Suppose an electron and a positron (= anti-electron) collide and annihilate. We'll consider it in the barycentric coordinate system. Then, presuming the particles are point-like, it must be a head-on collision. Both particles will completely annihilate (destroy) one another, leaving only the energy corresponding to their masses conform Einstein's famous equation: $E = mc^2$.

This energy will leave the place of disaster in the form of two photons (or, in Einstein's terminology: energy quanta, he never used the word photon), each ~~having~~ being half of this total energy (which is ~ 511 keV/photon = gamma radiation).

What we *do* know is that those photons will leave in exactly opposite directions, what we *don't* know is what the actual direction will be. As far as we know, their distribution (of many annihiliations) is isotropic[1], all directions are just as probable. If the direction of the photons is not known in advance, we can also not say anything about where they will end up, so the ultimate consequences of the annihilation are not known in advance.

The electron and positron have no known properties from which we can deduce the direction of the photons. Maybe the particles already annihilate when they come closer to one another than say their Compton wavelength? Then the impact parameter might somehow affect the direction of the photons, but I don't know any experimental results thereabout. Altogether, this strengthens the vision that the future is fundamentally unpredictable, meaning nature is non-deterministic.

Prediction is very difficult, especially about the future.
Niels Bohr.

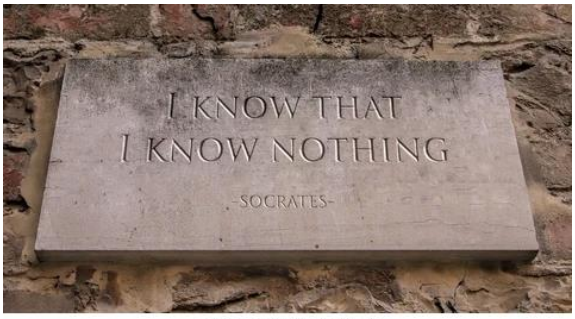
Now suppose we detect two photons of 511 keV each, going in exactly opposite directions. Then we can, with great confidence, presume they originate from an electron-positron annihilation. What are the properties of a photon? Its energy (hence via $E = h\nu$ its frequency), its polarisation, and its momentum vector yielding its direction. The magnitude of the momentum ($p = E/c$) brings nothing new.

From these photon properties we cannot ever deduce the original momentum vectors (hence angle of incidence) of the annihilated electron and positron, i.e. we cannot ever deduce where they came from. **This means that, at the level of elementary particles, the past is just as un*post*dictable as the future is un*pre*dictable!**

Postdiction is very difficult, especially about the past.
Henk Reints.

Is information conserved? Apparently not. Can time be reversed? I think not, but even if it could, it would not bring nature back to where it came from. **There is a fundamental unknowability in both directions of time.**

Will we ever find ~~the~~ **a** theory of everything?
Maybe, but it won't explain all of the universe.



[1] https://physics.stackexchange.com/questions/555916/during-particle-antiparticle-annihilation-are-the-photons-expelled-perfectly-pe

