CBEB 2024
XXIX CONGRESSO BRASILEIRO DE ENGENHARIA BIOMÉDICA

Deep Learning for Medical Image Analysis: tips, tricks and traps

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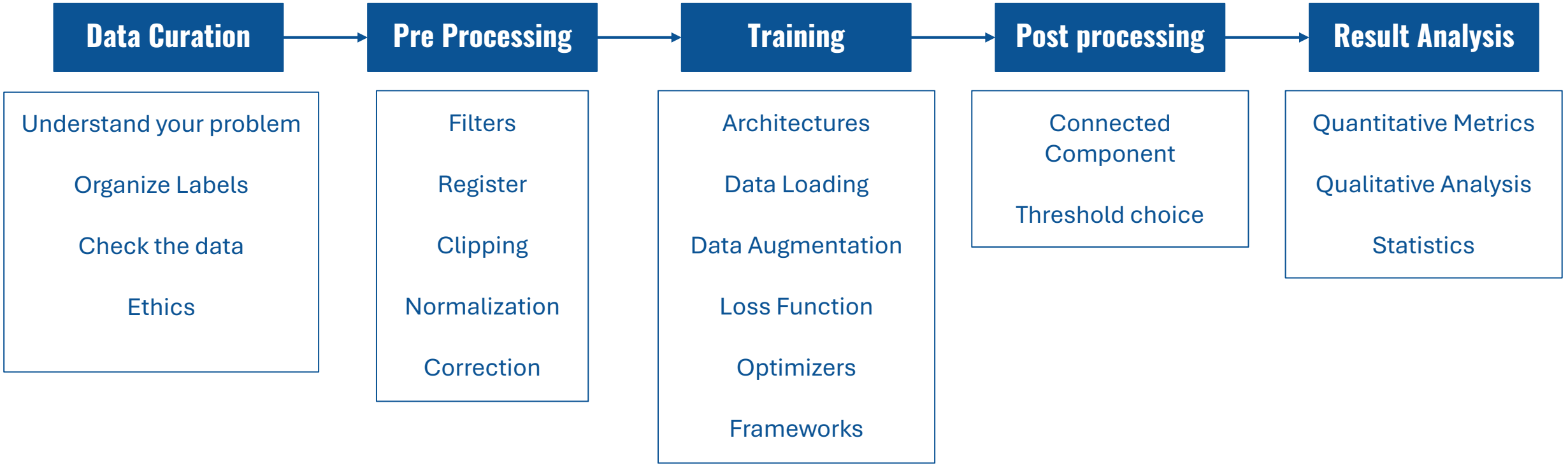
Pipeline típico de análise



Pipeline típico de análise

Análise Quantitativa

Análise Qualitativa

Análise Estatistica

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Análise quantitativa: que métrica escolher?

