

# **ForAge User Manual**

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ForAge is a program for estimating the age-at-death of human skeletal remains based on 3D laser scans of the pubic symphysis. The program is written in Java and should run on any platform with a native Java Runtime Environment (JRE – <https://java.com/>). ForAge is available for download at <http://morphlab.sc.fsu.edu/software/forAge/>.

ForAge calculates three shape measures of the pubic symphysis – the *SAH-Score*, the minimum bending energy (BE) calculated by thin-plate splines (TPS) and the curvature of the ventral margin. The *SAH-Score* and the BE both measure the “flatness” of the symphyseal face and capture the transitioning of the symphyseal surface from being covered by ridges and furrows to becoming flat as the age of the individuals progresses. The curvature of the ventral margin quantifies the transition of the pubic symphysis to a more oval shape. ForAge produces age-at-death estimates using regression models for each of the three shape measures. In addition it estimates the age-at-death using two multivariate regression models combining the ventral curvature measure with the *SAH-Score* and the BE. The choice of measures, their mathematical basis, the details of their implementation, and a discussion on the regression models are provided in the following publications:

1. Slice, D. E. and Algee-Hewitt, B. F. B. (2015), Modeling Bone Surface Morphology: A Fully Quantitative Method for Age-at-Death Estimation Using the Pubic Symphysis. *J Forensic Sci*, 60: 835–843. doi:10.1111/1556-4029.12778
2. Stoyanova, D., Algee-Hewitt, B. F. B. and Slice, D. E. (2015), An enhanced computational method for age-at-death estimation based on the pubic symphysis using 3D laser scans and thin plate splines. *Am. J. Phys. Anthropol.*, 158: 431–440. doi: 10.1002/ajpa.22797
3. Stoyanova, D., Algee-Hewitt, B. F. B., Kim J. and Slice, D. E. (2016), A Computational Framework for Age-at-Death Estimation from the Skeleton: Surface and Outline Analysis of 3D Laser Scans of the Adult Pubic Symphysis. *J Forensic Sci* (accepted)

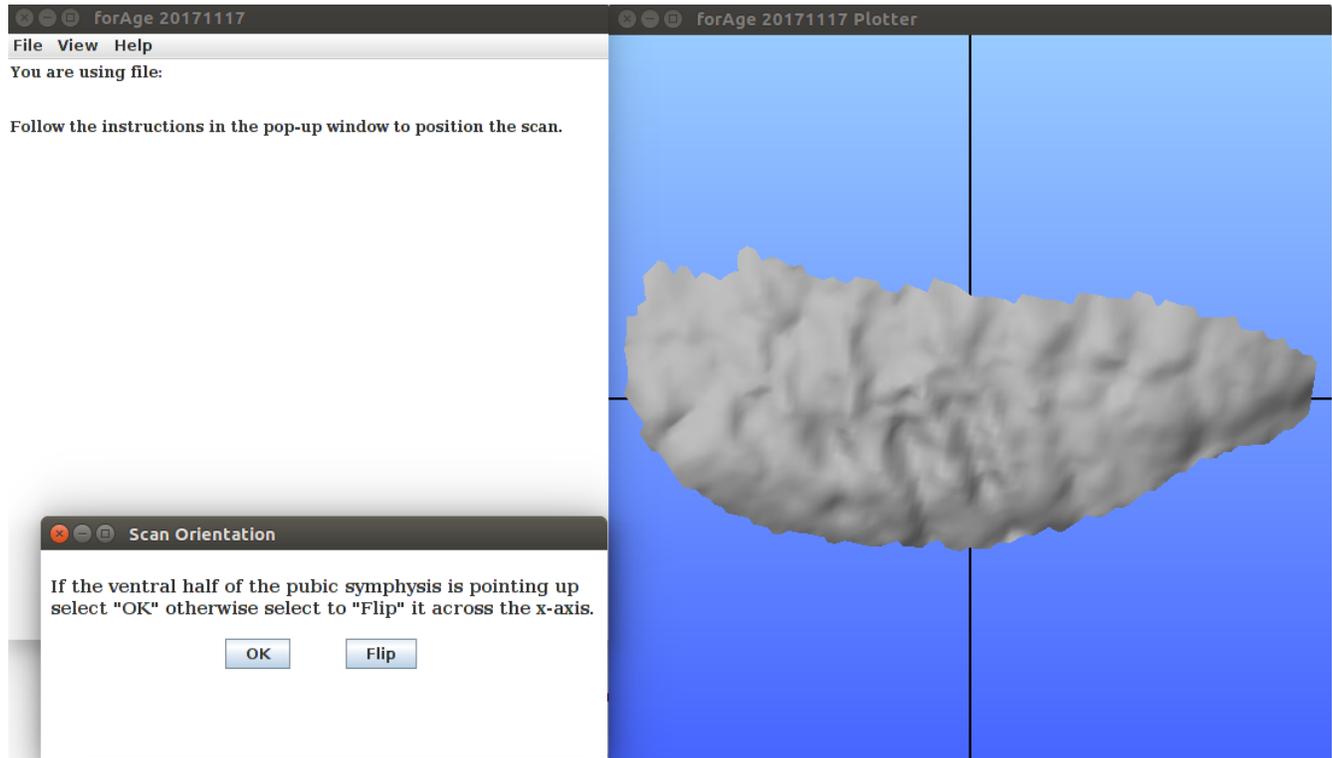
**Installation:** ForAge is a multiplatform program. To install it, simply download the .zip file and unzip into a convenient directory.

