Summary

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***Reinforcement learning for automatic mesh generation – a soft-actor critic approach***

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Mesh generation consists of transforming a geometric domain, composed of piecewise linear edges, into a set of quadrilateral elements. The quadrilateral elements must satisfy the following criteria:

* Each element is quadrilateral
* The inner angle of each element should be between 35 and 145 degrees
* The aspect and taper ratios should be within a predefined range for each element
* The transition between a dense mesh and a coarse mesh should be smooth

To be more specific, mesh generation can be divided into four steps, iterated:

* Choosing a reference vertex
* Constructing a quadrilateral element
* “Removing” the element
* Updating the boundary inwardly

This can be achieved using reinforcement learning, where at each time t, the agent observes the environment (the boundary), performs a series of actions to construct the quadrilateral element, and the environment responds by updating the boundary of the geometric domain.

The reward function would correspond to the quality of the edges produced during construction of the quadrilateral element. In this paper, the reward function is a combination of element quality (shape of the quadrilateral element, a perfect square corresponding to the highest quality value of 1), quality of the angles formed with the remaining boundary upon removal of the previously generated element, and density factor of the mesh (smaller density meaning more dense).

A policy can be learned in reinforcement learning directly (policy-based) or indirectly (value-function-based).

Using value-function based methods, the reward using an optimal value function can be estimated and used to guide the agent to choose a vertex or to construct the corresponding edges for a chosen vertex. After each action, the state and action spaces will change, thus rendering the method sub-optimal when a feasible action becomes hindered by the change.

In policy-based methods, a policy directly guides the agent to perform certain actions given an environmental state.