Humanoid Soccer Optimization

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The tuning of parameters thanks to automatic procedure has been widely studied in the past. Mimicking humans and using machine learning algorithms are the most common ways to tune individual moving parameters and collective strategies parameters. Starting from a set of parameters, short modifications are applied iteratively to improve the set of parameters, according to a fitness function. The optimization process can be achieved with different ways to adapt the next generation according to previous generations' results: by applying a *Covariance Matrix Adaptation Evolution Strategy* (CMAES) [1]; by applying a *Confident Local OPtimization* (CLOP) [2].

In the CMAES evolution strategy, best parameters sets are selected and are used to make new candidates according to a multivariate normal distribution and a covariance matrix that contains pairwise dependencies in the distribution. In the CLOP iterative process, new samples are produced by iteratively performing regression that consider samples with best results. During the process, all samples are considered to produce a robust local regression based on very noisy outputs and non-negative Hessians.

Therefore, optimization techniques can be applied to individual, pairwise and collective optimization (Fig. 1). By using parametric models [3,4], the optimization process was applied to both morphological characteristics and walking parameters [5]. The forward walking speed was improved by tuning 2 morphological and 3 functional parameters using the CLOP. Two policies were finally proposed to define a best-first agent and a best-average agent. Results showed improvements of the morphological model as the optimization process produced faster humanoid walkers, with more realistic, safe and precise walk. The same optimization framework was used to increase kicking skills of humanoids [6]. For a kick move, the skill optimization process needs different subsets of parameters of kicking parameters. Results showed that sequential sub-process optimization can lead to better results. All individual behaviors [7] were tuned separately thanks to an adapted optimization process, which tends to produce an heterogeneous team of players. To reduce the gap between individual and collective behaviors, MacAlpine and Stone [8] have proposed to settle an uniform-velocity omni-directional walk. To produce flexible kicks, Ferreira *et al.* [9] have developed kicks (more independent to player's path) that reduce player's positional restrictions. To reduce the gap between simulation and real humanoid optimization, Farchy *et al.* [10] introduced Grounded Simulation Learning.

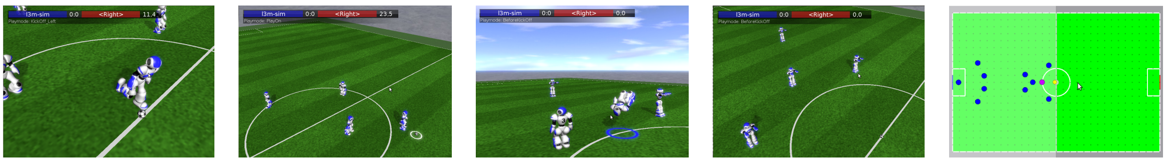

Fig. 1. Individual (kicking, assisting and diving), Pairwise and Collective Moves

It remains to identify new optimization techniques and provide comparative studies, that should be more generally applied for individual, pairwise and collective optimizations, from simulated to real humanoids.

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