# Behavioral Animation

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CSE 888.14X

# Goal…

- Have  an autonomous character determine its own actions
- Free the animator from the need to specify each detail of every character's motion
- Make reactions of characters more believable

# Applications…

- Games and movies
- Simulation of emergency situations
- Animated pedagogical agents

# Flocks, herds and schools: A distributed behavioral model
## Craig W. Reynolds
## SIGGRAPH‘87

- Flock motion - aggregate result of the actions of individual animals, each acting solely on the basis of its own local perception of the world
- Approach - assumes a flock is simply the result of the interaction between the behaviors of individual birds
- To create a simulated flock - create some instances of the simulated bird model (with correct flock - member behavior) and allow them to interact

# Artificial fishes: physics, locomotion, perception, behavior
X Tu, D Terzopoulos
SIGGRAPH ‘94

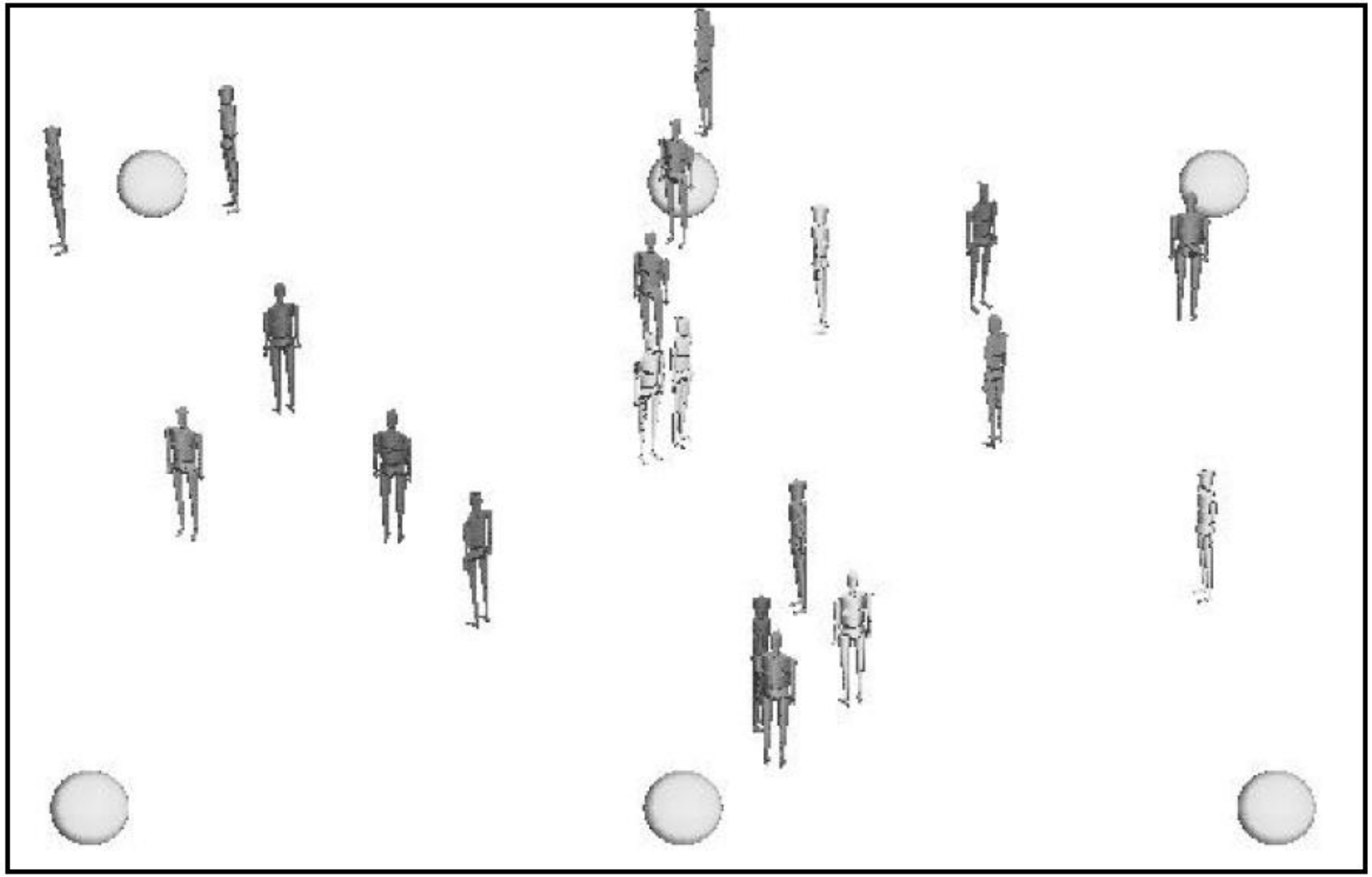
- Approach – model each animal holistically as an autonomous agent situated in its physical world
- Their behavior depends on their perception of the dynamic environment
- Implementation - At each time step the intention generator issues an intention based on the fish’s habits, mental state, and incoming sensory information. It then chooses and executes a behavior routine which in turn runs the appropriate motor controllers

