# G-CSC Epidemics group
# An introduction to disease modelling via SEIRD

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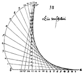
# Overview





# Situation

1. Diseases are not nice
2. Infectious diseases are doubly not nice
3. Infectious diseases in todays interconnected world are horrible

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**Question:** Are we able to broadly understand their behavior?

# Situation

- Infectious disease models can give quantitative answers
- Although not perfect, results can guide policy
- Won't yield insights into disease itself but its effect on society

- The **EpidemicsRunner** developed by the G-CSC allows the user to test various scenarios and relate these models to the real world
- The user can define scenarios...

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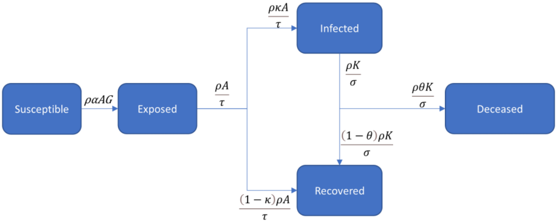
- The user can define scenarios...and fit the models to real life data

The EpidemicsRunner is quick response guidance tool, that allows a non-expert user to quickly simulate various epidemics scenarios based on real data.

# SEIRD Model

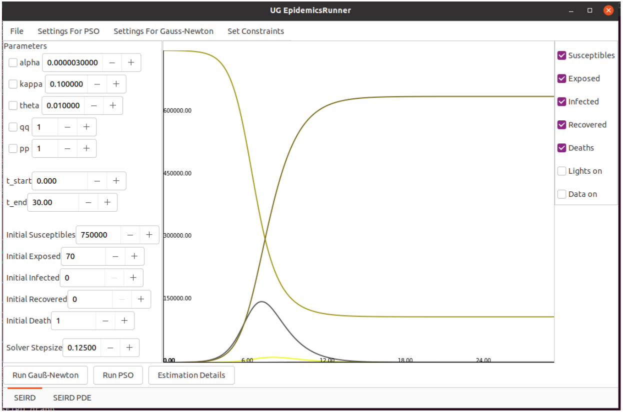
- The (S)usceptible (E)xposed (I)nfected (R)ecovered (D)eceased model is a well known framework to model the spread of infectious diseases
- It is the simplest model found in EpidemicsRunner
- Is a robust basis for other more specialized models



# SEIRD Model (ODE)

$$
\begin{aligned}
\frac{dS}{dt} &= -\alpha SE \\
\frac{dE}{dt} &= \alpha SE - \frac{1}{qq}E \\
\frac{dI}{dt} &= \frac{\kappa}{qq}E - \frac{1}{pp}I \\
\frac{dR}{dt} &= \frac{(1-\kappa)}{qq}E + \frac{(1-\theta)}{pp}I \\
\frac{dD}{dt} &= \frac{\theta}{pp}I
\end{aligned}
$$

# ODE Widget - Overview



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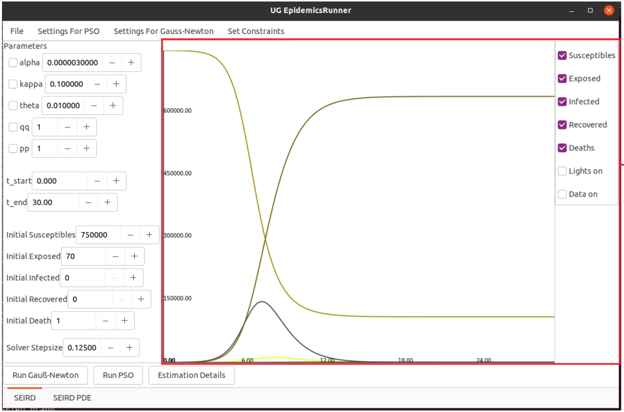


