**Table S3** The definitions of radiomics features

|  |  |
| --- | --- |
| Features | Definition |
| Shape feature |  |
| Elongation | ElongationHere, and are the lengths of the largest and second largest principal component axes. The values range between 1 (where the cross section through the first and second largest principal moments is circle-like (non-elongated)) and 0 (where the object is a single point or 1 dimensional line). |
| Flatness | FlatnessHere, and are the lengths of the largest and smallest principal component axes. The values range between 1 (non-flat, sphere-like) and 0 (a flat object). |
| Least Axis Length | This feature yield the smallest axis length of the ROI-enclosing ellipsoid and is calculated using the largest principal component . In case of a 2D segmentation, this value will be 0. |
| Major Axis Length | MajorAxisLengthThis feature yield the largest axis length of the ROI-enclosing ellipsoid and is calculated using the largest principal component . |
| Minor Axis Length | MinorAxisLengthThis feature yield the second-largest axis length of the ROI-enclosing ellipsoid and is calculated using the largest principal component .  |
| Maximum 2D Diameter Column | Maximum 2D diameter (Column) is defined as the largest pairwise Euclidean distance between tumor surface voxels in the row-slice (usually the coronal) plane. |
| Maximum 2D Diameter Row | Maximum 2D diameter (Row) is defined as the largest pairwise Euclidean distance between tumor surface voxels in the column-slice (usually the sagittal) plane. |
| Maximum 2D Diameter Slice | Maximum 2D diameter (Slice) is defined as the largest pairwise Euclidean distance between tumor surface voxels in the row-column (generally the axial) plane. |
| Maximum 3D Diameter | Maximum 3D diameter is defined as the largest pairwise Euclidean distance between surface voxels in the ROI.Also known as Feret Diameter. |
| Sphericity | SphericitySphericity is a measure of the roundness of the shape of the tumor region relative to a sphere. It is a dimensionless measure, independent of scale and orientation.The value range is 0 < sphericity ≤ 1, where a value of 1 indicates a perfect sphere (a sphere has the smallest possible surface area for a given volume, compared to other solids). |
| Surface Area | AN is the number of triangles forming the surface mesh of the volume (ROI) and are the edges of the ith triangle formed by points , and .Surface Area is an approximation of the surface of the ROI in mm2, calculated using a marching cubes algorithm. |
| Surface Volume Ratio | SurfaceVolumeRatioHere, a lower value indicates a more compact (sphere-like) shape. This feature is not dimension less, and is therefore (partly) dependent on the volume of the ROI. |
| Voxel Volume | The volume of the ROI is approximated by multiplying the number of voxels in the ROI by the vol ume of a single voxel . This is a less precise approximation of the volume and is not used in subsequent features. This feature does not make use of the mesh and is not used in calculation of other shape features. |
| Mesh Volume | The volume of the ROI is calculated from the triangle mesh of the ROI. For each face *i* in the mesh, defined by points , and , the (signed) volume of the tetrahedron defined by that face and the origin of the image () is calculated. The sign of the volume is determined by the sign of the normal, which must be consistently defined as either facing outward or inward of the ROI. Then taking the sum of all V*i*, the total volume of the ROI is obtained.  |
| First order feature |  |
| 10Percentile | The 10th percentile of **X** |
| 90Percentile | The 90th percentile of **X** |
| Energy | Here, is optional value, dened by “voxelArrayShift”, which shifts the inten sities to prevent negative values in **X**. This ensures that voxels with the lowest gray values contribute the least to Energy, instead of voxels with gray level intensity closest to 0. Energy is a measure of the magnitude of voxel values in an image. A larger values implies a greater sum of the squares of these values.  |
| Entropy | Here, is an arbitrarily small positive number (≈ 2:2 × 10-16).Entropy species the uncertainty/randomness in the image values. It measures the average amount of information required to encode the image values |
| Interquartile Range | InterquartileRangeHere and are the 25th and 75th percentile of the image array, respectively. |
