

Tools for processing and visualization of tomographic and confocal data

Prostriedky pre spracovanie a vizualizáciu tomografických a konfokálnych dát

(APVV grant proposal)

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Institutions and Personnel

- Faculty of Mathematics, Physics and Informatics:
 - Šrámek Miloš, Ftáčnik Milan, Zimányi Marek, Novotný Pavol, Parulek Július, Červeňanský Michal, Vaško Anton, Blázsovits Gábor, Vnučko Ivan, Streňanská Barbora
- International Laser Center:
 - Mateašík Anton, Bacharová Ljuba, Chorvát Dušan, Smolka Jozef
- Commission for Scientific Visualization, AAS
 - Dimitrov Leonid I., Straka Matúš
- Institute of Molecular Physiology and Genetics:
 - Zahradník, Ivan

Required Financing & HW

- APVV financing: 3.7 mil SK
 - PhD students: 5.000 Sk/month (full time)
 - Conferences: 443.000 SK
 - HW:
 - 2 workstations
 - 5 PCs
- HW environment
 - Windows & Linux PCs
 - 16 node cluster at ILC

Goals

- Develop new methods for
 - Representation
 - Processing
 - Visualization of volumetric data
- Implement:
 - A set of simple-to-use tools (libraries, classes)
 - A set of specific applications (proof-of-the-concept) for AVT, Iris, fd3...
- Data sources:
 - Radiology (CT-angiography)
 - Biomedicine (confocal microscopy)

Goals (technical)

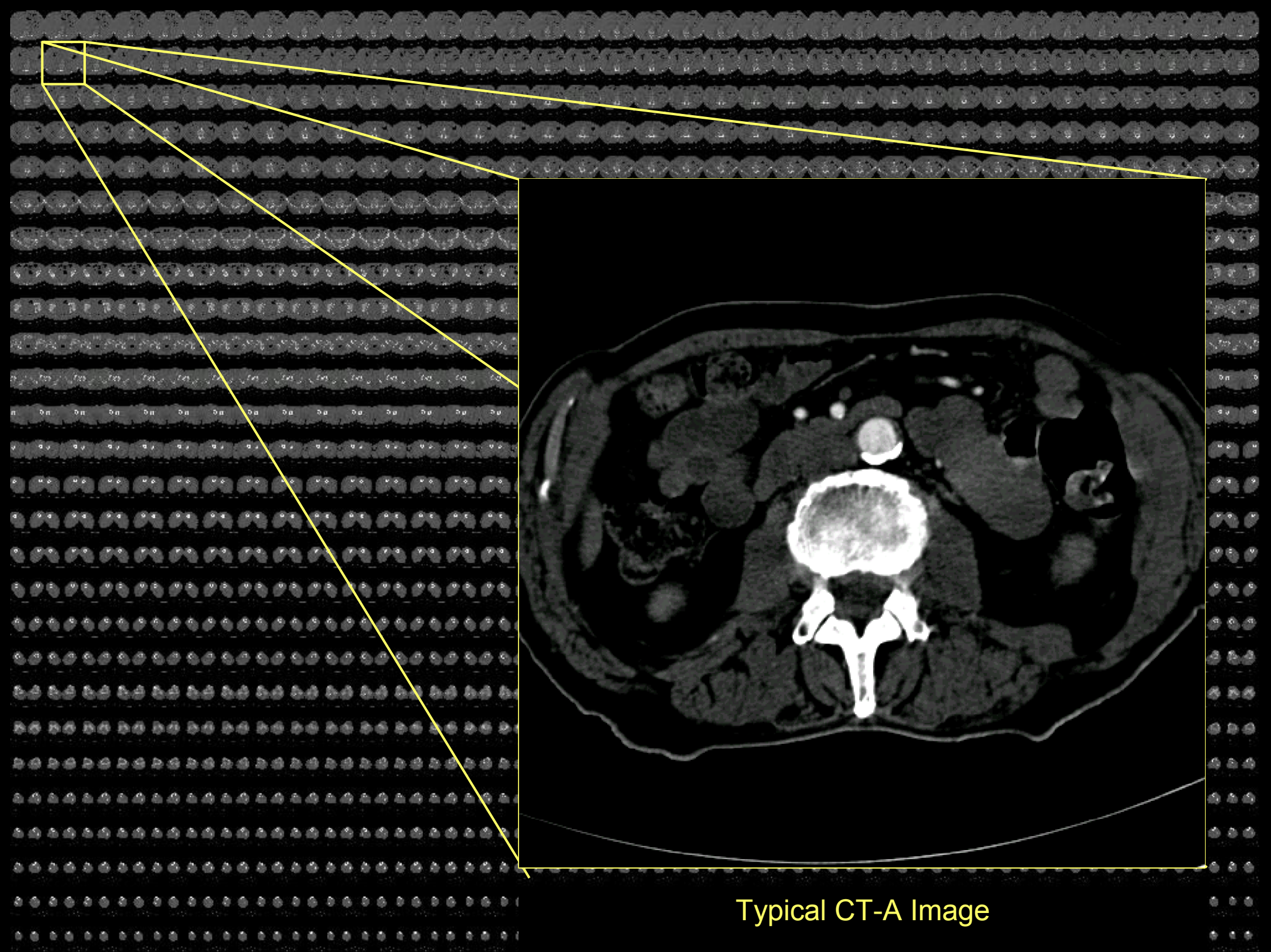
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Goals (other)