**Modelling results**

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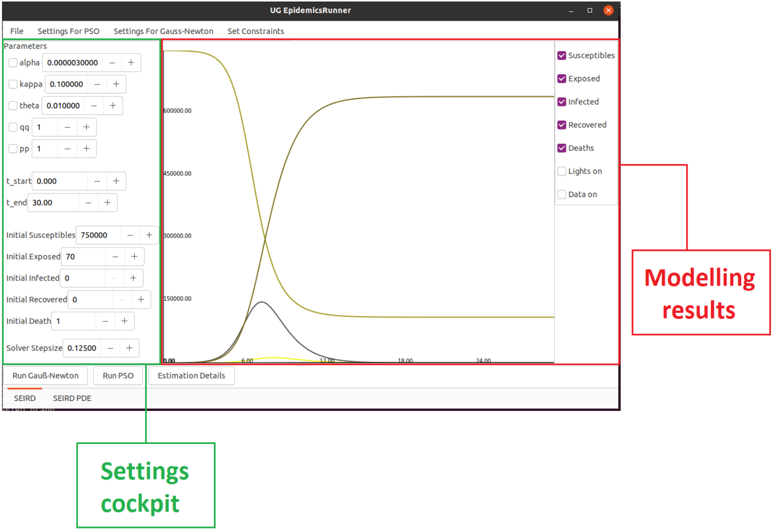

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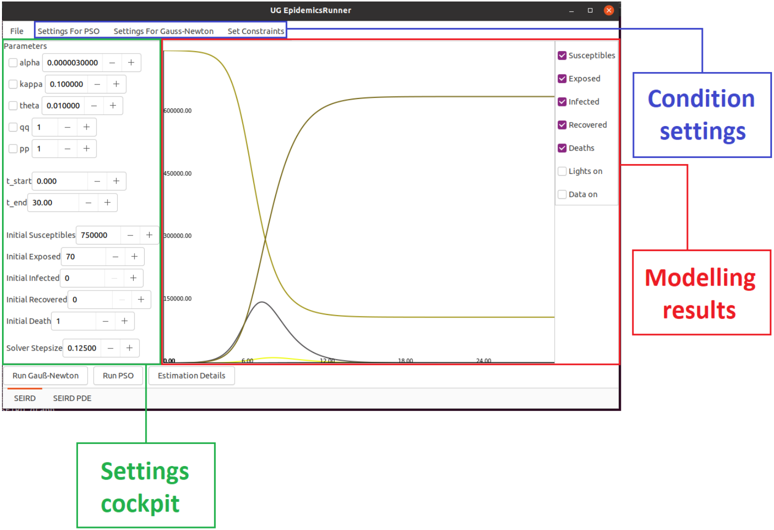

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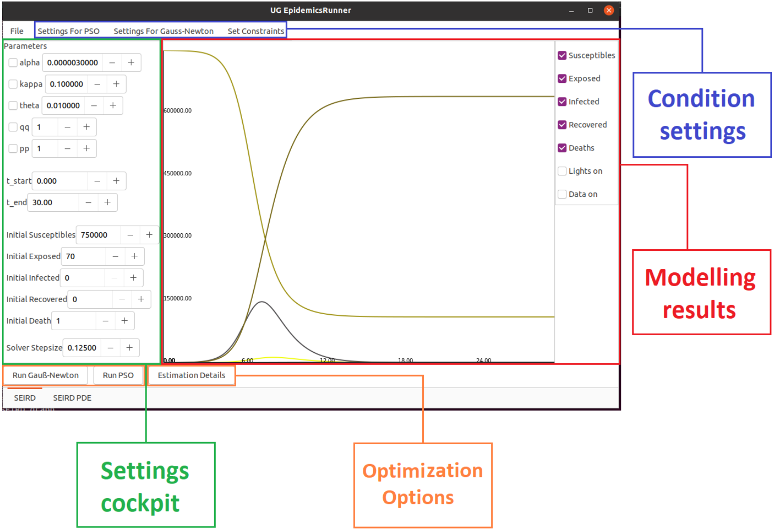

# Live "modelling" session 1

Let us model $\alpha$ for a scenario:

1. Rapid spread:

| | |
|---|---|
| Infected | 820000 |
| Exposed | 2018 |
| timeframe | 37 days |

2. Infection Wave (optional):

| | |
|---|---|
| Infected | 820000 |
| Exposed | 8147 |
| timeframe | 81 days |

# Partial differential Equations (PDE)

Limits of the **ODE** model:

- Only dependent on time
  $\rightarrow$ no spatial or structural "awareness" of the model
- Different regions need to either be modelled individually or clustered together

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Advantages of the **PDE** model:

