



Quantitative Analysis of Biomedical Images in 3D

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Background **#**

Imaging

• 3D μ CT imaging

- DanMAX (and ForMAX) at MAX IV
- 3D Imaging Center at DTU
- 4D Imaging Lab at LTH, Lund
- Structural quantification is the most time-consuming part of imaging
- Users are often not analysis experts
 - difficulty in handling data
 - difficulty in finding method that match problem data is not utilized to its full potential!

QIM: The Center for Quantification of Imaging data from MAX IV

- Support users at MAX IV & lab facilities with image analysis
 - Case-specific collaboration
 - Competence development
 - Development of tools and analysis pipelines and platform
- Collaboration between LU, KU, DTU, and MAX IV supported by RegionH

Resources

Webpage with activities, tutorials, and tools: <u>http://qim.dk/</u>



DanMAX at MAX IV





Given three dice Q1: What is the lowest you can get? A1: Easy!

$$3 \cdot 1 = 3$$

Q2: What is the highest you can get? A2: Easy!

$$3 \cdot 6 = 18$$



Q3: What is the likelihood of getting 6 with one dice? 1 A3: Easy! $1/6 = \frac{1}{2}$

Q4: What is the likelihood of getting at least one 6? A4: Difficult! (if you are in fourth grade)

$$\frac{6}{6} = \frac{6}{6} \frac{5}{6} \frac{3}{6} = \frac{91}{216}$$



- Segmentation is a central part
- Time-consuming often 10-100 times longer than the rest
- Result depends on accurate segmentation





Characterizing 3D structures



Brain tissue





Segmentation **E**

- Image segmentation:
 - Partition the image into regions
 - Enables structural measures
 - Enables visualization

• What to segment – task dependent





Segmentation – with machine learning

- InSegt²
- Tool for interactive segmentation and feature detection
- Real time update of labels
- Easy and intuitive
- Especially useful for repetitive patterns
 - Fiber composite analysis
 - Analysis of insect eyes
 - Analysis of peripheral nerves, etc.



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CT-scan of glass fiber composite. The goal is to detect individual fibers. The user marking on the left are propagated to the image on the right.



Analysis method employs a dictionary that links image patches to dictionary patches and allow fast informatino flow.





Layered surface segmentation

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- Segmentation of layered structures
- Very robust method using graph-based optimization
- Geometric transformation allows segmentation of tubular and spherical structures





Extracting layeres in volumetric images using st-graph cut. Top shows a complex textured layer of trabecular boneand bottom layeres in low contrast packaging material.

















Sparse layered graphs





Fast and accurate segmetnation for volumetric images – guarantee of non-overlap and containment. This was not possible with conventional st-graph cut based segmentation methods.





- QUAITOM the center for quantitative AI-based tomography
- Common platform for
 - data storage and sharing,
 - visualization, and
 - quantitative analysis.
- Software preinstalled and shared
- Open source install on own hardware
- Support staff to help image analysis
 - extends the support from beam-line scientists









Thank you! Questions

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