

# A Computational Framework for Egress Analysis with Realistic Human Behaviors



Principal Investigators: Prof. Kincho H. Law<sup>1</sup> and Prof. Jean-Claude Latombe<sup>2</sup> Student: Mei Ling (Zan) Chu<sup>1</sup>  
<sup>1</sup>Civil & Environmental Engineering Department <sup>2</sup>Computer Science Department

## Motivation

- **Human and social behaviors** play an important role in emergency evacuations.
- **Oversimplified assumptions** in current computational models.
- There is a dire need to “**improve the realism and accuracy of crowd behavior movement**, in addition to improvising visual aesthetics [in existing commercial tools].”<sup>1</sup>

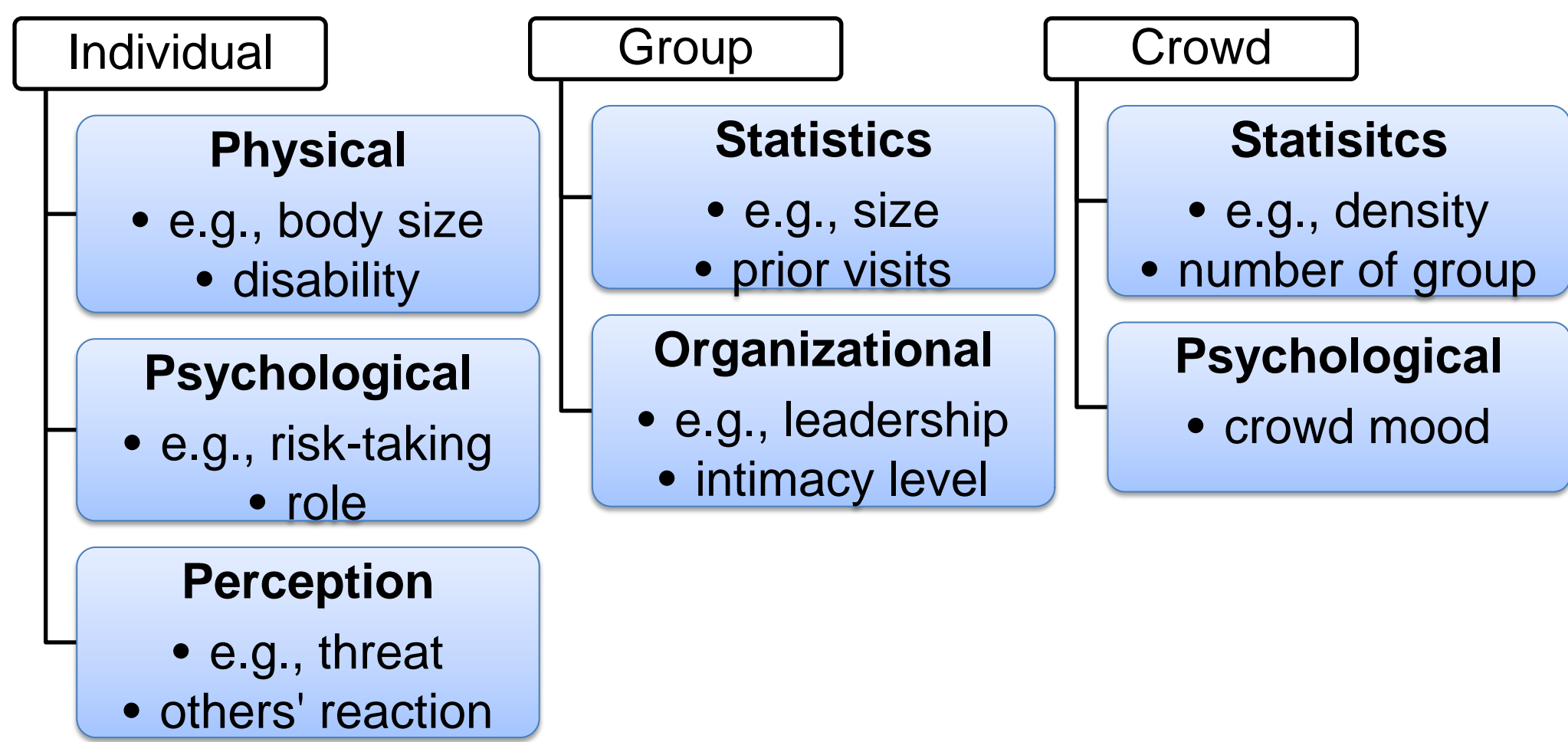
## Research objectives

1. Establish a **theoretical framework** to study and represent egress related theories.
2. Develop a **computational framework** using a multi - agent based simulation paradigm.
3. Validate the computational framework with real-life data and past events data.

## THEORETICAL FRAMEWORK

### Individual, group & crowd factors

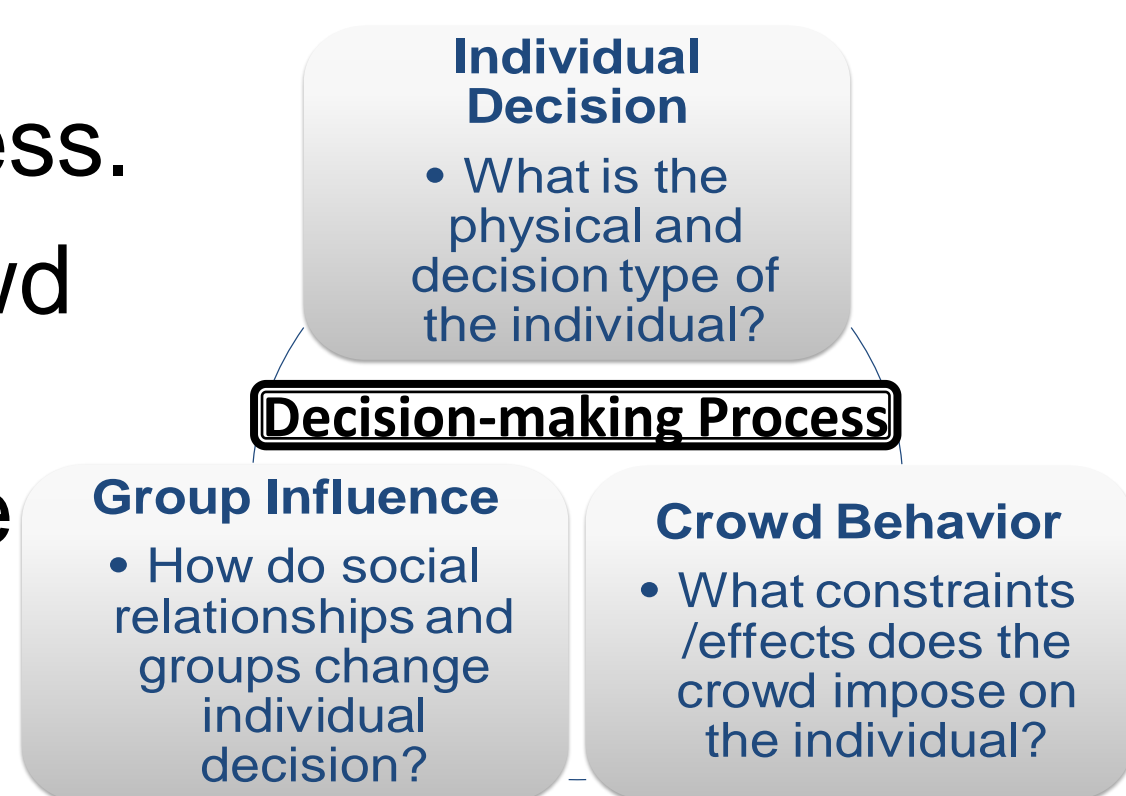
- Study social science and disaster management literature regarding emergency crowd behavior.
- Extract features and rules governing peoples' decision-making process.



