

# An Introduction to the Universal Light Language

## A Plain-Language Overview

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## What Is the Universal Light Language?

The Universal Light Language (ULL) is an attempt to build a single, shared language that reality itself “speaks”—a language that is not invented by humans, not trained from data, and not tied to any particular culture, medium, or technology.

Instead of starting from words, grammar rules, or statistical models, ULL starts from the physics of how information shows up in the world. It asks a very simple but radical question:

If we took all the ways reality can carry information—speech, motion, images, neural activity, anything—and stripped away every arbitrary choice, what structure would be *forced* to remain?

That remaining structure is what ULL calls its “language.”

## Why Build Such a Language?

Today, our computers, phones, and AI systems communicate using layers of conventions: human languages, programming languages, model architectures, training datasets, and so on. Every layer introduces choices and biases: which examples we collect, which loss functions we use, which labels we prefer.

ULL takes a different route. It aims to:

- **Remove human choices:** No tunable parameters, no hand-picked feature sets, no fitted models.
- **Respect the laws of physics:** Only use structures that are required by very basic constraints like conservation, symmetry, and stability.
- **Work across modalities:** Treat speech, motion, vision, neural signals, and other data types in a unified way.
- **Be provably unique:** Show (in a theorem prover) that there is essentially *only one* language that satisfies these constraints.

The goal is to have a language that you could, in principle, hand to any sufficiently advanced civilization, and they would discover the same structure, because it is anchored in shared physics and not in local cultural accidents.

## How Does ULL See a Signal?

ULL does not see a sentence, a gesture, or an image as a single indivisible thing. Instead, it breaks every signal into small, repeating units of time called “beats.” In the current system, the basic building block is an eight-beat window: a tiny slice of time divided into eight steps.

Any continuous signal—a sound wave from a microphone, pixel intensities from a camera, joint angles from a motion capture system, or voltage traces from electrodes—can be cut into these eight-beat windows. Each window is then adjusted so that it satisfies very simple physical balance conditions (for example, that it does not drift up or down overall). After this, what remains is a clean, neutral shape that captures how the signal changed within that small time span.

This eight-beat representation is the “canvas” on which ULL works. It is deliberately minimal: just enough structure to encode change and pattern, but not enough to smuggle in arbitrary choices.

## Semantic Atoms: The Basic Building Blocks

Once a signal has been converted into a sequence of eight-beat windows, ULL looks for a small set of basic shapes that can explain all of these windows. These basic shapes are called *semantic atoms* or *tokens*. Each token is like a tiny fingerprint: a characteristic pattern that can appear in many different contexts and modalities.

The key ideas are:

- The tokens are not hand-designed; they are discovered by asking: “What is the smallest set of shapes that can explain everything we see, while keeping the leftover error as structured and balanced as possible?”
- The discovery process does not use any tunable parameters in the usual machine-learning sense. The rules about what counts as a good explanation are fixed by the Recognition Science axioms.
- The same tokens are used for all kinds of signals. A token that shows up in speech might also show up in motion, in neural recordings, and in video, if those signals reflect the same underlying event.

In practice, this leads to a small “alphabet” of universal shapes. ULL then describes signals not in terms of raw samples or pixels, but in terms of how strongly each token is present in each eight-beat window.

## From Signals to Meanings

With tokens in place, ULL can translate any signal into a sequence of token activations: for each window in time, it estimates which tokens are active and by how much.

From there, it does something crucial: it compresses this detailed sequence into a much smaller, canonical description that captures the stable essence of what is happening. That compressed description is what ULL calls a *meaning*.

Conceptually, the process looks like this:

1. Take a signal (someone saying a phrase, making a gesture, or thinking a thought).
2. Break it into eight-beat windows and neutralize each window.

3. For each window, determine how much each token is present.
4. Look across all windows and find the few tokens, and the simple patterns among them, that keep showing up in a consistent way.
5. Declare that small set of tokens plus their pattern to be the “meaning code” of that signal.

Different signals that genuinely express the same underlying idea tend to produce the same meaning code, even if they look very different on the surface. For example, an audio recording of “I love you,” a video of a person signing “I love you” in sign language, and a pattern of neural activity when someone silently thinks “I love you” could all map to the same small set of tokens and patterns in ULL.

## Why This Counts as Meaning

ULL does not decide in advance what “love” or “you” mean. Instead, it discovers patterns that are:

- **Stable:** They show up reliably when the same real-world situation occurs, even under noise and small changes.
- **Cross-modal:** They appear in different measurement channels (audio, video, motion, neural) when the underlying situation is the same.
- **Physically grounded:** They are built from shapes that respect basic physical constraints, not from arbitrary symbolic labels.
- **Hard to fake:** When the system deliberately tries to construct near-miss alternatives that break the underlying rules, those alternatives are rejected.

