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Extension of the SIR Model Using a Stratified Population and a Hospital Compartment

Dr. Leonard Mada[1]

[1] Syonic SRL, Timisoara, Romania

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Acknowledgments

- Team Project 2021

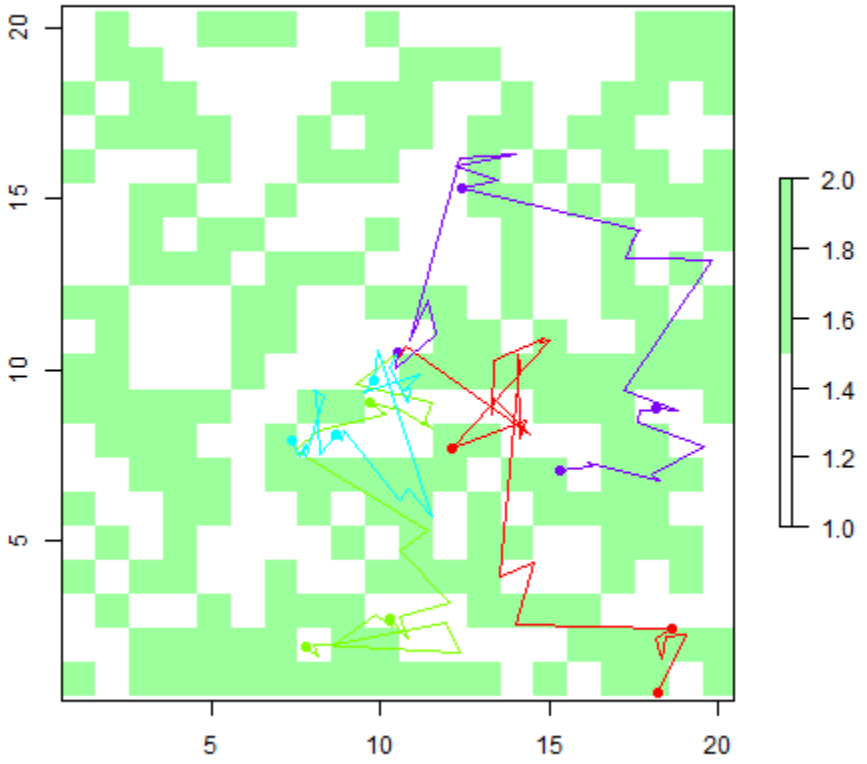
  - Dora Calea, Ioana Obreja, Liviu Sopon and Dragos Ursan – students at West University, Timisoara;
  - Explored the various models;
  - Project initiated by Syonic SRL and supervised by author;

Introduction

- Modeling Epidemics
  - Compartment models: SIR model;
  - Agent Based Models: SpaDES, NetLogoR;
  - Other techniques: particle diffusion;

Introduction: Models

- Agent-Based Models
  - Complicated;
  - Difficult to evaluate;
  - R packages:
    NetLogoR, SpaDES;



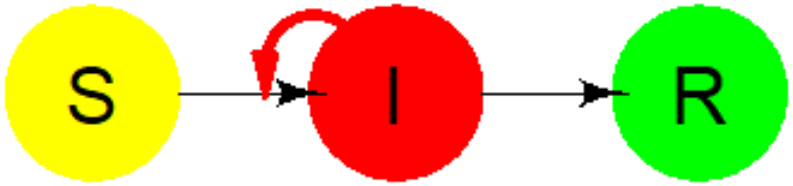
4 agents, but NO interactions

Introduction: Models

- SIR Model
  - Very simple model:
    Too simple!
  - 3 Compartments:
    Susceptible / Infected / Removed;

Advantages:

- Much simpler to program;
- Evaluation: much cleaner;



Objectives

- Extend SIR Model
  - New Compartments
  - Interactive exploration
  - Project for students