A simplified organization of occupants and environment features

### Generalization of different social theories

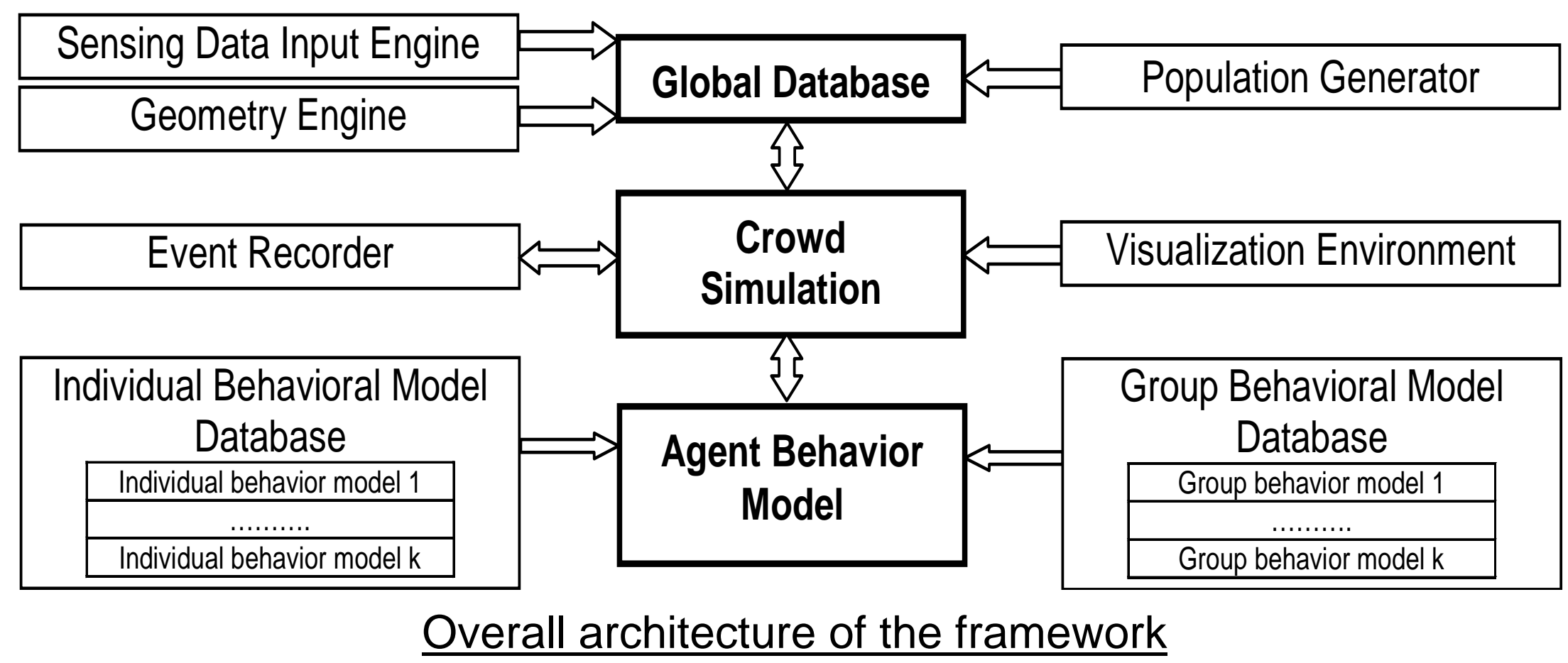
- Develop a staged decision making process.
- Relate group and crowd factors to individual decision, based on the occupant's type and environment.



