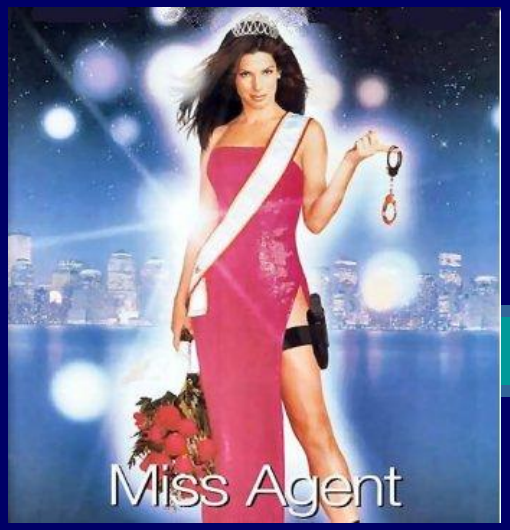
CROWD SIMULATION FOR EMERGENCY RESPONSE USING BDI AGENT BASED ON VIRTUAL REALITY

Based on a true story ...

Idea – what is going on ???

- Simulation

- BID AGENTS



- Emergency response
- Crowd

- Virtual reality

Scenario

- management of crowd evacuation under a truck bomb attack in an open public area

Used tools

- AnyLogic:
  BDI framework (commercial ☹)
- CAVE:
  Cave Automatic Virtual Environment

Human behavior in crowd

- Expanded BDI architecture:
- - deliberator
- - planner (reasoning processor)
- - decision-executor
- - confidence state