$$Dice\ Coefficient = \frac{2 * TP}{FN + (2 * TP) + FP}$$

$$Jaccard\ Index = \frac{TP}{TP + FN + FP}$$

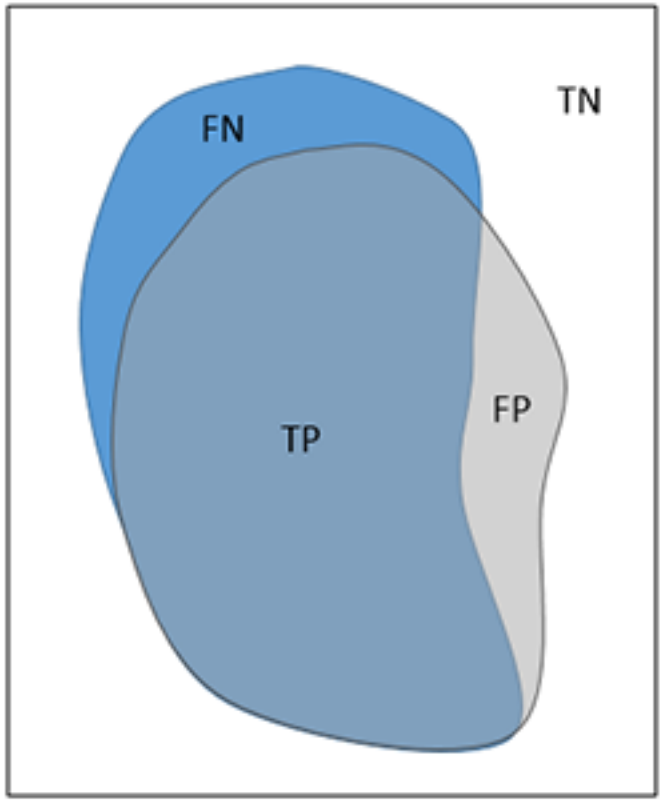
$$Sensitivity = \frac{TP}{TP + FN}$$

$$Precision = \frac{TP}{TP + FP}$$

TP - true positive
TN - true negative
FP - false positive
FN - false negative

Manual Segmentation

Automated Segmentation



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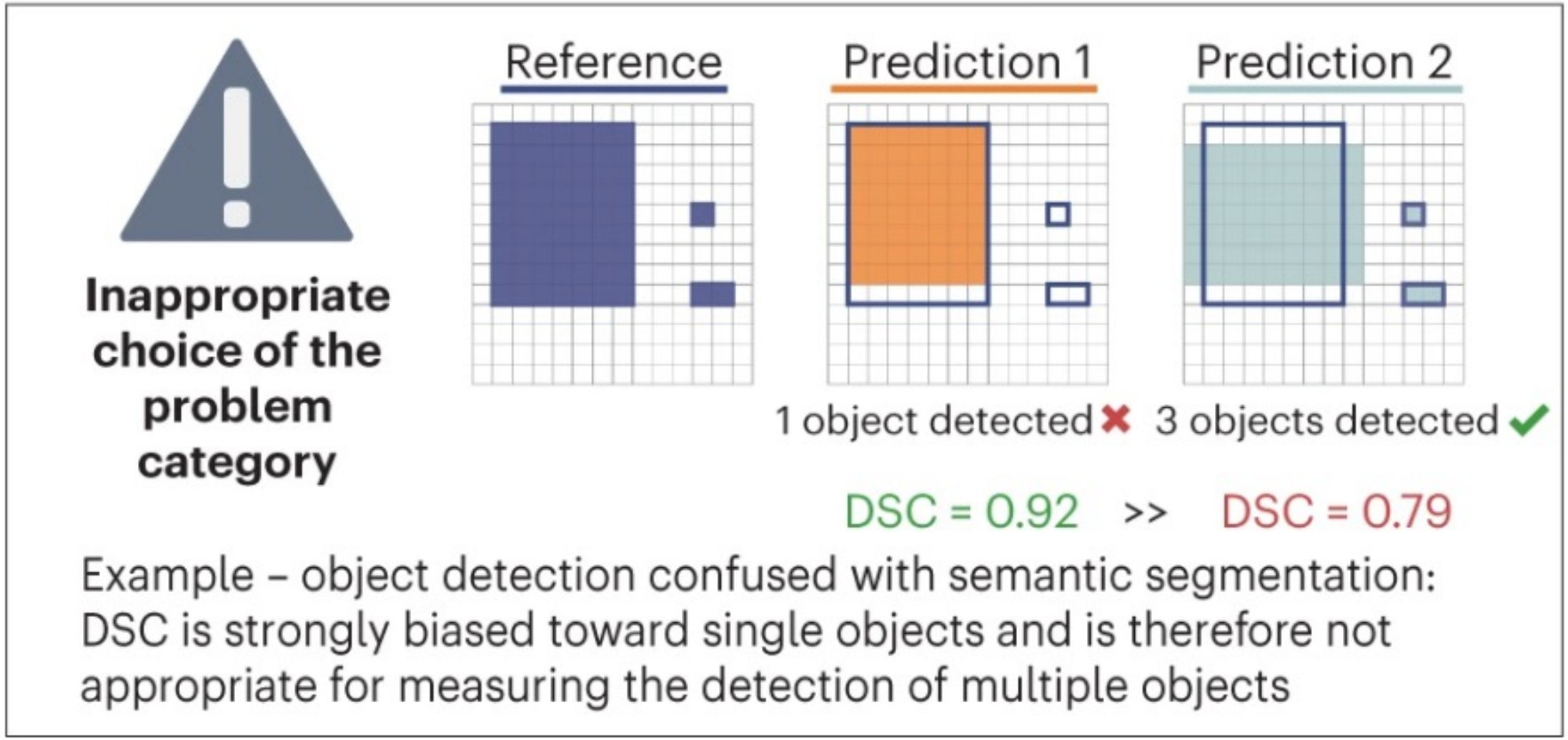

Maier-Hein L. *et al.* Metrics reloaded: recommendations for image analysis validation. *Nat Methods* **21**, 195–212 (2024).

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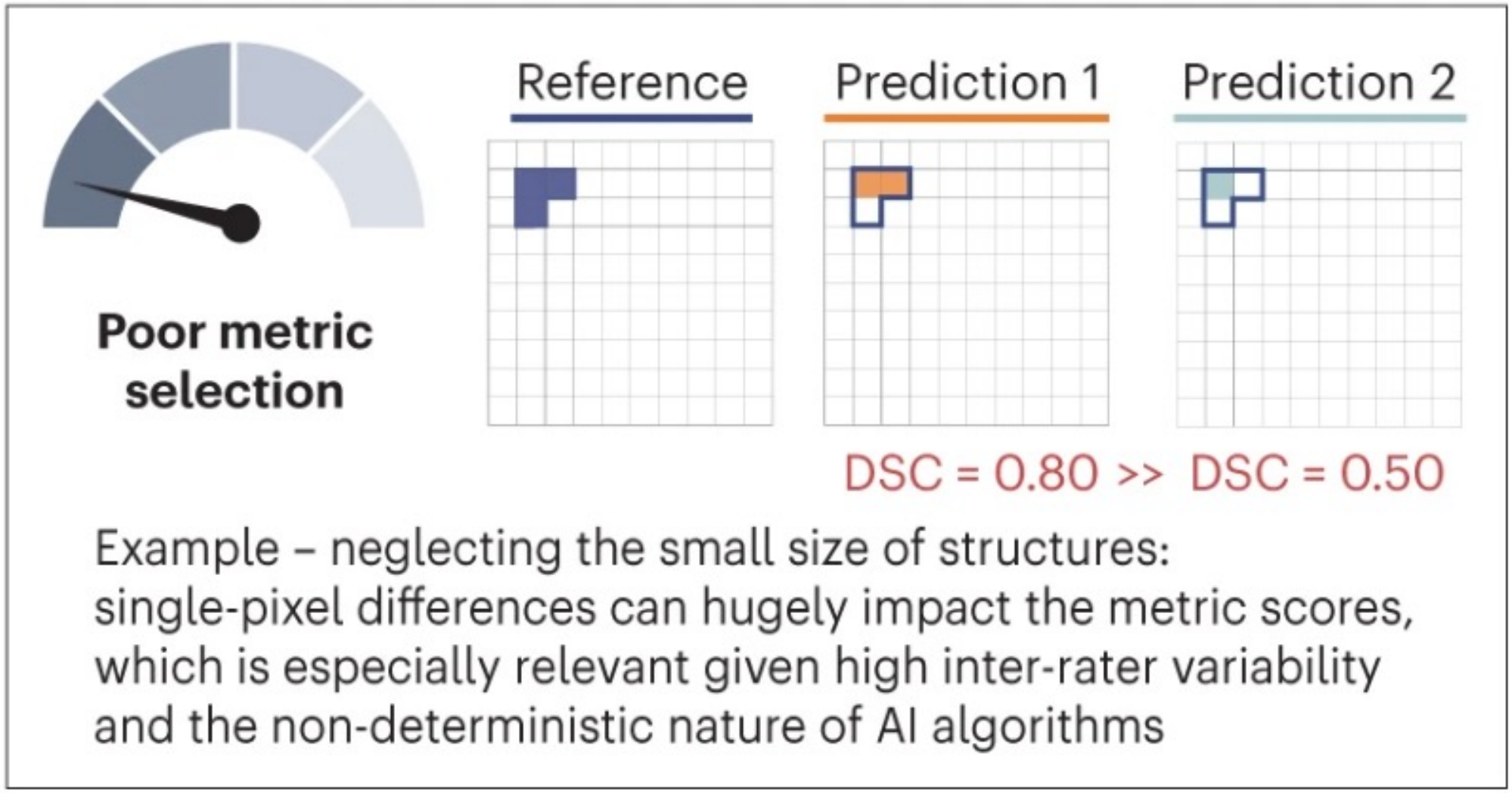

