Spreading of Influenza Epidemic

- Four state variables.
- Initial population of 10,000 non-infected individuals.
- Stem of influenza is introduced into the system.
- Infections occur spontaneously.
- Virus spread in infected individuals and after some time, the individuals fall sick.
### Spreading of Influenza Epidemic

- Contagious people = sick + infected, spread the disease further
- The sick people eventually get cured, immune people
- Immune period is temporary due to mutation of virus.
- Immune people turn into non-infected people again who are again susceptible to infection.

### Influenza Model Parameters

- Time to breakdown, 4 weeks
- Actual sickness period, 2 weeks
- Immune period, 26 weeks

\[
\text{Incubation} = \text{floor} \left( \frac{\text{Infected population}}{\text{Time to break down}} \right)
\]

\[
\text{Activation} = \text{floor} \left( \frac{\text{Immune population}}{\text{Immune period}} \right)
\]

\[
\text{Cure Rate} = \text{floor} \left( \frac{\text{Sick population}}{\text{Sickness duration}} \right)
\]
Influenza Model Parameters

- Average weekly contacts of a person with others, \( C_{wk} = 15 \)
- Contraction rate per contact, \( \text{Rate}_C = 0.25 \)

\[
\text{Infection\_rate} = \min(\text{floor}(\text{Non\_infected\_population} \times C_{wk} \times \text{Perc\_infected} \times \text{Rate}_C + \text{Initial}), \text{Non\_infected\_population})
\]

\[
\text{Perc\_infected} = \frac{\text{contagious}}{\text{total}}
\]

Governing Equations

\[
\frac{d(\text{Non\_Infected\_population})}{dt} = \text{Activation} - \text{Infection\_Rate}
\]

\[
\frac{d(\text{Infected\_population})}{dt} = \text{Infection\_Rate} - \text{Incubation}
\]

\[
\frac{d(\text{Immune\_population})}{dt} = \text{Cure\_Rate} - \text{Activation}
\]

\[
\frac{d(\text{Sick\_population})}{dt} = \text{Incubation} - \text{Cure\_Rate}
\]
Block Oriented Approach

Object Oriented Approach #1

- Influential
  - Components
    - Cure: Rate_C
    - Sick: time_to_breakdown, immune_period, infected_population, sick_population

- Constants

- Immune
- Sick
- Non Infected
- Infected
- Less Components
Object Oriented Approach #2

Object Oriented Approach #3, multiple connectors or connect several comp.
Coclusions

- The influenza epidemic spreads rapidly
- Within 4 weeks, the percentage of sick people reaches its maximum of roughly 25%
- A steady state is reached about 20 weeks
- The disease does not die out naturally.
- A certain percentage loses immunity sufficiently fast to get infected before the virus stem has disappeared.
Exercise

• Make the influenza library with the suggested packages, components, interface, and example

• Tip: The inner and outer operators can be useful (what happens with the encapsulation rule?)
  Define the constants in the package level