DIE PROJECT

XRAI PIPELINE – THE CREATION OF A CONDITIONALLY ADAPTIVE LOSS FUNCTION FOR USE IN MEDICAL SEGMENTATION TASKS

GROUP-1

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AGENDA

01 AI in Medical Field

02 Data and problems

03 Existing Loss Functions

04 Proposed Solution

05 Our Approach

06 Conclusion

AI IN THE MEDICAL FIELD

Medical Imaging

- AI IN RADIOLOGY
- IMAGE ANALYSIS

Drug Discovery

- DRUG DISCOVERY
- OPTIMIZE CLINICAL TRIAL

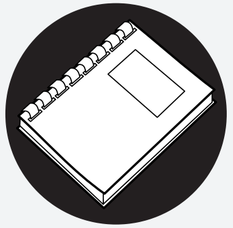
Robotic Surgery

- SURGICAL ROBOTS
- REAL-TIME DECISION SUPPORT

Predictive Analytics

- DISEASE PREDICTION
- POPULATION HEALTH MANAGEMENT

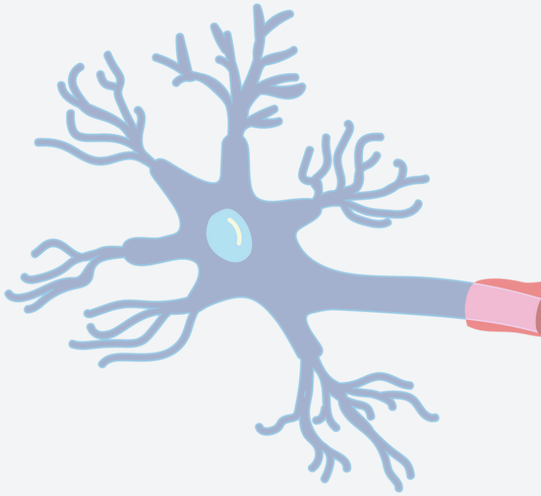
SEGMENTATION OF MEDICAL IMAGES



Manual Segmentation

Semi-automated Segmentation