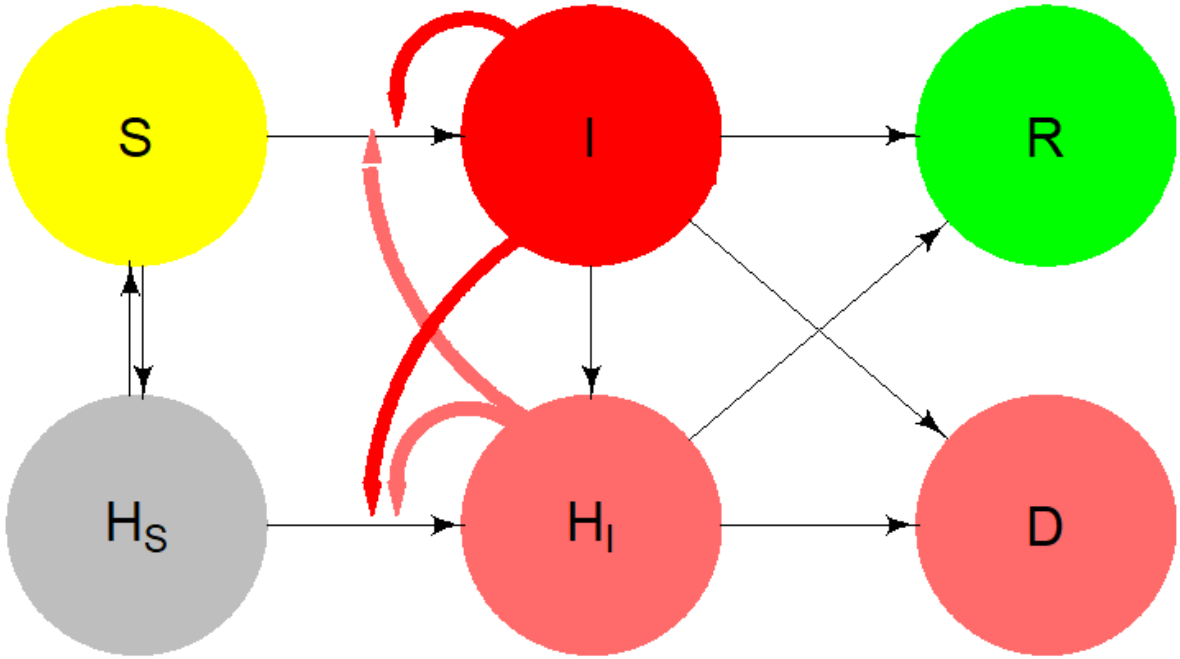
Modeling

- R packages

deSolve	Solve numerically systems of ODEs
ggplot2	Visualisation
shiny	Interactive web app

