



THE UNIVERSITY OF  
CHICAGO

Department of Statistics

MASTER'S THESIS PRESENTATION

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Topology of Deep Learning

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#### ABSTRACT

Deep neural networks give rise to state-of-the-art solutions to many hard problems in machine learning. Nevertheless, there has been relatively little understanding of what makes it such a successful scheme. We provide evidence and attempt an explanation for two features that we think are critical in deep neural networks: (i) a *nonsmooth* activation functions (such as  $\max(0, x)$ ) as opposed to a smooth one such as  $\tanh(x)$ ; (ii) a large number of layers despite the well-known fact that any function can be approximated arbitrarily well by a two-layer neural network. We will argue that deep neural networks operate by changing the topology of the input space—transforming a topologically complicated data set into a topologically simple one. Additionally, adopting Euler characteristic as a proxy for a topological measure of complexity, we express expected changes in the Euler characteristics of the decision regions as those pass through a general layer in a neural network.

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