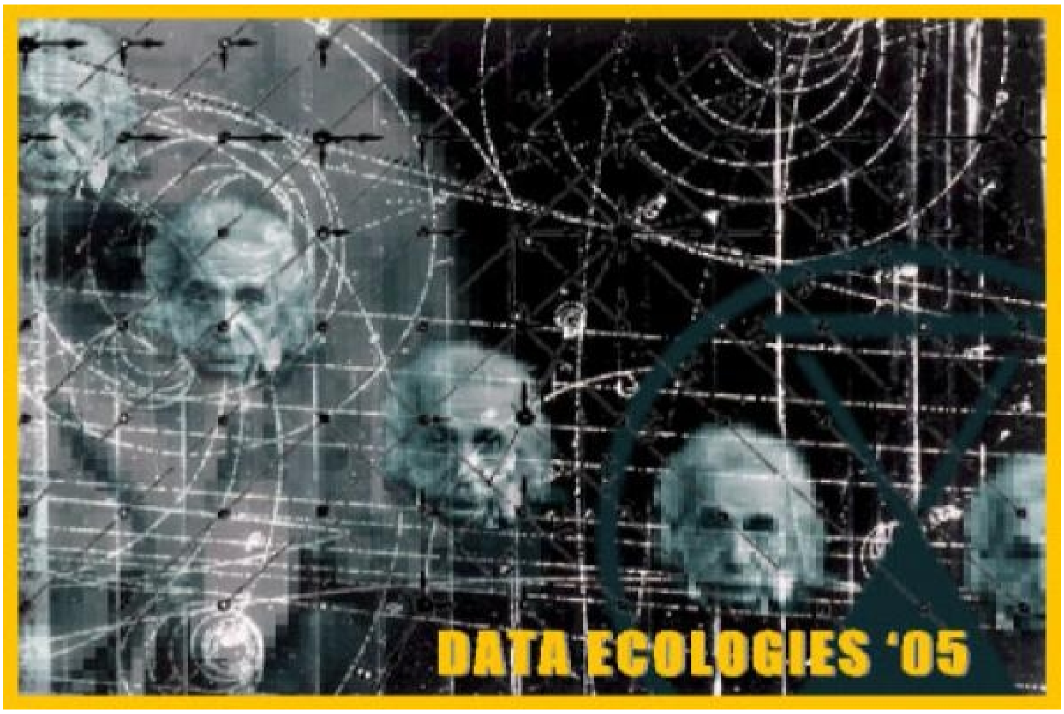

Symposium

Time's Up Laboratories
Linz

May 12th - 14th

Introduction

100 years after Einstein published five papers that rocked and then essentially overthrew the then-current physical understanding, the murmurs of discontent are arising. Theories extending, expanding, explaining or just plain overthrowing the tenets of the now-current model(s) are making the rounds.
Fifty years after Wheeler's description of the space-time foam at the Planck scale, the discreteness of time and space that he was implying is becoming apparent, and the ideas behind this vision are becoming clearer, or at least less murky.
In a society filled with computation and processes, it is no surprise that current metaphysics are being built around concepts of computation and process, discreteness and time steps.Pattern formation by self-referential algorithms, diagrams of data structures and their spontaneous self-manipulation, tessellation systems and their dynamics, self-perpetuating flaws and defects in processes ---- these and many other models are creeping out of the woodwork.

This workshop aims to bring together people working in various aspects of these fields, to allow them to talk directly and without needing to couch their claims in unnecessarily standardised terms. We invite algebraists, artists, modelers, writers, computational geometers, physicists and everybody interested in being part of a discussion of what a computational universe is and might be, what it would mean for us and how we might know.

