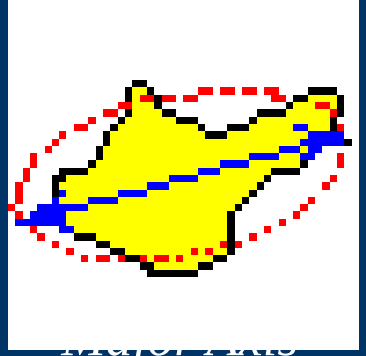
Technology of detection and calculation of topology features for 3D medical objects

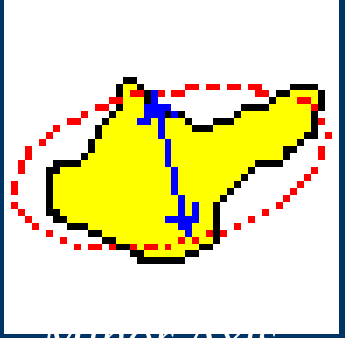
- Alexander Nedzved, United Institute of Informatics Problems

- *The technology of detection and calculation of topology features for 3D objects are proposed. This technology should be include to software library of 3D image processing. 3D objects are considered through* ***four presentation: net, convex, holes, skeletons****. From this representation propose software calculate characteristics for such shape description as branchness, tailness and many other characteristics of shape complexity. This characteristics allow to describe interior structure of 3D objects and interior influence (between separate parts of objects).*

Measuring



Major Axis



Minor Axis

Major Axis

• The major axis is the (x,y) endpoints of the longest line that can be drawn through the object.

– The major axis endpoints (x 1 ,y 1) and (x 2 ,y 2) are found by computing the pixel distance between every combination of border pixels in the object boundary and finding the pair with the maximum length.

Major Axis Length

• The major-axis length of an object is the pixel distance between the major-axis endpoints and is given by the relation: – The result is measure of object length.

Major Axis Angle

• The major-axis angle is the angle between the major-axis and the x-axis of the image:

– The angle can range from 0° to 360°.

– The result is a measure of object orientation.

Minor Axis

• The minor axis is the (x,y) endpoints of the longest line that can be drawn through the object whilst remaining perpendicular with the major-axis.

– The minor axis endpoints (x 1 ,y 1) and (x 2 ,y 2) are found by computing the pixel distance between the two border pixel endpoints.

Minor Axis Length

• The minor-axis length of an object is the pixel distance between the minor-axis endpoints and is given by the relation:

– The result is measure of object width.

Measuring

Compactness

• Compactness is defined as the ratio of the area of an object to the area of a circle with the same perimeter.

– A circle is used as it is the object with the most compact shape.

– The measure takes a maximum value of 1 for a circle

Objects which have an elliptical shape, or a boundary that is irregular rather than smooth, will decrease the measure.

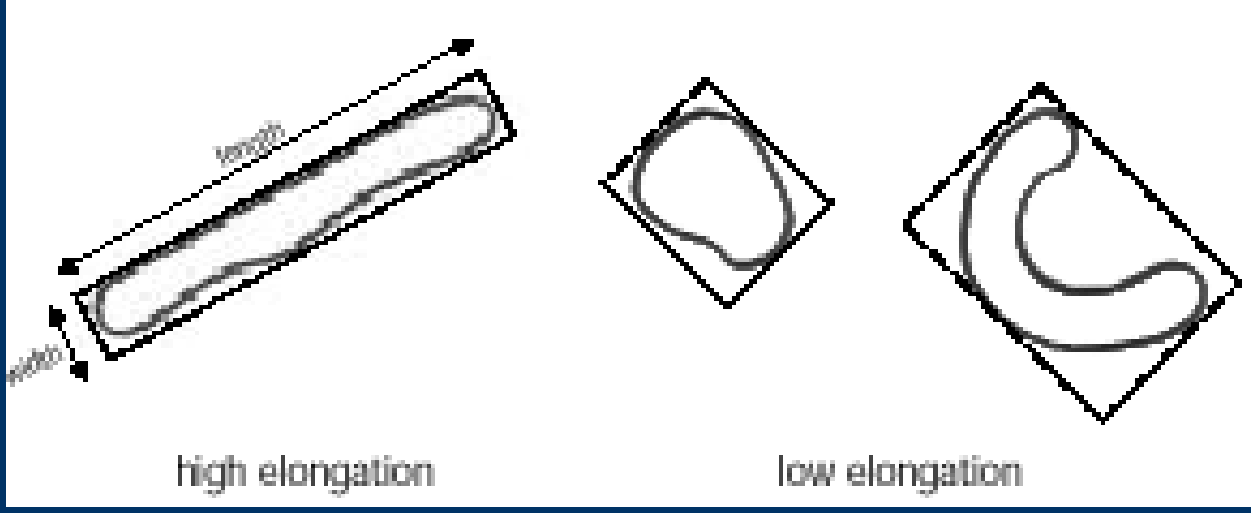
– An alternate formulation:

– The measure takes a minimum value of 1 for a circle

– Objects that have complicated, irregular boundaries have larger compactness

Measuring

Elongation



In its simplest form elongation is the ratio between the length and width of the object bounding box:

– The result is a measure of object elongation, given as a value between 0 and 1.

– If the ratio is equal to 1, the object is roughly square or circularly shaped. As the ratio decreases from 1, the object becomes more elongated

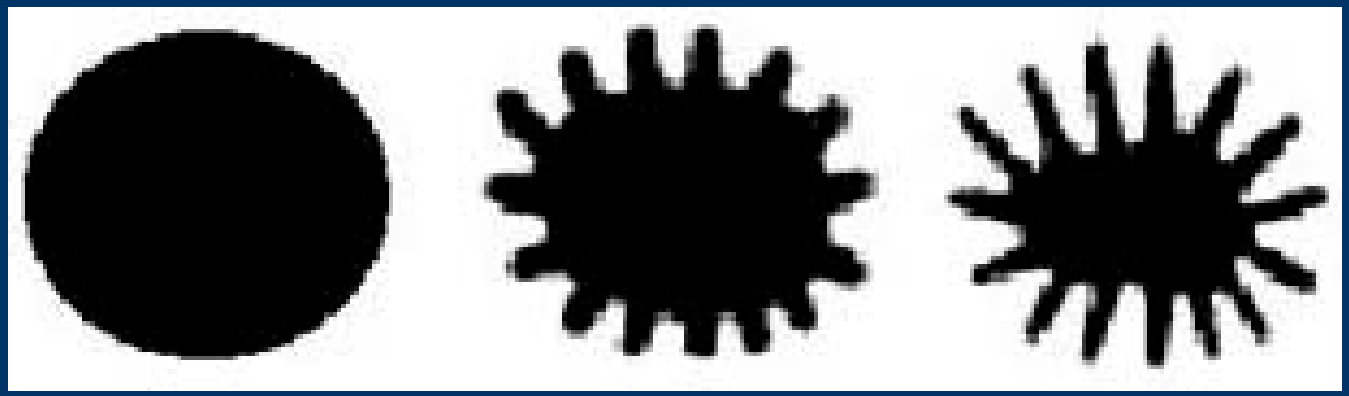
This criterion cannot succeed in curved regions, for which the evaluation of elongatedness must be based on maximum region thickness.

– Elongatedness can be evaluated as a ratio of the region area and the square of its thickness.

– The maximum region thickness (holes must be filled if present) can be determined as the number **d** of erosion steps that may be applied before the region totally disappears.

Measuring

Convexity, Solidity



Convexity =1
Solidity=1

Convexity=0,483
Solidity=0.782

Convexity= 0,349
Solidity=0.592

Measuring

Texture description

Intercept *Anisotropy* *ChordSum* *ChordRef*

Intercept is a stereological parameter which is defined as the number of times the horizontal or vertical grid crosses the phase boundary. The spacing of the grid is defined by the global variable *GridSpace* which has a default value of 1.

Anisotropy is derived from the intercept and defines the general anisotropy of the phase relative to the coordinate axes.