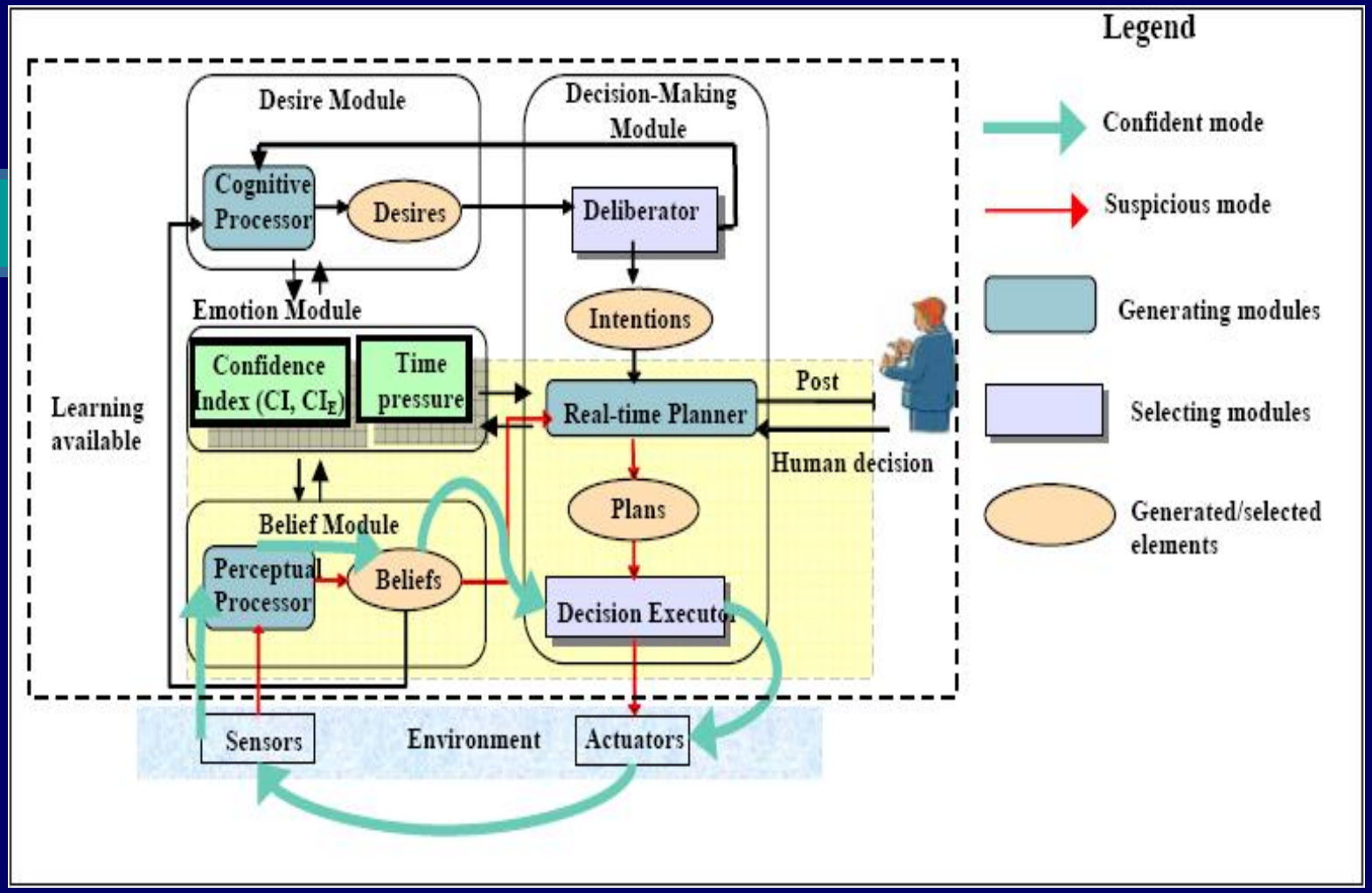
BDI agents – short review

- B = belifes
- D = desires
- I = intentions

BDI agents – short review

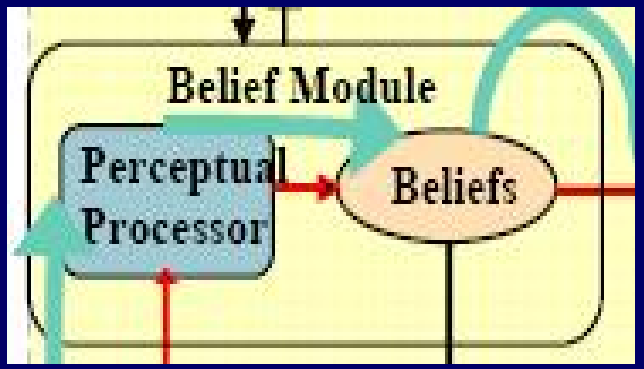
- Inteligent agent:
- - autonomous
- - cooperative
- - learnable

Extended BDI architecture



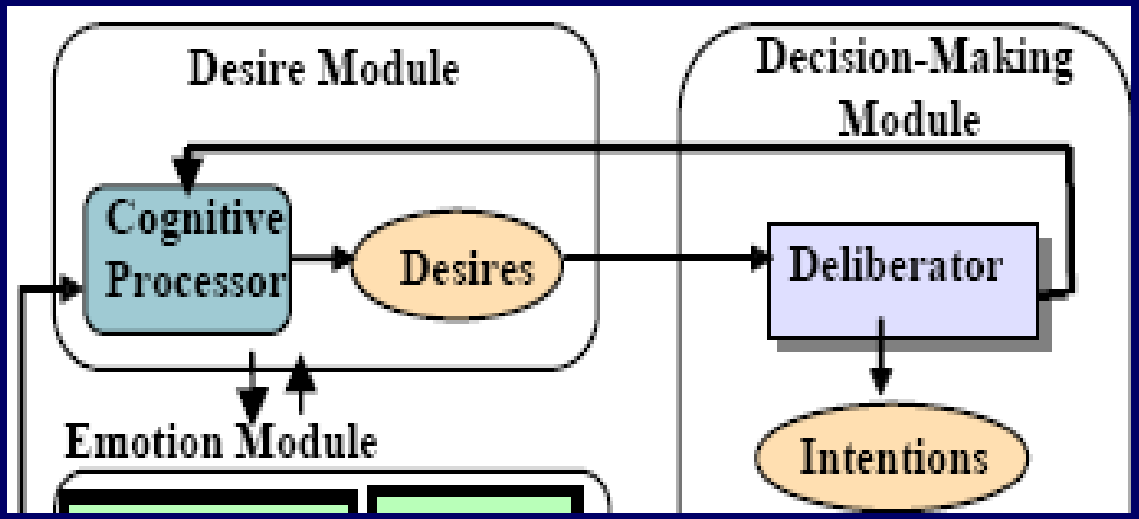
Perceptual processor

- observes the environment and tries to interpret the data coming from the sensors/external environment.



