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# A Multi-agent Model for the Panic Behavior in Crowds

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# *Introduction*

Collective Behavior (formal definition):

“Collective Behavior is the set of social behaviors which the usual conventions stop driving the actions and the individuals transcend, exceed or collectively subvert the standards and the institutionalized structures”

(Killian & Turner, 1952)



# *Collective Behavior*

An informal definition:

“Collective Behavior happens when a group of people engage to a non-institutionalized and a restriction-free social behavior, which is induced by an event that was not previously planned”



# *Panic Behavior*

- It's not exactly what you might think...
- Panic is a kind of **crowd** which is, in turn, one of the many forms of C. B.
- Three major characteristics:
  - It is not planned
  - It is induced by a dangerous situation that threatens life
  - There is a need to act and to get the situation back to normal or to survive by leaving the environment

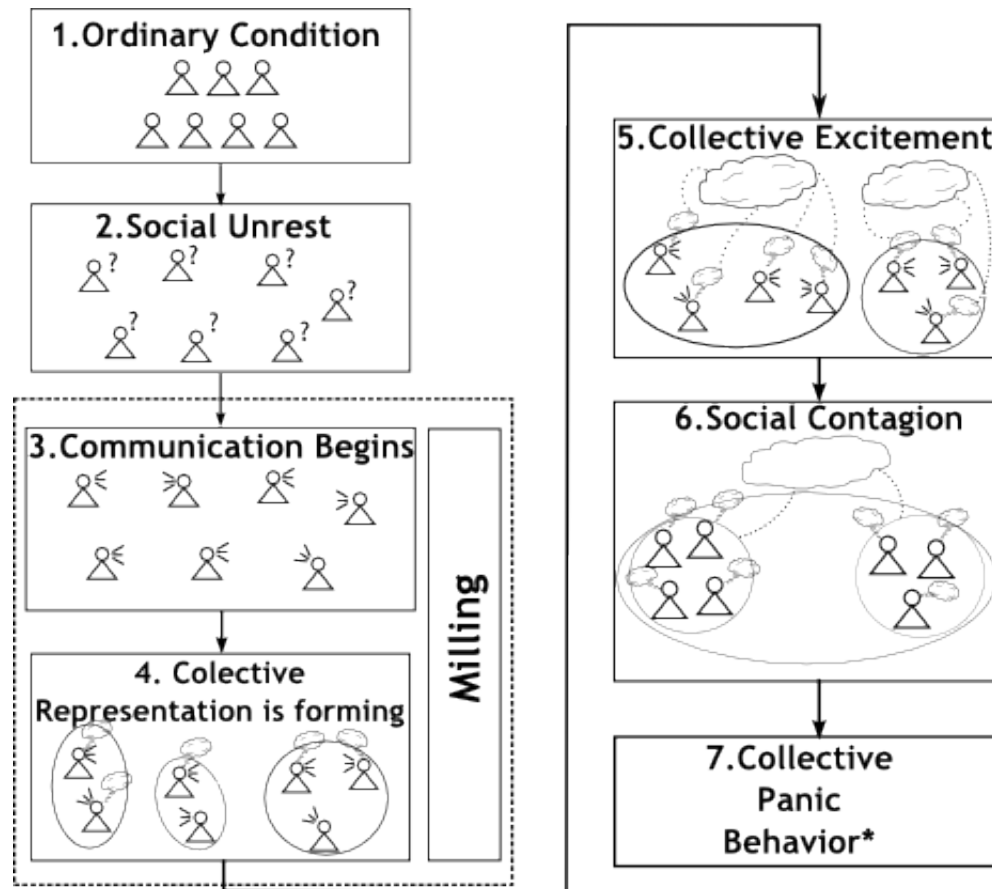


# *Panic Behavior – Why simulate?*

- There are not so many social-based simulations\*, let alone Collective Behavior simulations
- A tool for sociology and an application for MAS
- Analytical simulations are fine, but how about a new look/approach ?
- Collective panic real-life simulations can be expensive, dangerous and even unethical



# Panic Behavior – Basic Steps



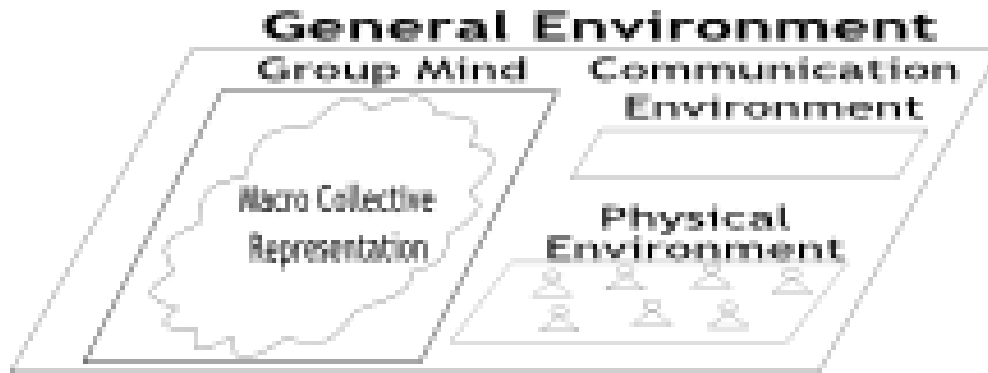
# *Proposing a Model*

In order to design a computational model for panic behavior, three elements were considered:

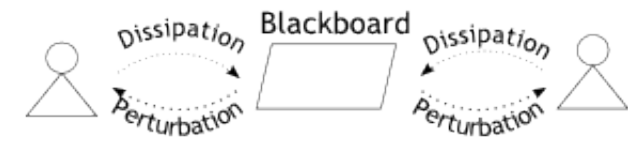
- i. Environments for Agent Interaction
- ii. Architecture of the Person Agent
- iii. Group Mind



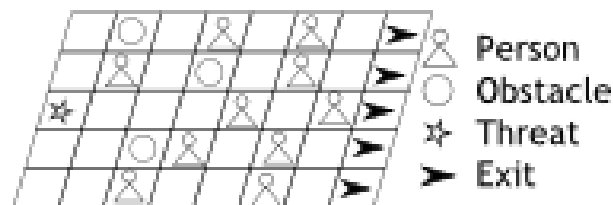
# Model - Environments



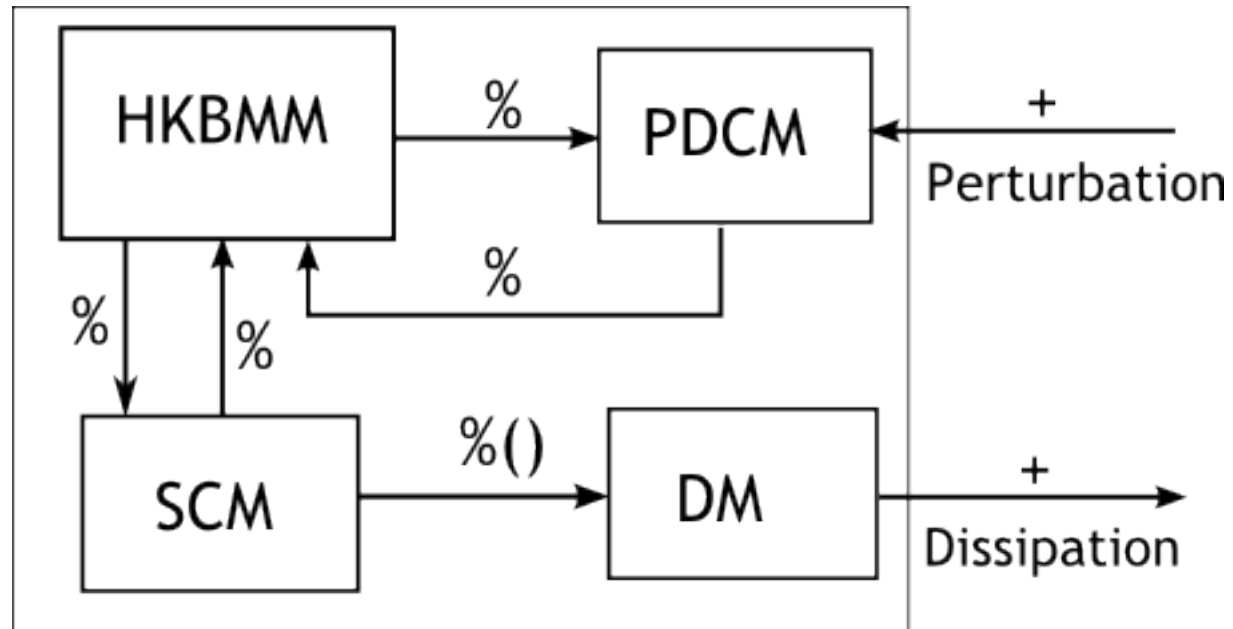
## Communication Environment



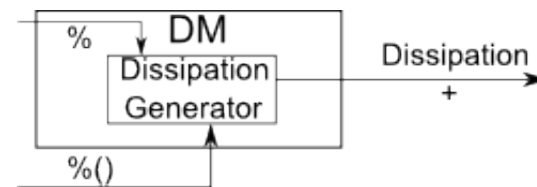
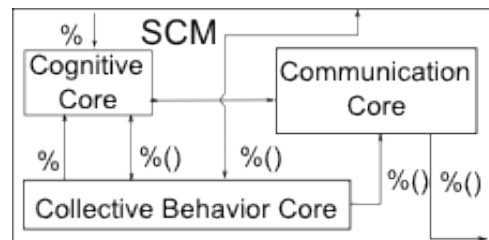
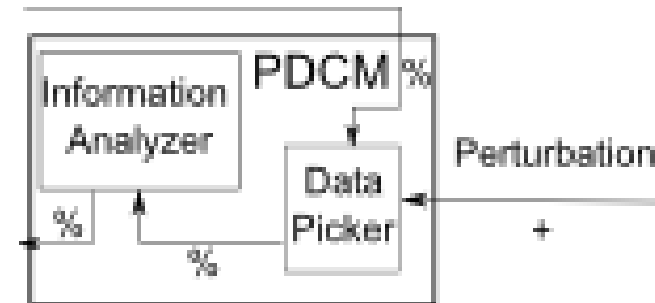
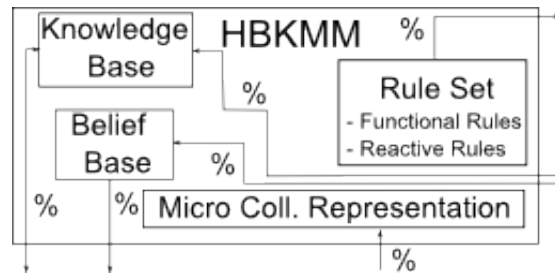
## Physical Environment



# Model - Architecture



# Model - Architecture



# *Model – Group Mind*

- At first, the Person agent makes a localized description of the situation, based on information gathered from the nearest agents. That description is called **Micro Collective Representation (MiColRep)**
- In turn, these representations are clustered and the resulting clusters form the **Macro Collective Representation (MaColRep)**



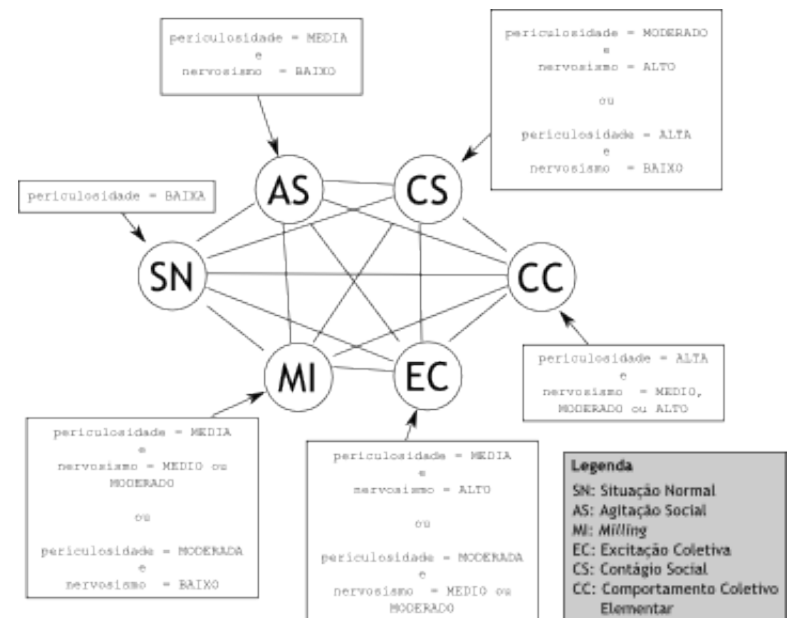
# Model – How it works (theoretically)

- The Person Agent is an Expert System
- The agent's state is defined by its variables, especially *hazardLevel* and *nervousness*
- Other variables deal with physical aspects, such as *temperature* and *freeSpace*, or social aspects such as *neighbNervousness*, *susceptibility* and *permissiveness*
- Finally, the agent chooses what to do based on its state, its experience and a predefined probability



