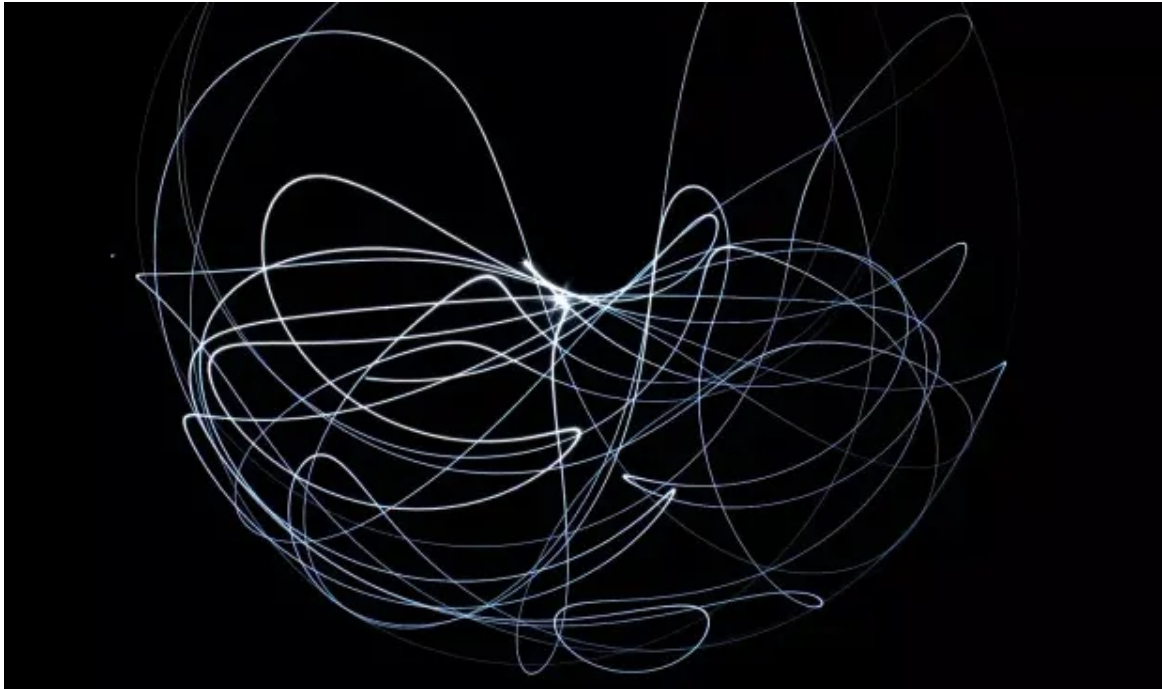


AGI: REPRESENTATION OF THE CONTINUAL OBJECTS

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The previous chapter [AGI: INFORMATIVENESS OF THE DISCONTINUITY POINTS](#) was about **discontinuity**. Now it's time to discuss **continuity** - the very thing that is the "carrier" of discontinuity, its "habitat."

The AGI system needs to represent **continuous processes** and **objects** to **predict** the course of events and **detect** and **identify** objects in the environment. That is, it is necessary to be able to **describe, memorize, compare**, and perform other operations specific to various cases, continual objects, and dependencies.

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The following ways of representing continuum dependencies/objects are possible:

A set of discrete samples

First of all, it's about **data from sensors**. For example, a temperature sensor periodically measures temperature as a function of time. The function is continuous but is represented by

a set of individual points. The tactile (touch) sensor, in the process of feeling an object, generates a series of coordinates of points in space. The video camera's light-sensitive matrix is generated for each pixel with the corresponding coordinates and the color component's brightness values.

Another source of representation of continual objects is data processing. For example, the output of the contour detection algorithm is a discrete set of points of a continual contour.

The most significant feature of such a representation is that ***the same continuous dependency/object can be represented by different sets of discrete samples*** (including a different number of them; for example, the same scene can be represented by frames with different ***resolutions***). This means there is ***no way to compare/identify objects/dependencies by comparing sets of corresponding discrete values***.