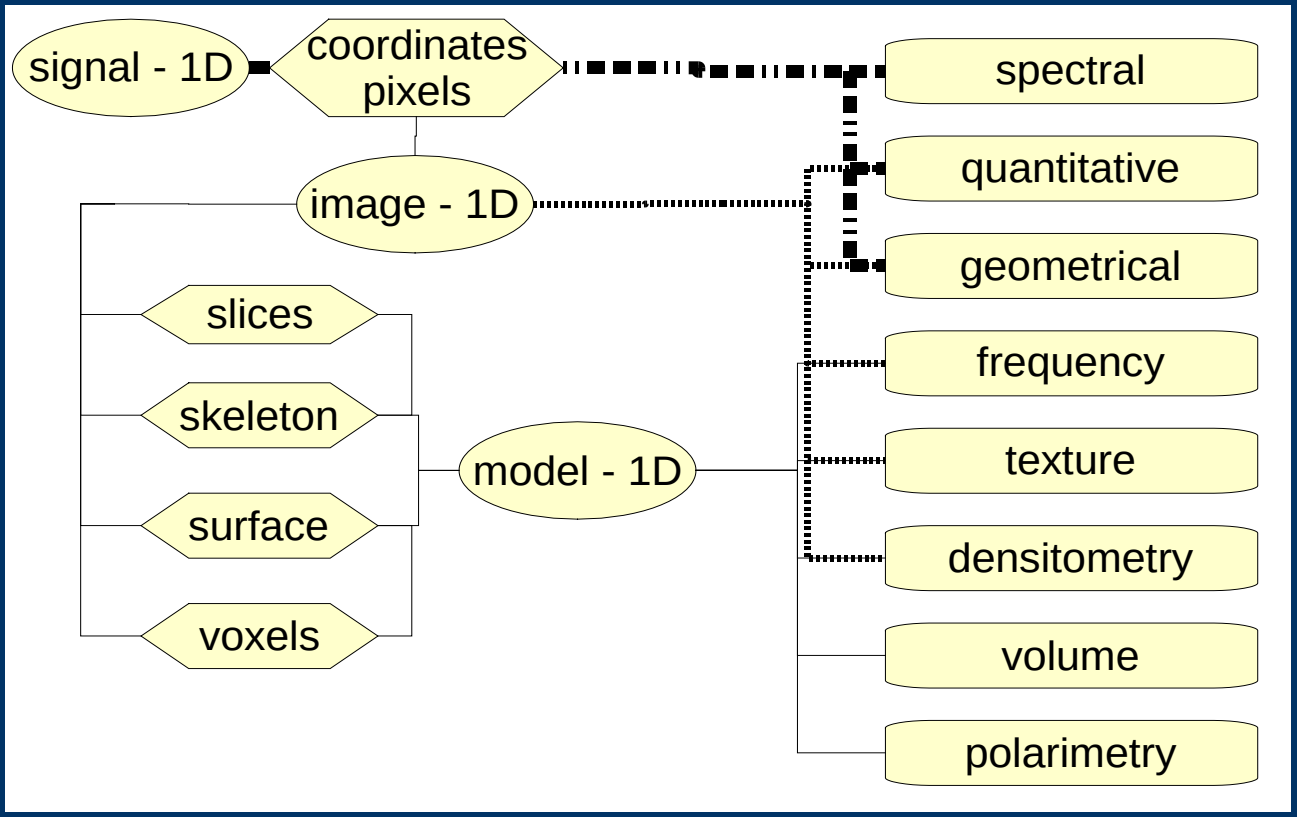
The sum of chords is a stereological parameter defined as the total length of horizontal grid lines falling inside the objects belonging the phase The spacing of the grid is defined by the global variable *GridSpace* which has a default value of 1

ChordSum returns the length of grid lines crossing the phase, in calibrated units:

ChordRef returns the total length of grid lines in the image or selection, in calibrated units:

3D measuement

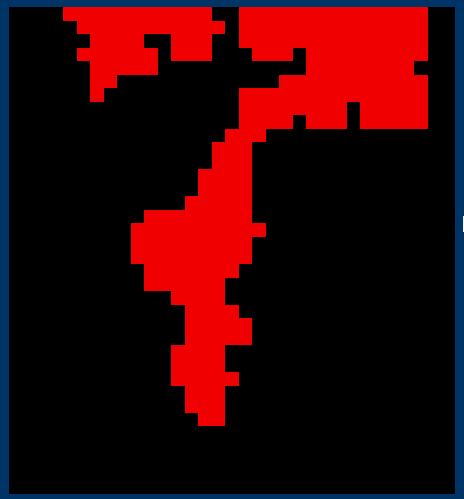
In computer tomography objects are defined as area on the image. This area corresponding to informative structures (to blood vessels, skeleton, organs, etc.).
Usually the full information about objects on the image correspond to characteristics (parameters). Its use for diagnosis statement. For investigation characteristics are defined on their basis conclusions about type of object or about quality of the contained image.

