ON THE NATURE OF TIME
(THE COMPUTATIONAL HYPOTHESIS)

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§1. The abstract

The effect of apparent 'slowing' of time for moving objects and due to gravity can be explained in much simpler terms, that does not involve the speed of light, gravity nor a need for postulates regarding them. These effects can be derived by using only simple deductions of computer science.

The effect of 'slowing' of time is also called 'time dilation' in Einstein's relativity theories, but it will not be called that here because we consider time to be constant and to emphasize that the effect is only related to a slow-down in *processing information*, and nothing more. The 'perceived' time can slow-down (meaning the time measured by any clock), and not the time itself. We will call this effect a perceived-dilation effect, to differentiate it from the notion of time-dilation.

The perceived-dilation effect is shown to be non-symmetrical, meaning that in relative motion, perceived time does not appear to slow down equally. The exact expression of perceived-dilation is not linear, and it depends on all other masses, their distances and speeds. In simple environments, such as measuring near large masses (such as Earth) or for very small masses, perceived time slows down for small masses, but not perceptibly for large masses.

The approach taken here (hereafter called the Computational-Hypothesis) will show the underlying cause of perceived-dilation to be the same regardless of whether it comes from relative movement or from the presence of other masses, and is related solely to processing information.

The computational-hypothesis formulas can be reduced to those of Special and General relativity in cases near large masses or when measurement of slowing of time is done for small masses.

Without any postulation, we will deduce that there must exist a local speed limit (which for very small masses is also known as the speed of light), and that the speed limit depends on masses, distances and speeds. This speed limit increases for large masses that are away from other large masses, and can exceed 186,000 miles/s far away from other large masses.

§2. Keywords

Nature of time; Time-dilation; Speed of light; Relativity; FTL; Faster than light; Information theory and physics; Computational-hypothesis.

II. INTRODUCTION

§1. The hypothesis

(1) The computational-hypothesis states that the inertial rest mass (just 'rest mass' in further text) is computational in nature, the details of which are the subject of this paper. Anything that has a rest mass

is referred to as an 'object' in further text, simply as a nomenclature helper. The hypothesis means that an object can gather information, process it, and then act on it.

§2. The summary of the computational-hypothesis

An object is defined by its information, and this information is inseparable from an object. Any enclosing surface surrounding an object contains all the information of an object at any point in time. An object has a limited storage for its information, and it processes information from all the objects in the Universe in order to compute its own change. Any physical process (including a tick of a clock) is defined by the amount of information it needs to complete. Change in distance on one hand and relative movement on the other are found to affect the amount of useful information an object is processing, resulting in a different speed of processing the information, and thus changing the speed of perceived time as measured by any clock. During the development of a formalized hypothesis, the analogies from driving on a highway (in III.§10.) may help to put some of the results in a perspective. The difference in approach between computational-hypothesis and the approach in SR[1]/GR[1] may be clearer from III.§19. The correlation of results of computational-hypothesis with SR/GR and the predictions thereof are given in III.§20. and IV.§2. respectively.

§3. Relative motion

(2) The only meaningful definition of the relative motion with respect to time is shown to be relative to all other objects. If you move at the speed of 60mph on a highway, your motion *cannot* be described as relative to Earth, nor as to any arbitrary set of observers. It can be described fully *only* relative to all other objects. For now, this may feel rather epigrammatic and even obvious. We will develop and formalize this seemingly laconic statement in (93) and (99).

The speed of light does not play a role in the computational-hypothesis. Rather its existence (as a form of a locally constant speed limit), as well as the approximation of formulas of SR and GR are deduced from the perspective of information processing.

III. THE COMPUTATIONAL-HYPOTHESIS

§1. Information

(3) In broader terms, the information in the computational-hypothesis is what describes an object. In specific terms, it is a set of facts that describe an object, such that no fact can be deduced by using any subset of the rest of the set. The facts are assumed to be of the same complexity (as more complex facts could be broken down to a set of simpler facts which in the simplest form would have a single physical representation), and thus can be said to take the same time to process. In essence, information is a set of basic 'bits' of the same size, each holding a different fact.

(4) Processing of information means combining facts to produce new facts. For example, if we have a single fact I_1, by itself it cannot change. If we introduce a new fact I_2, then the processing of two can

produce a result. If we introduce a set of N new facts, they can be combined with I_1 to produce a result, in which case the processing would take N times longer. In general, if we have two sets of facts (one with N and one with M facts), then in order to compute a new set of facts out of the two, the minimum cost of computing a new set of facts out of the two is $N*M$ (accounting for combining each fact from one set with each fact from the second set). Since this method of computation is minimal and the simplest needed to account for every fact from both sets, we will use this method to calculate the cost of computation.

(5) We will consider the processing of information to be non-instantaneous. A reason for this important assumption is that if it didn't take some time, there would be a potential to affect infinite number of changes simultaneously.

(6) We assume that computation is deterministic in nature, meaning that the same input information will always produce the same output. We will show later though that this does not imply the Universe itself is deterministic (see (29)).

§2. *Objects and information*

In the computational-hypothesis, information can be detected for the sole purpose of including that information in a computation. For the purposes of the computational-hypothesis, an 'object' is defined by its capability of possessing and computing (processing) information only. This restriction also keeps us in line with this being a hypothetical model.

An object has information that describes it in some way. We call this information a *definition-information*, or just the 'definition'. In the computational-hypothesis, an object is purported to be solely a computational entity that has the ability to possess and process information for the purpose of affecting its own change. To say this in a more broad and relaxed manner, an object represents the purported computational nature of reality. Objects exist in the three-dimensional Euclidean space. The number of objects is assumed to be finite. An object occupies some volume of space.

§3. *Information processing*

(7) An object must have a finite amount of definition-information, as processing of any information takes a finite time to process, and an infinite amount of information would take infinity to process.

(8) On the surface of a sphere centered at a point-like object a definition-information of an object may be found in order for other objects to be able to use it in their computations. Because such a sphere fully encloses an object, the surface of any such sphere has all the object information. If it did not, some information would exist on some preferred sphere, but not on the spheres surrounding it or being surrounded by it. Similarly, we will assume that no radially outward direction from an object is preferred. From this, we conclude the amount of information on any fixed small surface declines proportional to the surface area of a sphere ($4\pi R^2$), i.e. with the square of distance.

We will extend the lack of preferred spheres (as in (8)) to be true for any moment in time. Thus, the relative movement of an object must be the same as the relative movement of its information, and vice versa.

Another way to think of (8) is to imagine a group of objects at rest. Each object occupies some volume of space, and the distances between objects are fixed. Let us say that each object's definition-information is on its surface. Now let us imagine that this whole picture scales up so that volumes (including objects themselves) and distances are bigger, but in a such a way that no object can tell otherwise (as far as information processing is concerned), i.e. the scenarios are equivalent. It follows that now all of object's definition must be also on its surface (which is now larger). It also follows that in any point in time, the very same information is on this surface as it is on the smaller one. It means that any enclosing surface has all the object's definition at any given time with no delay.

In order to quantify information, we will use *i* to denote a measure of information. It signifies the number of facts in it (see (3)). Since the amount of information is finite (per (7)), the number of facts is finite too. Therefore, *i* is a dimensionless integer. Even though *i* is an integer, we will assume it to be a large one and as such can be used as a rational number, or a near-real number for the purpose of calculations here. The consequences of it being an integer are not the subject of this paper.

We will call an object with large amount of definition-information a 'large object', and the one with comparatively small amount of definition-information a 'small object'. These notations do not imply size nor mass, only information.