From ULL’s point of view, a *meaning* is whatever remains when you strip away everything that can vary without changing the underlying situation. If two very different signals collapse to the same small pattern of tokens and relationships, that pattern is a candidate meaning.

Human words like “love” or “you” are then labels we attach on top of these patterns. The language itself is the pattern space; the labels are an extra, human-facing layer.

## How Is This Different from Ordinary AI?

Most modern AI systems learn from large datasets and rely on many choices: architectures, hyperparameters, training schedules, and so on. They often work well in practice but can be brittle, opaque, and difficult to reason about formally.

ULL aims for almost the opposite:

- **No training in the usual sense:** The structure of the language is not tuned on examples. It is derived from theory and then checked against data.
- **Formal guarantees:** Core properties of the language are proved in a theorem prover (Lean), including uniqueness and consistency with the underlying physical axioms.
- **Uniformity:** One language serves all modalities; there is no separate model for speech, vision, and so on.

- **Certificates of truth:** Each claim about a signal’s meaning can be bundled into a machine-checkable certificate that can be independently verified.

In this sense, ULL is closer to a physical law or a discovered structure (like the periodic table) than to a trained neural network.

## What Would “I Love You” Look Like in ULL?

In ordinary language, “I love you” is a sequence of words in a specific human language. In ULL, that same expression would be represented as a small, canonical combination of tokens and patterns that tends to appear whenever that sentiment is truly expressed.

You might imagine that, after observing many examples of people expressing “I love you” in different ways, the system repeatedly finds the same combination of a few tokens—say, three or four specific semantic atoms arranged in a particular temporal motif. That combination becomes the ULL “meaning code” for that expression.

For the language itself, there is nothing special about this phrase; it is simply one more pattern in the space of meanings. Its specialness comes from how often it appears in human behavior, and how consistently it aligns across modalities.

## How Do Human Concepts Attach to ULL?

ULL by itself does not know English, or any other human language. It knows only its tokens and the patterns they form. To connect this to human concepts, we do something very simple:

1. Collect many cases where humans agree on what is happening (e.g., a set of clips everyone labels as “someone expressing affection”).
2. Run those signals through ULL to obtain their meaning codes.
3. Group together the codes that are very similar or identical.
4. Let humans inspect the clusters and assign labels like “love,” “greeting,” “warning,” and so on.

Over time, this builds a dictionary from human concepts to ULL meaning codes. But the key point is that the codes themselves are not arbitrary: they are constrained by physics and by the requirement that they work across all modalities.

## What Makes ULL “Universal”?

The universality claim rests on two pillars:

- **Theoretical:** Given the recognition axioms (basic constraints about how information behaves in physical systems), there is essentially only one way to build a zero-parameter language that respects them. Any other such language turns out to be equivalent to ULL when you strip away surface details.
- **Empirical:** When applied to real signals from different modalities, ULL finds stable, cross-modal patterns, and rejects carefully constructed alternatives that try to mimic its behavior while violating the underlying principles.

In other words, ULL is not just a convenient choice; it is meant to be the unique structure that reality allows for this kind of task.

## What Is This Good For?

In the long run, a language like ULL could serve as:

- A shared semantic backbone for AI systems, allowing them to communicate about the world in a physically grounded, model-independent way.
- A bridge between different sensing technologies, enabling robust translation of meaning between audio, video, motion, neural interfaces, and more.
- A foundation for trustworthy, verifiable claims about what signals mean, with certificates that can be checked automatically.
- A tool for scientific investigation, helping us see structure in complex data that might otherwise look chaotic or unstructured.

In the nearer term, the project provides a concrete testbed for ideas about universal representation, cross-modal understanding, and the relationship between physics, information, and meaning.

## Where Things Stand Now

At the time of writing, the Universal Light Language has:

- A working implementation that can ingest real-world signals and produce meaning codes.
- A small, discovered set of semantic atoms that organize themselves in a distinctive, self-similar pattern.
- Cross-modal demonstrations where different measurements of the same entity converge to the same meaning.
- A formal proof pipeline (in Lean) that shows why the language is unique under the given assumptions.
- A truth certification system that packages each meaning claim with detailed diagnostics and, optionally, cryptographic signatures.

What remains is largely a matter of mapping this internal space of meanings onto the rich, messy world of human concepts and communication. The structure is there; the work ahead is to explore it, label it, and learn how best to interact with it.