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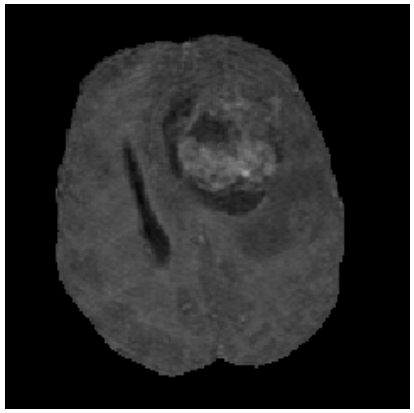
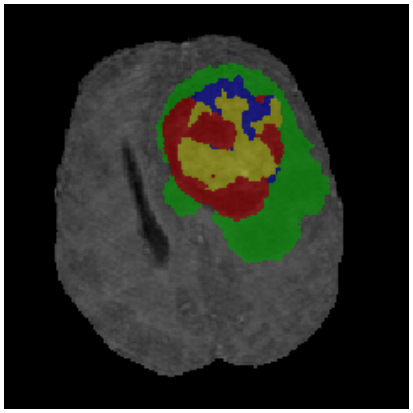
TCGA Glioma Research Group Weekly Meeting

Multimodal Brain Tumor Segmentation





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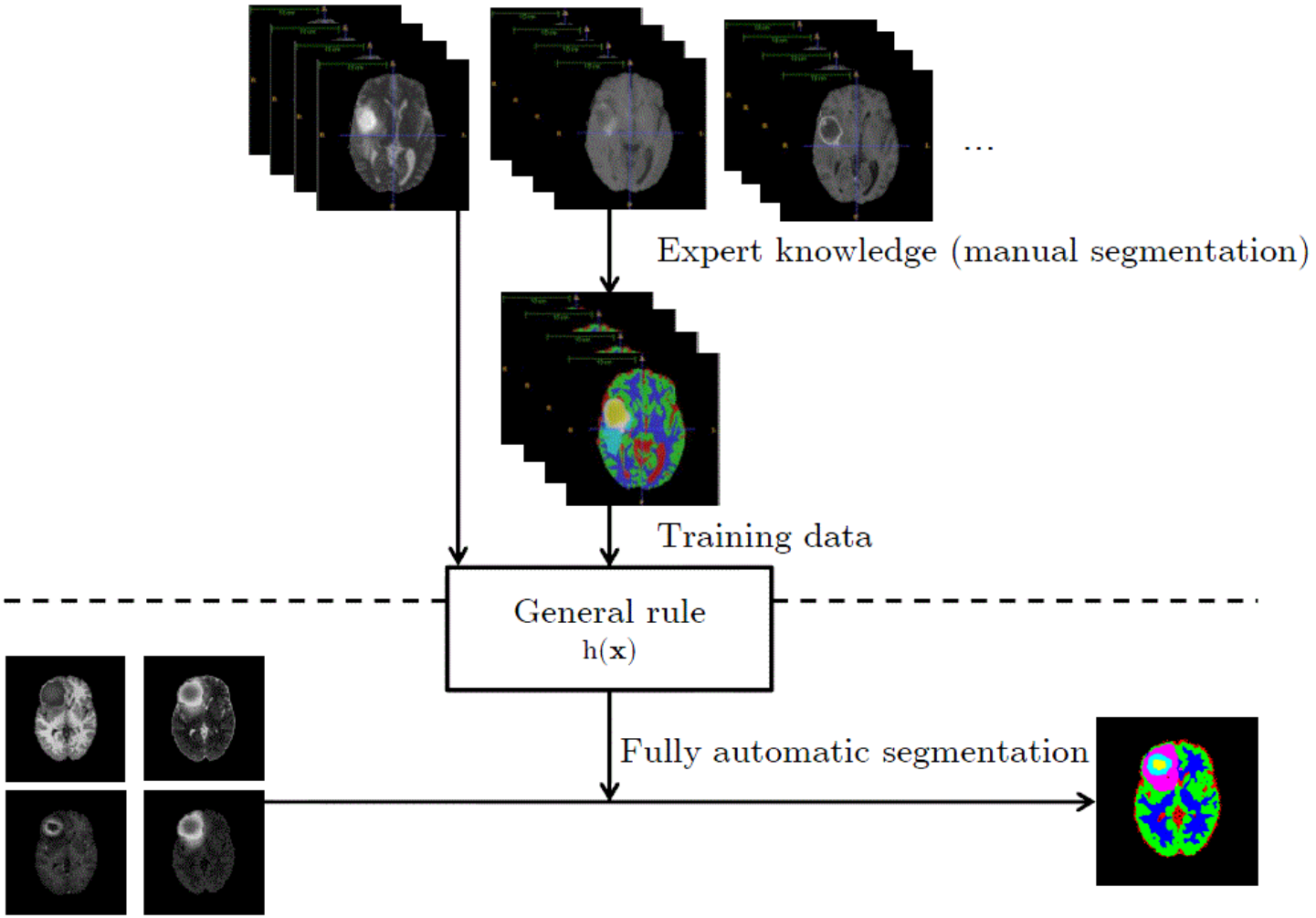
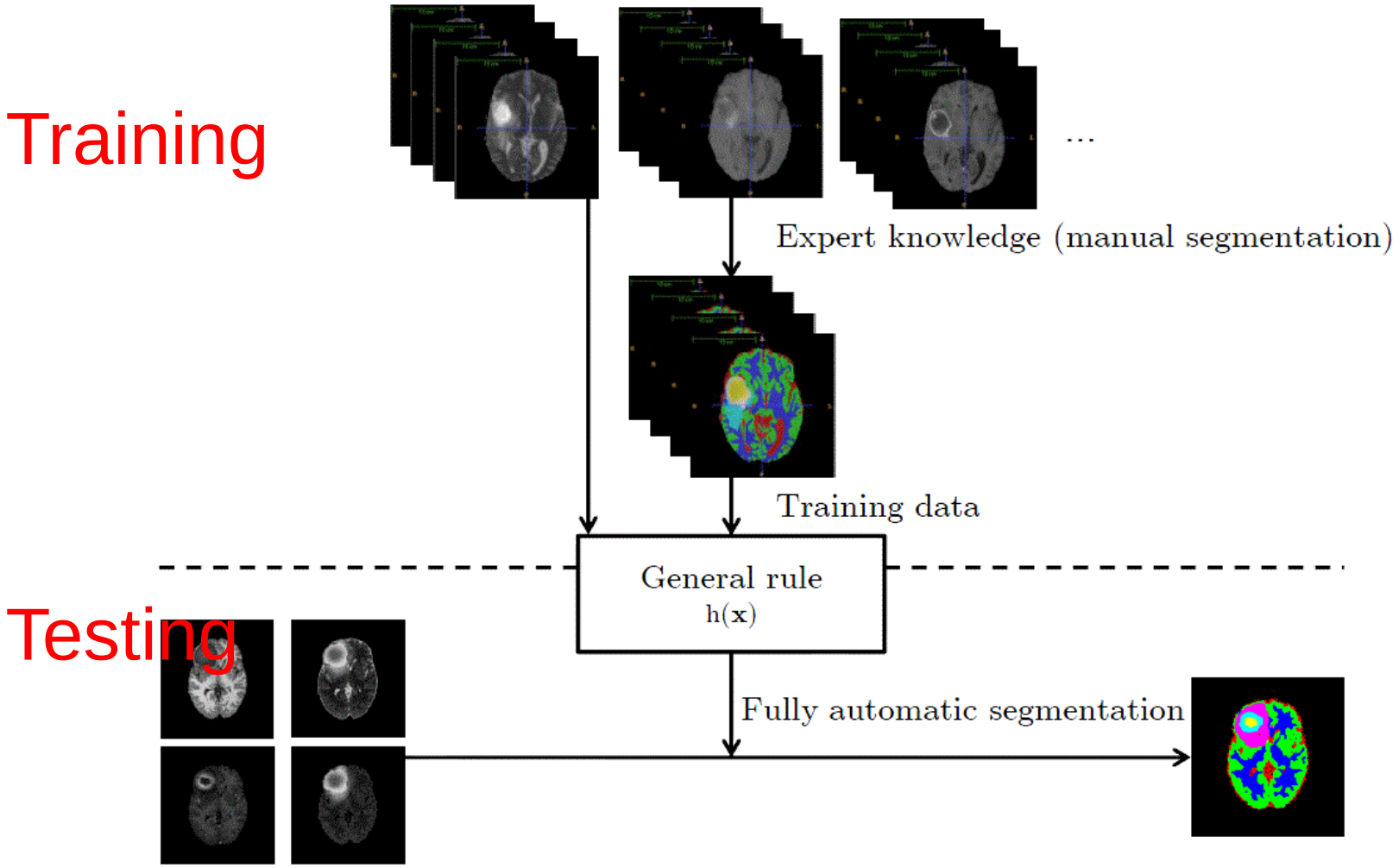
Medical Image Analysis Group

