

Glossary of Radio Astronomy and AI/ML Terms

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1 Radio Astronomy Terms

- **Radio Telescope:** A specialized antenna and receiver used to detect radio waves from astronomical radio sources in the sky.
- **Interferometry:** Combines signals from multiple telescopes to simulate a larger aperture, enhancing resolution and sensitivity.
- **Aperture Synthesis:** Combines data from an array of telescopes to create high-resolution images of celestial objects.
- **Baseline:** The distance and orientation between two telescopes in an array, crucial for resolution and imaging capabilities.
- **Spectral Line:** Specific frequencies of electromagnetic radiation emitted or absorbed by atoms and molecules, used to study celestial objects.
- **Continuum Emission:** Broadband radio emission spanning a wide frequency range, typically from synchrotron radiation or thermal processes.
- **Polarization:** The orientation of electromagnetic wave oscillations; provides information on magnetic fields and emission mechanisms.
- **Synchrotron Radiation:** Radiation generated by charged particles spiraling around magnetic field lines at relativistic speeds.
- **Cosmic Microwave Background (CMB):** Thermal radiation from the Big Bang, offering insights into the early universe.
- **Very Long Baseline Interferometry (VLBI):** An interferometry technique using telescopes thousands of kilometers apart to achieve high angular resolution.

2 Radio Frequency Interference (RFI) Terms

- **Radio Frequency Interference (RFI):** Unwanted radio signals from human-made sources contaminating astronomical observations.
- **RFI Mitigation:** Techniques to reduce or eliminate RFI impact on radio astronomical data.
- **Spectral Masking:** RFI mitigation by excluding contaminated frequency channels from analysis.
- **Time-Domain Filtering:** Removes RFI based on temporal characteristics like impulsive or periodic signals.
- **Spatial Filtering:** Uses spatial information from telescope arrays to filter RFI from specific directions.
- **Adaptive Filtering:** Dynamic filtering that adjusts to changing RFI conditions in real-time.
- **Flagging:** Marks contaminated data (e.g., time-frequency bins) for exclusion from analysis.
- **Baseline Calibration:** Adjusts measurements from different telescopes to a common reference for accurate RFI identification.

3 Artificial Intelligence (AI) and Machine Learning (ML) Terms

- **Artificial Intelligence (AI):** Systems capable of tasks requiring human intelligence, like learning, reasoning, and problem-solving.
- **Machine Learning (ML):** Algorithms enabling computers to learn from and make predictions based on data.
- **Deep Learning:** ML algorithms using neural networks with multiple layers for complex pattern modeling.
- **Neural Network:** A model with interconnected nodes (neurons) processing information in layers.
- **Convolutional Neural Network (CNN):** Neural networks for grid-like data (e.g., images), widely used in pattern recognition.
- **Recurrent Neural Network (RNN):** Handles sequential data by maintaining a memory of prior inputs, useful for time-series analysis.
- **Supervised Learning:** ML model training on labeled data to map inputs to outputs.
- **Unsupervised Learning:** ML model identifying patterns in unlabeled data without predefined categories.
- **Reinforcement Learning:** Agent learns by performing actions and receiving rewards or penalties.
- **Feature Extraction:** Transforms raw data into characteristics for ML tasks.
- **Classification:** ML task of assigning input data to predefined categories.

- **Regression:** Predicts continuous values based on input data.
- **Overfitting:** When a model learns training data noise, leading to poor generalization.
- **Cross-Validation:** Assesses model generalization by partitioning data into subsets.
- **Hyperparameter Tuning:** Optimizes training parameters for ML model performance.
- **Transfer Learning:** Reusing a model for one task as a starting point for another related task.
- **Dimensionality Reduction:** Reduces input variables while preserving essential information.
- **Support Vector Machine (SVM):** Classifies data by finding the optimal hyperplane in feature space.
- **Random Forest:** Ensemble method combining multiple decision trees for accuracy.
- **Principal Component Analysis (PCA):** Transforms data into orthogonal components, reducing dimensionality.

4 AI/ML Applications in RFI Mitigation

- **Anomaly Detection:** Identifies unusual patterns indicating RFI presence.
- **Signal Classification:** Uses ML to categorize signals, distinguishing between astronomical sources and RFI.
- **Blind Source Separation:** Separates multiple sources without prior knowledge, isolating RFI.
- **Time-Frequency Analysis:** Analyzes signals in time and frequency to identify and mitigate RFI.
- **Real-Time Processing:** AI/ML for immediate RFI mitigation during data collection.
- **Data Augmentation:** Enhances ML model robustness against RFI by expanding training data.

5 Additional Relevant Terms

- **Signal-to-Noise Ratio (SNR):** Compares desired signal level to background noise, assessing data quality.
- **Dynamic Range:** The ratio between largest and smallest values, important for capturing weak and strong signals.
- **Calibration:** Adjusts radio telescope system parameters for accurate measurements.
- **Beamforming:** Directs signal reception or transmission in specific directions.
- **Data Pipeline:** Processes raw data from collection to analysis, including preprocessing and feature extraction.