Crowds @VHLab

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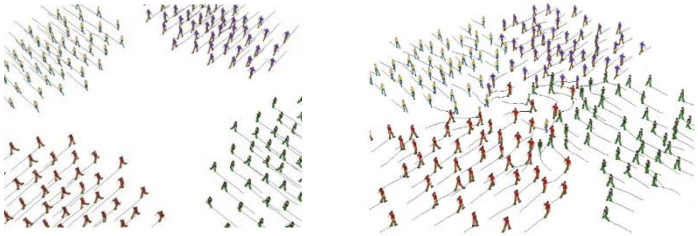
Crowd Tools @VHLab

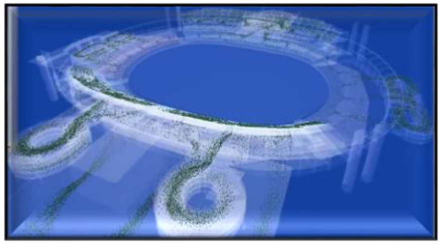
- BioCrowds

VH simulation based on biological patterns



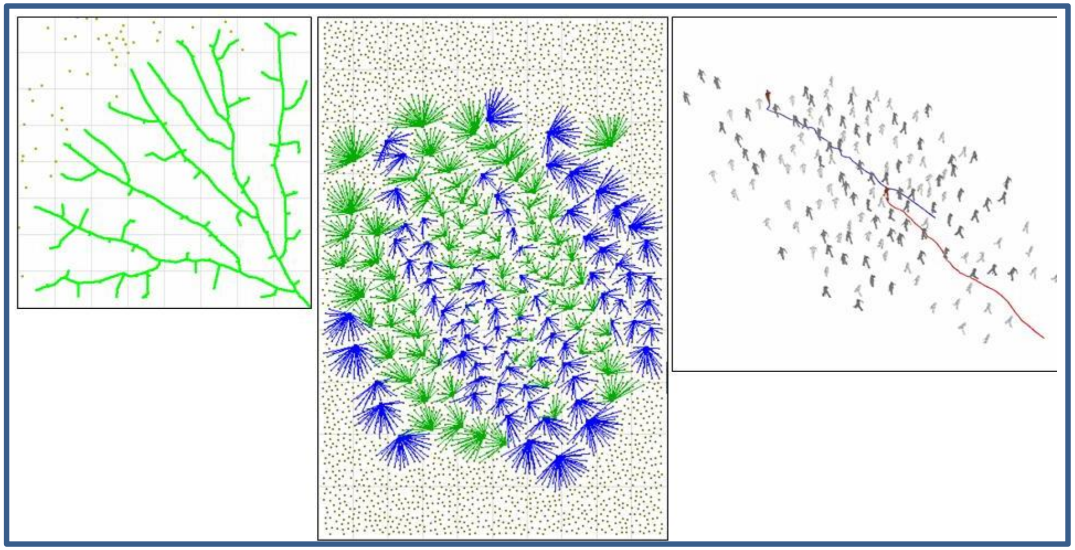
- CrowdSim

Rule-based system. Collision is geometrically based.



BioCrowds

- doi:10.1016/j.cag.2011.12.004 (Bicho et al, CG&A, 2012)
- A method for crowd simulation based on a biologically motivated space colonization algorithm which was originally introduced to model leaf venation patterns and the branching architecture of trees
- BioCrowds operates by simulating the competition for space between agents