Methodology

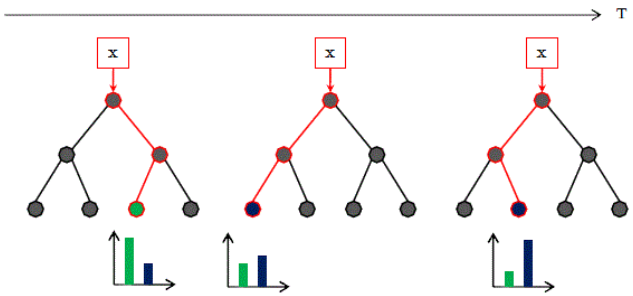


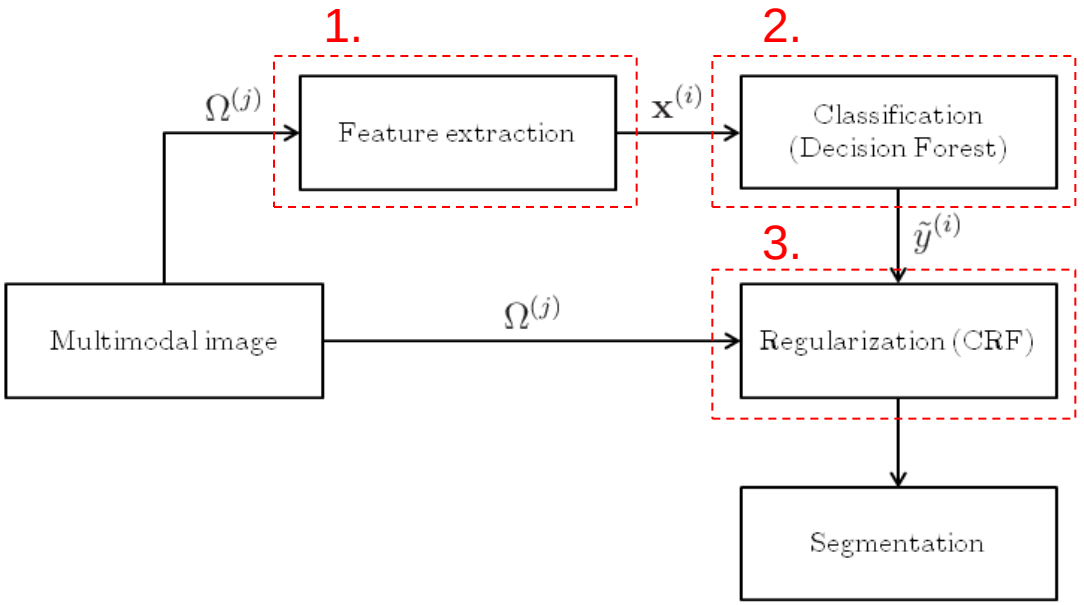
Methodology



Methodology

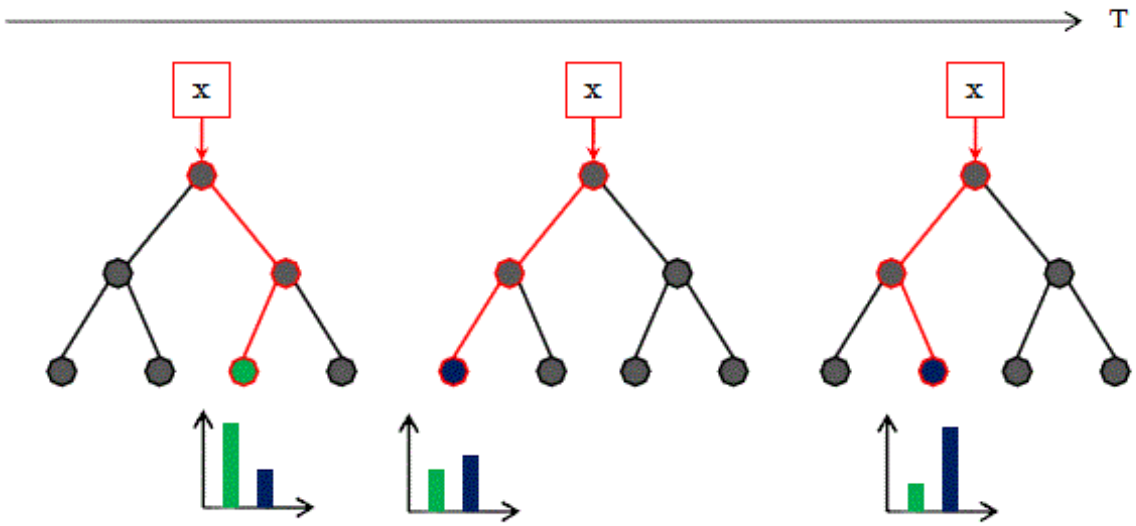
- Machine-learning based approach
  - Classification (Decision Forest) with subsequent spatial regularization (CRF)





Methodology

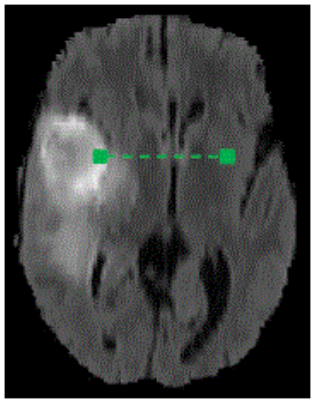
- Decision Forest
  - Idea: Aggregate decision trees to improve predictive erformance
  - Output: Average posterior probability over all trees