- Start inter/intra-institutional collaboration, create a group
- Learn a lot both in data processing and programming
- Proceed our careers: write papers, theses
- Get some extra money and/or hardware
- See the world
- Do something useful, have fun

Input Data

- CT data (angiography, colonoscopy)
 - Huge, just some parts interesting
 - Identification of objects, segmentation
 - Proper visualization techniques
- Confocal microscopy data
 - Huge, multiband, temporal series
 - Complex structures, noise, blurred
- Synthetic data
 - High resolution
 - Object modeling



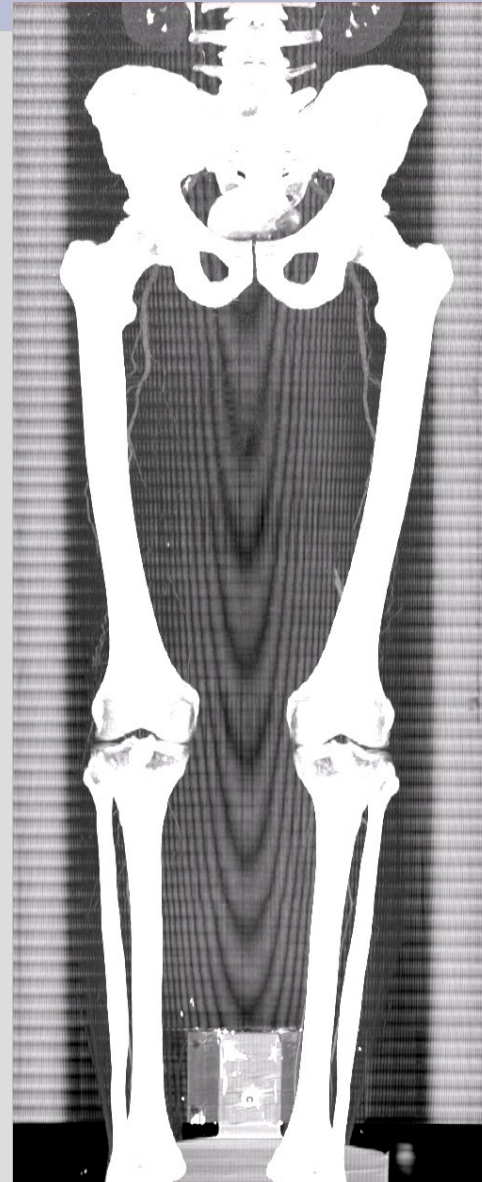
Typical CT-A Image

What is important here?