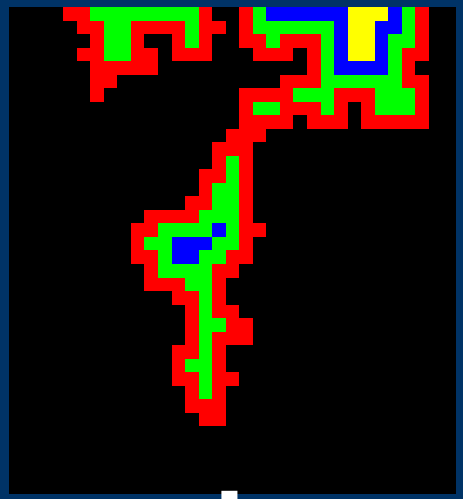


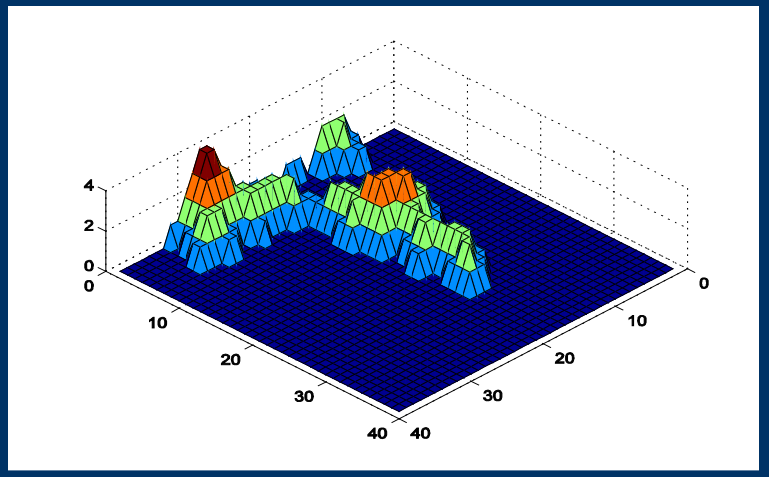
The classification of objects is defined by dimension of objects. In the field of the analysis of medical images three dimensions are most extended. In depending on dimension characteristics are defined for description object. In this connection for dimension there is a heredity factor, between characteristics. there are relations for different classes of characteristics. Its result from each other. The scheme of interaction of characteristics was developed