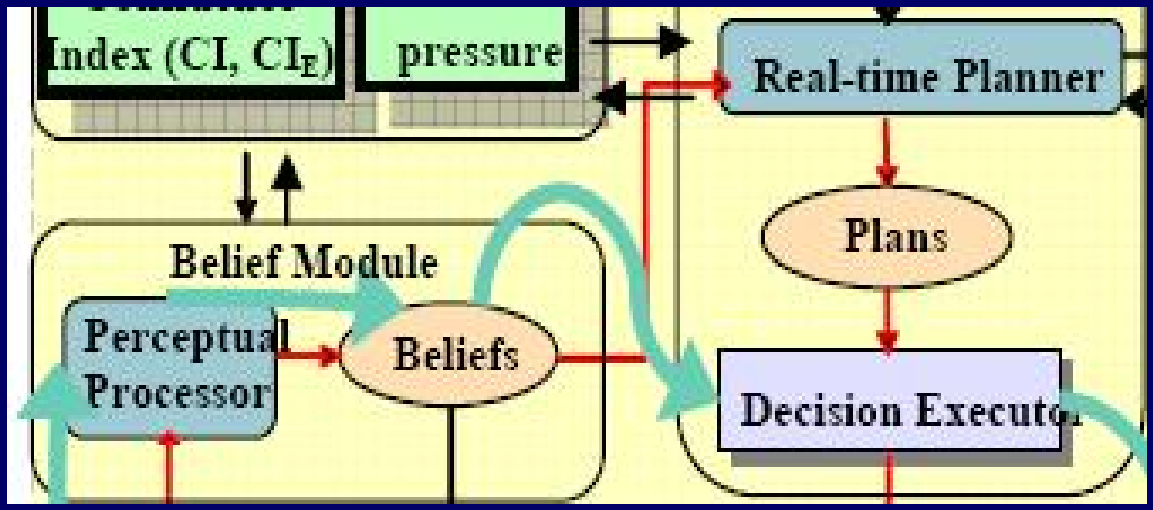
Deliberator

- filters desires to select one intention.



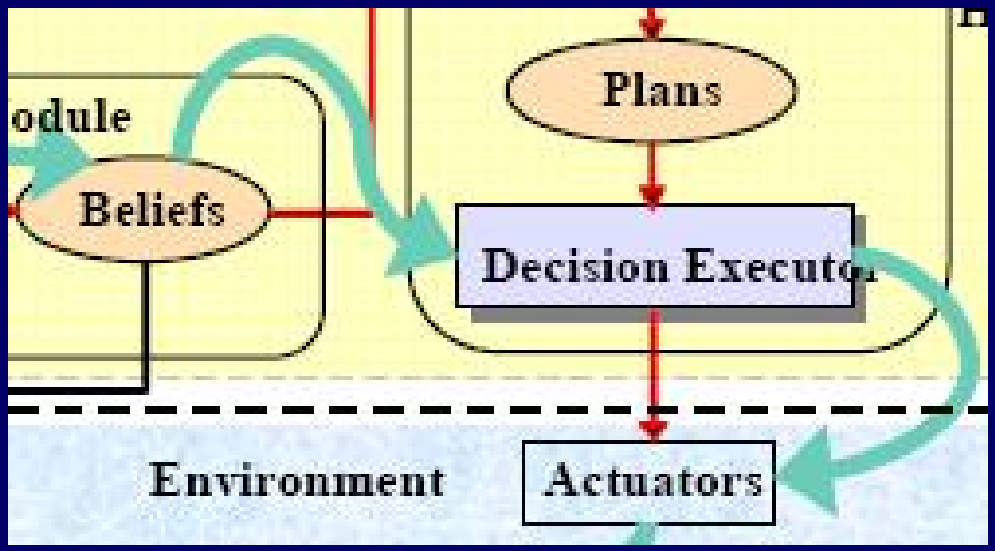
Real time planner

- generates different plausible plans to achieve the selected intention based on the current beliefs.