# A Model of Human Crowd Behavior: Group Inter-Relationship and Collision Detection Analysis

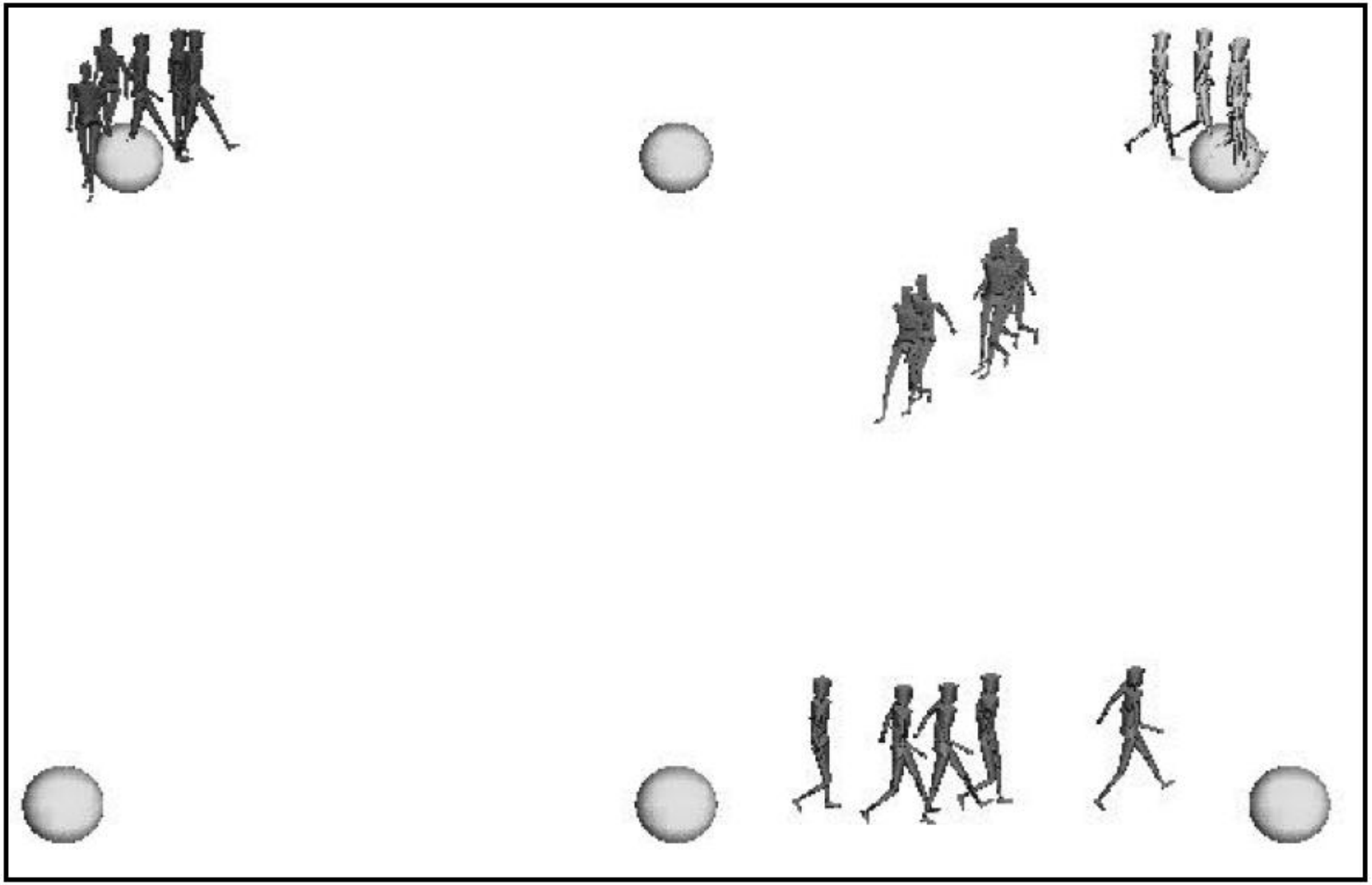
SR Musse, D Thalmann

CAS `97

- Goal – to simulate the behavior of a collection of groups of autonomous virtual humans in a crowd
- Creation of a behavior based on inter-groups relationships
- Group behavior – seek goal and flocking
- Individual behavior – a walk, a collision avoidance and a relationship behavior which occurs when the agents meet each other