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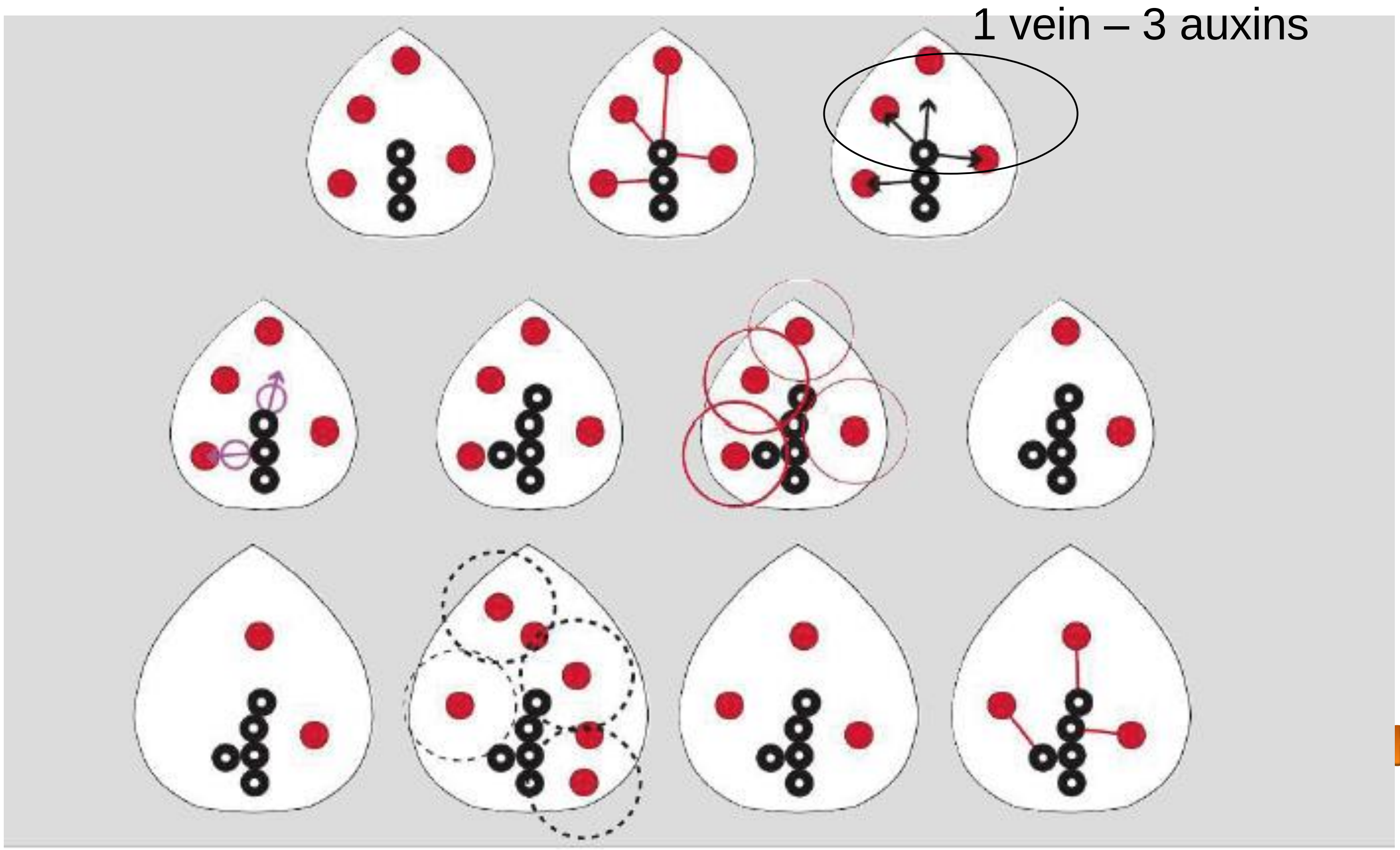
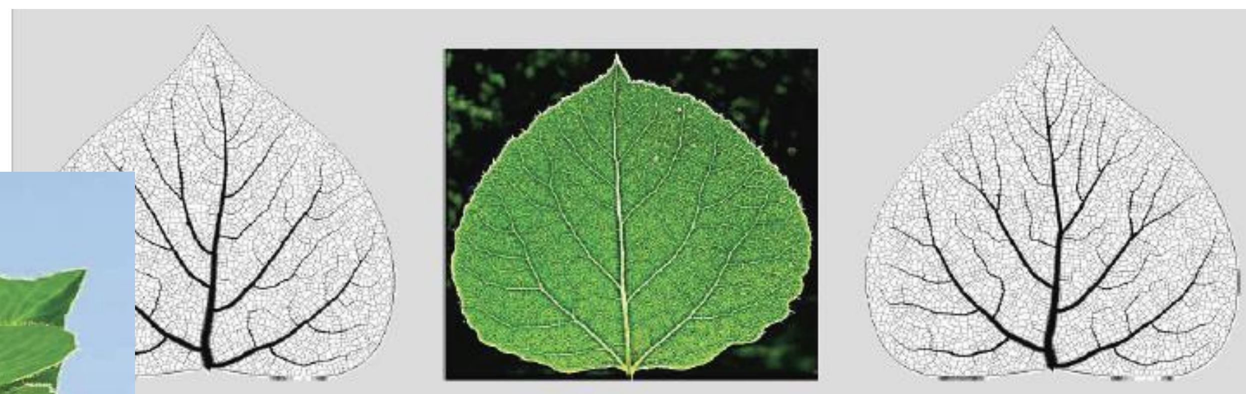
BioCrowds

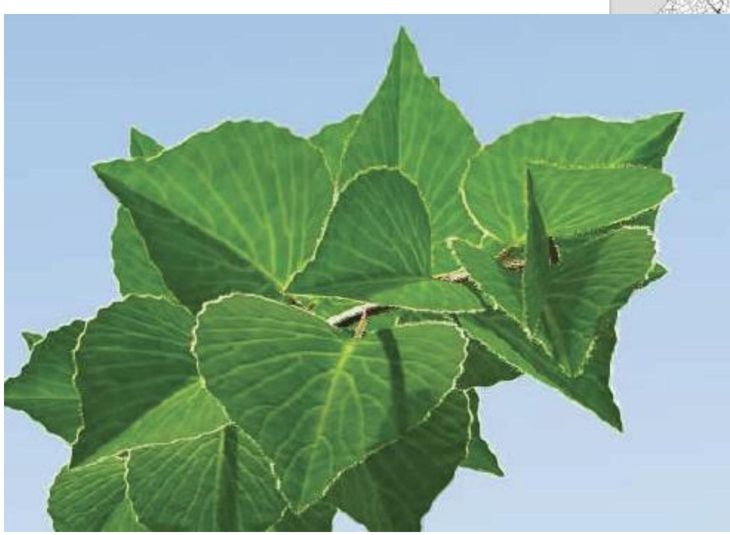
- Space colonization algorithm (auxins, veins):



