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Date: 2013-10-09
Title: A Calculus for the Present

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A CALCULUS FOR THE PRESENT

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It is true that a unification at the level of the development of calculus is needed, and in this we might take note of the following:

(1) The development of calculus involved the introduction of a natural way of dealing with infinitesimals. Computing in its current form doesn't allow natural ways of dealing with continuous spaces. It is likely the case that binary has run its course, and that the time is right to introduce a new layer of foundation: ternary. In this way, we can deal with a decision of more, less, or the same, as a primitive, base-level notion. This is the class of decision involved in perceptual work. Perception in its true form, not a bolted on hack, is what is needed to allow computing to progress.

(2) Once perception is allowed to play its proper role, we can move on to allowing non-linguistic means of operating that will allow computing to feel more like the real world. We should not be forced to name things before we know what they are. Spatial relations should be primitive. Material properties such as weight, and its temporal equivalent, natural degradation, should be primitive, allowing proper value judgements as they are made in the real world. This will allow a proper value system which doesn't inappropriately collapse distances, and cause the types of distortions of judgement that we read as the social problems of the current time period.

(3) We can then move on to developing higher level primitives that reflect human experience, such as a calculus of faces. From a long and developed history of art, we know a great deal about how humans process wide classes of phenomena. All of these constitute computing on higher level primitives, and the calculus we speak of will be derived from our knowledge of these.

(4) It will be acknowledged that we have a long and developed history of gaining intuitions about high dimensional spaces. This is

called perception. We know a great deal about how to process this information: We make line drawings that capture essential characteristics of the huge space of perceptual information, condensed to a compact form. We know that significant information clusters in small regions of the space, and that small variation can cause immensely different interpretation. The Curse of Dimensionality has been known in this form, and has a very long and developed history.

(5) We will learn to take advantage of the fact that we can interpret the past as a space with full geometric properties, with distances fixed; the near future as a topological space with certain characteristics determined but distances not yet fixed; the far future as a discrete space with connectivity not yet clear; and the present as a moving crystallization front. With this interpretation in place, we will have a clearer sense of the type of decision-making that is necessary to obtain a desirable future, and how to go about navigating towards that state.

(6) It will be clarified how the move to increased abstraction comes with a cost: The process of word formation and abstraction is indeed the very same as the process of integration. The same cost of omitting constants has its equivalent in removing perceptual information, and connection to the setting in which a compact description was formed. The cost is typically offset by knowledge of history and the arts, which contain the information for how differentiation can be performed in a valid way. From this we can know whether the current setting is similar enough to the prior one in which the description was formed, to determine if the piece of knowledge is indeed applicable, and how it may be applied. If we fail to acknowledge that the balance between sparse and dense spaces must be maintained, then we find ourselves in problematic situations, which are revealed in full when the environment changes, and prior strategies, blindly applied, fail spectacularly.

Is it the case that we are arguing whether the Mercator Projection or the Robinson Projection is the correct one, having forgotten that we are arguing over a flattened, reduced representation, and not speaking about the world itself? We do indeed need topology to provide us a map of where our algorithms are taking us, as well as geometry to know what distortions there may be. We've been taken on a wild ride, and by directly addressing the lack of perception in computing, we may finally be able to come to our senses. We are not in a world unlike any that has existed before, and when

we have strong methods that say how to recover what was lost from the few clues we do have, then it will become more clear how to proceed.

Though our computational tools are new, computation itself is merely our descriptive tool for how the world works. We may add new layers of abstraction to deal with an increasing number of elements, but the world we're describing functions by the same principles, so our strategies should likewise be no different. As long as our eyes and ears and basic biology remain the same, we have grounds to use the same strategies that have been around for some time.

It is the case that ideas of calculus arise in connection to physical problems in mapping the land and describing space. Is it the case that populations to whom the benefits of characterizing the landscape were of essential importance may have placed emphasis on developing similar tools? Is it the case that mobile populations, nomadic pastoralists, leading flocks over large distances and through hostile environments would benefit from descriptive tools which capture essential information in compact form, allowing for reduced reliance on physical infrastructure? Is it the case that techniques for memorization might be of use, that compact poetic forms might develop, and that other art forms like music and dance might develop alongside it to tell of the context in which abstractions were formed? When boundaries are eventually drawn, is it the case that underlying inclinations that develop over the course of time may be preserved, as these populations choose to maintain some aspects of their traditions?