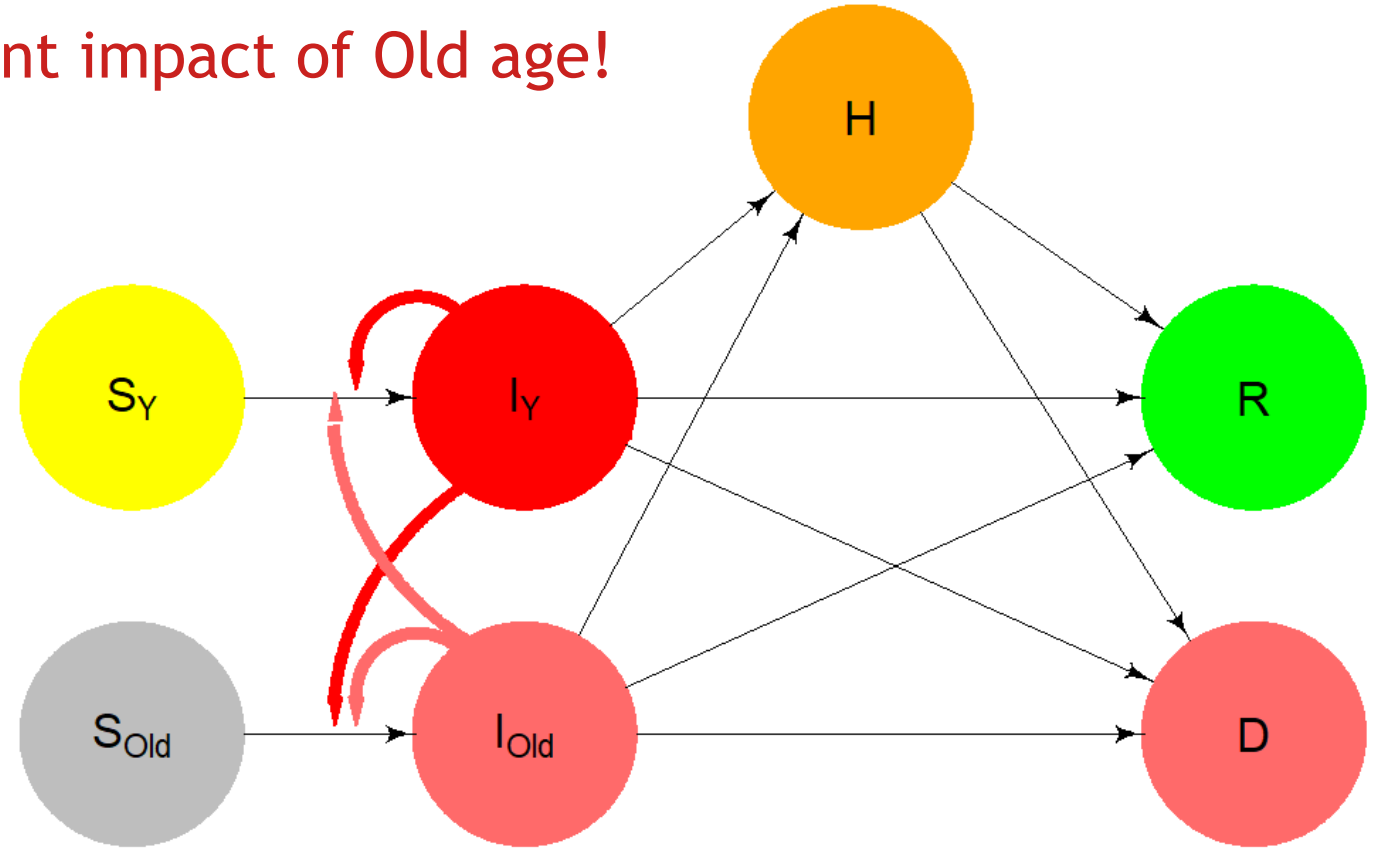
Extended Models

- Model 1: Hospitalization, Death
  - Important compartments



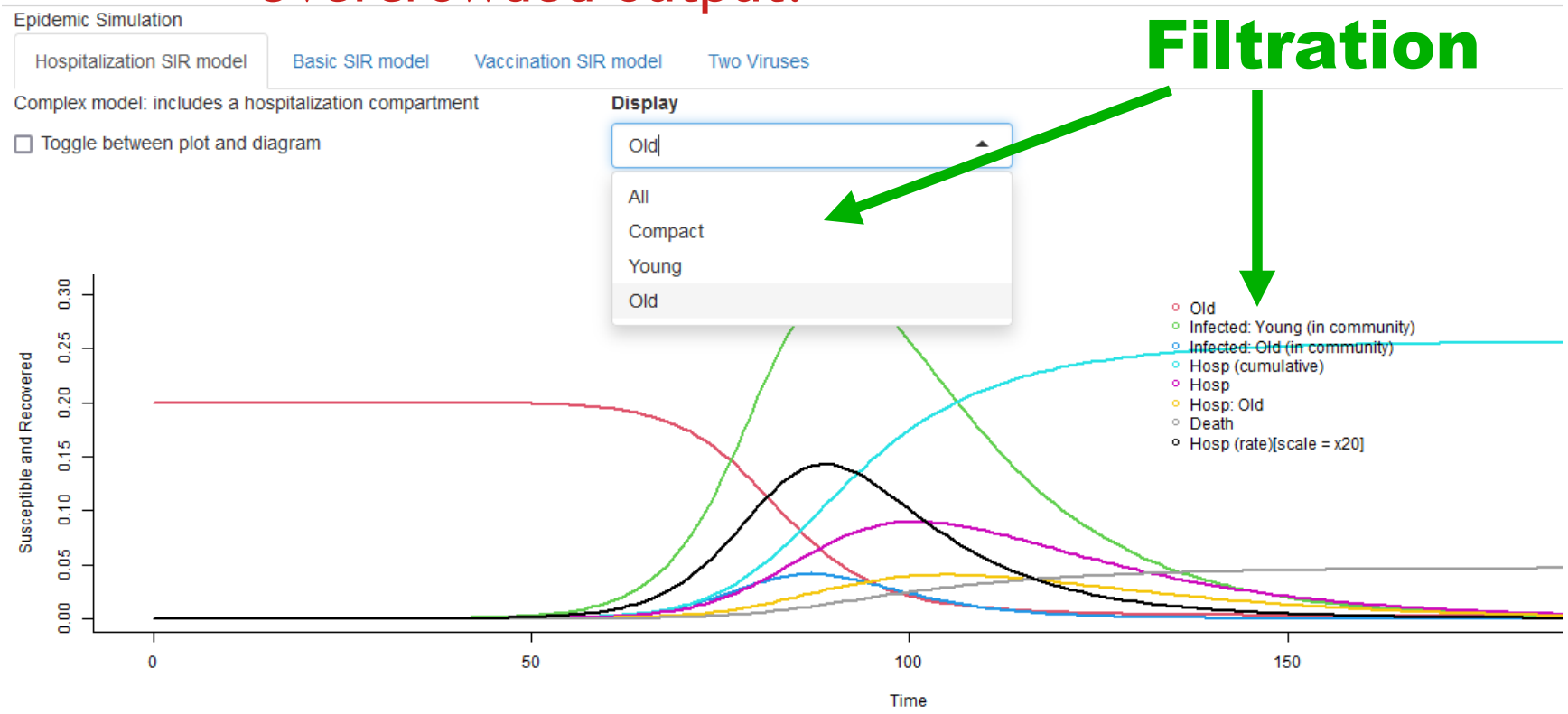
Extended Models

