the cost of questioning spacetime

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1 Abstract

We create a new type of object, working to allow for a fixed or knowledgeable path-ordering on readily accessed memory for cheaper computation.

To facilitate sorting, we weight operators per computational runtime, and assemble these weighty operators in mostly stable clusters.

We may initialize clusters in a distribution, on which descent-with-modification - or - collisions, may occur.

In particularly dense contexts of clusters, like enzyme action or molecular rearrangement, our operators rise to questions.

2 frames and objects

We create a space in which to fly.

Create an active object, o. For now, we may just call it an operation, but I will suggest that a cluster, designating a lobed nature, may be more accurate. When we instantiate o, we may add cusps.

Like,

$o = \langle\psi| H*$ or $o = \int_{\mathbb{R}^4} R*$

Where, when applying our operation concludes (by finding a ket $|\rangle$) as an inner-product around a Hamiltonian operator - asking the energy of a wavefunction - or perhaps questions (via a function on the metric, say $\sqrt{-g}$) on some curvature R in an Einstein-Hilbert action - to find a miraculous path through spacetime.

Clearly, those operations themselves are composed, as say $H = \mathbf{T} + \mathbf{V} = -\frac{\hbar^2}{2m}\nabla^2 + V$ for further operators of $\mathbf{T}$ and $\mathbf{V}$, kinetic and potential energy. So we may acknowledge that each o is itself a set of o's:

$$o := \{o_i\}$$

For particular constituent operations or operators, o_i.

For now, this is cardinal set, since we have not specified a way to order $\{o\}$.

o appears pleasingly recursive, generated by levels of operators for operations [1]. We may imagine making o as rich-and-interesting as we need for a given problem, mathematical context, and, perhaps, the allowance of Gödelian logic to expand one's deck.

We will first collect all the mathematical possibilities as the power set S of the union $\bigcup$ of all instances k of o.

$$o_S = S(\bigcup_k^\infty o_k)$$

o_S is far too heavy for most calculations, as some subsets may be infinite-in-size. This merely serves as a useful cap for our space. For most calculations, we index by a frame f

$$o_S[f] := \{o\}_f$$

Such as $\{o\}_{GR}$, the set of all operators or operations possible we might find in general relativity GR - especially those with the Palatini identity, a particularly pleasing way to relate well-trodden structures in GR - covariant vectors[**?**].

$\{o\}_f$ may still be large, infinite even, considering that we may apply any variation of operators defined within our frame [2].

We can reduce this set by grouping. For example, a set that contains a derivative operator ∂ can be condensed within o as such:

$$o = \{\cdots\{\partial_0, \partial_1, \cdots\}\}$$

For the 0th derivative, an identity or existence check, 1st derivative, and so on. Then, we may solely apply $\{\partial_0, \partial_1, \cdots\}*$ to a test - or probe - state s_p. Then, we only allow operations (or a set of operations) that may occur within a cutoff time t_{cutoff}

$$\{\partial_0, \partial_1, \cdots\} * s_p|[t < t_{cutoff}]$$

Let us generally apply such an algorithm. We subvert the halting problem by not asking which operations *do* halt, but enforcing that *all* do.

Our rationale is as follows, which perhaps may appear as a general principle of this universe:

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[1]Something to note, however, is of course

$$\Delta x \Delta p, \Delta E \Delta t \geq \frac{h}{4\pi}$$

- the uncertainty relation, where a function on energy - or -space - is necessarily limited by applying another function on time - or a precise notion of momentum - in the same domain. For by applying a function, we perturb - or spring - space. This relation may hold promise in

demonstrating we may not perform a finer decomposition on space without losing information in some (combined) domain

[2]With this frame in mind, I might cheekily define a rate, t^{-1}, the pulse by which an instance of this frame renews. To create a clock, later on, we will need to allow sync

One expects the laws of physics must manifest - or render - in a finite time, to give particles and waves a stage.

As such, for a sufficient timestep Δt perhaps related to the Planck time $\sqrt{\frac{hG}{c^5}}$, we must imagine that at least the following is true:

2.1 Axiom 1

$$\forall o \exists \tau; \quad o * \Psi \to \Psi$$

in

$$t < |\tau|$$

;

That any operation o when acted upon a global wavefunction Ψ will yield the original Ψ in a reasonable time. We expect the same universe[3] back at the end of the question. If the question halts or fails to, the universe will go on.

