Hello folks,

Here is what's been going on in medical physics and related areas the last 24 hours. Here's what you folks might find interesting today:

RADIOTHERAPY AND HADRON THERAPY

Direct probabilistic IMPT treatment planning with setup and range errors for neuro-oncological patients

This paper presents a probabilistic planning approach for intensity-modulated proton therapy (IMPT) that explicitly handles setup and range errors using patient-specific acceptance probabilities. The method uses a percentile-based optimization framework where dose percentiles are approximated as a linear combination of expected value and standard deviation, calculated efficiently by sampling a polynomial chaos expansion of the dose-influence matrix. It employs a nested optimization structure with warm-starting to iteratively update and improve the accuracy of the percentile estimate. Compared to standard robust optimization, this probabilistic approach achieves improved trade-offs between target coverage and organ-at-risk sparing in neuro-oncological patients. This work is highly relevant to robust optimization under anatomical and beam-delivery uncertainty, offering a clinically feasible pathway to better proton therapy treatments.

UNCERTAINTY QUANTIFICATION AND IMAGING PHYSICS

Calibrated Closed-Form Uncertainty for Radiative Gaussian Splatting in Sparse-View CT

This work tackles the lack of trust signals in radiative Gaussian splatting for sparse-view CT reconstruction by introducing a variational density posterior with closed-form predictive variance. The authors exploit the fact that projection and voxelization are strictly linear in per-Gaussian densities for transmissive X-ray imaging, allowing uncertainty to propagate exactly in a single forward pass. They present the first systematic calibration study for Gaussian-splatting CT, demonstrating that the resulting per-voxel uncertainty effectively ranks true reconstruction error across various view budgets. Furthermore, they identify different coverage regimes and show how principled uncertainty can inform a coverage-gated, maturity-scheduled acquisition policy and a dose-adaptive stopping rule. This is a strong contribution to calibrated uncertainty in image reconstruction, bridging geometric architectures with information-geometric treatment of inference.

NOVEL ARCHITECTURES AND OBJECTIVES FOR IMAGING

Improving Medical Image Generative Models with Frechet Distance Loss

The authors address the limitation of standard denoising objectives in diffusion models, which often smooth out high-variance, irregular structures characteristic of heterogeneous tumors. They propose finetuning generative models with a Frechet Distance loss (FD-loss) that aligns the first and second order feature statistics of real and generated images in a pretrained encoder space. This objective encourages the generator to capture complex structural variations without relying solely on per-pixel error. The method is integrated across diverse architectural settings on multiple liver and brain cancer datasets, leading to downstream segmentation networks that consistently achieve superior performance. This work offers a conceptually novel loss function derived from feature statistics rather than empirical pixel-wise tuning, making it highly relevant for improving clinical workflows involving synthetic data.

Back tomorrow with more!

P.S. In the most recent submission window: physics.med-ph: 4 papers cs.CV: 98 papers