General Limit Order Book Format

$$LOB_t = \{(p_i, v_i, d_i) \mid i = 1, 2, \ldots, N\}$$

where p_i represents price level, v_i is the volume at price p_i, and d_i is the direction ($+1$ for buy, -1 for sell).

Base Features (Computed with Rust)

$$\text{Mid } (\textit{Midpoint Price}) = \frac{A + B}{2}$$

$$\text{Spread } (\textit{Spread}) = A - B$$

$$\text{VolImb } (\textit{Volume Imbalance}) = \frac{V_B - V_A}{V_B + V_A}$$

$$\text{PWVolImb } (\textit{Price-Weighted Volume Imbalance}) = \frac{\sum_i p_i v_i d_i}{\sum_i v_i}$$

$$\text{MomentumN } (\textit{Momentum with respect to N periods}) = P_t - P_{t-N}$$

$$\text{VolatilityN } (\textit{Volatility computed with respect to N periods}) = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(r_i - \bar{r})^2}$$

$$\text{DepthN } (\textit{Depth in top N levels}) = \sum_{i=1}^{N} v_i^{\text{bid}} + \sum_{i=1}^{N} v_i^{\text{ask}}$$

Advanced Features (Computed with Python)

FFT_BaseFeature_K (*Fast Fourier Transform of BaseFeature over K periods*)
SpecDens_BaseFeature_K (*Spectral Density of BaseFeature computed over K periods*)
SpecCentroid_BaseFeature_K (*Spectral Centroid of BaseFeature*)
SpecSpread_BaseFeature_K (*Spectral Spread of BaseFeature*)
SpecEntropy_BaseFeature_K (*Spectral Entropy of BaseFeature*)

Mathematical Definitions for Spectral Features

$$\text{FFT\_BaseFeature\_K} = \sum_{k=0}^{K-1} x_k e^{-i2\pi k/K}$$

$$\text{SpecDens\_BaseFeature\_K} = \frac{1}{K}\sum_{k=0}^{K-1} |X_k|^2$$

$$\text{SpecCentroid\_BaseFeature\_K} = \frac{\sum_{k=0}^{K-1} k|X_k|^2}{\sum_{k=0}^{K-1} |X_k|^2}$$

$$\text{SpecSpread\_BaseFeature\_K} = \sqrt{\sum_{k=0}^{K-1}\left(\frac{k}{K} - \text{SpecCentroid\_BaseFeature\_K}\right)^2 |X_k|^2}$$

$$\text{SpecEntropy\_BaseFeature\_K} = -\sum_{k=0}^{K-1} P_k \log P_k, \quad P_k = \frac{|X_k|^2}{\sum_{m=0}^{K-1} |X_m|^2}$$