Simulation-Based Optimization of Radiotherapy: Agent-Based Approach

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Along with surgery and chemotherapy, radiotherapy is an effective way to treat cancer. Over half of cancer patients take delivery of radiation. The goal of radiotherapy is to destroy the tumor without producing damage to healthy tissue. Due to the complexity of the procedure, the use of modeling and simulation can be helpful for radiotherapy. In this research we have tried to optimize the dose calculation of therapy by use of new approach. Our research had two steps. At the first step we developed an agent based simulation of avascular tumor growth based on biological evidences. Our multi-scale model takes account of subcellular and cellular scales. The effects of radiation on tumor growth also has modeled. Based on this model we simulated different scenarios of radiotherapy. At the second step we developed an algorithm for optimizing radiotherapy. Two key elements of therapy is radiation dose and fractionation scheme. To optimize the therapy we tried to determine these two factors using reinforcement learning technique. We consider each fraction as a state variable and the intensity of radiation as an action variable. The outcome of each action including positive effects on tumor or negative effects on healthy tissue is considered as rewards. At each step by applying a new action (dose intensity value) the agent based simulation is run and the reward of state is determined based on the simulation results. As the algorithm goal is to collect as much reward as possible, it continues until some terminal state is reached (like specified tumor size). Our research presented the power of agent based approach combined with reinforcement learning for simulation and optimization of complex biological problems such as radiotherapy. At this stage we assume the tumor as avascular tissue to overcome the complexity of simulation. But our research is in progress and we are trying to develop a more real model.