Abdominal Adipose variables from Dixon MRI
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Date: July 03 2019
Version: 2.0

All presented variables are extracted from the predicted segmentation maps of the FatSegNet pipeline. FatSegNet is a fully automated deep learning pipeline to accurately segment visceral and subcutaneous adipose tissue inside a consistent anatomically defined abdominal region. More information can be found :

- Estrada S, Lu R, Conjeti S, et al. FatSegNet: A fully automated deep learning pipeline for adipose tissue segmentation on abdominal dixon MRI.Magn Reson Med. 2019;00:1–13. https:// doi.org/10.1002/mrm.28022
  Note: Please cite this paper if you used any of the pipeline variables

FatSegNet generates variables for the Visceral Adipose tissue (VAT) and Subcutaneous adipose tissue(SAT). Each measured variable has the following labeling: region_variable-name_unit (i.e.wb_Vol_cm3, if the variable is weighted contains a W in the beginning of the variable name, wb_W_Vol_cm3). The weighted measurements take into account the water and fat intensities for each voxel. Given a water image (I_{water}) and a fat image (I_{fat}), the weighted volume (W_{vol}) for a given voxel x is calculated as follows :

$$Weighted(x) = \frac{I_{fat}(x)}{(I_{fat}(x) + I_{water}(x))} \tag{1}$$

$$Wvol(x) = Weighted(x) \cdot Voxel_{volume} \tag{2}$$

where $Voxel_{volume}$ is a constant of the acquisition protocol. The weighted approach gives more power to voxels with higher fat content and improves the partial volume effects on tissue boundaries; contrary to normal volume calculations where all voxel have the same importance ($Weighted(x) = 1$). Furthermore weighted values are recommend for mass quantification as demonstrated in [1].

Note: If the compartment option was used; the FatSegNet additionally generates variables for N equally subsets from the input region (the subsets don't correspond with any anatomical landmark). Each subset is identified with the following scheme:

- Whole Body (wb): All input volume
- Q1: First compartment of wb from Head to Feet (Closest to the Head)
- QX : X compartment of wb
- QN: Last compartment of wb from Head to Feet (Closest to the Feet)

The pipeline variables summary in presented on Table 1 .

Table 1: **FatSegNet Variables Summary**. The variable name follows the format region_variable-name_unit and the region(xx). Note– wb : whole abdominal region

Variable Name	Unit	Description
SLICES		Number of slices segmented from a subject
xx_HEIGHT_cm	cm	Height of the segmented region. The height is calculated measuring the segmented slices on the Z-axis
$_{x}x\_AVG\_AREA\_cm2$	cm^2	Average area of abdomen in the region of interest. The area is calculated for each individual slice and then average over the slices in the region
xx_AVG_PERIMETER_cm	cm	Average perimeter of the abdomen in the region of interest. The perimeter is calculated for each individual slice and then average over the slices in the region
xx_VOL_cm3	cm^3	Volume of the abdomen in the region of interest
xx_SAT_VOL_cm3	cm^3	Volume of the Subcutaneous Adipose Tissue in the region of Interest
xx_VAT_VOL_cm3	cm^3	Volume of the Visceral Adipose Tissue in the region of Interest
xx_AAT_VOL_cm3	cm^3	Volume of the Abdominal Adipose Tissue in the region of Interest ($AAT = SAT + VAT$)
xx_VAT_VOL_TO_SAT_VOL		Volume ratio of VAT/SAT
xx_VAT_VOL_TO_AAT_VOL		Volume ratio of VAT/AAT
xx_SAT_VOL_TO_AAT_VOL		Volume ratio of SAT/AAT
xx_W_VOL_cm3	cm^3	Weighted Volume of the abdomen in the region of interest
xx_WSAT_VOL_cm3	cm^3	Weighted Volume of the Subcutaneous Adipose Tissue in the region of Interest
xx_WVAT_VOL_cm3	cm^3	Weighted Volume of the Visceral Adipose Tissue in the region of Interest
xx_WAAT_VOL_cm3	cm^3	Weighted Volume of the Abdominal Adipose Tissue in the region of Interest ($WAAT = WSAT + WVAT$)
xx_WVAT_VOL_TO_WSAT_VOL		Volume ratio of $WVAT/WSAT$
xx_WVAT_VOL_TO_WAAT_VOL		Volume ratio of $WVAT/WAAT$
xx_WSAT_VOL_TO_WAAT_VOL		Volume ratio of $WSAT/WAAT$
FLAGS		The Pipeline additionally generates warning flags, cases with a flag different than **False** should visual inspect for assessing the segmentation quality and data inclusion. The generated flags are the follow : • VAT/SAT increase over the threshold : volume increase of over 40% between consecutive slices • High VAT to SAT ratio : VAT/SAT ratio higher that 2.0 • Check image contrast : Images with possible fat-water swap or extreme noise

References

[1] Ute A Ludwig, Florian Klausmann, Sandra Baumann, Matthias Honal, Jan-Bernd Hövener, Daniel König, Peter Deibert, and Martin Büchert. Whole-body mri-based fat quantification: A comparison to air displacement plethysmography. *Journal of Magnetic Resonance Imaging*, 40(6):1437–1444, 2014.