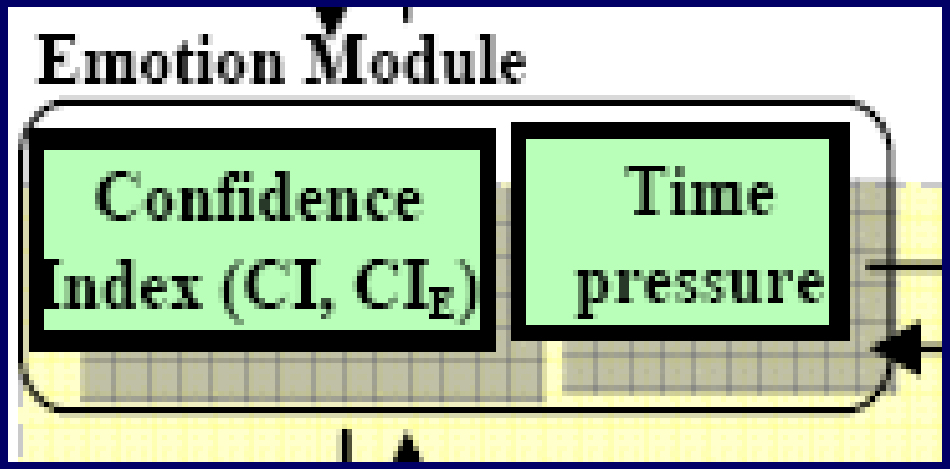
Decision executor

- selects one of several plans generated by the real time planner

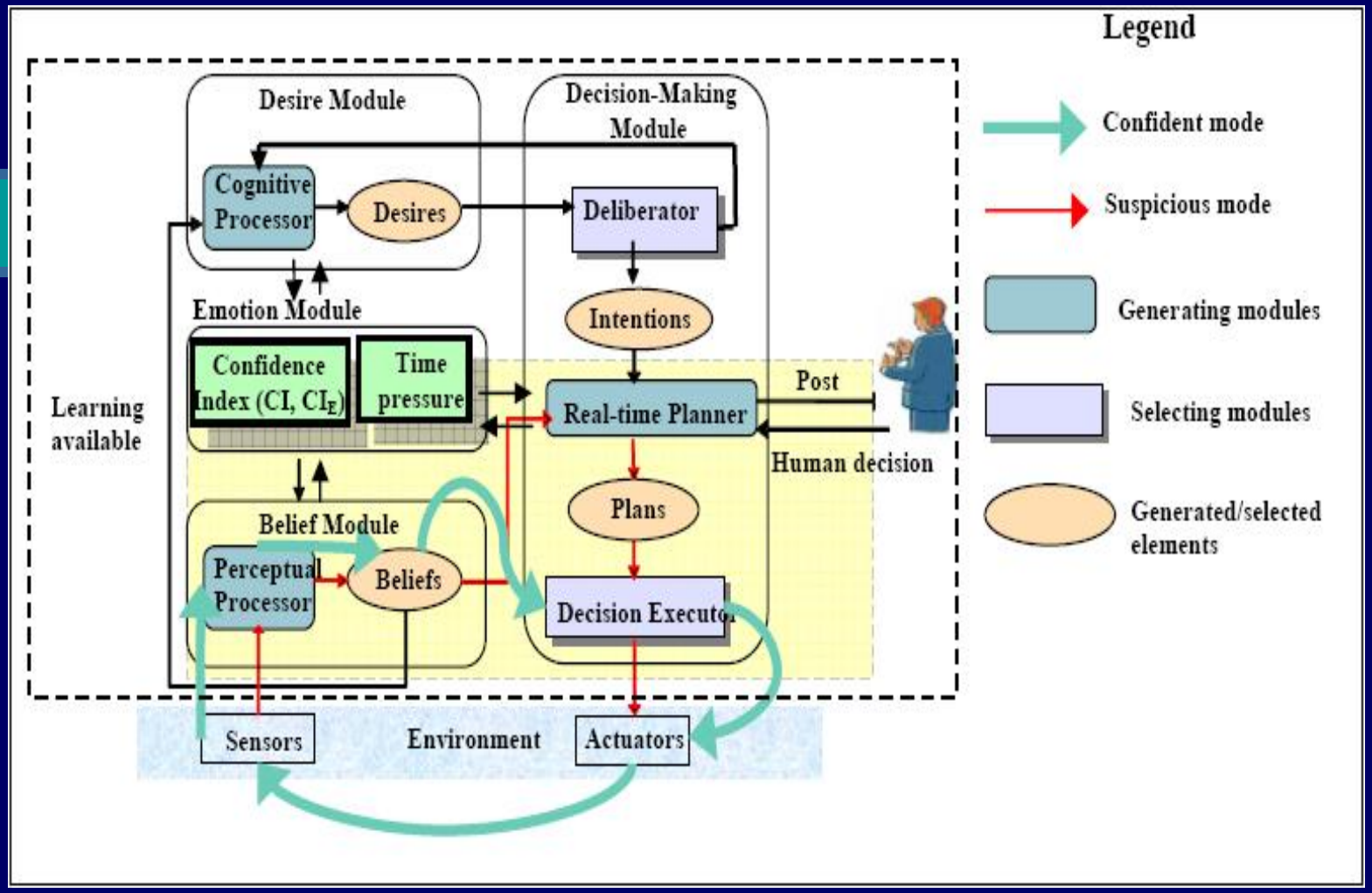


Confidence index

- denotes the agent's optimism about achieving it's intentions

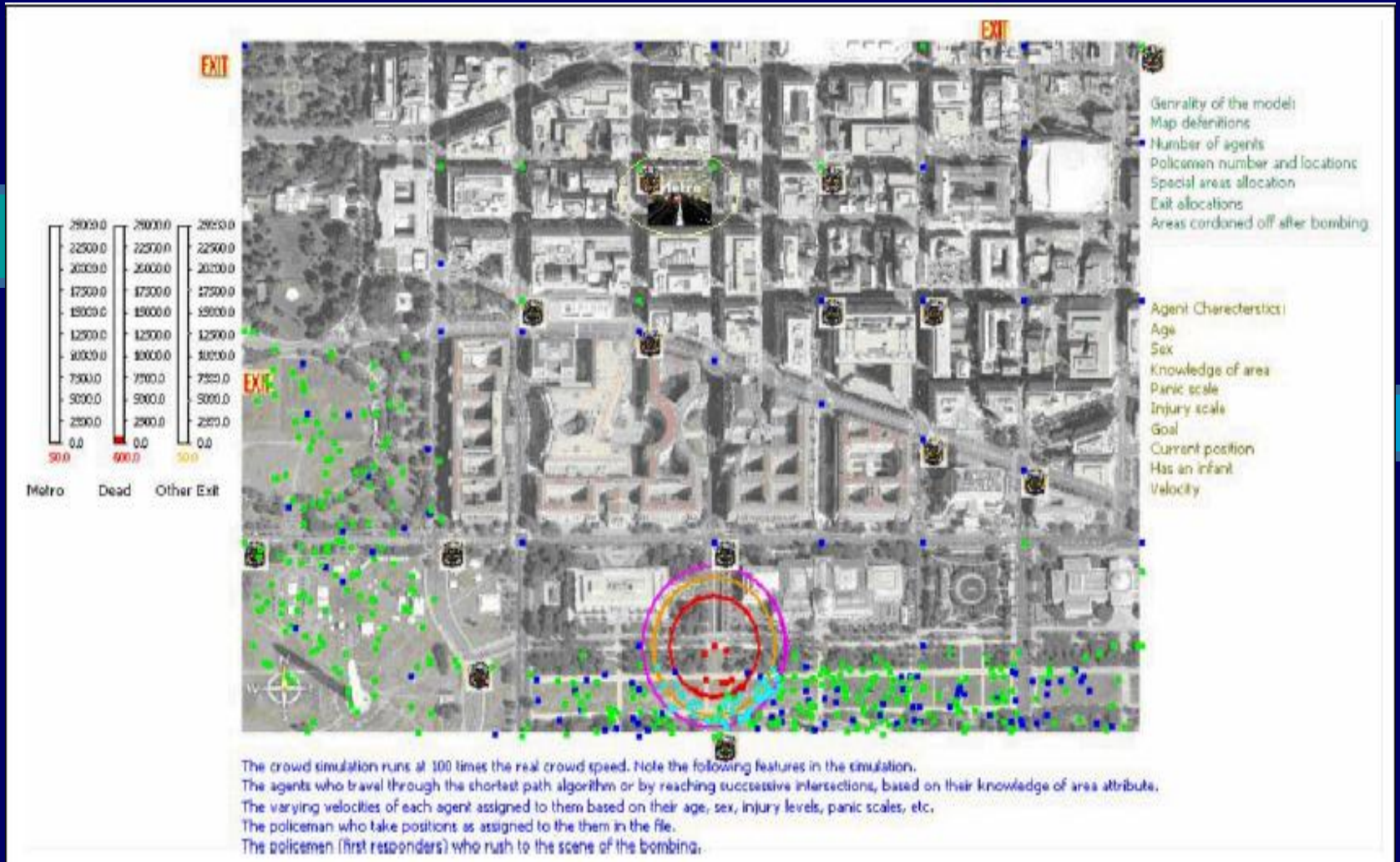


Extended BDI architecture, once more



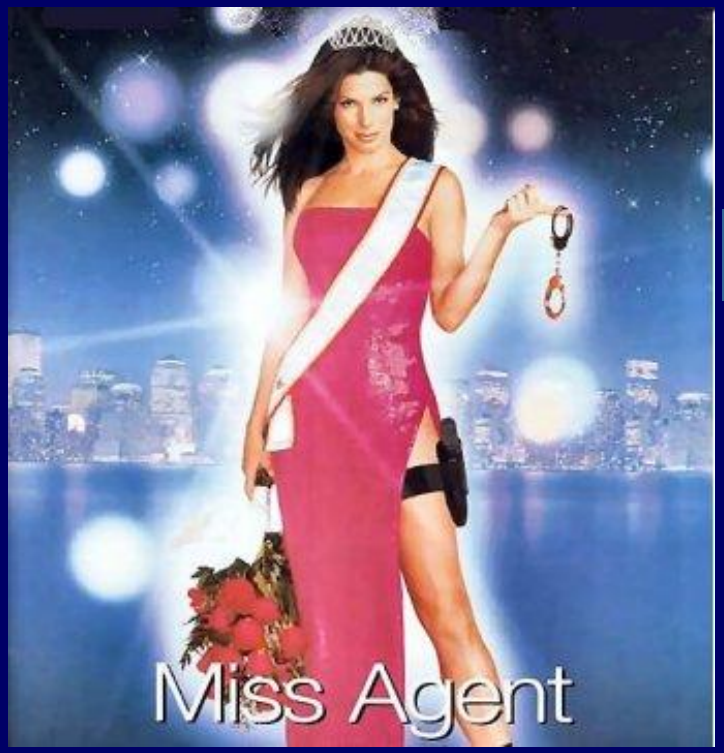