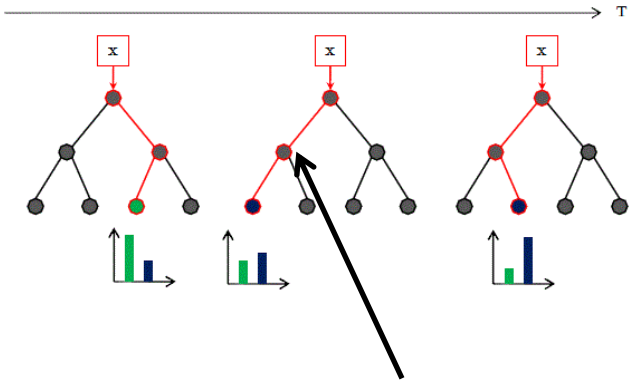
$$p(y|\mathbf{x}) = \frac{1}{T}\sum_{t=1}^{T} p_t(y|\mathbf{x})$$

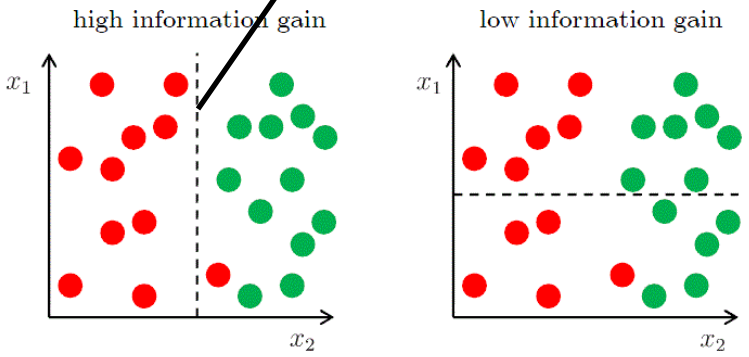
Features

- Appearance-sensitive features
  - Multimodal intensity and intensity differences
  - First-order texture features
  - Gradient textures
  - Multiscale representation
- Context-sensitive features
  - Atlas-normalized coordinates
  - Multi- and monomodal ray features
  - Symmetry features
- 237-dim. feature vector



