Effective User Guidance in Online Interactive Semantic Segmentation

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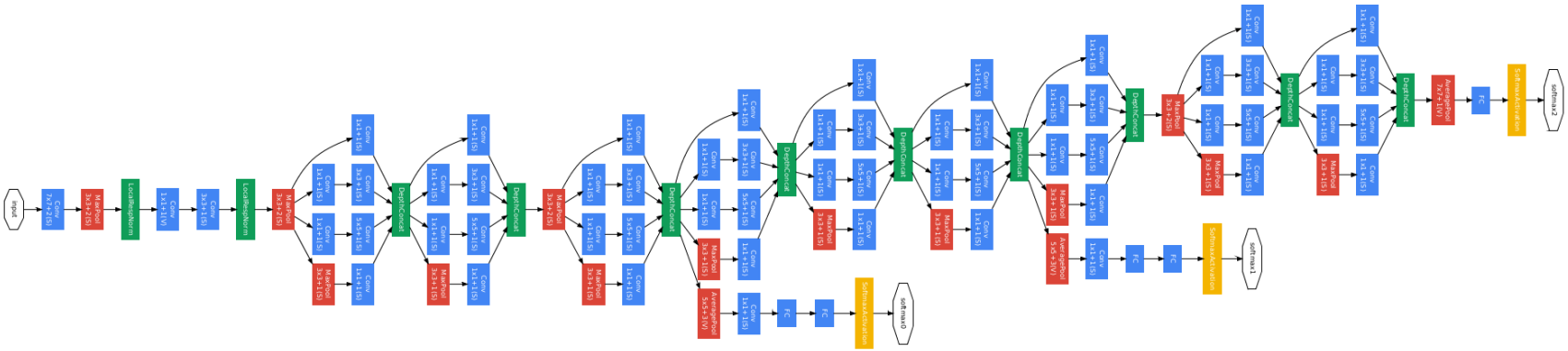
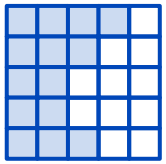
Why Interactive Segmentation?



