THE SIXTH SMART CITY APPLICATIONS INTERNATIONAL CONFERENCE

Agent-Based Model for Analyzing COVID-19 Infection in the Campus Using AnyLogic Software

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Outline

- Introduction
- Problem Statement
- Literature Review
- Research Methodology
- Results and Analysis
- Conclusion and Recommendations
- References

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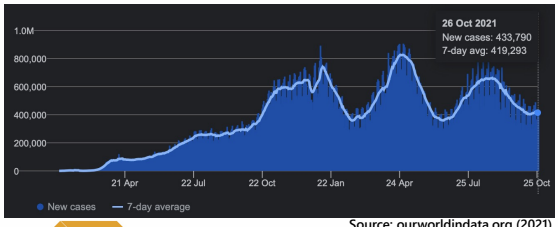
INTRODUCTION

- Coronavirus disease 2019 (COVID-19) is a fatal global pandemic that caused by severe acute respiratory syndrome coronavirus.

Until 26th Oct 2021
Global: 245 million cases



Source: ourworldindata.org (2021)

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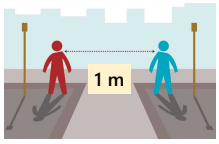
World Health Organization (WHO)



- ~ 92% of cases will be lowered if the proper social distancing practices are conducted (Prem et al., 2020).

Source: JHU CSSE (2021)

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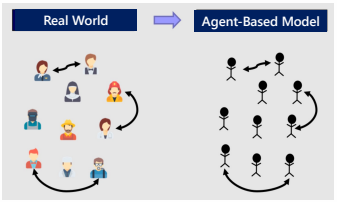
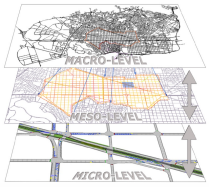
- Computational models like **Agent-Based Modelling (ABM)** can be used to analyze diseases spread in terms of geographical and demographic aspects .





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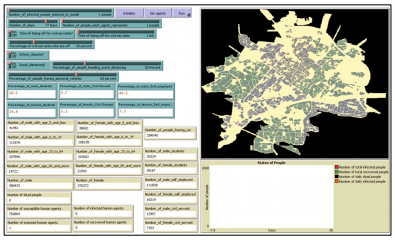
EXAMPLE 1 - Macro Level



ABM model for Urmia city, Iran
Developer: Gharakhanlou and Hooshangi (2020)

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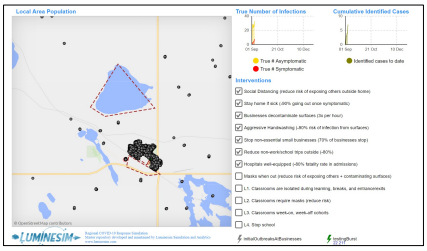
EXAMPLE 2 - Meso Level



ABM model for small town in rural Canadian municipality

Developer: Luminesim (2020)

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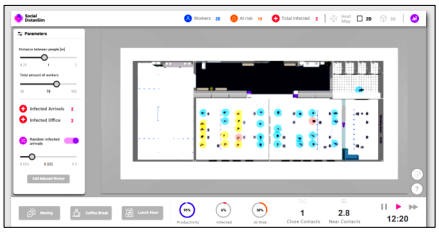
EXAMPLE 3 - Micro Level



Office ABM model

Developer: Accenture (2020)

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PROBLEM STATEMENT

83 COVID-19 clusters

1st January 2021 to 21st April 2021

Source: Perialathan et al. (2020)

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Students will come back campus for conducting academic works

Aim of the Study:

To model and analyze the COVID-19 infection inside the campus using ABM

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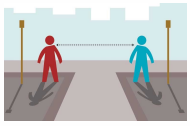
LITERATURE REVIEW

INFECTION FACTORS OF COVID-19

Social Distance | Ventilation | Exposure Time



(Burridge et al., 2021; Jones et al., 2020; Sun and Zhai, 2020)

