Solution for 2nd competition of MLHEP-2021

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Solution overview

~ Baseline architecture

Standard preprocessing

Auxiliary output
(Lecture: Network architectures: tips and tricks)

Combining models
(Somewhere from Ensembles lectures)
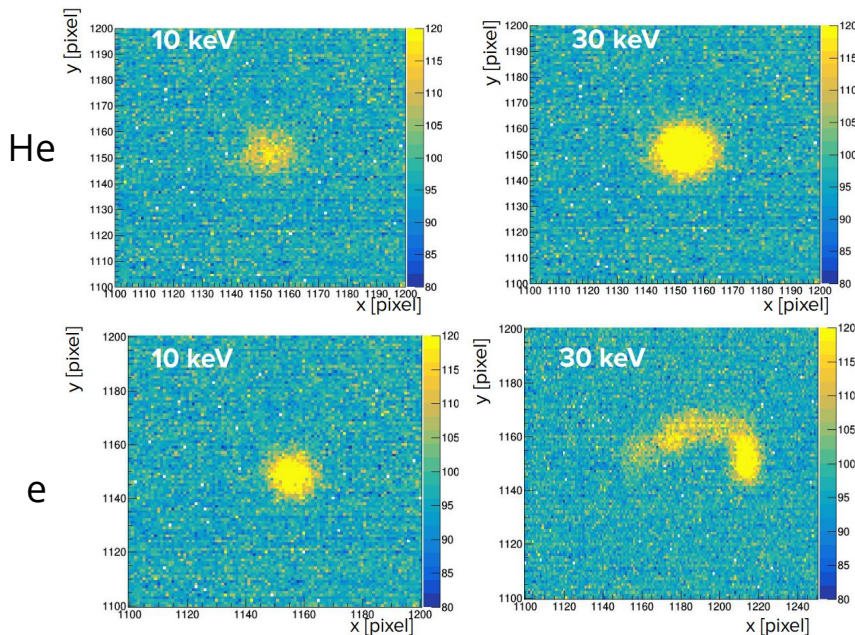
Intuition for the network architecture

- Energy deposits of electrons and He differ a lot.
- Classification between two can help in energy regression.

On the contrary - dataset specifications.

- Train dataset consists of 3, 10, 30 keV electrons and 1, 6, 20 keV He.
- Test dataset is reversed.

→ Regression can be biased by classification.

→ Need to find a balance: still using classification as an output but it shouldn't be too good?

Giulia D'Imperio's presentation "Dark matter and CYGNO experiment."
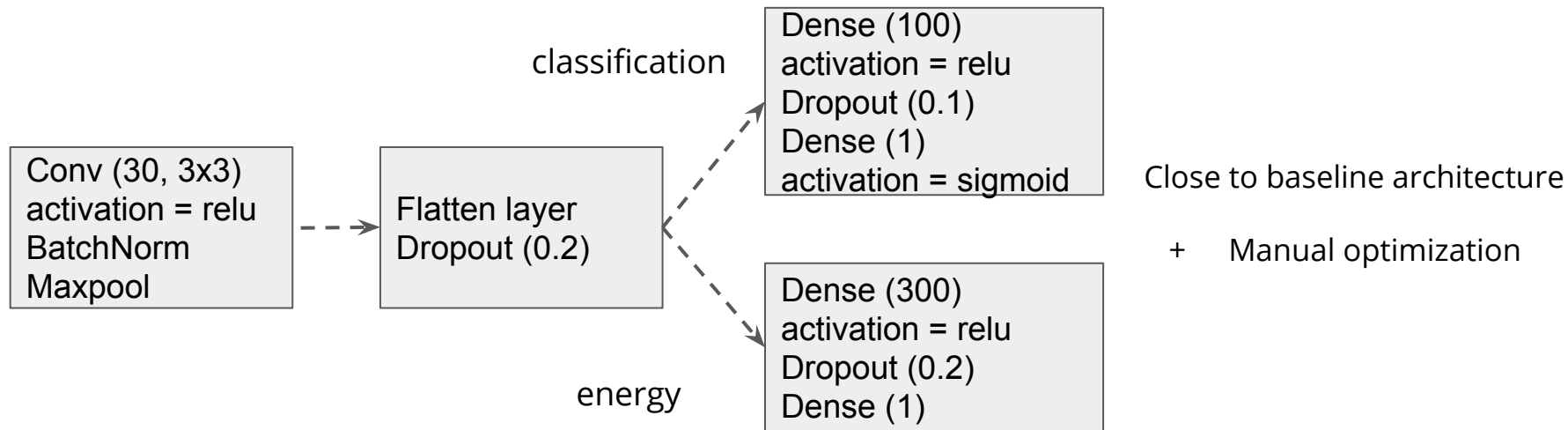
3

Network architecture

Preprocessing: Cropping (126, 126), MinMaxScaler for the input images, target unchanged.

