A look inside the particle identification of MiniBooNE
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**Particle Identification (PID)**

Designed to classify signal and background.

**Signal** = oscillation $\nu_{CCQE}$ events
**Background** = everything else (intrinsic $\nu_e$, misID)

All variables are required to have good agreement between Data and MC simulation within statistical and systematic errors.

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**Simple Example**

The goal of the classifier is to separate blue (signal) and red (background) populations.

Two ways to use decision trees. 1) Multiple cuts on X and Y in a big tree, 2) Many weak trees (single-cut trees) combined

1) Development of a single decision tree (growth steps 1-4)
2) Many weak trees (single cut trees) only 4 trees shown

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**Boosted Decision Trees**

• Given a training sample, boosting increases the weights of misclassified events (background with is classified as signal, or vice versa), such that they have a higher chance of being correctly classified in subsequent trees.

• Trees with more misclassified events are also weighted, having a lower weight than trees with fewer misclassified events.

• Build many trees (~1000) and do a weighted sum of event scores from all trees (score is 1 if signal leaf, -1 if background leaf)

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**Summary and Outlook**

• MiniBooNE is looking for $\nu_{\mu}$ to $\nu_e$ oscillations with a probability of ~0.25%

• A powerful particle identification is essential to achieve this goal. Boosted decision trees provide a way to effectively combine all the information available in each event.

• NuMI and high energy MiniBooNE events provide useful checks of this particle identification on electron neutrino events.

• On track for a result as soon as this summer.