

Motion Planning

The Motion Planning Problem

The problem

The **motion planning problem** has these inputs:

- A description of $\mathcal{C}_{\text{free}}$.
- A start configuration $q_{\text{init}} \in \mathcal{C}_{\text{free}}$.
- A goal configuration $q_{\text{goal}} \in \mathcal{C}_{\text{free}}$.

The output should be:

- A path through $\mathcal{C}_{\text{free}}$ from q_{init} to q_{goal} , if a path exists.
- A failure status, if no path exists.

This is sometimes called the **piano movers' problem**.

The problem



Combinatorial approaches

Good news: Combinatorial algorithms exist to solve this problem.

Bad news: These algorithms are:

- Difficult to understand.
- Difficult to implement.
- Exponential time.

More bad news: This problem is PSPACE-complete. So we shouldn't expect to ever come up with an efficient algorithm.

(PSPACE-complete is at least as bad as NP-complete, and likely even worse.)

What's the problem?

The complexity of the problem comes from the fact that the C-space obstacles can be difficult to compute and represent.

- The configuration space may have high dimension.
- The obstacle boundaries may be complicated.
- Accurately describing the obstacle boundaries may require an absurd amount of memory.