A. Runions, M. Fuhrer, B. Lane, P. Federl, A.-G. Rolland-Lagan, P. Prusinkiewicz
Modeling and visualization of leaf venation patterns. ACM Trans Graph, 24 (3) (2005), pp. 702–711

Results (Runions method)



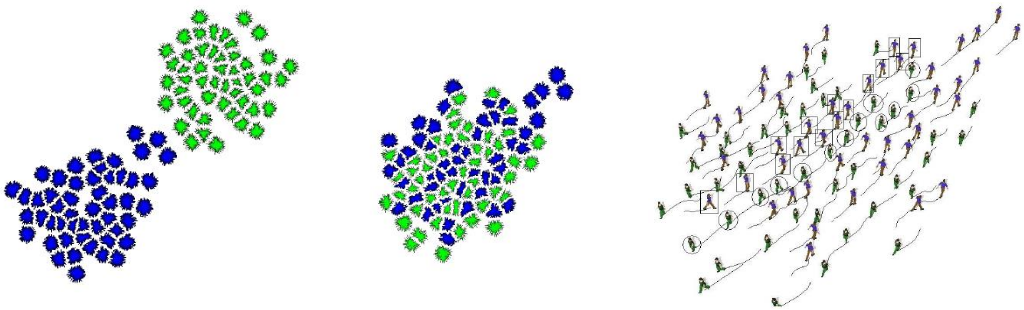


BioCrowds

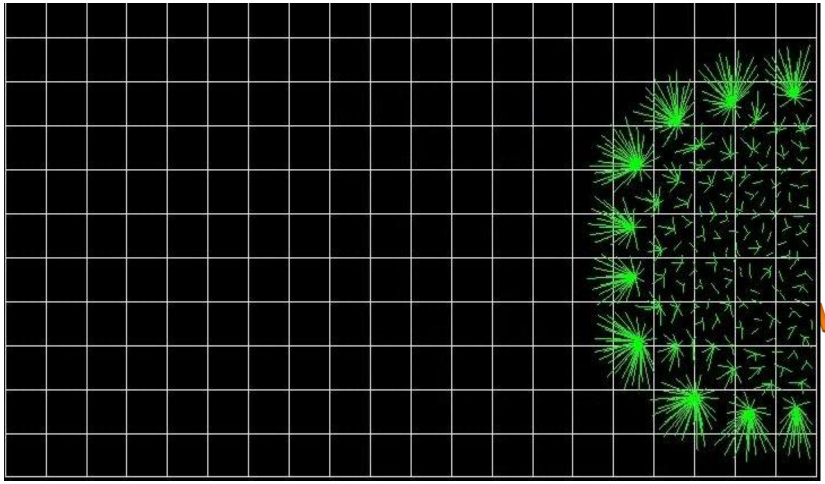
- Parameters:
  - *N* Markers *(Dart-throwing);*
  - *Agent i positions* x_i*(t), goals* g_i*(t) and desired maximum speed* s_{max}^{i}
  - Perception field (Circular region) R_i.
- At each timestep and for a given agent i:
  - $A = \{a_1, a_2, \dots, a_N\}$, markers that are closer to agent i than any other agent
  - $m = \sum_{k=1}^{N} w_k(a_k - x)$, motion vector
  - $w_k = \frac{f(g-x, a_k-x)}{\sum_{i=1}^{N} f(g-x, a_i-x)}$, f should prioritize markers that lead the directly to its goal
  - $v = s\frac{m}{||m||}$, where $s = \min\{||m||, s_{max}\}$, v is agent displacement
  - Next agent position is $x(t+1) = x(t) + v$

BioCrowds: Examples of Emergent Behaviors

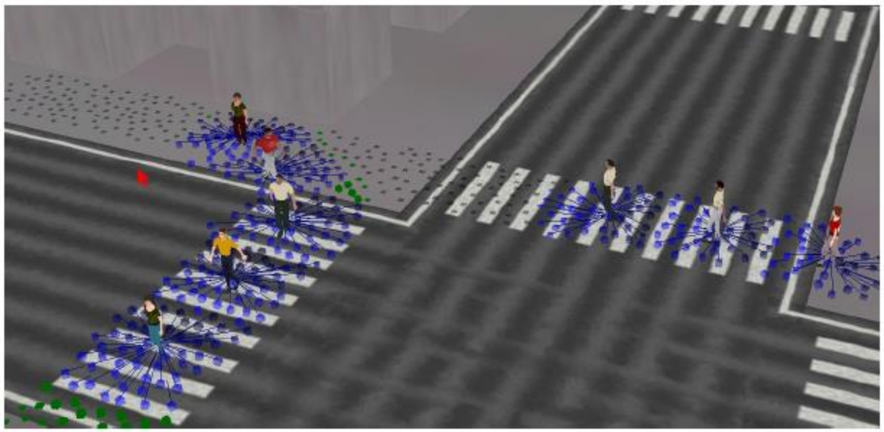
- Lanes formation:

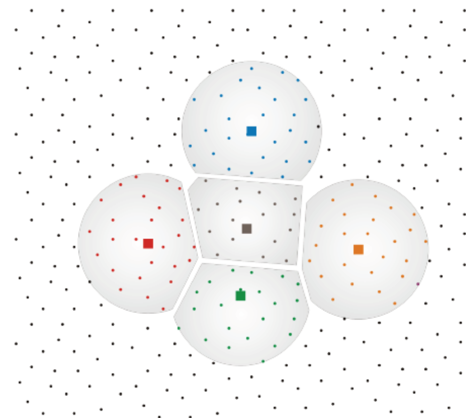


- Arcs formation:



BioCrowds





- BioCrowds emerges Voronoi Diagram

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BioCrowds: Problems

- One agent does not see any other
- Local minimum (there was no path planning)


Obstacle 2x2


Obstacle 2x4

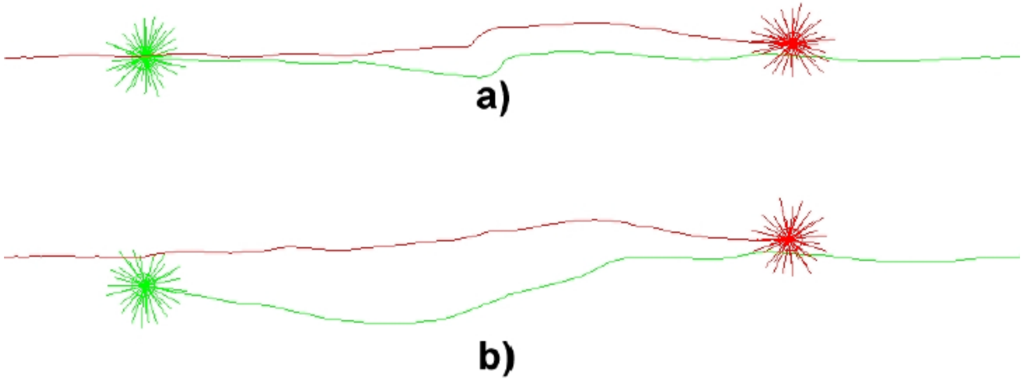
- Some possible solutions:
  - Increase the perception ray
  - Path planning

BioCrowds Extensions

Main idea: to control the agents based on the environment…

- BioCrowds Steering behavior:
  http://dx.doi.org/10.1080/08839514.2010.492167

- BioCrowds Antecipation:



Terrain reasoning

The idea was to put weights and semantic info in the markers, so we could generate regions where markers can be walkable, not walkable, probably not walkable and etc...



Groups

The idea of this work was to extend BioCrowds to group behavior

R. Hocevar ; H. Braun ; MARSON, F. P. ; V. Cassol ; BIDARRA, R. ; **MUSSE, S. R.** . From their Environment to their Behavior: A Procedural Approach to Model Groups of Virtual Agents. In: Intelligent Virtual Agents, 2012, Santa Cruz. Lecture Notes on Computer Science, 2012. v. 7502.

Current Research: Contagion

Main idea: To estimate the crowd characteristics in XX minutes…

(PhD student @ PUCRS)

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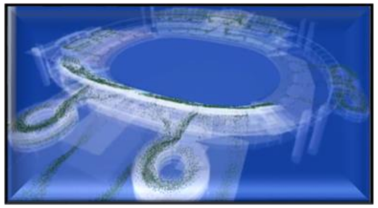
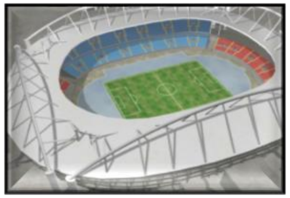
Current Research: Time Machine

Main idea: To estimate the crowd characteristics in XX future minutes…

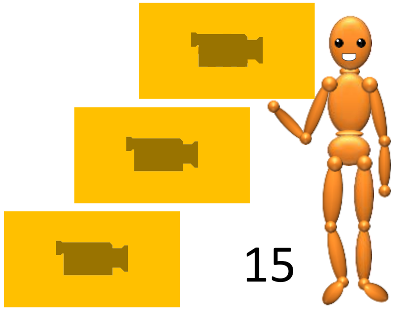
(PhD student @ PUCRS)

CrowdSim





- Evacuation-based software
- Collision avoidance is only geometrically defined
- Many new modules and experiments have been executed using CrowdSim
- Tested in real life: Night club, School, Olympic Stadium in Rio de Janeiro, Buildings at PUCRS, ...
- Demo?



Validation is Always a problem...

