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

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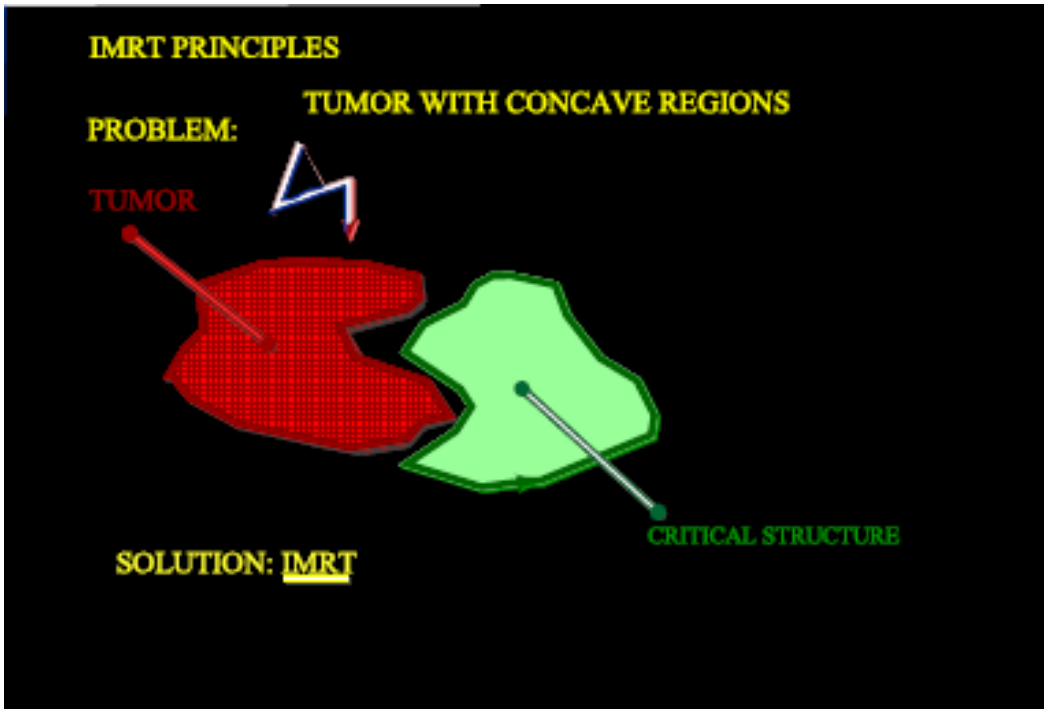
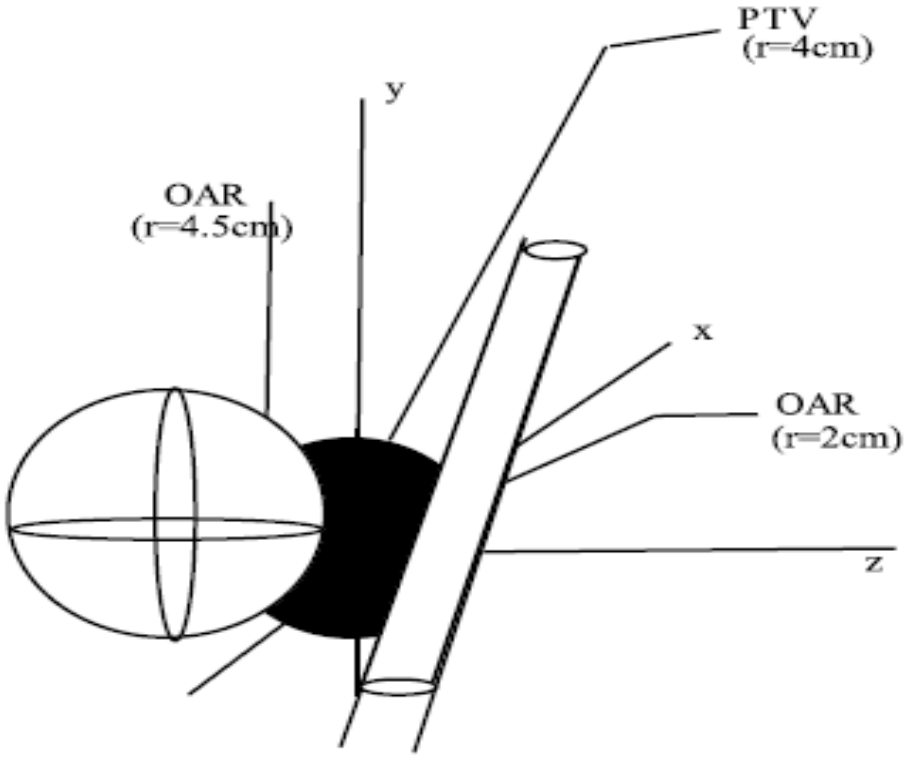
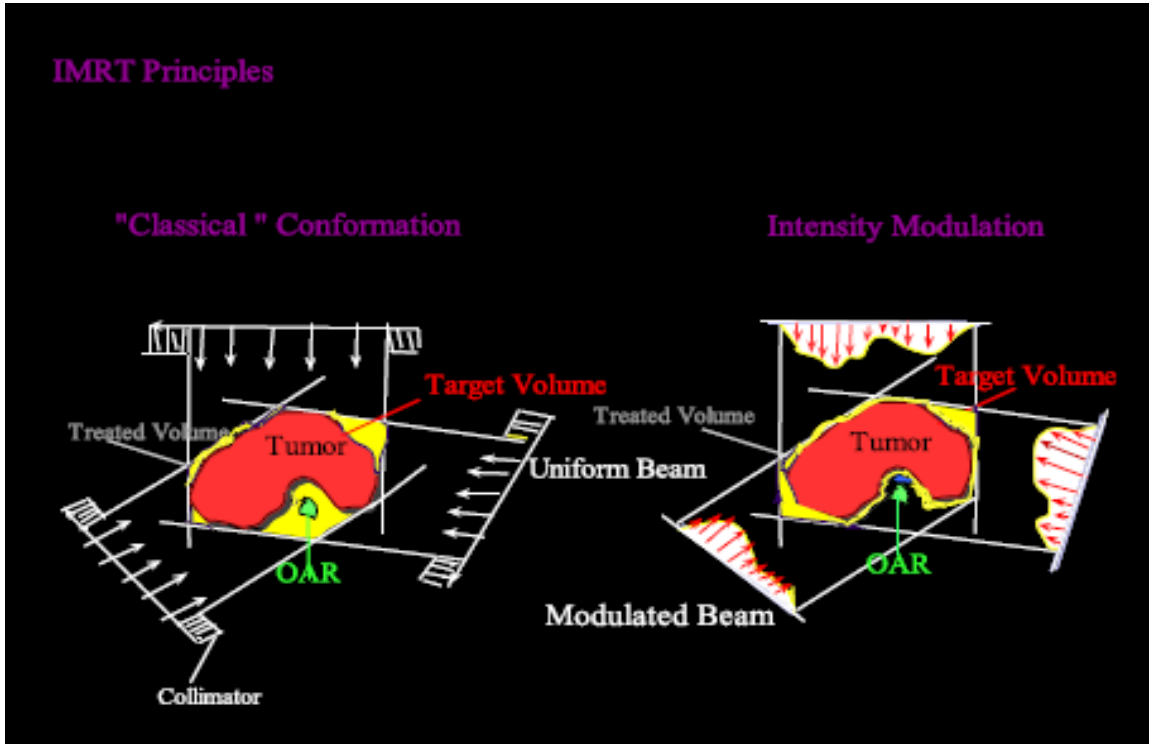
IMRT PRINCIPLES