| Kurtosis | Where µ4 is the 4th central moment.Kurtosis is a measure of the “peakedness” of the distribution of values in the image ROI. A higher kurtosis implies that the mass of the distribution is concentrated towards the tail(s) rather than towards the mean. A lower kurtosis implies the reverse: that the mass of the distribution is concentrated towards a spike near the Mean value.  |
| Maximum | Maximum = max(**X**)The maximum gray level intensity within the ROI. |
| Mean Absolute Deviation | Mean Absolute Deviation is the mean distance of all intensity values from the Mean Value of the image array. |
| Mean | The average gray level intensity within the ROI. |
| Median | The median gray level intensity within the ROI. |
| Minimum | Minimum = min(**X**) |
| Range | Range = max(**X**) - min(**X**)The range of gray values in the ROI. |
| Robust Mean Absolute Deviation | Robust Mean Absolute Deviation is the mean distance of all intensity values from the Mean Value calculated on the subset of image array with gray levels in between, or equal to the 10th and 90thpercentile. |
| Root Mean Squared | Here, is optional value, defined by “voxelArrayShift”, which shifts the intensities to prevent negative values in **X**. This ensures that voxels with the lowest gray values contribute the least to RMS, instead of voxels with gray level intensity closest to 0.RMS is the square-root of the mean of all the squared intensity values. It is another measure of the magnitude of the image values. This feature is volume-confounding, a larger value of increases the effect of volume-confounding. |
| Skewness | Where µ3 is the 3rd central moment.Skewness measures the asymmetry of the distribution of values about the Mean value. Depending on where the tail is elongated and the mass of the distribution is concentrated, this value can be positive or negative.  |
| Total Energy | Here, is optional value, defined by “voxelArrayShift”, which shifts the intensities to prevent negative values in **X**. This ensures that voxels with the lowest gray values contribute the least to RMS, instead of voxels with gray level intensity closest to 0.Total Energy is the value of Energy feature scaled by the volume of the voxel in cubic mm. |
| Uniformity | Uniformity is a measure of the sum of the squares of each intensity value. This is a measure of the heterogeneity of the image array, where a greater uniformity implies a greater heterogeneity or a greater range of discrete intensity values. |
| Variance | Variance is the the mean of the squared distances of each intensity value from the Mean value. This is a measure of the spread of the distribution about the mean. By denition, variance = *σ2* |
| GLCM feature |  |
| Autocorrelation |  |
| Joint Average |  |
| Cluster Prominence |  |
| Cluster Shade |  |
| Cluster Tendency |  |
| Contrast |  |
| Correlation |  |
| Difference Average |  |
| Difference Entropy |  |
| Difference Variance |  |
| Joint Energy |  |
| Joint Entropy |  |
| Imc1 |  |
| Imc2 |  |
| Idm |  |
| Idmn |  |
| Id |  |
| Idn |  |
| Inverse Variance |  |
| Maximum Probability |  |
| Sum Entropy |  |
| Sum Squares |  |
| GLRLM feature |  |
| Gray Level NonUniformity |  |
| Gray Level NonUniformity Normalized |  |
| Gray Level Variance |  |
| High Gray Level Run Emphasis |  |
| Long Run Emphasis |  |
| Long Run High Gray Level Emphasis |  |
| Long Run Low Gray Level Emphasis |  |
| Low Gray Level Run Emphasis |  |
| Run Entropy |  |
| Run Length NonUniformity |  |
| Run Length NonUniformity Normalized |  |
| Run Percentage |  |
| Run Variance |  |
| Short Run Emphasis |  |
| Short Run High Gray Level Emphasis |  |
| Short Run Low Gray Level Emphasis |  |
| GLSZM feature |  |
| Gray Level NonUniformity |  |
| Gray Level NonUniformity Normalized |  |
| Gray Level Variance |  |
| High Gray Level Zone Emphasis |  |
| Large Area Emphasis |  |
| Large Area High Gray Level Emphasis |  |
| Large Area Low Gray Level Emphasis |  |
| Low Gray Level Zone Emphasis |  |
| Size Zone NonUniformity |  |
| Size Zone NonUniformity Normalized |  |
| Small Area Emphasis |  |
| Small Area High Gray Level Emphasis |  |
| Small Area Low Gray Level Emphasis |  |
| Zone Entropy |  |
| Zone Percentage |  |
| Zone Variance |  |
| GLDM feature |  |
| Dependence Entropy |  |
| Dependence NonUniformity |  |
| Dependence NonUniformity Normalized |  |
| Dependence Variance |  |
| Gray Level NonUniformity |  |
| Gray Level Variance |  |
| High Gray Level Emphasis |  |
| Large Dependence Emphasis |  |
| Large Dependence High Gray Level Emphasis |  |
| Large Dependence Low Gray Level Emphasis |  |
| Low Gray Level Emphasis |  |
| Small Dependence Emphasis |  |
| Small Dependence High Gray Level Emphasis |  |
| Small Dependence Low Gray Level Emphasis |  |