- Motivation: to be able to simulate with realism (Santa Monica, Kiss)

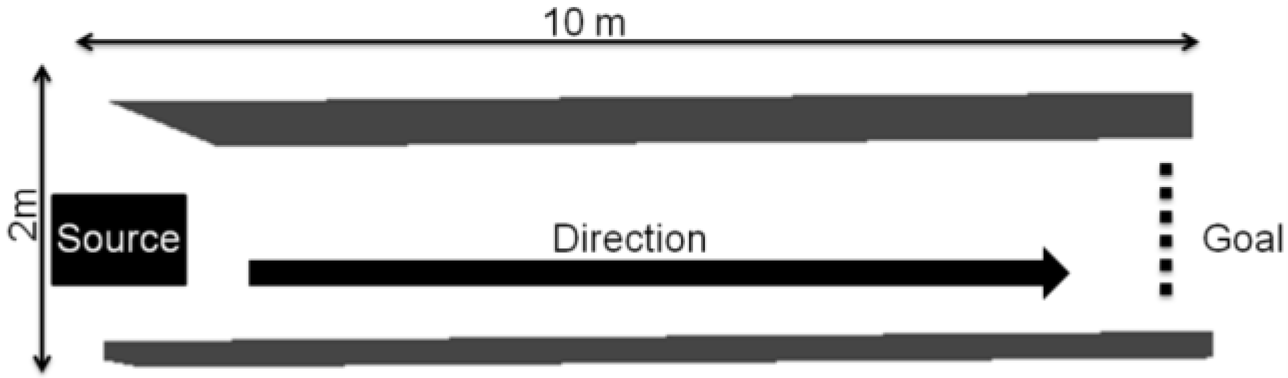
242 dead and 680 injured

Tests and verification

- Validations according to Galea [1], specifically for evacuation systems. International Maritime Organization (IMO) developed guidelines for evacuation analysis for new and existing passengers ships [3] based on Galea's work.

Formal: Component Testing (IMO)

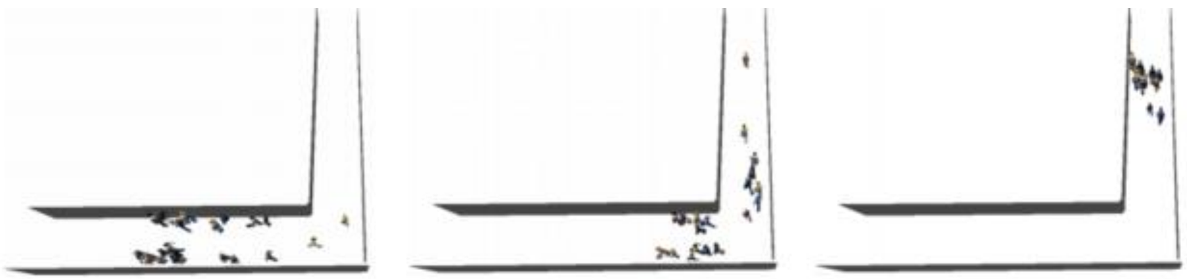
- Maintaining walking speed in corridors



- Sucess: agent's speed close to 1m/s

Formal: Component Testing (IMO)

- Around Corners



(a) time = 10 seconds (b) time = 15 seconds (c) time = 25 seconds

- Sucess:
  - Agents should navigate without penetrating the boundaries
  - Agents should not overlap at any time

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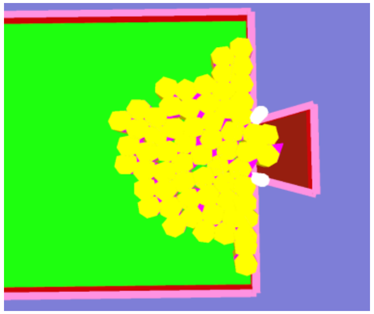
Quantitative Validation

- Exit Flow (IMO)- crowd dissipation from a large public room, considering 4 and 2 exit doors
  - Success: According to IMO, the elapsed time of the second case should be around 50 percent greater than in case 1.
- Speed reduction in stairs (IMO)
  - Success: speed reduction in 20%



- Emergent behaviors
- Historic quantitative validation (IMO) – real cases

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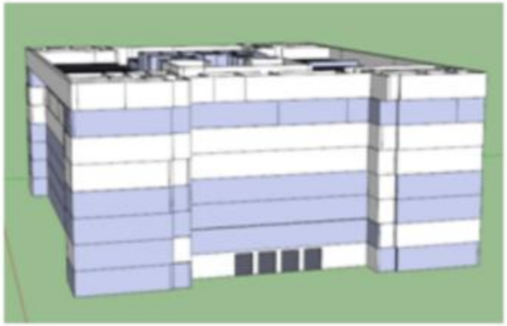
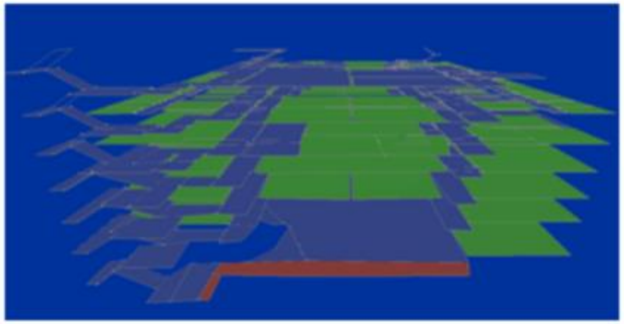
Real case: Building at PUCRS