- Segmentation required:
 - Manual? Thresholding? Which threshold then? More sophisticated techniques required? Is the result correct? Did we get what we wanted to?

How to visualize?

- Volume rendering?
Surface rendering?
MIP? CPR?

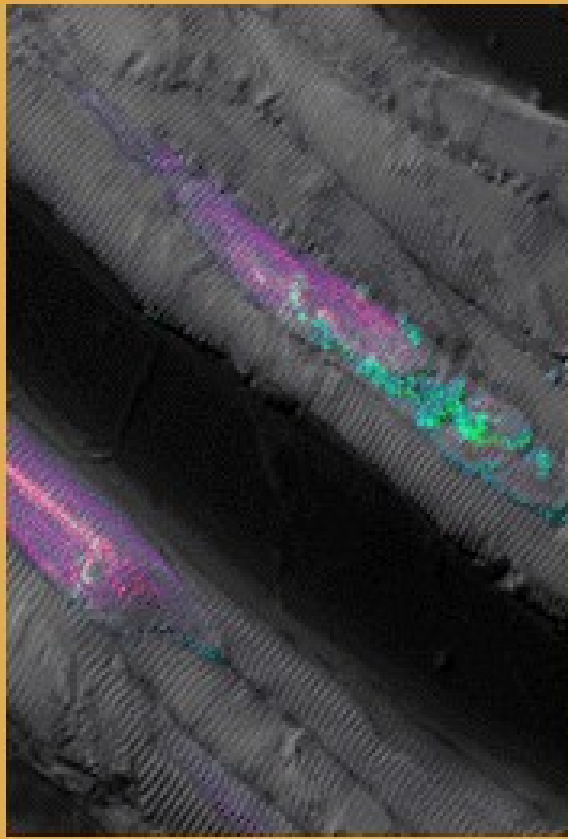


Input Data

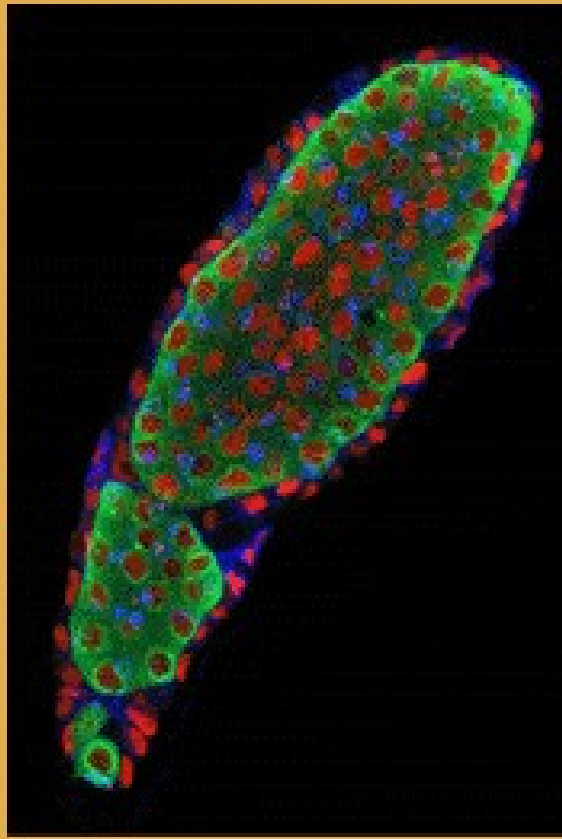
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Confocal Data