Hence, from (8), the following should hold true:

$$i_R = a * \frac{i}{R^2} \quad (9)$$

i_R is the amount of the definition-information at distance *R* from the object over some fixed small surface.
R is the distance from the object.
i is the definition-information of the object.
a is a dimensional constant. For the purpose of this paper, we will consider it to be exactly [1 m^2] and will not write it in equations for simplicity.

(10) An object must have a limited storage for its definition, or at the very least it always uses only a limited storage. An unlimited storage would imply that an unlimited amount of information can be had, which would lead to infinite processing times.

§4. Change of information

(11) A basis for producing the change of an object is the definition from all objects (including itself). This definition-information (coming for all objects) is available at location of every object, per (9). The information available at object's location is called *available-information*. It is all the definition-information available to an object between its own changes (i.e. between two points in time when computation affects change, since computation is of finite speed, see (5)).The available information, in order to be processed, must be stored in object's own information storage that is used for processing. Since the result of this processing *is* definition-information, the storage for it must be distinct from the storage used for the definition. We will refer to this storage as the *state* of object because it embodies

the state of information from all objects (including itself) available at the location of a given object. This storage is limited in size, for the same reason as in (10). An information originating from all objects (including itself) that is stored in the object's state is the *state-information*. Since the available information can be larger than the storage of object's state, the available-information and state-information are generally not the same.

(12) In order to make for the fastest computation with the maximum use of information available, new information is added to state-information anytime the available information changes. State-information is a subset of available-information, where any information from available-information has the same probability of being included in the state-information.

(13) In the computational-hypothesis, processing information yields new definition, and this information affects change of an object. This is in contrast to having an extraneous origin of an object's change, unrelated to computing information. If both were possible, it would introduce two mechanisms of change. By choosing a simpler solution, we will say that object's change happens only and only as a result of computing the information.

And object must have two states (as defined in (11)). Without accounting for at least two information states (previous and current), the past changes of an object would never in any way be accounted for. Having more than two information states would increase the available information about past changes but would also produce slower computations.

We will use the simplest model of two information states. Each information state represents the information available to an object (as in (11) and per (9)) at two different (but close) moments in time (signifying previous and current state):

- Information just prior to change (previous-state of an object).
- Information of change (current-state of an object).

(14) In essence, an object works off of two sets of information: initial values (previous-state) and a new information (current-state).

(15) We will assume that each object computes only its own state-information, i.e. no information processing is duplicated. Because of that, the two information states (previous and current) are independent (i.e. no information in either set can be derived from the other in a general case).

(16) The result of a computation (attained from the computational combination of previous and current information states) represents the new object's definition. This new definition is what then contributes to the information available to all objects (i.e. their own states), including self, as in (11) and (9). A change of an object is the result of the availability of this new definition-information.

§5. Information of objects in any location in space

As stated in (11), the state-information an object processes (previous and current state) comes from an object itself and from every other object in the Universe (i.e. the available-information).

The state-information (being limited due to the limited storage space, see (10)) is derived from available information. If there is more available-information than the storage for state-information can hold, any information has the same probability to be processed (meaning no information is preferred in case some of it will be used and some will not).

The necessary data structures of an object are shown in Figure (1):

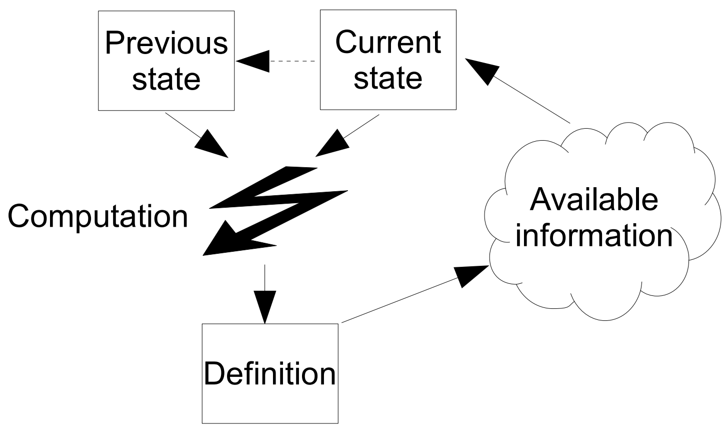


Figure 1

Total available information at a location of an object is:

$$i_t = i + i_a \quad (17)$$

where

i_t is all the available information.
i is the object's definition.
i_a is the information of all other objects.

The example for the following concepts regarding information-influence is given at the end of this chapter (see (30)).

The proportion of available information without and with the object itself (f) is:

$$f=\frac{i_a}{i_t}=\frac{i_a}{i+i_a}=\frac{1}{1+\frac{i}{i_a}} \quad (18)$$

This proportion describes the ratio of available-information processed at an object when its own definition is *not* counted and when it *is* counted. It describes how much of processing comes from the information of other objects versus its own information.

Since information from any object declines with the square of its distance (see (9)), i_a can be written as a sum:

$$i_a=\sum_{j=1}^{U}\frac{i_j}{R_j^2} \quad (19)$$

where:

U is the number of all other objects.
i_j is the information of all other objects.
R_j is the distance to all other objects.

In general, a quantity f is describing informational influence of the Universe at an object (from (18) and (19)):

$$f=\frac{1}{1+\frac{i}{\sum_{j=1}^{U}\frac{i_j}{R_j^2}}} \quad (20)$$

Summation goes for all other objects in the Universe (a number of which is U). We will call f the *information-influence*. The information-influence determines the ratio of available-information from all other objects (not including an object itself) versus for all objects (including an object itself).

Similarly, the information-influence of an object X on any given object is (from (18)):

$$f_X=\frac{\frac{i_X}{R_X^2}}{i+\frac{i_X}{R_X^2}+\sum_{j=1,j\neq X}^{U}\frac{i_j}{R_j^2}}=\frac{1}{1+\frac{i}{i_X}*R_X^2+\sum_{j=1,j\neq X}^{U}\frac{i_j}{i_X}*\frac{R_X^2}{R_j^2}} \quad (21)$$

Apparently:

$$0<f_X<1 \quad (22)$$

It is clear from (21) that the sum of all information-influences (of all objects, including self, which accounts for $U+1$) on any given object must equal 1 (which is another way of saying that the information storage for current-state is fixed):

$$\sum_{1}^{U+1} f_j = 1 \quad (23)$$

(24) If an object is sufficiently far away from other objects, then its definition-information is all that is available to it, therefore its state-information would be equal to its definition-information in order for an object left alone to not lose its own information in a computation ('left alone' meaning information-influence of itself would be practically 1). Thus, the actual amount of available information from any object X (including self) that is present in object's state-information is (from (16) and (23)):

$$i * f_X \quad (25)$$

If the information-influence of X is much greater than that of any other object (for example X is close and is a large object), then from (21):

$$f_X \approx \frac{1}{1 + \frac{i}{i_X} * R_X^2} \quad (26)$$

When X is large and closer to an object than other objects, from (26):

$$f_X \approx 1 \quad (27)$$

When X is small compared to other objects, from (26):

$$f_X \approx 0 \quad (28)$$

In more informal terms, the state-information of small objects is overwhelmed by nearby large objects (as in (27) where most of object's state-information comes from a large object X). Similarly, the state-information of large objects is underwhelmed by nearby small objects (as in (28) where very little of object's state-information comes from a small object X).

(29) Per (25) and (21) the actual amount of information used at object C from any other object X is always smaller than the definition-information in X. This implies the inherent lossyness of object's information processing, even if computation itself is deterministic (see (6)).

(30) For example, let us observe three objects in Figure (2) below.