Compex objects analysis

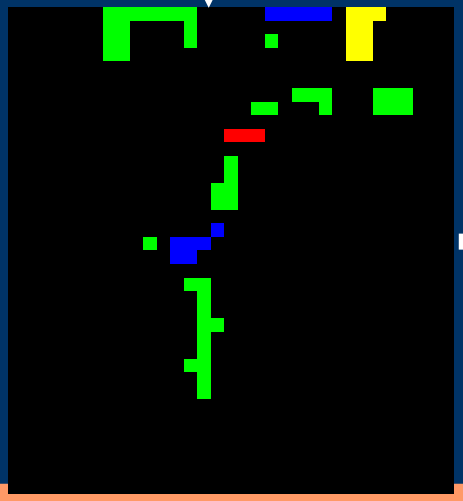
Distribution of objects width

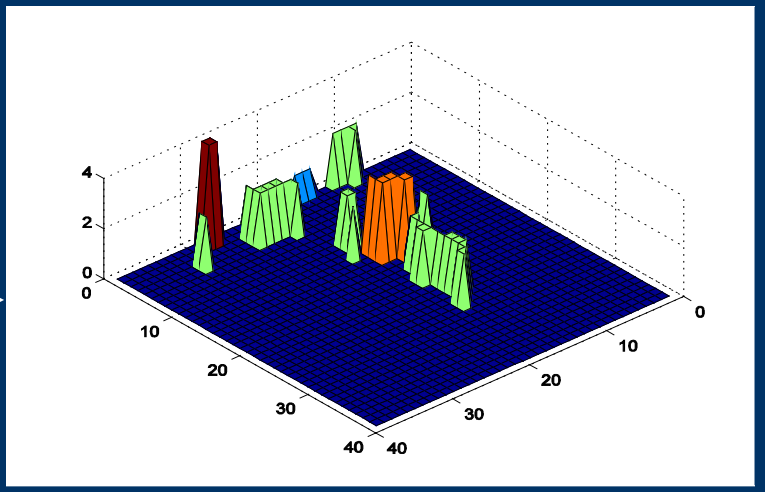






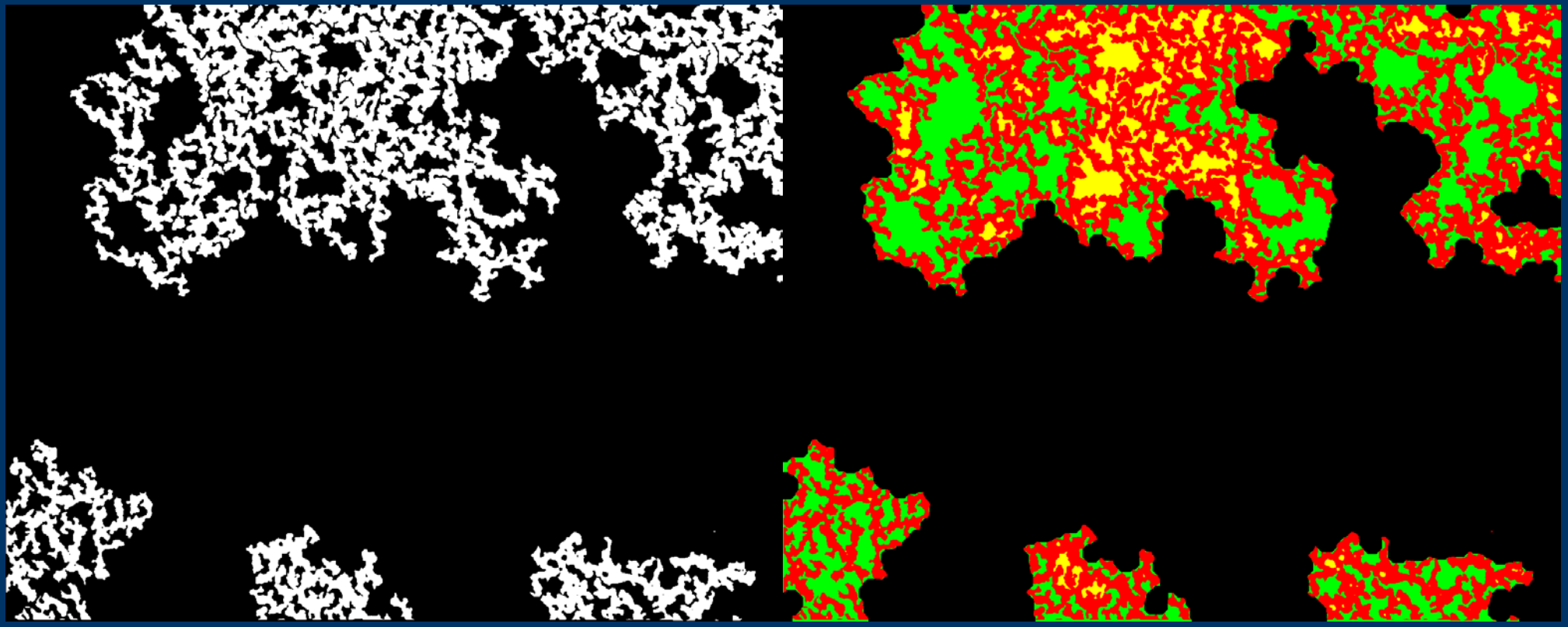
1. Form image calculate distance map, level of any point correspond distance to border
2. Detect local maximum (points in distance map with equal distance)