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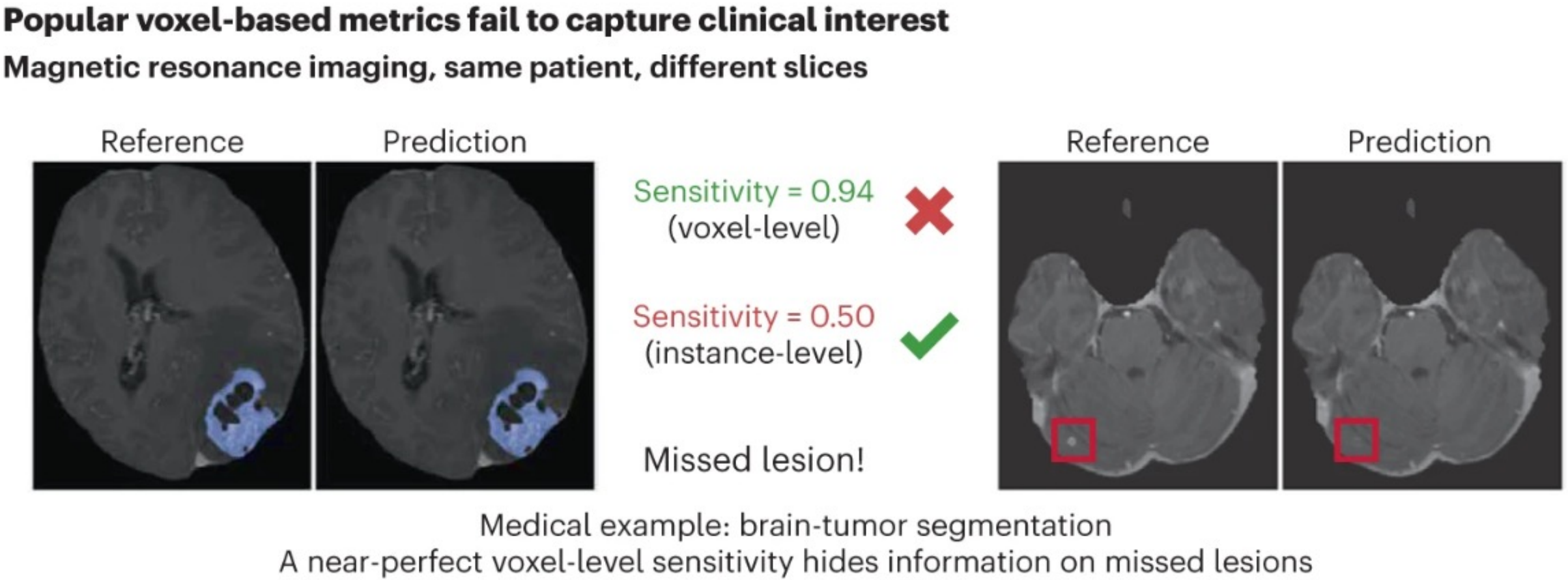
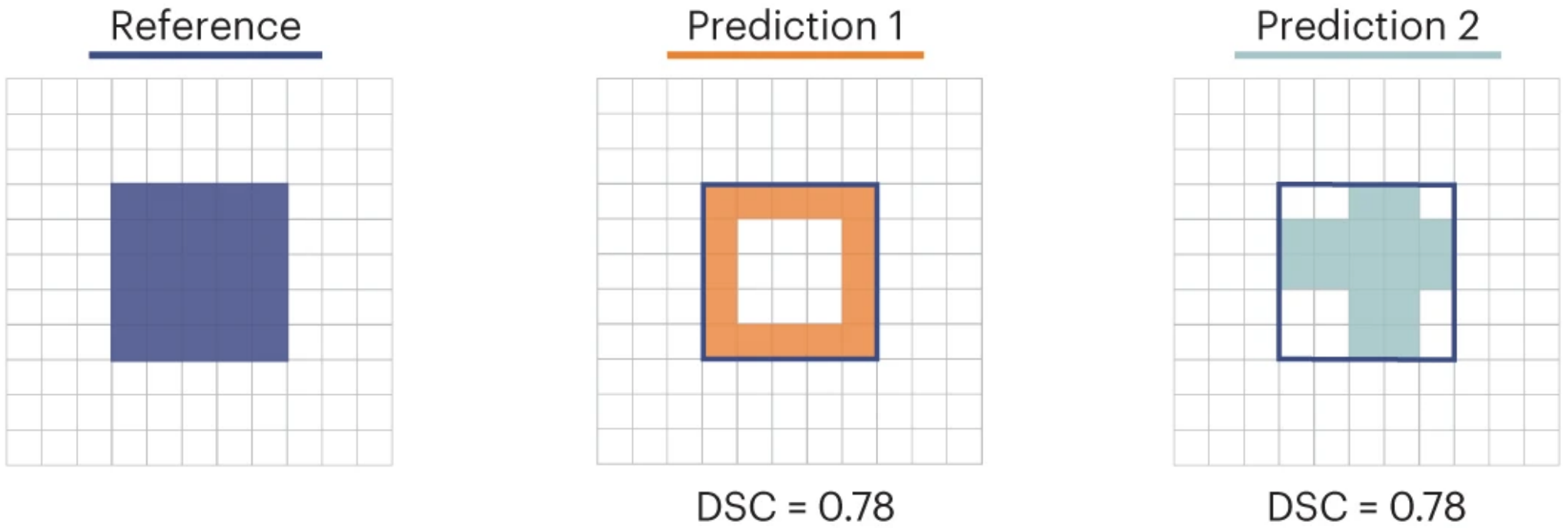


