GECCO-2011

Submissions

My Submissions

pap795 Review Details

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Title: Generating Gaits for Physical Quadruped Robots: Evolved Neural Networks vs. Local Parameterized Search
Authors: Clune, Hidalgo, Lipson, Nguyen, Yosinski, Zagal

Key for the below column headings: hide

Review Categories (higher is better):

rel: RELEVANCE TO THIS CONFERENCE: Is the subject of this paper relevant to this conference?
[1-5]

sig: SIGNIFICANCE OF THE PROBLEM: Is the subject of the paper important?
[1-5]

orig: ORIGINALITY OF THE WORK: Does the paper presents an original contribution to the scientific field?
[1-5]

ach: ACHIEVEMENT OF STATED OBJECTIVE: Does the paper clearly establish its main point (problem, issue, etc.) and stay focused and deliver on this stated objective?
[1-5]

writ: WRITING QUALITY: How good is the organization, sentence structure, mechanics (e.g., figures, tables), spelling, and, above all, the clarity of this paper? Please suggest ways to improve the readability of the paper in the "Comments to Authors" box below.
[1-5]

rep: REPLICABILITY: If the paper describes an experiment, is there adequate information in the paper to permit replication of the experiment?
[1-5]

tech: TECHNICAL SOUNDNESS: Is the paper technically well developed? If experimental results are described, are these results investigated for statistical significance?
[1-5]

rec: ABSOLUTE RECOMMENDATION (1-5) OF PAPER: Based on your opinion of what should and should not be accepted at the conference. The values of all reviews of the paper will be averaged. The average value will then be directly used for the paper ranking in the track. Based on this paper ranking, the decision for rejection/poster/paper will be derived. By choosing the Absolute Recommendation score, you thus can influence the decision whether the submission will appear as poster or full paper.
[1-definitely reject outright, 2-probably accept as poster, 3-definitely accept as poster, 4-probably accept as full paper, 5-definitely accept as full paper]

conf: CONFIDENCE: This concerns the reviewer's confidence.
[1-5]

bp: BEST-PAPER AWARD NOMINATION: Do you recommend this paper to be nominated as best paper in its track?
[no, yes]

Summary of reviews of pap795s1

Reviewer	rel	sig	orig	ach	writ	rep	tech	rec	conf	bp
Reviewer 1	3	3	1	4	4	4	4	1-definitely reject outright	4	no
Reviewer 2	5	4	3	3	4	4	2	5-definitely accept as full paper	4	yes
Reviewer 3	5	4	3	2	3	3	3	3-definitely accept as poster	3	no
Reviewer 4	4	4	4	3	5	4	5	4-probably accept as full paper	2	no
Averages:	4.2	3.8	2.8	3.0	4.0	3.8	3.5	3.2	3.2	0.2

Commitee Comments jump

Reviewer 1 Comments top

Comments for Authors:
A nice, readable survey comparing different approaches for evolving effective gaits. A great lecture for a student, but with no novelty whatsoever. Maybe it could have been submitted to RWA, authors claim that results are superior to human-designed solutions...

Moreover, the practical tricks (such as mounting a Wii remote on the robot) are really nice and appealing.

Why worrying about performances of the search? Gaits are designed only once, and then used forever on.

The "outline of sections" should be moved at the end of the introduction.

Please, double check "orphans and widows".

Reviewer 2 Comments top

Comments for Authors:
This paper explores the evolution of forward movement in real-world quadruped robots. It uses both standard learning algorithms as well as the HyperNEAT system.

I think the real value of this work is in demonstrating the value of HyperNEAT to real-world physical systems, and for this proof-of-concept alone I believe this paper is a valuable contribution. I am less impressed with the comparisons performed to the learning algorithms, though I do still find those results somewhat interesting.

My problems with the comparisons performed have to do with the low statistical power (as noted by the authors) and the fact that HyperNEAT was given an unfair advantage. The authors argue that this advantage goes in the opposite direction since many HyperNEAT runs had the robots leaving the arena or moving into an illegal position, incurring a loss of 1/2 of their fitness. However, such penalties are likely to be a result of the simple fact that they were able to move so rapidly, and were any of the other algorithms so successful, they would be coping with a similar fitness loss.

The reason I feel that the other algorithms were put at a disadvantage is due to the noise in the fitness function. Normal hill-climbing techniques behave more like evolutionary algorithms when performed on a noisy landscape, however due to the population size of one, they are much more likely to be caught in a dead-end that they can't easily climb out of. I would bet that if a population size of nine was used (like was done in HyperNEAT), and instead of normal mutations, these algorithms were used to generate subsequent generations, the results would be much better. Simply put, evolutionary algorithms (HyperNEAT or otherwise) deal much better with noise.