Is it the case that adaptation to changing circumstances, rather than resistance, may be the accepted course of action when the environment is harsh and uncontrollable? Is it the case that when a previously stable environment begins to change, then those having dealt with changing environments, or those with the inclination to adapt, may be the ones with some notion of how to proceed? Is it the case that leadership appropriate to this circumstance may arise in this way? Is it the case that this situation has possibly arisen in the past, not once, but repeatedly, leading to an expectation that it will again under similar circumstances?

Perhaps we have heard this story before: A system is put in place which serves a purpose, but its rigidity becomes clear when a level of maturity is reached, and then a new system must be formulated which balances the need for structure with a need for self-determination. We describe objects in Cartesian coordinates until they're developed enough to be described on their own terms, then we invent manifolds to do so. We draw the world

exactly as we see it, until we figure that, the developed skill now allows us to speak our own message. We read all the texts until we find that they don't say all there is to be said, and then we start to use our senses to experience the world. We go to school, but then we graduate and start lives of our own and create the structures that we need.

In the Vedic era, adhering to texts and rituals, and to maintaining a hierarchical social system was appropriate up to a point. Beyond this, doctrines were challenged by the Shramanic emphasis on direct experience, as well as criticism of a social system which no longer served the needs and best interests of the population. A merging of the traditions allowed a more robust system, able to absorb opposing viewpoints and allow large-scale cooperative behavior.

In that computing is the lens through which interactions with governance and the environment increasingly take place, in that the communication infrastructure guides behavior, it is necessary that an architecture be in place that can accommodate a response more complex than a yes or no. Language contains discontinuities; the world does not. When we perceive a discontinuity, we know that we are viewing a reduction from the full space, and we should make the effort to understand the phenomenon in its full dimensional form.

We inherit a changing environment of seemingly complex problems. But complex problems do not ask for complex solutions. They ask for understanding of their origin. Successfully reading the environment for clues of what is to come and where to go, successfully navigating through harsh terrain, these will require a willingness and ability to make changes, and to cooperate. It will require willingness to be prepared, to look at the map rather than trust the turn by turn instructions, to demand a situation which allows individuals to take responsibility, and then to do so. No one solution is the best fit for everyone, and the environment changes fast enough that the best solution a minute ago is not the best anymore. But this is nothing new. We know exactly how to deal with this because we play piano and violin, play soccer, dance, do all of these things with great success. We just need the tools to allow us to play. Recognizing the game will get us on the right track.

Gottingen under Klein, Courant, we have good models for how to learn about the world without heading off the deep end into abstraction. We know that abstraction leads to fragility, and that degeneracy is a principle of design that allows robust solutions. Yet our value system can only

reflect worth as increases in productivity. This is naive, and reflects little sophistication about how the world works. Outdated viewpoints like these will need to change.

Here we are inheriting the world, left holding the bag, saddled with the debts of those pushing problems down the line, to be dealt with at a later time. And here the debts are coming due, the water is rising, and we're kicked off the life raft, sorry, no more room. The best we can do is learn to adapt to the changes which will undoubtedly be coming. Learn to swim. Learn about the most powerful tools at our disposal, how they work, and how we may put them to use, to cope as best we can. Math at least provides the assurance that, given a certain situation, we can with absolute confidence say that something else is true. It unfortunately can't speak to the state of the environment. Sensors can help gather information, the data can help learn the landscape, statistics can help us make statements about it, machine learning can help to guess based on these statements, topology can help to structure and organize them, geometry can help to show their similarity to previous statements, algebra can help in manipulating these objects. But at the end of the day, we are still people, making the decisions to do any of these things, using just the same senses we are born with.

The burden is on us to use reason, as well as use our senses, not one at the expense of the other. To be reasonable and to make sensible decisions. This is the way forward.