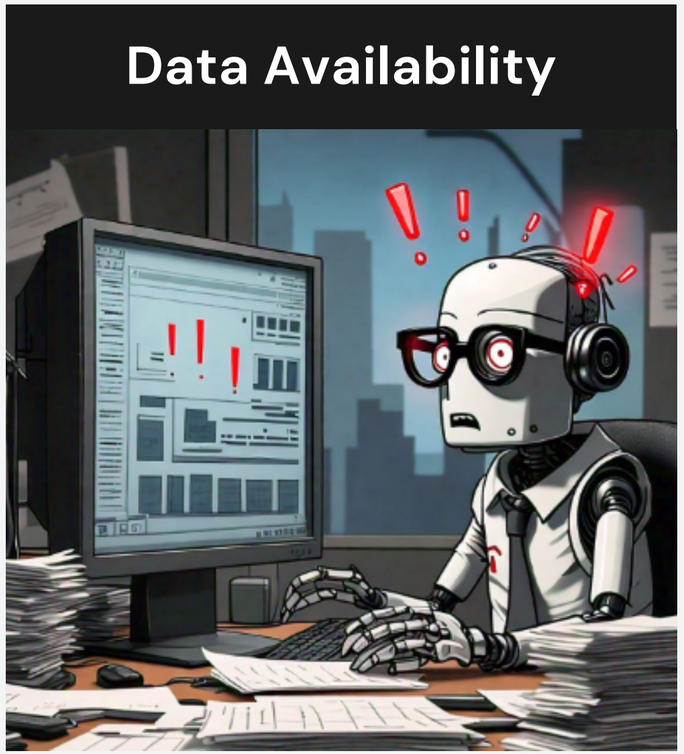
Automated Segmentation



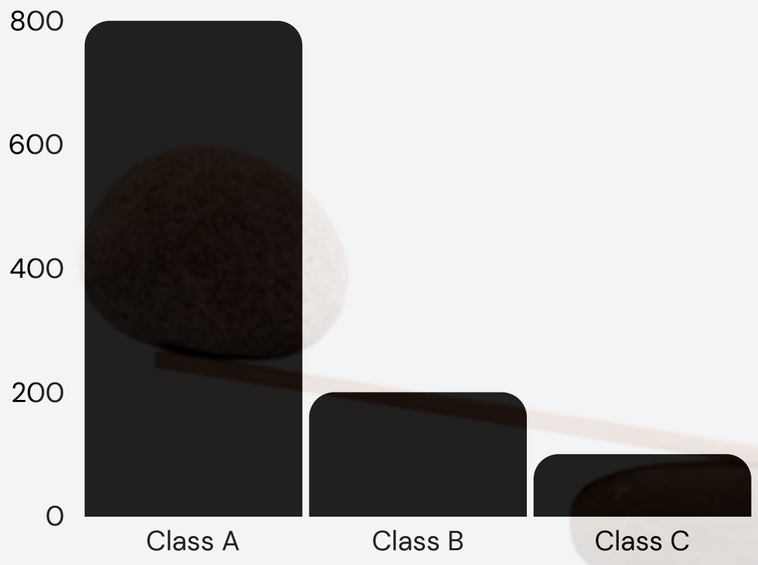
MISDIAGNOSIS

Source: https://medicalexecutivepost.com/

DATA & PROBLEMS



IMBALANCED DATA



CLASS IMBALANCE

MODEL BIAS

POOR PERFORMANCE

The Dangers of Human-Like Bias in Machine-Learning Algorithms

Daniel James Fuchs, *Missouri University of Science and Technology*

Follow

Artificial Intelligence and Race: a Systematic Review

Published online by Cambridge University Press: **16 September 2020**

Channarong Intahchomphoo and Odd Erik Gundersen

Can AI be racist? Color-evasiveness in the application of machine learning to science assessments

Tina Cheuk

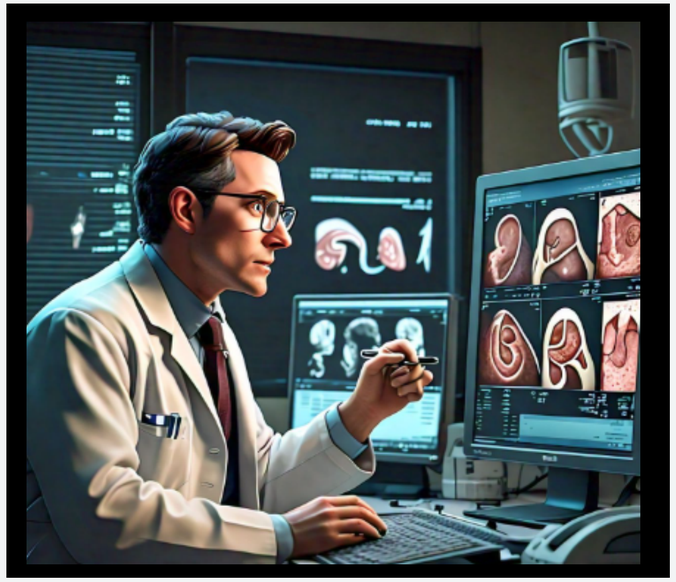
First published: 03 July 2021 | https://doi.org/10.1002/sce.21671 | Citations: 22

