Suppose that you have just flipped a coin. You say: ‘Actually it has come up heads, but it could have come up tails. What is more, one of this options must have occurred.’ The philosophy begins when we ask whether the distinction ‘actual – possible – necessary’ has roots in the objective reality. The affirmative answer to the question is given by advocates of real possibilities. They claim that there are properties responsible for possibilities inherent to coins. According to the opposite answer, which refers to works of David Hume, there is no property in the world that would ground the modalities, that is, possibility and necessity. Therefore, modalities are only linguistic phenomenon or a part of our conceptual framework. The follower of the Humean view, we have learned how to use words ‘may’ and ‘must’ to describe coin flips, but these words have no counterparts in the objective reality. He interprets the multitude of possible outcomes of coin flipping by saying that any of them is consistent with the laws construed by us within the appropriate science (sciences are here examples of conceptual framework). As a consequence, modal notions are reduced to logical notions (non-contradiction) or similar (such as compatibility).

Despite the importance of the controversy about real modalities, the situation is far from being clear. Therefore our first task will be to give a precise analysis of the subject of this controversy. This analysis should provide us a criterion for determining whether a given theory (philosophical or scientific one) contains real modalities.

In the first place we will focus on branching-style theories, especially Belnap’s (1992) branching space-time (BST). It seems to be obvious that real modalities occur in time and space, and that they are dependent on them. Something is possible in May 2016, but not after this period of time; something is possible in Krakow, but not in Bristol. It seems that such dependencies are accurately captured by branching-style theories, especially BST, which apply to them the notion of multiple possible histories. With a mentioned criterion in hand, we will then ask whether the theories of branching describe real possibilities. That they indeed do so, is argued by Nuel Belnap and his collaborators, but the theory has been seriously challenged.

Real modalities can be understood globally or locally. In the first case, modalities are explained in terms of alternative worlds or courses of history. Previously mentioned BST belongs to this category. However, our thinking about the world rarely operates on such big objects. Therefore it is reasonable to consider real possibilities locally understood. There are two formal models of them, namely Müller’s (2010, 2014) and Rumberg’s (2015) theory of transitions and Placek’s theory of continuations (2011). We want to study these theories from the logical point of view. We suspect that they resemble the classical theories presented already in 1967 by Arthur Prior, which would be advantageous.

Our knowledge about allowed courses of events in the world is based on special sciences, therefore they are the best place for searching ”traces” of real possibilities. We focus on theories of physics, following an intuition that real possibilities, if there are any, should manifest on the fundamental level, investigated by theories of physics. These theories provide equations of evolution, which enable us to calculate the behaviour of some physical system modelled by them. In order to perform these calculations also so called boundary conditions are needed; in the simplest case they describe the state of physical system at the moment of the beginning of evolution. Sometimes equations of evolution give us more than one solution for the same boundary conditions. It seems reasonable to treat this phenomenon as the suggestion of the existence of real possibilities. However, this issue is more complicated, because of the intricate connection between the structure of physical theory and the structure of reality modelled by it. Our initial observation is that there are a few strategies in physics that are used to re-interpret non-unique solutions to a theory’s basics equations: under the re-interpretation, non-uniqueness does not tell in favour of the existence of real possibilities. Our aim is to describe and analyse these strategies.

Our last task is an analysis of specific and relatively little known problem in the theory of general relativity: the existence of non-isometric extensions of a general relativistic spacetime. It illustrates the importance of the distinction between global and local understanding of possibilities, this time in the case of physics. In such cases we encounter a puzzling phenomenon. The spacetime as a whole evolves indeterministically, that is, there is more than one possible evolution of it allowed by the theory; in contrast, each individual object has only one possible evolution, so the objects behave deterministically. We suspect that the possibilities inherent to individual objects are more fundamental than those referring to a spacetime as a whole.

For bibliographical references, see the full description of the project.