Radiomic/Radiogenomic approach and use of artificial intelligence in pediatric brain tumors: our MB experience

GUY SEBAG AWARD 2021

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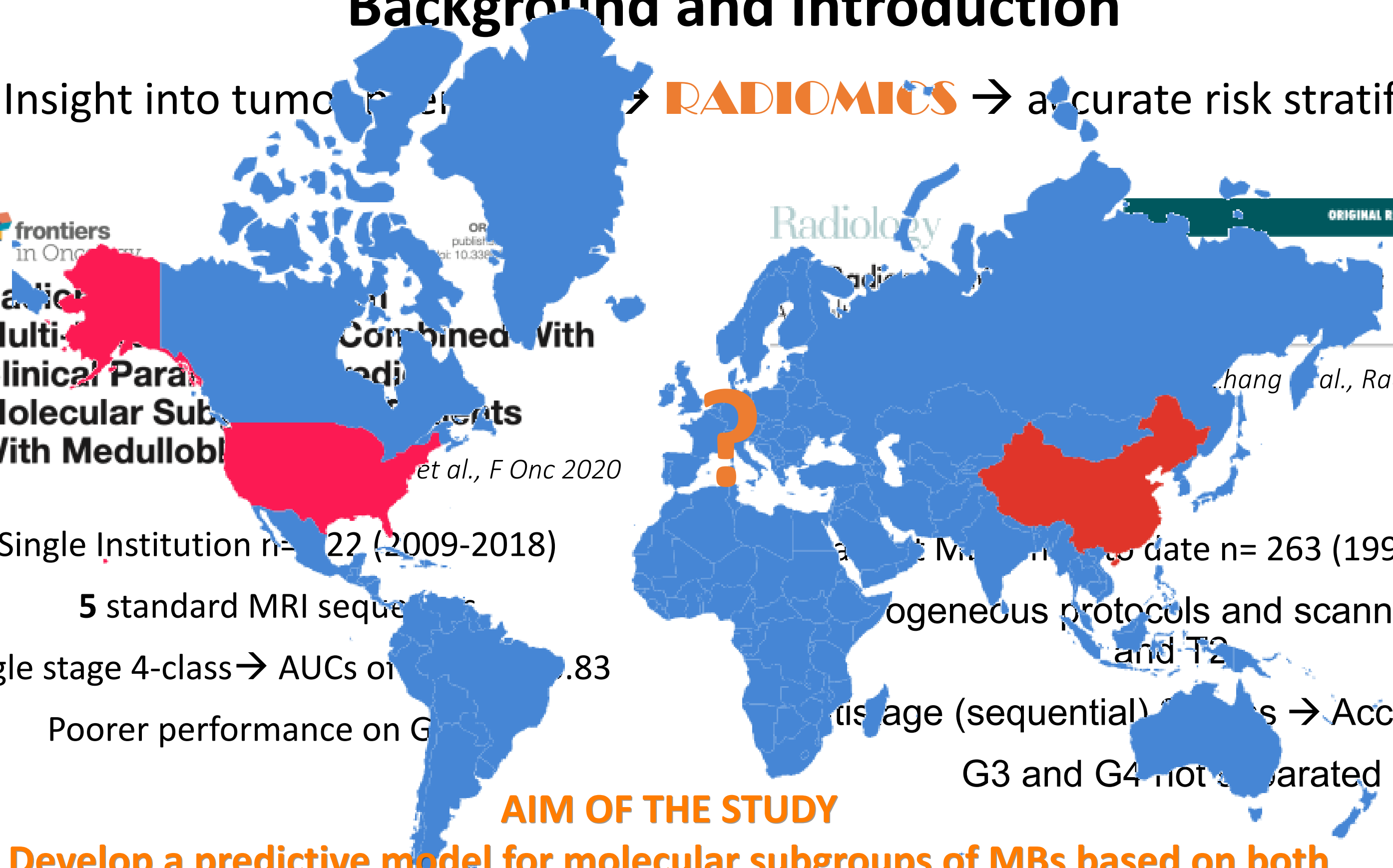
Background and Introduction

Insight into tumo[...] → **RADIOMICS** → a[...]curate risk stratification



frontiers in Onc[...]

