PROJECT FAQ

- Can a PID controller be considered as a steering function?

Yes and no. Not for exact steering, yes for approximate steering. But it is unclear how the PID would be implemented in configuration space - that would have to be defined.

- If we have a configuration space R^2xS but S is constrained we can plan on the space R^2xR. However, can we say this is equivalent to R^3 or is there any condition for this equivalence to be true?

R^2xR is homeomorphic to R^3, so yes, R^2xR = R^3

R^2xS is not homeomorphic to R^2xR

If the angle is limited to a subset of the circle, e.g. [-theta_max, theta_max] with theta_max < pi. Then, one can indeed use [-theta_max, theta_max] \subset R for the configuration space. And then we are in the first point above.

- Is the differential flatness different than linearizing around Pitch=0 and Roll=0? What would be the differences?

Yes, they are two different and independent concepts. A system can always be linearized - but it will still contain the DoFs (e.g. pitch and roll will still be there for the case of the linearized quad - else it would not move). The definition of differential flatness is in the slides.

- Time complexity of graph search methods

Planning Algorithms book (page 35-37):

For FIFO and LIFO, one has to go through all the vertices (to get outgoing edges) and all the edges (to get to vertices), thus time complexity is |V|+|E|. Dijkstra's time complexity does depend on the implementation of the heap. The running time is O(|V | lg |V | + |E|), in which |V | and |E| are the numbers of edges and vertices, respectively, in the graph representation of the discrete planning problem. This assumes that the priority queue is implemented with a Fibonacci heap, and that all other operations, such as determining whether a state has been visited, are performed in constant time. If other data structures are used to implement the priority queue, then higher running times may be obtained.

- Configuration space definition

When a space is formed by multiple subspaces, we use the Cartesian product to represent it. We denote the Cartesian product with "x". In latex, you would use "\times".

For example, if we have a configuration space formed by R^2 and S^1 then we say C = R^2 x S^1.

When a subspace is repeated multiple times we can write ()^{number of times repeated|.

For example, S^1 x S^1 can be written as (S^1)^2.

For C an arbitrary subspace, C^{n times} is not necessarily homeomorphic to C^1 x C^1 x....x C^1. So, they might not be equivalent!

For example, R^1 x R^1 is homeomorphic to R^2. So, both represent the same space. R x .... x R is also homeomorphic to R^n.

But S^1 x S^1 is NOT homeomorphic to S^2. S^1 x S^1 is a torus and S^2 is a sphere. So, they are not equal.

Comments on preliminary reports

Here is a list of some common corrections and comments from previous years in hopes this will help you do a great project!

1- **Differential drive:** Some of you use a differential drive model which is too simple. Try taking a slightly more complicated model such as the bicycle model.

2- **Template:** Please use the template provided in brightspace! (Also don't forget about the abstract and references!)

3- **Goal of the project:** The focus of this work is on the motion planning algorithm you are using and how you use it to solve your task. In other words, take care to explain the algorithm, provide pseudocode, explain it and provide an explanation of how it has been adapted to the robot model. Also, you have chosen a planning algorithm for a reason. Therefore you should design experiments that will allow you to showcase the benefits you are talking about. Also, you should design experiments that will allow you to showcase the shortcomings of the chosen method (e.g. provide an ablation study, check your algorithm's result for different hyperparameters, and explain what's happening, ...). This way you will obtain insightful results that will allow you to write an interesting discussion, conclusion, and future work.

4- **Robot Model:** Take in mind that you have little space for the report. Therefore consider that everything in the robot model section should be written with the ultimate goal of deriving the equations of motion of your system.

5- **Configuration space and workspace:** There are too many of you who have not explained clearly what the workspace and configuration space is. You have to do it and then justify why.

6- **Notation:** You must explain all the notation in your equations. There is no point in putting an equation in your reports if the reader cannot follow your reasoning.