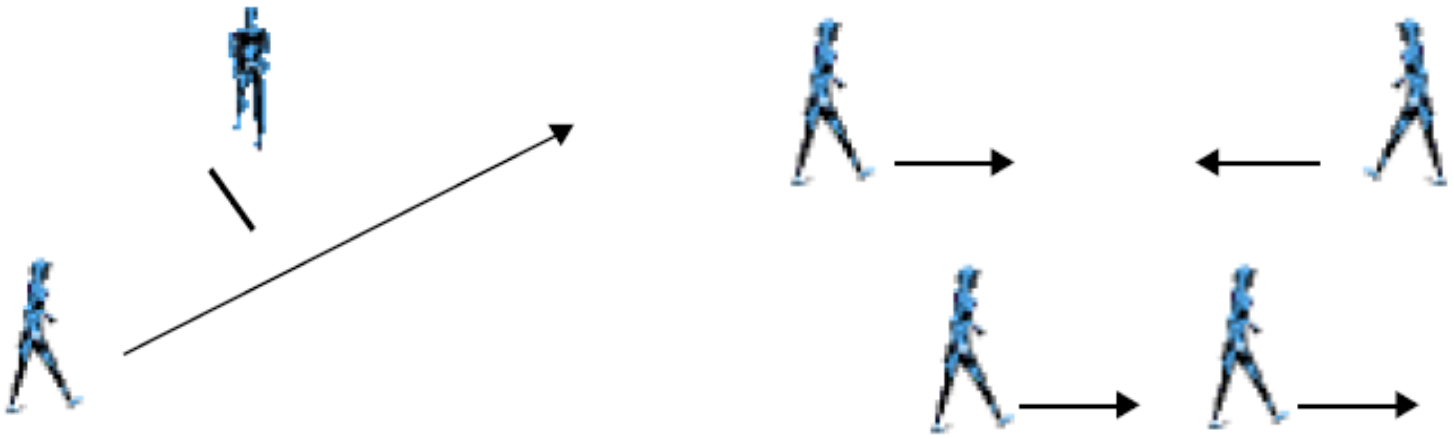


Initial population visiting a museum



Formed groups in museum

- Multi-resolution collision avoidance model
- Two types of collision avoidance



Collision avoidance type 1

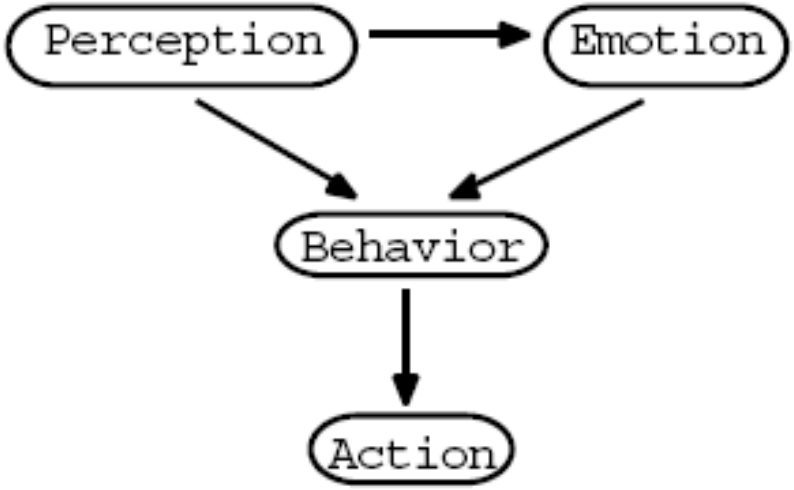
Collision avoidance type 2

# A Behavioral Animation System for Autonomous Actors personified by Emotions

P Becheiraz, D Thalmann

WECC ‘98

- Goal – increase believability of virtual actors by preventing actors from reacting in same manner in identical contexts
- Use of an emotional model
- Behavioral model deals with perception and motor control
- Emotional model deals with generation and representation of emotions
- Four modules dealing with perception, generation of emotions, selection of behaviors and execution of actions