Environment

Environment



Agent Characteristics

- different attributes to give each and every one an unique character set:
  - age
  - sex
  - knowledge of area
  - panic scale
  - leadership
  - independence
  - injury scale
  - current positions

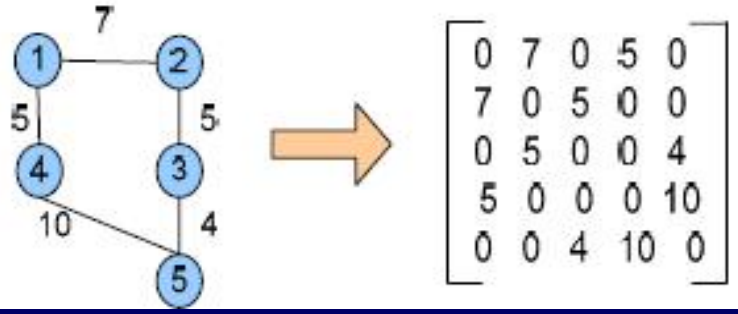


Major Data Structures

- network of roads = weighted graph with the vertices of the graph being intersections
- graph is represented as a distance matrix
- other areas = approximated rectangles.

Major Data Structures

Figure 5: Part of Washington DC



Shortest path algorithm

- Dijkstra's algorithm is used to calculate the shortest path.
- The time complexity of Dijkstra's algorithm is O(|V|2)

  |V| - numberof vertices in the graph.

