

But I very much doubt that any such obvious symmetry between space and time exists in the fundamental rules for our universe. And instead what I expect is much like we have seen many times before in this book: that even though at the lowest level there is no direct correspondence between space and time, such a correspondence nevertheless emerges when one looks in the appropriate way at larger scales of the kind probed by practical experiments.

As I will discuss in the next several sections, I suspect that for many purposes the history of the universe can in fact be represented by a certain kind of spacetime network. But the way this network is formed in effect treats space and time rather differently. And in particular—just as in a system like a cellular automaton—the network can be built up incrementally by starting with certain initial conditions and then applying appropriate underlying rules over and over again.

Any such rules can in principle be thought of as providing a set of constraints for the spacetime network. But the important point is that there is no need to do a separate search to find networks that satisfy such constraints—for the rules themselves instead immediately define a procedure for building up the necessary network.

### **Time and Causal Networks**

I argued in the last section that the progress of time should be viewed at a fundamental level much like the evolution of a system like a cellular automaton. But one of the features of a cellular automaton is that it is set up to update all of its cells together, as if at each tick of some global clock. Yet just as it seems unreasonable to imagine that the universe consists of a rigid grid of cells in space, so also it seems unreasonable to imagine that there is a global clock which defines the updating of every element in the universe synchronized in time.

But what is the alternative? At first it may seem bizarre, but one possibility that I believe is ultimately not too far from correct is that the universe might work not like a cellular automaton in which all cells get updated at once, but instead like a mobile automaton or Turing machine, in which just a single cell gets updated at each step.

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