

CERN Summer Student Project

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PDEFoam – a probability-density estimation
method based on self-adapting phase-space binning

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- ① Project definition
- ② What is T Foam?
- ③ PDE Foam algorithm
Example: classification with two separate foams
- ④ Parameter study
- ⑤ Energy reconstruction in ATLAS-HCAL

- ① Development of a new event classification and regression method based on TFoam [Jad02]
- ② Implementation of the new method into TMVA [HSS⁺07]
- ③ Parameter study and optimisation of the method
- ④ Application of the new method to energy reconstruction in ATLAS-HCAL

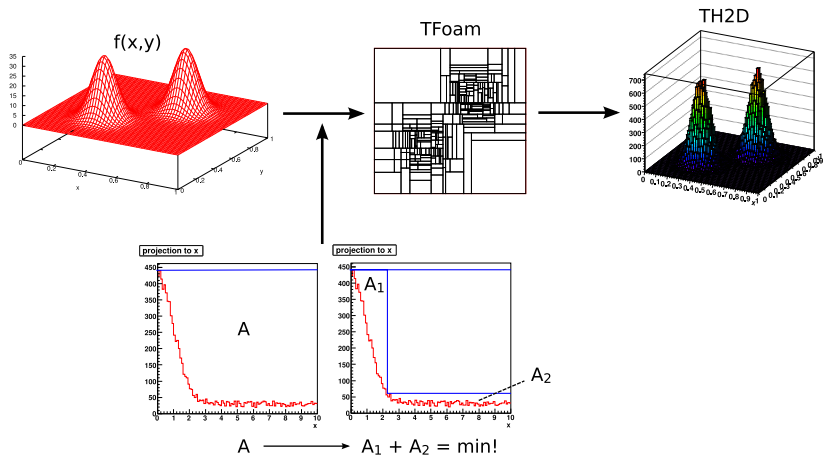
What is T Foam?

- A general Purpose Cellular Monte Carlo Event Generator
- A Monte Carlo Integrator

Example: Monte Carlo Event generation according to

$$f(x, y) = \frac{100}{2\pi} \exp\left(-\frac{(x - \frac{1}{3})^2 + (y - \frac{1}{3})^2}{0.01}\right) + \frac{100}{2\pi} \exp\left(-\frac{(x - \frac{2}{3})^2 + (y - \frac{2}{3})^2}{0.01}\right)$$

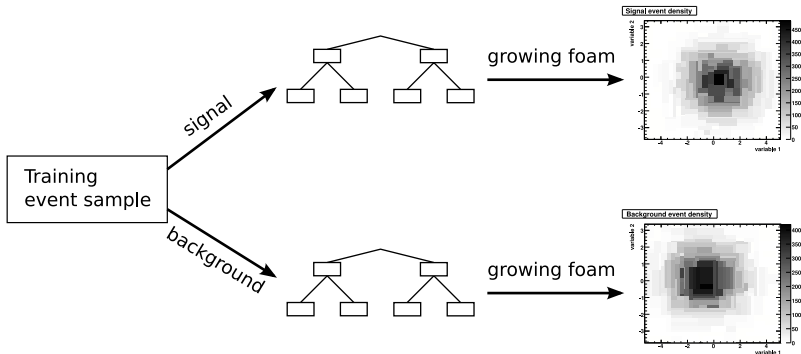
What is TFoam?



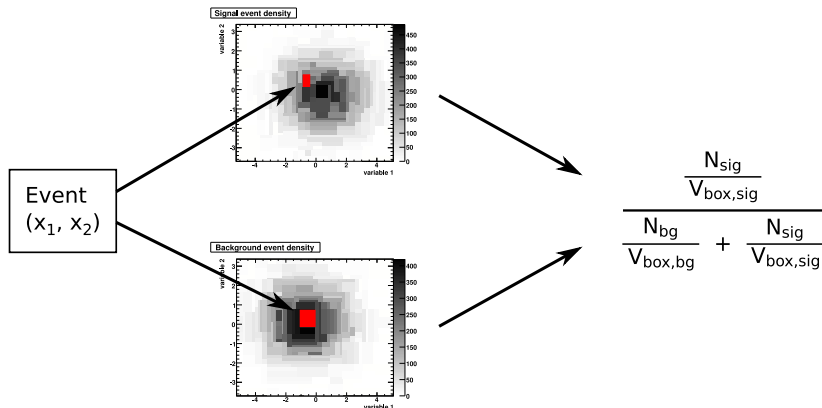
There are four build in PDEFoam algorithm:

- Event classification (signal or background?)
 - Two separate Foams for signal and background events
 - One single Foam which includes all signal and background events
- Regression (reconstruction of event variables, see ref. [HSS⁺07])
 - Mono target regression
 - Multi target regression

Classification with two separate foams — Training



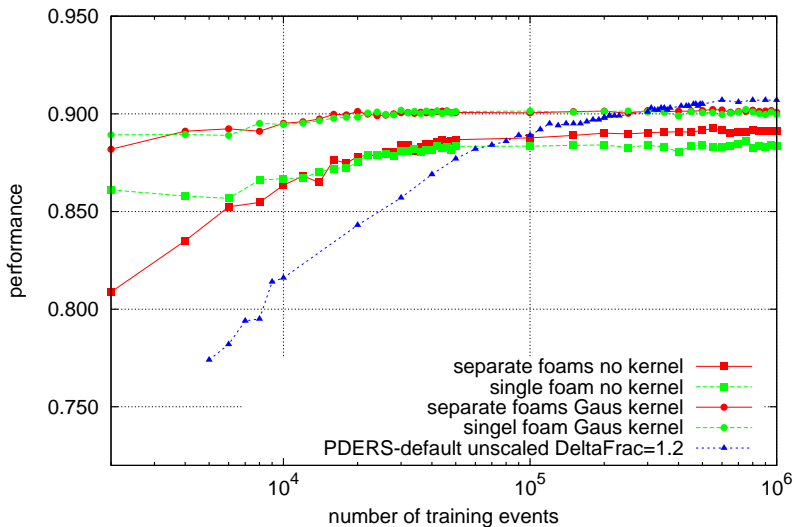
Classification with two separate foams — Evaluation



Benefit: rough representation of training event sample by cells \Rightarrow memory saving and fast responding classifier

Extract from the parameter study

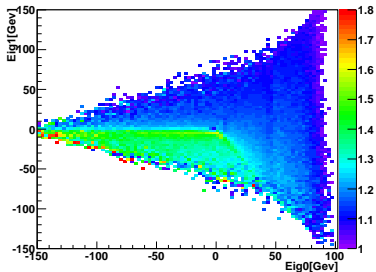
Example 3 (nBin=5, VolFrac=0.0333, nSampl=2000, nCells=2000, Nmin=100)



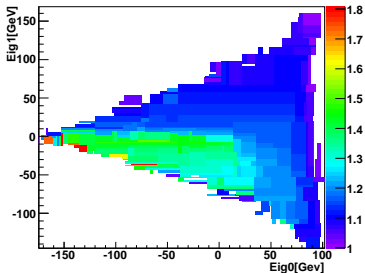
Energy reconstruction in ATLAS-HCAL




- 1 Fill MC data into foam/TProfile2D: $w = \frac{E_{\text{true}}^{\text{MC}}}{E_{\text{vis}}^{\text{MC}}}$
- 2 Reconstruction: $E_{\text{reco}} = w \cdot E_{\text{vis}}$

Weight table for Layer 5 (all energies)



Layer5 Mono Target Regression Foam: Projection 1:2



-  Tancredi Carli, Dominik Dannheim, Alexander Voigt, and Peter Speckmayer.
PDE-Foam – a probability-density estimation method based on self-adapting phase-space binning.
in preparation.
-  Andreas Höcker, Peter Speckmayer, Jörg Stelzer, et al.
TMVA Toolkit for Multivariate Data Analysis with ROOT.
CERN-OPEN-2007-007, physics/0703039, 2007.
-  Stanislaw Jadach.
Foam: A General-Purpose Cellular Monte Carlo Event Generator.
CERN-TH/2002-059, physics/0203033, 2002.