Cerebral necrosis after radiation therapy for patients with brain metastases is being recognized as a problem more common than previously estimated.

The initial goal of this project is trying to develop a diagnosis model with machine learning techniques to predict the onset of necrosis in order to improve current diagnosis. And the ultimate goal is to better understand the onset of necrosis, reduce its occurrence and generate general guides on radiation therapy dose value for metastases treatment.

Brain metastases, or secondary brain tumors are cancer cells that spread from their original site to the brain. They are the most common malignancy occurring within the cranium. In America, about 25% of cancer patients suffered from secondary brain tumors [1].

Treatment of brain metastases is multidisciplinary with radiation forming the cornerstone [2]. However, significant risks are accompanied by radiation therapy.

Cerebral necrosis, which is one of these, is the unnatural death of the cells in an organ or tissue surrounding the tumor. Given that its characteristics on standard imaging are no different that tumor recurrence, traditional diagnosis of necrosis is time-consuming and challenging.

The goal of this project is to leverage the plentiful information of patient data to identify the patients with a higher risk for radiation necrosis, and consequently lead to more effective treatment strategies for brain metastases patients.

Table 1. Model Performances - Log-loss (AUC).

<table>
<thead>
<tr>
<th></th>
<th>Logistic Regression</th>
<th>Random Forest</th>
<th>Gradient Boosting</th>
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<tbody>
<tr>
<td>Under-sampling</td>
<td>.90 (.72)</td>
<td>.65 (.81)</td>
<td>.67 (.79)</td>
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<td>9.83 (.63)</td>
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<td>.71 (.79)</td>
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As shown in Figure 2., the model had achieve an accuracy of 93%. It performed well in predicting non-necrosis but it still need to be improved to identify necrosis patients.

As suggested by the important features of the model, one possible reason of the vague prediction on necrosis was lacking important information about each metastasis. Current available data was only patient-level. Next step of this project will be collecting metastasis-level data, exploring weighted techniques to handle unbalanced data and then generating suggested radiotherapy dose value for metastases treatment.

References


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