Applications of Adaptive Simulated annealing algorithms to Intensity Modulated Radiotherapy (IMRT) planning problems

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Contents

- The IMRT Principles (problem statement)
- Methods
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IMRT PRINCIPLES

PROBLEM: TUMOR WITH CONCAVE REGIONS

SOLUTION: IMRT
IMRT PRINCIPLES – 3D
“Classical” conformation vs Intensity Modulation

IMRT Principles

"Classical" Conformation vs Intensity Modulation

- Target Volume
- Tumor
- OAR
- Uniform Beam
- Modulated Beam
- Collimator

Treated Volume
Conventional Planning vs Inverse planning
Methods: Combinatorial Optimization Algorithms.

- Genetic algorithms
- Projection onto convex sets
- Bayesian optimization
- Maximum entropy
- Gradient-based optimizations
- Simulated annealing algorithms
- Monte-Carlo based simulated annealing
- …etc.
Simulated Annealing (SA): Algorithm (Kirkpatrick et al. 1983)
Ensemble based simulated annealing (EBSA): (George Ruppeiner et al., 1991)
The EBSA hypothesis on IMRT settings

- The EBSA hypothesis states that given only thermodynamic information, constant thermodynamic speed cooling schedule (EBSA) is optimal. (Frost Concepts -- Facts, Conjectures, and Improvements for Simulated Annealing, Peter Salamon, Paolo Sibani, Richard Frost)
The lowest energy seen for a graph partition problem (Pedersen 1989)
Applications of EBSA to real world applications – Geophysical prospecting (Reflection Seismology)

- Seismic Model Optimization with sparse Prior Information.
- Inversion Of Post-stack Seismic data.
Model 2D- IMRT Problem

"DosPrescription.dat" using 1:2:3
Preliminary results: SA to IMRT

"DosCalculations3.dat" using 1:2:3
Preliminary results: EBSA to IMRT
Preliminary results: Dose Volume Histogram (DVH)
Future directions

- Advanced Geometries and 3D IMRT
- Comparative analysis of results with existing IMRT algorithms, in particular, with existing parallel SA.
- Implementation of the EBSA IMRT through the open source Mathlab SA Tools. (www.frostconcepts.com/software)

Radiobiologically guided IMRT (RB IMRT)
Collaborations

- National Alliance for Medical Imaging and Computing (NA-MIC)
- National Resource For Biomedical Supercomputing, PSC
- Department Of Radiation Oncology, OU College Of Medicine
- OU Supercomputing Center for Education & Research
- OSU High Performance computing Center
Grant Submission

Questions and discussions
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