GradCEM

Source: Model-Predictive Control via Cross-Entropy and Gradient-Based Optimization

Cross Entropy Method (CEM) based motion planning algorithm

1. Sample controls from a gaussian distribution.
2. Clip the controls within the control bounds of the agent.
3. Rollout the trajectories.
4. Score the trajectories.
5. Select the elite trajectories.
6. Set the mean and covariance of the gaussian distribution as the mean and covariance of the elite trajectories.
7. Goto step 1.

CEM: Advantages and Disadvantages

Advantages:

1. Exploratory in nature.
2. Works with non-smooth cost functions.

Disadvantages:

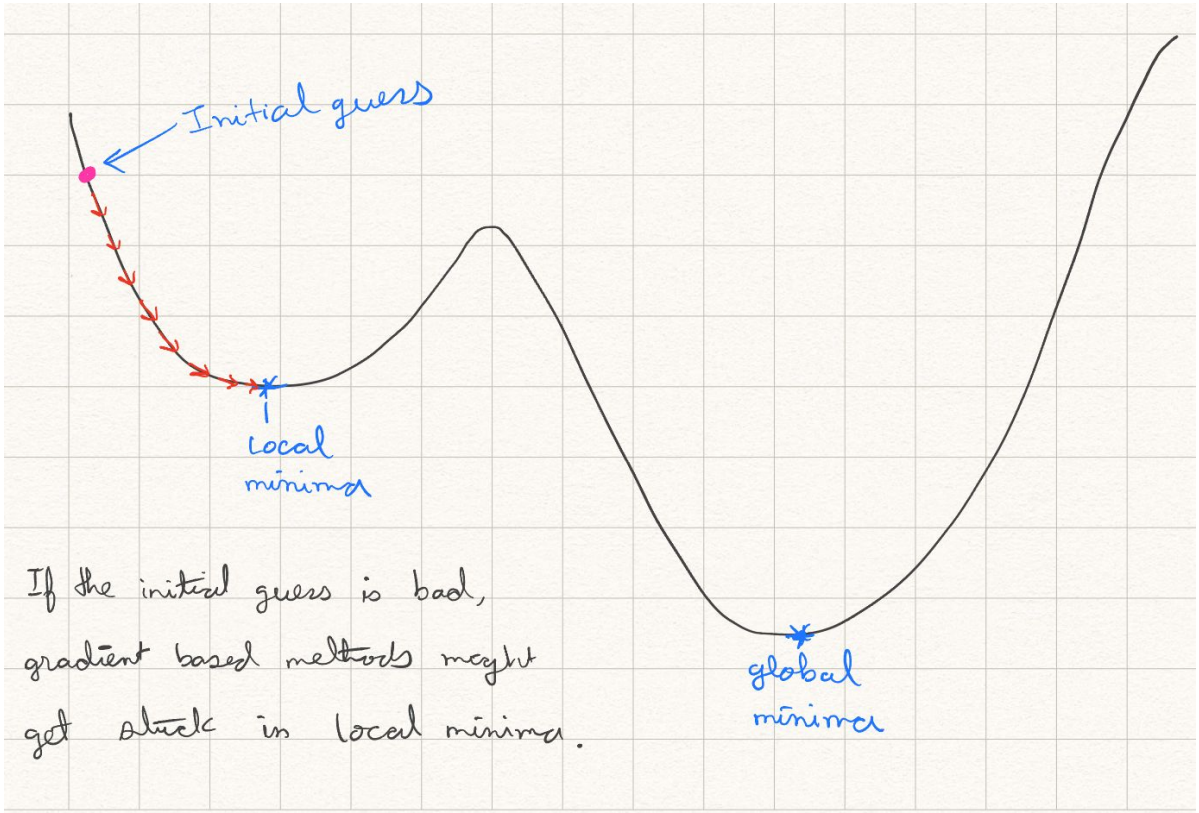
1. Computational time increases as the dimensionality of the action space increase.

Gradient based motion planning algorithm

1. Involves backpropagating derivatives of the scoring function with respect to actions for updating the sequence of actions iteratively through gradient descent.

$$\bar{a}_{0:H}^{(k)} := \bar{a}_{0:H}^{(k-1)} + \alpha \nabla_{\bar{a}} \bar{R}(\bar{a}_{0:H}^{(k-1)}, \bar{s}_{0:H}^{(k-1)}), \qquad k = 1, 2, ..., K$$

2. **Advantages:** They tend to be very fast even when the action dimension increases.
3. **Disadvantages:**
   a. Gradient based approaches like sgd need a good starting guess.
   b. The scoring functions needs to be differentiable.
   c. They tend to converge to a local-minima.



If the initial guess is bad, gradient based methods might get stuck in local minima.

How do we combine the advantages of both the approaches?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GradCEM based motion planning algorithm

1. Sample controls from a gaussian distribution.
2. Clip the controls within the control bounds of the agent.
3. Rollout the trajectories.
4. Score the trajectories.
5. Compute gradients of the scoring function wrt the controls
6. Perform gradient descent
7. Select the elite trajectories.
8. Set the mean and covariance of the gaussian distribution as the mean and covariance of the elite trajectories.
9. Goto step 1.


ENOUGH TALK
LET'S CODE


CEM/MPPI
GradCEM
WHAT TO CHOOSE?
JAKE-CLARK.TUMBLR
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Thank you :)