Two aspects are of main importance for this event:

Where does space come from? Does Leibnitz' idea of monads and relations rather than Newton's idea of space and objects have more veracity, does it say more about the way in which space might be? Wheeler's “It from Bit” talks about pregeometry, about some kind of combinatorial / computational structurs that gives rise to what we call geometry, that is, space, from the bottom up. What other spaces are there? How many spaces do we move ourselves within, and in what way can these be made physical or at least pseudophysical.
Given that we have space, what sort of processes might occur? If space is a network, does it have to be clean and regular, or is the noise of the network an essential part of the process that takes part in that space? Are space and action even separable? Spin foam theorists talk about space-time as being a four dimensional bubble bath, with the edges between bubbles arising and dissipating stochastically. They talk about knots in the net as the fundamental parts of nature, twists that are topologically irremovable as irreducible particles.
We welcome contributions to thes themes and the curve that they throw upgenerate. Topics of interest include, but are in no way limited to the following:

combinatorial invariants of knotted nets artists investigating the production and perception of space in modern media the determination of structure from noise as the basis of perception pregeometries in all flavours interactive explorations of the nature of space, time and spacetime the nature of a computational nature – what could the universal computer be doing? experiments to examine the computational nature of the universe experimental evidence of a preferred frame of reference possible algorithms for our universe can we possibly harness the computations in which we are seemingly immersed to our practical use?" in what respects is quantum computation different from classical computations, and why?

Tommaso Toffoli
Boston University

Computation: The LEGO of physics

How can Everyman appreciate what theoretical physics is and what it is for? I doubt that a diet based exclusively on pulp press titles like "The Mystery of Black Holes," "Teleporting Schroedinger's Cat," "Thrills on the Edge of Chaos," or "In Search of the Last Quark" can be of much help. What we truly understand is only what we may make ourselves out of pieces we own and can play with.

Computation is such a "LEGO" kit. Computation IS dynamics that we can specify and run. It thus allows us to make worlds of our own. In this light, the eternal appeal of cellular automata is that ANYONE can create and run a nontrivial world and truly claim to know how it works. What may come as a surprise is that our physical world shows much evidence of having been constructed out of a kit of the same kind.

We'll show how QUITE SIMPLE computational models can fully capture---conceptually as well as empirically---non-frivolous aspects of physics such as relativity, the second principle of thermodynamics, and the variational principles of mechanics.

By means of kitchen experiments that they can actually run themselves we try to make our children intimately familiar with biology and evolution (breed water fleas in a fish tank) or chemistry and electricity (make a "potato clock"). What I will show you is "kitchen experiments" of theoretical physics.

Karl Svozil
Institut für Theoretische Physik,
University of Technology Vienna,
Wiedner Hauptstraße 8-10/136,
A-1040 Vienna, Austria

Aesthetics and scarcity
a physics perspective

A theory of aesthetics is presented which is based on natural forms characterized by statistical and algorithmic means. Several strategies and options to create sophisticated natural forms and ornaments are discussed. One of the questions that arises is whether and how the variants of noise and symmetry may contribute towards aesthetics.

Try to answer the following question instantly and without much thinking. Suppose you have ten minutes to spare. Where would you rather be: on Park Avenue in Midtown Manhattan, or in New York's Central Park? Surely, Park Avenue has to offer much more modernity and is dominated by artistic structures created by valiant human imagination. In contrast, Central Park may appear dull with its re-enactment of a natural habitat by landscape gardening. All those trees and plants appear boring compared to the hip of Manhattan's skyrocketing skyscrapers, don't they? It is not unreasonable to speculate that most people would prefer Central Park over Park Avenue when they should choose a location for idling around. (I am not considering here the curiosity of suburbians studying man-made canyons.) Why have so many who could afford left the city centres for rural surroundings? Why is hiking and vacationing in beautiful habitats a means to refresh our minds? You may also ask yourself where you would rather like to live in a galaxy far away, shaken by Star Wars: on the planet Naboo, or on Coruscant? Again, I suppose most people would choose Namboo; at least after the siege of the Trade Federation is lifted. Likewise, why is it so that most of us would not like to spend your holidays in a present-day virtual reality instalments but rather undergo great hardships of travel and visit uncontrollable spots far away? Would it not be much more risk-free, convenient, personalized, funnier, satisfactory and thereby cheaper to go virtual? Why those choices? It is suggested here that there exists a very simple answer to all these whys; though many contemporary artists will not like it. This answer discredits many modernistic artistic emanations such as International Style architecture, as well as paintings and concert hall music as either being too monotonic and dull, or appearing irritatingly irregular and erratic, and it imposes a high burden on those who create virtual human habitats.

