Applying Deep Learning to Real-time FRB Classification

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Fast Radio Bursts (FRBs)

- Highly energetic ($10^{10-15}$ times pulsar luminosity)
- Ubiquitous: thousands per sky per day
- $\sim$millisecond duration (also probably much less)
- Far away! $z \sim 0.1-2.5$

Lorimer et al. 2007
Apertif

5°
Machine Learning

AI

Deep Learning

Representation Learning

Goodfellow et al. 2016

http://www.deeplearningbook.org/contents/intro.html
Feature extraction  Classification

- Input layer
- Convolution layer I
- Pool layer I
- Convolution layer II
- Pool layer II
- Fully connected layers
- Output layer

Connor & van Leeuwen 2018
Feature extraction (1d-convolution + pooling + dropout)

Feature extraction (2d-convolution + pooling + dropout)

Feature extraction (2d-convolution + pooling + dropout)

Connor & van Leeuwen 2018
Feature extraction (2d-convolution + pooling + dropout)

Feature extraction (1d-convolution + pooling + dropout)

Feature extraction (2d-convolution + pooling + dropout)

Merge DNNs to hybrid net

Connor & van Leeuwen 2018
Can we blindly search raw data?
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Convolution: $\mathcal{O}(n_k N_t N_f \log_2(N_t))$

DNN parameters

Traditional, brute force technique $\mathcal{O}(N_t N_f N_{dm})$
FRB 121102 Detection and Periodicity

Input layer

Zhang et al. 2018
• Convolutional neural networks are well suited to the FRB false positive problem

• Real-time classification pipeline is currently running on Apertif

• Traditional search software may be replaced by large, pre-trained DNNs