Ra[...] Multi-[...] Co[...]bined With Clinical Para[...] Molecular Sub[...] With Medullobl[...]

[...]et al., F Onc 2020

Single Institution n=[...]22 (2009-2018)

5 standard MRI seque[...]

Single stage 4-class→ AUCs o[...].83

Poorer performance on G[...]

Radiolo[...]gy

ORIGINAL RESEARCH • PEDIATRIC IMAGING

[...]hang [...]al., Radiology 2022

[...] date n= 263 (1997-2020)

[...]ogeneous protocols and scanners → T1 and T2

[...]ti[...]age (sequential) [...]s → Accuracy 92%

G3 and G4 not [...]arated

AIM OF THE STUDY

Develop a predictive model for molecular subgroups of MBs based on both radiomics and clinical data from a single European Institution

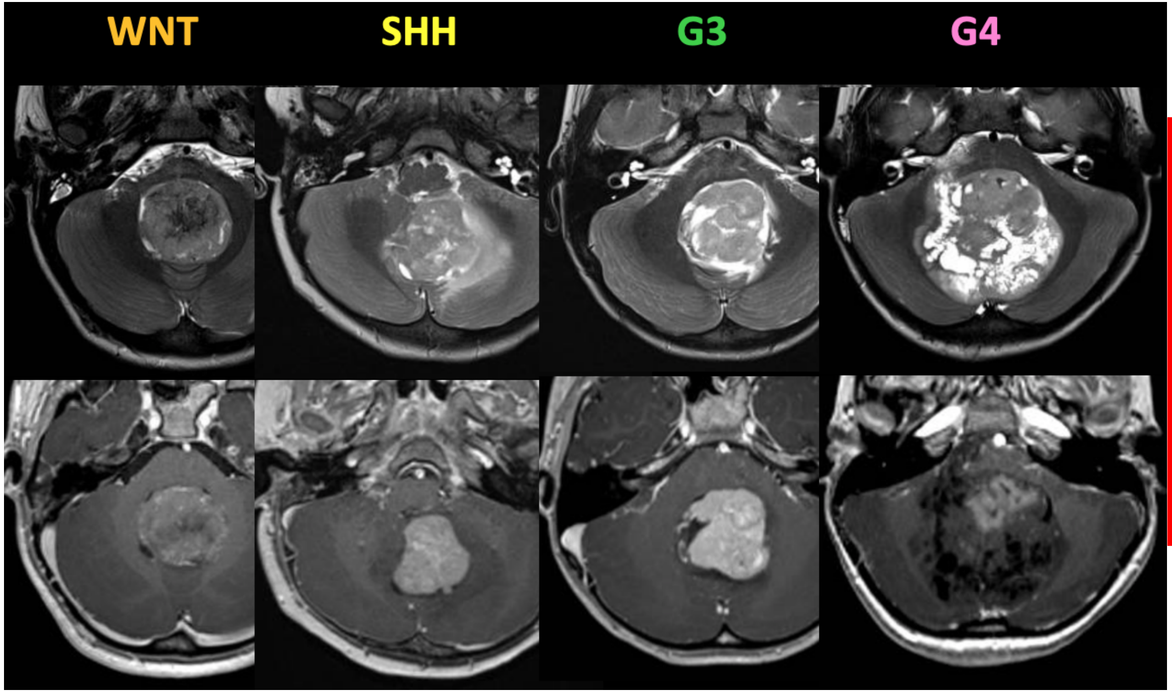
Methods and Patients (1) – PATIENT SELECTION and MRI

Retrospective study → 55 Patients Jan 2011- Dec 2020 @ BGCH

Standard preoperative MRI protocol 3T scanner (Magnetom Skyra, Siemens)

INCLUSION CRITERIA:
Availability of:

- Pre-op MRI (including Gd+ MPRAGE, Ax T2 TSE, Ax FLAIR and ADC map)
- Clinical variables (**age, sex, tumor location**)
- Molecular status