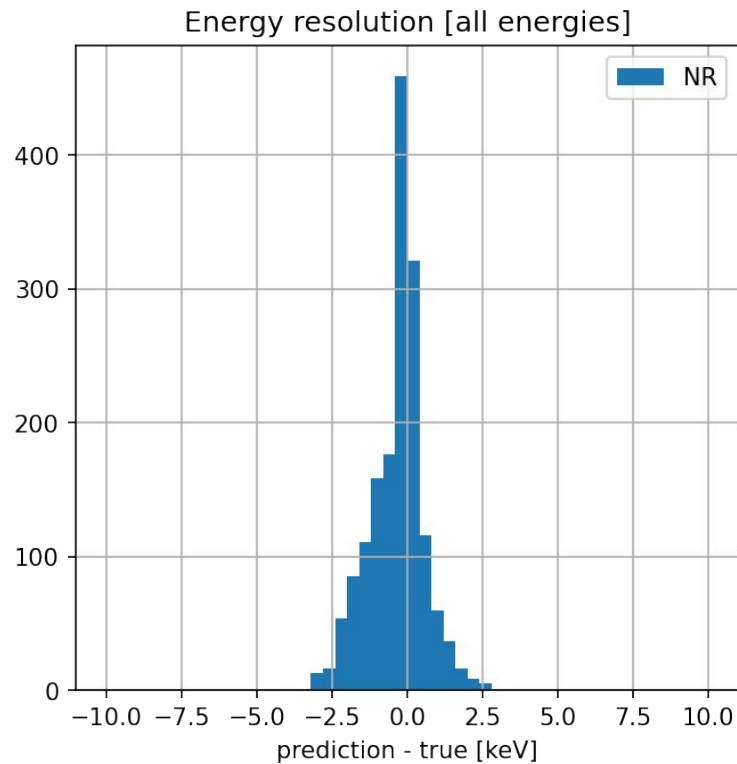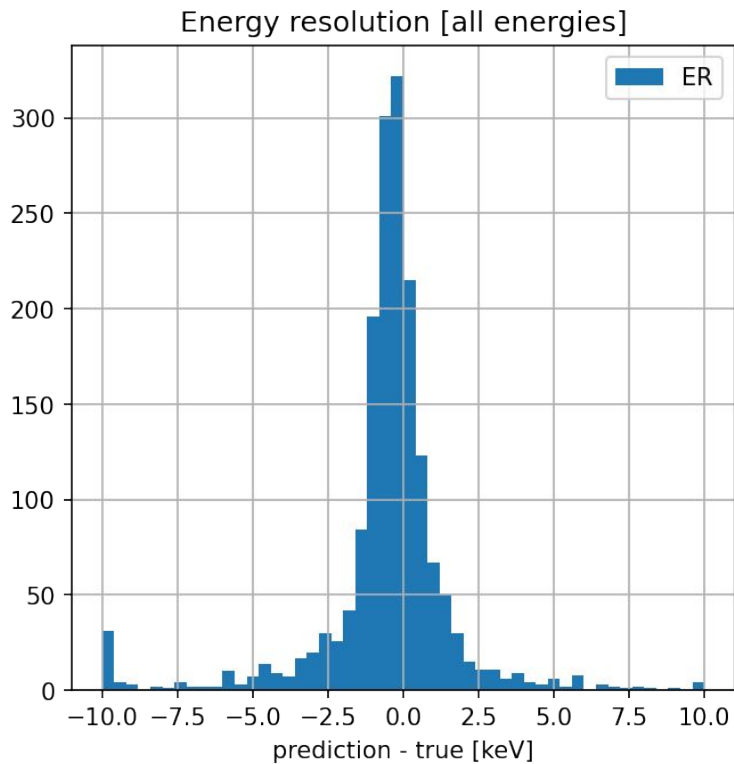**Validation:** 80/20 split on the training dataset.