Structure of behavioral model

$$em_{pot} \in [0..1]$$

$$em_{\theta} \in [0..1]$$

$$em_{i} \in [0..1]$$

if $cond(perception)$

$$em_{pot} = f_{perc}(perception)$$

else

$$em_{pot} = 0$$

if $em_{pot} > em_{\theta}$

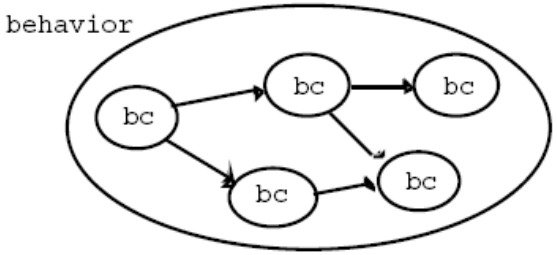
$$em_{i} = f(em_{pot})$$

else

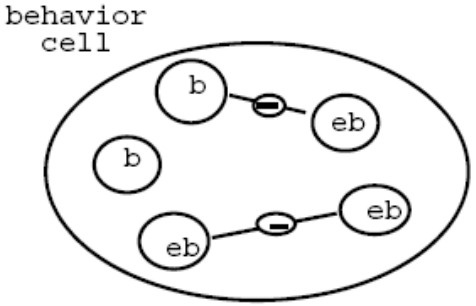
$$em_{i} = 0$$

$$em_{i} = \frac{em_{pot} - em_{\theta}}{1 - em_{\theta}}$$

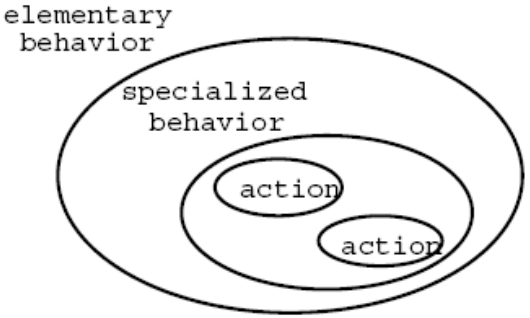
Computation of emotion



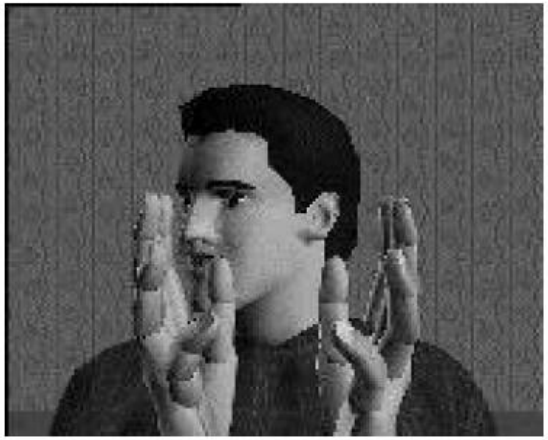

Structure of behavior




Structure of a behavioral cell




Elementary behavior encapsulating a specialized behavior



Actor shows attraction for the puppet

Barman shows resentment and the consumer feels job

The barman shows reproach

Barman shows sadness and the consumer feels distress

Visitor fears encounter with a vampire

Vampire hopes an encounter with a visitor

Visitor encounters vampire

Vampire is satisfied

And frightens the visitor

# BEAT: the Behavior Expression Animation Toolkit
# J Cassell, HH Vilhjálmsson, T Bickmore
# SIGGRAPH ‘07

- Allows animators to input typed text to generate synchronized nonverbal behaviors and synthesized speech
- Three main processing modules – language tagging, behavior generation and behavior scheduling
- Behavior generation – suggestion module and selection module
- Knowledge base – draw inferences from typed text
- Provides some common gestures – beat, deictic, contrast, iconic, etc.
- Iconic gestures – added to the database by the animator
- Set of behavior generators implemented – beat, action iconic, contrast, eyebrow flash and gaze
- Behavior selection – conflict resolution filter and priority threshold filter

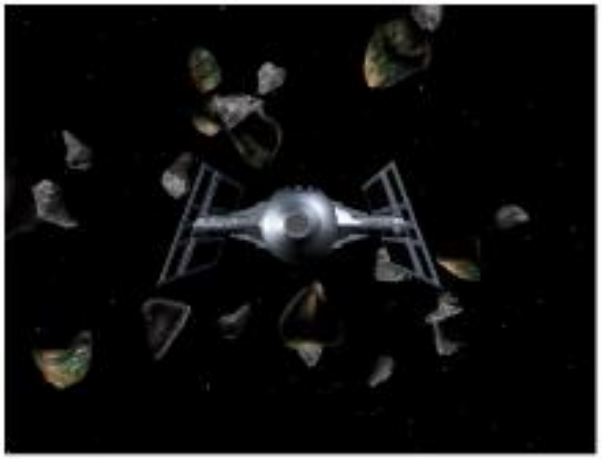
# Fast and learnable behavioral and cognitive modeling for virtual character animation

J Dinerstein, PK Egbert, H Garis, N Dinerstein

Computer Animation and Virtual Worlds ‘04

- Fast execution of a cognitive model using neural network approximation

- Novel technique for a virtual character to automatically learn an approximate behavioral or cognitive model by itself (off-line character learning)

