

Quantifying Adaptive Triggers Using Geometric, Dosimetric, and Radiobiological Metrics

Chloe DiTusa¹, Panayiotis Mavroidis PhD², Ara Alexandrian PhD³, Emma Sargent MS¹, Christopher W. Schneider PhD³, Sotiri Stathakis PhD³

- 1) Physics Department, Louisiana State University, Baton Rouge, LA
- 2) Department of Radiation Oncology, University of North Carolina, Chapel Hill, North Carolina
- 3) Mary Bird Perkins Cancer Center, Baton Rouge, LA



Introduction

- **Daily Dose Evaluation:** using quantitative geometric, dosimetric, and radiobiological metrics applied across 72 patients and two disease sites
- **Disease sites:**
 - Head and Neck (18)
 - Prostate (54)
- **Quantify:**
 - Identify fraction-level deviations using Displacement of structures, Dice scores, Complication-Free Tumor Control Probability (P_+), and Objective Scores (Score Card objectives).

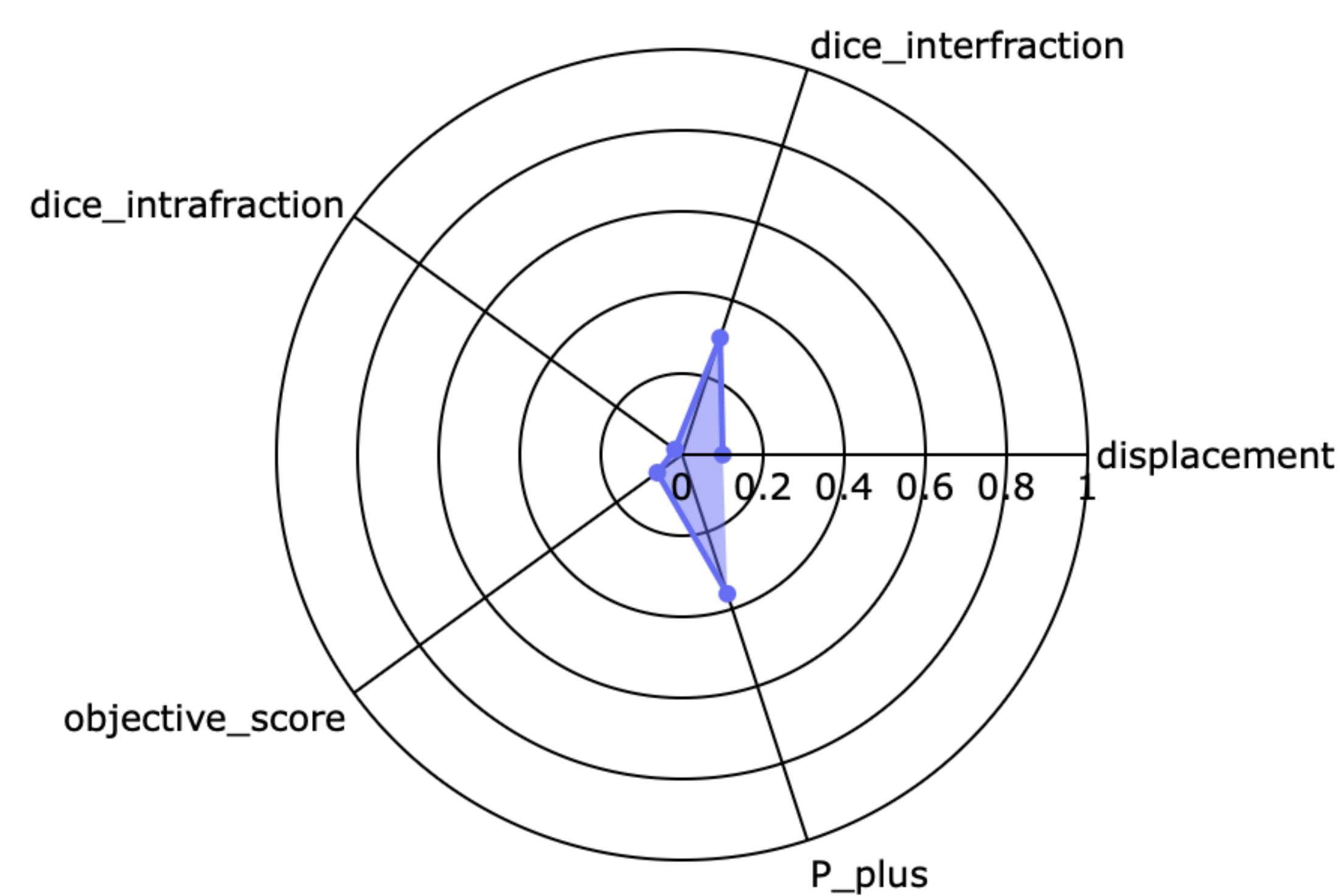


Figure 1. Radar Chart of 5 metrics

Methods

- **Web-Based Dashboard:**
 - Computed five metrics per fraction
- **Disease Site Workflow:**
 - **H&N:** 28-35 fractions, prescription of 70Gy, using pseudo-CTs of the daily CBCTs to recalculate daily dose.
 - **Prostate:** 5 fractions, prescription of 36.25, using daily MRIs and recalculating the reference plan on daily anatomy
- **Dashboard processing:**
 - Daily RT Dose and Structure sets were imported into a PostgreSQL backend
- **Evaluation:**
 - Identify any temporal trends and fraction-specific outliers.

Results

- **H&N:** exhibited clear time-dependent degradation. Interfraction Dice (Figure 2A), Objective Scores, and P_+ metrics worsened throughout treatment. Radar Area (Figure 3A) expanded overtime, indicating progressive global deterioration relative to reference plan.
- **Prostate:** substantial fraction-to-fraction variability without temporal drift shown in Interfraction Dice (Figure 2B). Radar area (Figure 3B) shows frequent elevated scores, but acceptable fractions (scores close to zero) also occurred, underscoring patient-and day-specific behavior.