**Running the program:** To run the program, assuming you have an appropriate Java runtime or development system installed, you can just double-click the forAge.jar file.

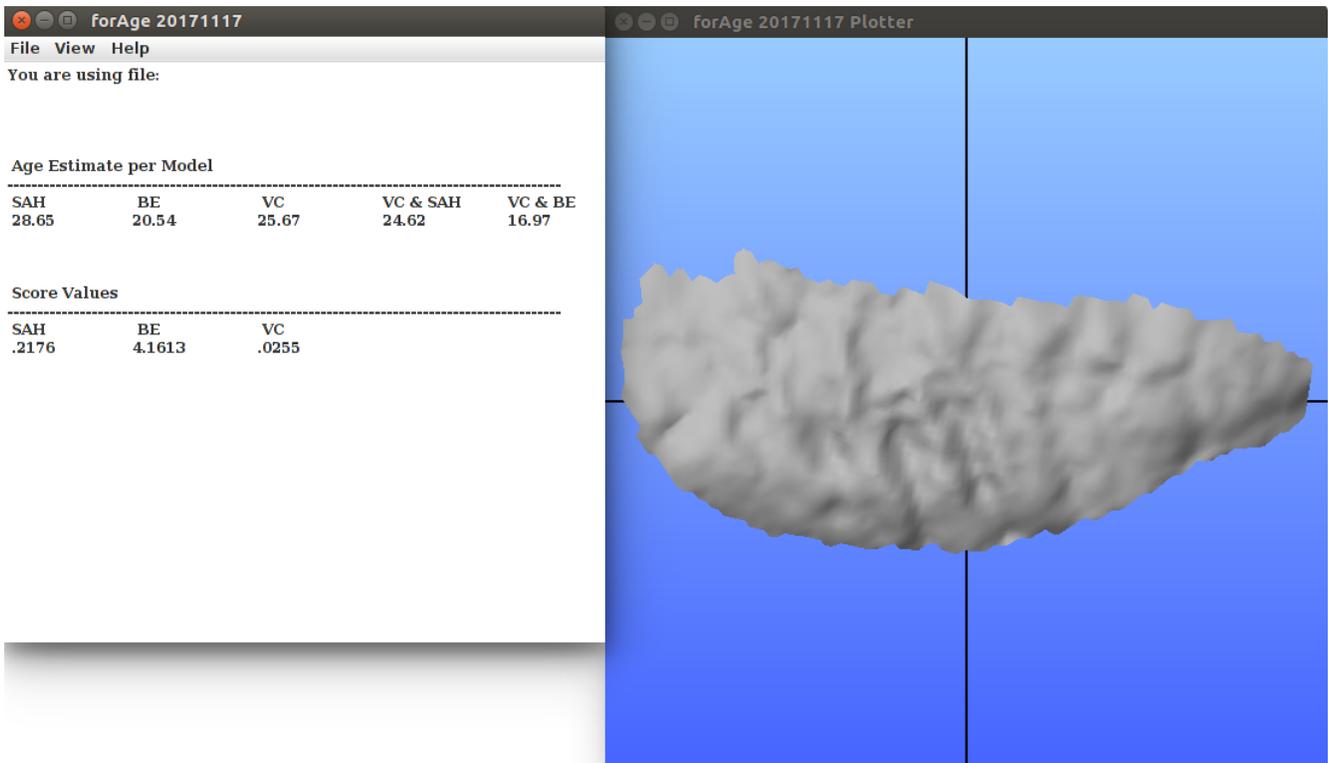
**Using the program:**

1. The program accepts one PLY file of the surface of a pubic symphysis ([https://en.wikipedia.org/wiki/PLY\\_\(file\\_format\)](https://en.wikipedia.org/wiki/PLY_(file_format))). The user should use the menu File → Open to select the PLY file.