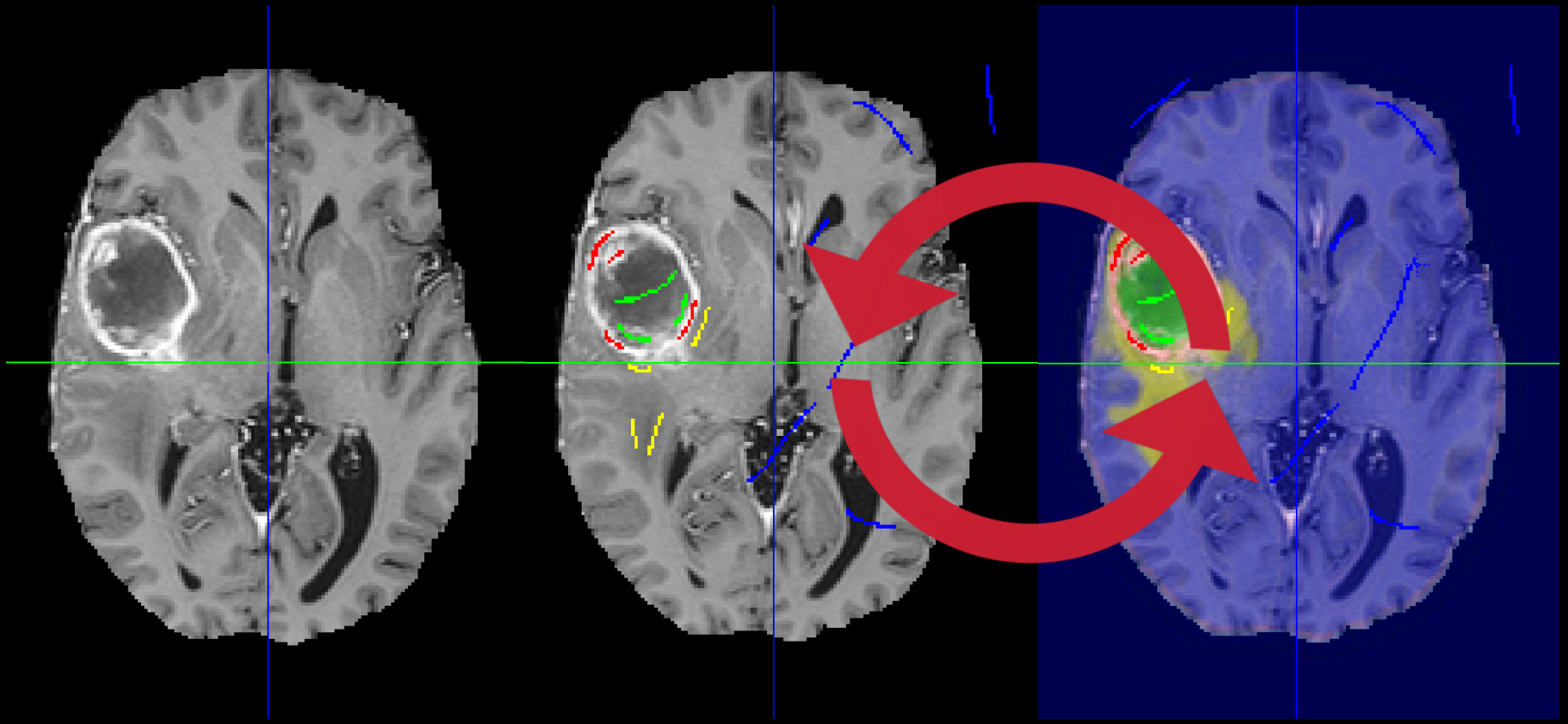
Types of Interactive Segmentation

- Contours
  - Intelligent Scissors / Live-wire / Snakes

- Seeded methods
  - Growing from seed point / region
  - Shrinking from bounding box



- Classifier-based
  - Predict pixels/superpixels
  - Good for multi-class problems → **Glioblastoma MRI**
  - Class probabilities



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Guiding Question

What types of user interactions yield the best results with as little effort as possible?

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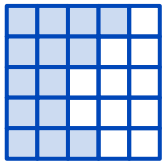


- Classifier-based → **Random Forest**
  - Good for multi-class problems
  - Class probabilities → **Uncertainty (Probability Entropy)**

Simulated User Interactions

- **UNCERTAIN**
  Annotate where classifier uncertainty is highest

10px

- **MISCLASS**
  Randomly correct classifier
- **MISCLASS-B**
  Randomly correct classifier, balancing inputs across classes
- **UNCERTAIN-MB**
  Randomly correct classifier where it is most uncertain, balancing classes
- **CERTAIN-MB**
  Randomly correct classifier where it is most certain, balancing classes

Details

Data

- BraTS 2013
- T1n, T1c, T2, FLAIR, T1c – T1
- 20 high grade glioma patients
- N3 bias-field correction (not FLAIR)
- Histogram matching
- Normalization by CSF mean