More minor points: * The robot appears to be tethered in Figure 1, but this was never mentioned in the paper. I presume the tether was use to reset its position after each test? If not, how was this done to make sure they stay inside the arena? This should be discussed. * I was a bit disappointed to not be able to see the movies, but I do understand how that would violate anonymity. * First paragraph of 3.1, "It weights 1.88 kg..." should be "weighs" (no 't'). * Next paragraph "the compact on-board CompuLab Fit-PC2" should probably have a comma after "compact". * In section 4.2, right before the specific algorithms are discussed, it says "...by starting them at the same three initial θ vectors in the three runs." This is the first mention that there are only three runs done of each. This should be stated explicitly earlier on. * Some of the figure (such as Figures 5 & 6) look like they were taken from previous papers (perhaps with modification). Make sure to cite their source. * Table 2 is a bit misleading. If there are only three data points for each row, it would almost be better to list them than talking about averages and standard deviations. The latter is only even meaningful for normal distributions, and with three data points you cannot know if you even have one.

Overall, I like the HyperNEAT portions of the paper were done, but the rest could use a lot more work.

Reviewer 3 Comments top

Comments for Authors:
The paper presents an interesting study and comparison of some different approaches to the evolution of controllers for a physical quadruped robot. The conclusion is that the "HyperNEAT" algorithm for evolving an ANN based controller significantly outperforms a local parameterized search on the given (restricted) task domain.

I think this will be of interest to the GECCO audience, particularly as it involves the use of a "real", physical, robot. It certainly deserves presentation as a poster. However, there are also significant limitations, which should be addressed, as far as possible, before final submission.

+ The most critical concern I have is about the comparability of the problem/task definition between the parameterized search case and the HyperNEAT case. Clearly the space of potential controller dynamics is significantly different in the two cases. Although this is acknowledged, there is no attempt to characterise the extent of the differences. Most seriously, while the parameterized search case definitely involves purely "open loop" controllers, the HyperNEAT case appears to allow closed loop control - as

the current joint angle positions are provided as inputs to the ANN. This distinction should be clarified and its impact for the interpretation of the results should be explicitly discussed.

+ While the paper abstract motivates generic work on legged robots by reference to "rugged terrain", the target task appears to involve completely flat terrains. This limitation in the study should be explicitly acknowledged, discussed and motivated.

+ While speed is an important metric for assessing robot gaits, it is hardly the only relevant one - power efficiency, accuracy, smoothness of travel, motor wear etc. are also all potentially important. (Indeed, "motor wear" is subsequently acknowledged as an issue, but handled in a purely ad hoc manner.) This should be more clearly discussed.

+ 3.1 refers to the "two halves" of the robot. This should be clarified diagrammatically (by elaboration of Fig 2 or otherwise).

+ The entire evolutionary algorithm was implemented with the on-board computer. This may be reasonable, but should be discussed and motivated.

+ The controller update rate should be mentioned already in 3.1.

+ The onboard computer is described as connecting through wireless (and bluetooth to the wiimote); but the photographs show tethering cables. These may be simply for power, but this should be clarified.

+ 3.2: Other approaches to the problem of the robot leaving the measurement arena should be mentioned/discussed (e.g., reducing the trial duration, increasing the height of the wiimote, reducing motor power etc.).

+ 4.2: A single trial/fitness evaluation is described as taking 15-20 seconds. This implies that the "return"/re-initialisation takes 3-7 seconds. It is stated earlier that there is usually no human intervention required. This implies that the return travel (presumably using a pre-designed gait and closed loop location feedback?) is consistently faster than the test gaits. This should be clarified/discussed.

+ The paper repeatedly uses the term "noise" to generically refer to variability. This may be misleading, and should at least be reviewed critically.

+ 4.3: The discussion of NEAT is a little confusing, in its reference to allowing "evolution of the topology of an ANN in addition to its weights". I guess this is technically true, but a reader might easily confuse this with suggesting that HyperNEAT, as used in this particular paper, can evolve the topology of its target ANN - which it plainly can't. This discussion of NEAT should be phrased more carefully to clarify this point.

+ 4.3: There is no motivation or critical discussion for key design choices, including the HyperNEAT population size and number of generations.

+ 5.1: The relevance or significance of this section is unclear. The data presented are extremely crude, and would not seem to bear the weight of any useful interpretation or conclusion. Nothing subsequently seems to rely on it. The section should be either much better motivated or simply removed.

+ The use of "body lengths per minute" as a measure should be motivated (or replaced with the standard

SI unit of m/s).

+ 5.3: There is a very strong conjecture, "We believe that this is because HyperNEAT was allowed to explore a much richer space of motions ...", but no substantive elaboration or critical discussion of this. In particular, as already noted, any potential role of joint angle feedback in regulating effective gaits is simply ignored.

+ 5.3: There is reference to "the slope of the HyperNEAT learning curve" but it is unclear what this means. If it implies a linear appoximation to Fig 9, then it hardly seems meaningful at all, given the limited sampling and huge variability in the performance. In any case this should be clarified.

Reviewer 4 Comments top

Comments for Authors:
This is a nice paper that compare different methods to design controller for generating gates for quadruped robots. No comments.

Committee comments to authors: top

None