EXCLUSION CRITERIA

- **Pre-op MRI outside BGCH**
- **Artifacts**

BGCH = Bambino Gesù Children's Hospital

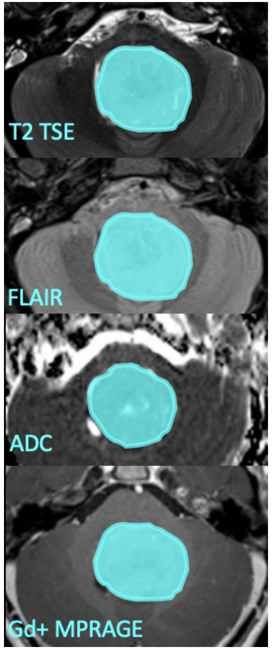
Methods and Patients (2) – RADIOMICS PIPELINE

Tumor segmentation → **Features Extraction** → **Feature selection** → **Model Development and Analysis**

Tumor segmentation

Pre-processing (Python)

Itk-SNAP (v 3.8)

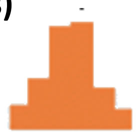


Features Extraction

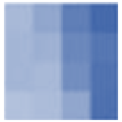
PyRadiomics on VOIs

IBSI-based Radiomic Features (10 built-in filters)

Shape



First-order intensity



Texture (GLCM, GLRLM, NGTDM, GLDM, GLSZM)

Feature selection

Radiomic Features

+

Clinical Data

RELEVANT and REPRODUCIBLE

Training → 60%

Testing → 40%

BORUTA +
- SVM
- RF
- LR

PLS +
- SVM
- RF
- LR

+/- SMOTE

Model Development and Analysis

Model DEVELOPMENT

BINARY
WNT/SHH *vs* **G3/G4**

MULTICLASS
WNT *vs* **SHH** *vs* **G3/G4**

Model PERFORMANCE

Sensitivity, Specificity

Accuracy, AUC

TESTING COHORT

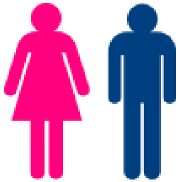
LR=Logistic regression; PLS=Partial Least Squares; RF=Random Forest; SMOTE=Synthetic Minority Oversampling Technique; SVM=Support Vector Machine

UD'A

Bambino Gesù OSPEDALE PEDIATRICO

Results (1) – FEATURES of the STUDY COHORT

47 patients met the selection criteria



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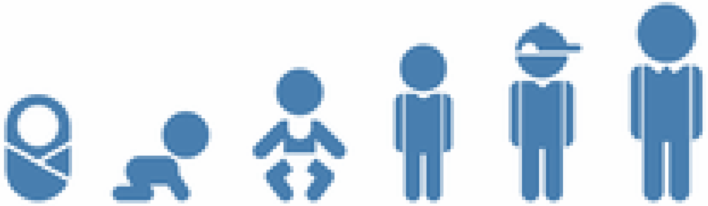
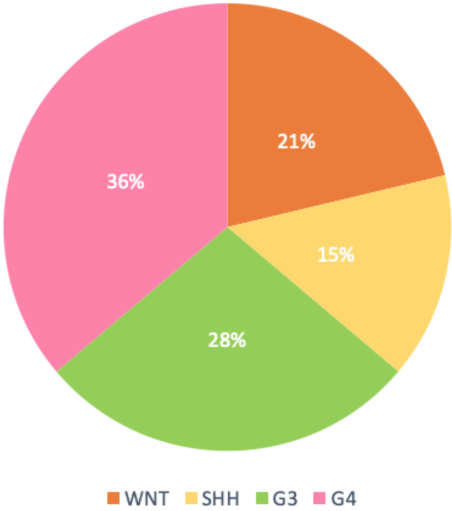
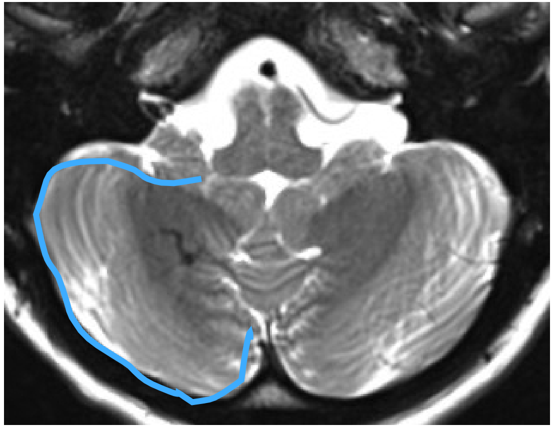


