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# MAX AFFINE SPLINE INSIGHTS INTO DEEP LEARNING

## ABSTRACT

We build a rigorous bridge between deep networks (DNs) and approximation theory via spline functions and operators. Our key result is that a large class of DNs can be written as a composition of max-affine spline operators (MASOs), which provide a powerful portal through which to view and analyze their inner workings. For instance, conditioned on the input signal, the output of a MASO DN can be written as a simple affine transformation of the input. This implies that a DN constructs a set of signal-dependent, class-specific templates against which the signal is compared via a simple inner product; we explore the links to the classical theory of optimal classification via matched filters and the effects of data memorization. The spline partition of the input signal space that is implicitly induced by a MASO directly links DNs to the theory of vector quantization (VQ) and K-means clustering, which opens up new geometric avenue to study how DNs organize signals in a hierarchical fashion. Beyond those insightful results, the MASO formulation provides a versatile and simple analytical formulation of DNs aiding theoretical studies and opening numerous research directions, some of which will be discussed.

## BIO

Randall Balestriero received the bachelor's degree in applied mathematics and economics from Toulon University, where he did research in signal processing and bioacoustics using the scattering network and large scale datasets. He received the master's degree from Pierre et Marie Curie University and Ecole Normale Superieure where he did research in signal processing, deep learning and real time finite element PDE approximation. He is now a PhD candidate studying deep networks at Rice University with primary research interests evolving around splines, deep networks, probabilistic graphical models, and optimization.

## DETAILS

Thursday, February 11, 2021 at 4:00 pm CST.

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