Random Forest

- 50 trees
- 10 maximum depth
- Gini impurity splits

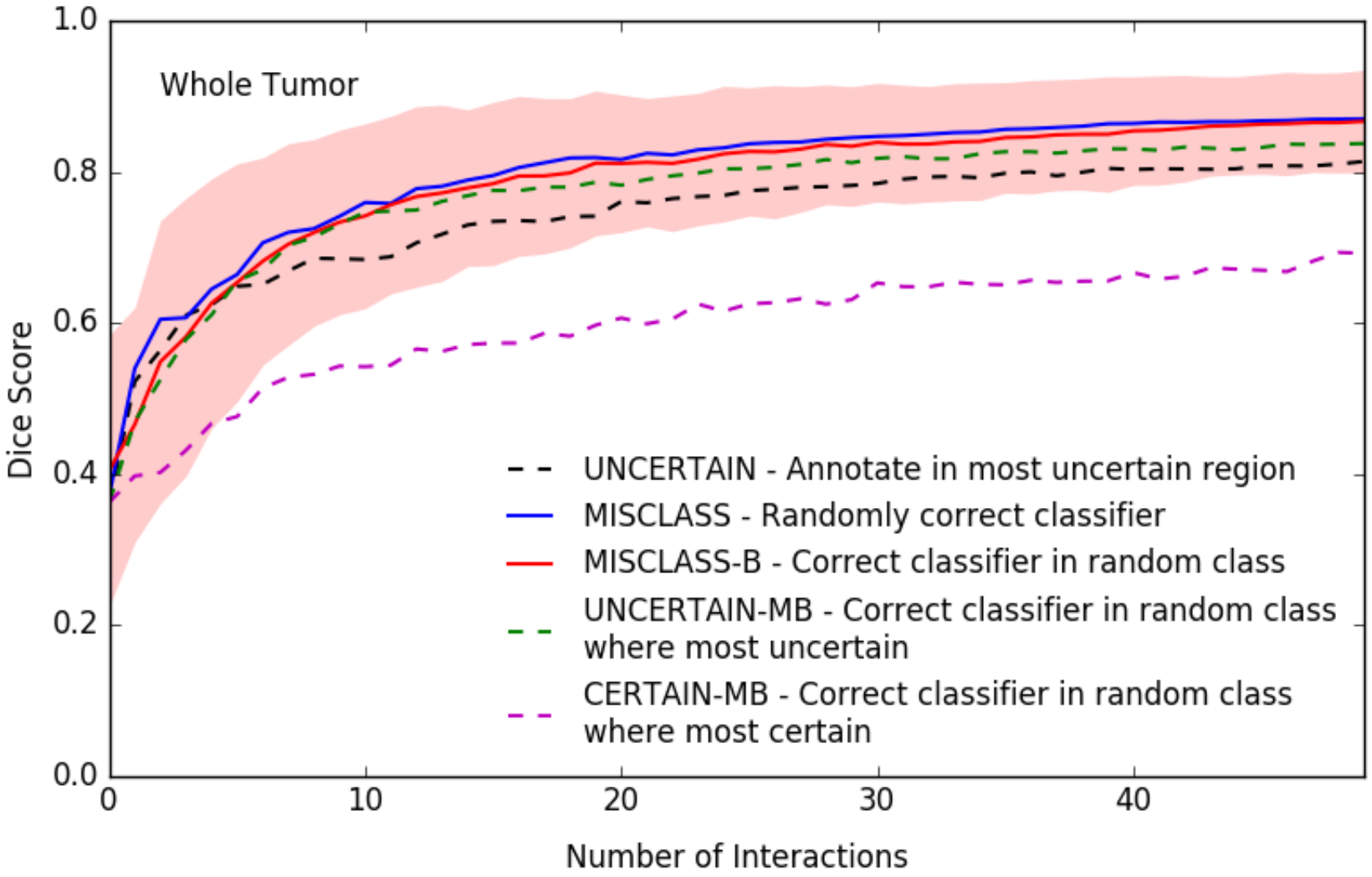
Image Features

- Gaussian Smoothing
- Gaussian Gradient Magnitude
- Laplacian of Gaussian
- Hessian of Gaussian Eigenvalues
- Structure Tensor Eigenvalues