Bias in Medical Big Data and Machine Learning Algorithms

Chapter | First Online: 07 May 2021

pp 217–228 | Cite this chapter

MEDICAL DATA ANNOTATION



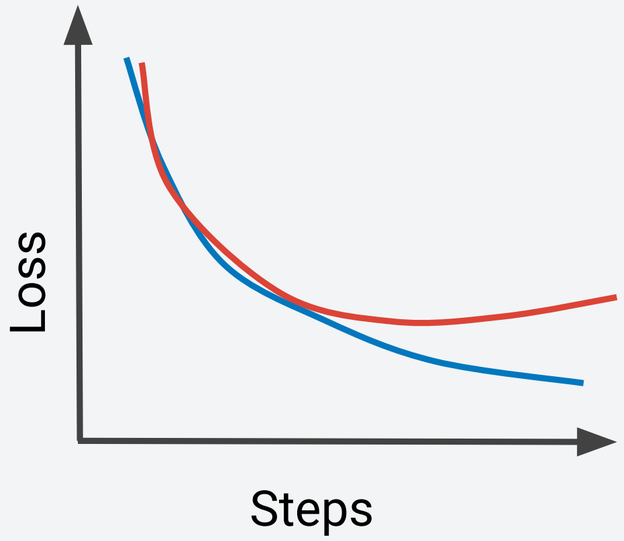
False Annotation

Inaccurate predictions

LOSS FUNCTION

TO OVERCOME THE CHALLANGES

MINIMIZE



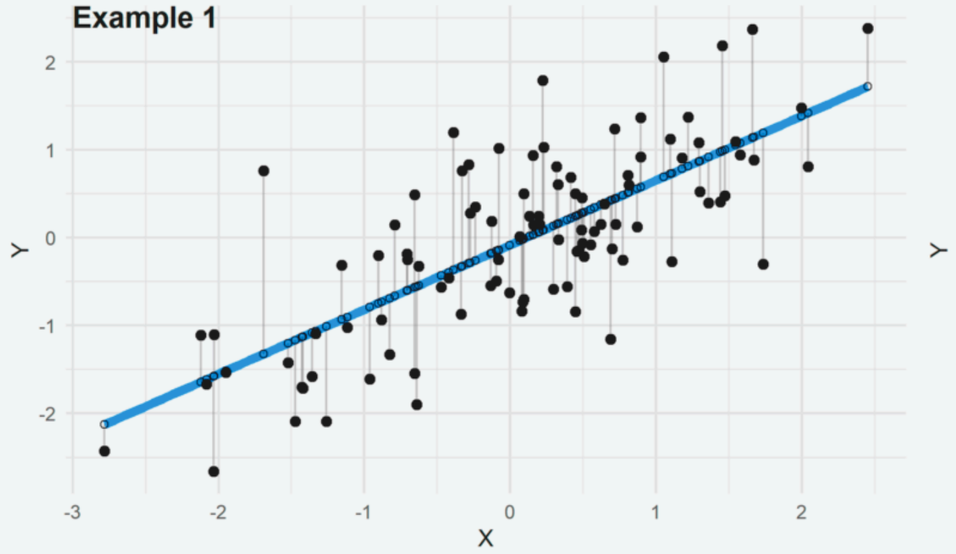
LOSS FUNCTION

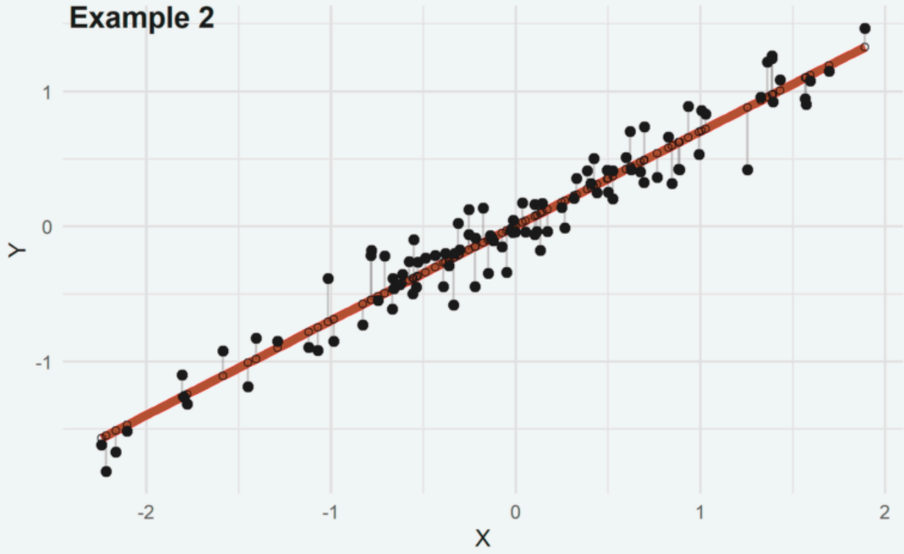
ENHANCE DL PARAMETER ESTIMATION

GUIDE TOWARDS OPTIMIZATION

LOSS FUNCTION(CONT.)

- A LOSS FUNCTION IS USED TO MEASURE MODEL PERFORMANCE BY CALCULATING THE DEVIATION OF A MODEL'S PREDICTIONS FROM THE CORRECT, "GROUND TRUTH" PREDICTIONS.
- ALSO TERMED AS "RESIDUAL ERROR" IN TRADITIONAL STATISTICS MODELING





EXISTING LOSS FUNCTIONS

- **Binary Cross Entropy (BCE):** Measures the performance of a model by comparing the predicted probabilities to the true binary labels (0 or 1).

$$\text{BCE} = -\frac{1}{N}\sum_{i=1}^{N}[y_i \log(p_i) + (1 - y_i) \log(1 - p_i)]$$

Use Case: Segmenting lung regions from chest X-ray images.

- **Dice Loss:** Measures the overlap between the predicted segmentation and the ground truth.

