A combinatorial neural code is a subset of the power set $2^n$. A neural code is convex if it arises as the intersection pattern of convex open sets in $\mathbb{R}^d$. In the past few years, there has been considerable progress on characterizing which neural codes are convex, but the problem remains wide open. Here, we show that a code has a realization with convex polytopes if and only if it is the image of a representable oriented matroid under a neural code morphism. We show that all known examples of non-convex codes are non-convex because they are not the image of any oriented matroid under a code morphism. (Received August 19, 2019)