Age range (years) 2-17
Mean (years) 7.7±4.3



WNT	10
SHH	7
G3	13
G4	17



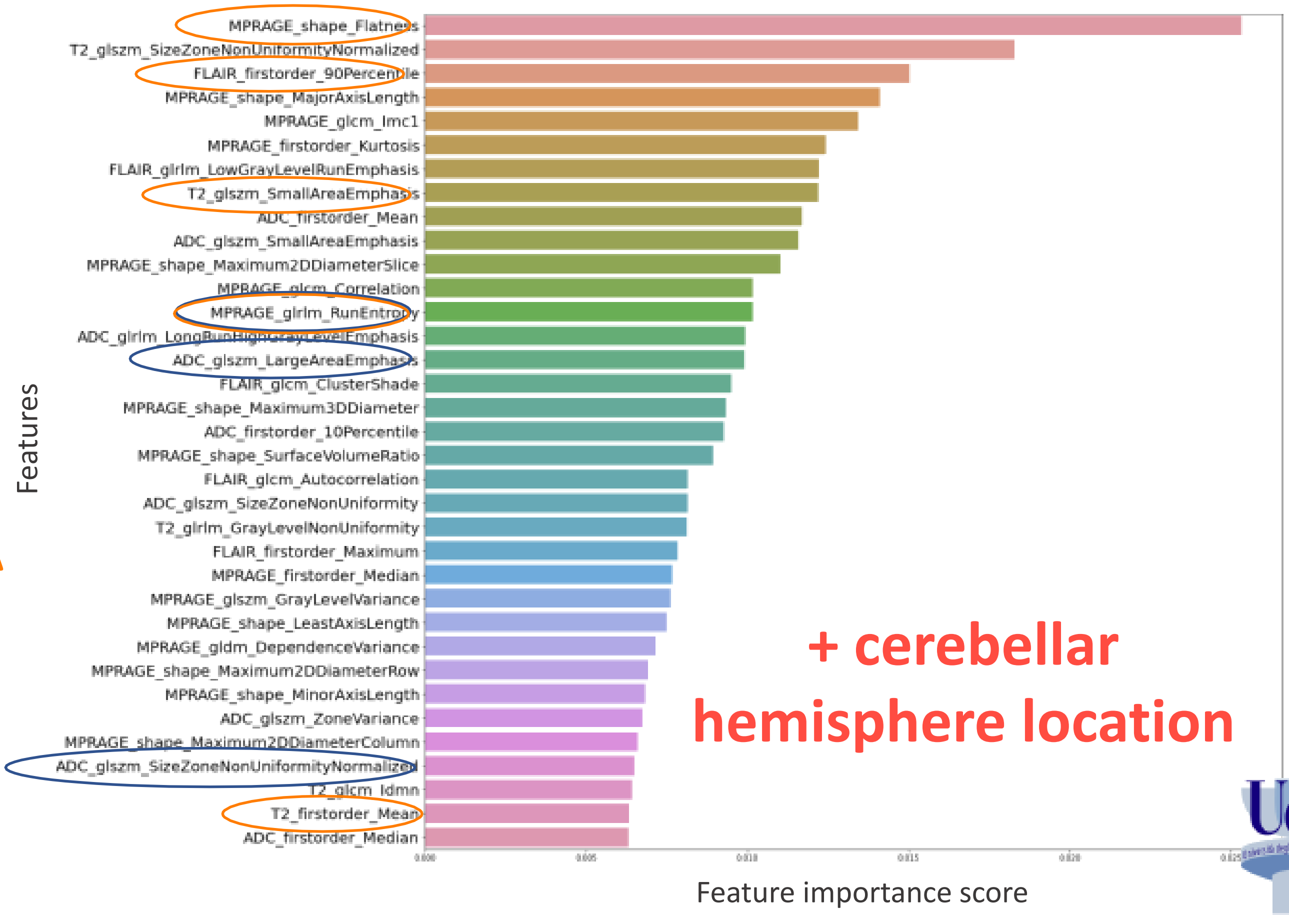
Tumor location:
CEREBELLAR HEMISPHERE
(n=15; SHH=13; G4=2)