- Other parameters can be factored into the modelling process (space, demographic, etc.)
- Multiple regions can be modelled at the same time with different parameters

# Partial differential Equations (PDE)

$$
\begin{aligned}
\frac{dS}{dt} + \nabla[-\mathbf{D}\nabla G] &= -\alpha SE \\
\frac{dE}{dt} + \nabla[-\mathbf{D}\nabla A] &= (\alpha SE - \frac{1}{qq}E) \\
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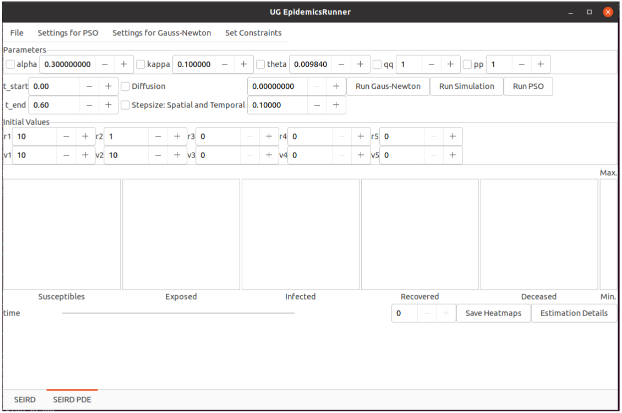
# The PDE widget - Overview



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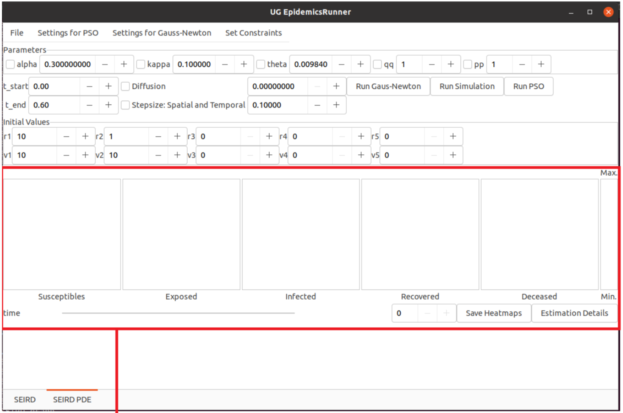


Modelling results

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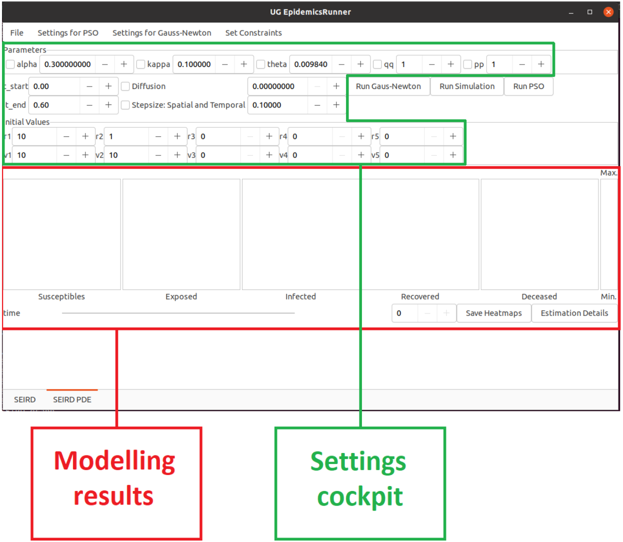

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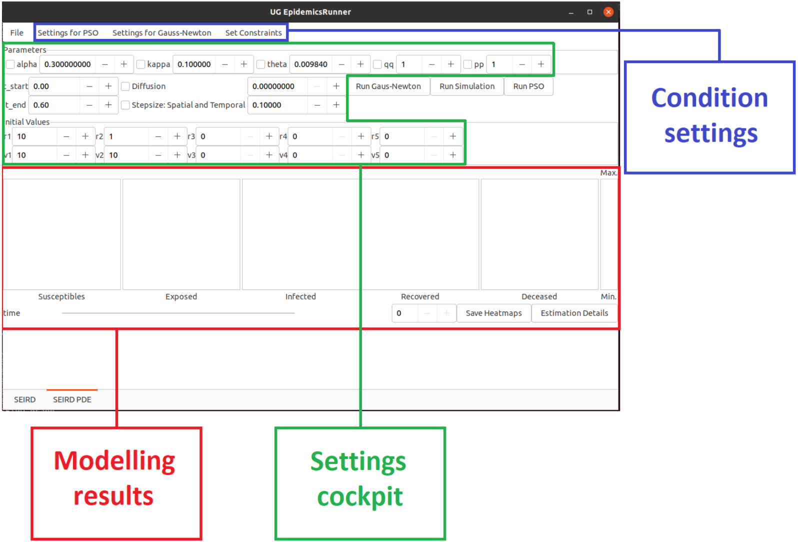