The available-information at object *3* is (from (9)):

$$i_3 + \frac{i_1}{R_1^2} + \frac{i_2}{R_2^2} \quad (31)$$

Since the storage for state-information is limited for any object, it follows that the amount of available-information in (31) can be greater than the storage for state-information of object *3*, which is i_3 (per (24)). Assuming all information has equal probability to be used, it follows that the actual amount of information used from each of the three objects must be:

$$i_3 * \frac{i_3}{i_3 + \frac{i_1}{R_1^2} + \frac{i_2}{R_2^2}} \quad \text{(from object 3)}$$

$$i_3 * \frac{\frac{i_2}{R_2^2}}{i_3 + \frac{i_1}{R_1^2} + \frac{i_2}{R_2^2}} \quad \text{(from object 2)} \qquad (32)$$

$$i_3 * \frac{\frac{i_1}{R_1^2}}{i_3 + \frac{i_1}{R_1^2} + \frac{i_2}{R_2^2}} \quad \text{(from object 1)}$$

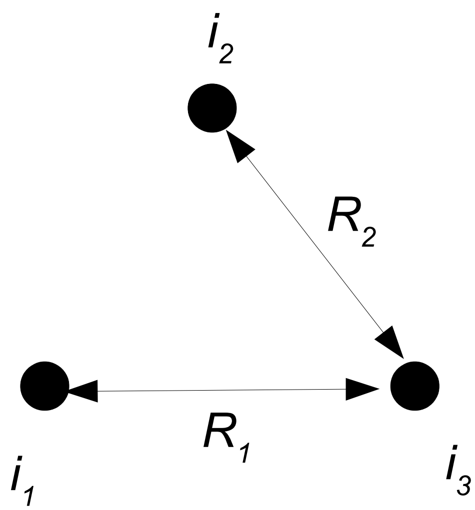


Figure (2)

so that the total storage used is exactly i_3 as expected:

$$i_3 * \frac{i_3}{i_3+\frac{i_1}{R_1^2}+\frac{i_2}{R_2^2}} + i_3 * \frac{\frac{i_2}{R_2^2}}{i_3+\frac{i_1}{R_1^2}+\frac{i_2}{R_2^2}} + i_3 * \frac{\frac{i_1}{R_1^2}}{i_3+\frac{i_1}{R_1^2}+\frac{i_2}{R_2^2}} = i_3 * \frac{i_3+\frac{i_1}{R_1^2}+\frac{i_2}{R_2^2}}{i_3+\frac{i_1}{R_1^2}+\frac{i_2}{R_2^2}} = i_3 \quad (33)$$

The ratio such as

$$\frac{\frac{i_2}{R_2^2}}{i_3+\frac{i_1}{R_1^2}+\frac{i_2}{R_2^2}} \quad (34)$$

represents the information-influence of object *2* on object *3*.

From (21), the (33) can be written as:

$$i_3 * f_3 + i_3 * f_2 + i_3 * f_1 = i_3 \quad (35)$$

This is an illustration of how available-information is reduced to state-information. From (35):

$$f_3 + f_2 + f_1 = 1 \quad (36)$$

The (35) and (36) illustrate (23) and (25).

§6. Relative movement and information

(37) At any location on any sphere centered around the object X, any fact from the definition of *X* has an equal probability to be found (see (8)). Since object's definition changes in time, so does the information at these locations. This information changes with some finite speed, as speed of computation is finite (see (5)). This means that in any given period of time, the information contained in multiple locations (even if they are recurring) will be greater than in any given location, the more so the greater the number of locations. If an object *Y* moves relative to *X*, the number of locations visited in a given period of time will be proportional to the speed of *Y* relative to *X*. Thus, the amount of additional information available to object *Y* that originated at X in a unit of time will be proportional to its speed relative to *X*. It also means that more information will be added to state-information within the time period it takes to perform the computation affecting change (see (12)).

An object *Z* at rest to *X* will *not* see this additional information, simply because the number of locations visited is smaller than it is for *Y* (assuming information-influence of *X* can be considered the same) .

The interesting conclusion is that the relative movement has a real effect on information processing and thus the very behavior of objects moving relative to one another is changed by the very act of moving. This is a simple consequence of the symmetry of three-dimensional space with respect to information and of the limited speed of computation.

§7. *Relative speeds and change in state-information*

(38) In this chapter an account of state-information increase due to the relative movement will be shown. Due to the limited storage for the two state-information sets (see (14)), any increase of available-information must cause lossyness. Please keep in mind, that for now we will only calculate the amount of state-information increase (assuming the storage space would increase to hold it) and in the following text (see (45)) examine the effect on information processing when the storage space does *not* change.

(39) When an object *M* moves relative to an object *C*, the state-information of *C* changes because the information available to C changes. This change is irrespective of distance (see (9)), but rather related to relative motion (see (37)).

(40) This change of state-information is proportional to the relative speed (see (37)), and the product of object's current state-information and the information-influence of *M* at *C* (i.e. the part of information from *M* that is *actually* processed at *C,* as in (25)).

Thus a relative change of current state-information of *C* is:

$$\frac{\Delta i}{i} = s * v * f_M \quad (41)$$

> Δi is the change in current state-information at *C* resulting from the relative movement of *M.*
> i is object *C*'s current state-information.
> s is a dimensional constant of proportion.
> v is a relative speed of an object *M* and *C* achieved in the local area of space where f_M can be considered constant.
> f_M is the information-influence of *M* at *C*. Change in current state-information only applies to actual contribution of *M's* definition at *C.* Per (22), it is a number between 0 and 1, effectively describing a proportion of computational resources used for processing information of *M* at *C*. This is what allows us to compute a *relative* (proportional) change of current state-information at *C*. Usage of f_M (see (39)) does not imply the change of information due to distance, but only a proportion of *M*'s definition-information that affects *C* by means of relative speed (if relative speed v is zero, so becomes Δi).

The exact equation for Δi would include all the objects in the Universe:

$$\Delta i = s * i * \sum_{j=1}^{U+1} v_j * f_j \quad (42)$$

where

> f_j is the information-influence of all other objects (see (21)).
> s is a dimensional constant .
> U is the number of all other objects in the Universe, so $U+1$ includes self.
> v_j is the speed relative to each object in the Universe, including self (where it is 0).

Δi from (42) shows the exact change of the current state-information in an object derived from relative movements of all other objects. If all other objects (save for *M*) are such that their information-influence is small compared to *M*, then we can use simplified (41).

(43) Note that in (41) we state that speed *v* must be achieved *locally* (where f_M can be considered constant), because if f_M changes, different changes of current information (Δi) will result from the same relative speed *v*. Also note that Δi cannot become greater than *i* due to limited information storage:

$$\Delta i \leq i \quad (44)$$

§8. *Processing speed and information change*

(45) Object's states are subject to computational processing to determine object's change. We will examine the effect of changing information on object's processing in light of limited information storage for the two state-information sets. From (29) and (42), the available information used by an object can change at any given time, depending on information-influences and relative speeds of all other objects. The change in information apparently affects current information set, as it happens in the present. The following discussion will investigate the change in the speed of computation when current information set increases (we use a term of 'increase' and not 'change' for the clarity of notations, with understanding the decrease is simply a negative increase).

Note that we're not assuming anything about how the internal information processing of an object actually works. The assumption that the current-set increases is not necessary. It is only taken because it's perhaps a bit clearer and more graphic to explain. We can just as well assume that both current-set and previous-set remain of the same size and get the same result. We will touch on this a bit later in this chapter.