- Model 2: Stratified Population
  - Relevant impact of Old age!



Extended Models

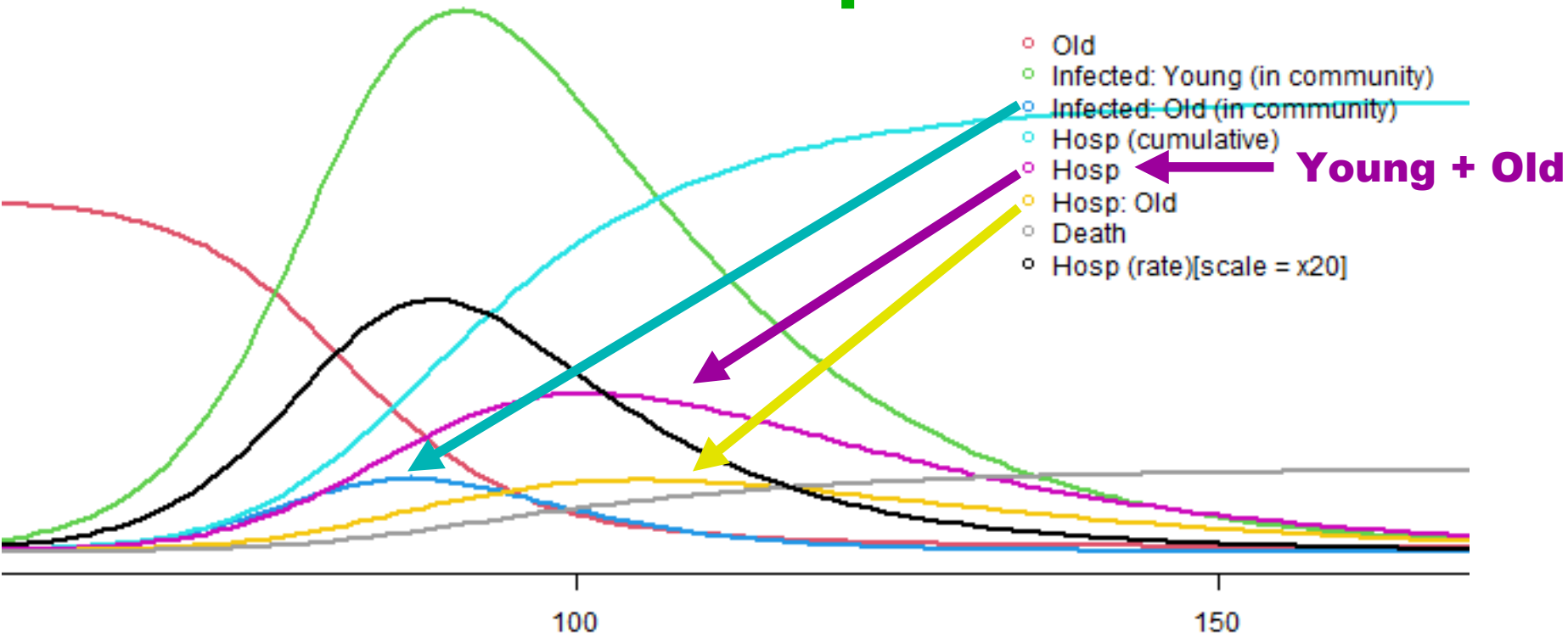
- Model 2: Stratified Population
  - Overcrowded output:



Model 2: Stratified Population

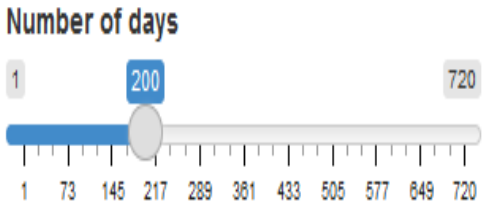
- Outcomes for **Old Age**:
  - Put into context!

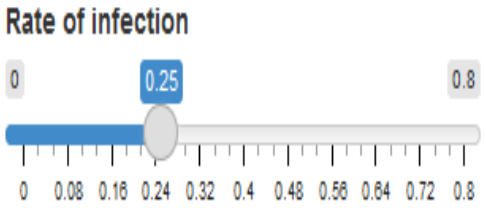
Important Outcomes

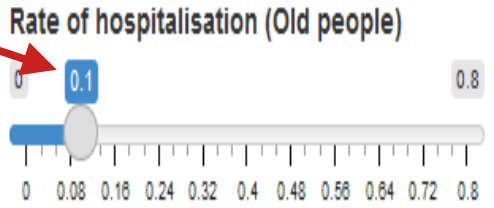


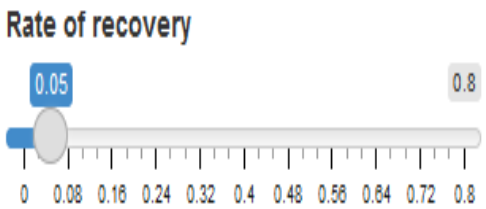
Model 2: Stratified Population

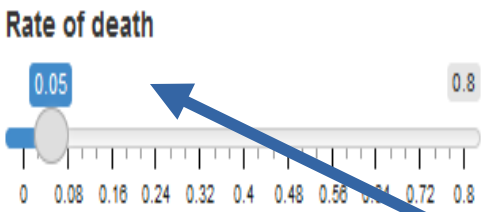
- Parameters:
  - Old Age: higher rate of hospitalization;