Feature Importance





Depth	Tumor vs. healthy	Healthy tissues	Tumor core
1	I_{FLAIR}	I_{T1}	I_{T1c}
2	I_{T2}	I_{T1c}	$I_{T1} - I_{T2}$
3	$I_{T1} - I_{FLAIR}$	I_{T1c}	$I_{T1} - I_{T1c}$
4	I_{T2}	$I_{T1} - I_{T2}$	I_{T2}
5	I_{FLAIR}	I_{T1c}	I_{FLAIR}
6	I_{FLAIR}	I_{T1c}	I_{T1c}
7	I_{T1c}	I_{T1c}	I_{FLAIR}
8	I_{T2}	I_{T1c}	I_{T1c}
9	I_{T1c}	I_{T1c}	I_{FLAIR}
10	I_{T1c}	I_{T1c}	I_{T1c}
11	I_{T1c}	I_{T1c}	I_{FLAIR}
12	I_{T1c}	I_{T1c}	I_{T1c}
13	I_{T1c}	I_{T1c}	I_{T1c}
14	I_{T1c}	I_{T1c}	I_{T2}
15	I_{T2}	I_{T1c}	I_{T1c}
16	I_{T2}	I_{T1c}	I_{T2}
17	I_{T2}	I_{T1c}	I_{T1c}
18	I_{T2}	I_{T1c}	I_{T1c}

Feature Importance

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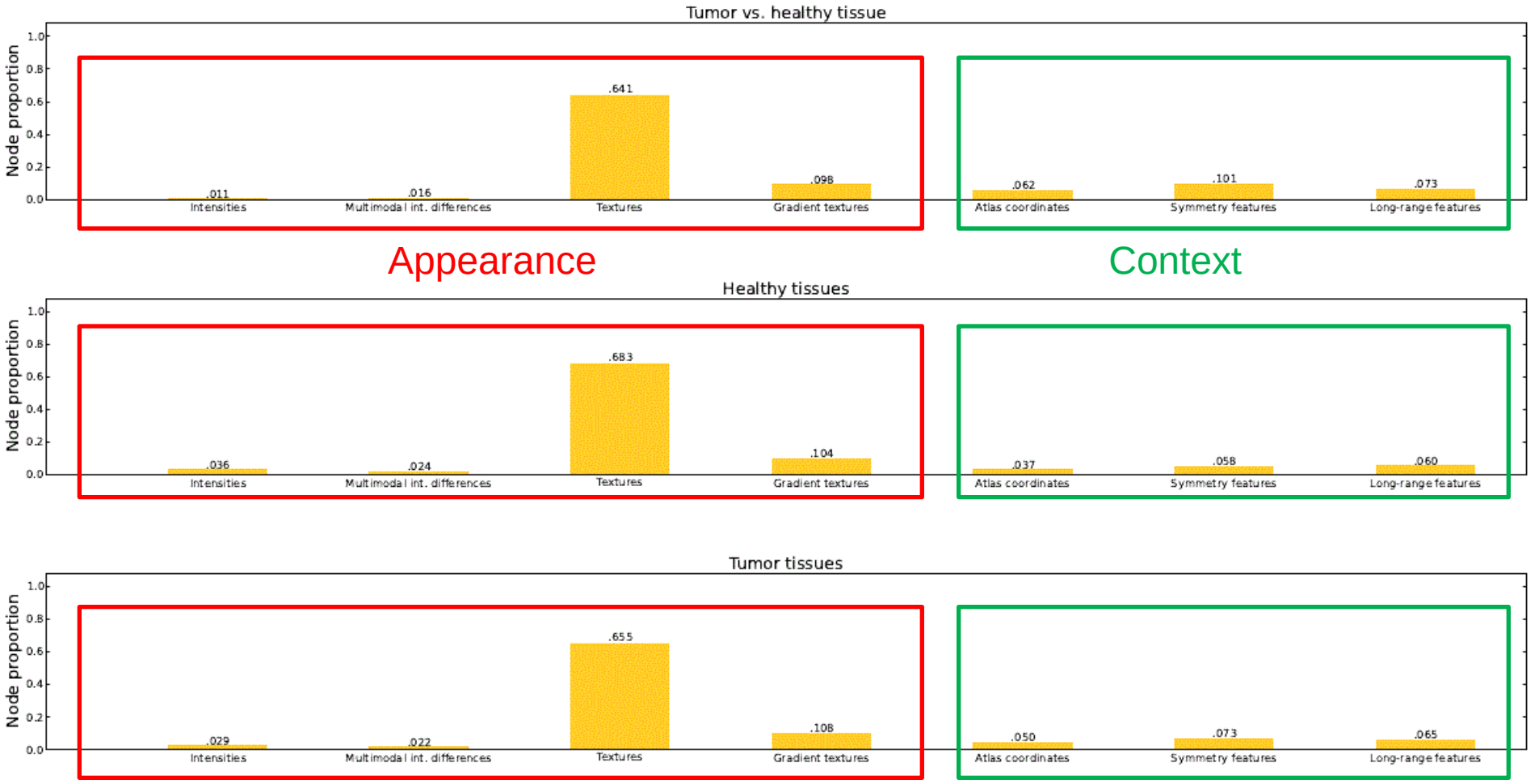
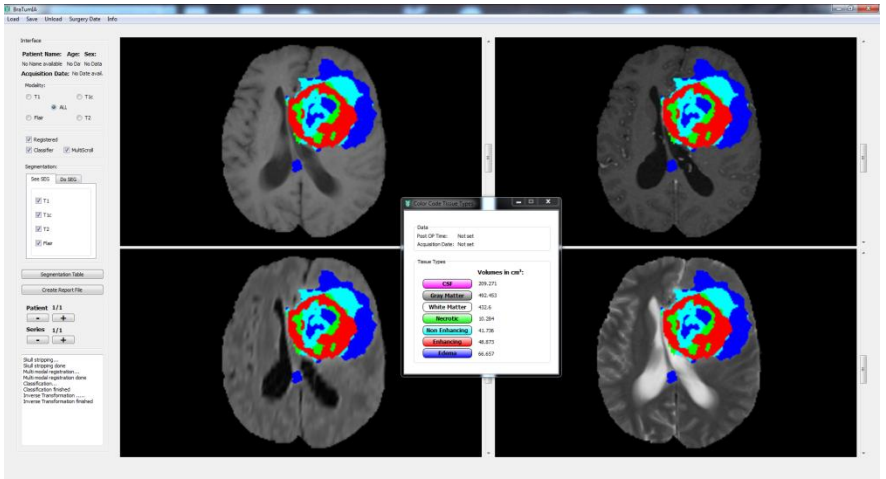