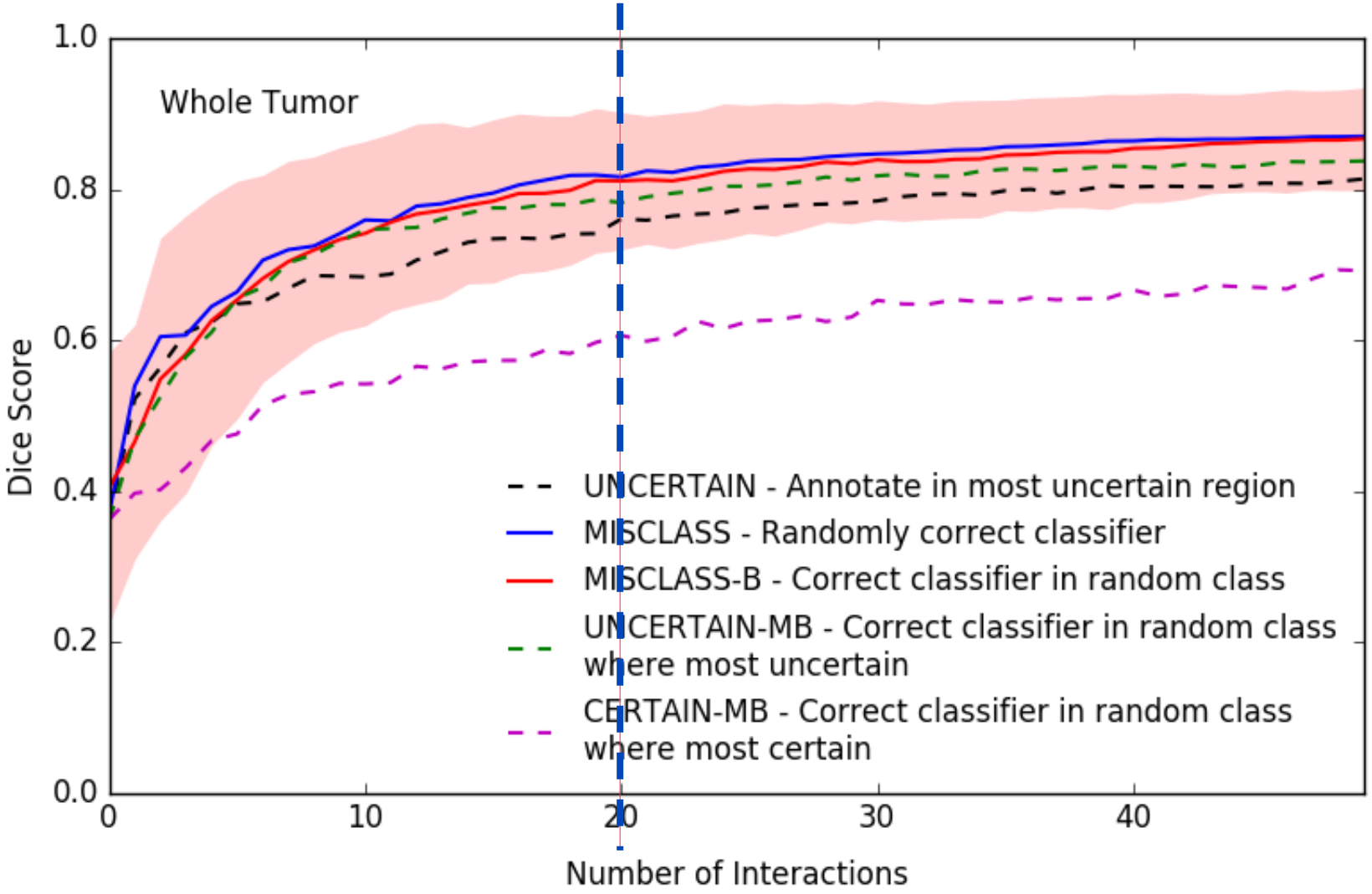
Evaluation

- 5 runs per patient
- Dice coefficient
- Wilcoxon signed-rank test
- Base significance threshold $p < 0.05$
- Bonferroni correction $p < 0.001$