Reinke A. *et al.* Understanding metric-related pitfalls in image analysis validation. *Nat Methods* **21**, 182–194 (2024).

Análise quantitativa: que métrica escolher?



Reinke A. *et al.* Understanding metric-related pitfalls in image analysis validation. *Nat Methods* **21**, 182–194 (2024).

Análise quantitativa: que métrica escolher?

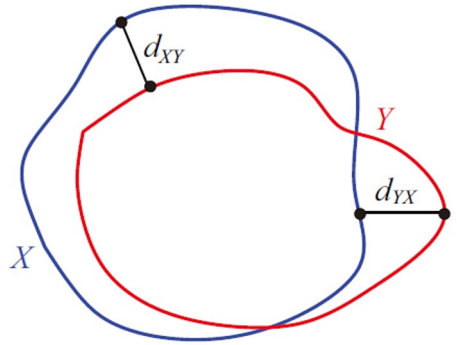
Métricas de segmentação têm vantagens e desvantagens. Sempre use mais de uma métrica, por exemplo, uma de sobreposisção e uma de distância de borda.

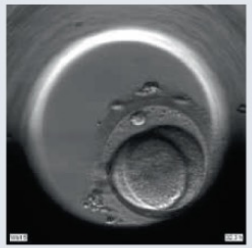
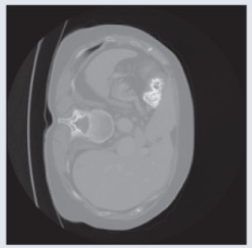
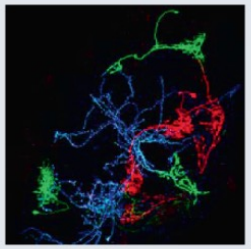
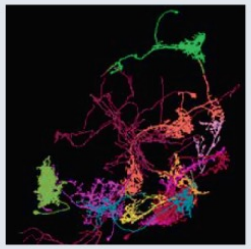
1) Dice Coefficient: The *DC* is an overlap measure defined as follows:

$$DC = \frac{2 * |M \cap A|}{|M| + |A|} \qquad (4)$$

2) *Hausdorff distance:* computa a distância entre os pontos das 2 bordas: a verdadeira e a predita.

Atenção: diferentes tarefas exigem diferentes métricas!



Problem description	ID	Scenario	Sample input image	Recommended ouput	Recommendation
Segmentation of large objects	SemS-1	Embryo segmentation from microscopy images			Problem category: Semantic segmentation Overlap-based metric (S6): Dice similarity coefficient (DSC) Boundary-based metric (S7): Normalized surface distance (NSC) Specific property-related metric: Liver segmentation: absolute volume difference
	SemS-2	Liver segmentation in CT images			
Segmentation and distinction of tubular objects	InS-1	Instance segmentation of neurons from the fruit fly in 3D multicolor light microscopy images			Problem category: Instance segmentation Per-class counting metric (S3): F_β score Multi-threshold metric (S4): average precision (AP) Overlap-based metric (S6): Centerline Dice similarity coefficient (clDice) Boundary-based metric (S7): NSD Localization criterion (S8): Neuron segmentation: mask IoU Instrument segmentation: boundary IoU Assignment strategy (S9): Greedy (by score) matching, set double assignments to FPs
	InS-2	Surgical instrument instance segmentation in colonoscopy videos			

Maier-Hein L. *et al.* Metrics reloaded: recommendations for image analysis validation. *Nat Methods* **21**, 195–212 (2024).

GETTING STARTED

Metric Selection

Duration 5-10min.

This module is designed to determine proper metrics for your study. Then the questions regarding to your study will begin.

Please select your problem category to start:

- **Semantic Segmentation**
- **Instance Segmentation**
- **Object Detection**
- **Image-level Classification**

Unsure which problem category you are at? Please follow the Problem Category Selection process first.

Merel Huisman, MD, PhD • 2nd
Radiologist | Clinical Epidemiologist AI
2mo •

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"A Single Metric is No Metric"

It's time to rethink how we evaluate AI tools in medical imaging. While AUC-ROC and accuracy are intuitive, they often fail to tell the whole story, especially in imbalanced datasets. It really pays off to do your due diligence and understand this matter. Relying solely on these metrics can be misleading and even harmful in clinical settings.

Mosquera et al. recognized this issue and published a great educational study in **European Radiology**. I had the honor to write a comment, in which I break down the issue and put it into context.