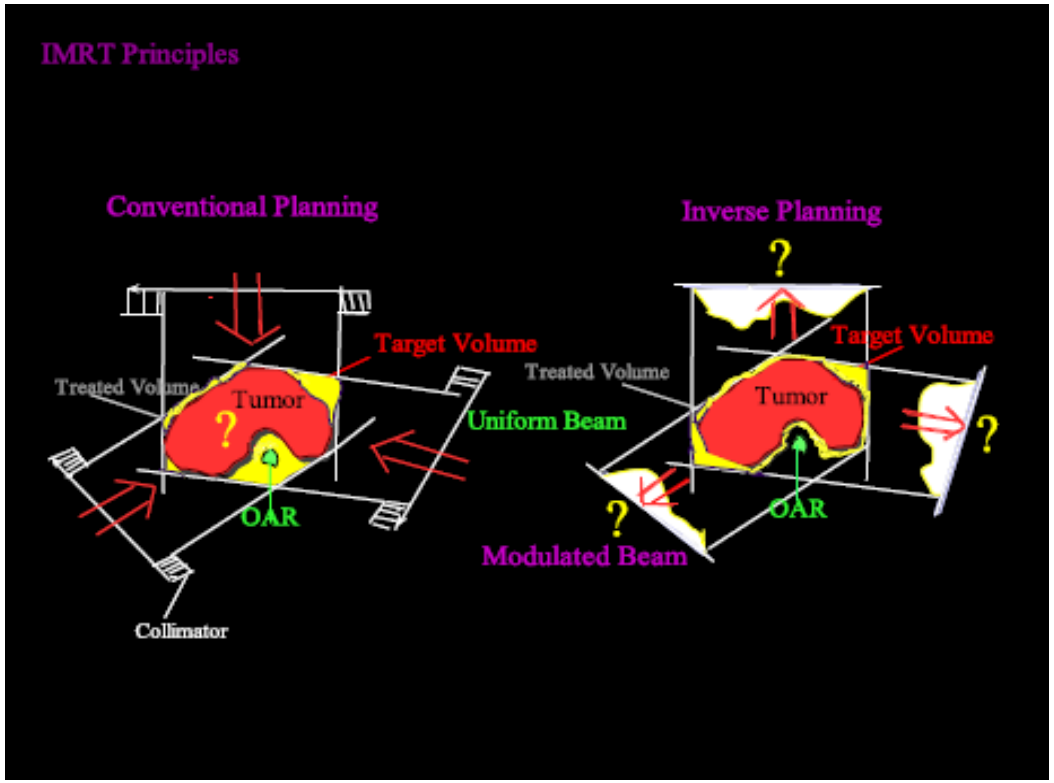
IMRT PRINCIPLES – 3D



“Classical” conformation vs Intensity Modulation



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.

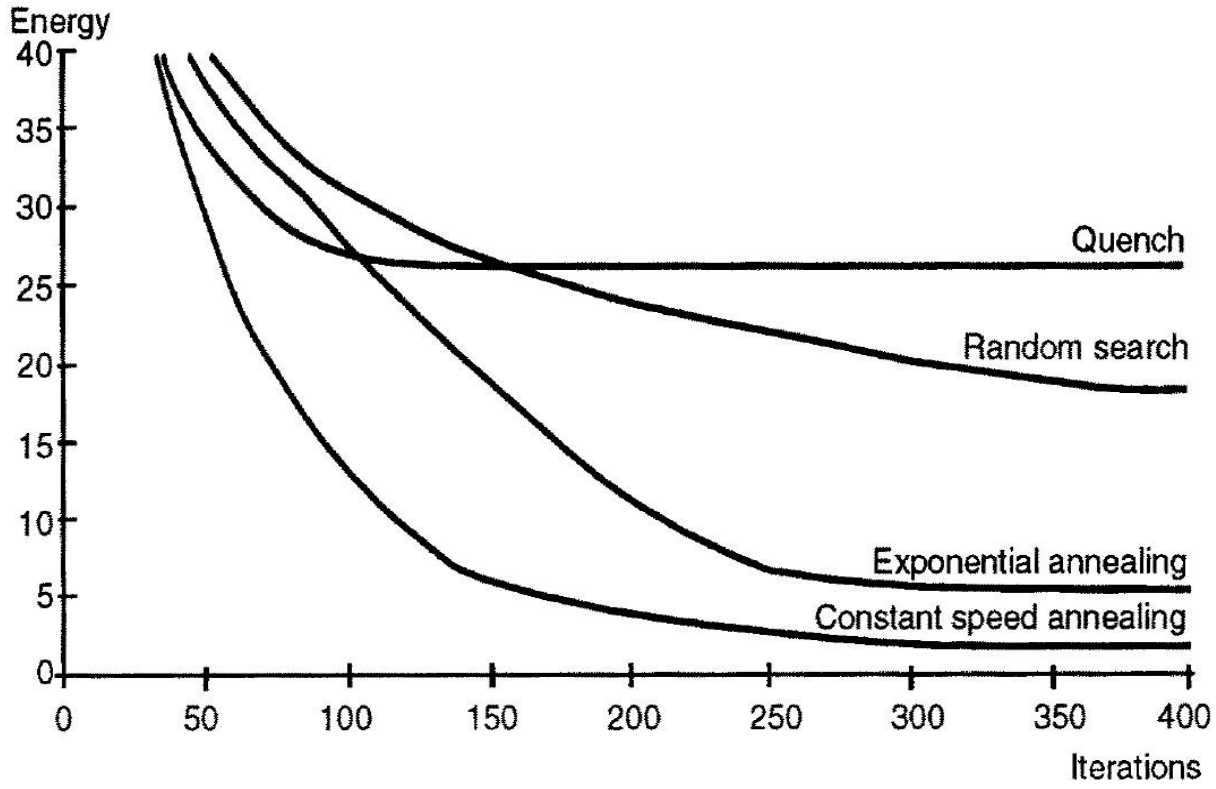
Simulated Annealing(SA): Algorithm (Kirkpatrick et al. 1983)

