Contribution ID: **24** Type: **not specified**

Sequential Experimental Design for X-ray CT

Monday 23 September 2024 16:52 (2 minutes)

In X-ray Computed Tomography (CT), obtaining projections from various angles is crucial for 3D reconstruction. To adapt CT for real-time quality control, it's essential to reduce the scan angles while preserving reconstruction quality. Sparse-angle tomography, which achieves 3D reconstructions with fewer data, necessitates selecting the most informative angles—a challenge equivalent to solving a sequential optimal experimental design (OED) problem. However, OED issues are marked by complexity, including high-dimensional, non-convex optimization that makes adaptive solutions during scanning difficult. To navigate these complexities, we approach the sequential OED problem through a Bayesian framework, modeling it as a partially observable Markov decision process and employing deep reinforcement learning for solutions. The approach learns efficient non-greedy policies to solve a given class of OED problems through extensive offline training rather than solving a given OED problem directly via numerical optimization. Consequently, our policy efficiently identifies the most informative angles for real-time operations, significantly enhancing the practicality of sparse-angle CT in quality control scenarios. This streamlined approach ensures that CT can be efficiently integrated into quality control processes, with the potential to significantly impact the field.

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Session Classification: Poster Session