



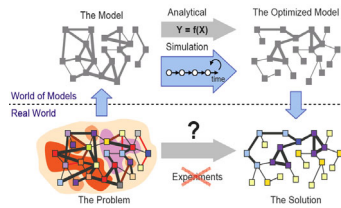
Using Multimethod Simulation Modeling for Pandemic Influenza Preparedness Planning in Intensive Care Unit

Stanko Grabljevec*
 Tatjana Mrvič*
 Barbara Grabljevec Kranjc*
 Andrej Škraba**

*University Medical Centre Ljubljana
 **University of Maribor

COMPUTER SIMULATION MODELING

- Computer simulation is the imitation of a real-world process or system over time – dynamic modeling
- Development of a computer simulation model and then conducting computer-based experiments with the model to describe, explain, and predict the behaviour of the real system



Source: A. Borshchev and A. Filippov, From System Dynamics and Discrete Event to Practical Agent Based Modeling: Reasons, Techniques, Tools. The 22nd International Conference of the System Dynamics Society, July 25 - 29, 2004, Oxford, England

COMPUTER SIMULATION – PROS

- Reveals complexity in a system through experimentation
- A simulation model is cheaper than experimenting with an existing system
- Modeling gives full control of conditions in an experiment
- Variability can be modeled better than in the real world

COMPUTER SIMULATION – CONS

- High price of computer simulation tool
- Time consumption
- Data hungry to get usable results

COMPUTER SIMULATION METHODS

The main three approaches used in simulation of healthcare systems:

- Discrete event simulation (DES)
 - System dynamics (SD)
 - Agent based simulation (ABS)
- } Hybrid simulation

COMPARISON OF SIMULATION METHODS

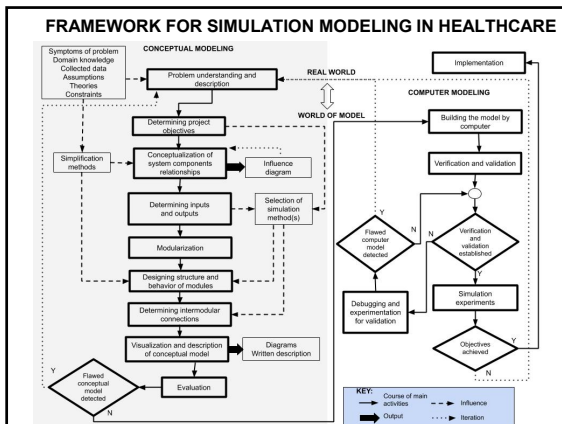
	DES	SD	ABS
Strengths	Queues that are common in healthcare systems are key concept Top-down approach Detailed system modeling	Emphasis on systemic view Top-down approach Modeling does not require much data	Emphasis on agents and connections between them Bottom-up approach
Weaknesses	Interactions between entities cannot be modeled After the entity enters the process, the process cannot be stopped and entity pulled out of it Continuous systems cannot be easily modeled	Models are deterministic and do not mirror individual variability Discrete processes cannot easily be modeled	No queuing concepts which is common for health-care systems Usually time consuming to build a model Usually demands a lot of computing power which might be limiting Usually a lot of data is needed

HYBRID SIMULATION

- In hybrid simulation multiple techniques/paradigms are combined in one
- These combination/integration of individual methods enable the symbiotic realization of the strengths of individual techniques, while reducing their limitations

COMPUTER SIMULATION OF HEALTHCARE PROCESSES

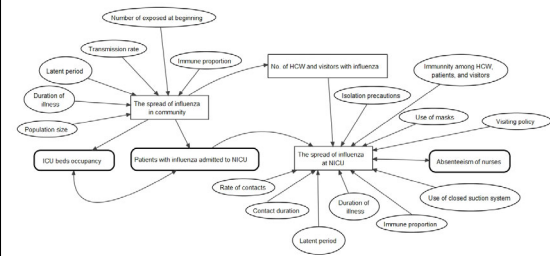
- Useful for improving and managing many issues such as:
 - better understanding of the system
 - patient workflow
 - throughput and waiting time
 - resources allocation and optimization
 - patient diversion policies
 - spreading of infections
 - building/work place design etc.
- simulation models as a Decision Support System (DSS)