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)

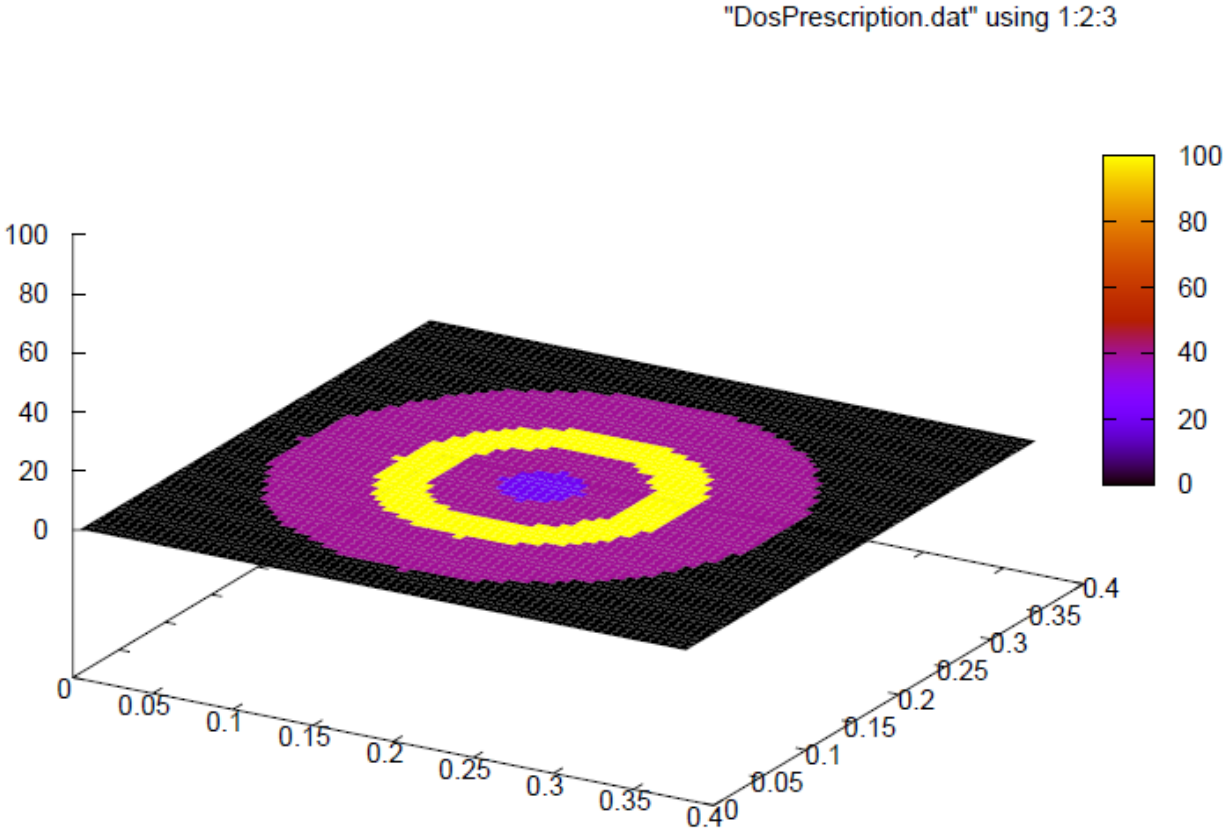
The lowest energy seen for a graph partition problem(Pedersen1989)



