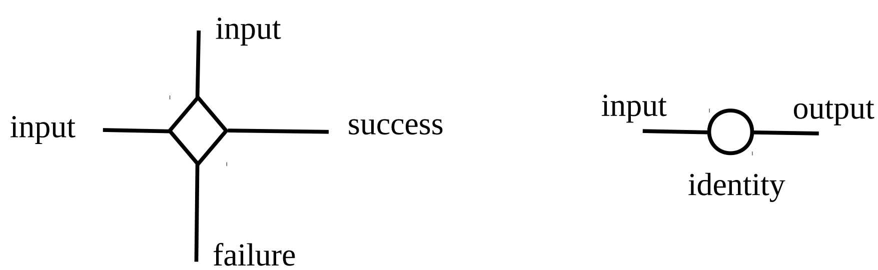
Time-Travel Logic

by Sven Nilsen, 2019

In this paper I present a generalization of Boolean functions which satisfy some intuitive properties of time-traveling. The motivation is to study isomorphic behavior to non-time-travel behavior which representation is better compressed when enabling time-travel.

Time-travel logic is easier to visualize using a diamond-block notation for activation of a system and a circle for identity (non-activation).



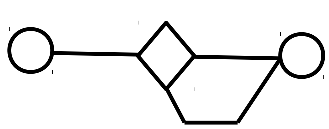
Boolean functions where `true` maps to `success` and `false` to `failure` can be generalized to a time-travel enabled space of functions. However, in order to simplify the introduction of time-travel logic, instead of mapping to `success` or `failure`, one can consider a singleton state where functions are separated only by side-effects from activating systems.

All singleton time-travel functions have a unique input state and a unique output state

For such normal functions without side effects, this space is inhabited by only one identity function, but in time-travel functions this space is inhabited by an infinite family of the time-travel analogue of functions.

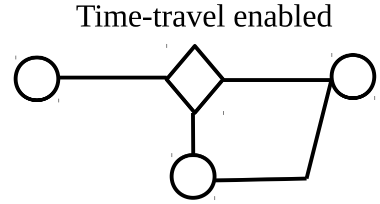
For example, reading from left to right, one starts in a state, activates a system and ends in a state:

Time-travel disabled



An outside observer sees the system being activated

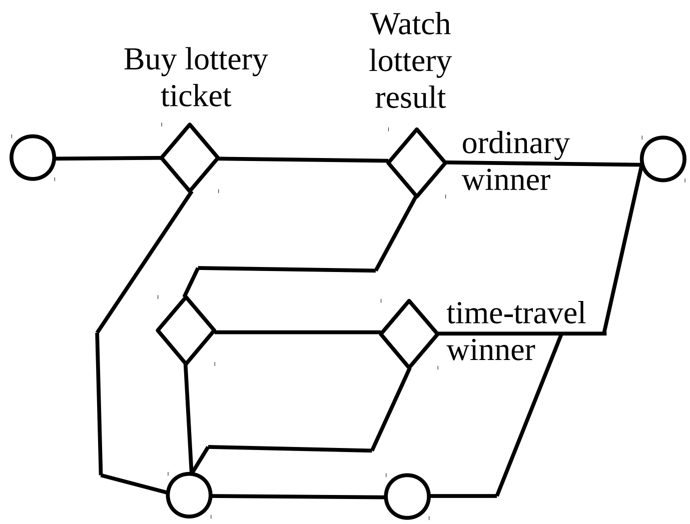
Time-travel enabled



An outside observer sees the system being activated, but only if the system succeeds

Since time flows from left to right, nodes in the same column overrides nodes up or right.

Common sense tells us that if I had a time machine, I could win the lottery. However, this is not always the case! Here is a diagram for a rational decision maker trying to win the lottery with time-travel:

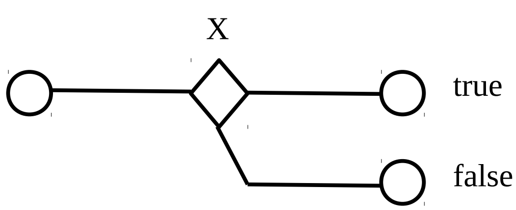


Using this diagram, the decision maker is guaranteed to not lose money, but not guaranteed to win.

It is not known in advance that a system will succeed or fail, because when I travel back in time and buy a different ticket, the future is changed such that the lottery number I thought would win can fail.

If the time-traveler watches his ticket fail, it is still possible to go back and try another number, or choose to not buy a lottery ticket at all. Winning the lottery this way is rational only if the expected return is higher than the costs of side-effects from going back in time.

Ordinary Boolean functions can be modeled in time-travel logic by using multiple output states:



id(x : bool) = x

A counter-intuitive property of this time-travel logic is that certain events must happen, such as posting an unopened letter, in order for the receiver to know the content of the letter by reading it, go back in time and choose to not open the letter.

It might seem at first that this kind of generalized logic is not practical, but it has many applications: Behavior where predictions of success are probabilistic can be modeled in time-travel logic to obtain the circuit diagram for decision making where the agent is part of the environment. The circuit diagram is a compressed and comprehensible representation of advanced probability distributions.