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abstract

The “mind-brain supervenience” conjecture suggests that all mental properties (e.g. consciousness, intelligence, personality, etc.) are derived from the physical properties of the brain. The validity of this conjecture has been argued in philosophical terms for over 2,500 years. Alternative conjectures, including various non-physical causes of mental properties, seem rather implausible to many, but proving or disproving these alternatives has remained elusive.

To address the question of whether the mind supervenes on the brain through empirical means, here we frame a supervenience hypothesis in rigorous mathematical terms and propose a modified version of supervenience (called  $\varepsilon$ -supervenience) that is amenable to empirical investigations and statistical analysis. To elucidate this approach, we posit a thought experiment that illustrates how the probabilistic theory of pattern recognition can be used to make a one-sided determination of  $\varepsilon$ -supervenience. The physical property of the brain employed in this analysis is the graph describing brain connectivity (i.e., the connectome), and  $\varepsilon$ -supervenience allows us to determine whether a particular mental property can be inferred from one’s connectome to within any given misclassification rate  $\varepsilon > 0$ , regardless of the relationship between the two. In addition to the theoretical results, we show via simulation that given reasonable assumptions about class conditional probabilities and the amount of data available, the thought experiment can actually be conducted on a simple organism, *Caenorhabditis elegans*, with currently available technology.

The potential significance of this work can be divided into distinct disciplines. To the philosopher, this work demonstrates that philosophical conjectures can be morphed into statistical hypotheses, amenable to experimental investigations, allowing the philosopher to add empirical support to their rational arguments. To the statistician, this work points out the limitations of hypothesis testing in a novel domain. To the neuroscientist, a theoretically possible experiment is proposed to garnish support for a hypothesis that is widely believed: that mental properties supervene on brain properties.