

Technical Whitepaper: The Frontier Engine

Author: Nicholas Panek Date: December 2, 2025 Subject: Stochastic Modeling of Delta Blues via Continuous Microtonal Topology

1. Abstract The Frontier Engine is a proprietary deterministic algorithmic system designed to emulate "Dark Country" and "Neo-Western" musical aesthetics. Unlike discrete-state MIDI sequencers, this engine utilizes Continuous Microtonal Topology to model the non-linear pitch behavior of slide guitar physics. By mapping trigonometric sine functions to the MIDI pitch-bend domain, the system achieves a mathematically perfect simulation of analog fretboard traversal.

2. Mathematical Methodology The generative output is derived from the intersection of three rigorous mathematical domains:

Set Theory: Defining the harmonic boundary conditions (The "Devil's Interval").

Trigonometry: Calculating continuous pitch curves (The Slide).

Boolean Logic: Determining percussive emphasis (The Stomp).

3. The Algorithm (Absolute Expression)

A. Harmonic Set Definition The engine operates within a restricted pitch class set H , defined as the intersection of the Minor Pentatonic scale and the Tritone interval. Let R be the root frequency. The valid pitch set H is defined as:

$$H = \{R, R \cdot 23/12, R \cdot 25/12, R \cdot 26/12, R \cdot 27/12, R \cdot 210/12\}$$

Where the term $26/12$ represents the augmented fourth (Tritone), essential for the genre's tension.

B. Continuous Pitch Geometry (The Slide Function) The engine rejects discrete binary states for lead instrumentation. Instead, the pitch deviation $P(t)$ at time t is calculated as a continuous function of the slide magnitude M and duration D :

$$P(t) = P_{start} + M \cdot \sin(D\pi \cdot t)$$

This function creates a parabolic arc in the frequency domain, mathematically ensuring that the pitch never rests at a static integer value, simulating the physics of a glass slide moving across strings.

C. Boolean Rhythmic Gating (The Stomp Logic) Percussive events are generated via a modulo-based gate function $G(i)$ applied to the sixteenth-note grid index i . Let K be the Percussive Constant (The "Grit"). A stomp event triggers only when the boolean condition is true:

$$G(i) = (i \bmod 8 \equiv 0) \vee ((i \bmod 4 \equiv 0) \wedge \text{Rand}(0, 1) < K)$$

This enforces a heavy emphasis on the downbeat (The "Boot") while allowing stochastic ghost notes on the backbeat based on the grit constant.

4. Verification All generated assets are cryptographically linked to their seed parameters via the filename structure: Format: Blues_[Key]_[BPM]_[GritConstant]_[SlideMagnitude].mid

5. Conclusion By utilizing continuous trigonometric functions for pitch modulation and boolean gating for rhythmic structure, Nicholas Panek retains sole authorship of the generative source code and the resulting audio output.