- Multiband, color data



Fluorescent & Transmitted



Fluorescent



Reflected

CM Data: Processing and Visualization

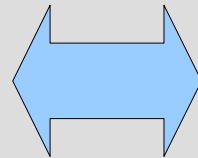
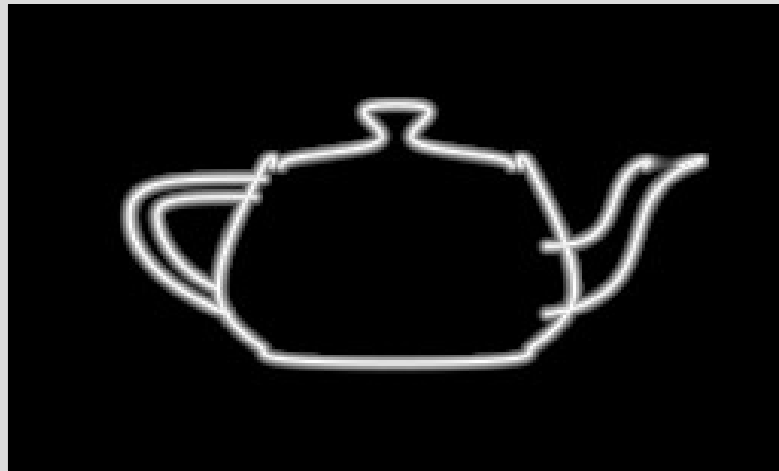
- Identification of interesting features – classification, reduction of band number, animation
- Choice of visualization techniques
- Data analysis....

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- **Synthetic data**
 - High resolution
 - Object modeling

Synthetic Data

- High resolution required (2000^3 ?)
- Most of the space is empty
- Sophisticated representation schemes required



Goals in Details: Data Representation

- Problem: Data sets are too big
- Possible solution: compression:
 - Overhead added, no direct access
- Goal: Find a compressed representation with fast access:
 - Run-length encoded
 - Block structures
- Expected result: f3d classes with iterators
- ToDo: Seminar talks (PN, AV, MaS, MiS)

Stream Processing

- Complex operations can be often built from simple ones
- Output of one is input of another
- Numerous operations are just local – knowledge of the whole data set is not required
- Goal: Design the data structures and algorithms in a way to enable streaming

Deconvolution

- Problem: Out-of-focus information in CM data, blurring
- Solution:
 - Estimation of scanner's PSF
 - Deconvolution
- Complications: huge data, parallel implementation required
- ToDo: next seminar talk (AM, MZ)?