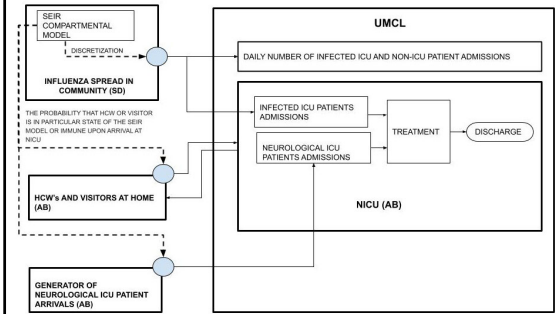
MAIN PROJECT OBJECTIVES

- better understanding of influenza spreading in community
- dynamic of relationship between intensity of influenza spreading in community and neurological influenza patient admissions to NICU
- how many of ICU-influenza patients could be admitted to NICU
- what could be potential effects of different infection control measures in NICU
- to build a simulation model that can be upgraded for other purposes

INFLUENCE DIAGRAM



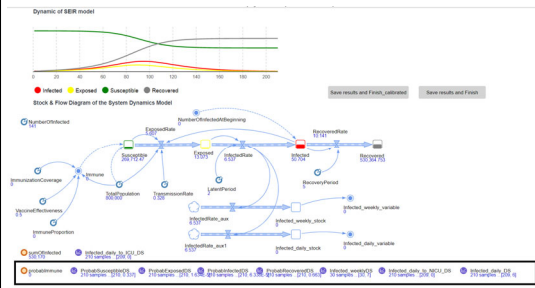
MODULARIZATION



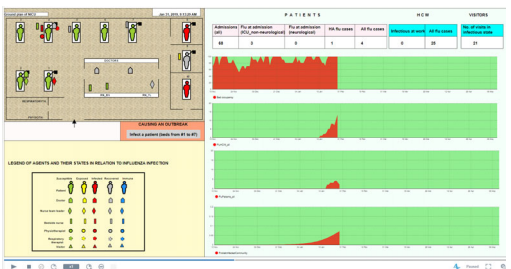
COMPARTMENTAL SEIR MODEL (1)

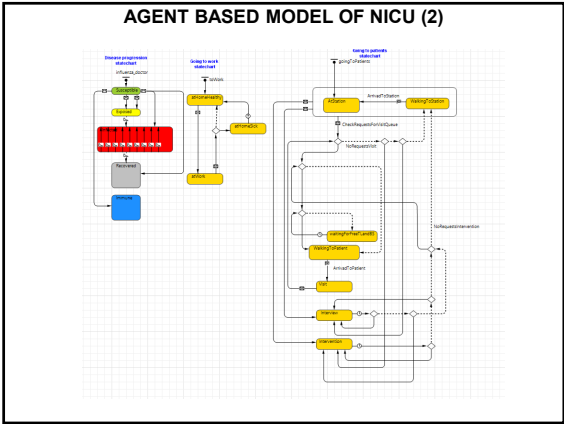
- Divide the population into compartments based on disease states:
 - **S**usceptible
 - **E**xposed
 - **I**nfectious
 - **R**ecovered
- Relatively simple
- Well studied
- Because of usual fully mixed, homogenous population assumption fails to capture the differences in contact patterns for different environments and age groups

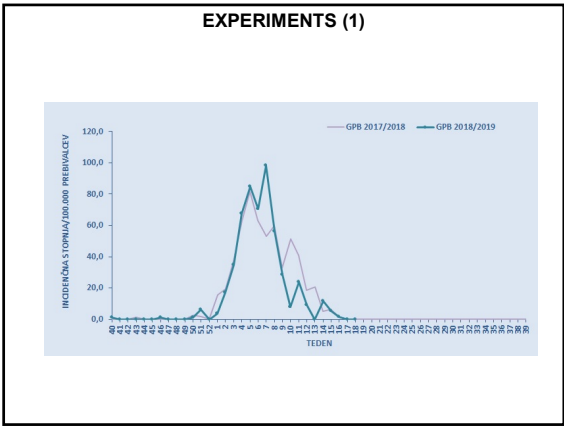
COMPARTMENTAL SEIR MODEL (2)