BraTumIA

- Clinical tool with GUI for fully automatic brain tumor segmentation
- Pipeline
  - Skull-stripping
  - Multi-modal registration
  - Tumor tissue segmentation
    - VASARI
- Output: Segmentation label images and quantitative volumes



BraTumIA

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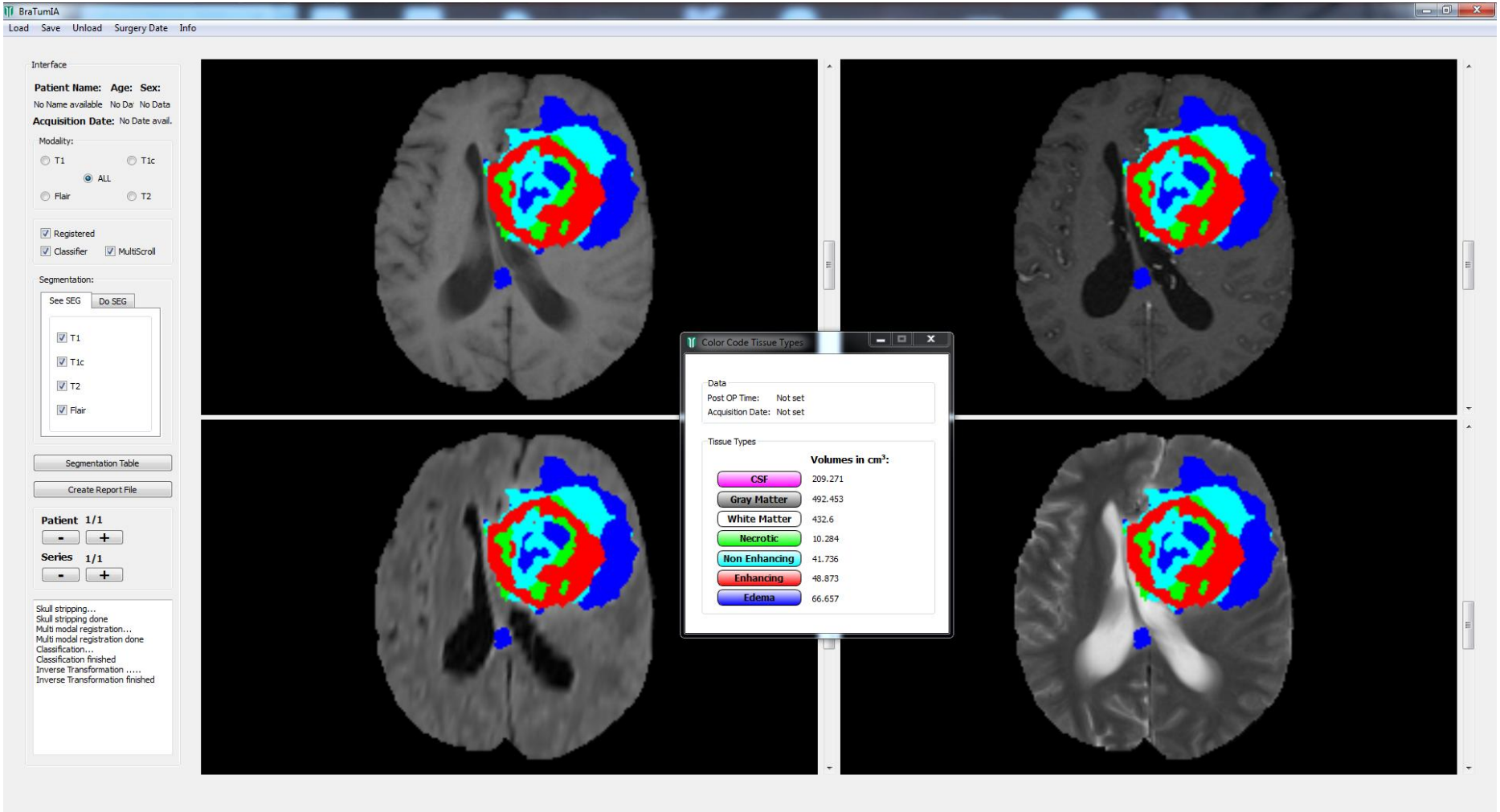