Jürgen Schmidhuber
IDSIA, Switzerland

Optimal Prediction in Computable Universes

1. Which universes are computable at all? Traditional Turing machines (TMs) are insufficient to answer this question. We need concepts such as generalized TMs and computability in the limit.
2. Our universe’s shortest and fastest algorithm has just a few lines and computes all possible universes, not just ours.
3. There is a Bayesian way to predict optimally in computable universes, but it needs more than the algorithm above, and also more than the anthropic principle: It needs a plausible prior measure on the possible universes.
4. Weak assumption on this measure: the universe is sampled from a formally describable prior (that's what all physicists assume). Then random futures without short descriptions are unlikely - Occam's razor!
5. Strong assumption: universe deterministic a la Zuse and created under resource constraints reflected by the Speed Prior. Much stronger nontraditional predictions about beta decay etc. Let us test them!

An experimental setup for measuring the one-way-phase velocity of a microwave signal

Hartwig W. Thim*, *Life Senior Member*, *IEEE*
Microelectronics Institute, Johannes Kepler University,
Altenbergerstrasse 69, A – 4040 Linz, Austria, and
Norbert Feist,
Leo-Fall-Strasse 26, D-86368 Gersthofen

Abstract **–** The Michelson-Morley null result is readily explained as a classical Doppler effect [1][2][3] due to the fact that the out-and-back phase velocity is isotropic and thus in both arms of the Michelson Interferometer equal to $c'=c(1-v^2/c^2)$. It is important to emphasize that the phase velocities rather than the group velocities must be considered which are different from each other in the transverse arm whereas they are identical in the longitudinal arm. This means that the Michelson Interferometer is - in principle – unsuited to detect an absolute frame of reference or ether-drift even if an ether drift exists.

In order to reliably detect an absolute frame of reference where the speed of light is isotropic and equal to $1/\sqrt{\varepsilon_o \mu_o}$ an experimental setup allowing to measure the one-way-phase velocity of an electromagnetic wave must be used. In this presentation a microwave setup will be described which uses a 12,5 GHz signal traveling along a 3m long signal path. Both generator and detector (oscilloscope) are synchronized by a specially designed 3m long "microelectromechanical" transmission line providing a non-electromagnetic and thus "ether-independent" signal path. This setup should be capable of detecting the absolute velocity of our solar system relative to the Cosmic Microwave Background (~360km/s) by simply changing the orientation of the signal path relative to the direction of the absolute velocity in a similar manner as Marinov [4] had done it already in 1975. However, Marinov's findings (v = 303±20 km/s) have not found widespread acceptance possibly because of insufficient accuracy. The experimental setup described here is based on a straight forward and much simpler method for testing the constancy of the speed of light and, hence, special relativity. Experimental results obtained with this setup will be presented at the conference.

References

[1] W. Voigt, "Theorie des Lichtes für bewegte Medien", Königliche Gesellschaft der Wissenschaften zu Göttingen, No 8, May 11, 1887 (Sitzung am 10. Juli 1986)
[2] N. Feist, http://www.norbertfeist.de
[3] J. P. Wesley, „The two velocities of classical waves", accepted by Physics Essays 2005
[4] S. Marinov, „Measurement of the Laboratory's Absolute Velocity", General Relativity and Gravitation, vol. 12, No. 1, pp. 57-66, (1980)