Segmentation

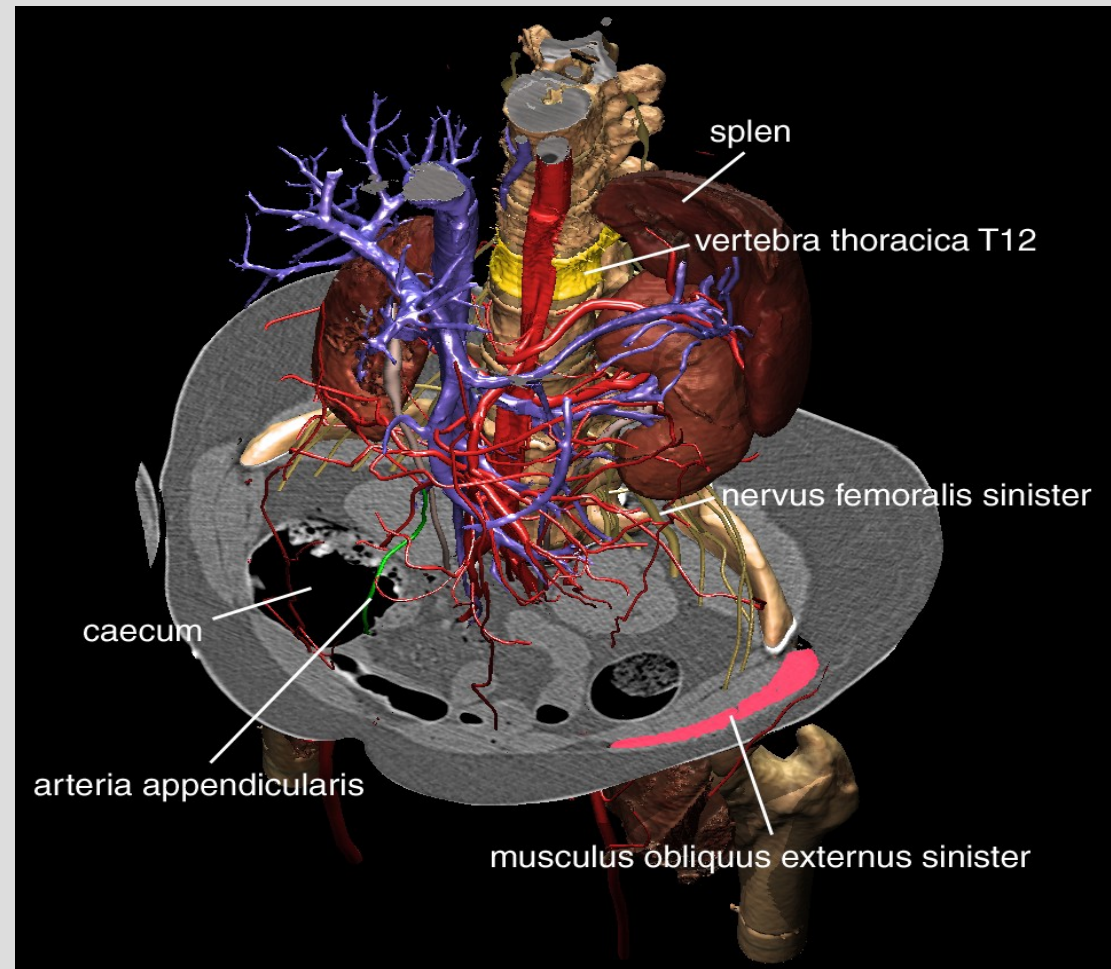
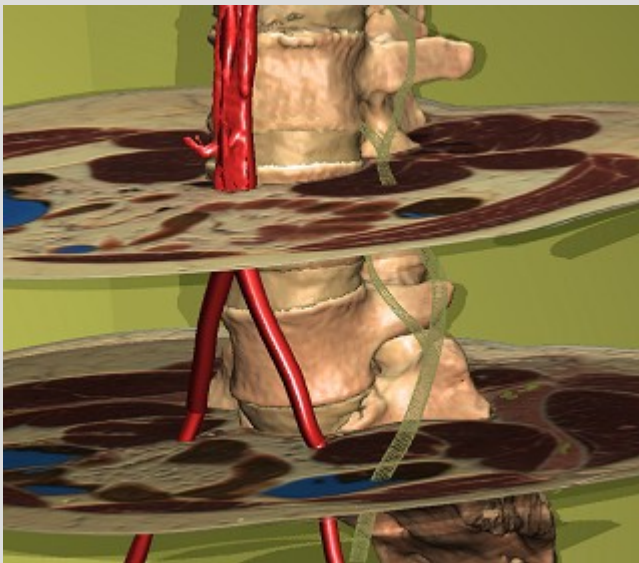
- An unsolved problem
- General-purpose (semi-interactive) techniques
 - Watersheds with HW support, user driven
- Specific techniques
 - Vessel detection in CTA data
 - Colon identification
 - Others
- TODO: talk on watershed segmentation (MS)

Visualization (1)

- Huge data
 - HW support
 - Parallel implementation
- Task specific techniques required
 - Focus&context (combinations of techniques)
 - Visualization of segmented data
 - Visualization of classified data.
 - Combination of techniques
- Expected result: A rendering engine (in the sense of computer games?)
 - HW, SW based, GUI independent, well defined interface

Visualization (2)

- Complex scenes
 - Multiple volumes
 - Multiple objects with attributes
 - Different techniques
 - Interactive property setting



Conclusion

- Create a set of useful, flexible, general-purpose but still simple tools
- Platform & GUI independent
- Separate processing from GUI
- Applications for everyday usage & education
- Be open-minded, find new and better solutions