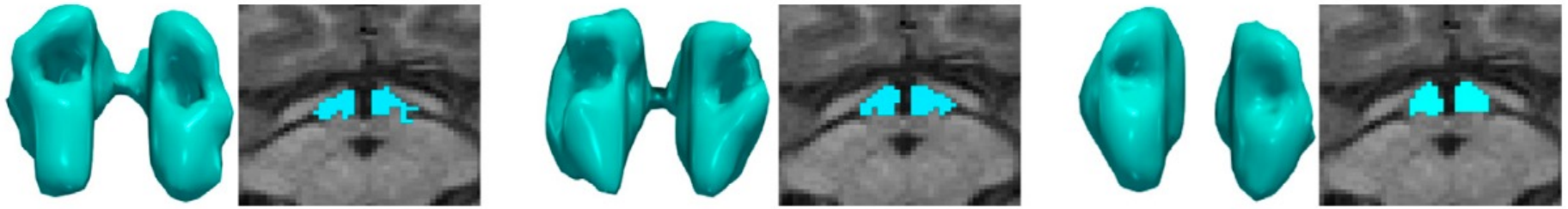
If you remember one thing, let it be this:

"a small imperfection in specificity gets magnified as a high false positive rate in rarer pathologies"

Análise quantitativa: meu resultado é bom?

- Variabilidade *Inter e intra-rater* também são importantes

Comparative	*DC*	*VS*	*AVD*	Hausdorff
Rater1 *vs* Rater2	0.71±0.04	**0.86±0.09**	0.31±0.04	2.93±0.51
Automated Segmentation *vs* Rater 1	**0.85±0.03**	0.95±0.03	**0.15±0.03**	**1.96±0.50**
Automated Segmentation *vs* Rater 2	0.73±0.04	0.86±0.08	0.27±0.04	2.67±0.66



(a) Rater 1 (b) Rater 2 (c) Automated Segmentation

Rodrigues et al. ***Neuroimage*** **(2022)**

Pipeline típico de análise

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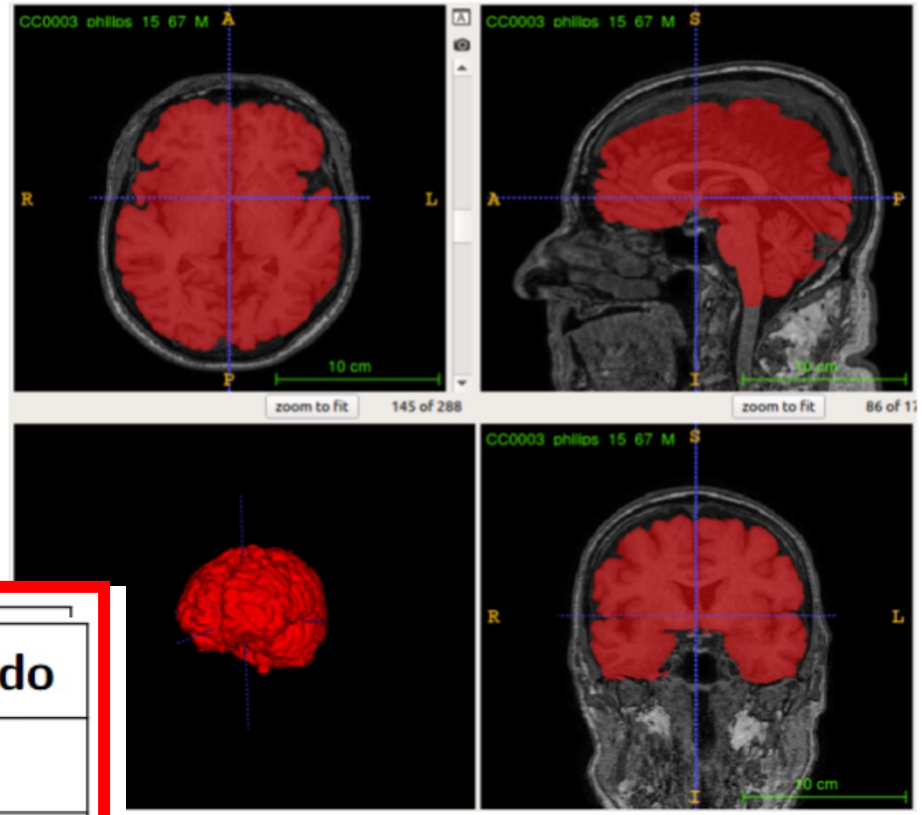
Análise Qualitativa

