Lifelike Interactive Characters with Behavior Trees for Social Territorial Intelligence

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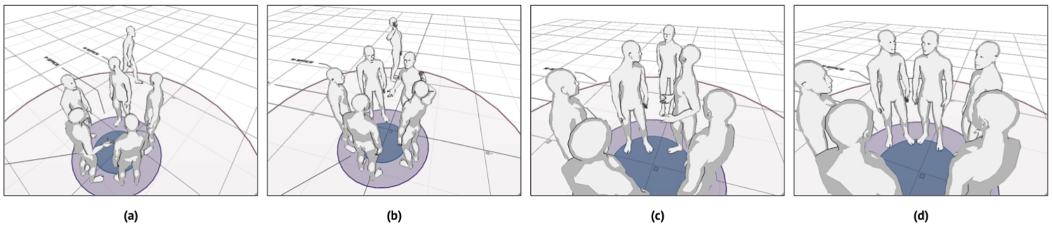

Figure 1: *The social group dynamics simulation in four steps. (a) Someone walking by is noticed when stepping inside the territory. Through common attention, somebody looks back after watching a member looking at the passerby. (b) The passerby is engaged and invited to join. Other members notice the salutation. (c) The newcomer is welcomed with a short glance. (d) The group opens up to make room for the new member that finally joins.*

State-of-the-art technology allows for photo-realistic graphics but this is not always enough. The gaming industry is slowly evolving the art of story telling but no matter how compelling the graphics or thrilling a story, awkward character behavior often breaks player immersion. In previous seminal work [Pedica and H. Vilhjálmsson 2010] we showed how the social theories of human territoriality and face-to-face interaction can serve as a solid base to model reactions expected by users when interacting with virtual characters.

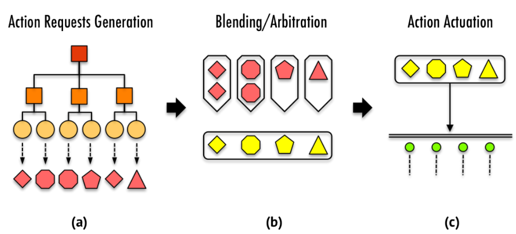

Figure 2: *The architecture in a nutshell. (a) Behaviors generate different types of action requests to control different bodily parts. (b) Action requests are gathered in groups of same type, combined, and packed into a motivation. (c) The motivation is sent to an actuation interface for action rendition.*

We have now integrated our reactive approach for social territoriality with Behavior Trees (BTs), an emerging game A.I. technique that is fast becoming a standard in the industry. This integration led to a variant of BTs where multiple branches can run simultaneously and blend. A middle-layer of custom-made arbitration strategies performs the blending before actuation, resembling command fusion architectures. We also gave behavior nodes a priority. High priority behavior branches can subsume lower priority ones to respond immediately to critical contingencies, akin to subsumption architectures. The resulting behavior achieves responsiveness, smoothness and continuity of motion when the decision logic simultaneously controls where to look, where to stand, how to orient the body and what animation to play.

In our variant of BTs, the leaf nodes generate action requests. A request demands a certain action such as ”look there”, ”move here”, ”play an animation”, etc, without actually implementing it. Some BTs implementations stop the decision logic after an action has been selected while in ours multiple decision branches can run simultaneously, each leading to a different action request. After generation, action requests are gathered into groups and each group blended through an arbitration strategy which resolves potential conflicts. The result is a set of final combined requests forming the attributes of what we call a *motivation*. A motivation models the psychological drive to react and results in a, compound collection of motion requirements to be issued to the actuation layer for action execution.

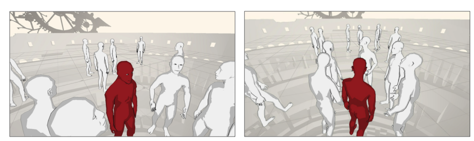

Figure 3: *Territoriality in an interactive scenario. The user controls the red character that can join or leave groups.*

Generally, different branches of the whole tree may pursue conflicting goals. What if a branch demands keeping proper body posture and position to show awareness of the ongoing social interaction while another wants to keep looking at something really important happening elsewhere? How can priorities be handled? We resolve this with behavior tree subsumption. Every behavior node has a priority and, if given an action request, it will suppress the execution of lower priority nodes. Subsumption helped organizing complex BTs in horizontal layers of goals at different levels of abstraction. Using this variant of BTs, our territorial behavior for conversation group dynamics [2010] became a parallel composition of nodes to keep personal distance, equality, cohesion and common attention. The resulting social animation system achieves new levels of realism of behavior as well as being easier to extend and reuse.

References

PEDICA, C., AND H. VILHJÁLMSSON, H. 2010. Spontaneous avatar behavior for human territoriality. *Applied Artificial Intelligence 24*, 6, 575–593.

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