Chapter 1

Free Will Systems

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Latest Draft: June 2017

*** WORK IN PROGRESS ***

Consider a system composed of a *finite* number of **objects** "O1..On", such that any object can be in any single one of a *finite* number of **states** "S1..Sn".

An *object* is any part of reality (actual or imaginary, concrete or abstract) that is somehow *distinguished* from everything else. Intuitive examples are *physical* macroscopic objects such as a rock, a planet or a galaxy; *metaphysical* objects such as persons or pets; and abstract objects such as numbers, words or drawings.

In physics, for instance, an object is usually referred to as a (physical) "system" and the distinction is drawn when that system is considered to be capable of being isolated from the rest: a rock for example is an object (or a physical system) for it can be physically separated from the surroundings such that certain properties about it remain the same when placed under many

different environment, that is, *when the distinction persist*. A subatomic particle, such as an electron, is also a physical object (or system) for it also can be persistently distinguished from other electrons and the rest of the atom on several different scenarios.

An object is a distinction, but distinctions are usually *drawn* rather than inherent. For example, a rock is really just a continuously mutating collection of molecules which just happen to be of a different type from the type of molecules usually found in the environment right around the rock, such as gas, water or dirt, giving that collection of molecules as a whole a certain set of characteristics from which the distinction can easily be drawn (mostly cohesion to form a solid body and surface texture to look a certain way when light reflects on it). Thus the fine details of the *process* of drawing the distinction--between the rock and the world for instance--dynamically defines the rock itself, process which involves the participation of an *external agent* drawing the distinction (whether is a person looking at it, or a mechanical device separating it from other objects).

Let us then define a **proper object** as any object that inherently distinguishes all by itself without the required participation of any external agent specifically drawing the distinction. The simplest examples of proper objects can be found in the abstract world. For example, a two-dimensional circle of radius 'R' centered on the origin of a certain cartesian coordinate system is a distinct proper object all by itself and there is no need to explicitly *make* a distinction in order for the circle to be itself. So is a number, or a word.

Actual *proper objects* in the real world are much more difficult to correctly identify. All our models of the physical universe, from planets to rivers to atoms to quarks, are based on carefully but artificially drawn distinctions based on observations and experiments. However, the concept and hypothetical reality of actual proper objects is central to the problem of free will, so this will be refined and qualified through the rest of the this work.

State is the collection of qualities, properties, or attributes of, about, or on an object. Simple examples for *physical* objects could be *temperature, acceleration, color, or shape.* For *metaphysical* objects could be *emotions, knowledge or motivation*. For *abstract* objects could be "*a list of numbers that represent something that is encapsulated in the abstraction*" or *"the style used on a piece of art"*.

In general, the word "state" is used to refer to *all* of the properties of an object, *everything* that is to know, or can be known, about it. Thus, "position" or "knowledge of history", are strictly speaking, partial or sub states. However, in certain contexts, just a part of the state, like a specific property such as position, can be referred to as "the" state even though is strictly just partial.

The individual qualities, properties or attributes which make up the state of an object are formally called **dynamic variables.** *Dynamic* because they change (or could change) over time, and *variables* because they have a value or measure that is unknown until they are determined. For any given object, some dynamic variables are independent of anything external to the object, for example, the radius of a circle (an abstract object) is independent of anything but that circle. Other dynamic variables are only the result of interaction between the *referent* object (the thing that the variable refers to) and a *reference* object(s) (the things that interacts with the referent). For example, the weight of a physical object depends on a property of the object itself (the rest mass) but also on the Earth whose gravitational field gives weight to the object. Whereas independent dynamic variables, such as the "mass" of physical object when considering the simplified models of the so-called "classical mechanics", are the same no matter the external conditions of the object (the mass is the same here or Mars), dependent dynamic variables are not, and the weight of the object is different here than in Mars.

This work proposes the existence of yet another type of dynamic variable depends on an *interpretation*, by an **observer** agent, specifically given to the result of the interaction between the object, the environment and the observer (the observer is always a part of the environment but not necessarily all of it). The simplest example is color. The color of a physical object is given by certain independent properties of the surface of the object plus the properties of whatever light reflects on it (if any, otherwise the object doesn't even have a proper color); but, unlike the case of Weight, it also depends on the processing of that light bouncing off the surface executed by an observer (a person or a device). The value of the variable is then the outcome of such processing.

Let us call

- **intrinsic dynamic variable** to any variable of an object that is independent of anything outside the object (such as the number of words on a book).

- **extrinsic dynamic variable** to any variable of an object that derives from the interaction between the object and its environment (such as the potential energy that a physical object possesses by being in a certain position within a certain energy field).

- **perceptual dynamic variable** to any variable that is the result of the processing made by and in an observing agent, of one or more intrinsic [1]or extrinsic dynamic variables.

An object then *possesses* an intrinsic state (the set of its intrinsic dynamic variables) and *displays* an extrinsic state. An observer (which is itself an object) *perceives* the extrinsic state of external objects (by interacting with them), and its own intrinsic state.

Notice that virtual objects also have dynamic variables (hence both intrinsic and extrinsic state and can be observed). An obvious example could be the "strength left" on a video-game avatar. A less obvious but still correct example could be "the (average) food-serving speed of a McDonalds store". Although the physically concrete serving is the result of physically concrete actions, so the speed in question can be properly traced back to concrete, not virtual entities, the variable as presented does not refer to any concrete physical entity. Is not the "order-taking" speed of Bob, or the "burger-cooking" speed of Alice that is being considered, but that of the virtual object that is the store. It does not matter which concrete actual persons work on the store (Bob, Alice or both), the store still has a well defined, perfectly observable, average food-serving speed. The existence and observability of state on virtual systems is central to this work on free-will and will be elaborated in the chapter on "role-based free-will systems".

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[1] In subsequent chapters we will elaborate on the fact that only self-perceptual variables might correspond to intrinsic variables; that is, when the observing agent is reflecting on its own intrinsic state