# AbstractID: 10843 Title: A Markov Decision Process Approach to Temporal Modulation of Dose Fractions in Radiotherapy Planning

**Purpose:** To use a Markov Decision process to explore the possibility of using non-constant adaptive fractionation schedules by incorporating the patient's cumulative response in optimizing the size of a fraction during the specified time period.

**Method and Materials:** Our method anticipates that advances in functional imaging and biological markers will soon enable us to observe the patient's response to radiation during a course of treatment. A stylistic Markov Decision Process model which incorporates key features of the problem through intuitive choices of state and action spaces, as well as transition probability and reward function is built. We first formulate the problem over a finite horizon by fixing the number of treatment sessions a priori. The optimal fraction size is determined by solving Bellman's equation through backward induction to maximize the expected total reward. Then the model is extended to an infinite horizon where the optimal stopping point (termination of the treatment) is found through value iteration algorithms. In case it is optimal to continue, the optimal size of fractional dose is determined by maximizing the expected total reward for the entire treatment course.

**Results:** Monotone optimal policy for the finite horizon formulation has been observed i.e. if dose $d$ is optimal in organ state $s$, then a dose at least as big as $d$ is optimal when the organs at risk/tumors are better/worse than state $s$.

**Conclusion:** We have taken initial steps to temporally modulated radiotherapy by exploiting radio-biological information available through advances in quantitative imaging modalities. As a result, this opens the door for including patient specific responses in designing treatment plans.