## COMPUTATIONAL FRAMEWORK

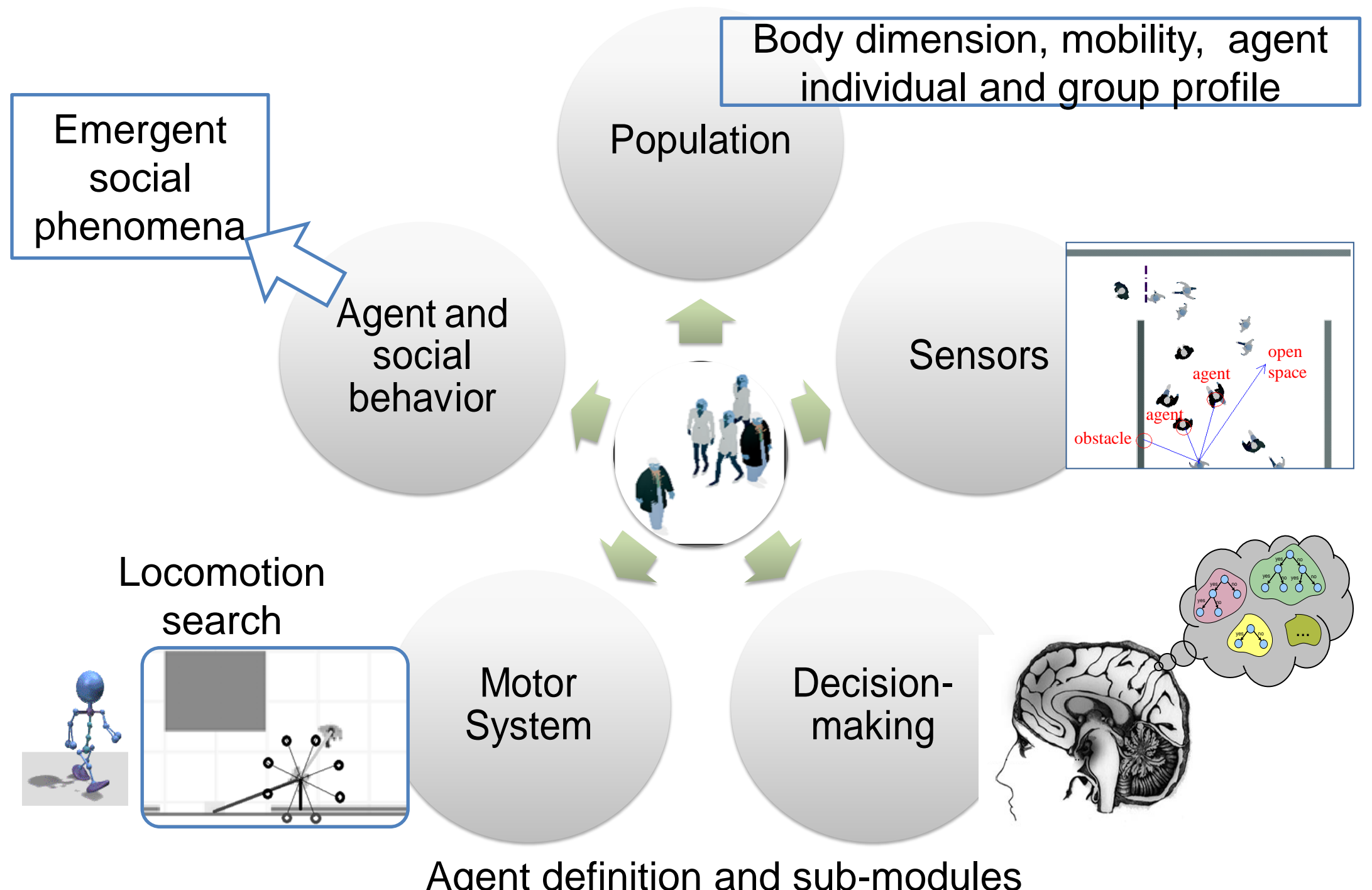
- Extend MASSEgress<sup>2</sup>, a multi-agent based framework designed to model human and social behaviors in egress.
- Incorporate the state-of-the-art human behavioral theories into the simulation model.