There are two state-information sets (previous and current, from (14)). Since the two sets have a fixed storage (see (14)), we have:

$$i_{previous} + i_{current} = constant \quad (46)$$

Previous information set is produced in the simplest form as a copy of a current information set from the previous computation (a lossless transformation, as information is the same):

$$i_{previous}(t) = i_{current}(t - \Delta t) \quad (47)$$

For the ease of developing the results, we will assume that previous and current sets are originally equal as in (47):

$$i_{previous} = i_{current} = i \quad (48)$$

In general, previous set is produced via data transformation from the current information set from the previous computation:

$$i_{previous}(t) = Q(i_{current}(t - \Delta t)) \quad (49)$$

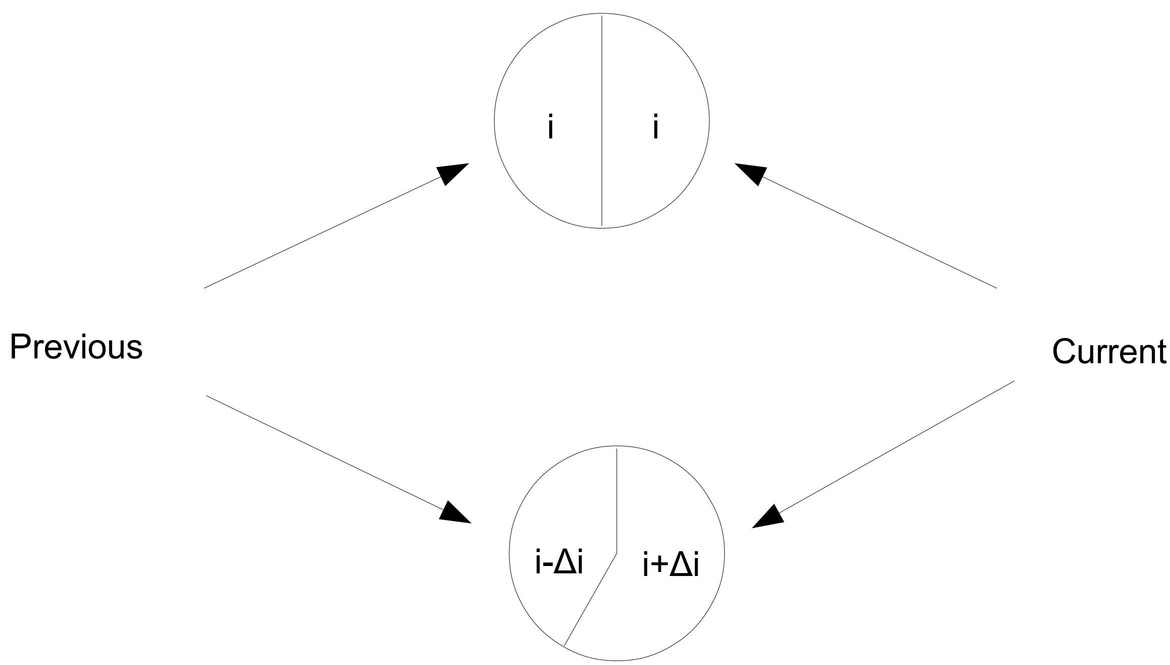
(50) If the amount of information in the current set increases, then the amount in the previous set must decrease and its information becomes lossy (as more information now fits the lesser storage), see Figure (3) below. Thus, transformation *Q()* from (49) is by nature lossy. As we use *i* to denote the information amount, we will use Δi to denote change in information, and so we have (see also Fig (3)):

$$(i_{previous} - \Delta i) + (i_{current} + \Delta i) = constant \quad (51)$$

In this case, a data transformation *Q()* (from (49)) must be used to produce a smaller previous information set from a larger current information.

(52) To process all the information of two independent information sets (such as previous and current) requires pairing each information from either set with each information from the other set, per (4). For example, if one set has facts (i_1^1, i_2^1, i_3^1) and the other set has facts (i_1^2, i_2^2, i_3^2), then pairs of facts to be processed are (i_1^1,i_1^2), (i_1^1,i_2^2), (i_1^1,i_3^2), (i_2^1,i_1^2), (i_2^1,i_2^2), (i_2^1,i_3^2), (i_3^1,i_1^2), (i_3^1,i_2^2) and (i_3^1,i_3^2), meaning that total information processed is the product of the amounts of information in both sets (in this case 3*3=9 pairs to be processed).

Figure (3)



The number of information pairs needed to compute the pairing of information in lossless (47) is thus (from (48)):

$$H_0 = i * i = i^2 \quad (53)$$

In case of different amounts of information in previous and current sets (as in (51)), the number of information pairs is:

$$H = (i - \Delta i) * (i + \Delta i) = i^2 - \Delta i^2 \quad (54)$$

Assuming processing each pair takes the same time (see (3)), processing the amount of information from (54) will apparently take less time than that of (53):

$$H < H_0 \quad (55)$$

Before the pairing of previous and current sets can take place in (54), the previous set must first be calculated through lossy transformation *Q()*. Any processing for lossy data transformation *Q()* is not used in computing the change – it only produces a lossy version of the same information, and thus it can be considered 'not useful'. For the reasons outlined in this paragraph, the quantities H and H_0 will be referred to as 'useful' information, because they are used to actually produce a change. This lossy transformation *Q()* should account for the additional information (from the current set) and the information that will be lost (from the previous set) in order to minimize the loss of information from both, and at a minimal computational cost.

In order to calculate the number of information pairs needed for the data transformation *Q()* from (49), we will consider the information involved. The previous information set in this case will have less storage (Δi being the difference in storage), and the current set will have more information (Δi being the difference in information). In other words, the transformation of the current set will have to account for the amount of extra information (Δi from $i+\Delta i$) pairing with the amount of information that will be lost (Δi) in order to produce the lossy information i-Δi. The number of information pairs for lossy data transformation *Q()* is therefore:

$$H_Q = \Delta i * \Delta i = \Delta i^2 \quad (56)$$

(56) can be also derived by looking at it from a different perspective where the two sets remain of the same size: the previous set can be simply copied from an unaugmented current set, then the extra Δi in the current set can be transformed (in a lossy transformation) using itself and the amount of information Δi from the previous set, and then the Δi from the previous set can be replaced with the result. The result of the cost to perform this is the same Δi^2.

The total number of information pairs (including lossy transformation itself H_Q and the processing of useful information H) is from (54) and (56):

$$H_1 = H + H_Q = (i - \Delta i) * (i + \Delta i) + \Delta i^2 = i^2 \quad (57)$$

or from (53) and (57):

$H_0 = H_1$ (58)

(59) The result in (58) means that the total number of processed pairs of information is the same both in lossless and lossy case of information processing, meaning that the time to process them will be the same.

However in the lossy case, the amount of useful information pairs affecting change (meaning not counting the lossy transformation itself) is given by (54)). Hence the amount of useful information processed (that can be used to affect change) is smaller in a case of a lossy transformation.

The above result can be obtained by assuming that current-set and previous-set do not change in size. In this case, the number of processed pairs is always i^2. Since additional information is of size Δi, to combine it with the existing current-set it takes Δi^2 pair operations. When compared to the case when there is no additional information, the amount of useful information processed in the same time is $i^2 - \Delta i^2$, which leads to exact same conclusions we already drew.

The speed of processing useful information (meaning current information from the present moment) in lossless case is given as the amount of information that is processed per unit of time:

$$S_{lossless} = \frac{i}{t} = \frac{i}{t(i)} \quad (60)$$

where

t(i) is the time needed to process information *i*.

The time *t(i)* is the function of *i* because we assume (see (3)) that processing any piece of information takes the same time. If this time (needed to process current information) is *t'*, then we can write alternatively:

$$S_{lossless} = \frac{i}{t} = \frac{i}{i * t'} = \frac{1}{t'} = constant \quad (61)$$

(62) The result in (61) means that the processing speed of any object when the size of the current information set is unchanged is the same. This means that the larger object would take longer to process its current information than a small object would.

The speed calculated in (60) accounts for the current information only because that is what is being processed. The previous information is a transformed current information (from the previous moment, representing the past of an object that's already been processed once), and therefore cannot be counted.

