UiO : Fysisk institutt
Det matematisk-naturvitenskapelige fakultet

Application of Supervised Machine Learning to the Search for New Physics in ATLAS data

A Study of Ordinary Dense, Parameterized and Ensemble Networks and their Application to High Energy Physics

William Hirst

May 19, 2023

Outline

Overview

Outline

Why apply machine learning to HEP problems?

How do we search for new physics?

Outline

A summary of the applied methods

Three neural network variants

- Ordinary dense neural network
- Ensemble networks utilizing Local-Winner-Takes-All (LWTA) layers
- Parameterized neural networks (PNN)

One boosted decision tree method

- XGBoost using default settings

How are the methods compared?

Training strategy

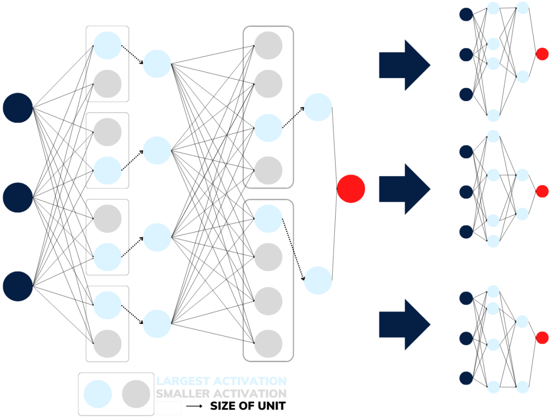
Outline

An introduction and study of each method

Ordinary dense neural network

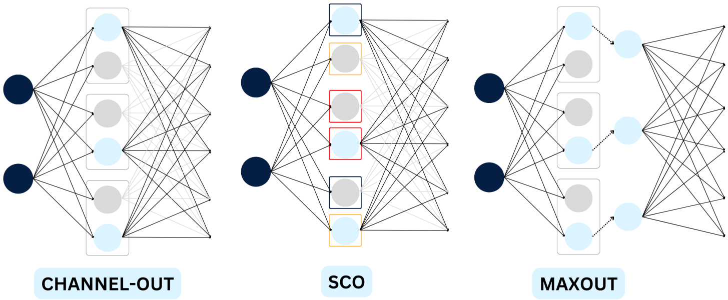
Ensemble methods - LWTA

- Dropout
- What is LWTA?
- Competing nodes - Units
- Pattern specific pathways



Channel-Out, SCO and Maxout

Layer	Separate Weights & Biases	Static Units
Channel-Out	Yes	Yes
SCO	Yes	No
Maxout	No	Yes



Parameterized neural network

Boosted decision trees - XGBoost

Outline

References I

Hartshorne, R.
Algebraic Geometry.
Springer-Verlag, 1977.

Helsø, M.
'Rational quartic symmetroids'.
Adv. Geom., 20(1):71–89, 2020.

Helsø, M. and Ranestad, K.
Rational quartic spectrahedra, 2018.
https://arxiv.org/abs/1810.11235

- Atiyah, M. and Macdonald, I.
Introduction to commutative algebra.
Addison-Wesley Publishing Co., Reading, Mass.-London-Don Mills, Ont., 1969

References II

[5] Artin, M.
'On isolated rational singularities of surfaces'.
Amer. J. Math., 80(1):129–136, 1966.

UiO : Fysisk institutt
Det matematisk-naturvitenskapelige fakultet

William Hirst

Application of Supervised Machine Learning to the Search for New Physics in ATLAS data

A Study of Ordinary Dense, Parameterized and Ensemble Networks and their Application to High Energy Physics