This o with the least cost, we may term o_Ψ, the continuity operator. It may function as analogous to an identity, but perhaps one that enforces a particular runtime.

As a note, τ may vary depending on the energetic or material properties of a particular instance or location in Ψ, and may vary steeply near boundaries.

2.2 Axiom 2

We may screen-off troublesome regions.

2.3 Axiom 3

Operators may be well-defined on no states, and we may not know which operators may fail to coalesce - the halting problem. Per Axiom 1, the universe is indifferent.

Theorem 1.1

$$(o * \Psi) = True$$

with

$$ind(o\Psi)$$

Axiom 1

$$(o * \psi) = ?$$

Axiom 3

$$\sum \psi = \Psi$$

[3] As a small proof by induction that a many-worlds may be similarly treated, we may envision an even more comprehensive Ψ, that all operators may act on to return the same, repeat as necessary. □

By definition of global Ψ

With a continuity operator that acts globally, we need to concisely define global time.

With general relativity, we must recover a notion of global time. In accelerating reference frames, experiencing an apparent force of gravity, our clocks go off each other's rate, but remain coupled by an invariant action. [**?**]

With our invariant action, we may stitch a notion of global time from synchrony, which is a process on time t [**?**].

The details of this synchrony likely depend on the particular environment, and may resemble systems of coupled oscillators, as in the Kuramoto model [**?**].

By any account, we envision a clock ϕ that ticks once a *timestep*. Crucially, the length of a *timestep* is dependent on material properties and boundary layers, but is nonetheless synced via a continuous pulsing. So we define renewal with the continuity operator.

As a foundation for this operator, we need

It is expected that o_Ψ is both organized and full, such that o_Ψ orders its operations in a way that allows a full computation on our global state in near or precisely the time it takes to do so.

An example sorting method on o could include o^n for all $n \in \mathbb{Z}_{\geq \not{k}}$. We note that however we order our (sub)sets we may still perform a *runtime* cutoff, but particular groupings may allow more operations before Δt is reached.

So we enforce some inclusion criteria for o:

$append(o, [append(\{\}, i)]$ for i in $o[\{\}]$ if $runtime[i * s_p] < t_{cutoff}])$

with

$$\sum \eta t_{cutoff} \leq \Delta t$$

Where if the operation does not halt on s_p before t_{cutoff}, we will not include it in our set and we subject all our cutoffs to sum to no-more than Δt, subject to some efficiency savings depending on our particularly ordering.

We may find that $t_{cutoff}(o_i) + t_{cutoff}(o_j) > t_{cutoff}(o_i, o_j)$

3 An aside on order

Presently, o may be well-defined as a cardinal set, but we wish to make it tractable for computation, so we might wish to place it in an order. In many cases, our order of operations may influence the results we receive[4].

We create a path-ordering operator $\mathcal{P}_\lambda$, which gives us a way to specify an order or our set, with parameter λ.

Where an example of how our path ordering might structure as follows:

$$\mathcal{P}$$

For a chain of operators, first O_1, then O_2, and so on.

[4]See, Unschärferelation

Let us assume that there is a vacuum ordering

$$\partial \mathcal{P}_{\lambda,\emptyset} = 0$$

Where the variance ∂ of a path we order on the vacuum, ϕ

So when our chain of operators clasps onto a state, it will first apply

But it may be some time before our operator chain clasps and may not stay as-is for long.

And, so, we create a cluster.

$init(\mathcal{P}_\lambda)\ enable([o])\ \mathcal{P}_\lambda(o) = [o]_o^{\Delta t}$

Where we create a structure, $[o]$

.

For example, with $\mathcal{P}$ tuned to mass, we may expect for

$$o_i = \mathcal{P}_{S,s_i} * \{\mathbf{O}_0, \mathbf{O}_1, \cdots\} |\Psi\rangle \tag{1}$$

Where the specific question Q of i results from (path)-ordering $\mathcal{P}$ a set of operators ('Is', 'Where', 'How many', etc.) to act on some state Ψ.

As a lighting proof, we note that there is no universal path-ordering.