Results (2) – BINARY MODEL: FEATURE SELECTION

390 starting features

PLS

BORUTA



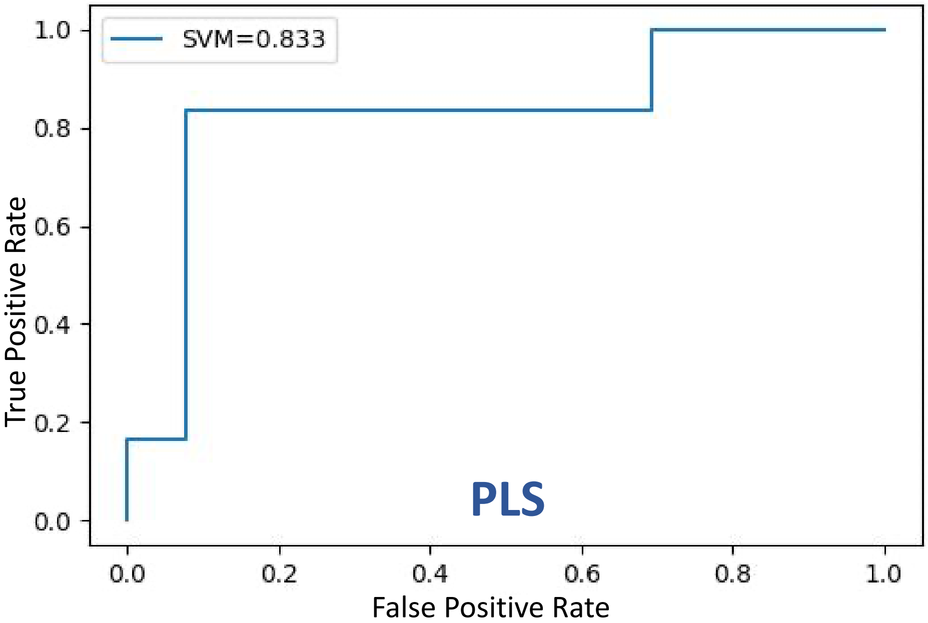
+ cerebellar hemisphere location

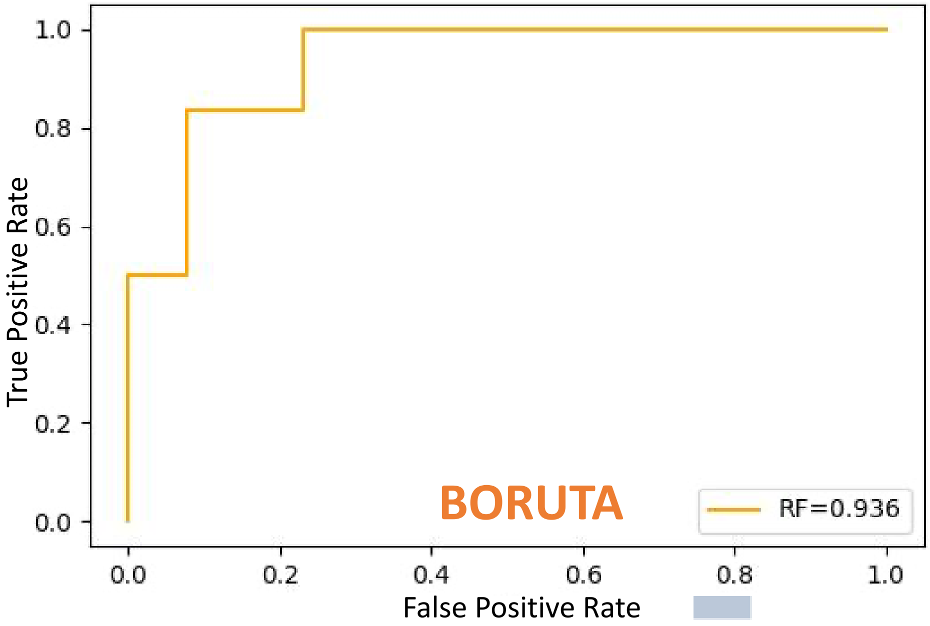
Results (3) – BINARY MODEL: PERFORMANCE

WNT/SHH *vs* G3/G4