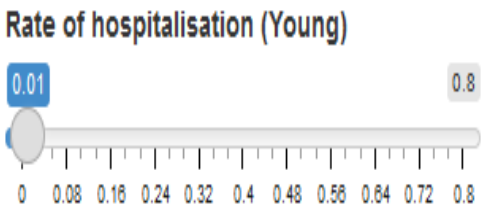


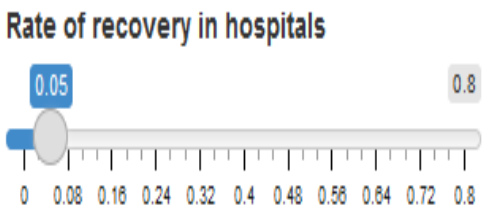


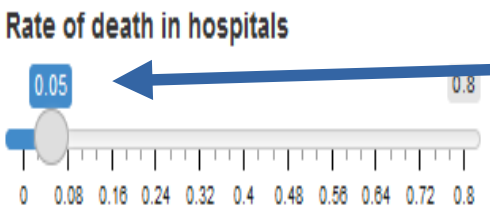








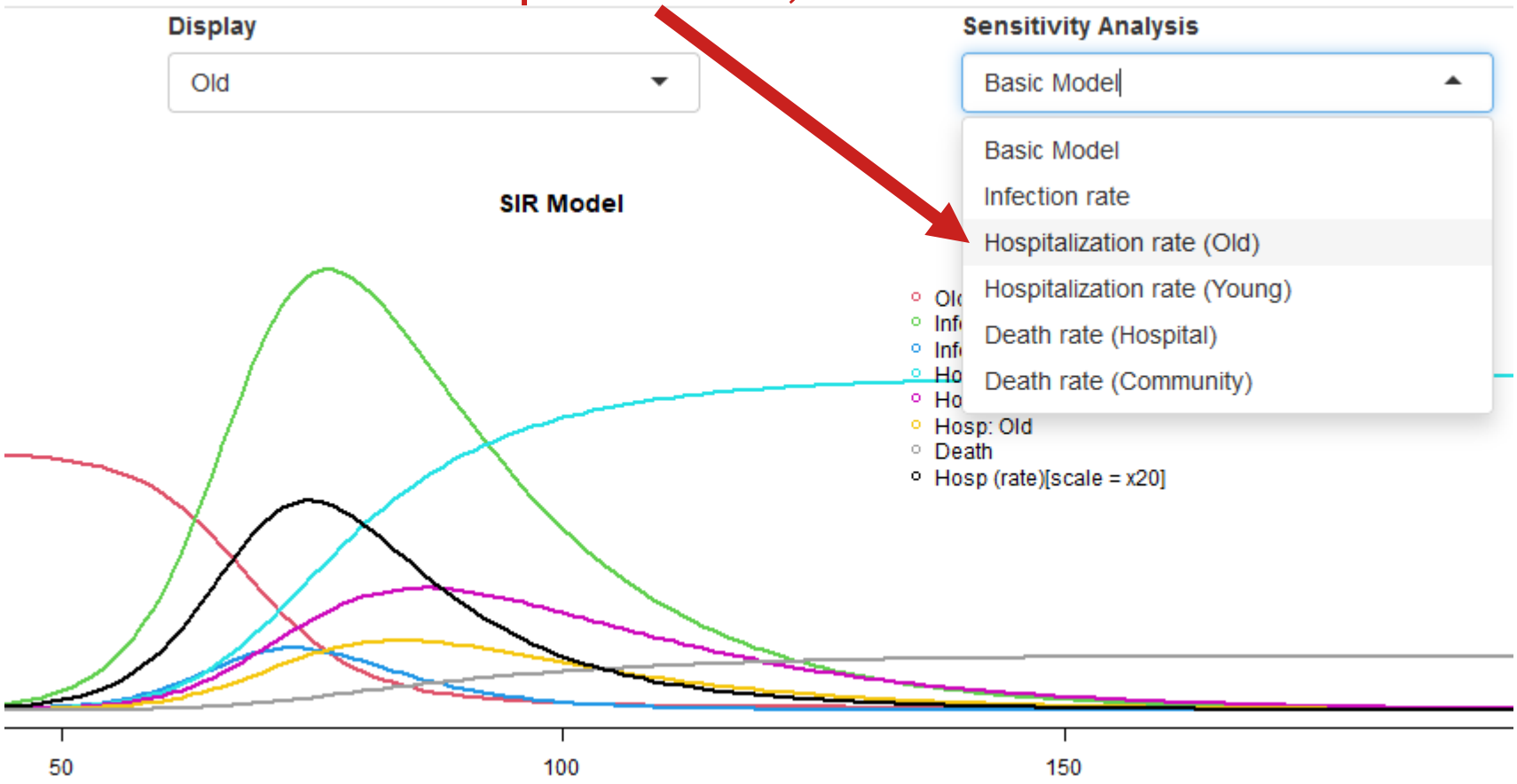




same for Young & Old
(separated in the meantime)