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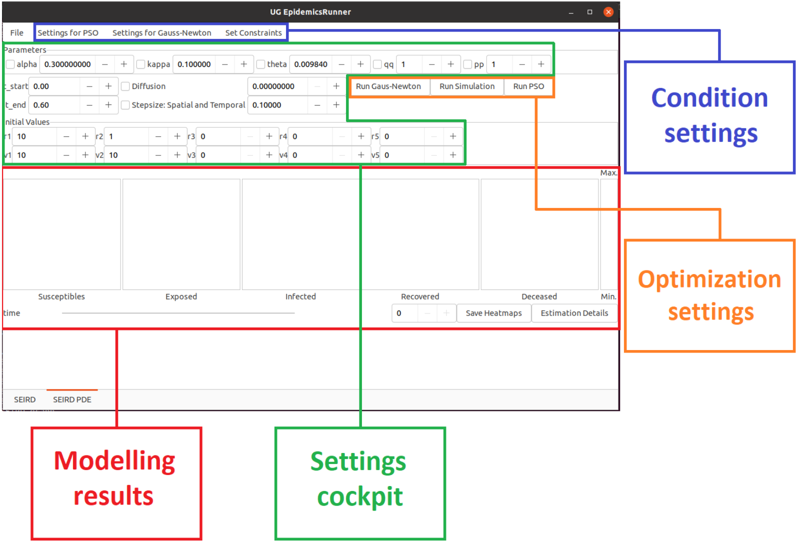


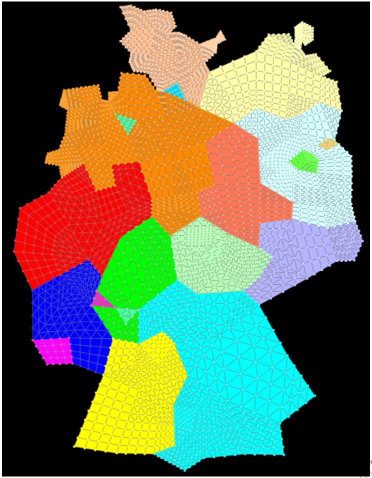
# Live "modelling" session 2

- Let us start to simulate a small scenario
- And meanwhile look at the result of a longer simulation, with a finer grid

# Modelling Covid in Germany

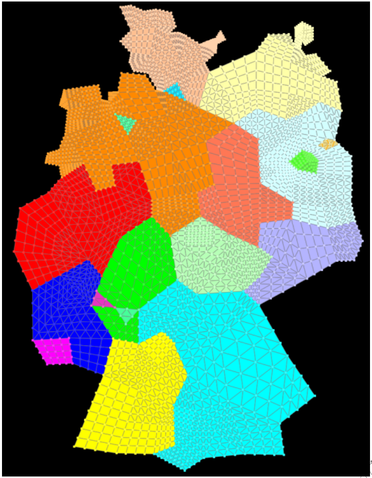
# Modelling Covid in Germany

- We started out with a grid of Germany.



# Modelling Covid in Germany

- We started out with a grid of Germany.
- But of course, once you have a gird...



