Splitoffs update

Debbie Bard
University of Edinburgh
djbard@slac.stanford.edu
Recap

Aim: find a measure to discriminate between real photons and splitoff clusters in the EMC

- Defining photon/’splitoff’:
  - At beta level, iterate through CalorNeutral list, check MC truth for each entry.
  - If particle does not truthmatch to photon (lundID==22), designated as splitoff.

- Method of discrimination: neural network (NN) chosen over sher.
  - Neural net constructed using ROOT TMultiLayerPerceptron neural network with default constructor (Stochastic minimization), 5 hidden layers.

• Optimisation:
  
  – Best separation obtained using all cluster-shape variables plus distance of closest approach (doca) of nearest track to neutral bump (measured EMC centroid to centroid).

  – Split sample into ecal bins (50MeV bins up to 0.5GeV, 100MeV bins 0.5-1 GeV, 200MeV bins 1-2GeV, 500MeV bins >2GeV), train NN separately on each bin.
What’s changed?

- Used $e^+e^-$ → taupau generic MC to train NN.
  - Now use generic $B\bar{B}$ MC to train network.

- Variables used in NN: s1s9, s9s25, absZernike20, absZernike42, lateralMoment, secondMoment, doca.
  - Now if doca > 50cm, set doca = 50cm.
Neural Net Inputs

Plots of the variables used as input to the NN:
signal (photons) in red, background (splitoffs) in blue.
### ecal \{ecal<3\} 

- **Entries**: 807675
- **Mean**: 0.1054
- **RMS**: 0.1678
- **Underflow**: 0
- **Overflow**: 0
- **Integral**: 8.076e+05

### htemp 

- **Entries**: 1242082
- **Mean**: 76.32
- **RMS**: 37.71
- **Underflow**: 0
- **Overflow**: 0
- **Integral**: 1.242e+06
NN output over whole ecal range

Figure 1: Neural Net output for net trained and evaluated on generic $B \overline{B}$ MC

Figure 2: Neural Net output for net trained on generic $B \overline{B}$ MC and evaluated on generic tau MC
**NN performance: $B\bar{B}$ (doca$\geq 50$) vs tau generic MC**

NN output and efficiency ($x$) vs contamination ($y$) plots for net in example ecal bins. Left is for net trained evaluated on generic $B\bar{B}$ MC, right is for net trained/evaluated on generic tau MC.

**Over all ecal energies:**

![Graphs showing NN output and efficiency vs contamination](image-url)
Example ecal bin: 0.05 - 0.1 GeV

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Example ecal bin: 0.35-0.4 GeV

NN output

efficiency:contamination

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Example ecal bin: 0.8-0.9 GeV

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Example ecal bin: 1.8-2.0 GeV

NN output

sigplot

Entries  5553
Mean   0.8399
RMS    0.1514

effcont

Entries  19
Mean x  0.8574
Mean y  0.6738
RMS x   0.2286
RMS y   0.1795

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Output function

- Raw NN output value not suitable as measure of 'splitoffness'.

- More universal variable - proportion of signal remaining if you were to cut at that value of NNout.

*How 'splitoffness' is calculated for 100 - 150 MeV ecal bin:*

Signal (photons) NN output in red, Background (splitoffs) in blue. function output in green, decreasing 1→0 as % of remaining signal decreases.
- Splitoffness not a continuous variable - use bins of 0.05 in NN output.
- Separate measure calculated for each ecal bin.

**Example plot of 'splitoffness' measure for generic $B\bar{B}$ MC, over all ecal energies.**

<table>
<thead>
<tr>
<th>measure {neutID!=22}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entries</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>RMS</td>
</tr>
<tr>
<td>Underflow</td>
</tr>
<tr>
<td>Overflow</td>
</tr>
<tr>
<td>Integral</td>
</tr>
</tbody>
</table>

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Implementation

- Suggestion to put function in EmcTools package
  - General repository for EMC tools, this is a tool.
  - Other members of package are all ROOT or Perl scripts.
  - Needs some work to link EmcTools into beta packages.
- Code already written, tested in BetaMiniUser app (analysis-22), ready to go!

- To do: look at data, plot pi0 peaks etc.