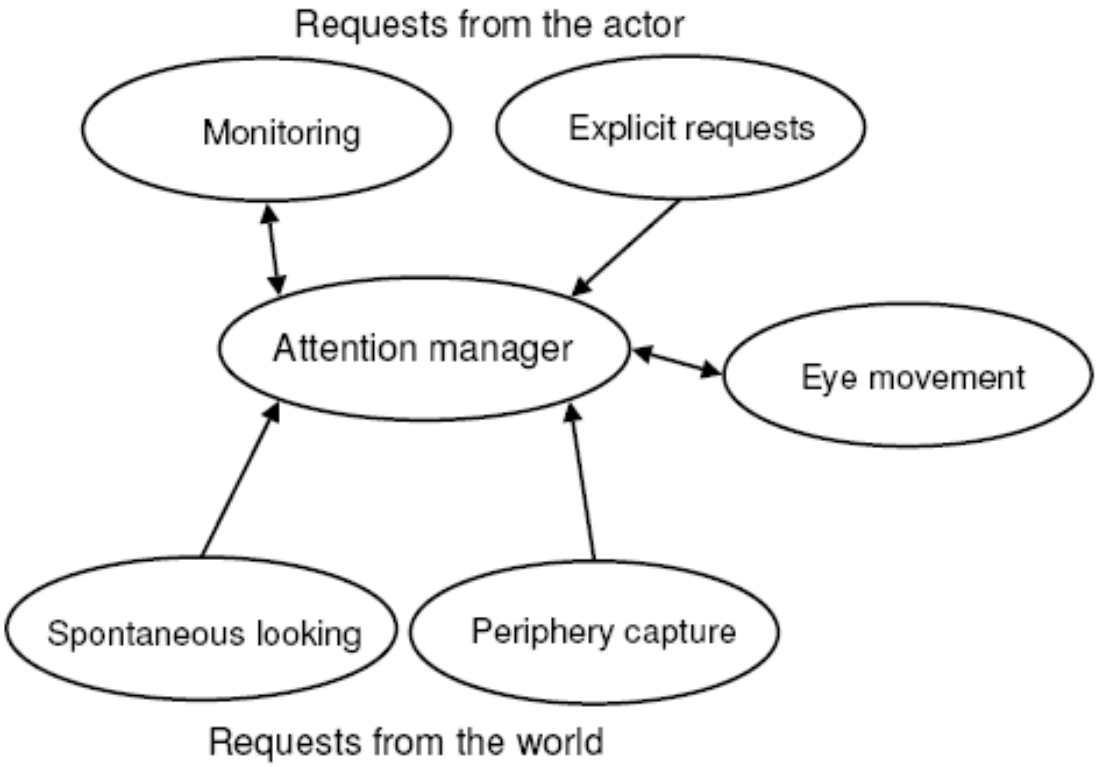


# Psychologically-based vision and attention for the simulation of human behaviour

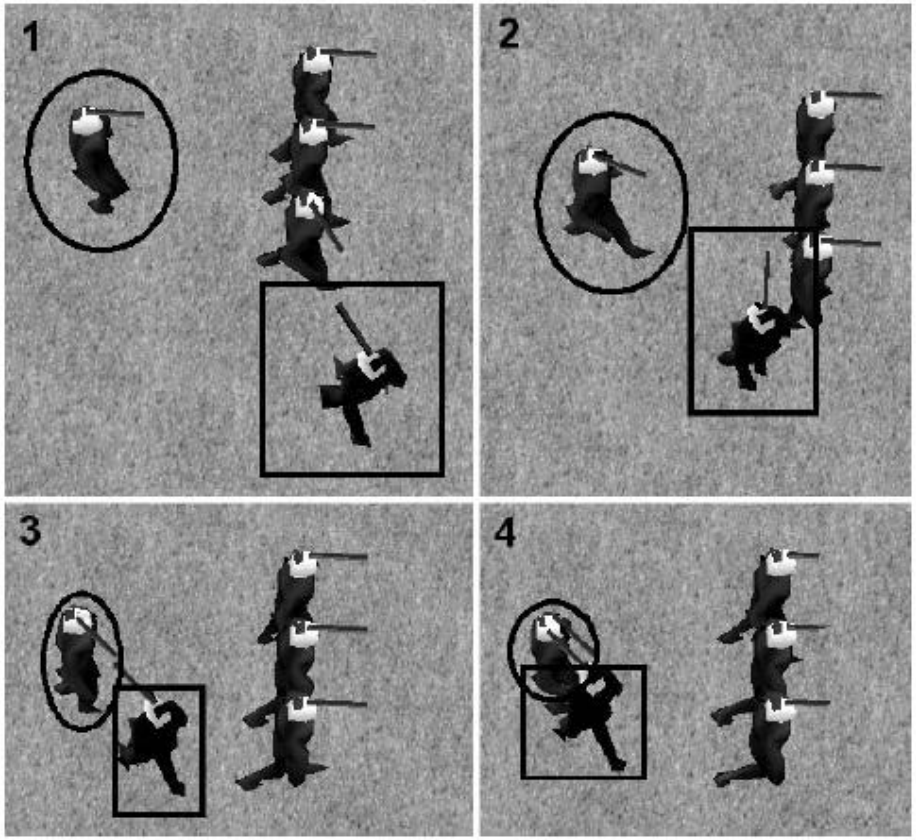
SJ Rymill, NA Dodgson

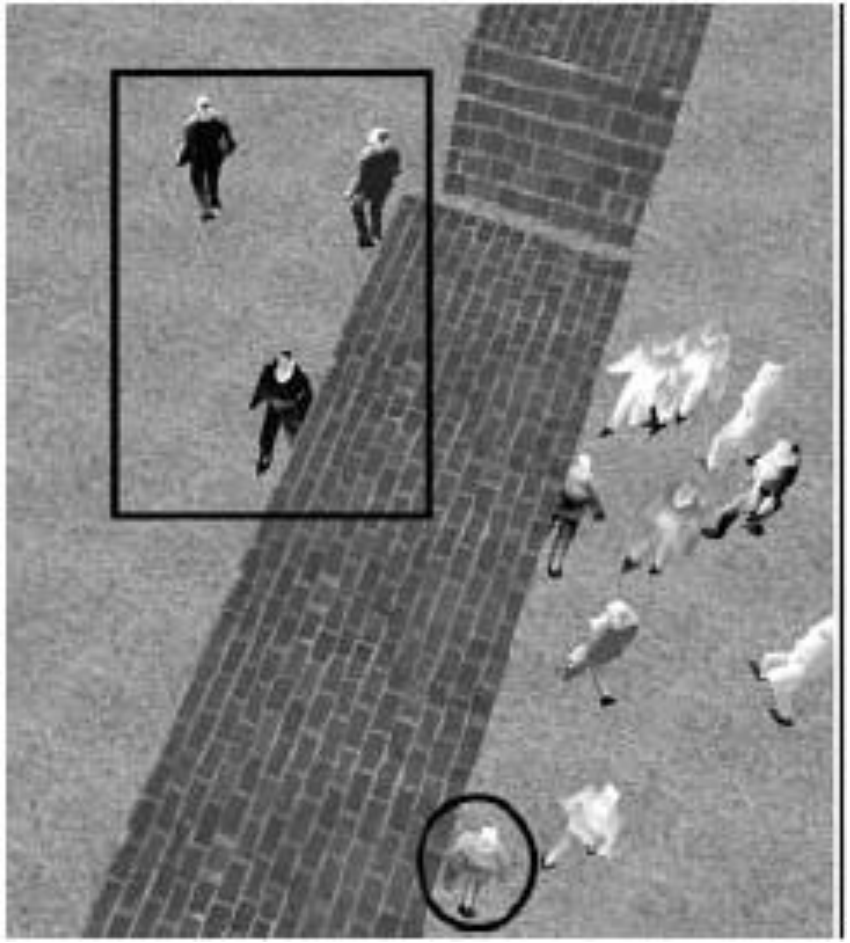
SIGGRAPH ‘05

- Realistic simulation of human behavior by considering the visual perception and attention of each individual in the crowd
- Shifts of attention and associated eye movements