Análise Estatistica

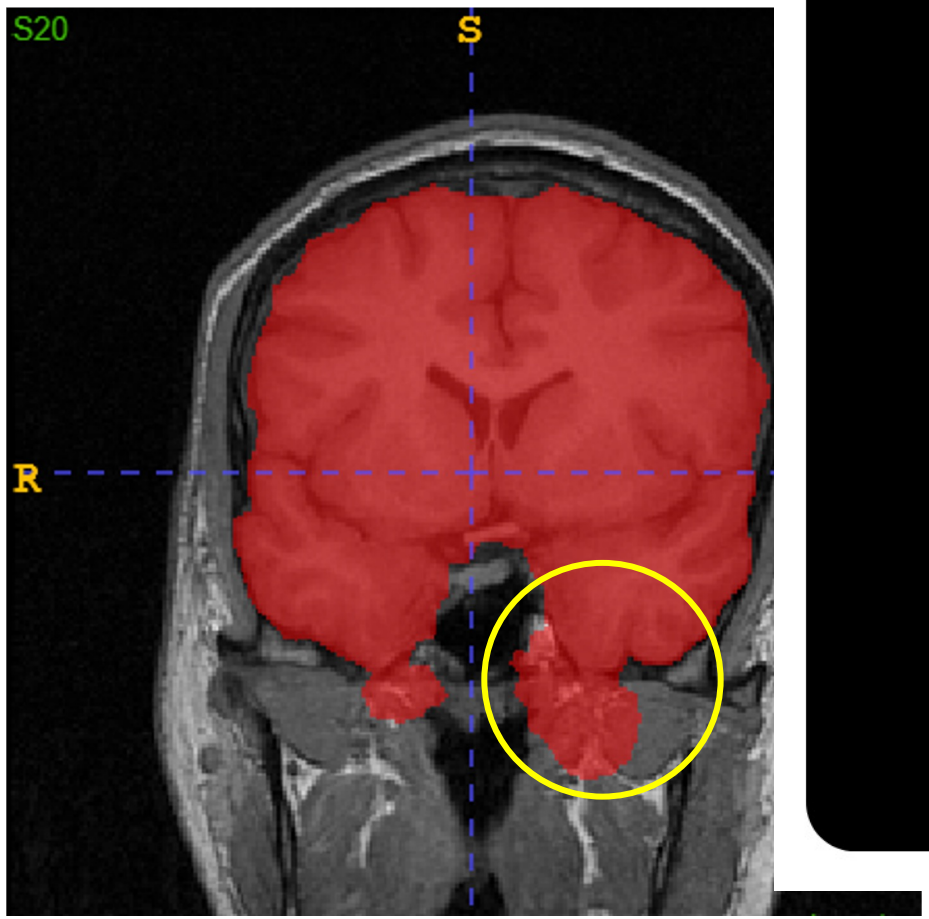
Análise qualitativa

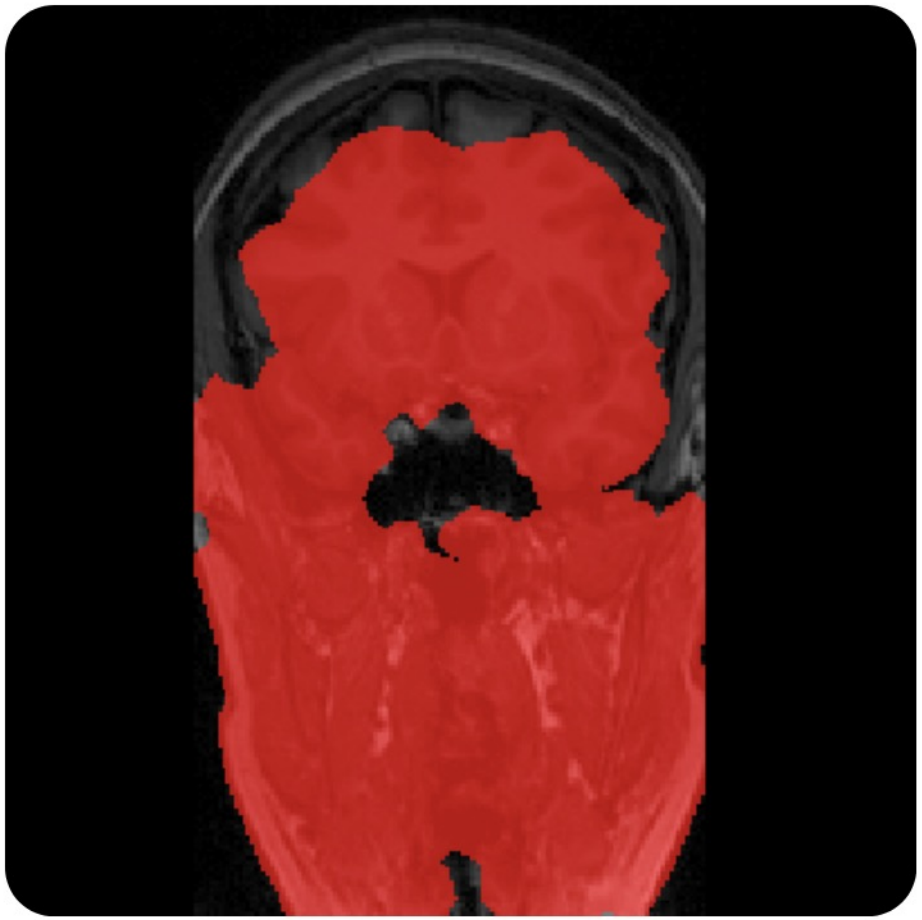


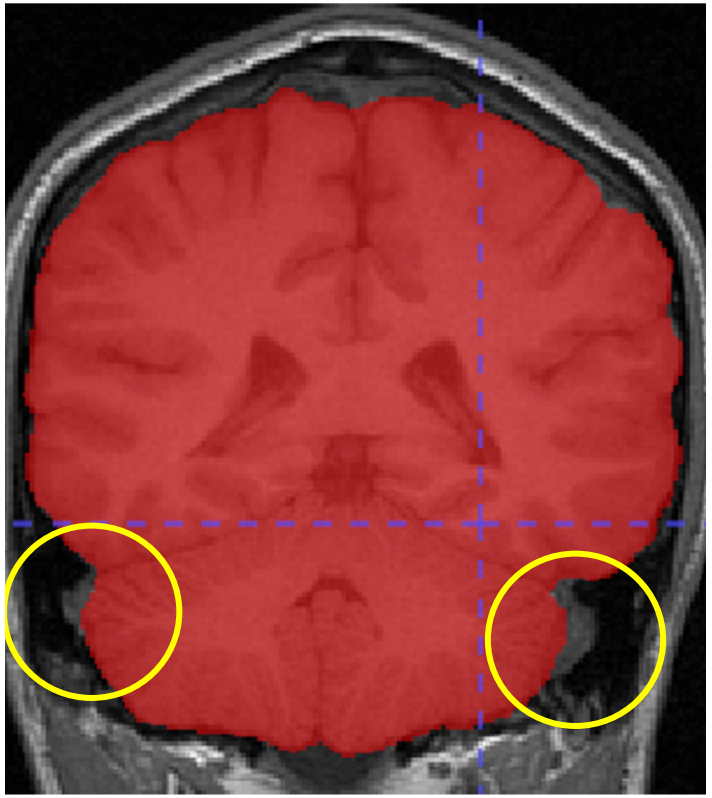
Método	Autor	Ano	Base	Dice Reportado
BET	Smith, S. M.	2002	Atlas	0.95
CONSNET	Lucena et al.	2019	UNet	0.97
HDBET	Isensee et al.	2019	UNet 3D	0.97
PARIETAL	Valverde et al.	2021	UNet 3D	0.97
ROBEX	Iglesias et al.	2011	Híbrido	0.96
SynthStrip	Hoopes et al.	2022	UNet 3D	0.96