Parameterized Boolean function

This is a ***Boolean expression*** that depends on discrete values and evaluates to ***true*** if the argument is any discrete sample from the corresponding set. For example, a circle can be described by a group of points on this circle and then substituting the coordinates of any of these points into the expression

$$(X - X_0)^2 + (Y - Y_0)^2 = R^2$$

will be ***true***. The parameters are the coordinates of the center of the circle $\{X_0, Y_0\}$ and the radius of the circle R .

If all elements of the set of samples from the microphone as pairs (p, t) , where p is the sound pressure and t is the time, are used as arguments to the Boolean expression

$$p = A \cdot \sin(2\pi f(t - t_0))$$

produce ***true***, this means that a sound with frequency f and intensity A is recorded.

All measurements in practice have some error, so exact equality is replaced by the requirement that the error does not exceed a specific limit. To do this, strict equality is replaced by an inequality that includes the allowable error ***eps*** as a parameter:

$$F(\dots) = 0$$

should be replaced by

$$|F(\dots)| < \text{eps}$$

while the expression remains Boolean.

The corresponding functions for complex (composite) objects can be constructed from multiple Boolean expressions using the logical **`and`** and **`or`** operations. Readers versed in the relevant branches of mathematics will see this as a variant of the ***predicate***. Readers familiar with computational geometry and spatial scene rendering will find similarities with the ***functions that describe the shape of bodies*** in POV-Ray [<http://www.povray.org/>] and similar software. To avoid confusion, we will use the term "***descriptive function***" (of an object/process).

An essential feature of this representation of continuum processes/objects is the ***dependence on the chosen coordinate system***.

Regarding processes and, accordingly, one argument (time), the role of the coordinate system has a particular ***initial time point***. Two processes can be identical up to a time shift and, in some cases, even up to a time scale (becoming identical after "squeezing"/"stretching" along the time axis.

In the case of ***spatial objects***, there are ***two spatial coordinate systems*** and a ***set of relations that transform the coordinates of a point*** in one coordinate system into another. A ***set of samples*** is represented in one coordinate system. The second coordinate system is used to build the ***description function***, and this coordinate system ***can be chosen based on some considerations of utility***.

Parameters of the particular descriptive function in different coordinate systems vary in value and meaning. A reasonable choice of the coordinate system allows us to ***separate the parameters that determine the shape of the object from the parameters that determine the scale/size of the object and its position***, and thus determines the ***standard/canonical*** continual representation, which allows you to ***reduce the comparison/identification of objects to a comparison of their descriptive functions***.

The geometry of the natural environment is such that two similar objects can be combined by shifting in space, rotating, and scaling. This fundamental specificity of the natural environment guarantees the possibility of constructing a descriptive function in a form that separates the parameters of the position and size of the object from the parameters, which determines its shape ***regardless of the set of sensors, the purpose of the system and the tasks it solves***.

For example, in the case of curves of the second order (circle, ellipse, parabola, hyperbola), the shape is determined by the single parameter - ***eccentricity***, and the size parameter is the minimum distance from the points of the curve to the focus/center.

Thus, the regularities of the physical world provide a fundamental opportunity to compare/identify continual objects, ***comparing only the type and parameters of***

descriptive functions, reduced to a "**canonical**" form that separates position, orientation, and size from shape parameters.

If it is possible to construct a descriptive function for some (large enough) subset of samples, this means that a corresponding object has been **detected** and can be remembered (by remembering the type and parameters of the descriptive function). If the descriptive function matches one of the already stored descriptive functions, the object has been **identified**; otherwise, a **new concept should be created**.

The construction of compound (composite) objects from simpler ones correspond to constructing a composite descriptive function from those for the object's components. Ultimately, this allows us to build a **structured description of the current situation**.

Constructing a descriptive function from a set of discrete samples is a non-trivial task, which is the foundation of unknown object detection algorithms. Discussion of the technology of constructing descriptive functions is the topic of one of the future chapters.

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