Molecular diffusion coefficients calculated using molecular dynamics (MD) simulations suffer from finite-size (i.e., finite-box size, finite particle number) effects. Results from finite-sized MD simulations can be upscaled to infinite simulation size by applying a correction factor. For self-diffusion of single component fluids, this correction has been well studied by many researchers including Yeh and Hummer (YH); while for binary fluid mixtures, a modified YH correction was only recently proposed for correcting MD-predicted Maxwell-Stephan (MS) diffusion rates. Here, we use machine learning to provide improvements to the finite-size correction factors for both self-diffusion and MS diffusion of binary Lennard-Jones (LJ) fluid mixtures. Using artificial neural networks (ANNs), the error in the corrected LJ fluid diffusion is reduced by an order of magnitude versus existing YH corrections and the ANN models perform well for mixtures with large dissimilarities in size and interaction energies where the YH correction proves insufficient.