Então o problema está resolvido?

Análise qualitativa

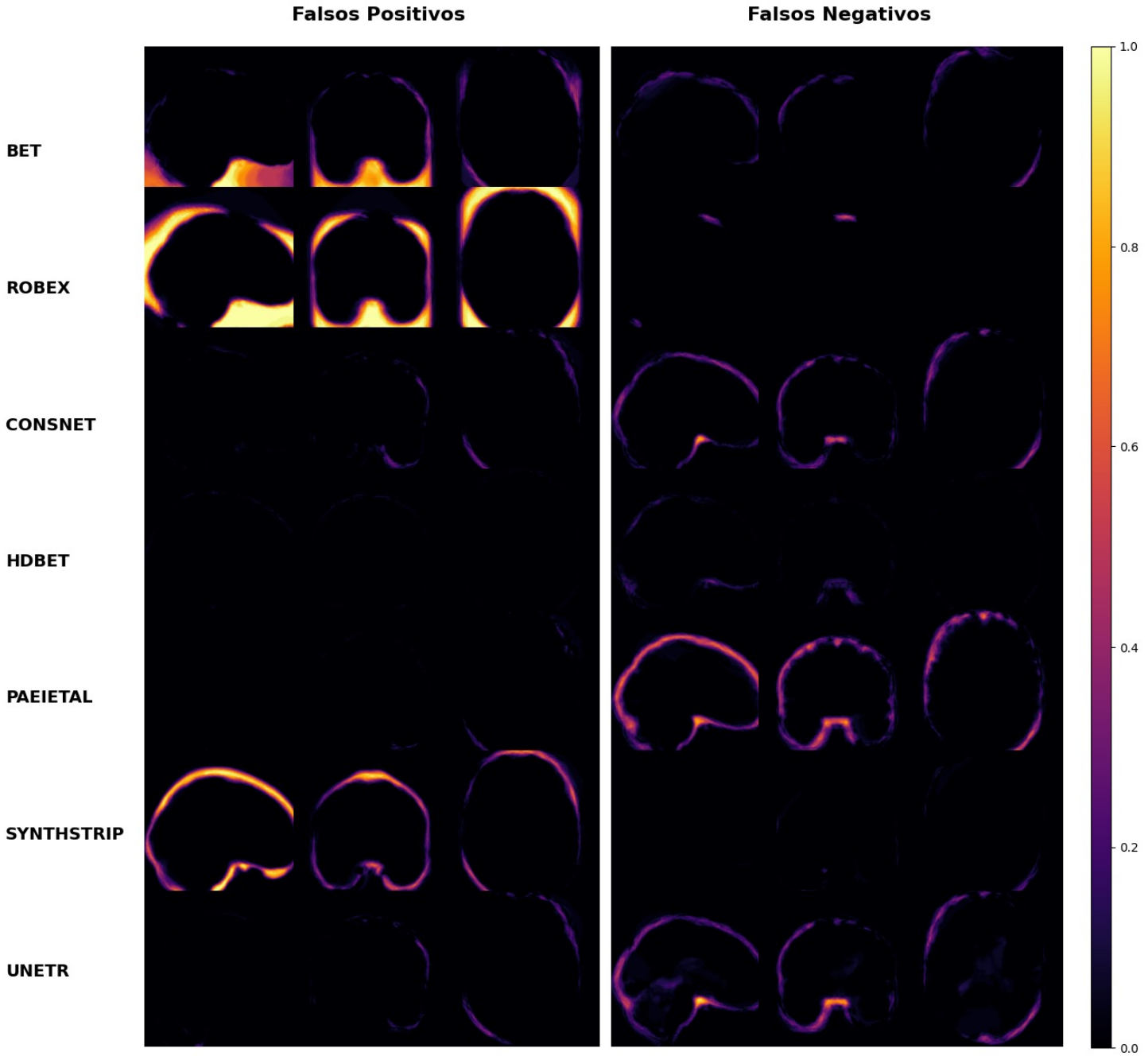






Análise qualitativa

- Números não são usualmente suficientes
- Inspecione os resultados visualmente, especialmente os piores casos
- Você pode também construir mapas de erros



Electrical Engineering and Systems Science > Image and Video Processing

[Submitted on 12 Apr 2023]

Automated computed tomography and magnetic resonance imaging segmentation using deep learning: a beginner's guide

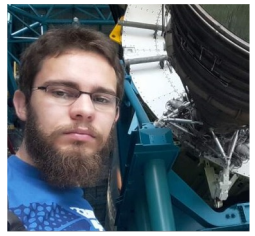
Diedre Carmo, Gustavo Pinheiro, Lívia Rodrigues, Thays Abreu, Roberto Lotufo, Letícia Rittner

