

EP08.15.

A deep learning approach to predict birth weight from third trimester MR images

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Introduction

- Birth Weight (BW) : an important determinant of fetal morbidity and mortality.
- SGA and LGA fetuses are both subjected to higher risks for themselves, or for their mother.

Predicting birth weight is therefore highly desirable as it could impact obstetricians practice, letting them take better decisions.

The objective was to improve the accuracy of birth weight predictions, by developing a neural network using 3rd trimester fetal MRI.

Methods

- Retrospective study at Lumiere platform (Necker Enfants Malades Hospital, Paris, France – IRB: NCT04142606).
- Pregnant women undergoing MRI with normal pregnancy at third trimester ([28 – 36] weeks).
- Multiple pregnancies were excluded.
- Fetal MRI acquired with an 1,5 T MRI, using the FIESTA sequence (see example Fig. 1).
- MRI volumes were submitted to a convoluted neural network (CNN), and the predictions of birth weight were evaluated with Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE).

Results

250 fetuses were included at 32 [28-36] weeks, with an 80/20% training/testing repartition for a 5-fold cross-validation. Mean GA ($\pm$ Standard deviation) at MRI were $32,4 \pm 2,3$ weeks. Mean GA ($\pm$ Standard deviation) at delivery were $39,5 \pm 1,3$ weeks. Interval between fetal MRI and delivery was $8,0 \pm 2,6$ weeks. At birth, infants weighted 3254 ± 413 g.

The model predicted birth weight with MAE = 254,6 g, and MAPE = 8,0 %.

Heatmaps were generated using the Grad-CAM method (example Fig. 2).

Conclusion

The network was able to predict BW with an MAE of 254,6 g and MAPE of 8,0 %.

It should be improved by adding US biometric measurements to improve performance.