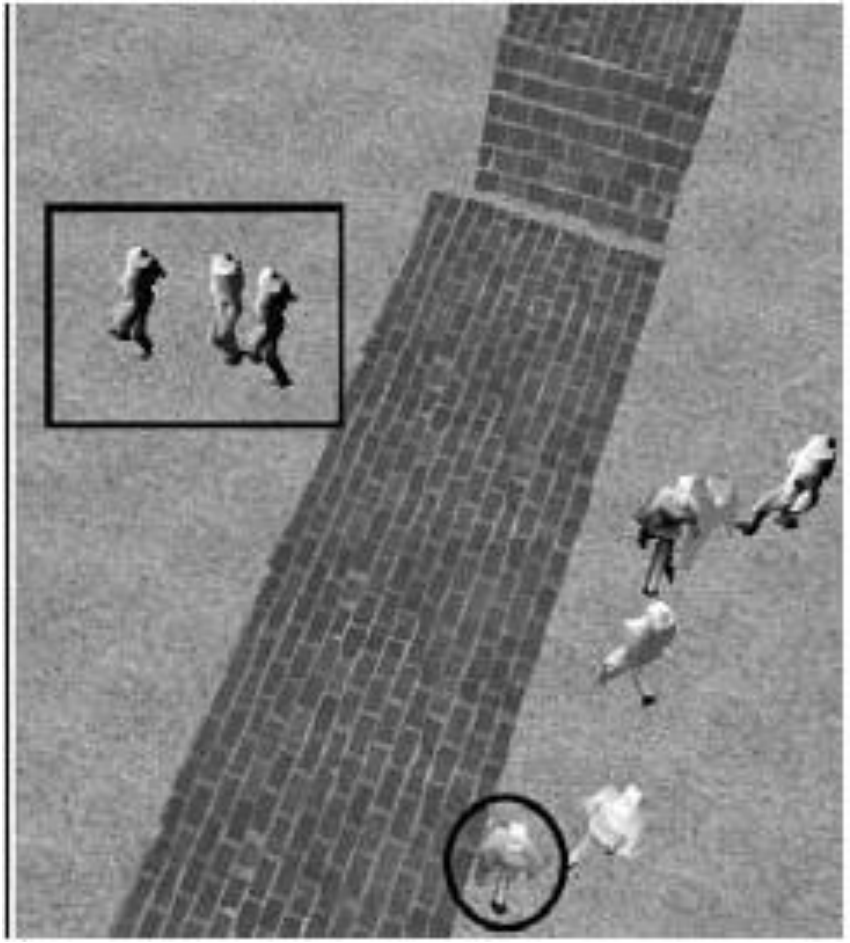


Effects of gaze simulation – collision occurrence due to the limited information available to an actor in its mental model