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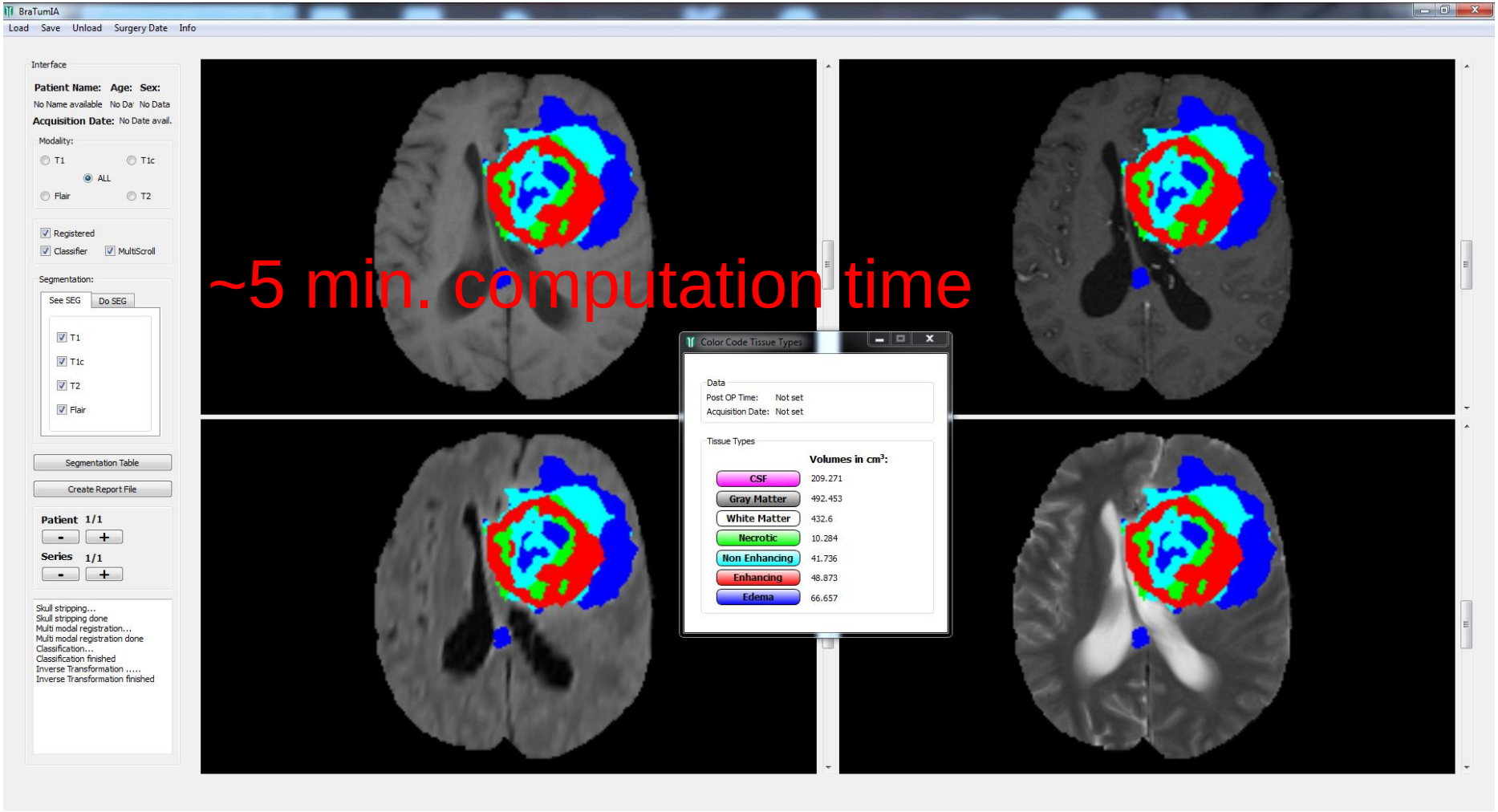
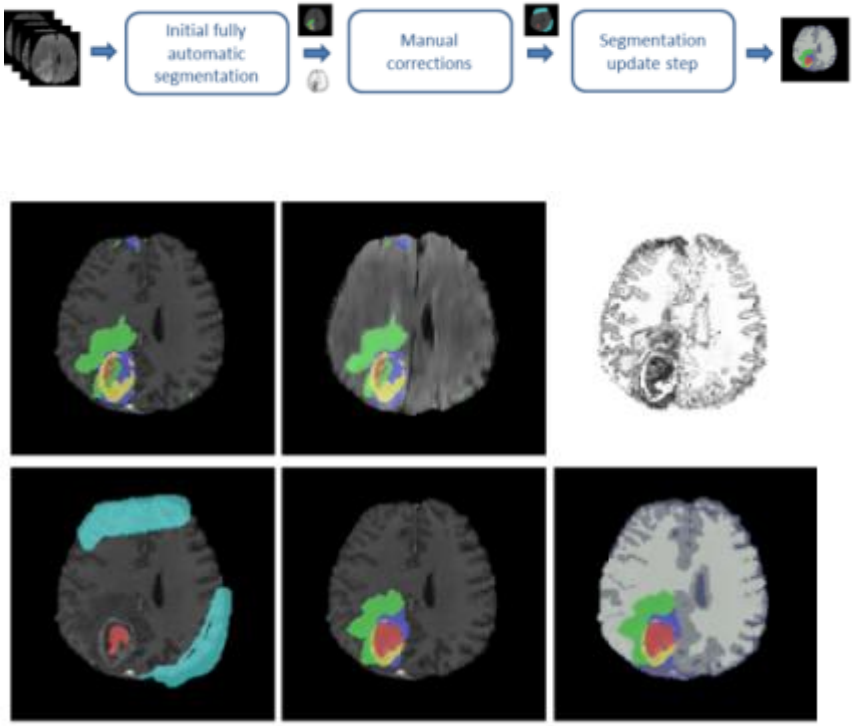


Future directions

- Interactive segmentation
- Postoperative image segmentation
  - Extend model to cope with postoperative images
- Segmentation of longitudinal MRI studies
  - Exploiting information from advanced MRI



Bauer et al., IEEE ISBI, 2014