The speed of computation for a lossy case can be deduced by modeling it with the equivalent situation where the two information sets are equal and both lossless (as in (53)). The advantage of that simple model is that it will show us what the equivalent information throughput would be if there was no loss, but the information storage shrank (as opposed to the reality of the constant information storage with the loss of information), and so from (53) and (54):

$$i_e * i_e = (i - \Delta i) * (i + \Delta i) \quad (63)$$

In (63), an equivalent lossless information (i_e) is recombined in pairs on the left side of the equation, and the right side is the lossy case. Because the total amount of time used to process both lossy and lossless transformation is the same (per (59)), the speed of processing useful information in the lossy case would be quantified with (from (63)):

$$S_{lossy} = \frac{i_e}{t} = \frac{\sqrt{(i - \Delta i) * (i + \Delta i)}}{t} = \frac{\sqrt{i^2 - \Delta i^2}}{t} \quad (64)$$

or from (61):

$$S_{lossy} = \frac{\sqrt{i^2 - \Delta i^2}}{i * t'} = \sqrt{1 - \frac{\Delta i^2}{i^2}} * S_{lossless} \quad (65)$$

(66) *S* is the speed of computation. What *S* means is that for example, if the size of both information sets is 20, and the size of each set is 10 (so 10+10=20), the amount of useful information processed would be a square root of 10*10, or 10 per unit of time. If the current set size is 11 and the previous is 9 (so 11+9=20), the amount of useful information processed would be a square root of 11*9, or approximately 9.95 per unit of time (9.95 being the approximate square root of 99). The lower useful information throughput is the direct consequence of the limited information storage when the amount of available information increases. In further text, the term 'information' will have a connotation of useful information.

§9. Conceptual diagram of information flow in an object

Figure (4) below shows a conceptual information flow of an object.

In step 1, generally lossy transformation Q() (see (49)) transforms the current information set into a previous set.

In step 2, information influence of all objects (including self) is reflected in the current state (see (23)).

In step 3, previous and current states are used to compute a definition information of an object which is a basis for change and is reflected in the informational influence (on any object), see (25).

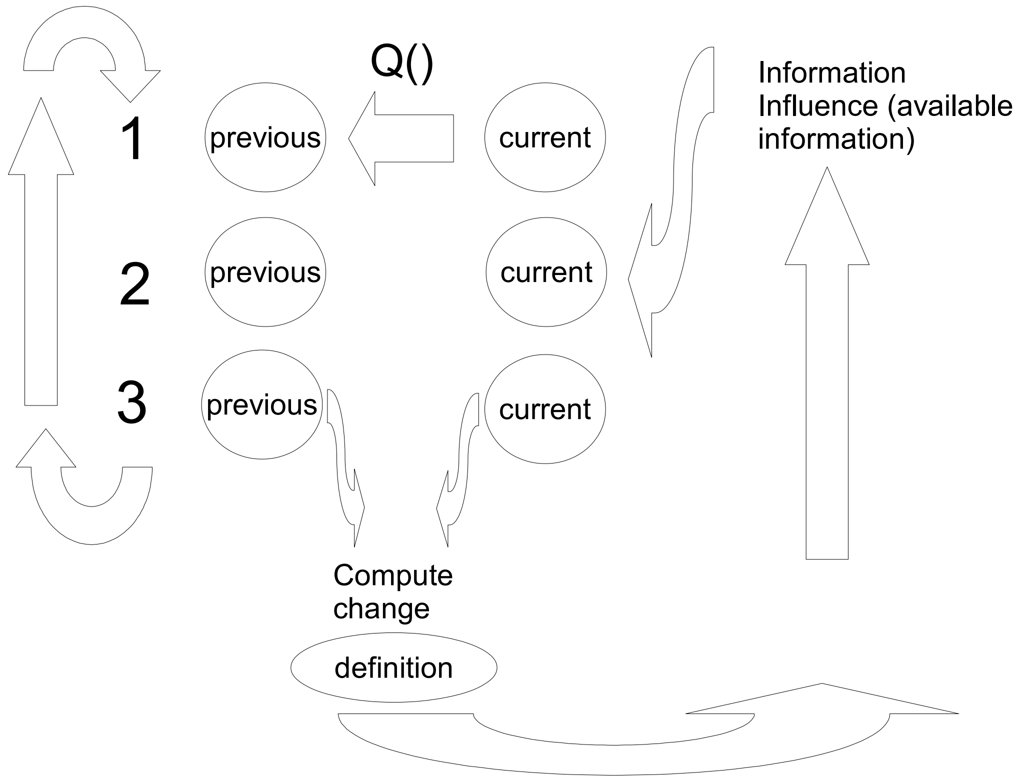


Figure (4)

§10. *The local speed-limit*

The dimensional constant s from (41) has a meaning beyond just being a constant of proportion. To start, the dimension of this constant must be the inverse of dimension for speed (*m/s*). Let us consider what happens when speed v_c is such that change in the current state-information becomes equal to storage for each set of state-information of an object:

$$\Delta i = i \quad (67)$$

(67) means that speed v is so high that the processing of information slows down to the point where it becomes zero (or near zero) because from (67) and (64):

$$S_{lossy} = \frac{\sqrt{i^2 - \Delta i^2}}{t} = \frac{0}{t^2} = 0 \quad (68)$$

(69) This speed then locally becomes the highest attainable relative speed of an object resulting from its own change, because its own change only comes as a result of computation. Because the speed of computation becomes zero, an object retains its current definition-information and it doesn't change it any more. In effect, an object becomes a carrier of information from a point in time when its speed of

computation reached zero (i.e. when it obtained maximum local speed). It will remain so as long as the condition of (67) persists.

From (41) and (67) it becomes:

$$s=\frac{1}{v_C*f_M} \quad (70)$$

In a system of two isolated objects, where one is much larger then the other (M is much larger than C for the purpose of this paragraph):

$$f_M \approx 1 \quad (71)$$

We will denote this maximum local speed v_C simply as c. From (70) and (71):

$$s \approx \frac{1}{c} \quad (72)$$

(73) From (70) it is clear that the value of c depends on the location. Near large objects (where (71) holds), the value of c is practically a constant.

However, farther from large objects, the following can be true:

$$f_M \ll 1 \quad (74)$$

In this case, the value of c can be much higher.

An exact value for maximum relative speeds c_j (relative to every other object) for a given object in a given location (from (42) and (67)) can be found by solving the following equation for every object in the Universe:

$$\sum_{j=1}^{U+1} c_j*f_j=\frac{1}{s} \quad (75)$$

It is important to note that speed c is simply that at which speed of information processing at a given location goes down to zero, and nothing more. In different locations, and depending on the relative motions of other objects, the maximum speed c can be different, so we can think of it as:

$$c=B_c(r_j, v_j, i_j, \forall j) \quad (76)$$

where

r_j is the distances to all objects.
v_j is the speeds relative to all objects.
i_j is the amounts of definition-information of all objects.
B_c is the function representing the solution of equation in (75).

i.e. the maximum local speed is dependent on object's own definition, distances to other objects, their relative speeds and the amounts of definition-information they hold. Because these change in time, so (in general) does the maximum local speed.

An expression for speed *c* for a given object near large isolated *M* is (from (70)):

$$c=\frac{1}{s*f_M} \quad (77)$$

As f_M can vary between 0 and 1 (per (22)), the speed *c* can vary too depending on the location relative to *M*:

$$\frac{1}{s}<c<max(B_c) \quad (78)$$

where B_c is the function from (76). The exact value for its maximum depends on the locale and the moment in time when it is calculated. If information-influence of other objects is sufficiently small, B_c can become arbitrarily big:

$$\lim_{f_j \to 0, \forall j}(max(B_c)) \to \infty \quad (79)$$

Near large objects, speed *c* has its minimum value of *1/s* while away from them it can be much higher, i.e. it is location-dependent. Note that the reason for (78) is because in (75), the speed of an object relative to itself is always zero (and so is the maximum speed relative to itself). Thus one element in the summation in (75) is always zero (related to itself). If f_{self} (i.e. information influence on self) is high, such as when sufficiently far away from other objects (see (24)), then maximum speed relative to other objects will indeed conform to (78).

