A new parameter with fractal behavior that can be applied directly to grayscale images

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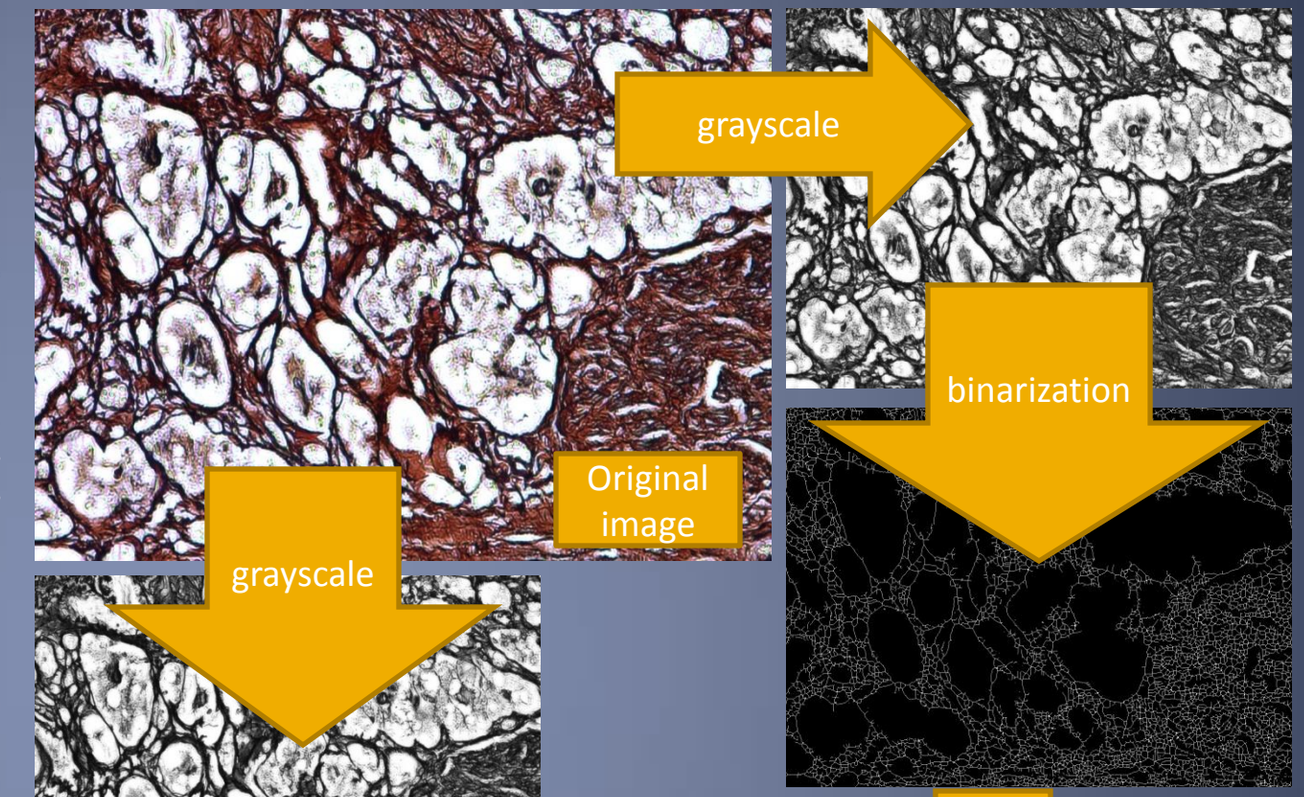
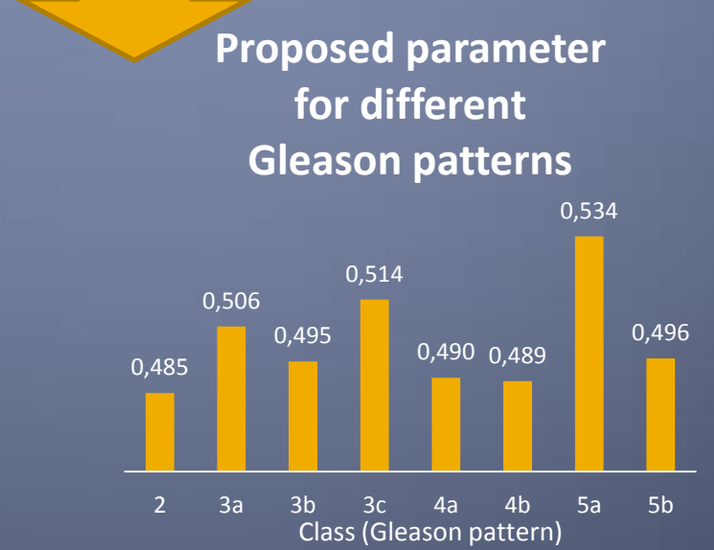
Characterization of medical images for automated analysis and classification tasks is a current problem of bioinformatics.
The fractal dimension (FD) is a real number ranging between topological dimension of a virtual object and the space dimension in which it is defined. In general, it is estimated by computing the logarithmic ratio of the different scaling properties.
The fractal dimension is calculated on binary (black and white) images, starting from medical images, which usually are color or grayscale, and requires an intermediary step, called binarization that implies setting a color threshold in order to transform them to black and white image.
Setting the binarization threshold is a sensitive problem, one can use the empirical threshold (set by observation, without a mathematical foundation) or can make different calculations to estimate the optimal threshold, but it never represents a clear choice.

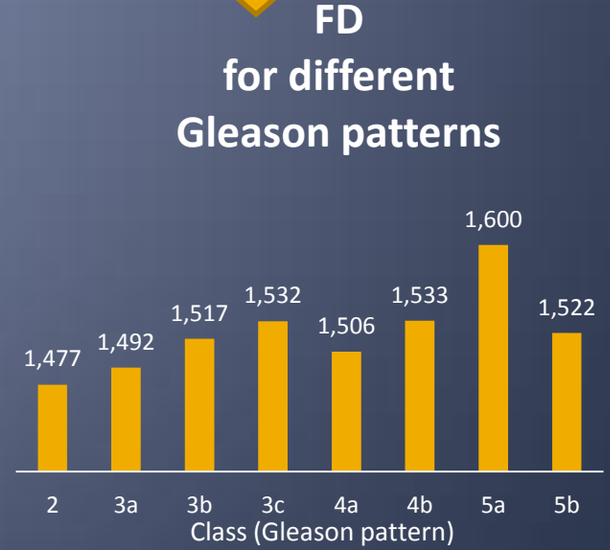
To overcome the drawback of choosing a binarization threshold we propose a new method for characterization of a grayscale image, through a fractal behavior parameter calculated as the logarithmic ratio between the maximum local amplitude and the actual volume at different image scales.
299 digital images, divided into eight classes (Gleason patterns), acquired from prostate cancer histological stained slides, colored with Gomory special staining for stromal quantification were used for testing the proposed parameter.
The proposed parameter was compared to the FD of the images calculated by a box-counting algorithm on binarized images (using an empirical threshold).

Results showed statistically superior discriminative behavior for the proposed parameter in favor of the fractal dimension computed with the box-counting algorithm. More than that the standard deviations values calculated for each class was reduced.

Proposed parameter exceeds the threshold setting drawback of standard fractal dimension algorithms, being applied to grayscale images and shows superior discriminative capabilities than the box-counting algorithm making it suitable for image analysis.







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