OverallGeneralMeasures:

Calculate overall SpO2 features.

Parameters:

- Signal: The SpO2 time series.
- ZC_Baseline: Baseline for calculating number of zero-crossing points. Typically use mean of the signal. Default value is mean of the signal.
- percentile: Percentile to perform. For example, for percentile 1, the argument should be 1. Default value is 1
- M_Threshold: Percentage of the signal m_threshold % below median oxygen saturation. Typically use 1, 2 or 5. Default value is 2.
- DI_Window: Window to calculate Delta Index. Default values is 12.

Returns:

OverallGeneralMeasuresResult class containing the following fields:

- AV: Average of the signal.
- MED: Median of the signal.
- Min: Minimum value of the signal.
- SD: Std of the signal.
- RG: SpO2 range (difference between the max and min value).
- P: percentile.
- M: Percentage of the signal x% below median oxygen saturation.
- ZC: Number of zero-crossing points.
- DI: Delta Index.

ODIMeasure:

Calculate ODI (average number of desaturation events per hour).

Parameters:

- Signal: The SpO2 time series.
- ODI_Threshold: Threshold to compute Oxygen Desaturation Index. Default values is 3.

Returns:

ODIMeasureResult class containing the following fields:

- ODI. It is the average number of desaturation events per hour. A desaturation is defined as SpO2 drops by x% below the baseline.
- begin: List of indices of beginning of each desaturation event.
- end: List of indices of end of each desaturation event.

DesaturationsMeasures:

Calculate Desaturations events-related features.

Parameters:

- signal: The SpO2 time series.
- begin: list of indices of beginning of each desaturation event. Typically, the list returned by the API odi_measure can be entered here.
- end is the indices of the end of those events. Typically, the list returned by the API odi_measure can be entered here.

Returns:

ODIMeasureResult class containing the following fields:

- DL_u: Mean of desaturation length
- DL_sd: Standard deviation of desaturation length
- DSA100_u: Mean of desaturation area using 100% as baseline.
- DSA100_sd: Standard deviation of desaturation area using 100% as baseline
- DSAmax_u: Mean of desaturation area using max value as baseline.
- DSAmax_sd: Standard deviation of desaturation area using max value as baseline
- DD100_u: Mean of depth desaturation from 100%.
- DD100_sd: Standard deviation of depth desaturation from 100%.
- DDmax_u: Mean of depth desaturation from max value.
- DDmax_sd: Standard deviation of depth desaturation from max value.
- DS_u: Mean of the desaturation slope.
- DS_sd: Standard deviation of the desaturation slope.
- TD_u: Mean of time between two consecutive desaturation events.
- TD_sd: Standard deviation of time between 2 consecutive desaturation events.

HypoxicBurdenMeasures:

Calculate Hypoxic Burden SpO2 Features.

Parameters:

- signal: The SpO2 time series.
- begin: list of indices of beginning of each desaturation event. Typically, the list returned by the API odi_measure can be entered here.
- end is the indices of the end of those events. Typically, the list returned by the API odi_measure can be entered here.
- CT_Threshold: Percentage of the time spent below the "ct_threshold" % oxygen saturation level. Typically use CT90. Default value is 90.
- CA_Baseline: Baseline to compute the CA feature. Default value is mean of the signal.

Returns:

HypoxicBurdenMeasuresResults containing the following fields:

- CA: Integral SpO2 below the baseline normalized by the total recording time
- CT: Percentage of the time spent below the threshold
- CDL: Cumulative duration of desaturations normalized by the total recording time
- AODmax: Cumulative area of desaturations using max value as baseline.
- AOD100: Cumulative area of desaturations using 100% as baseline.

ComplexityMeasures:

Calculate Complexity SpO2 Features.

Parameters:

- Signal: The SpO2 time series.
- CTM_Threshold: Radius of Central Tendency Measure. Default value is 0.25.
- DFA_Window: Length of window to calculate DFA biomarker. Default value is 20.
- M_Sampen: Embedding dimension to compute SampEn.
- R_Sampen: Tolerance to compute SampEn.

Returns:

Pandas Dataframe containing the following features:

- ApEn: Approximate Entropy.
- LZ: Lempel-Ziv complexity.
- CTM: Central Tendency Measure.
- SampEn: Sample Entropy.
- DFA: Detrended Fluctuation Analysis.

PRSAMeasures:

Calculate PRSA SpO2 Features.

Parameters:

- Signal: The SpO2 time series.
- PRSA_Window: Fragment duration of PRSA.
- K_AC: Number of values to shift when computing autocorrelation.

Returns:

PRSAResults class containing the following fields:

- PRSAc: PRSA capacity.
- PRSAad: PRSA amplitude difference.
- PRSAos: PRSA overall slope.
- PRSAsb: PRSA slope before the anchor point.
- PRSAsa: PRSA slope after the anchor point.
- AC: Autocorrelation.

PSDMeasures:

Calculate PRSA SpO2 Features.

Parameters:

- Signal: The SpO2 time series.

Returns:

PRSAResults class containing the following fields:

- PSD_total: The area enclosed in the FFT signal.
- PSD_band: The area enclosed in the FFT signal, within the band $0.014 - 0.033\ Hz$.
- PSD_ratio: Ratio of area enclosed in the FFT signal within the band $0.014 - 0.033\ Hz$, with respect to the total area.
- PSD_peak: Peak amplitude of the FFT signal within the band $0.014 - 0.033\ Hz$.