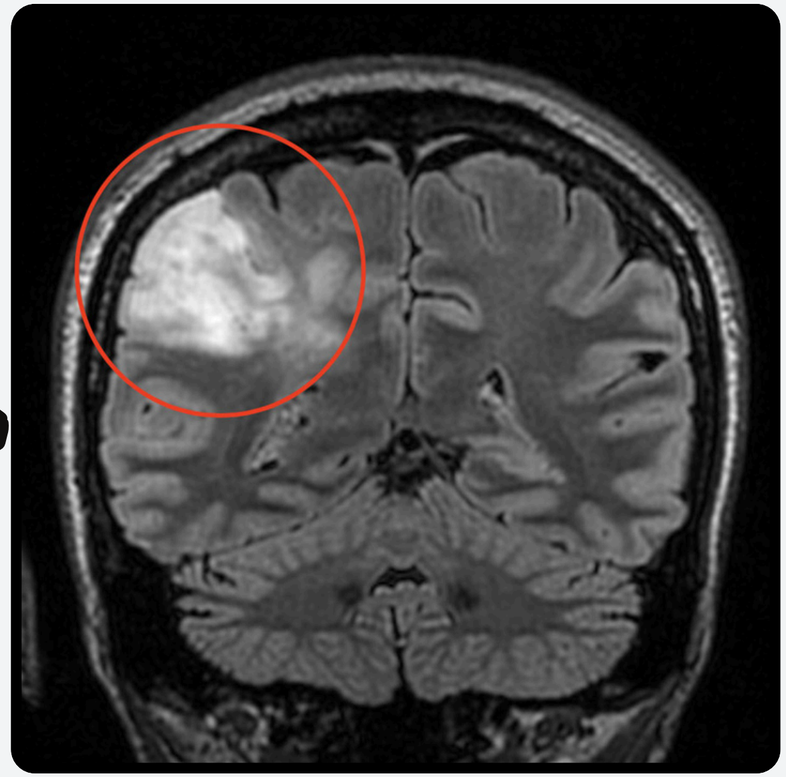
$$\text{Dice} = \frac{2\sum_i p_i y_i}{\sum_i p_i^2 + \sum_i y_i^2}$$

Use Case: Segmenting small tumors in MRI scans.

EXISTING LOSS FUNCTIONS

REGION OF INTERST

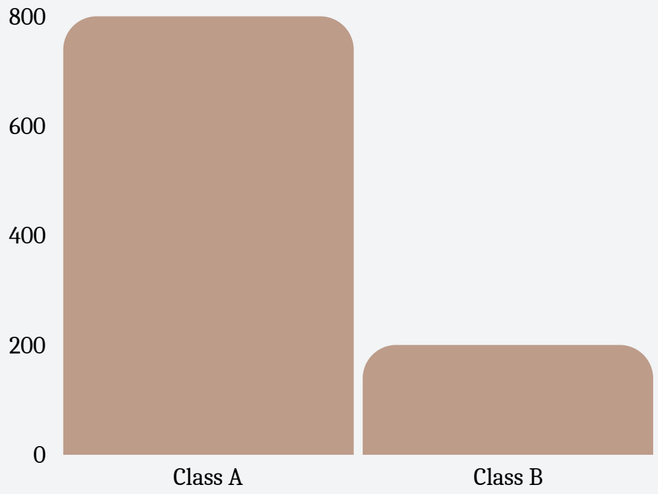
SMALL



MODEL MAY SEEMS TO PERFORM VERY WELL BUT ACTUALLY NOT.

EXISTING LOSS FUNCTIONS

TO ADDRESS IMBALANCES



- WEIGHTED BCE
- TVERSKY LOSS
- FOCAL LOSS

EXISTING LOSS FUNCTIONS

- **Weighted Binary Cross Entropy (WBCE):**
    - Extension of **BCE** that accounts for **class imbalance**.
    - Assigns **weights** to the **positive and negative** classes.
- **Tversky Loss:**
    - Generalization of **Dice loss** function.
    - Introduces a **weighting mechanism** that controls the balance between **false positives** and **false negatives.**
- **Focal Loss:**
    - Focuses more on **hard-to-classify** examples.
    - Introduces a **balancing factor** to adjust the importance of **positive vs. negative** examples.
    - Includes a **focusing parameter** to reduce the loss contribution from **easy** examples.

