Evolving virtual creatures

Overview
In computer animation, a classic trade-off is that of complexity vs. control. Indeed, it is often difficult to build interesting or realistic virtual entities and still maintain control over them. An example of this trade-off is that of kinematic control vs. dynamic simulation. If we directly provide positions and angles for moving objects, we can control each detail of their behavior, but it might be difficult to achieve physically plausible motions. If we instead provide forces and torques and simulate the resulting dynamics, the result will probably look correct, but then it can be very difficult to achieve the desired behavior, especially as the objects we want to control become more complex.

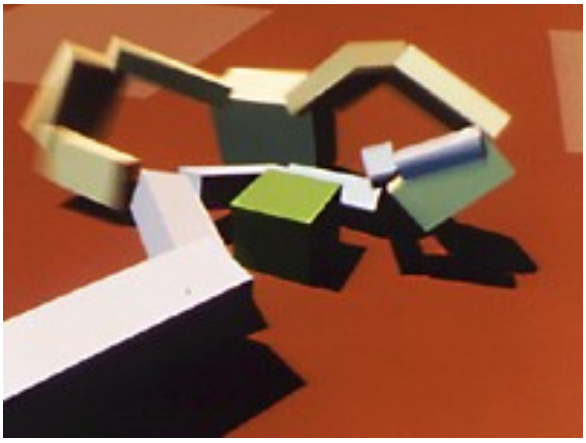

Figure 1: Two competing virtual creatures.

Karl Sims proposed an approach [1] in which the 3D physical structure of a virtual creature can adapt to its control system, and vice-versa. Furthermore, the “nervous systems” of the simulated creatures are also completely determined through optimization: the number of internal nodes, the connectivity, and the type of function each neural node performs are included in the genetic description of each creature, and can grow in complexity as an evolution proceeds. Together, these remove the necessity for a user to provide any specific creature information such as shape, size, joint constraints, sensors, actuators, or internal neural parameters.

Project
Implement a virtual-creature simulator based on [1], that allows evolving virtual creatures to wards performing certain tasks: swimming, hopping, competing, following a moving target, etc. If necessary use a physics engine (e.g. Bullet, ODE, etc.) to help implementing correct physical behaviour (collision response, articulated dynamic, etc.) of your simulated creatures.

References
[1] "Evolving Virtual Creatures" K.Sims, Computer Graphics (Siggraph '94 Proceedings), July 1994, pp.15-22.