Loss functions: MAE for regression (weight 1), BinaryCrossentropy for classification (weight 0.1).

Hyperparameters: lr = 0.0001, batch size = 32

Epochs: Early stopping on validation energy + callbacks on the best loss.

classification

Dense (100)
activation = relu
Dropout (0.1)
Dense (1)
activation = sigmoid

Conv (30, 3x3)
activation = relu
BatchNorm
Maxpool

Flatten layer
Dropout (0.2)

Close to baseline architecture

+   Manual optimization

Dense (300)
activation = relu
Dropout (0.2)
Dense (1)

energy

Network results (on validation sample)

Energy resolution [all energies] — ER
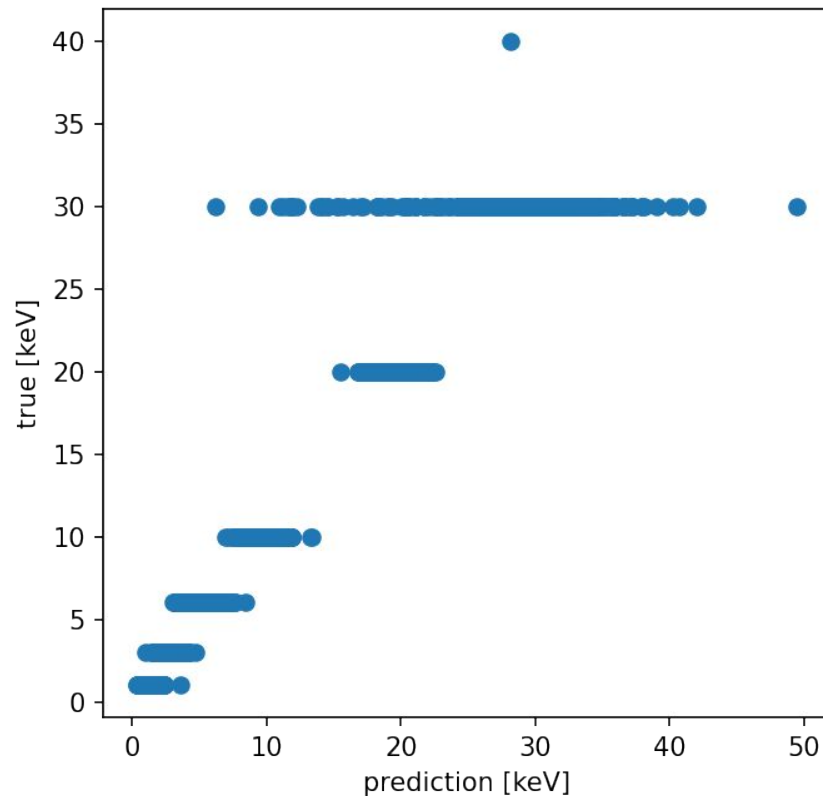
Energy resolution [all energies] — NR

Score on the test sample: 1.39

Intuition for combining models

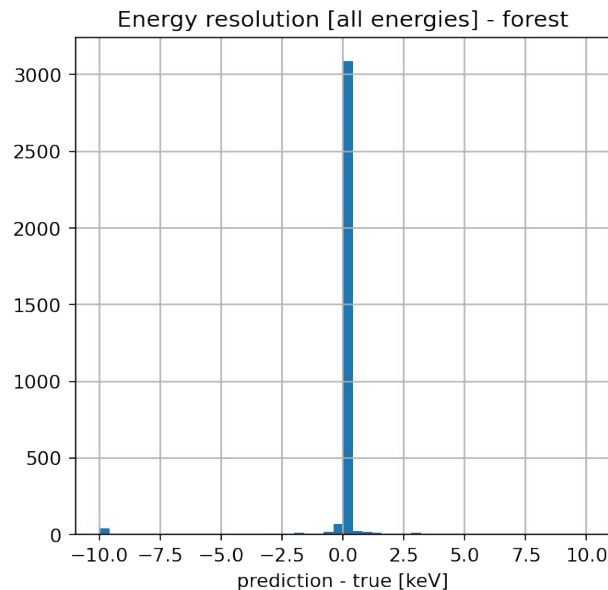**Disclaimer:** very dataset-specific solution, not for physics experiment.
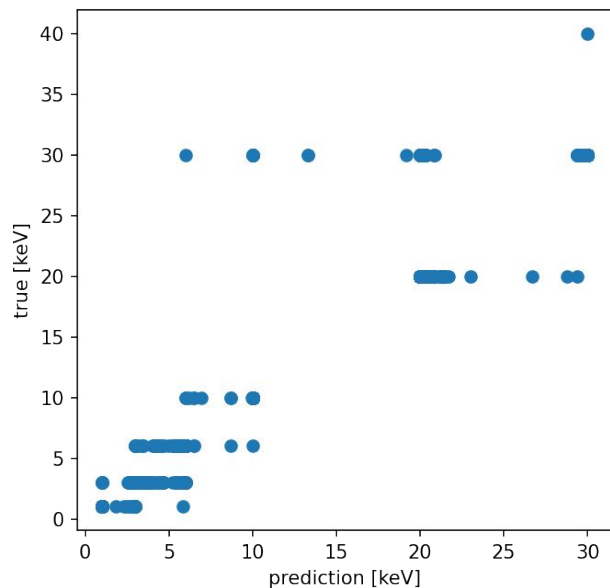
Target energy consists of only 6 possible integer values →using another algorithm to regress to this specific values.