EXISTING LOSS FUNCTIONS

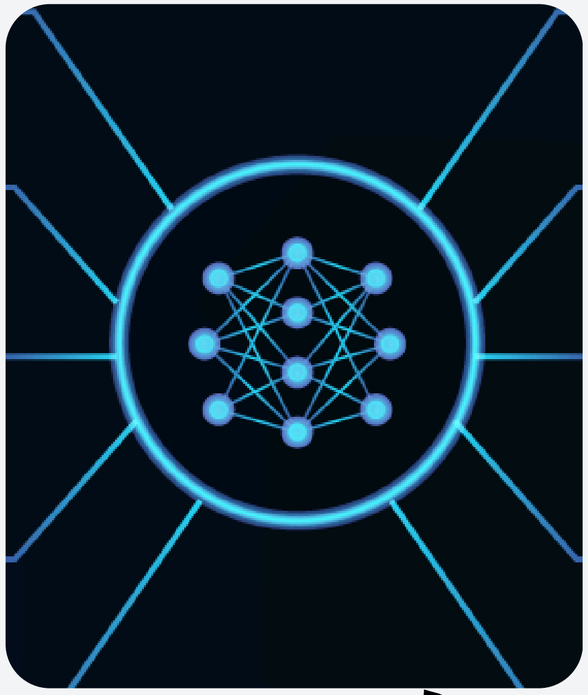
WHEN TO CHOOSE WHICH LOSS FUNCTION ?

REQUIRES MORE MANUAL SETTING

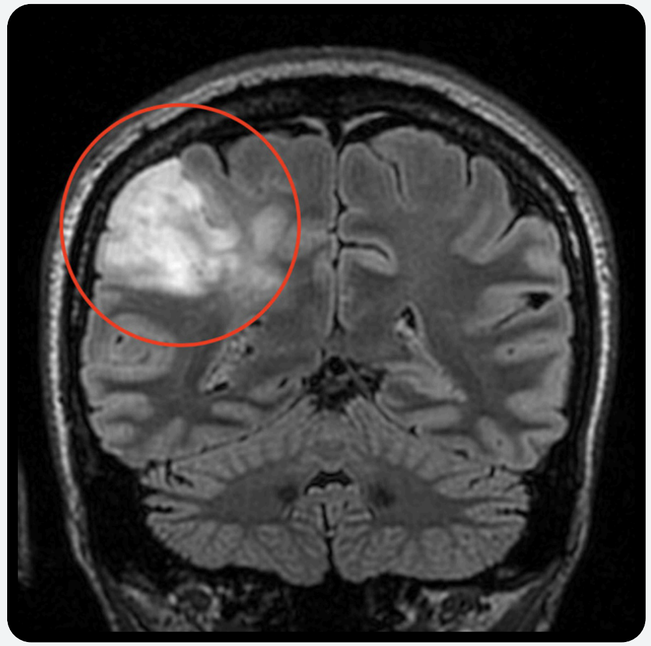
MIMICS THE INPUT ANNOTATION FORMAT

PROPOSED SOLUTION

DL BASED TECHNIQUE

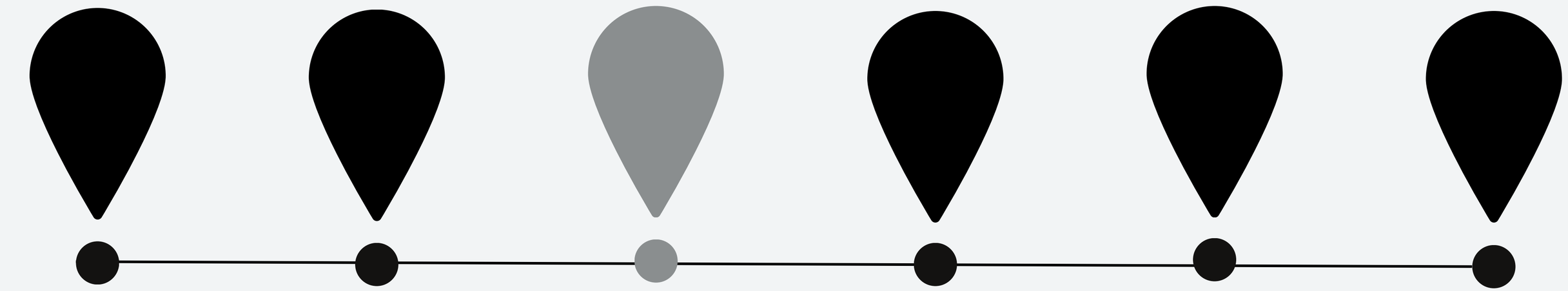


DATA DISTRIBUTION



- LOSS FUNCTION 1
- LOSS FUNCTION 2
- LOSS FUNCTION 3
- LOSS FUNCTION N

OUR APPROACH



PUBLICATION

OUR GOAL

PERFECTING EXISTING METHODS FOR CANCER DETECTION IN ORDER TO IMPROVE PATIENT CHANCES

QUESTIONS