Study Report of Week 2

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Study Content

1. Read the paper of the SIR+TTI model
   - Focused on the 'method' part of the paper
   - Learn the use of Matlab and run the code of this paper
2. Read the paper of Covasim
   - Learn how to use Covasim software
   - Done an experiment of covasim using the data of NSW

Understanding of Covasim

Aim

To provide real decision-making opinions based on different scenarios, including predicting trends, exploring intervention, and estimating resource allocation.

Method

Covasim simulates the state of individual people as agents, over a number of discrete time steps.

Logic flow

1) create simulation objects (load initial settings)
2) create agents
3) Integration loop
   i. dynamic rescaling
   ii. applying health system constrains
   iii. update state of each agent
   iv. applying interventions
   v. calculating disease transmission
   vi. applying analysers

Outcomes

Covasim can be used to simulate real-world situations by a small piece of code efficiently, providing a mechanistic understanding of the covid-19.

Important concepts

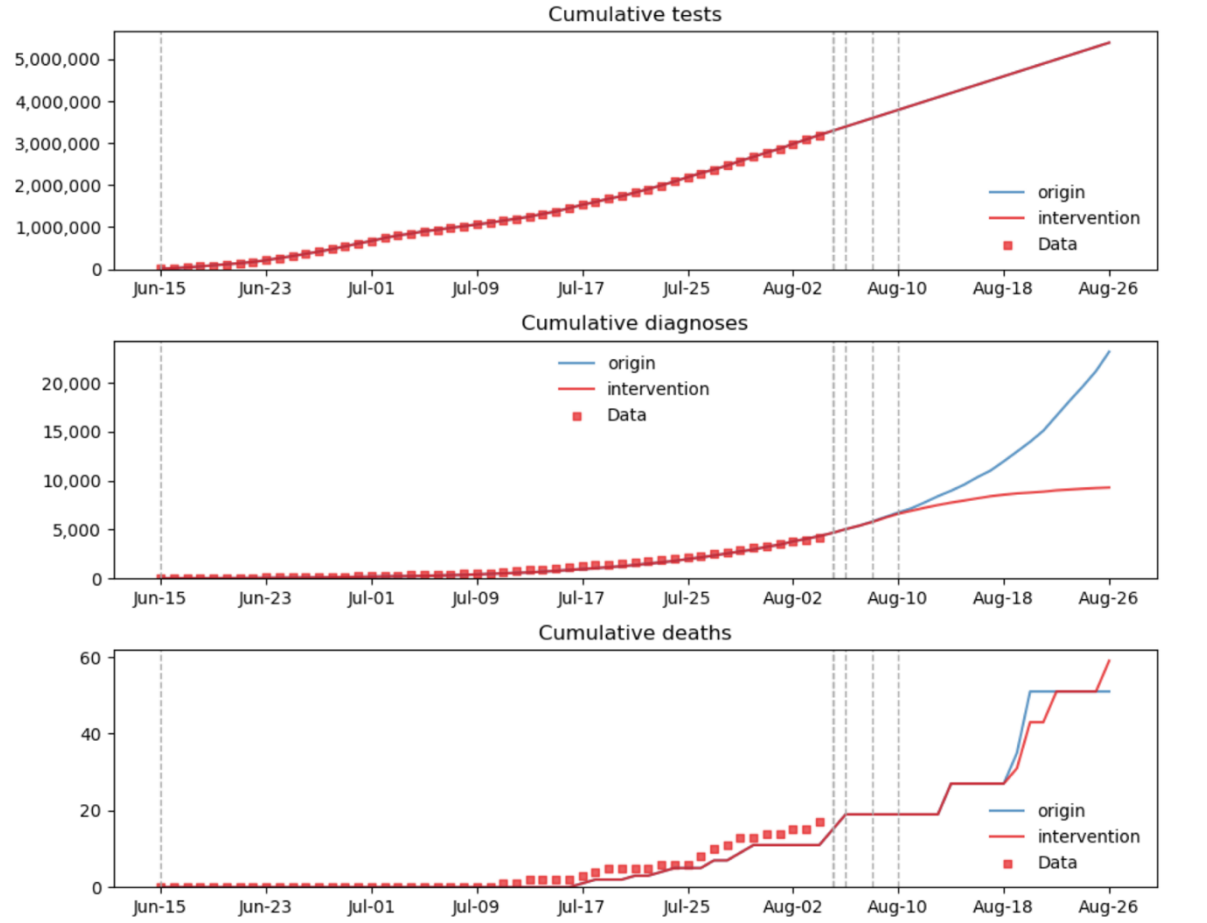
1. contact network models:
   - random networks. (situations: prisons, cruise ships)
   - SynthPops network (need data-rich settings)
   - hybrid networks. (appropriate in most modelling contexts)
2. interventions, can be used to simulate following events:
   - closing school, lockdown
   - protecting elderly
   - applying physical distancing, masks and hygiene
   - applying testing and diagnosis, contact tracing and isolations
3. Dynamic rescaling
   - can be used to simulate arbitrarily large populations
   - improve performance
4. Calibration