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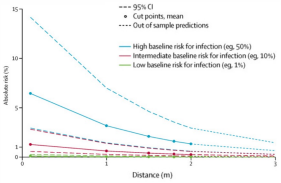
1st Factor: Social Distance

Country	Social Distancing Rule
China	More than 1 m
Malaysia	At least 1 m
South Africa	At least 1 m
Australia	Keep 1.5 m
Japan	At least 1.8 m
Brazil	At least 2 m
Canada	At least 2 m
United Kingdom	At least 2 m
United State	Maintain 2 m

Source: Xie et al. (2020)



Source: Chu et al. (2020)

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2nd Factor: Ventilation

Modified Wells-Riley Model (Sun and Zhai, 2020)

$$P_I = 1 - exp(-P_d \frac{Bqpt}{E_z \cdot (Q/N)})$$

- P_I: Probability of infectious risk
- P_d: Social distance probability
- B: Exposure time
- q: Effectiveness of ventilation factor
- p, t: Exposure time
- E_z, Q/N: Effectiveness of ventilation factor

Minimum Ventilation Rate Requirement based on ASHRAE (ASHRAE, 2019)

Occupancy Category	Ventilation Rate (L/s/person)
Lecture Classroom	3.8
Office Space	2.5
University/College Laboratories	5

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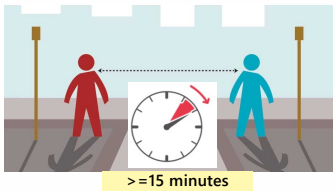
3rd Factor: Exposure Time



>=15 minutes

Close Contact

(CDC, 2021)

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RESEARCH METHODOLOGY

- Phase 1: Planning Phase
  - Literature Review
  - Data Collection
- Phase 2: Design and Development Phase
  - Setting of Analysis Parameters
  - Design ABM Model
  - Develop ABM Model using AnyLogic software
- Phase 3: Analysis Phase
  - Analysis with Developed ABM Model

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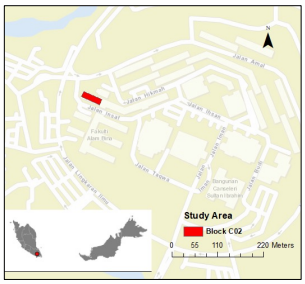
Study Area



Block C02, FABU, UTM

Floor Level	Room Type	Room Name
1	Laboratory	GIS Lab 2
2	Administrator Office	Postgraduate Office - Reception Area
4	Lecture Room	Lecture Room 2

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Data Source

Data Types	Source
FABU Room Shapefile	PHB UTM
FABU Room Interior Layout	PHB UTM
Number of Students	FABU UTM
Number of FABU Staffs	FABU UTM

Software

anylogic

Personal Learning Edition Version 8.7

Scenarios

- Laboratory
- Lecture Room
- Postgraduate Office (Reception Area)

Students (Agents)

enter → Study Area (cool air environment)

Social distance:
- 1 m, 1.5 m, 1.8 m, 2 m

Exposure time:
- 10 min

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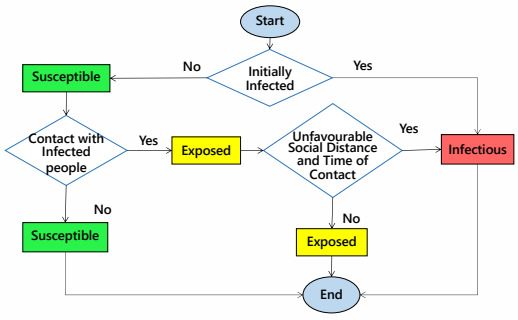
CONCEPTUAL DESIGN OF ABM MODEL



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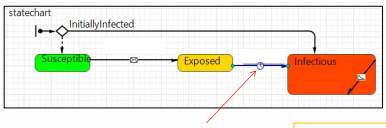
DEVELOPMENT OF ABM MODEL IN ANYLOGIC

