Table of possible features to train the model:

Table 2.1: Summary of features derived from source material for stroke ML model training, focusing on Neural Avalanches (NAs) and explainability.

Feature/Metric Name	**What It Measures (Significance)**	**How It Is Measured**	**Linked Metrics and Relationship**
Neuronal Avalanches (NAs)	Aperiodic, scale-free bursts of activity nested within oscillations, representing dynamic, optimal, and flexible large-scale brain dynamics.	Identified as events starting when at least one source-reconstructed signal deviates significantly (e.g., $\|z\| > 2.5$ or $\|z\| > 3$ standard deviations) and ending when all regions return to baseline. Requires specific temporal binning (e.g., ≈ 8 ms).	**ATM, ASM, Size, Duration**. NA emergence is linked to **SGDC** and $1/f$ **activity**.
Avalanche Transition Matrix (ATM)	Quantifies the **spatio-temporal spreading** and trajectories of NAs. Captures the probability of perturbation propagation across brain regions.	A matrix where element (i, j) is the probability that region j was active at time $t + \delta$ (time lag, e.g., ≈ 8 ms) given region i was active at time t. Matrices are averaged across individual avalanches.	**Nodal Strength/EC, PI**. Using a time lag minimizes spurious zero-lag correlations due to volume conduction.
Nodal Strength / Eigenvector Centrality (EC)	Measures the **network centrality** or **involvement** of a specific brain region (node) in the process of avalanche spreading. Higher centrality (EC) indicates a region is more recruited by transient bursts.	Calculated from the ATM as a topological parameter. Nodal Strength is the sum of probabilities (ij-edges) that a node interacts with all others during spreading. EC measures how central a node is in the transition matrix.	**ATM**. Found to correlate with clinical measures (e.g., disease duration in ALS; memory performance in TLE).
Functional Repertoire Size	A measure of **brain flexibility**. Quantified as the total number of distinct and unique avalanche patterns observed over time.	Defined as the number of unique spatial activation patterns (sets of recruited regions) occurring during all detected avalanches.	**NA**. Derived directly from the set of observed avalanche patterns. Linked to predicting disease severity.

Table 2.1: Summary of features derived from source material for stroke ML model training, focusing on Neural Avalanches (NAs) and explainability.

Feature/Metric Name	What It Measures (Significance)	How It Is Measured	Linked Metrics and Relationship
Avalanche Size / Duration (Life Span)	Traditional metrics characterizing the overall scale-free dynamics of NAs. Size is the total number of active regions; Duration is the total time length.	Measured by counting the total number of active brain regions (Size) or the time bins elapsed (Duration) during an avalanche.	**Mean Spatial Extension/Duration (BROI-wise)**. Regional averages of global metrics.
Avalanche Spectral Matrix (ASM)	Characterizes the **spectral fingerprint** of NAs, linking avalanche occurrences to underlying oscillatory and non-oscillatory activity.	Computed by selectively averaging the whitened time-frequency content (e.g., scalograms using Morlet wavelets) across the time points corresponding to an NA.	**Alpha Band**. NAs display a significant spectral signature in the alpha band (8-13 Hz). Used as the basis for **Avalanche Clustering**.
Spectral Group Delay Consistency (SGDC(r))	Quantifies local **"burstiness"** and the consistency of phase alignment (group delay) across spectral components *within a single brain region.* High SGDC(r) promotes large amplitude, above-threshold fluctuations.	Calculated as one minus the circular variance of the incremental phase across frequencies within a region (Equation 1/A.18).	**Kurtosis, Local Above-Threshold Fluctuations**. Positively correlated with the number of local salient events (bursts).
Spectral Group Delay Consistency (SGDC(ω))	Quantifies the **transient cross-regional synchronization** of above-threshold bursts at a *specific frequency* (ω), such as the alpha band.	Calculated as one minus the circular variance of the incremental phase across brain regions (Equation 2/A.19).	**NA Emergence, pSGDC**. Key ingredient for realistic NA emergence. Supports the co-occurrence of alpha bursts across regions.
Pairwise SGDC (pSGDC)	Quantifies **co-bursting** and cross-regional bursts synchronization between a pair of regions (r_1, r_2), mechanistically linking spectral coherence to simultaneous bursts.	Combines the mean burstiness (average of SGDC(r_1) and SGDC(r_2)) with the correlation of group delays across frequency values (Eq. A.23).	**Co-activation, Cokurtosis**. Correlates significantly with observed NA co-activation patterns.
Co-activation Matrix / Profile	Measures the **topography of co-activations**, indicating how frequently pairs of brain regions are jointly recruited during avalanches.	Calculated by counting the total number of co-participations (co-activations) of pairs of regions across all detected avalanches.	**pSGDC, Cokurtosis**. Significantly correlates with both pSGDC and Cokurtosis measures.
Propagation Index (PI)	Represents a **global summary measure** of the overall flow or "propagation" capacity captured by the ATM.	Computed as the mean across the non-zero elements of the ATM.	**ATM**. Used to check correlation with clinical factors like age and epilepsy duration.

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Feature/Metric Name	**What It Measures (Significance)**	**How It Is Measured**	**Linked Metrics and Relationship**
SHAP Value ($\phi_{i,j}$)	Provides **feature-based interpretability** for the ML model, quantifying the fair and unbiased contribution of feature j to the prediction of sample i. Explains *why* the prediction deviated from the average prediction.	Calculated using methods derived from Shapley values (e.g., TreeSHAP or Kernel SHAP). Weighted averages of a feature's marginal contributions across all possible coalitions.	**Model Prediction**. The sum of all SHAP values plus the average prediction equals the individual prediction: $f(i) = \phi_o + \sum \phi_{i,j}$. Values are expressed in the units of the model prediction.