   minimize a function that measures the differences between observed data and model perditions.

Experiment of Covasim

In this experiment, I used the real data of NSW, together with dynamic rescaling to simulate the trend of NSW; and I used calibration to fit the model and data, and the results of different interventions were compared. The intervention includes closing school, workspace and community, contact tracing, etc.

Although it is a simple model, there is a conclusion: if intervention is carried out, the accumulated cases will gradually increase, otherwise it will grow exponential.



Questions

1. About the experiment:
    a. Since it is difficult to find data of Sydney alone, can I use NSW data instead?
    b. Are there any suggestions for improvement for my Covasim experiment? what's your expectation?
    c. Can I spend more time digging into the SIR model using numerical methods? (I need to prepare for a COSC7500 project related to this topic)
2. About research
    a. If I want to do research, what aspects can I do next?
    b. What is your project look like?
    c. From a video of the Safe Blues project, I find a technique used Neural ODE to solve model problems. Can you study this technology or something like that?

Plan for next week

1. Continue to understand covasim (refine the experiment by adding vaccine etc.)
2. Try to understand the technical principles behind covasim
3. Continue the study of the SIR+TTI mathematical model

Appendix

Code for the experiment:

```
from datetime import timedelta, datetime

def dayShift(d):
    return (datetime.today() + timedelta(d)).strftime("%Y-%m-%d")
start_date='2021-06-15'
end_date = dayShift(21) # '2021-09-15'
today = datetime.today().strftime("%Y-%m-%d")
init = processDate(start_date)

# Parameters
pars = dict(
    location = 'Australia',
    pop_type  = 'hybrid',
    pop_size  = 81.66e3, # 8.166M people
    pop_scale = 100,
    pop_infected = init * 0.01,
    rescale   = True,
    rescale_threshold = 0.05,
    rescale_factor = 2,
    start_day = start_date,
    end_day   = end_date,
    beta      = 0.023,
)

# Interventions
tn_data = cv.test_num('data')  # actural data from csv
tn_fixed = cv.test_num(daily_tests=100000, start_day=today)  # daliy test
tp = cv.test_prob(symp_prob=0.2, asymp_prob=0.001, symp_quar_prob=1.0,
asymp_quar_prob=1.0, do_plot=False)
ct = cv.contact_tracing(start_day=today, trace_probs=dict(h=1.0, s=0.5, w=0.5,
c=0.3), do_plot=False)

interventions = [ # intervension using just fixed daliy test after today
    tn_data,
    tn_fixed
]
sim1 = cv.Sim(pars=pars, datafile="nsw.csv", interventions=interventions,
label='origin')

interventions = [
```

```
    cv.clip_edges(days=today, changes=0.0, layers='s', do_plot=True), # close
schools
    cv.clip_edges(days=[dayShift(1), dayShift(3), dayShift(5)],
                changes=[0.3, 0.3, 0.3], layers=['w', 'c'], do_plot=True), #
close/reopen work + community
    tn_data,  # actual data from csv
    tn_fixed, # daliy test
    ct        # contact tracing
]
sim2 = cv.Sim(pars=pars, datafile="nsw.csv", interventions=interventions,
label='intervention')

# Run and plot
msim = cv.MultiSim([sim1, sim2])
msim.run(n_runs=1)
msim.plot(to_plot=['cum_tests', 'cum_diagnoses', 'cum_deaths']);
```