detection and calculation of topology features

Topology analysis



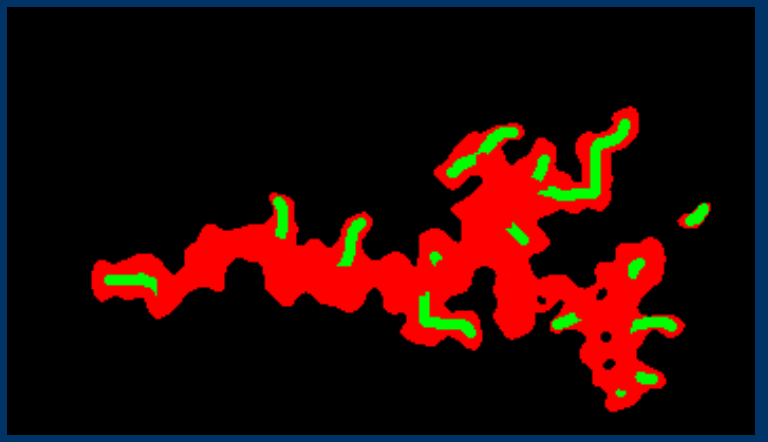
RED – body
Green – gulf
Yellow - holes

1. Volume(gulf)/Volume(hoes)
2. Total Volume = Volume(gulf)+Volume(holes)+Volume(body)
3. Space filling = Volume(gulf)/TotalVolume;
   Volume(holes) /TotalVolume;
   Volume(body) /TotalVolume;

detection and calculation of topology features

Tails analysis.
It can be used for calculation characteristics

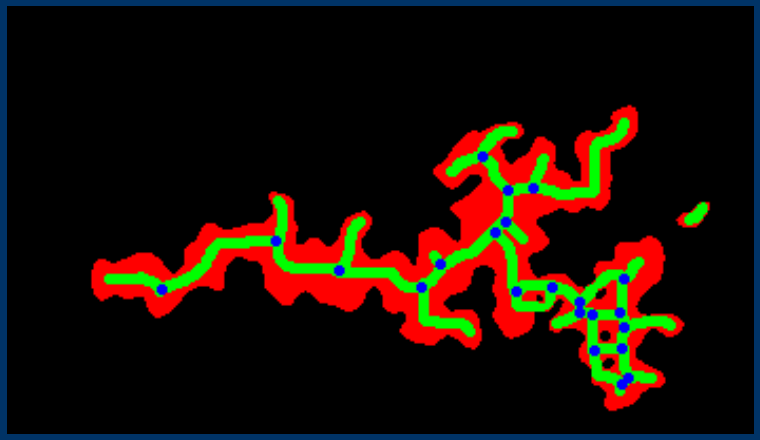
Tailness = count(tails)/ length(skeleton)
tails curliness=count (tails)/count(segments)
tails ratio=length(tail)/length(skeleton)



Tails - green objects

Node analysis.
This function detected Nodes of body branch. It is the useful characteristic for the description of body branches. It can be used for calculation characteristics

Brencheness=count(nodes)/length(skeleton)
Curliness= count(nodes)/count(segments)