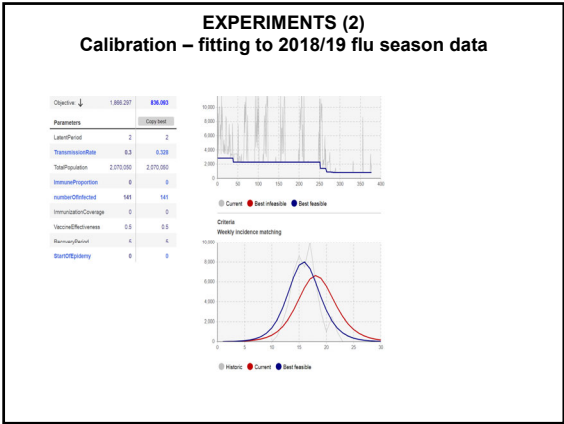


AGENT BASED MODEL OF NICU (1)

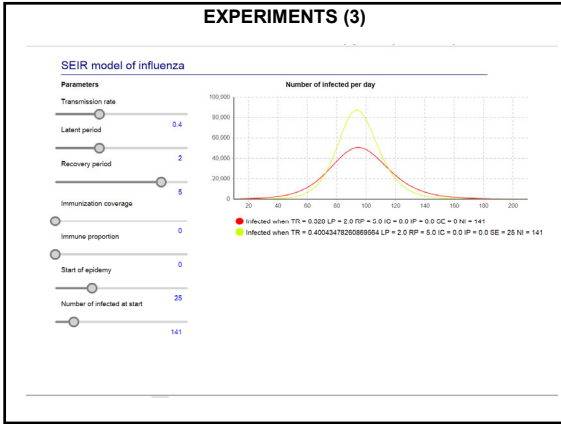




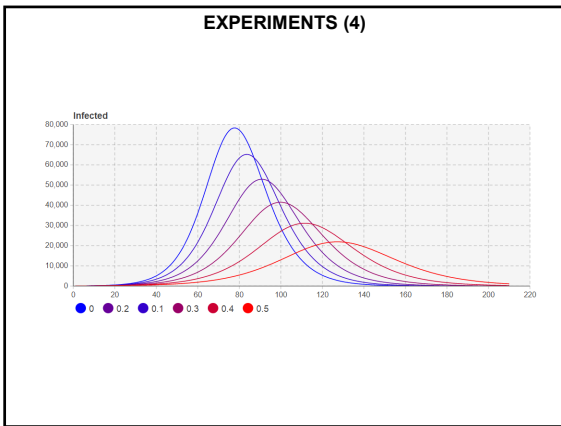




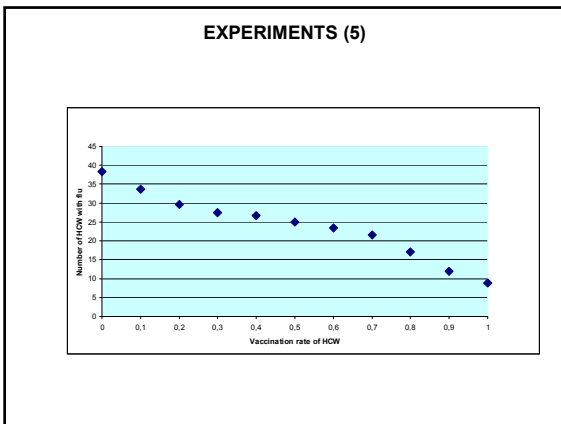
EXPERIMENTS (3)



EXPERIMENTS (4)

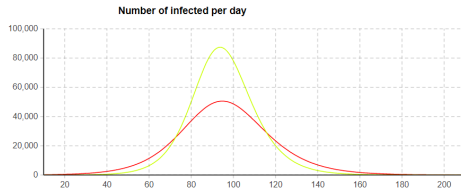


EXPERIMENTS (5)



EXPERIMENTS (6)

Reprod. number	Patients				HCW		Visitors
	Flu at admission (ICU, non-neurological)	Flu at admission (neurological)	HA flu cases	All flu cases	Infectious at work	All flu cases	No. of visits in infectious state
1.5	9	2	4	15	24	41	64
2.0	11	2	4	17	29	42	72



EXPERIMENTS (7)

- banning visits is an ineffective preventive measure
- strict use of mask by all close HCW-patient contacts during influenza season is an effective preventive measure for decreasing HA-influenza cases, especially in ICU with low vaccination rate among HCW
- the same applies to HCW-HCW, but how to achieve this?

FUTURE WORK

- improving the quality of the input data
- upgrading the simulation model into DSS for seasonal and pandemic influenza preparedness planning for the entire UMCL

CONCLUSION

"All models are wrong but some are useful".

George Box
