Chapter 1

Free Will Systems

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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 properties 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, such as just position, can be referred to as "the" state even though is strictly just partial.

For any given object, some properties 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 properties are only the result of interaction between the *referent* object (whose property is considered) 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. Independent properties, such as the "mass" of a 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), while dependent properties, such as the weight of the object which is different here than in Mars, are not.

Let us define :

- The **Internal Property** of an object is any property that is independent of anything outside the object (such as the number of words on a book).

- The **External Properties** of an object is any property 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, like gravity).

An object then *possesses* an internal state (the set of all internal properties) and *displays* an external state (the set of all external properties)

Notice that virtual objects also have properties (hence both internal and external state). An obvious example could be the "remaining strength" of a video-game avatar. A less obvious but still correct example could be "the (average) food-serving speed of a McDonalds store". Although the serving is the result of physically concrete actions and the speed in question can be properly traced back to concrete, not virtual, entities, that property 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".

In order for *us* to do anything with the properties (internal or external) of an object, they need to be given a representation. For example, in the field of physics, the representation comes out of *quantification* : that is, a process

known as *measurement* assigns a numeric value--a quantity-- to the property. Having properties represented by numbers allows us not only to be as exact and precise as possible but to operate mathematically with them and relate different properties of an object (such as its position and speed), or among objects (such as the gravitational force between a pair of objects). Even if a measurement is performed by subjectively mapping the property to a variable on an arbitrary scale, such as when a doctor asks a patient to rank their own pain on a scale from 1 to 5, once a property has been formally quantified (represented numerically) it can be logically and mathematically used (for example, the doctor can formally record the reported pain rank, then other health care professionals can look at the note and infer what to do).

Outside science, properties might not be quantified but they are still represented, using *qualification*.For example, a snack could be qualified as tasty or dull, and that adjective--that quality--becomes the representation of that property of the given snack.

- A **Variable** is any representation, whether quantity or quality, of an internal or external property of an object.

- An **Observable** is any property of an object for which a *process* mapping such property to a *variable*, known as **observation** (or measurement)**,** exists, even if only in theory.

- An **Observer** is any agent carrying out an observation. That is, mapping an object's property to a variable.

- A **Measurement** is the variable (representing a property) obtained by observation.

The distinction between (internal or external) properties, variables, observables and measurement as outlined above is important for the development of the concepts in this work, but have in mind that these terms are sometimes used interchangeably on certain contexts, even in the fields of physics.

In this work, the term property refers to the intrinsic characteristic of an object on and by itself, regardless of anything we can tell about it; whereas a variable is a representation of a property that we create within our cognitive world. This distinction is important in developing certain concepts that are fundamental to the problem of free-will. For example, in physics, we describe the position of an object in terms of variables, but the object is at a certain place regardless of our attribution of its position. Even if the there is no such thing as a "position" property, there is, necessarily, a property or properties of the object

from which we attribute the variable "position".

In the case of scientific fields, say physics, or economics, variables are governed by mathematical equations (or other *formal methods*) that predetermine the values of variables in different conditions, such as the evolution of time or as the result of interaction. Scientific calculations might yield exact values, as in Classical Mechanics, intervals, as in Market Forecasting, or probabilities, as in Quantum Mechanics; but in all cases, what is expressed by the equations, or the so-called "Laws of Science", is the *expected* value of the variables of an object according to any particular theory or model for the object in question.

A measurement is then a variable that is effectively obtained by an observation process as opposed to just calculated from an equation. This distinction is often implied, or omitted, but is critical since measurements validate the expected variables that result from theories.

Notice that an observable does not demand the actual existence and operation of observation, only that observation is possible. For example, each and every planet on the Universe is considered to be an observable even if we had never yet actually observed each and every planet. On the other hand, there are, or could be, proposed properties of an object that are not *yet* observables. A classic example is the consciousness-related properties of human beings. Notice that any (proposed) property that is not observable now might turn into one if the observation becomes possible in the future.

Fundamental to this work on free-will is the observation that, any ulterior reason for *expecting* the calculated variables given by a particular theory to match measurements, is ultimately a metaphysical presupposition. For example, using the equations from classical mechanics we can expect a moving object, for which we know its initial position, mass and speed (what physicist call the *configuration phase space* of the object), that is subjected only to certain known forces, to end up at a certain expected position after a period of time. And as far as we can tell, any measurement had always matched the expected position (within the limits of the measurement precision). However, that the object will-- in the future--effectively be found at the expected position can only be demanded by assuming a certain metaphysical worldview, such as determinism. Separating the utility of theories, such as classical or quantum mechanics, in robustly predicting dynamic variables from the variety of metaphysical worldviews that may account for the success of such predictions, allows us to consider different and competing such worldviews. This work for example presents a worldview based on free will systems.

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