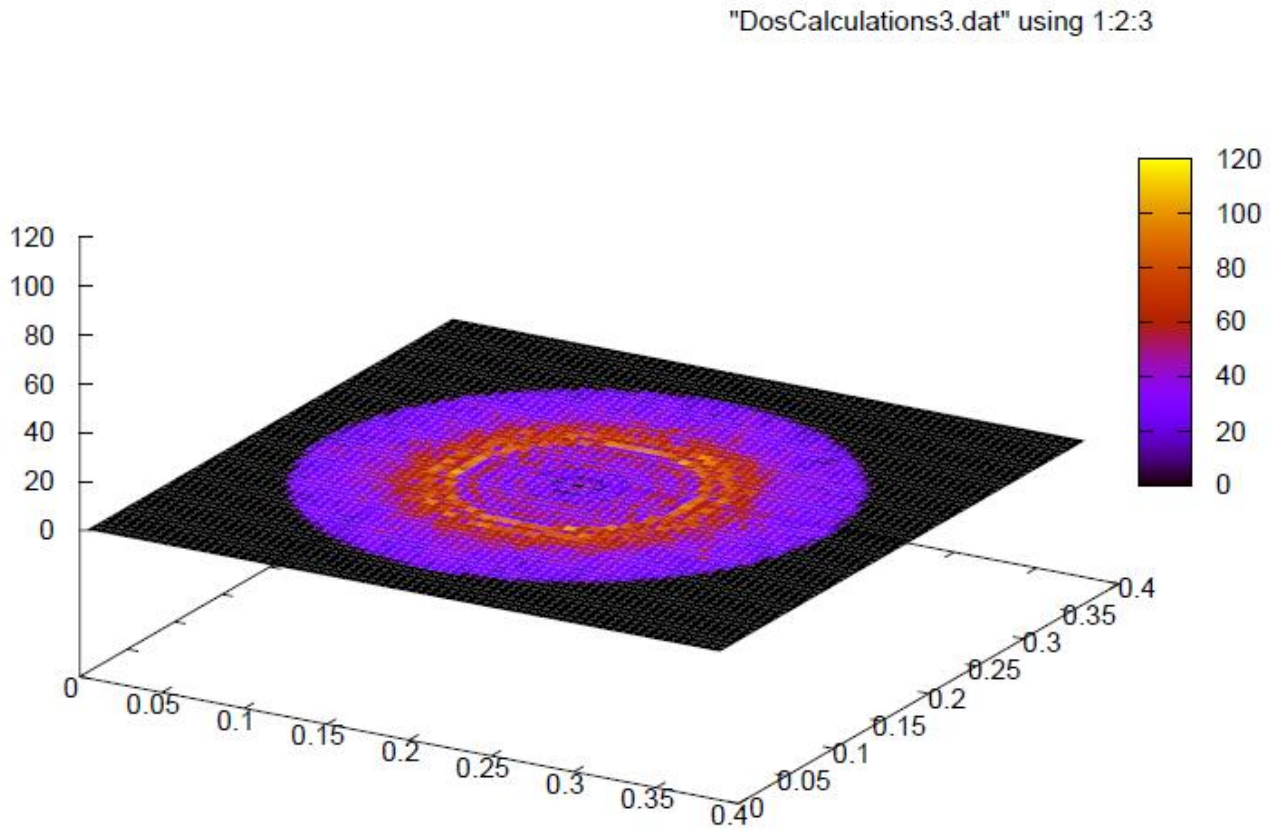
Applications of EBSA to real world applications – Geophysical prospecting(Reflection Siemology)

- Seismic Model Optimization with sparse Prior Information.
- Inversion Of Post-stack Sesmic data.