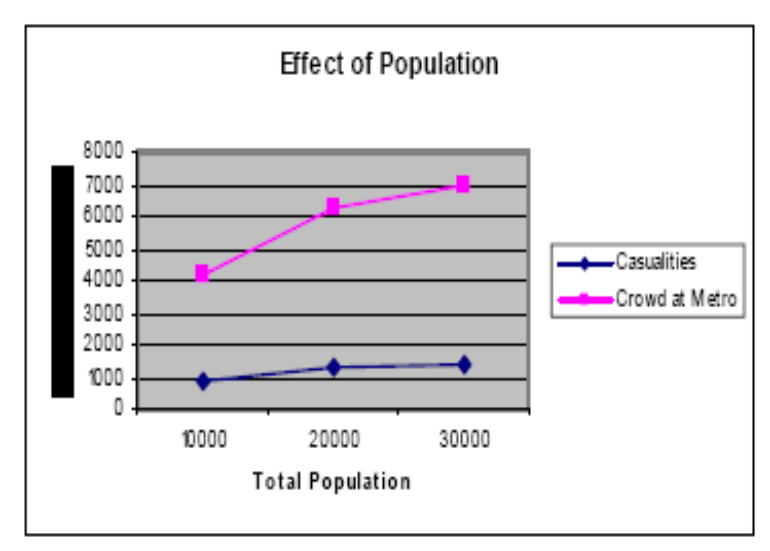
Experimentation and results

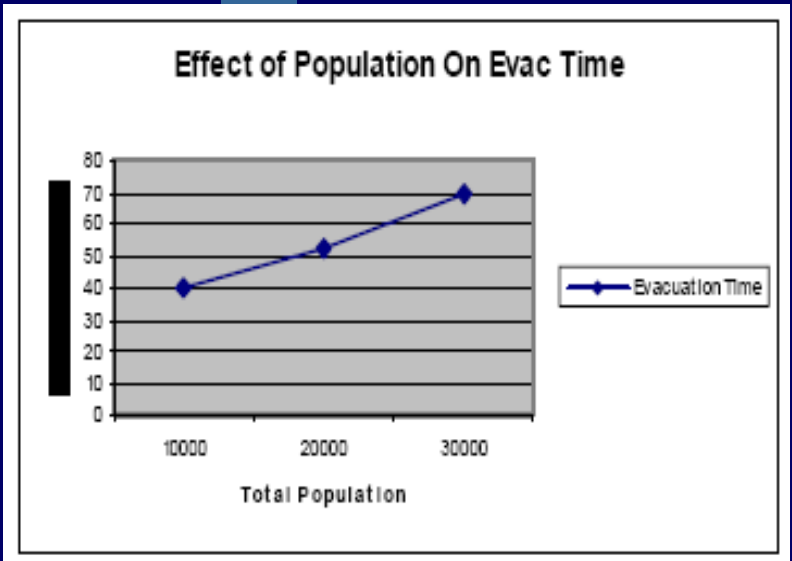
Table 1a: Weight Assignments

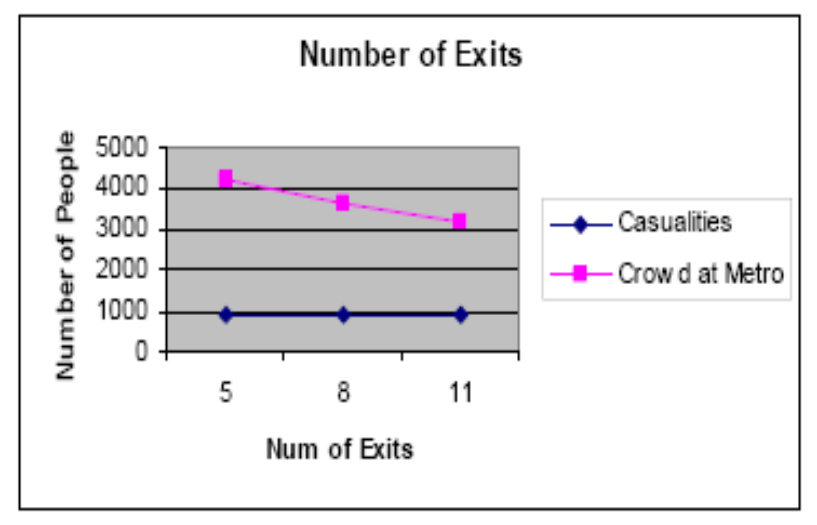
	Weight(15)		Weight(15)
Danger paths	6	Short paths	4
Exit paths	4	Medium paths	9
Police paths	3	Long paths	2
Crowded paths	2		

Table 1b: Velocity Validation using VR

	Avg Velocity
Human1	5.08 m/s
Human2	4.12 m/s
Human3	4.36 m/s


Effect of Population
8000
7000
6000
5000
4000
3000
2000
1000
0
10000
20000
30000
Total Population
Casualities
Crowd at Metro


Effect of Population On Evac Time
80
70
60
50
40
30
20
10
0
10000
20000
30000
Total Population
Evacuation Time


Number of Exits
Number of People
5000
4000
3000
2000
1000
0
5
8
11
Num of Exits
Casualities
Crowd at Metro

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THANK YOU FOR YOUR ATTENTION ☺