If $X$ and $Y$ are varieties over a field, there are two interesting candidates for the set of homotopy classes of maps from $X$ to $Y$: the first is simply the quotient of the set of maps by the relation generated by $^1$-homotopies, and the second is the set of maps in the $^1$-homotopy category of Morel-Voevodsky. They are different in general. The former often carries relevant algebro-geometric information, while the latter is more mysterious but also more computable. Comparing them is therefore an essential step to apply $^1$-homotopy theory to concrete classification problems in algebraic geometry. In this talk I will survey existing comparison results as well as some recent work with Aravind Asok and Matthias Wendt