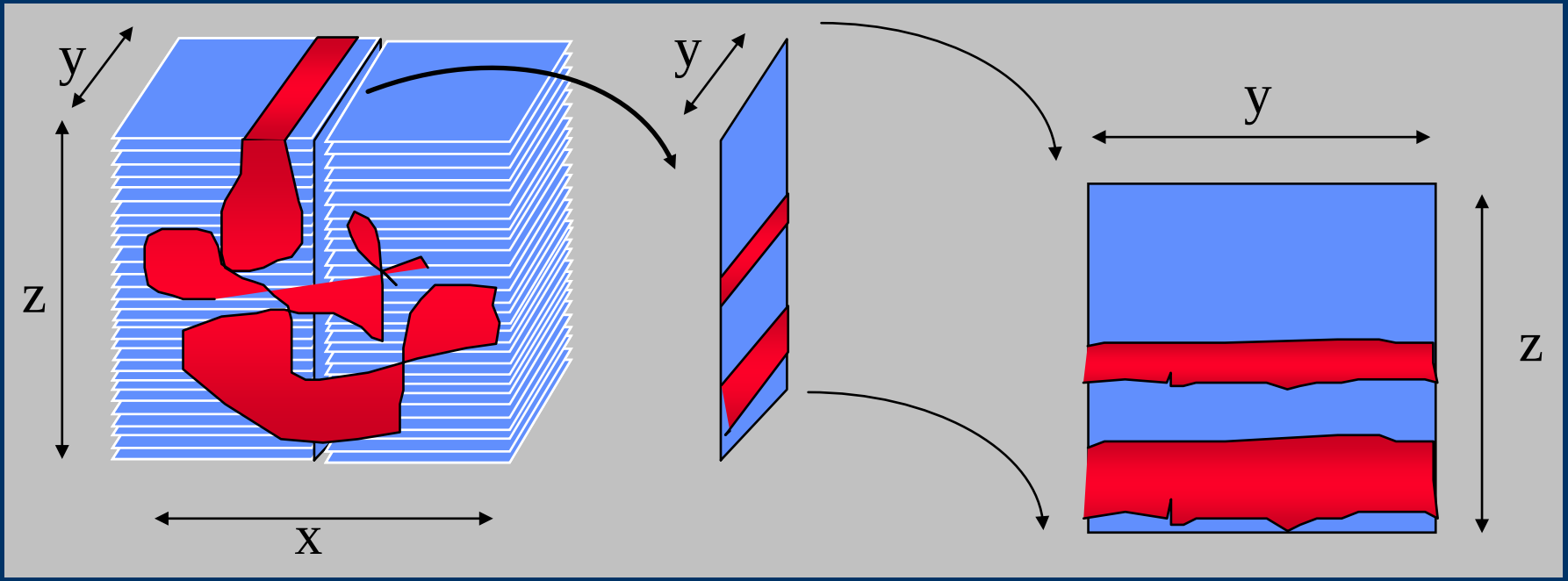


Skeleton – Green
Nodes – blue
Segments – fragment of skeleton between nodes

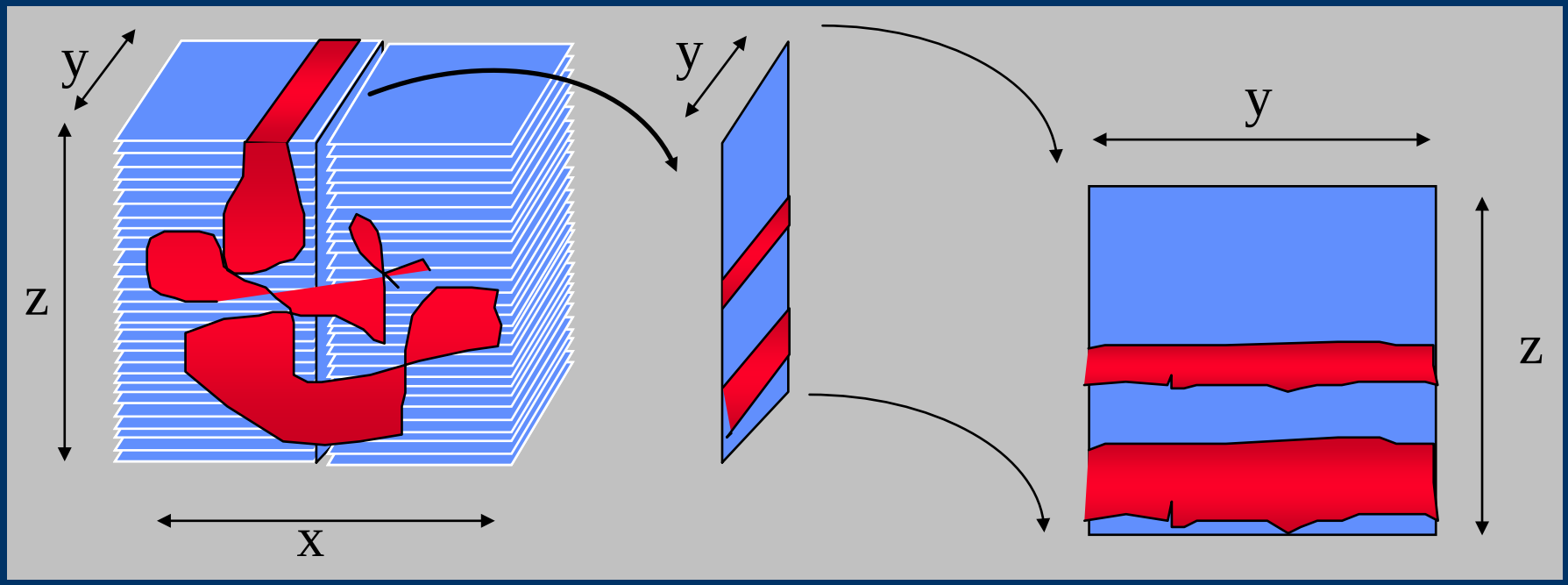
Common characteristics

dendrite length =Length(skeleton)
mean dendrite width=Volume(body)/length(skeleton

Scheme of analysis



Measurement function are working by algorithm of analysis of connected components to slice by slice.


y
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