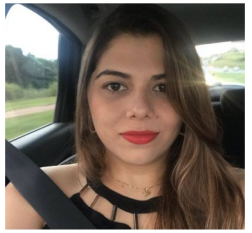
Medical image segmentation is an increasingly popular area of research in medical imaging processing and analysis. However, many researchers who are new to the field struggle with basic concepts. This tutorial paper aims to provide an overview of the fundamental concepts of medical imaging, with a focus on Magnetic Resonance and Computerized Tomography. We will also discuss deep learning algorithms, tools, and frameworks used for segmentation tasks, and suggest best practices for method development and image analysis. Our tutorial includes sample tasks using public data, and accompanying code is available on GitHub (this https URL). By sharing our insights gained from years of experience in the field and learning from relevant literature, we hope to assist researchers in overcoming the initial challenges they may encounter in this exciting and important area of research.

Comments: Equal contribution from Diedre Carmo, Gustavo Pinheiro, and Lívia Rodrigues

[1] Carmo, D., Pinheiro, G., Rodrigues, L., Abreu, T., Lotufo, R., & Rittner, L. (2023). Automated computed tomography and magnetic resonance imaging segmentation using deep learning: a beginner's guide. *arXiv preprint arXiv:2304.05901*.








Medical Image Computing Lab - MICLab Unicamp

The lab was created under the leadership of Roberto Lotufo and Letícia Rittner to be a focal point for the majority of the students under their supervision

20 followers · University of Campinas · https://miclab.fee.unicamp.br

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Popular repositories

e2dhipseg — Public

This contains official implementation for Extended 2D Volumetric Consensus Hippocampus Segmentation

Python ☆ 20 6

CONSNet — Public

CONSNet: Convolutional Neural Networks for Skull-stripping in Brain MR Imaging using Consensus-based Silver Standard Masks

Python ☆ 17 4

ia636 — Public

Python Toolbox for Teaching Image Processing

Python ☆ 14 38

medseg — Public

Official repository for reproducing COVID and Lung segmentation prediction (old version of MEDPSeg)

Python ☆ 10 3

medpseg — Public

MEDPSeg: Official implementation of Modified EfficientDet for Pulmonary Polymorphic Segmentation

Python ☆ 9 4

inCCsight — Public

Python/Dash/Plotly implementation of a data exploration platform for corpus callosum data in DTI

Python ☆ 5 2

People

Top languages

Python · Jupyter Notebook

https://github.com/MICLab-Unicamp

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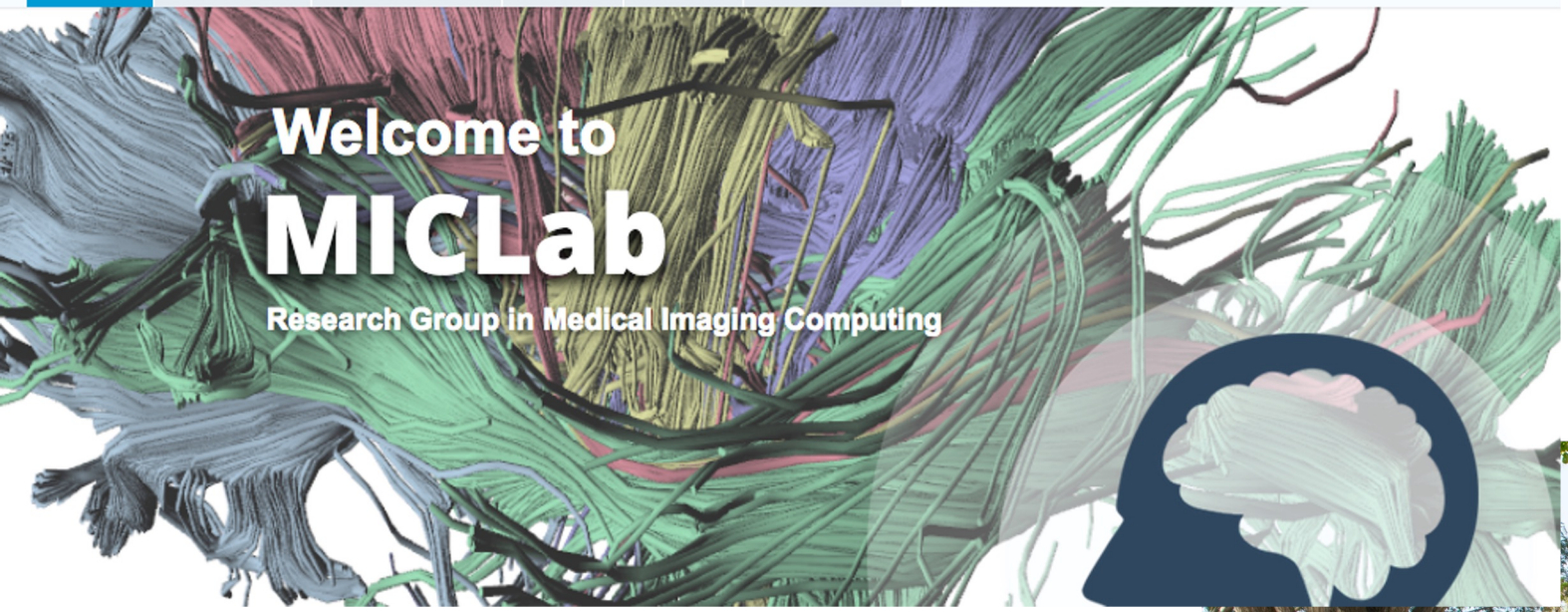

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BRAIN – Brazilian Institute of Neuroscience and Neurotechnology

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