<u>SetRange:</u>

Remove abnormalities of SpO2 signal, i.e values greater than 100 or lower than 50.

Parameters:

- Signal: The SpO2 time series.

Returns:

The processed signal.

ResampSpO2:

Resample the SpO2 signal to 1Hz.

Parameters:

- Signal: The SpO2 time series.
- OriginalFreq: The original frequency.

Returns:

The resampled signal.

MedianSpO2:

Apply a median filter to smooth the SpO2 signal.

Parameters:

- Signal: The SpO2 time series.
- FilterLength: The length of the filter. Default value is 9.

Returns:

The processed signal.

		Name	Definition	Unit
General statistics	1	AV	SpO2 mean	%
	2	MED	SpO2 median	%
	3	Min	SpO2 min	%
	4	SD	SpO2 standard deviation	%
	5	RG	SpO2 range	%
	6	Pxx	xxth percentile SpO2 value, by default xx = 1	%
	7	Mx	Percentage of the signal xx% below median oxygen saturation, by default xx = 2	%
	8	ZCxx	Number of zero-crossing points at the xx% SpO2 level (Xie and Minn 2012), by default xx = AV	nu
	9	ΔIx	Delta index (Pepin *et al* 1991). The default value of the windows is 12 seconds.	nu
Desaturation measures	10	ODIxx	The oxygen desaturation index (Jung *et al* 2018, Behar *et al* 2020), by default xx = 3	Event/h
	11	DL_μ	Mean of desaturations length	sec
	12	DL_σ	Standard deviation of desaturations length	sec^2
	13	$DDmax_\mu$	Mean of desaturations depth	%
	14	$DDmax_\sigma$	Standard deviation of desaturations depth	%^{2}
	15	$DD100_\mu$	Mean of desaturations depth using 100% SpO2 level as baseline	%
	16	$DD100_\sigma$	Standard deviation of desaturations depth using 100% SpO2 level as baseline	%^{2}
	17	DS_μ	Mean of the desaturation slope	%/sec
	18	DS_σ	Standard deviation of the desaturation slope	(%/sec)^2
	19	$DAmax_\mu$	Desaturation area defined as the mean of desaturation area using the maximum SpO2 value in each desaturation event as baseline	%*sec
	20	$DAmax_\sigma$	Standard deviation of desaturation area	(%*sec)^2
	21	$DA100_\mu$	Desaturation area: mean of desaturation area under the 100% SpO2 level as baseline	%*sec
	22	$DA100_\sigma$	Standard deviation of desaturation area under the 100% SpO2 level as baseline	(%*sec)^2
	23	TD_μ	Mean of time between two consecutive desaturation events	sec
	24	TD_σ	Standard deviation of time between 2 consecutive desaturation events	sec^2

Hypoxic burden	25	PODxx	Time of oxygen desaturation event, normalized by the total recording time (Kulkas *et al* 2013), by default xx = 3	sec
	26	AODmax	The area under the oxygen desaturation event curve (Kulkas *et al* 2013), using the maximum SpO2 value as baseline and normalized by the total recording time	%*sec
	27	AOD100	Cumulative area of desaturations under the 100% SpO2 level as baseline and normalized by the total recording time	%*sec
	28	CTxx	Cumulative time below the xx% oxygen saturation level, by default xx = 90	%
	29	CAxx	Integral of SpO2 below the xx SpO2 level normalized by the total recording time, by default xx = AV	%*sec
Non-linear	30	ApEn	Approximate entropy (Pincus 1991)	nu
	31	LZ	Lempel-Ziv complexity (Lempel and Ziv 1976)	nu
	32	CTMxx	Central tendency measure (Álvarez *et al* 2006) with radius xx, , by default xx = 0.25	nu
	33	SampEn	Sample entropy (Richman and Moorman 2000)	nu
	34	DFA	Detrended fluctuation analysis (Peng *et al* 1995a)	%
Periodicity	35	$PRSAd_c$	PRSA capacity (Bauer *et al* 2006, Deviaene *et al* 2019a). With d the fragment duration, by default $d = 10$.	%
	36	$PRSAd_{ad}$	PRSA amplitude difference (Bauer *et al* 2006, Deviaene *et al* 2019a). With d the fragment duration, by default $d = 10$.	%
	37	$PRSAd_{os}$	PRSA overall slope (Bauer *et al* 2006, Deviaene *et al* 2019a). With d the fragment duration, by default $d = 10$.	%/sec
	38	$PRSAd_{sb}$	PRSA slope before the anchor point (Bauer *et al* 2006, Deviaene *et al* 2019a). With d the fragment duration, by default $d = 10$.	%/sec
	39	$PRSAd_{sa}$	PRSA slope after the anchor point (Bauer *et al* 2006, Deviaene *et al* 2019a). With d the fragment duration, by default $d = 10$.	%/sec
	40	AC	Autocorrelation (Deviaene *et al* 2019a)	$\%^2$
	41	PSD_total	The area enclosed in the FFT signal (Zamarrón Sanz *et al* 1999)	%
	42	PSD_band	The area enclosed in the FFT signal, within the band $0.014 - 0.033\ Hz$ (Zamarrón Sanz *et al* 1999)	%
	43	PSD_ratio	Ratio of area enclosed in the FFT signal within the band $0.014 - 0.033\ Hz$, with respect to the total area (Zamarrón Sanz *et al* 1999)	nu
	44	PSD_peak	Peak amplitude of the FFT signal within the band $0.014 - 0.033\ Hz$ (Zamarrón Sanz *et al* 1999)	%