3.1 Theorem 2.1

Assume that we may compose[5] a $\mathcal{P}$ that takes two parameters:

A vacuum state S_0, and a particular state $s*$

$\mathcal{P} = f(S_0, s*)$

We may move down a parameter, and see if $\mathcal{P} = f(S_0)$ alone exists.

Assume: $\exists \mathcal{P}; \mathcal{P} = f(S_0)\tilde{(}\mathcal{P} = f(S_0, s)$

or $s \notin g(\mathcal{P})$ where $g = f^{-1}$ for an arbitrary test state s and a reversible path ordering $\mathcal{P}$.

Then we may arrange a cheat, such that we always expect $\mathcal{P}(o) * |\psi\rangle = k$. For a knowable k, an arbitrary state $|\psi\rangle$ and a particular question o

$$o_\emptyset * = \mathcal{P}_{S,s_\emptyset} * \{\mathbf{O}_0, \mathbf{O}_1, \cdots\} * \tag{2}$$

We remove information about the state s_i on which the question acted, but let's keep this question as some ordered arrangement of operators. S might help. Let's call it entropy.

We have created an unstable object, and a mathematically ill-defined one. Don't worry, that was by design. It'll only exist for a short while.

4 A duel with τ

Time, as rich a space as it may be, is best reserved for the real world.

Before we find that place we allow all operators to rotate in phase space $\phi = [0, 2\pi]$, arranged on a unit circle.

[5] Or tend, as Mendel might

τ, perhaps an epoch, is represented by a collection of arcs on the circle, for example $\int_\circ d\phi$ or $\sum_i L_i = 2\pi$ for an arc length L_i.

In 1τ, a computation encoded in τ may be done. We let τ speak for the epoch as a whole and serve as an initialization structure.

In a picture consisting of arc lengths, we may associate each arc length with a file, and in it place an extraordinary tensor, ι.

When held on an operator, ι will create a balance, of all the constituents within reach, that weights each accordingly.

$While\ \ iota(o) : o_j[Min(Run(o[i]) < \tau_{epoch})]\ Let$

ι will return a call to reassemble.

5 A comforting dream

Let us fill a spacetime with composites and collisions of clusters. We wish to allow sufficient descent with modification, and perhaps collisions, such that our operators eventually questions may occur.

We envision a splendid matrix, M, which we parameterize in space spanned by indices μ and ν, and define

$$M_\mu^\nu(o) \equiv \cdots \int_S \prod^i \sum_i f_i e^{-o}$$

Of in a chain we'd travel through a space S of permutations $\int_S \prod$ over all of space S, of an product array Π with a demonstrable size, of that worked on a weighted-by-function sum $\sum f$ of an exponential $e^{-kT^{-1}}$.

Let us choose a particular flavor of o, that gives us an intrinsic thermodynamic quality k and an external gradient that may drive dynamics, T

For posterity sake, let us choose $o = (kT)^{-1}$

o, in this state

For in a damped exponential you could place an oscillator, that rode the waves generated by kT^{-1}. And this would would always be $True == ((k, T\&S) = True)$

Before we conclude an argument, we will note the nature of $-kT^{-1}$. It seems a small pearl, with an internal constituency k found alongside an external temperature - or voltage - T^{-1}. Perhaps k reacts in T. k appears composed, as consisting perhaps of innumerable puncta, described by energies and swirls.

Jump back to the magnificent still-a-matrix, or perhaps, understandably, a tensor.

Does it exist?

The answer, quite cleverly, is no, as I'm afraid the empiricists realized the experimental apparatus weighted the score.

$$\Delta x \Delta p \geq \frac{\hbar}{2}$$

And

$$E_B \geq k_B T \ln 2$$

Our magnificent matrix, when computed, would become a black hole.

5.1 Lemma 1.2

We cannot know all of a global state.

5.2 Splitting

In the presence of energy, or mass, let us allow instability of our compositions:

$$\{O_i\}_t \neq precisely(\{O_i\}_{t+1} \tag{3}$$

As if our state is identical between epochs.

At another time $t+1$ we get a new composition $\{O_j\}$ along with some fragment γ.

