

OBUS – Gestational Age Overview

Summary

The Gestational Age (GA) model predicts the gestational age of a singleton fetus in the mother's womb. By convention, the gestational age is measured from the last menstrual period (LMP). But self-reported LMP has long been known to be unreliable [1]. Ultrasound estimation of fetal age is useful, either to confirm the gestational age predicted by last menstrual period or to provide a new estimate, preferably as early as possible in the pregnancy. A reliable gestational age can then be used to determine the appropriate timing of care or—if warranted—intervention. Gestational age determination is particularly useful for determining the presence of growth restrictions; low birth weight is associated with 80% of neonatal deaths in low- and middle-income countries (LMICs).

The determination of gestational age by ultrasound conventionally involves the manual measurement of fetal anatomical structures (head, abdomen, femur or, earlier in pregnancy, the crown-rump length) and the use of established formulas for estimating gestational age, e.g., the Hadlock formula [2]. But this task requires a highly skilled sonographer, which may be in short supply in low-resource settings such as LMICs. The GA model is designed to estimate the gestational age 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 having an unreliable gestational age estimate.

The GA model functions as a regressor, returning the estimated gestational age (in days) 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

For the NEJM subset, the best obstetric methods were applied to determine the ground truth gestational age during the mother's initial visit to the clinic. The best estimate of the gestational age uses a combination of the mother's reported last menstrual period and biometric measurements. This initial gestational age estimate was used as the anchor for the ground truth gestational age for all subsequent visits of the same patient. Please refer to Figure 1.

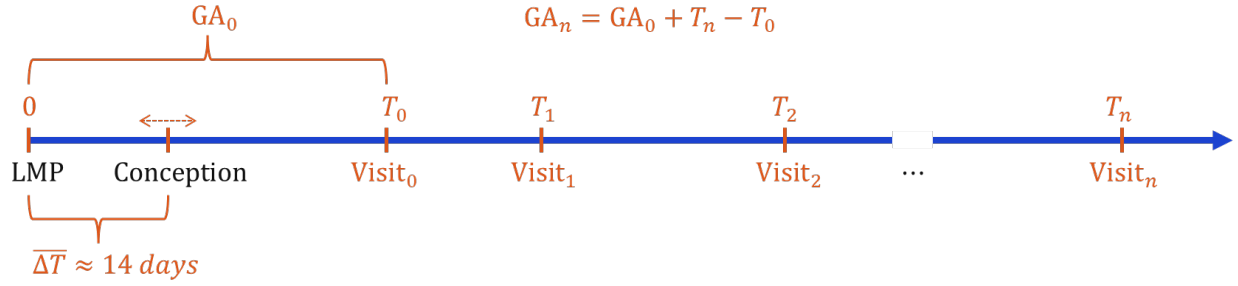


Figure 1. Gestational age for all subsequent visits is calculated by adding to the earliest estimation the number of days since the visit date of the first estimation.

Accuracy assessment

The error for the gestational age model is computed by subtracting the ground truth gestational age from the model's predicted gestational age for each exam. The model's exam level output is computed using a weighted average of feature vectors across all the video frames that are part of each exam and passing the average feature vector through a regressor. The weights for this averaging process are also determined by the model (through an attention mechanism as outlined in the Algorithm Approach Document). The ground truth can be determined either by standard biometric estimates, in which the earliest available measurement is typically the most accurate, or by using a reported last menstrual period (LMP).

We report two metrics to evaluate the performance of the model on the test set. First, the mean absolute error (MAE) is the average of the absolute values of the errors in the test set, in number of days. This is a single value. Secondly, the 5-95% prediction interval is the range, again in days, between the 5th percentile error and the 95th percentile 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, but also by trimester. A reasonable target is to achieve the same or lower estimation error than the aforementioned biometric estimate at the same time in the pregnancy (provided that the ground truth was based on an accurate LMP or previous biometric estimate). This roughly corresponds to a 5-95% prediction interval of $[-7, 7]$ days for trimesters 1 and 2, and $[-14, 14]$ days for trimester 3.

References

- [1] M. Kramer, F. McLean, M. Boyd and R. Usher, "The validity of gestational age estimation by menstrual dating in term, preterm, and postterm gestations," *JAMA*, vol. 260, pp. 3306-3308, 1988.
- [2] F. Hadlock, R. Deter, R. Harrist and S. Park, "Estimating fetal age: computer-assisted analysis of fetal multiple fetal growth parameters," *Radiology*, pp. 497-501, 1984.