Random forest

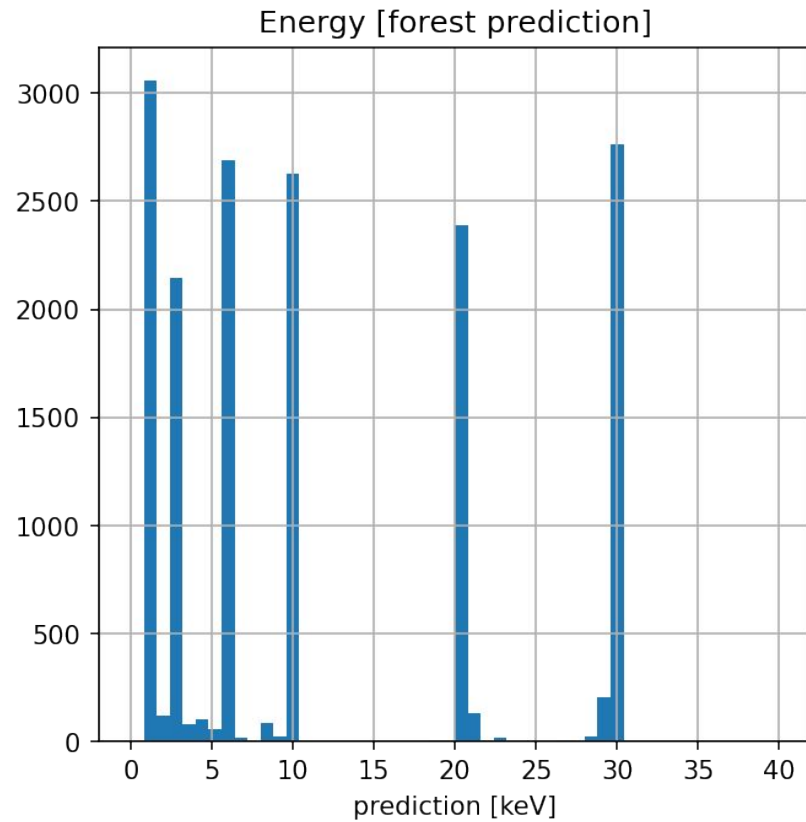**Input:** network energy predictions, sum of the image pixels.
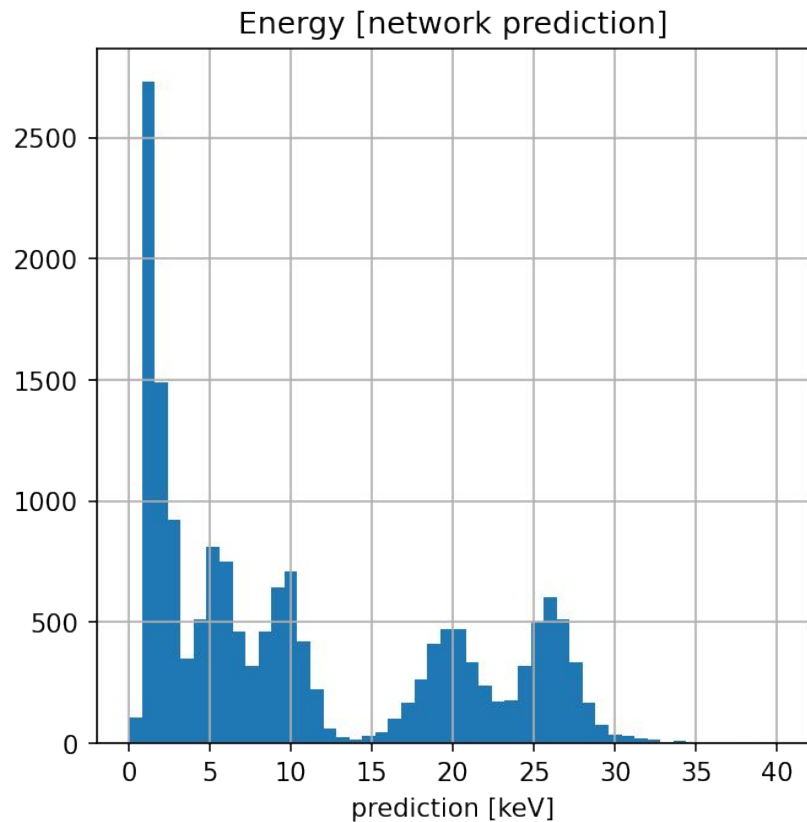
Hyperparameters: Almost "out-of-the-box", only specified criterion='mae', max_depth=50.