Agent State - Statechart



$$t = -\frac{In\,(1 - P_I) \cdot E_z \cdot Q/N}{P_d \cdot Bqp})$$

Time taken for becoming infectious

Susceptible Exposed Infectious

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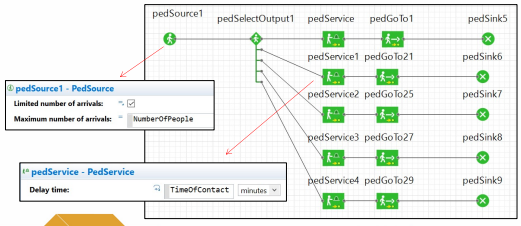
DEVELOPMENT OF ABM MODEL IN ANYLOGIC

Agent's Behaviors - Pedestrian Library

Simulate the movement of agents to enter the room and stay in the seats



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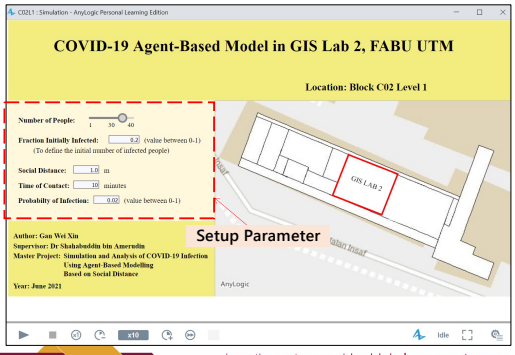
INPUT INTERFACE



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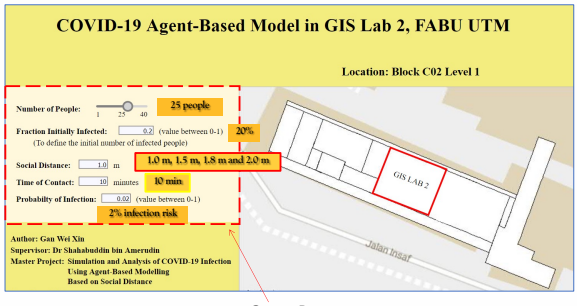
Analysis Parameter



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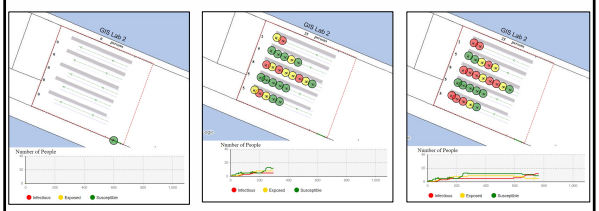
RESULT INTERFACE



Initial Simulation | Simulation after 5 minutes | Simulation after 10 minutes

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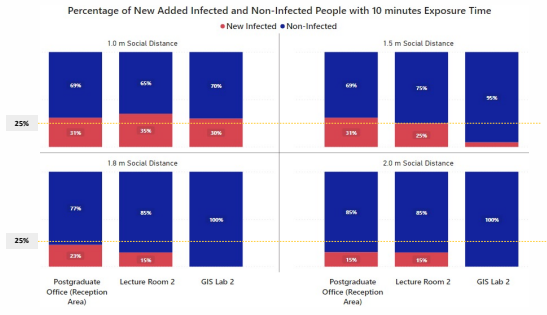
COMPARISON OF THE ANALYSIS



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CONCLUSION

- ABM is a technique that can simulate and analyze the phenomenon of the COVID-19 spread in the indoor environment.
- Social distance is a guideline for administrator to arrange the capacity of the room.
- ABM models can give the awareness to the administrators and students.

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RECOMMENDATIONS

1. Larger extent that covered the rooms for all buildings in the campus in 2D and 3D model
2. Add new parameters:
   - Room size (dimension)
   - Seat arrangement
3. Time of contact in the rooms when all of the susceptible agents will get infected

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Thank You!

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