Sematic segmentation of bone implants – MDLMA project

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Hamburg, 4. Dec. 2020

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In cooperation with
Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung
UNIVERSITÄT ZU LÜBECK

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

Multi-task Deep Learning for Large-scale Multimodal Biomedical Image Analysis

MDLMA Project

Motivation:

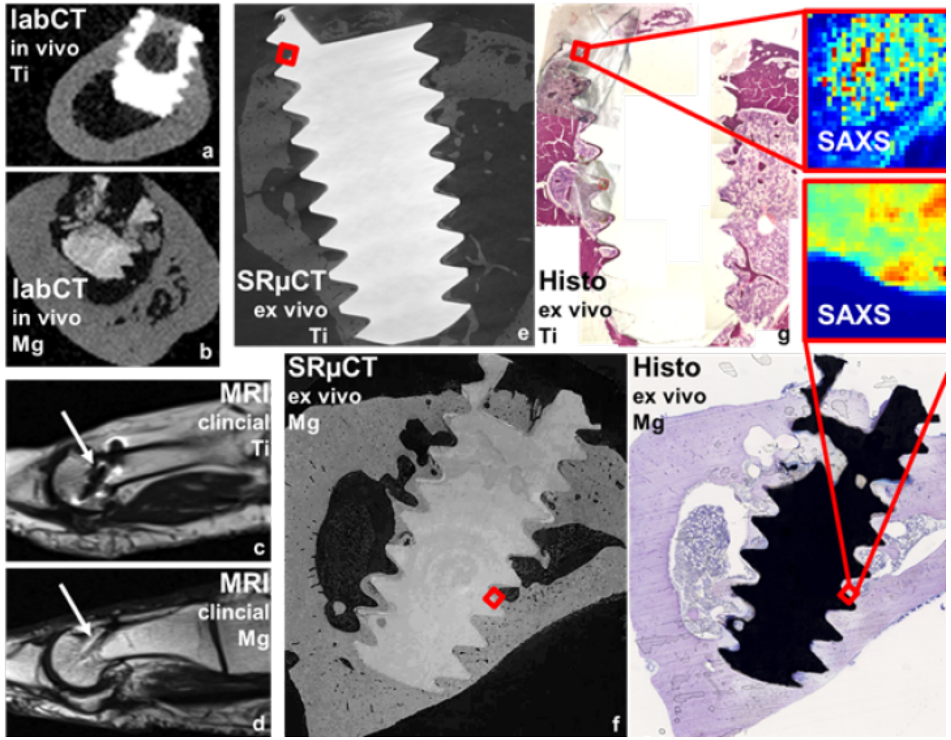
- characterization of degradable bone implants

Problem:

- many time-consuming steps to get final results:
  image acquisition, -reconstruction, -enhancement
  registration, segmentation and measurements

Goal:

- leverage multi-task to improve results of each individual task
- combine information of multimodal images



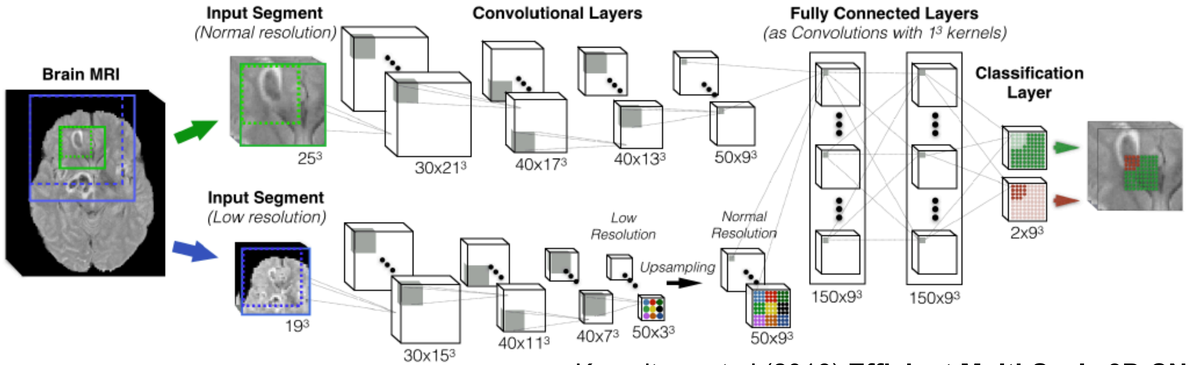
Project and industrial partners:

Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung

UNIVERSITÄT ZU LÜBECK

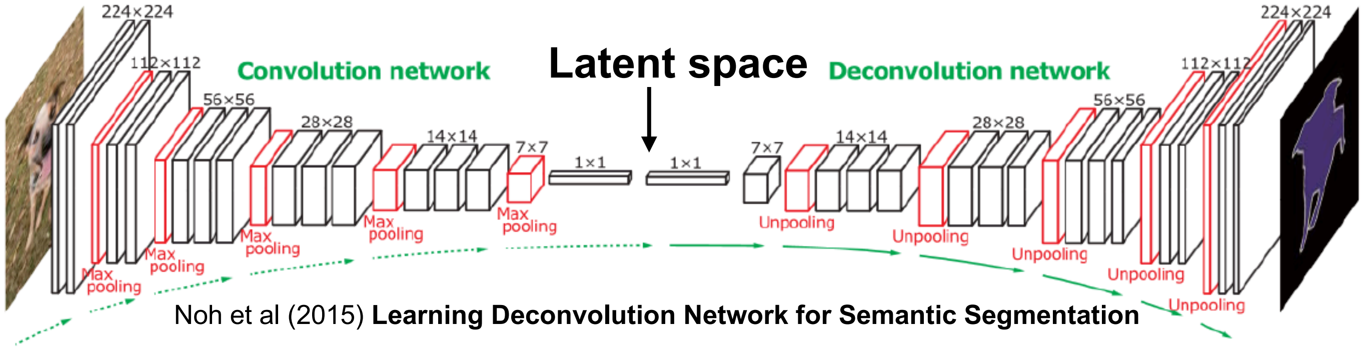
SYNTELLIX

Semantic segmentation architectures



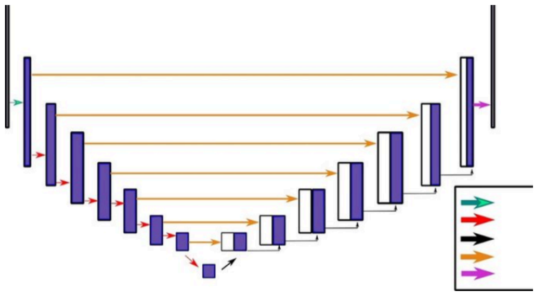
Kamnitsas et al (2016) **Efficient Multi-Scale 3D CNN with Fully Connected CRF for Accurate Brain Lesion Segmentation**

Multiple paths architecture: local and global

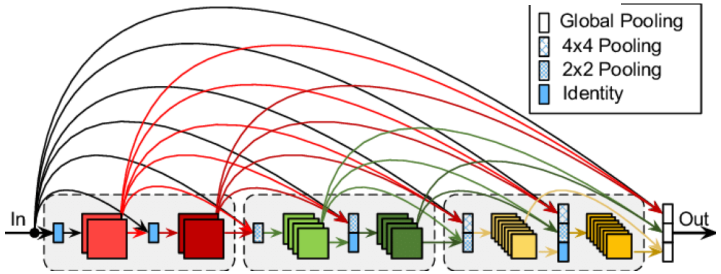


Noh et al (2015) **Learning Deconvolution Network for Semantic Segmentation**

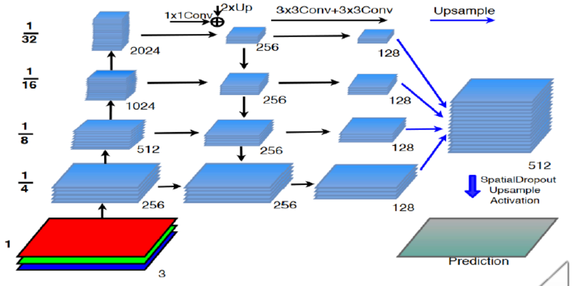
Encoder / Decoder architecture: Latent space



U-Nets



Dense Nets as encoder



Feature Pyramid Nets

Rethinking receptive fields for high-dimensional SRµCT data

(baseline and work in progress)

- Classic U-Net architecture has a receptive field of **140 x 140 pixels** at the bottleneck layer
- Receptive field is the size of the region in the input that produces the feature
- In contrast the SRµCT data has $\approx 1500^3$ pixels -> one tenth of the input image contributes to each feature

Hypothesis:

- Simply increasing the input size is similar to increasing the batch size for small receptive fields
- To truly leverage the large input size (i.e. high resolution), the receptive field needs to be increased.
  - Stacking conv-layers, increase kernel size or employing dilated convolutions
  - Different combinations can increase the receptive field to 1080 x 1080 pixels

Very preliminary results

Dice:

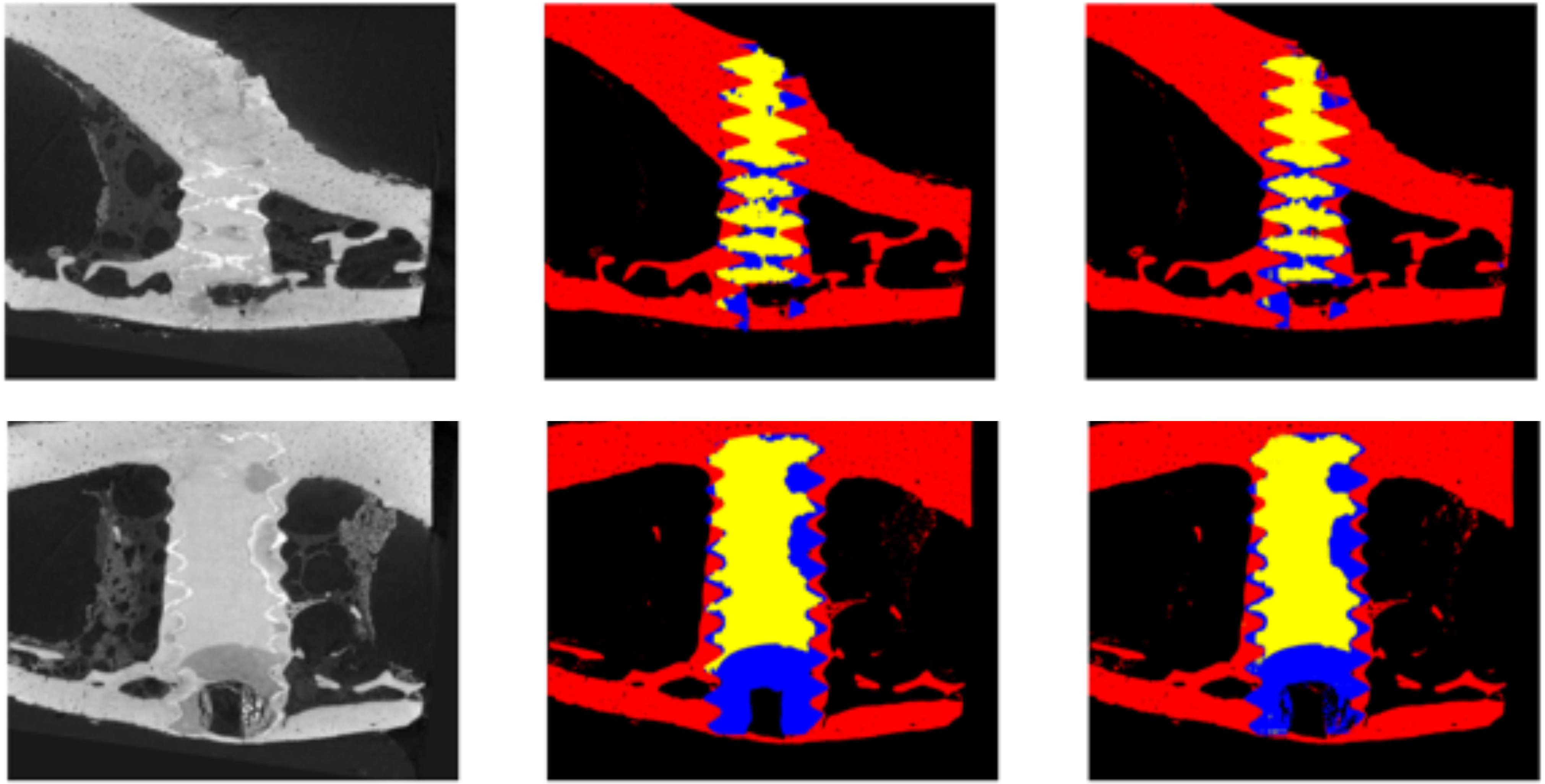
Avg = 0.933

Bone = 0.976

C. screw = 0.861

Screw = 0.961

Input image slice | **Workflow GT** | **Model prediction**



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