To expand on this, imagine an object that has attained a speed of:

$$c_1=\frac{1}{s} \quad (80)$$

in a location where that speed is a limit. Let that object now move to a location where the limit is:

$$c_2=\frac{10}{s}=10*c_1 \quad (81)$$

(82) The object will still have a speed of c_1 unless there is a reason to accelerate. The speed of $c = B_c(r_j, v_j, i_j)$ (per (76)) is only the locally attainable maximum speed and nothing more. Conversely if an object has attained a speed of $10*c_1$, and then moves to a location where the limit is c_1, its relative speed to objects near that location will remain the same and be beyond the local speed limit. This is again the consequence of the speed limit being local, i.e. being the maximum speed *attainable locally through object's own change* (see (43) and (41)). When an object moves to a location with the lower speed limit, its speed of computation was zero and will remain so (see (44)).

As is apparent from the previous text, a word 'local' is often used in the computational-hypothesis to denote *local* conditions, and not just a place in the space. It means the distance to all other objects, but it also refers to the definition-information from all other objects and to the speeds relative to all other objects.

In the further text, we will use '*c*' to denote the speed limit for a given object in a given location in a given moment in time with full understanding it depends on that locale (that is, on all object's information influences and their relative speeds).

§11. *Analogies*

(83) To shed some more light on the change in speed limit (see (82)), imagine you're driving on a highway and using a cruise control set to 65 miles an hour, with the speed limit being the same. Now the speed limit on a highway changes to 75 miles an hour. The change in speed limit does not imply that your cruise control will suddenly accelerate your vehicle to 75 miles an hour. You *could* do that, but if you don't do it you will still move at 65 miles an hour. The reverse is true as well.

This analogy can perhaps clarify the thinking about *why* the speed limit in some places is 45mph, in others 65mph and in yet others 75mph. The reason is simple: where the speed limit is lower, there is usually more people around the road and your maximum speed has to be lower so that you can process all the information about them (and not get hurt or hurt somebody else). Where the speed limit is higher, there is usually no people around the road, making it possible to have a higher speed limit, as you don't have to process the additional information.

(84) And to use the driving analogy once more, a concept of lossy transformation (see (50)) can be shown in another light. When you drive at 45 miles an hour, you can see more details in your immediate surroundings, because you're not driving too fast. When you drive at 75 miles an hour, some of the details you were clearly able to see before are now a blur. This blur is somewhat akin to a lossy transformation of information that is clearly there, but you cannot see it that clearly. There is simply too much information. In an object, to simplify things for a moment, more information vies for a limited space than the space can hold, and it gets a bit blurry and some information is thus lost.

§12. *A few more words on speed*

(85) The (77) and (78) imply that far from large objects, an object C can accelerate to maximum speeds greater than those attainable near large objects. In addition, the larger the object *C* is, the higher the speed limit for it will be (because f_M for an object *C* is smaller if object *C* is larger, as could be seen in simplified (26)).

(86) Another noteworthy consequence of (72) is that if an object tries to obtain its own maximum speed near large object *C*, it will always hit the same speed limit *c* relative to *C,* regardless of what was its speed (assuming it was attained locally) before attempting to obtain this maximum speed. In other words, near large object C, if an object is accelerated to the highest possible speed from a group of objects moving with some speed *v* (an emitter), this speed will always be *c* when viewed from *C* (regardless of speed *v*) . Such an object will always move at speed *c* relative to *C* regardless of the

speed of the emitter (assuming emitter was accelerated locally).

(87) In general case, the local speed limit can be resolved using (75). The speed limit occurs when condition (67) is satisfied, the same as in an isolated two object scenario, only the results may vary with objects' information and their information-influences and speeds. Because speed limit is truly local, even near large objects (where speed limit is generally constant, per (72)) there can be a minute varying of this speed limit depending on aforementioned factors.

§13. *A clock and the perceived time*

(88) A process of pairing of previous and current information sets results in some amount of information processed in a unit of time. Any physical change of an object would be made manifest by the change of its definition information (see (16) and (13)). Since the amount of definition information of an object is fixed, so should be the amount of information required to affect any given physical process. Or to put it in different words, any such process is bound by the amount of information it needs to complete. Until all the information required is processed, any physical process cannot complete. A cycle of a clock is a physical process like any other.

Thus the measurement of time by a clock is governed by the very same principles. 'Time' measured by a clock is dependent on the speed of processing information. We will call the 'time' measured by a clock *perceived time*, to differentiate it from the time itself.

According to (64), the speed of lossy computation S can vary depending on the difference of information in information sets, for example:

$$S_1=\frac{\sqrt{i^2-\Delta i_1^2}}{t}$$
$$S_2=\frac{\sqrt{i^2-\Delta i_2^2}}{t} \quad (89)$$
$$S_1(t)\neq S_2(t)$$

A consequence of this is that because of different speeds, different amounts of information will be processed in the same unit of time t. This means, *perceived time* must be different too.

Since all required information needs to be processed for a clock cycle (or any other physical process) to complete, it means that the amount of time to do so must be such so the same required set of information is completely processed. That further means this varying amount of time (varying with Δi according to (89)) must be indeed the unit of perceived time, because this varying amount of time is such that the same information is processed regardless of Δi, and thus the same clock cycle (or any other physical process) completes in that time. Hence, in order for clock cycles to be the same when measured in perceived time, the speed of computation becomes the function of this varying amount of time, where *t1* and *t2* are units of perceived time:

$$S_1(t_1)=S_2(t_2) \quad (90)$$

The statement in (90) means that when speed of computation is measured in perceived-time, it should be the same. For example, if every physical process slows down by 20%, the clock slows down by 20% too. As measured by that clock, therefore, the perceived-time to complete any physical process is still the same as it was before slowing-down, because both the process being measured and the clock have slowed down in the same proportion. That is another way of justifying (90).

We have (keep in mind *t1* and *t2* are units of *perceived* time):

$$\frac{\sqrt{i^2-\Delta i_1^2}}{t_1}=\frac{\sqrt{i^2-\Delta i_2^2}}{t_2} \quad (91)$$

and:

$$t_1=t_2*\sqrt{\frac{i^2-\Delta i_1^2}{i^2-\Delta i_2^2}} \quad (92)$$

From (42) and (92) we have:

$$t_1=t_2*\sqrt{\frac{1-s^2*(\sum_{j=1}^{U} v_{j1}*f_{j1})^2}{1-s^2*(\sum_{j=1}^{U} v_{j2}*f_{j2})^2}} \quad (93)$$

The (93) represents the general transformation of local units of perceived time of a clock at different speeds relative to all other objects and with different information-influences from all other objects, where:

> t_1 is the *perceived* unit of time of the clock with speeds of v_{j1} relative to all other objects, and each such object having information-influence of f_{j1}.
> t_2 is the *perceived* unit of time of the clock with speeds of v_{j2} relative to all other objects, and each such object having information-influence of f_{j2}.

(94) Note that the transformation (93) is stated to be *local*, because factors f_j are local. Furthermore, the laconic statement from (2) can now be given a full formalized meaning with (93), with apparent dependency of transformation of local units of perceived time on *all objects* (their information-influences and their relative speeds). To put this philosophical foot a bit further, the meaning of motion relative to any given (or any subset of) objects is incomplete. Rather, the relative motion has truly a meaning *only as a motion relative to all other objects.*

§14. *A case of relative speed near large isolated object*

Let us consider a situation of a small moving object *C* near large isolated object *M*. The information-influence f_M is nearly 1 (from (27)), and the information-influence of all other objects is nearly 0.