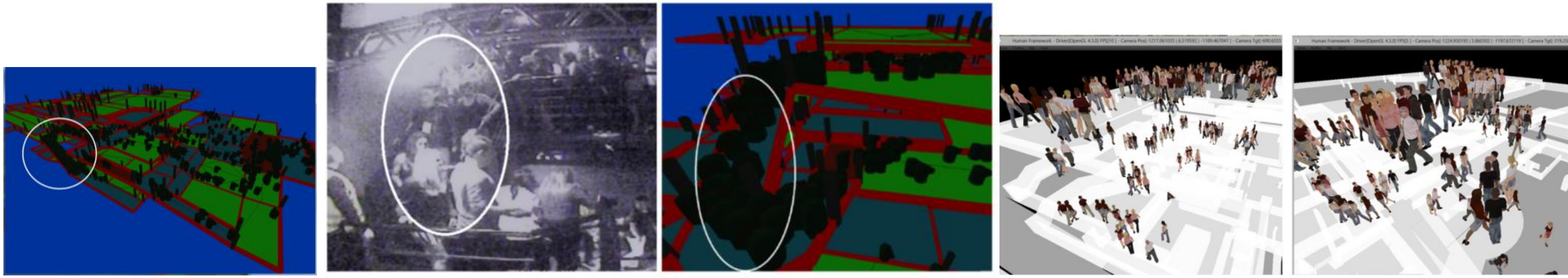




	Simulation 1	Simulation 2
Total time for evacuation (seconds)	464 = 7min44segs	479 = 7mins59segs
Highest Density (people/m2)	4.6	4.3
Place of highest density	Stairs in 7th floor	Stairs in 7th floor
Time when highest density was observed	Second 165	Second 90
Highest speed (m/s)	1.4	1.4
Smallest speed (m/s)	0.08	0.11

The only captured data in real experiment was the total time = 8min20seconds

Real case: Night Club



	Simulation	Real world data
Total time for evacuation (seconds)	119	175
Highest Density (people/m2)	5.4	4.5
Place of highest density	Stairs in 2nd floor	Stairs in 2nd floor
Time when highest density was observed	Second 40	Second 50
Highest speed (m/s)	1.3	1.5
Smallest speed (m/s)	0.1	0.2

<u>**Time from real experiments > simulated experiments**</u>

After CrowdSim was evaluated (?)....

- We added features in the simulation that are very hard to evaluate... Like simulation of people under alcohol influence [5].
- Project developed in collaboration with PAHO/WHO (USA).

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Simulation of people under alcohol influence in CrowdSim

BAC (g/100ml)	Effects on the body (partially from [2])
< 0.01	Nothing
0.01 - 0.05	Inconsistent effects on behavioral task performances
0.06 - 0.10	Decreased attention, slowed reactions, impaired coordination,
0.10 - 0.15	Dramatic slowing of reactions, impairment of balance and movement
0.16 - 0.29	Several sensory and motor impairment
0.30 - 0.39	Non-responsive stupor, loss of consciousness, death
> 0.39	reduced muscle strength, reduced ability to make rational decisions Unconsciousness, death

Table 1. Partially used table from[2]

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Main hypothesis:

- To model a simple relationship among the main characteristics of each BAC level and the agent goal persistence (*gp*):

$$gp_k = \alpha \times e^{(-\beta \times BAC_k)}$$

- Where α = 1, value of *gp* when BAC_k = 0 and β = 7.44 (decay constant).
- Based on gp, we compute for each agent k how many frames from the next ones it´s going to persist in its goal.

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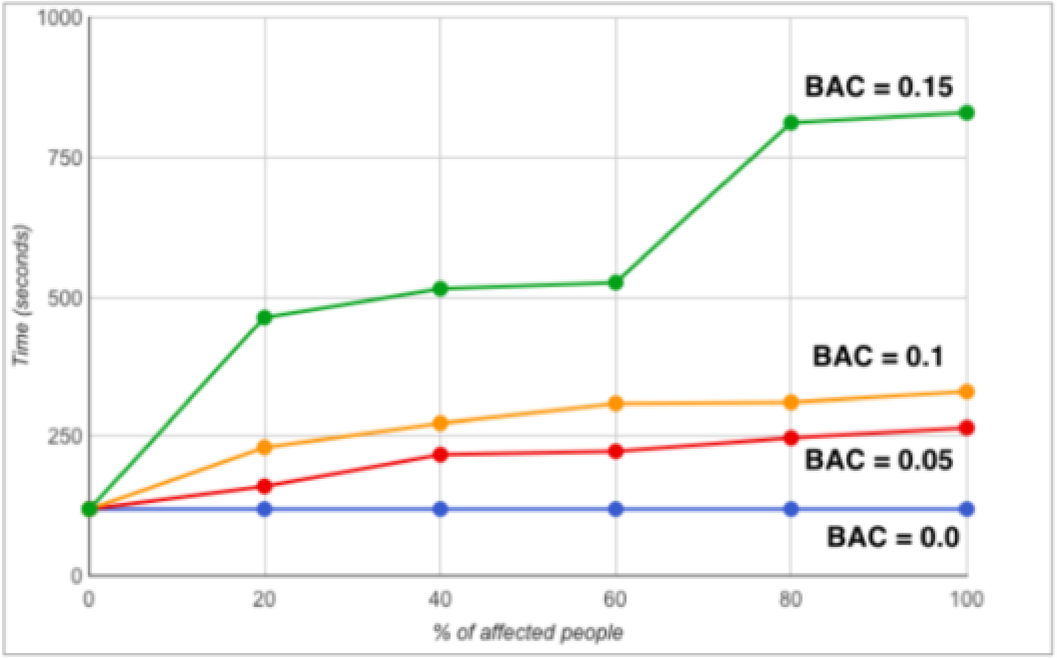
Preliminary Results:



BAC level	gp	Frames to goal	Frames wandering
0,00	1,00	10	0
0,05	0,69	7	3
0,10	0,48	5	5
0,15	0,33	3	7
0,29	0,12	1	9
0,39	0,05	1	9

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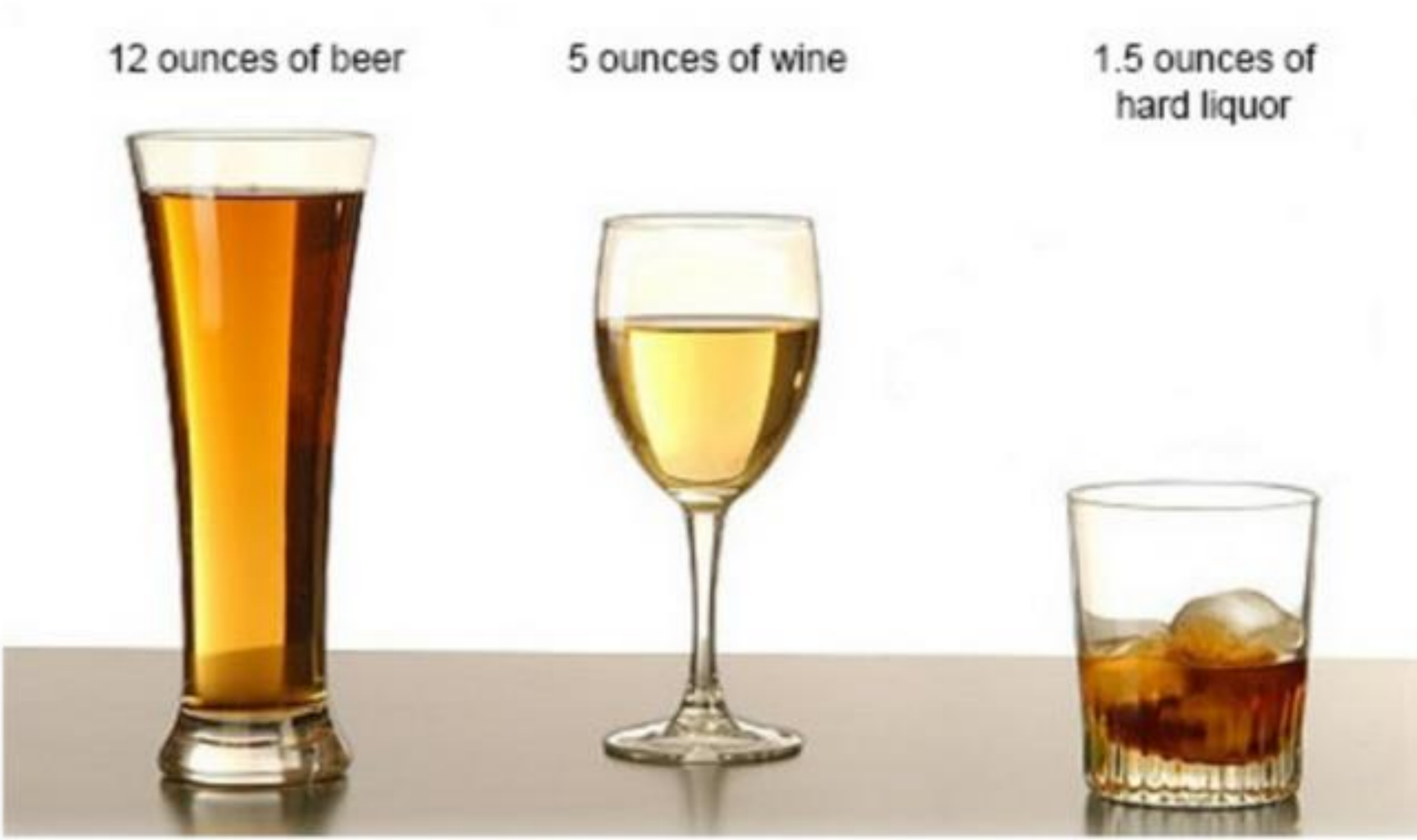
What is BAC?

