TOPOLOGICAL ASPECTS OF ROBOT MOTION PLANNING

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The set of physical states of a robot or mechanical system carries the structure of a topological space, the so-called configuration space of the system. The motion planning problem of robotics then translates to the topological problem of assigning to each pair of points in configuration space a path between them. If the configuration space is not contractible, then no such assignment of a path can be found which depends continuously on the input points. From a topological perspective, a motion planning algorithm may be viewed as optimal if it minimizes the discontinuities in a suitable sense.

These observations led Michael Farber to introduce a new numerical homotopy invariant, called *topological complexity*, which quantifies the complexity of motion planning algorithms in the given configuration space [2, 3]. By now the theory of this invariant is fairly well developed, with many computations, examples and variants in the literature.

In these talks I will survey the topological complexity of motion planning algorithms, starting with basic examples and building up to recent research. If time permits I will discuss directed [1] and symmetrized [4] topological complexity of spheres, and group-theoretic lower bounds for the topological complexity of $K(\pi, 1)$ spaces [5].

References

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[3] M.Farber: *Instabilities of robot motion*, Topology Appl. **140** (2004), no. 2-3, 245-–266.

[4] M.Grant: *Symmetrized topological complexity*, J. Topol. Anal., to appear. arXiv:1703.07142

[5] M.Grant, G.Lupton and J.Oprea: *New lower bounds for topoological complexity of aspherical spaces*, Topology Appl. **189** (2015), 78—91.

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