Medical imaging signatures with topology for cancer

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What the author is interested in is the connection between medicine and mathematics. A human body is equivalent to a tube or donut (without considering holes of nose and eyes). The central hole is a digestive system. The body is covered by surface tissue (epithelial cells). The epithelial cells exposed to the outside world might have gene mutations, thereby resulting in cancer cells. On the other side, the heterogeneity of pixel values in medical images (computed tomography, magnetic resonance imaging, positron emission tomography, etc) would reflect biological tumor heterogeneity, which could be related to the degree of malignancy and patients' prognoses. We have attempted to develop novel medical imaging signatures, which are defined as sets of features calculated based on mathematical models from medical images, for prediction of the degree of malignancy and patients' prognoses. As results, the author's group has shown several data that the topological imaging signatures could be superior to conventional ones in terms of the prediction. The topological image features are derived from Betti number maps (b0, b1, and b2) within cancer regions of medical images. The assumption that the author has thought through (not twisting things around) is that the b0, b1, b2 features may characterize high tumor cell density areas, scattered dead cell areas (necrotic tissues), cancer blood vessels (angiogenesis), respectively. The author will present the basics of topological image features and the applications to lung cancer and head and neck cancer.