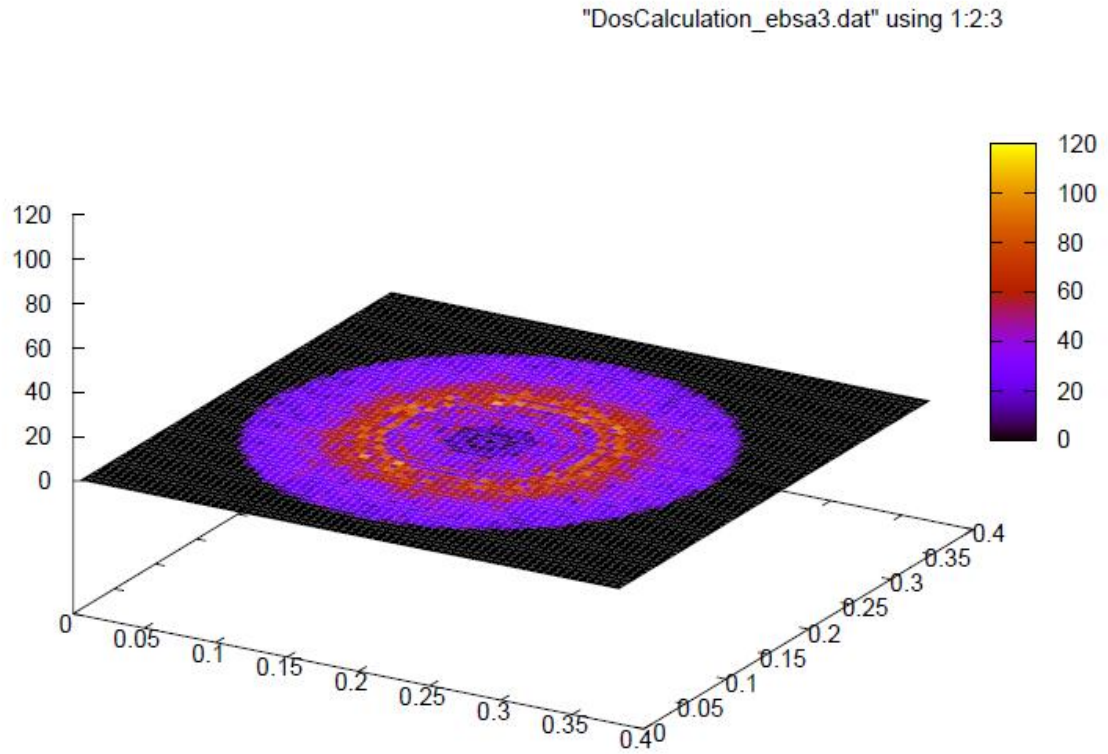
Model 2D- IMRT Problem



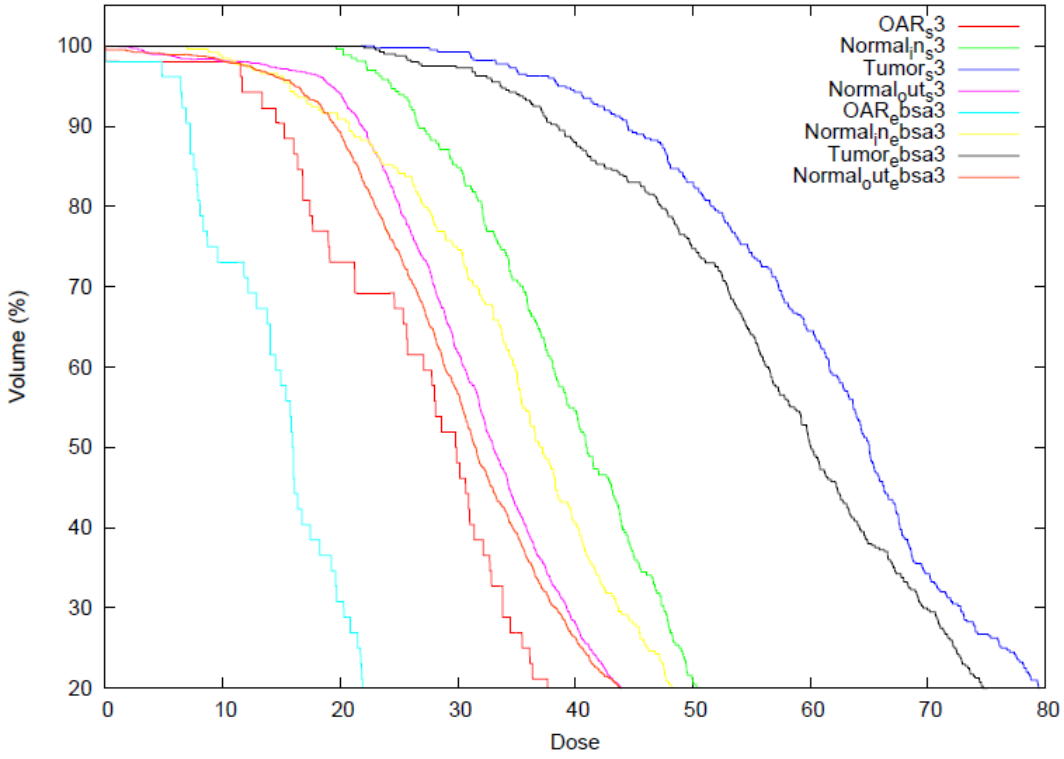
Preliminary results: SA to IMRT



Preliminary results: EBSA to IMRT



Preliminary results: Dose Volume Histogram(DVH)



Future directions

- Advanced Geometries and 3D IMRT
- Comaprative 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

- NIH-NA-MIC R21 – Under preparation for resubmission.

Questions and discussions

Acknowledgment

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