Assignment: Problem Formulation (G=0.1)

Write a problem formulation that identifies a compelling gap between some behavior we desire from our robots and the performance they can presently achieve. Propose a specific source of bioinspiration to close that gap. The problem motivation and proposed solution approach must derive authority from the scientific literature as manifest in an annotated bibliography to which specific citations are made in the text of this problem formulation document. The hypothesized improvement must be couched in terms of empirical tests that could be performed on the robot to ascertain the degree of benefit conferred by the proposed solution.

Remarks

This is the opportunity for the group to gather together its individual members’ various directions of curiosity or insight about legged machine mobility and its biological counterparts and pull out a central hypothesis – an idea about how to improve performance that can be experimentally tested. The need to test the hypothesis and the value of the improvement must be documented against what your group (and, more broadly, the class) has learned about the larger scientific literature in the course of the lectures and the Literature Review (assignments C.1 & C.2). Because this is a group effort and because it reviews skills already learned, the standards will be somewhat higher than in the previous assignments.

It is now expected that you are adept at finding, assessing the importance of, and annotating a relevant set of background scientific literature. Thus, this problem statement must also incorporate the components of the previous assignment, C.2 as part of the background

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literature review. In some cases, you will be able to use directly the papers (engineering, bioinspired, precursors, successors) and quality/importance assessments and annotations that a group member has already submitted for the prior C.2 assignment. In other cases, the problem you settle upon may be different enough from anything that any group members have yet researched that you will have to undertake some degree of new literature searching. In these cases it is expected that you will once again provide evidence for the value of the sources on which you rely using the same types of evidence and styles of documentation as you did in C.1 and C.2. That is, you should furnish in the annotation sections for the most important papers and their precursors and successors an appropriate combination of: citation rates, impact factors of journals or conferences (when you can get them), and quality assessments of the authors including their technical affiliations and, where appropriate – e.g., when the citations for the particular paper in question are not plentiful – their individual publication history or h-index).

This written material is a sober, neutral problem formulation. In contrast, you will use it as the foundation for the oral mid-term presentation, C.4 that will take the form of a project proposal – a “pitch.” This written problem statement and hypothesis for performance improvements will also be largely recycled to become the introductory section of your eventual class report C.7 – C.10.

**Evaluation Rubric**

**Structure of the Problem Statement Essay**

**C.3.1) Desired Behavior or Capability (~ 2 paragraphs)**

Integrate the best ideas across the group to define and articulate the problem domain. The writing and background materials can be completely new, or it can be partly harvested from the (group members’ only please) material developed in response to assignments C.1 or C.2. Reflecting the advantages of group process and time for improvement upon the efforts earlier in the semester, this should be a stronger and more convincing statement of the desirability of the behavior or capability than any of the prior responses. These paragraphs must state clearly what missing robotic capability or general behavior your group’s question will address. They must justify the importance or value of achieving it.

**C.3.2) Present Unavailability (~ 1 paragraph)**

For this aspect of your essay, either use the robotics literature group members have identified in their responses to C.2.2, or develop a new web of literature more relevant to the chosen problem domain (but with similar or better attention to documenting its quality). Specifically, if the problem domain is significantly different from anything that group members have previously considered, then gather an augmented collection of relevant papers using the same search methods you have been practicing. In either case, you will want the group effort to improve upon quality of the previous literature review efforts: in particular, take special care
to follow the rubric of C.2 including your justification of why the selected papers are likely to be appropriate and of high quality.

With a body of literature identified and its quality ascertained, contrast the existing contributions of the prior work to the target problem(s) of interest to the group. Use this prior body of work to justify your claim that your proposed problem(s) of study have not yet been solved.

C.3.3) Desirability of Bioinspiration (~ 1 paragraph)

Again, for this aspect of your essay, use the robotics literature group members have identified in their responses to C.2.3. Or, if the problem domain is significantly different from anything that group members have previously considered, then gather a new collection of relevant papers using the same search methods. Again, in either case, you will want the group effort to improve upon quality of the previous literature review efforts – just as in C.3.2.

Now use this literature to argue that a bioinspired solution to the targeted problem may be possible and could lead to desirable advances in robot behavior. Explain why your group cannot simply find an existing mathematical technique or engineering design method, learn how to use it (assuming you were given the necessary time and instruction to do so) and apply that to the proposed problem with good likelihood of success.

The Hypothesis

Your problem statement should conclude with a specific, testable hypothesis bearing on the utility of the bioinspiration you have identified in the literature as helping to achieve the desired capability or behavior you have motivated and demonstrated by literature review to be presently unachievable.

C.3.4) The Idea (~ 1 paragraph)

What specific additional design step or change in existing design will add (or help lead to adding) the desired capability?

C.3.5) Refutability (~ 1 paragraph)

What measurement or analytical method can be applied to test whether or not the proposed design step has the desired effect? By the time the semester is over and you write your final project report, you will need to identify some body of literature that documents the correctness and efficacy of the measurement or analytical techniques that you apply. It would be very advisable to start identifying this literature now by means of specific citations to specific original papers, tutorials, or textbooks that are of high quality (documenting this in your writing using the various metrics of high quality we have covered already in the class).

C.3.6) Necessary Means (Two or more different procedures)

What methods, procedures, or tests available to your group will be used to refute or support the hypothesis? This could take the form of a table with at least two rows (the two or more different procedures) and at least four columns (procedure; necessary materials or
software or simulation techniques required to apply it; outcomes that would support the hypothesis; outcomes that would tend to refute the hypothesis).

**Annotated Bibliography**

There should be at least two major sources of authority. The first, taken from the robotics literature, was used to justify the gap between desired and presently available robot capabilities. The second, taken from the biology literature, was used to document the animal’s superior ability respecting this specific capability.

**C.3.7) Review Major Source(s) of Authority from the Robotics Literature (~ 2 brief paragraphs)**

Use the rubric from C.2 (that is, items C.2.6 – C.2.9). There should be a paragraph of careful sentences that describe the nature of the contribution(s). The review paragraph should close by documenting why you are convinced that the paper(s) represent(s) an important source of authority for your project and were worth tackling for this review.

In a second paragraph there should be an account of two or three precursors and two or three successors (or a brief recap of a search, preferably with hotlinks, that document the absence of successors to date). For each of these “closest, most important neighboring” papers in the web of science you should briefly (in a phrase or two) note what the reference is about, how you judged it to be the most important “neighbor”, and how it relates to your topic.

**C.3.8) Review Major Source(s) of Authority from the Biology Literature (~ 2 brief paragraphs)**

Again use the rubric from C.2 (that is, items C.2.6 – C.2.9). There should be a paragraph of careful sentences that describe the nature of the contribution(s). Again, the review paragraph should close by documenting why the paper(s) represent(s) an important source of authority for your project.

Next, there should again be a paragraph accounting for two or three precursors and two or three successors (or a brief recap of a search, preferably with hotlinks, that document the absence of successors to date). Again, for each of these “closest, most important neighboring” papers in the web of science you should briefly (in a phrase or two) note what the reference is about, how you judged it to be the most important “neighbor”, and how it relates to your topic.

**Submission to Class Wiki**

Mandatory Consultation with TCP-Fellow: 2/1 – 2/15
Submission of Draft to Class Wiki: 2/15
Scoring of Mechanics (TCP fellow scores structure and written clarity of C.3.1 – C.3.6)
Scored Draft emailed back: 3/1