Classifier error more important than classifier uncertainty



Classifier error more important than classifier uncertainty



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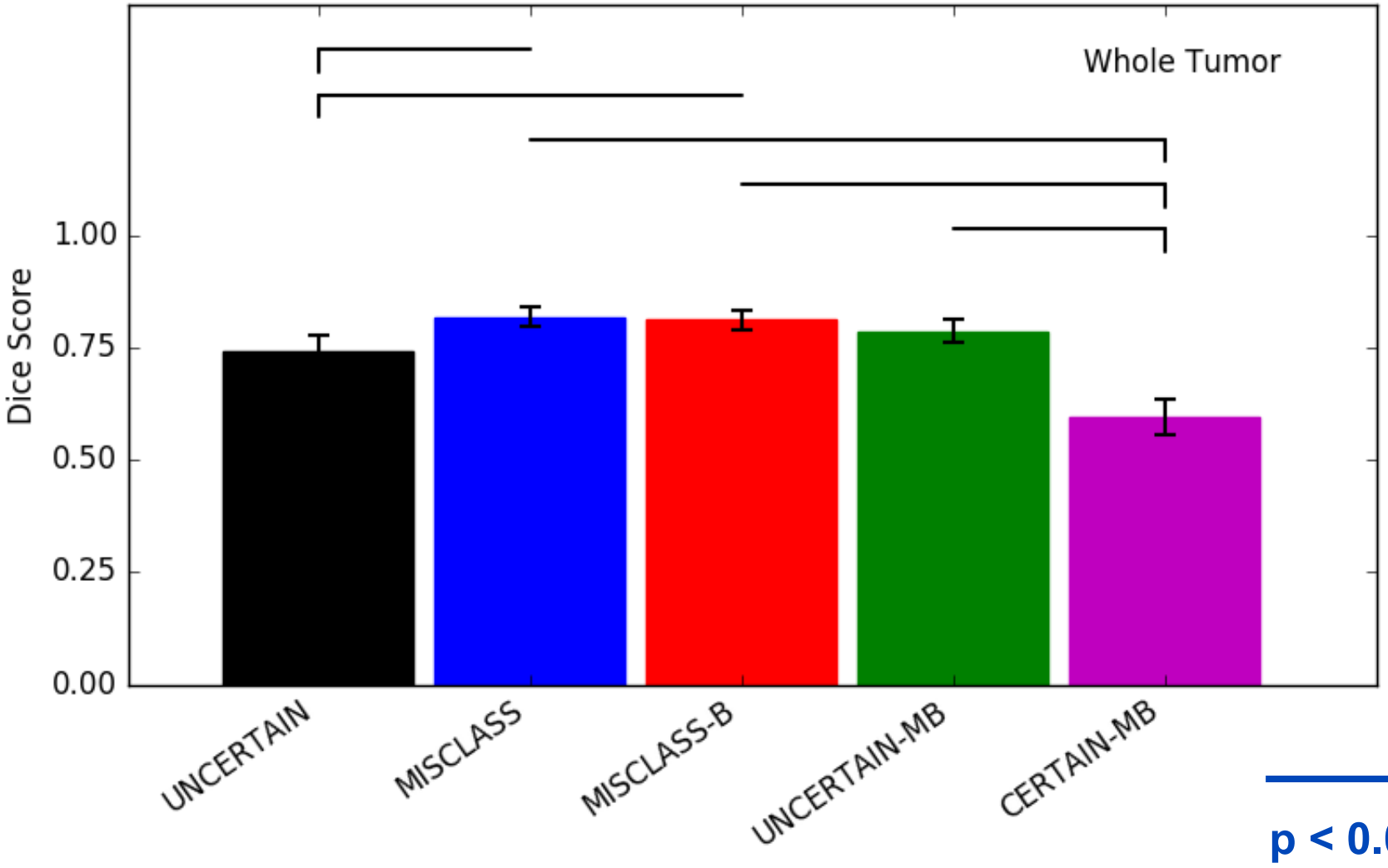
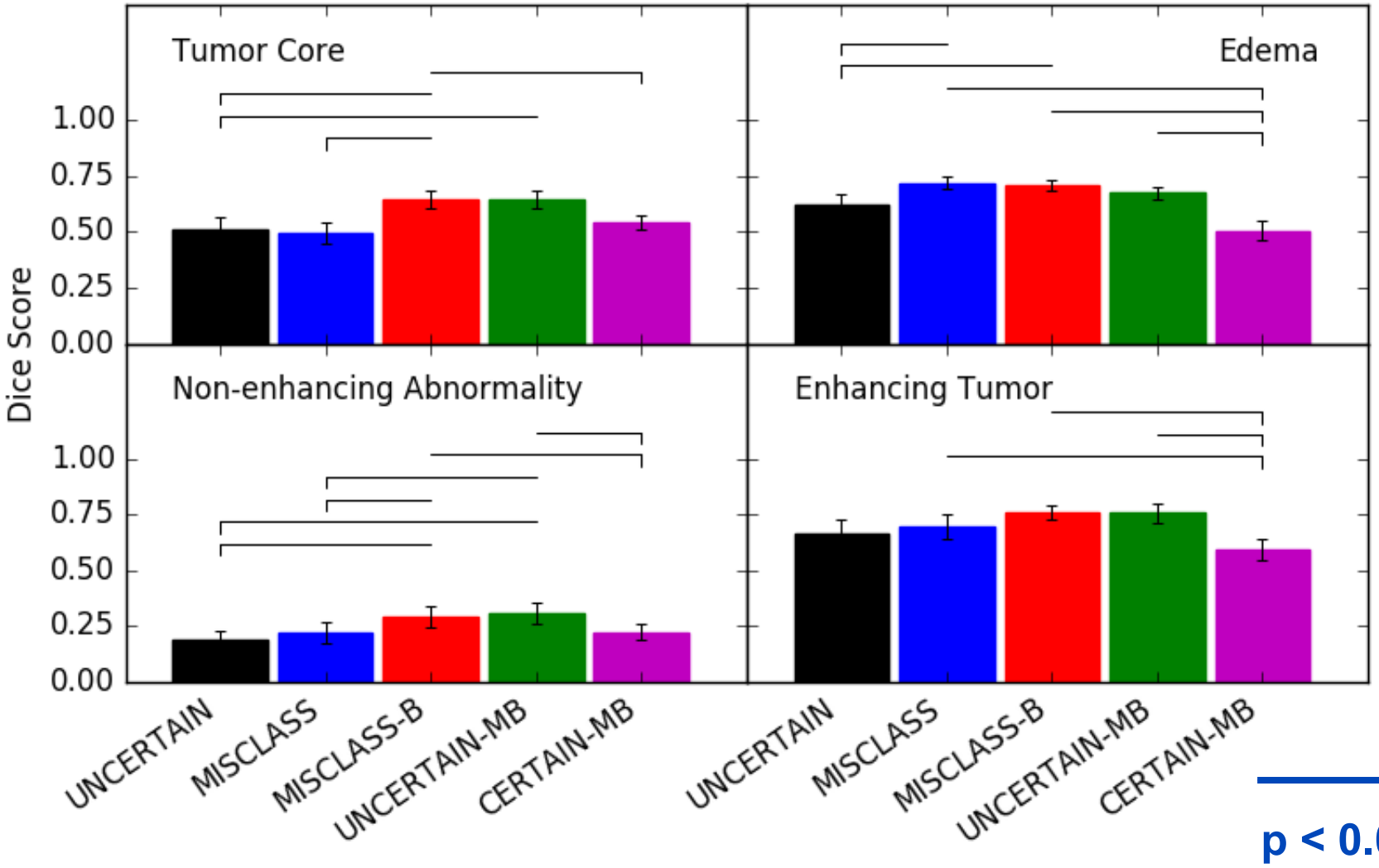


Balance inputs if class imbalance is large



Summary & Discussion

- Better to annotate where classifier is wrong than where it is uncertain
- Balance inputs across classes
- No added value when combining corrections with uncertainty information
- Assumes user knows groundtruth
- Not Bayesian uncertainty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Thank you
for your attention!