γ may contain viable operators, in which case we might write:

$$\{O_i\}_t \rightarrow \{O_j\}_{t+1} + \{O_k\}_{t+1} \tag{4}$$

This is all well and good, but we'll need to let these operators change in a particular way. Finally, we may clasp.

Let us create a hidden layer. We haven't decide we want the result just yet.

$s_p = f(|\Omega\rangle \vee \mathcal{M}_{trivial})$

Where we envision our test state as comprising vacuum state $|\Omega\rangle$ or acting on the trivial manifold $\mathcal{M}$ defined with our topology.

Since we have defined our operators with this manifold or state, we expect a result, r.

$$\{O_i\} * s_p = r$$

Let us not-yet print this to the console. Instead, let's mask it:

$mask(r)$, and create a hidden variable. We may as just well mask the whole process:

$$mask(\{O_i\} * s_p = r)$$

And assign this masking to a (pseudo)random number.

$$mask(\{O_i\} * s_p = r) = \alpha$$

5.3 Cofactors

As we map operators to clusters:

For a certain operation to occur, we may require two or more clusters acting on a particular spacetime.

$(O_i + O_j + \cdots) |\psi\rangle$

As in cofactors.

5.4 Stickiness

We will make a strong, but reasonable assumption.

$$\exists \langle o \rangle |_\emptyset$$

That every cluster of operators o has at least an $\exists$ expectation $\langle\rangle$ on the vacuum $\emptyset$. This will be a nice constraint to preclude improper operators from forming and hogging runtime.

This expectation may yield null $\mathbf{0}$, as in our cluster has little-to-no influence on the expectation of the vacuum. This is of no-concern, it may just inform that we are operating in a high-energy, or biological, physics context.

5.5 Descent with modification

We may need to envision a purpose for our cluster.

St. Anselm weeps.

A cluster must be self-evident

This can be computed ahead of time, but since the order of operations is subject to uncertainty with time, leaving that unclasped may promote mutation.

$(O_i, O_j, \cdots)* \rightarrow (O_j, O_i, \cdots)*$

6 A certain tick

Let us propose a concise question:

$$q_i * \psi = (min(\mathcal{P})_{S,s_\emptyset} * \{\cdots, \mathbf{O}_1, \mathbf{O}_0\}) * \psi \tag{5}$$

Where we tune as follows:

min compares numerous orderings of path operators.

7 Allow a brief shuffle

Our composition of o may be remarkably unstable. Top-heavy with too-early integrations, sharp without stabilizing differentiation. So we allow a drop or a mix Γ to give us a chance before we land on $|\Psi\rangle$.

Each grouping of operators in a cluster we may encode in a frequency band δf. The frequencies may be multiplexed and allowed to compute for a finite time.

$$(MUX(\sum_i \delta f_i)) * o_\Psi | \tau$$

Which manifests itself as:

$$Min(Compute(\forall f * f))$$

Or the shortest coupling across all frequencies. *Compute* may only need 1τ to occur

8 A coherence on x

There is a cost associated with constructing, setting-up, and configuring spacetime. Call it a fixed cost.

Every (active) observable on a space requires an additional cost. Perhaps term it a variable cost.

We create two bins, Fix and Var, and distribute our operators throughout each.

$$\forall o \in O^*, \;\; o \in Fix \;\; \vee \;\; o \in Var$$

The union of Fix and Var

9 A minimum cost

The full algorithm is something special, a stored-in-memory Ψ:

$$compose(min\{load_i(o\Psi)\}, piece(x, u)_*)$$

Where a part $*$ of the *piece* clasps with an efficient o.

10 A conclusion, of sorts

o is an operation, cluster, or unlabeled particle, it consists of sets, which ought couple and potentially mutate, as might our physical laws. If a concise formulation can be arranged, we can ask precise questions of space, which naturally occurs over an interval time. In fact, it must.

The universe needs to render in finite time, as it seems c dictates. Every operator must, at-the-minimum

c will only admit coupling with a G upon a balancing of masses $m_1 m_2$. Unless balanced by $\hbar$, which fits snugly alongside c in a loop.

We can demonstrate efficiency by creating a proper spacetime, asking all the questions we can, and then modifying or extending the spacetime to answer the next class of problems. Repeat *ad infinitum*, or until we run out of inspiration or permutation for cleverer tools.