

The Hong Kong University of Science and Technology

Department of Mathematics

PhD THESIS EXAMINATION

Convolution Ideas in the Studies of Mixed Volumes, Neural Networks and Convolution Algebra

By

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<u>ABSTRACT</u>

Convolution is an important operator in analysis. In this thesis, we introduced the convolution ideas in the studies of mixed volumes, Neural Networks and the construction of convolution algebra. Mixed Volumes, defined on convex bodies, is related to Alexandrov-Fenchel inequality, one of the most fundamental results in convex geometry. The convolution idea leads to a new perspective of the concept of mixed volume. We extend the concept to the vector space spanned by the indicator functions of bounded semi-algebraic sets using convolution method. Deep Learning is a popular topic in recent years. Convolutional Neural Networks has achieved much success in computer vision tasks. We proposed randomized methods to study the interpretability of CNN. Complex algebra could be generalized using convolution method. For a complete lattice L and a relational structure $\mathfrak{X} = (X, (R_i)_I)$, a new algebra L^X called convolution algebra is constructed. The construction is bifunctorial and extensions are made through meets instead of joins.

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