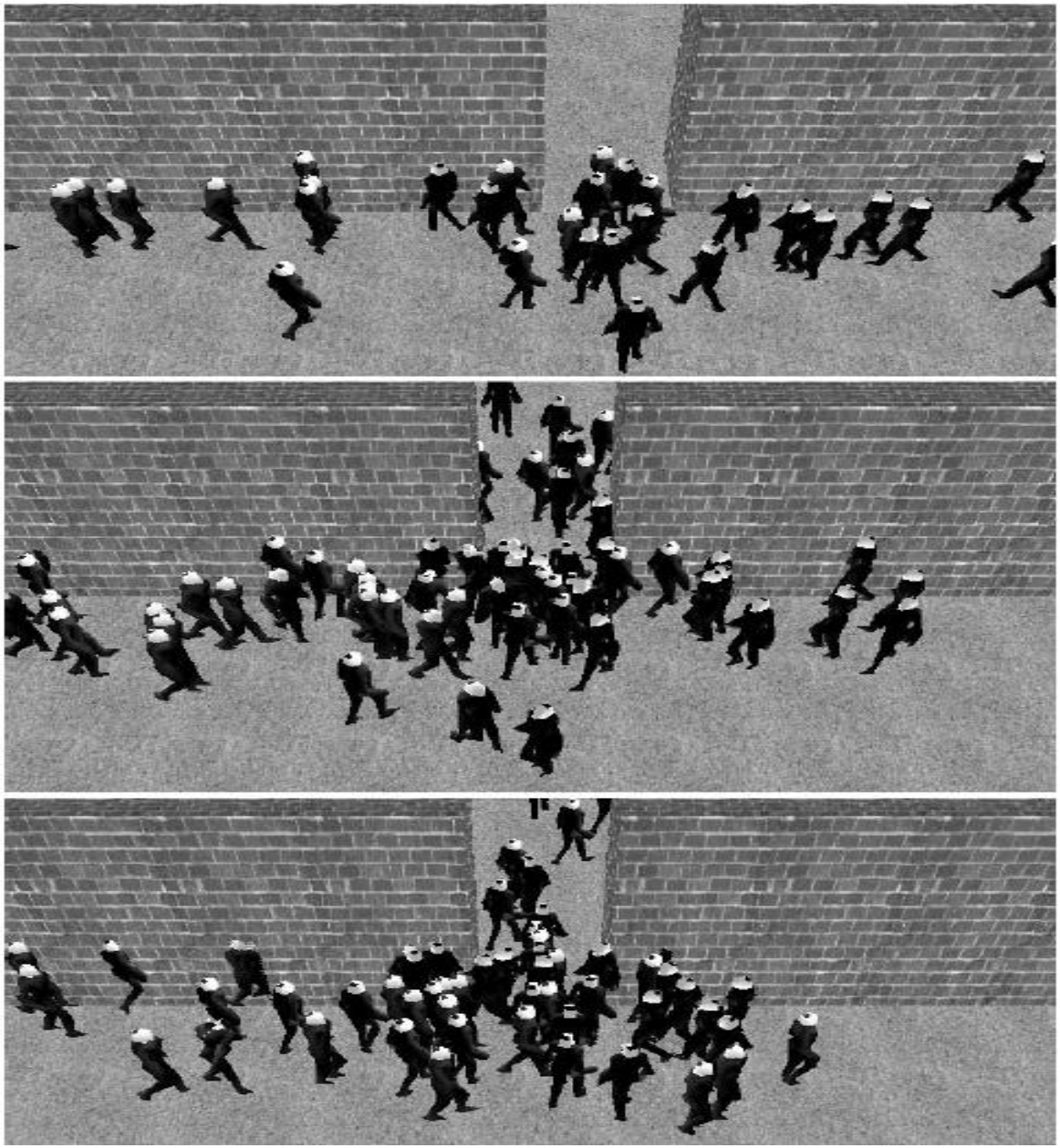




Real positions of actors



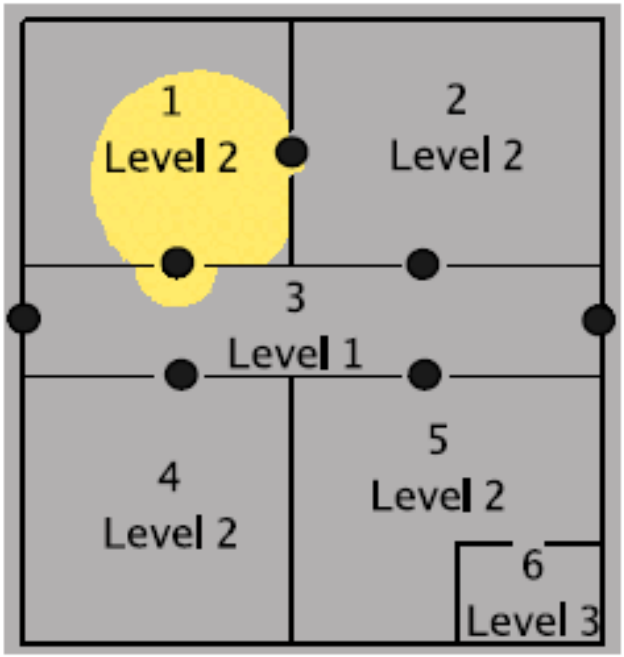
Mental model positions



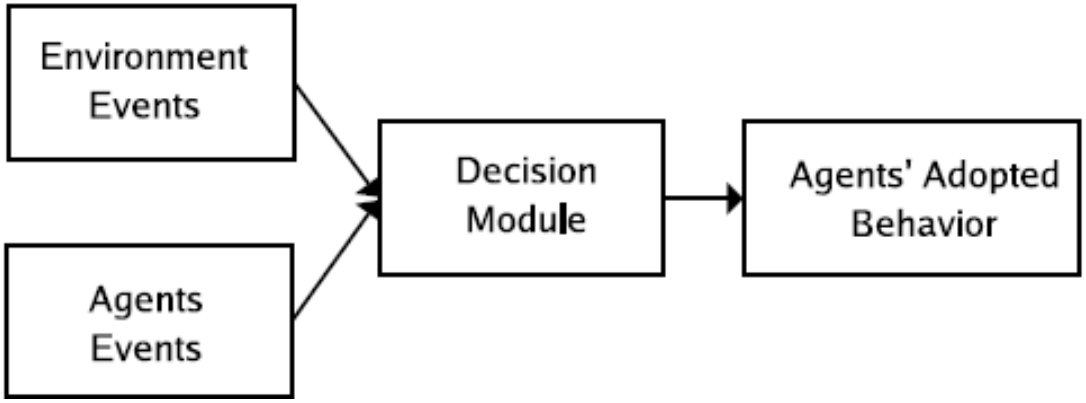
A crowd forms as actors try to walk through a gap

# Simulating virtual crowds in emergency situations
## A Braun, BEJ Bodmann, SR Musse
## Virtual reality software and technology ‘05