*hartwig.thim@jku.at, http://www.ime.jku.at

Nik Gaffney and Maja Kuzmanovic
Foundation oAM
Brussels

metaphors for inspiration vs metaphors for interpretation

"The design of responsive environments, and mixed reality spaces at FoAM is motivated by the conviction that living spaces (including materials, clothing, built or grown artifacts, and architectures) should not be designed as static or predefined structures. Rather, we approach them as malleable, alive entities able to be influenced and shaped by the activities occurring within and around them. Through a continuous, spontaneous interaction with human participants, the surroundings becoming active agents affecting our social relationships in everyday life. On one hand, the seemingly solid matter which constitutes our realworld, is ripe for infusion with responsive media; on the other, digital worlds are being designed with more tangible, immersive properties. Both trajectories have been followed in FoAM, shaping a series of collaborative projects between 2000 and 2005; from tGarden, to txOom and most recently trg."

there is also a diagram you might like {to complete.. } ->

```
                          o-tgvu-[..?]------o-[...?]->
                         /                 /
    o-tg1+2-o-tg3-o-tg4-o         o-[eerm]o-[timesup?]->
                         \       /
                          o-tx1-o-tx2-o
                                       \
                                        o--trg->

     o->



                  o->


       o







             o
           .


            .
```

Edward Fredkin
CMU West (USA)
digitalphilosophy.org

A Computing Architecture for Physics

Two future problems for programmers are Artificial Intelligence and Physics. In both cases there are ultimate goals: for AI it is human level intelligence and beyond, for Physics it is programming the TOE (Theory of Everything). Of course, if and when we have an AI system far more intelligent than anyone we can let it solve the remaining programming problems. The reason AI research has proved so difficult is because we don't yet know how to program AI. It's also true that our understanding of physics is far from complete. We assume, rightly or wrongly, that the only reason we cannot program a perfect model of fundamental processes in physics is that we don't yet understand the physics. However we may also be in need of new computing paradigms. We want to believe that there is no magic in physics, just things we don't yet understand. Our ignorance mustn't discourage us from trying to make progress. This paper is a report on one frontier in computation; steps towards inventing computing architectures that might let us understand aspects of fundamental processes in physics.

Five big questions with pretty simple answers

Under the roof of one controversial assumption about physics, we discuss five big questions that can be addressed using concepts from a modern understanding of digital informational processes. The assumption is called finite nature. The digital mechanics model is obtained by applying the assumption to physics. The questions are as follows:
1. What is the origin of spin?
2. Why are there symmetries and CPT (charge conjugation, parity, and time reversal)?
3. What is the origin of length?
4. What does a process model of motion tell us?
5. Can the finite nature assumption account for the efficacy of quantum mechanics?

Digital mechanics predicts that for every continuous symmetry of physics there will be some microscopic process that violates that symmetry. We are, therefore, able to suggest experimental tests of the finite nature hypothesis. Finally, we explain why experimental evidence for such violations might be elusive and hard to recognize.

Dan B Miller
(Carnegie Mellon University)

Implementing Digital Physics

This paper introduces a novel Reversible Cellular Automata, or RCA, that we believe is computation universal, and capable of universal construction, in the sense described by Von Neumann. Where Von Neumann's original CA was irreversible, two-dimensional, and required 29 distinct states to perform its functions, the present RCA is reversible, threedimensional, and requires only two cell states (albeit using a spatio-temporal partitioning scheme). To our knowledge, to date the simplest 2-D CA that is known to be a universal constructor is shown by Banks. Banks' CA was irreversible, two-dimensional, and required four distinct states. The simplest 2-D reversible cellular automata we are aware of that is known to be capable of universal computation is introduced in [Margolus], and is based on the so-called BBM (Billiard Ball Model). The Margolus CA is a two-state, reversible CA in two dimensions; to our knowledge it has not been ascertained whether this CA is also a universal constructor. In this paper we will describe the general class of CA's we refer to as "Salt" automata. We then proceed to analyze one specific rule set within this new class. We will show that the CA in question is a reversible automata, and is capable of universal computation, through the existence of 'gliders' that interact to perform logic operations. We will offer strong evidence that this particular CA is also capable of so-called universal construction, through the interaction of gliders strategically emitted from a central location.