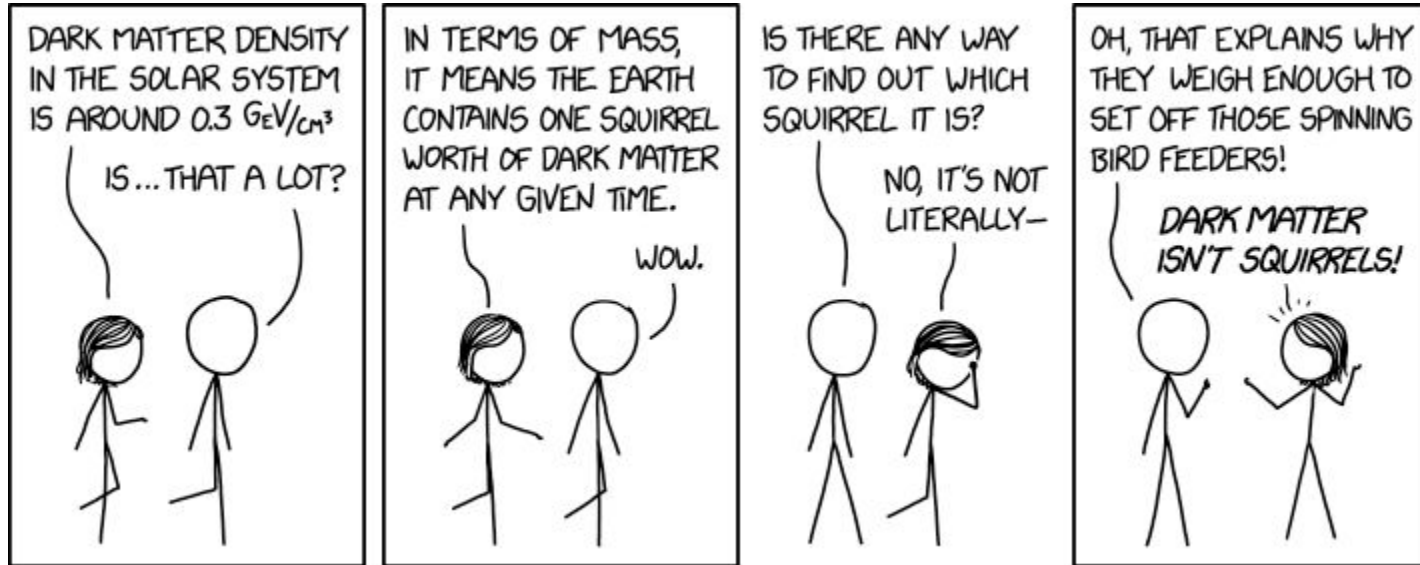Not ideal prediction to exactly 6 values and second features don't play any role (importances: 0.9995/0.0005).

But still works well so no further optimization.

Test sample predictions

Score on the test sample: 0.36

Thank you for your attention!

https://www.explainxkcd.com/wiki/index.php/2186:_Dark_Matter