OBUS – Fetal Weight Overview

Summary

Ultrasound-based fetal weight estimation and gestational age prediction share several methodological and clinical similarities, as both rely on biometric measurements obtained through ultrasound imaging. Key parameters such as biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) are commonly used in both tasks, when performed conventionally. These measurements reflect fetal growth and development, and their patterns over time can be modeled to infer either the approximate weight of the fetus or its gestational age.

Clinically, both estimations are crucial for monitoring fetal health and guiding obstetric decision-making. If gestational age is estimated early enough in the pregnancy to give an accurate result, fetal weight estimation can be used to detect growth issues, such as intrauterine growth restriction (IUGR), small for gestational age (SGA), or large for gestational age (LGA). Low birth weight is associated with 80% of neonatal deaths in low- and middle-income countries (LMICs). Note that if gestational age is estimated at the same time as fetal weight, detection of growth abnormalities is problematic because the two estimates are highly correlated.

The determination of fetal weight by ultrasound conventionally involves the manual measurement of fetal anatomical structures (head, abdomen, femur) and the use of established formulas for estimating fetal weight, *e.g.*, the Hadlock formula [1]. But this task requires a highly skilled sonographer, which may be in short supply in low-resource settings such as LMICs. The EFW model is designed to estimate the fetal weight from a series of blind sweeps of the gravid abdomen that may be performed by minimally trained healthcare professionals, such as nurses and midwives. Given the availability of low-cost ultrasound devices, this model can significantly reduce the burden of morbidity and mortality resulting from low birth weight and other fetal growth abnormalities.

The EFW model function as a regressor, returning the estimated fetal weight from a series of blind sweeps conforming to the canonical set of blind sweeps described in [0.1 OBUS Data Description].

Ground truth label definition

The true fetal weight during pregnancy cannot be directly measured (unless very soon after the ultrasound exam there is a stillbirth or a live birth), hence for this model we must settle on using the estimated fetal weight based on the biometric measurements and Hadlock formula (1985 4-component) as the ground truth.

Accuracy assessment

The error of the EFW model is determined by measuring the difference between the model output estimated fetal weight and the ground truth value as a fraction of the ground truth value (relative error, RE). The method for computing the exam-level outputs is the same as for the GA model. However, the EFW model does not output the estimated fetal weight directly. Rather, the model is trained to output estimates for the four biometric measurements BPD, HC, AC, FL. The model then uses the 4-component Hadlock formula for computing the estimated fetal weight based on the estimated biometric outputs.

We report two metrics to evaluate the performance of the model on the test set. First, the mean relative absolute error (MRAE) is the average of the absolute values of the relative errors in the test set, as a fraction or percentage. This is a single value. Secondly, the 5-95% relative prediction interval is the range between the 5th percentile error and the 95th percentile relative error. In other words, the middle 90% of predictions fall within this range. This is reported as two values, corresponding to the 5th percentile and 95th percentile errors. We report these on the overall test set and also observe how the relative error correlates with the ground truth estimated fetal weight.

References

[1] F. Hadlock, R. Harrist, R. Sharman, R. Deter and S. Park, "Estimation of fetal weight with the use of head, body, and femur measurements—A prospective study," *Am. J. Obs. & Gyn.*, vol. 151, no. 3, pp. 333-337, 1985.