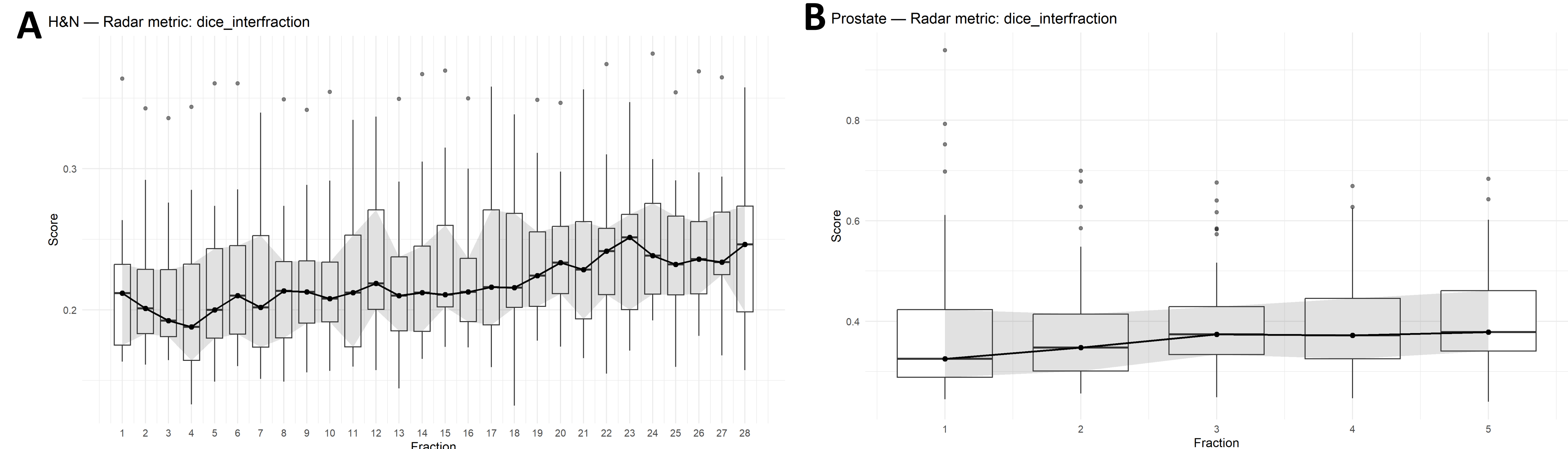


Figure 1. Dice Interfraction Metric that compares the overlap of the same structure from the Reference (expected anatomy) and the current fraction. H&N (A) patients see an increase over time, where Prostate (B) patients see a slight increase with large outliers on a daily basis.

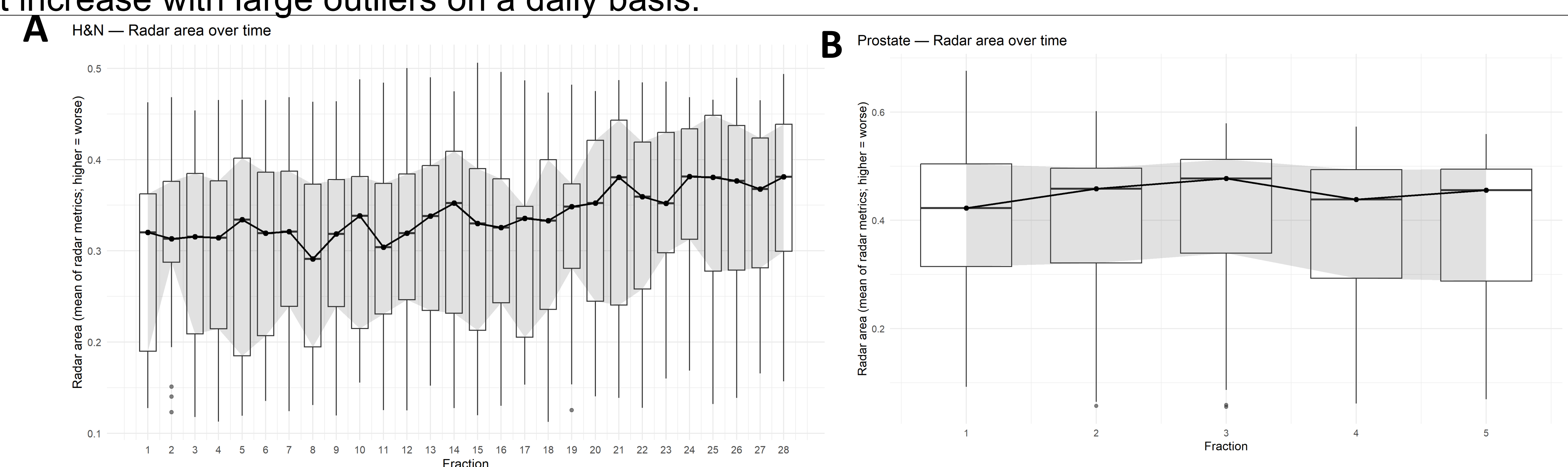


Figure 2. Radar Area. For H&N patients (A) we see an upward trend over time. For Prostate patients (B) we see a more stable trend over time, with small increase or decrease, but no temporal dependence observed.

Conclusion

H&N behaves as a time-dependent system with cumulative degradation, supporting threshold-based mid-course reassessment. Prostate SBRT demonstrates persistent, fraction-specific variability, supporting daily plan evaluation rather than fixed replanning schedules. Metric-based decision support may enable site-specific adaptive policies that improve resource allocation and better reflect clinical reality.

Contact Information

Email: cditus2@lsu.edu