MODEL	ACCURACY	AUC
Random Forest	0.842	0.82
Support Vector Machine	0.89	0.83
Logistic Regression	0.64	0.88

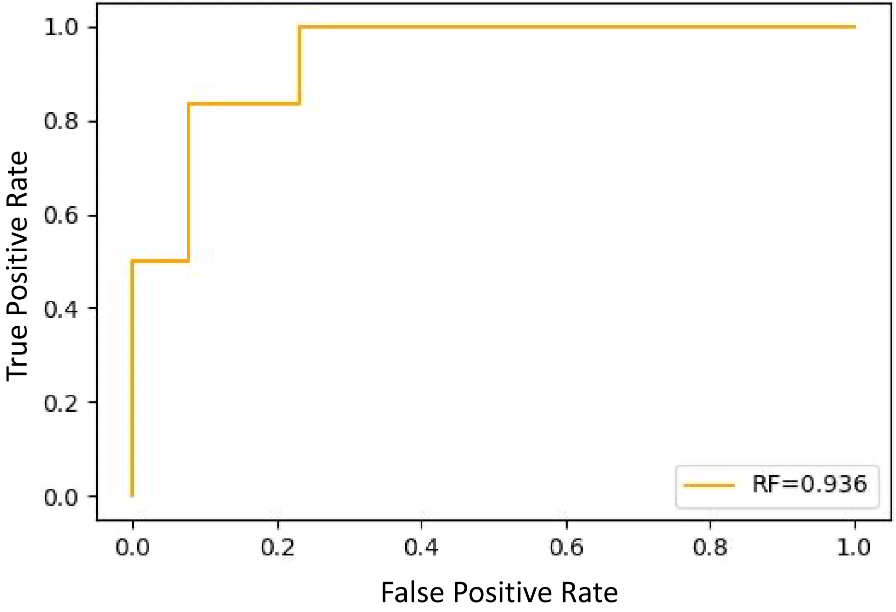
MODEL	ACCURACY	AUC
Random Forest	0.895	0.936
Support Vector Machine	0.737	0.808
Logistic Regression	0.895	0.88



