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Learning sensitivity derivative by implicit supervision

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In control theory, variables called sensitivity derivatives quantify how a system's performance depends on the commands from its controller. Knowledge of these derivatives is a prerequisite for adaptive control, including sensorimotor learning in the brain, but no one has explained how the derivatives themselves could be learned by real neural networks, and some say they aren't learned at all but are known innately. Here we show that this knowledge can't be solely innate, given the adaptive flexibility of neural systems. And we show how it could be learned using forms of information transport available in the brain. The mechanism, which we call implicit supervision, explains how sensorimotor systems cope with high-dimensional workspaces, tools, and other task complexities. It accelerates learning and explains a wide range of findings on the limits of adaptability, which are inexplicable by any theory that relies solely on innate knowledge of the sensitivity derivatives.