## System architecture



Overall architecture of the framework

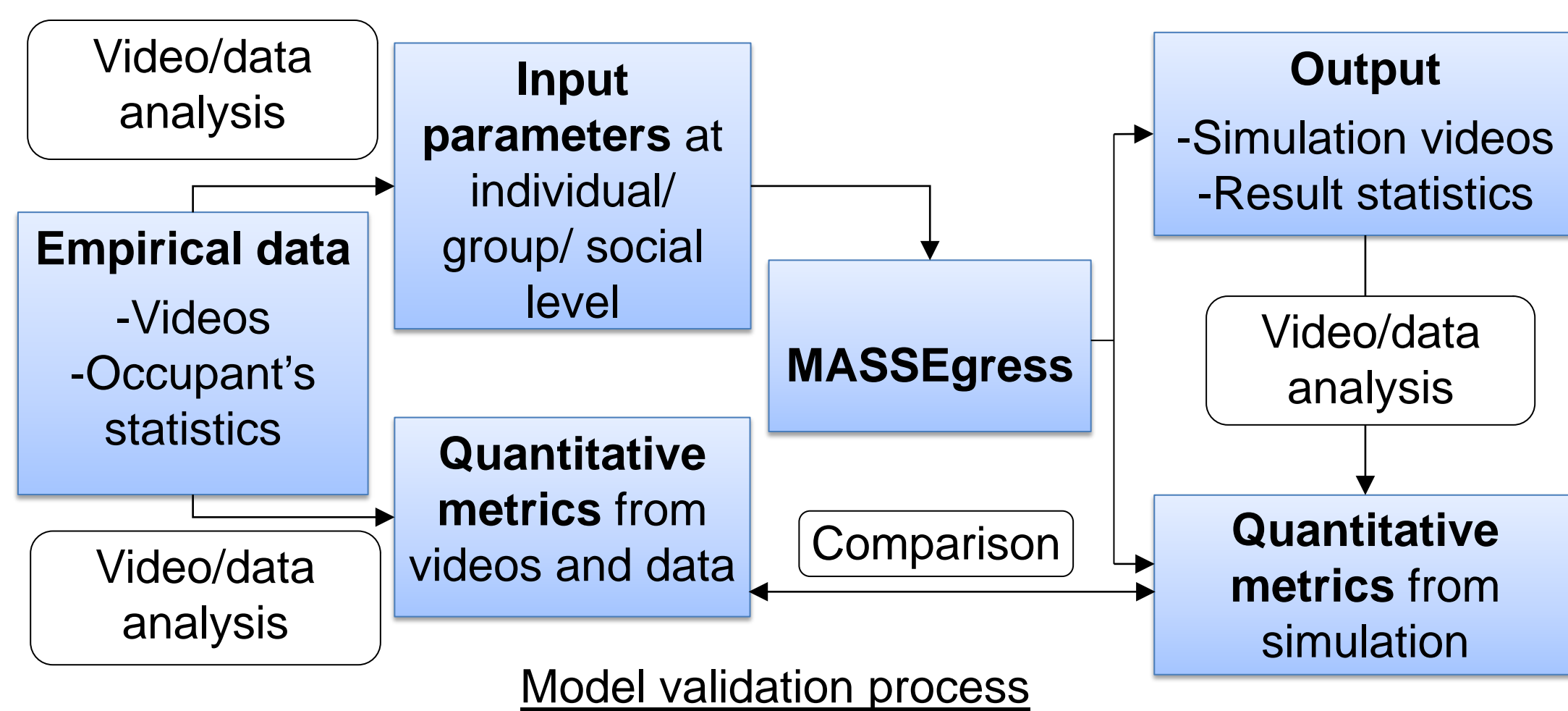
## Agent representation and sub-modules



Agent definition and sub-modules

## VALIDATION AND TESTING

- Collect datasets including historical fire accidents in buildings and facilities, as well as videos and statistical data from industrial partners.



Model validation process

## RESEARCH IMPACTS

- Bridge the gap between the state-of-the-art social theories and current egress simulation practice.
- Develop a tool for theories implementation and validation.
- Assist facilities managers in developing a wider range of possible solutions to crowd problems specific to scenarios and occupant's characteristics.

### References:

1. Challenger, W., Clegg W. C., and Robinson A.M. (2009). Understanding Crowd Behaviours: Guidance and Lessons Identified, Technical Report prepared for UK Cabinet Office, Emergency Planning College, University of Leeds, 2009.
2. Pan, X., Han, C. S., Dauber, K., and Law, K. H. (2007). "A Multi-Agent Based Framework for the Simulation of Human and Social Behaviors during Emergency Evacuations," AI & Society, 22, 113-132.