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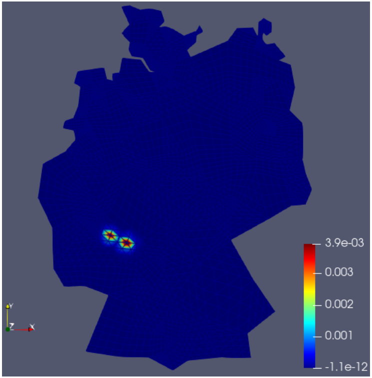
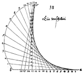



reasonable parameters



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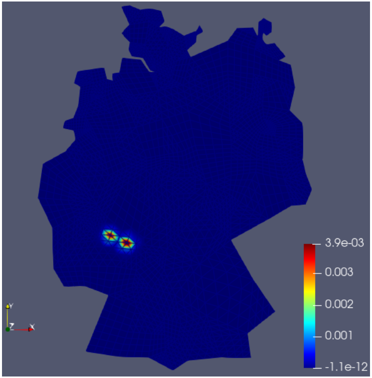


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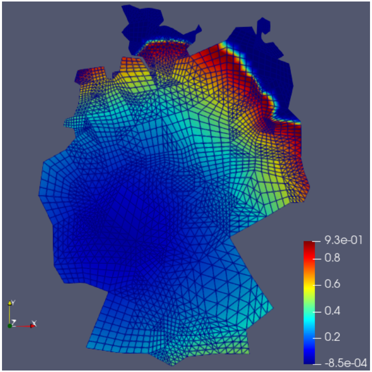
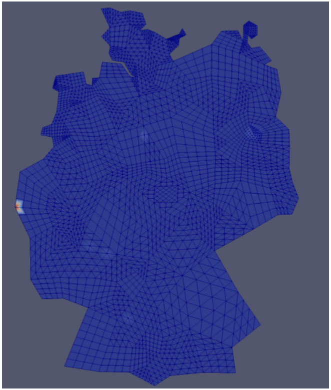



not so reasonable parameters

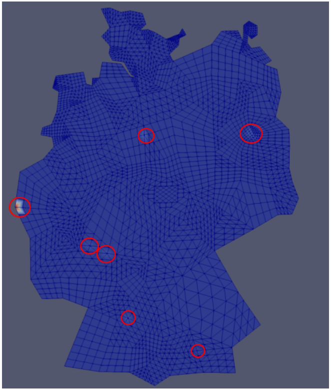
# Modelling Covid in Germany

- Of course we also did some serious modelling



# Modelling Covid in Germany

- Of course we also did some serious modelling
- PDE model for seven cities in Germany
  - Hannover
  - Heinsberg
  - Frankfurt
  - Wiesbaden
  - Stuttgart
  - München
  - Berlin



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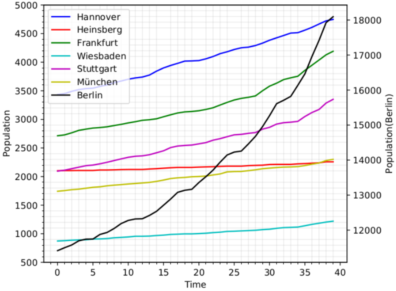
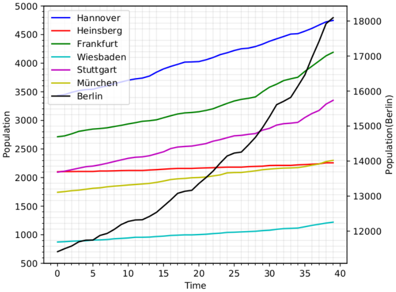
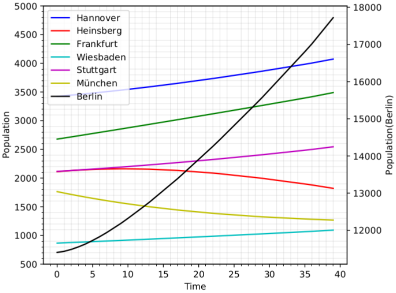



Real world infection cases

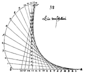
# Modelling Covid in Germany




Real world infection cases




Modelled infection cases



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Future topics:

- Modelling of smaller areas with finer grid [in progress]
- Use the model in differenct scenarios (countries, diseases, ...)
- Compare SEIRD with statistical models

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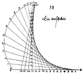
Current applications:

- Public health management (easy modelling of scenarios)
- Use SEIRD to prepare for future epidemics/pandemics (Supplies, Beds, Employees)
- Study and understand the mechanics of disease spreading



# Questions, Answers and Discussions

**Thank you for your attention and for hosting this event!**