2. After selecting the PLY file the visualization tool displays the scan after it has been translated, scaled and rotated using principal component analysis (PCA). The calculation of the ventral curvature requires that the ventral margin of the pubic symphysis is facing upward. This positioning cannot be automated

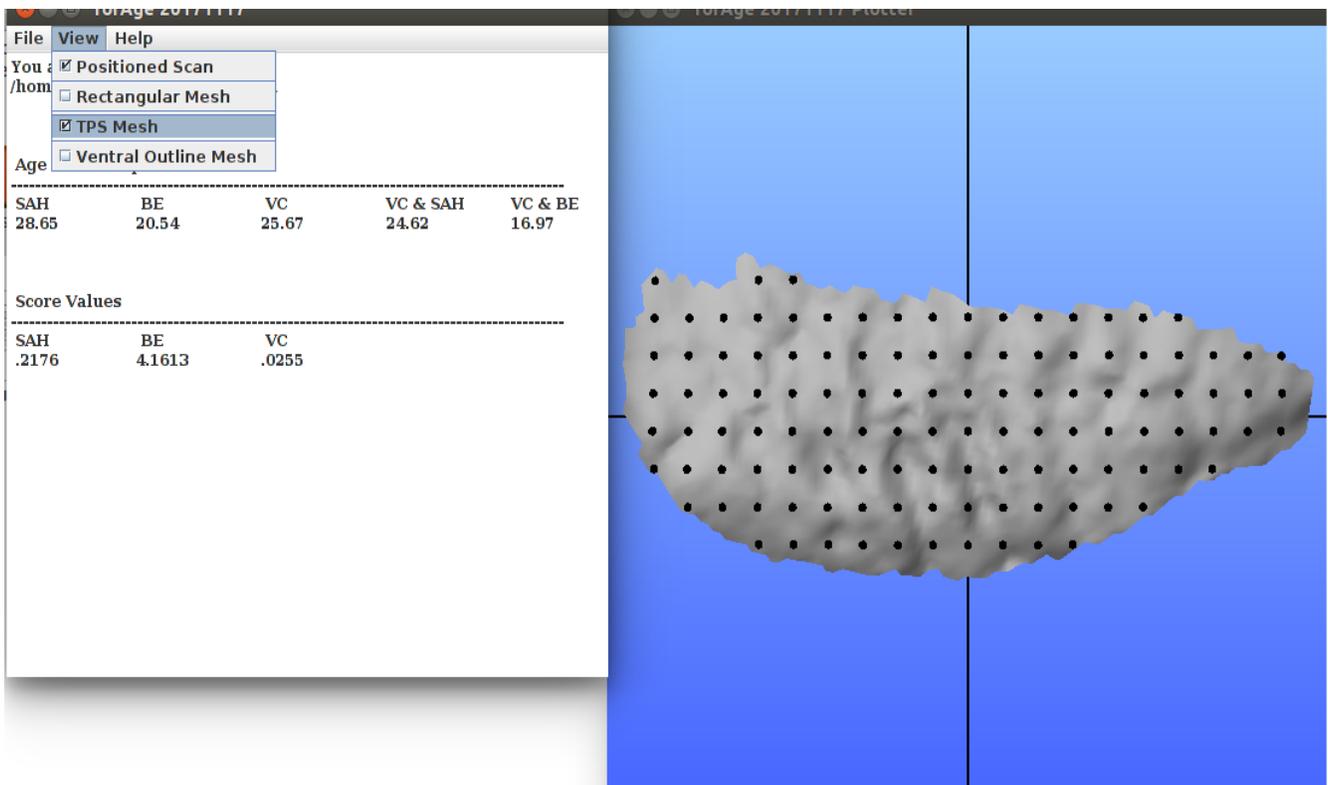
and therefore the user is prompted to flip the scan along the  $x$ -axis if necessary so that the vertices along the ventral margin have the positive  $y$ -coordinates.