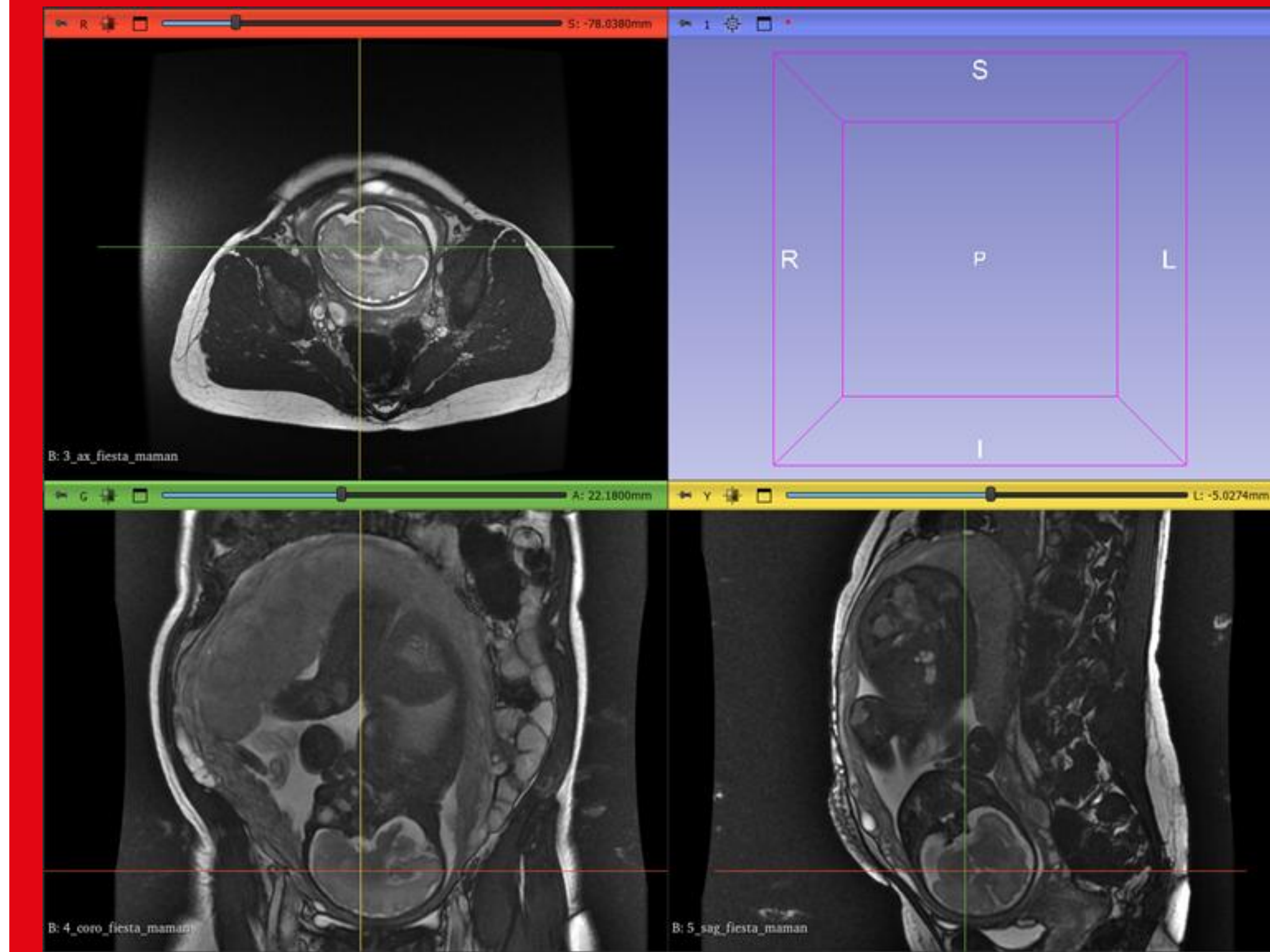


Fig 1. Example of acquisitions in three different planes, using the FIESTA sequence

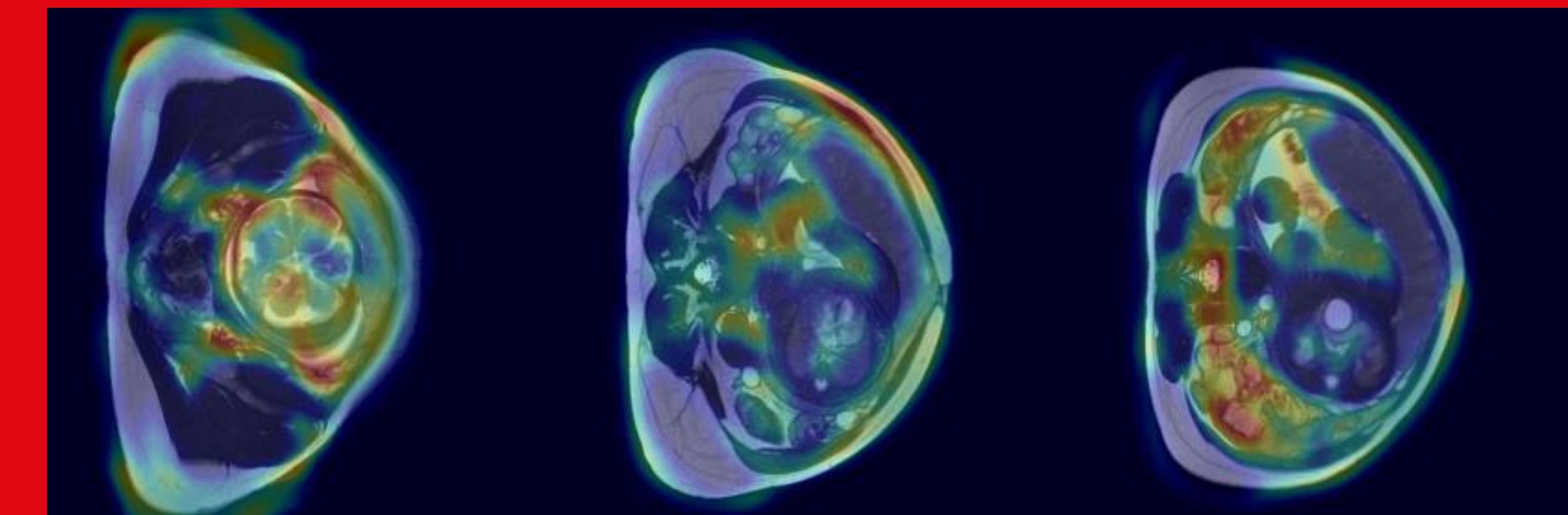


Fig 2. Example of 3D heatmaps along 3 different slices of an axial volume. The attention is visualized using a jet color map