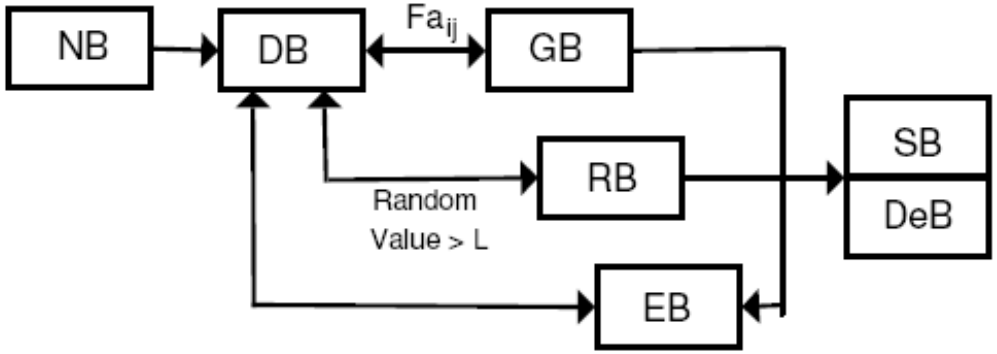
- Goal – to simulate virtual human crowds in emergency situations
- Treatment of complex environments
- management of alarms distributed in space
- The virtual agents endowed with perception of emergency events
- Decision making
- Response to the hazard event




Environment with 6 contexts




Execution flow of simulation

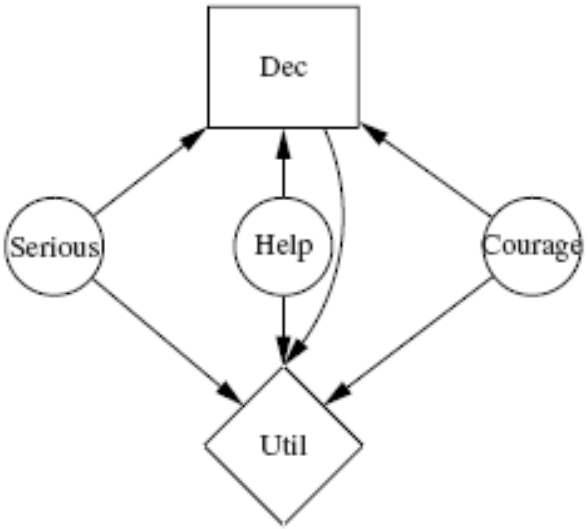



Execution flow of simulation

# A decision network framework for the behavioral animation of virtual humans
## Qinxin Yu, Demetri Terzopoulos
## SCA ‘07

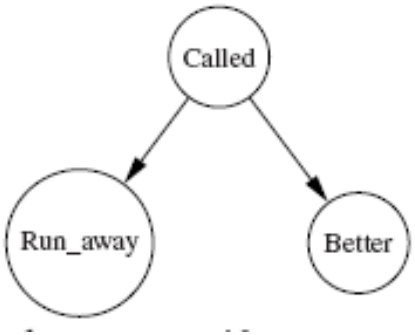
- Simulating social interactions between pedestrians in urban settings
- Decision network framework for specifying and activating human behaviors
- Four behavior models – emergency response behavior, acquaintance behavior, partnering behavior, and collision avoidance behavior

| P(Serious) | | P(Help) | | P(Courage) | |
|---|---|---|---|---|---|
| yes | no | yes | no | s | w |
| sr | 1.0-sr | he | 1.0-he | n | 1.0-n |

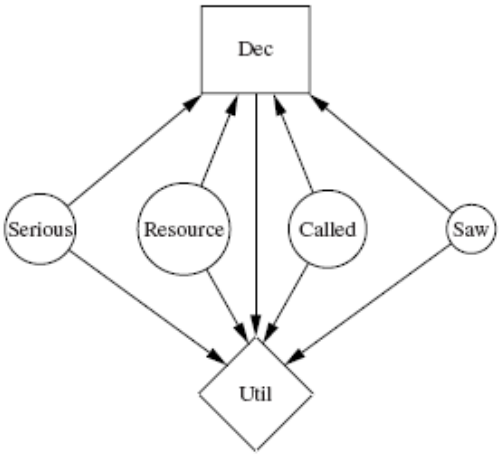


| Serious=*yes* | | | | Serious=*no* | | | |
|---|---|---|---|---|---|---|---|
| Help | Courage | Dec | Util | Help | Courage | Dec | Util |
| yes | s | ig | -10 | yes | s | ig | -5 |
| yes | s | run | 8 | yes | s | run | 5 |
| yes | s | obs | 6 | yes | s | obs | 3 |
| yes | w | ig | -8 | yes | w | ig | 3 |
| yes | w | run | 6 | yes | w | run | 2 |
| yes | w | obs | 7 | yes | w | obs | 4 |

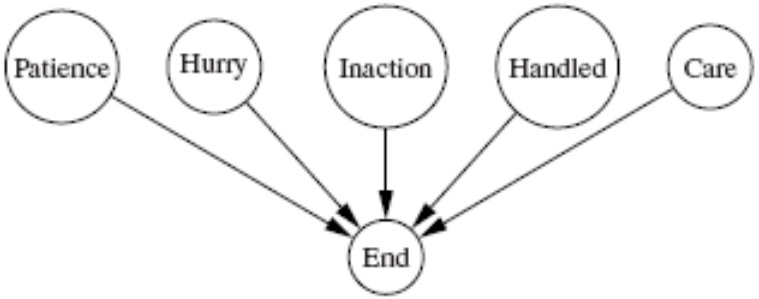
Network to determine how to respond
To the emergency




Network to assess if someone
else is calling the police




Network to decide if a police
officer is to be fetched




Network for deciding to end the
emergency response behavior

# Future Work

- Interactively train a virtual character for cognitive learning
- Interaction models to simulate sophisticated coordination and cooperation behaviors among multiple characters
- Real-time specification of personality traits