# Model – How it works (theoretically)

- Fuzzy and Direct Rules are evaluated in each simulation step
- The agent also has a memory which logs the choices and the information gathered by the agent
- Helbing (2002) provides a structural validation
- And a dynamic validation?
- The agent has a non-deterministic finite state machine



# Comparison with other models\*\*

Features	First Category		Second Category	
	[6]	[7]	[8]	Proposed Model
Reactive or Cognitive Approach	REA <sup>1</sup>	REA	COG	COG
Micro-level explicitation	Movement Formulas	Social Force Model	Individual Behavior Model and Global Rules	Collective modeled agents
Macro-level explicitation	Not available	Not available	Not available	Imaginary and Group Mind formation
Commun. forms	Indirect message exchange	No message exchange	Not available	Perturbation and dissipation
Dynamic Behaviors Modeling	Not available	Not available	Not available	Dynamic Behaviors Modeling on Symbolic Interactionism



# Conclusion and Future Works...

- It's a different approach. A cognitive one, based on social theories
- Future works:
  - MAS frameworks, such as Swarm (<http://www.swarm.org>), JADE (<http://jade.tilab.com>) and JESS
  - It could be possible to use this model for other types of collective behavior
  - Macro affected by the micro, and micro induced by the macro
  - The emergency of two roles: followers and leaders



*Thank you!*

Questions?

More info at <http://sma.robsonfranca.eti.br>