Let us have t_1 and t_2 such that the relative speed of the two objects is v_2 for a unit of perceived time t_2, and they are at rest ($v_1=0$) for a unit of perceived time t_1, so now:

$$\begin{gathered} f_M \approx 1 \\ f_j \approx 0, \forall j, j \neq M \\ v_1 = 0 \\ v_2 \neq 0 \end{gathered} \quad (95) \qquad \textit{(we will denote } v_2 \textit{ simply as } v\textit{)}$$

the (93) and (95) become for a small object *C* (using (27) and (72)):

$$t_1 \approx t_2 * \sqrt{\frac{1 - s^2 * 0^2}{1 - s^2 * (v+0)^2}} = \frac{t_2}{\sqrt{1 - s^2 * v^2}} = \frac{t_2}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (96)$$

Perceived time runs slower for a small object *C* when moving at speed *v* (*c* is *C*'s maximum speed attainable locally through own change). The effect is also known as perceived-dilation.

For a large object *M*, we will have:

$$\begin{gathered} f_C \approx 0 \\ f_j \approx 0, \forall j, j \neq C \\ v_1 = 0 \\ v_2 \neq 0 \end{gathered} \quad (97) \qquad \textit{(we will denote } v_2 \textit{ simply as } v\textit{)}$$

And from (93) and (97), we have for a large object *M* or an object sufficiently away from other large objects:

$$t_1 \approx t_2 * \sqrt{\frac{1 - s^2 * 0^2}{1 - s^2 * 0^2}} = t_2 \quad (98)$$

(99) With relative speed, units of perceived time will be different for a small object, but will be nearly the same for a large object, when compared to an at-rest situation. There is no reciprocal perceived-dilation for a large object *M.* This makes sense as we said before that information-influence in an isolated two object scenario is very small on a large object, but nearly pervasive on a small object (see (27) and (28)). Thus speed of information processing changes for a small object, but almost not at all for a large object.

§15. *Clock synchronization*

The perceived-dilation of any clock depends on the relative speeds and information-influences of all other objects, per (93). In principle, it's impossible to know exact relative speeds and information-influences of all other objects, because those depend on the results of computations each object performs and it would take a computer of larger capacity than the Universe to know them. However, near large objects, the information-influence of all other objects is very small and therefore in practical terms knowing the perceived-dilation of clocks becomes possible, based on their relative speeds and distances. Assuming that reading of the two same clocks very near one another can be synchronized to begin with, their readings could then in practical terms be known if the rates of perceived-dilation are known to a good degree, even when they are separated.

§16. The meaning of the speed of processing

From (61) and (65), the time needed to process the definition information of *i* (thus affecting change in form of a physical process, see (88)) when available information has changed by Δi is:

$$T(i,\Delta i)=\frac{i}{S_{lossy}}=\frac{i}{S_{lossless}*\sqrt{1-\frac{\Delta i^2}{i^2}}} \quad (100)$$

This measure of 'resistance-to-change' (or time needed to process the increase of the available information to the effect of producing the change) can be used to quantify an object because such a measure can be used to easily compare the objects. If we denote this measure as *m*, it follows:

$$m\propto T(i,\Delta i)=\frac{y*i}{\sqrt{1-\frac{\Delta i^2}{i^2}}} \quad (101)$$

where *y* is a dimensional constant of proportion that absorbs the constant $S_{lossless}$ and produces measurable quantity *m*, the dimension of which is not important for this discussion. When there is no change in available information (for example sufficiently away from other objects):

$$m_0=y*i \quad (102)$$

From (101) and (96) (based on (93)) the measure varies with speed in a simple two object scenario:

$$m_1\approx\frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} \quad (103)$$

(104) Same as for perceived-dilation, the exact measure of changing of the quantity *m* ('resistance-to-change') is given by the equivalent of (93) and varies with speeds and information-influences of all objects. The correlation between information and the change in information to quantity *m* justifies our original assumption that the rest mass is computational in nature (see (1)). The information inherent in the rest mass is responsible for its resistance-to-change, i.e. for the very definition of it, including the notion of relativistic mass in (103) that arises because of change in available information. Thus m_0 in (102) is the rest mass, and m_1 in (103) is the relativistic mass (or just mass).

§17. *Distance and information*

(105) Let us observe an object at-rest at some distance from a non-rotating object *M,* the two objects isolated. Any physical volume an object occupies can be split into smaller volumes, where each such smaller volume contains some information. Information changes in each such smaller volume with each change of *M*. Because any information of *M* has equal probability to be found in each smaller volume, it means there is more information added to state-information of an object (see (12)). The more information of *M* is present at the location of an object, the more information is added to state-information as described above. Thus, when distance to *M* changes by some small amount, the change in state-information is proportional to the available-information of *M* at that distance. Since change of *M* takes some finite time to complete, the longer *C* is present at the same location, the higher the chances that *M*'s change will add to its state-information. Hence (considering (9)):

$$d(\Delta i_C)=w*\frac{i_M}{R^2}*i_C*f_M*dt \quad (106)$$

where

- $d(\Delta i_C)$ is the change in additional state-information of *C*.
- w is the constant of proportion.
- i_M is the definition-information of *M.*
- R is the distance between *M* and *C.*
- f_M is the information influence of *M.*
- i_C is the definition-information of *C.* The product i_C*f_M is the portion of *C*'s information that comes from *M.*
- dt is a small time period in between *C*'s own changes (since the additional state-information Δi_C is created and consumed between *C*'s changes as well).

The above effect is due to the fact that an object *C* has a physical volume which it occupies. Because of that different parts of this volume will see different available-information and different changes of it. This adds to state-information whenever available-information changes (see (12)).

§18. *Perceived-time and distance*

From (105) an object *C* will see additional information at any distance from *M*. It means that an object *C* moving from very far away to some near distance *R* to a non-rotating object *M* would be seeing increasingly more information added to its state information. This is not due to relative speed but is due to distance and the fact that any object occupies some space. We will find out what the increase in state-information would be, and then derive the change in the speed of information processing (similar to (38) and (45)). Note that the effect of the rotation of *M* can be accounted for by means of relative speeds (as in (93)).

(107) A simple way to quantify this effect is to model it with the relative speed. We can do that because in the computational-hypothesis, change in perceived time comes solely due to a change in the speed of information processing. For relative motion of objects, a change in the speed of information processing comes from a change in state-information due to relative movement. For distance, a change in the speed of information processing comes from a change in the state-information due to distance and a

volume an object occupies. In both cases, it's the change in state-information that causes the difference in the speed of information processing, meaning that the underlying cause is the same. This is why we can meaningfully model the effect of distance on the speed of processing by using the equivalent case describing the same effect by means of relative movement.

(108) In this model we will imagine that the available-information of *M* is constant, but *C* has some speed (instead of *C* being at rest and available-information of *M* changing). We will model a situation of a practical infinite distance between *M* and *C* with the speed of zero, meaning there is no change in information processing. When distance between the two declines to *R* we will model this situation with some speed *v* (whatever it may be to affect the same effect on the change of the speed of processing). Changing the distance between *M* and *C* by *dR* would effectively mean changing the speed by *dv.* While distance changes from *R* to infinity, the speed would change from *v* to zero.

