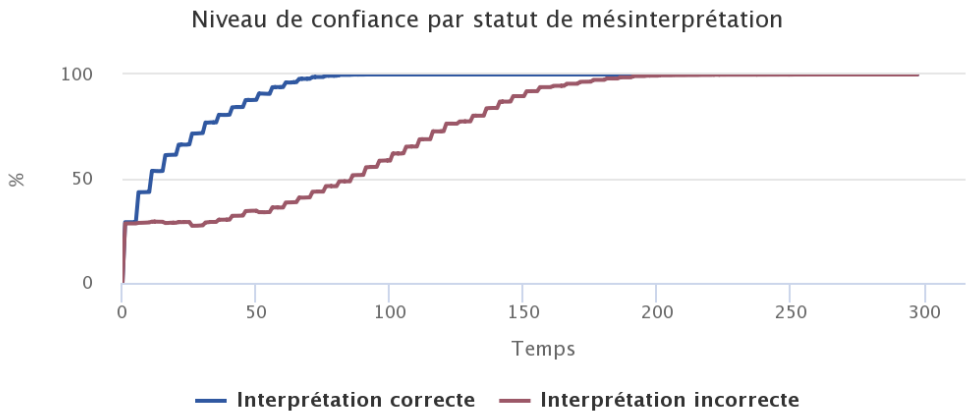
Outputs:

- Trust level per misinterpretation status
- Deceased per vaccination & per misinterpretation status



Trust and misinterpretation

Population's initial average trust: **0.3**



Population's initial average trust: **0.7**

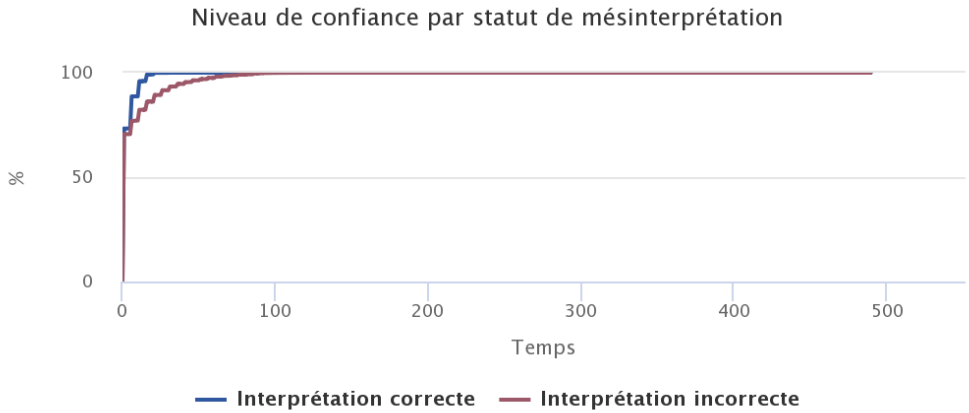
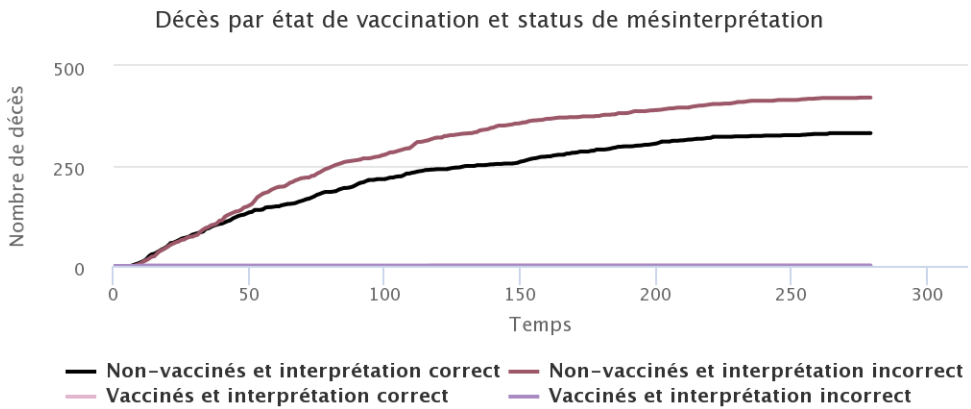


Figure 2: Average trust level per misinterpretation status

Deceased, vaccinated and misinterpretation

Population's initial average trust: **0.3**



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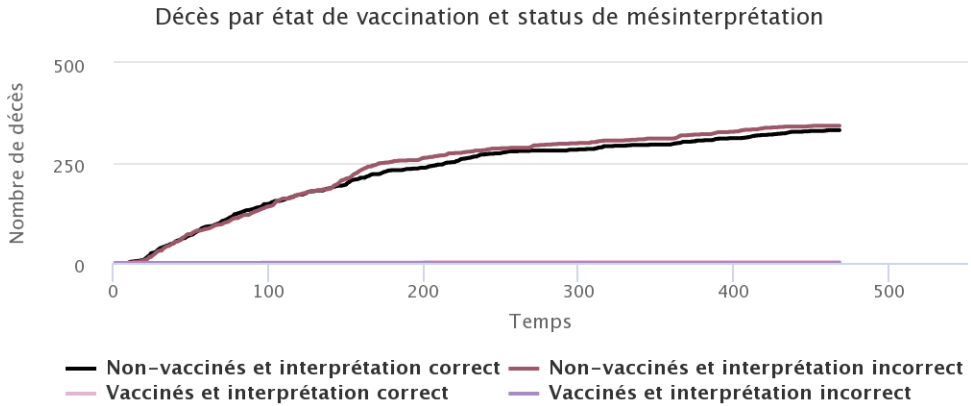

Figure 3: Deceased per vaccination & per misinterpretation status

Contribution

- Combination of epidemiological ABM & trust in vaccines
- Population trust is important and needed before the start of the vaccination campaign
- Making sure that the population correctly understands given information is crucial to heighten trust and give people the desire to get vaccinated

Future plans

- Add age groups
- Households (influence trust among families)
- Different types of information sources (influence trust differently)

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