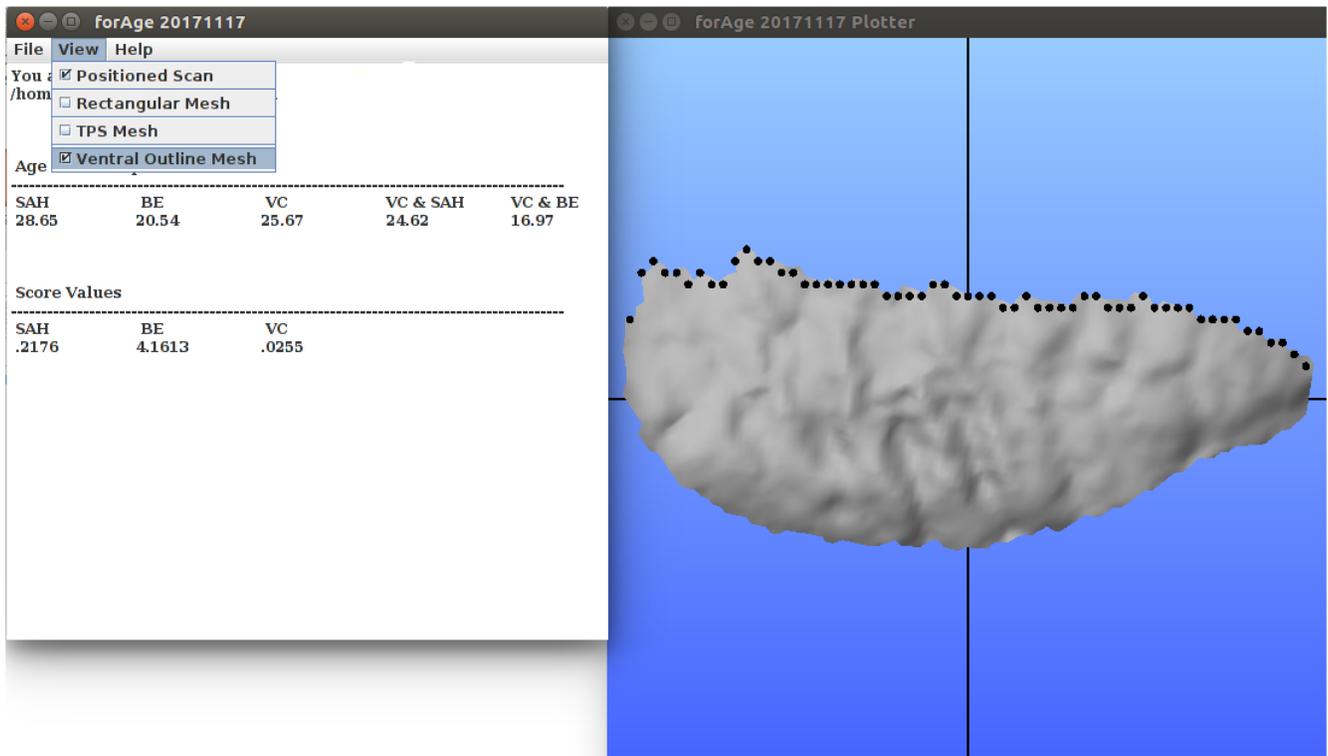


3. When the user accepts the position of the scan the age estimates for each of the three measures and the two multivariate regressions are displayed. The *SAH-Score*, BE and ventral curvature values are also shown in the output window. This allows the users to generate their measures and do their own statistical analysis.



4. Additional options (under menu View) allow for the visualization of the meshes used by the computational algorithms.





5. The user can also use the menu (File->Save) to save the positioned scan (in PLY format) or the meshes (in OBJ format). The exported coordinates allow the scientists to further analyze the data.