The change of speed *dv* in our imagined equivalent model will cause change in additional state-information. From (41), the change in additional information is (information influence f_M is some constant value *f*, so we substitute *S=s*f*):

$$d(\Delta i_C) = S * i_C * dv \quad (109)$$

From (106) and (109) and substituting constants (*W=w/S)*:

$$dv = -W * \frac{i_M}{R^2} * f_M * dt = -W * \frac{i_M}{R^2} * \frac{1}{1 + \frac{i_C}{i_M} * R^2} * dt \quad (110)$$

where

- *w* is a dimensional constant of proportion.
- i_M is the definition-information of *M.*
- i_C is the definition-information of *C.*
- *R* is the distance between *C* and *M.*
- the minus sign signifies that the speed *v* would be higher with lower *R* (i.e. the when *dv* is positive, *dr* is negative).

Multiplying both sides of (110) by *v*, and knowing that *dR=v*dt* we have:

$$\int_v^0 v * dv = -\int_R^\infty W * \frac{i_M}{R^2} * \frac{1}{1 + \frac{i_C}{i_M} * R^2} * dR \quad (111)$$

From (111):

$$v^2 = 2 * W * i_M \left(\frac{1}{R} - \sqrt{\frac{i_C}{i_M}} * \left(\frac{\pi}{2} - \arctan\left(\sqrt{\frac{i_C}{i_M}} * R\right)\right)\right) \quad (112)$$

and then from (96) and (112) and (102) and substituting *G=W/y* and assuming $i_C << i_M$ and *R>>0*:

$$v^2 = \frac{2*W*i_M}{R} \quad (113)$$

$$t_2 \approx \frac{t_1}{\sqrt{1 - \frac{2*W*i_M}{R*c^2}}} \quad (114)$$

$$t_2 \approx \frac{t_1}{\sqrt{1 - \frac{2*G*m_{M0}}{R*c^2}}} \quad (115)$$

This is the perceived-dilation due to the distance to an object (or due to its rest mass m_{M0}). The equation of (112) holds only for two isolated objects. In general case, information-influence would have to account for other objects as well (instead of just the two).

To obtain a general transformation of perceived time (perceived-dilation) with distance in a system of any number of objects with any relative speeds, use (93) and (112) without information-influence factor for distance perceived-dilation (see (108)). The (115) is a simplified expression involving two isolated objects. In addition to perceived-dilation, an object's mass also increases in the same proportion (see (103)).

§19. *A word on the approach*

(116) Computational-hypothesis derives the approximations for both the SR (as per equation (96)) and GR (see (115)) formulas, the necessity of a local speed limit (see (75)) and the concept of mass (as per equations (102) and (103)) as a fundamental property of information processing.

The approach taken is to examine the informational effect of all objects, including (importantly) *all* the relative motions and the very existence of all objects on any single object. An object performs its function only by processing such information, and it means that an object is *acting solely on the basis of its own information processing, and not on the basis of conformance to any outside laws*. This is in contrast to the approach of using any vantage point to verify that a set of assumptions holds true when observed from any such point.

An analogy from a perspective of a human society may help understand this difference. A person (out of many) acts based on the totality of information available to that person. From this arise the rearrangement of a large number of solely personal decisions into a mathematically quantifiable outcome to some extent, where the societal behavior is virtually no longer attributed to individual decisions but rather to the social, economical and political laws governing them (as observed from any given vantage point). All the while, the exact change in society is always driven by a sum of individual decisions (based on available information) and *nothing* else. Even though this is a crude analogy indeed, it may help to illuminate the fundamental difference of approach for the subject at hand.

§20. *The computational-hypothesis and SR/GR*

SR and GR (simplified) formulas:

$$t_2 = \frac{t_1}{\sqrt{1-\frac{v^2}{c^2}}} \qquad t_2 \approx \frac{t_1}{\sqrt{1-\frac{2*G*m}{R*c^2}}} \quad (117)$$

are analogous to (96) and (115), respectively.

(118) The rest and relativistic masses (from (102) and (103)) are directly related to the current-state information *i* of an object and the change of available information Δi. This relationship will be used in the predictions further in the text to compute the information influence, where rest masses can be used (from (104) and (26) for two isolated objects):

$$f_X \approx \frac{1}{1+\frac{i}{i_X}*R_X^2} = \frac{1}{1+\frac{m_0}{m_{0X}}*R_X^2} \quad (119)$$

(86) follows a derivation of apparent constant speed of light regardless of the speed of the light emitter near large objects. When a photon is emitted, it always moves near the highest local speed limit. A photon is essentially an object that achieves a speed near its own local speed limit. This limit cannot depend on the speed of the emitter near large objects (see (73)), so the light always appears to move at the constant speed *c* regardless of the emitter's speed.

(120) Per (69), information processing in an object that's achieved (near) its maximum local speed is practically zero, and it becomes effectively an information carrier through space, where the information being carried reflects the state of an object at the moment when the maximum local speed has been achieved. An object's definition becomes 'frozen' and is carried by an object. This is a behavior that is commonly attributed to photons under some circumstances. Because information of an object is present elsewhere instantly (but not as a whole), this method of transferring information has the advantage of moving the entire information content of the carrier, but it also suffers the delay in transmission due to its limited speed of movement.

IV. THE PREDICTIONS

§1. *A word of caution*

There are some divergences from SR/GR that are worth mentioning. The following are a few free-form discussions, stated in less than a vigorous fashion. This paper itself, until this paragraph, provides a precise understanding of what perceived-dilation is purported to be and what the exact consequences are and how to extrapolate them. Not nearly all of such consequences are derived, nor (due to desire to limit the size of this paper) all are explored.

As it is apparent from the derivation of perceived-dilation in the computational-hypothesis, the cause of perceived-dilation has nothing to do with the constancy of speed of light, nor with gravity, but rather with the single cause – the speed of processing information. Still, near the large objects, speed perceived-dilation predicted by the computational-hypothesis is practically the same as in SR. Same goes for GR.

§2. The new phenomena

The perceived-dilation effect is not symmetrical. The smaller objects experience more perceived-dilation than the larger objects, as per (99). This means that in a generic experiment where particles are accelerated, perceived time really slows down for a particle, however it effectively does not do so for the experimenter.

Near large objects, speed of light is practically always constant and the same regardless of the speed of the emitter of light (per (72)), although it can experience minute deviations depending on location (see (77)) or the exact time of measurement due to changing information-influences in time.

Away from the large objects, the speed-related perceived-dilation effect fades (see (98)) and the maximum speed c increases, as per (78). This means that the maximum speed limit is generally different in different locations, much more so away from large objects, or for large objects themselves. A photon is then an object that achieves a speed near its own maximum local speed limit (as this speed limit depends on the rest mass). It *does not* mean that a photon will have a substantially different speed when moving from location to location (see (83)). It also *does not* necessarily mean that the speed of a photon can be substantially different than approximately 186,000 miles per second in a different location simply because it is so small compared to known emitters, so photons are likely to move at that speed locally. A large object though *can* be made to accelerate up to higher local speed limits (which can be much higher away from other large objects and it depends on the rest mass of the object being accelerated), see (85).

In general, (75) and (93) represent general equations for the local speed limit (achieved locally) and for transformation of perceived times in two different locales (respectively), out of which, directly or indirectly, all of the above example conclusions have been drawn.

When comparing notes and predictions of computational-hypothesis with SR/GR, always keep in mind the difference in approach (see (116)). The two approaches are *inherently irreconcilable* and although they may produce nearly identical results in virtually all currently practical situations, they invariably part ways at some point, namely with distances, rest masses and speeds beyond the currently practical. Given that most *direct* experimentation so far appears to have been performed in those exact situations where the results are practically identical, the value of the approach of computational-hypothesis may lay in the more careful considerations of indirect experiments or in the entirely new class of direct ones.

References
[1]Einstein A. (1916), Relativity: The Special and General Theory, New York: H. Holt and Company