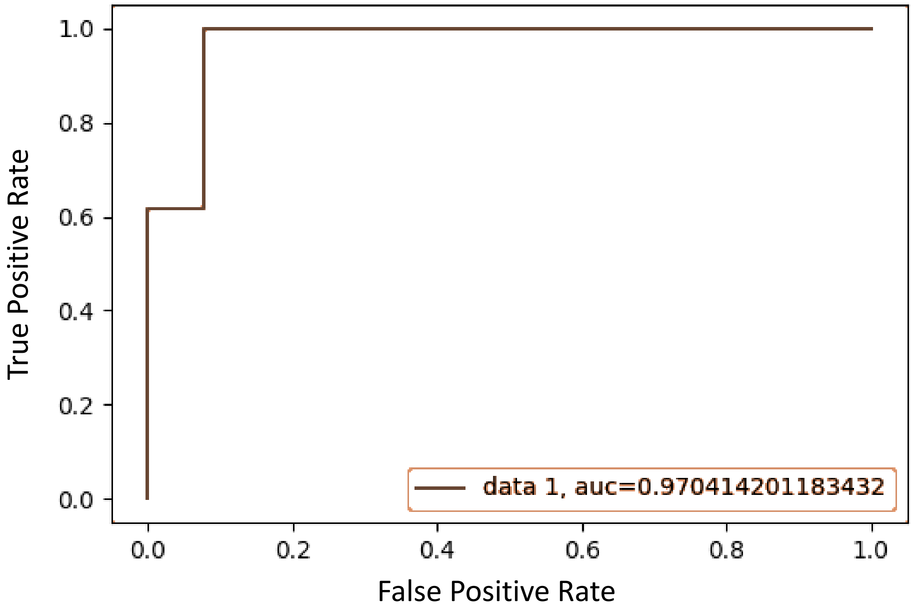


Results (4) – BINARY MODEL: PERFORMANCE w/ SMOTE

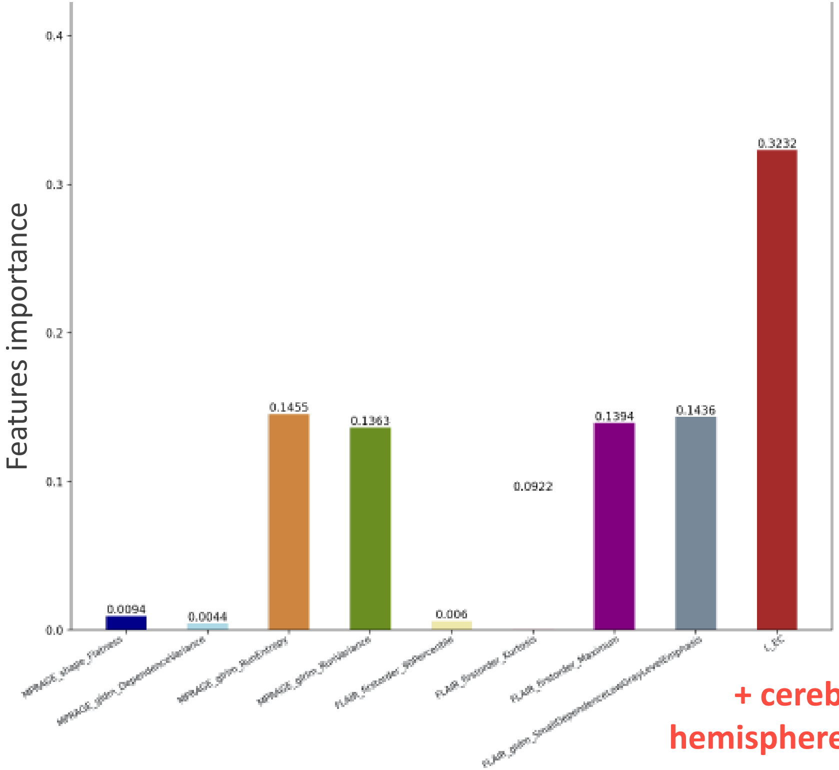
SMOTE -



SMOTE +



Results (5) – MULTICLASS MODEL: BORUTA + RF



+ cerebellar hemisphere location

Discussion and Conclusions

- The best machine learning approach to develop a MULTICLASS model predictive of the MB molecular subgroups
  - Different approach from previous studies, but comparable in terms of performance *Zhang et al., Radiology 2022; Yan et al., F Onc 2020*

- both RADIOMIC and CLINICAL model
  - post-GD MPRAGE → qualitative enhancement pattern already described *Łastowska M et al., J Neurooncol 2015*
  - FLAIR → tumor biology? *Zhang et al., Radiology 2022; Yan et al., F Onc 2020*
  - Clinical data are still key

- Large cohort from a Single European Institution → even **larger** (external?) cohort
- **ADVANCED SEQUENCES**
- **GROUP 3 AND GROUP 4 MBS**

Ud'A

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OSPEDALE PEDIATRICO

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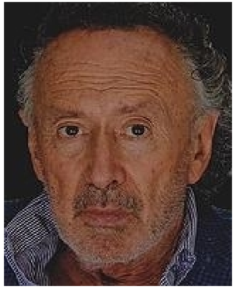

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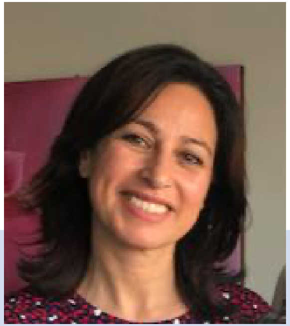

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Paediatric young radiologists
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