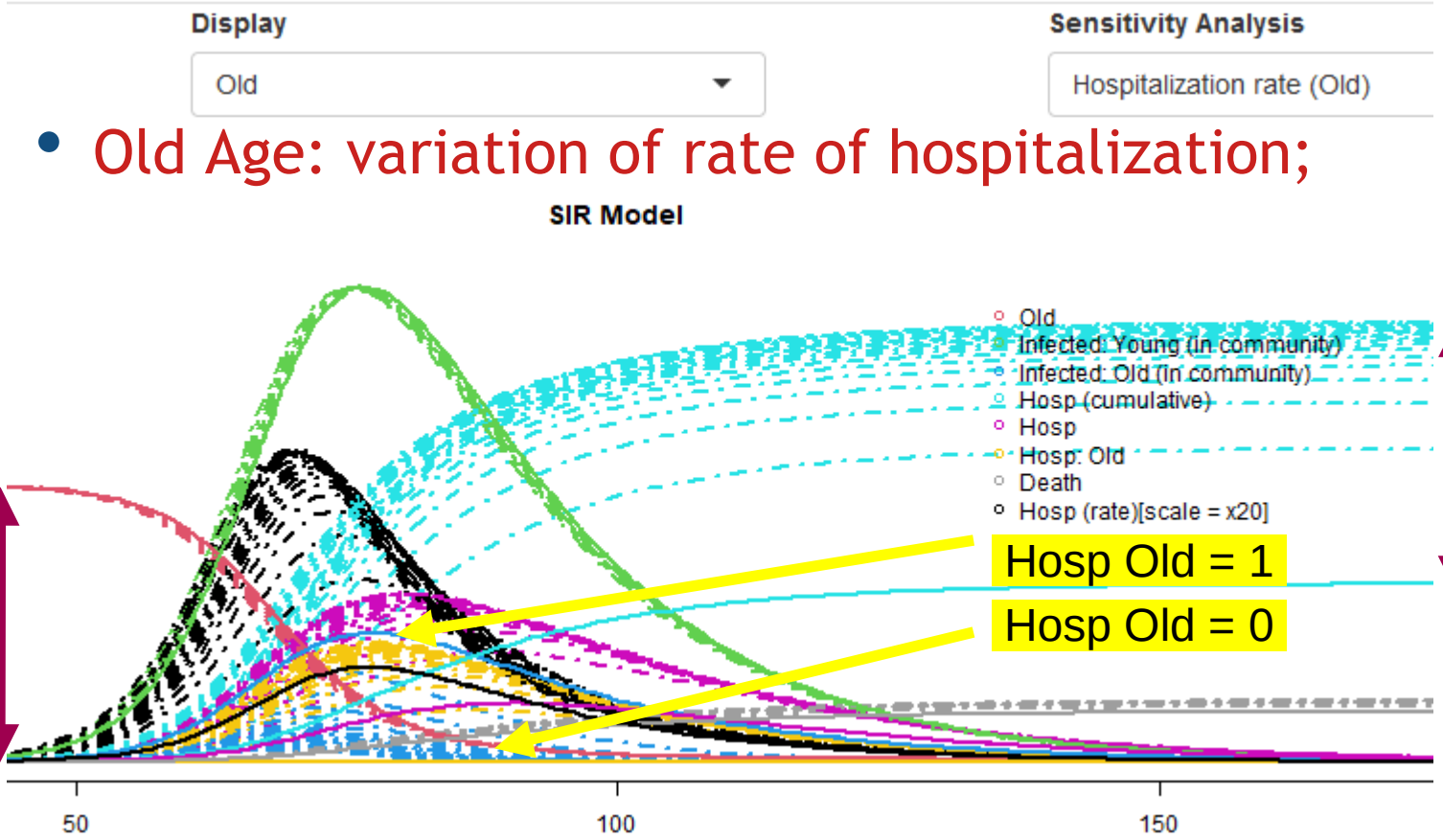
Model 2: Stratified Population

- Sensitivity Analysis:
  - Variation of 1 parameter;



Model 2: Stratified Population

- Sensitivity Analysis:



- Old Age: variation of rate of hospitalization;

Extended Models

- Model 3: + Vaccination
  - Not yet properly implemented!
  - dS = ... – *vacc_rate*;

    vacc_rate = constant daily capacity, but ...;
  - TODO: vaccination strategies, e.g. Old vs All;

Challenges / Issues

- Challenges:
  - Fit real data!
  - Visualization:
    How to display many outcomes?
  - Parameters:
    How to interact with many parameters?

Conclusions

- Extended SIR:
  - Extension is easy:
    - Interactive, real-time!
  - Sensitivity analysis: impact of 1 parameter;
- Challenges:
  - Fit real data
  - More compartments: Visualisation, Parameters?

Thank you!

Abstract:
L. Mada. Extension of the SIR Model Using a Stratified Population and a Hospital Compartment. Vol 43 No Suppl. S1 (2021): RoMedINF2021. Section: Special Issue - RoMedINF2021
https://ami.info.umfcluj.ro/index.php/AMI/article/view/838