For Males

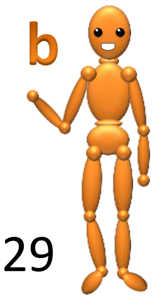
Body weight (lbs)	1 drink	2 drinks	3 drinks	4 drinks	5 drinks	6 drinks	7 drinks	8 drinks	9 drinks	10 drinks
100	.043	.087	.130	.174	.217	.261	.304	.348	.391	.435
125	.034	.069	.103	.139	.173	.209	.242	.278	.312	.346
150	.029	.058	.087	.116	.145	.174	.203	.232	.261	.290
175	.025	.050	.075	.100	.125	.150	.175	.200	.225	.250
200	.022	.043	.065	.087	.108	.130	.152	.174	.195	.217
225	.019	.039	.058	.078	.097	.117	.136	.156	.175	.198
250	.017	.035	.052	.070	.087	.105	.122	.139	.156	.173

What is "one drink"?



For Females

Body weight (lbs)	1 drink	2 drinks	3 drinks	4 drinks	5 drinks	6 drinks	7 drinks	8 drinks	9 drinks	10 drinks
100	.050	.101	.152	.203	.253	.304	.355	.406	.456	.507
125	.040	.080	.120	.162	.202	.244	.282	.324	.364	.404
150	.034	.068	.101	.135	.169	.203	.237	.271	.304	.338
175	0.29	.058	.087	.117	.146	.175	.204	.233	.262	.292
200	.026	.050	.076	.101	.126	.152	.177	.203	.227	.253
225	.022	.045	.068	.091	.113	.136	.159	.182	.204	.227
250	.020	.041	.061	.082	.101	.122	.142	.162	.182	.202



The Time Factor

Hours since first drink	Subtract this from BAC
1	.015
2	.030
3	.045
4	.060
5	.075
6	.090

Source: Evans, Glen and Robert O'Brien (1991) The Encyclopedia of Alcoholism.

Current status:

- Testing in different environments
- With different number of people
- Adapting to have a curve of “drink sales” and party duration to have more realism in the method
- Adapting the gp_k to BAC as a function of time

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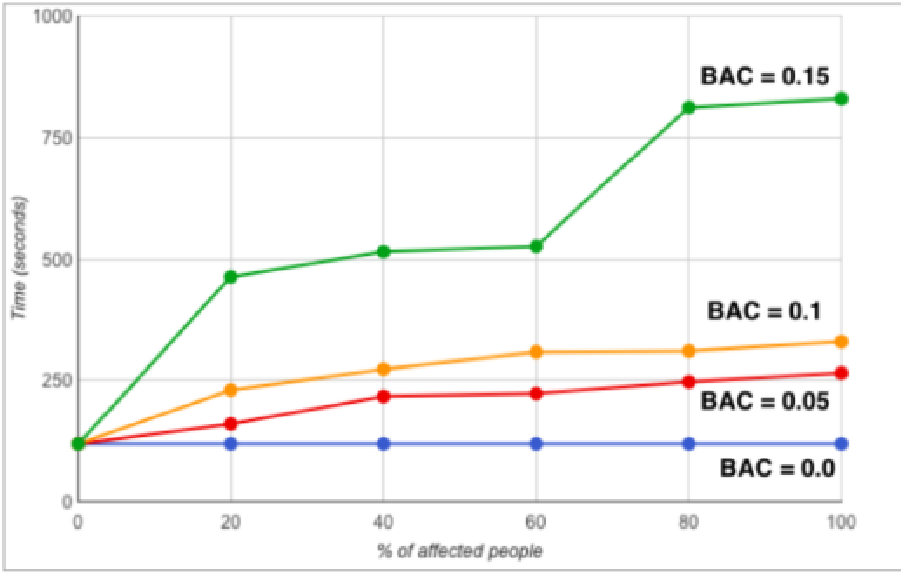
Current status:

- Our hypothesis:



"Even if half of population drinks, they disturb almost as much as if all population drinks…"

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Contact

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VHLab - Virtual Humans Simulation Laboratory

http://www.inf.pucrs.br/vhlab/

https://www.facebook.com/vhlabpucrs/

Youtube channel:

https://www.youtube.com/channel/UCmscDyh7rLCcUaTSsaf9lBQ

References

- [1] E. R. Galea, A general approach to validating evacuation models with an application to EXODUS, Journal of Fire Sciences 16 (6) (1998) 414–436.
- [2] Organization, W.H.: Drinking and Driving: a road safety manual for decision-makers
  and practitioners. Global Road Safety Partnership, Geneva (2007)
- [3] Guidelines for Evacuation Analysis for new and existing passenger ships, International Maritime Organization, Marine Safety Committee, London, 2007.
- [4] Bolei Zhou, Xiaoou Tang. Measuring Crowd Collectiveness. IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, VOL. 36, NO. 8, AUGUST 2014
- [5] Vinícius Jurinic Cassol, Cliceres Mack Dal Bianco, Alexandre Carvalho, Jovani Brasil, Maristela Monteiro, Soraia Raupp Musse:
  An Experience-Based Approach to Simulate Virtual Crowd Behaviors Under the Influence of Alcohol. IVA 2015: 124-127
- [6] A Model to Compute People Disturbance in Crowds. Cliceres Mack Dal Bianco, Adriana Braun, Jovani Brasil and Soraia Raupp Musse. ACM MIG 2015
- [7] *Adams, Ernest (2014). Fundamentals of Game Design. New Riders Press.*