# Update: Towards an advanced SectorMap

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# Changes since last meeting

- SpacePoint2TrueHitConnector: relation weight between SpacePoint and TrueHit encodes additional information on the relation between Clusters and TrueHits
- new MCVXDPurityInfo container (by Jakob mainly) for storing informations on the MCParticles related to the Clusters of SpacePoints
- new createPurityInfos function that creates these objects from SpacePoint containers (SpacePointTrackCand, etc.)
- new ThreeHitSamplesGenerator module for generation of training samples

# Planned course of actions

Replace three hit filters by a neural network (multilayer perceptron - MLP)

- use three hit combinations (neighbours) that passed the two hit filter stage of the VXDTF
  - $\rightarrow$ SNR $\approx 1 - 1.5$ after two hit filters
- feed three hit combinations to the MLP that classifies the combinations into signal or noise/background

Planned further steps thereafter (corresponds to four hit stage of VXDTF)

- train MLP to do a helix fit and decide by helix parameters if combinations are compatible
  - use cutoffs on helix parameters
  - use another MLP (can then be rather simple) to decide if combinations are compatible

As a first approach global network(s) (i.e. covering the whole detector) will be trained/used

# Designing a multilayer perceptron

Main factors to be determined/chosen:

- Activation function: only weak constraints from universal approximation theorem, in general a sigmoid function (also possible: piecewise linear for implementation on FPGA)
- Error or cost function: can be a handle to tune efficiency and SNR (using mean squared error for starting)
- Number of hidden neurons $N_h$: main parameter, has to be chosen carefully:
  - $N_h$ too small $\rightarrow$ MLP is not able to perform desired task
  - $N_h$ too large $\rightarrow$ MLP is not able too generalize any more

# Determining the number of hidden neurons

Probably most time consuming part!

- literature research: $N_h \gtrsim d_{LS}$, where $d_{LS}$ is the dimension in which the classification problem gets linearly separable
- Approach (short-term/experimental only): try to use a self-organizing map to determine $d_{LS}$
  - $\rightarrow$ after first tests, this seems to not be a feasible way
- Approach (long-term): empirical determination of optimal $N_h$ by scanning through *reasonable range*

# Current work in progress

- simulation of generic events with generic background for generating training samples
- for fast prototyping → MATLAB:
  - tools for getting data from simulation to MATLAB → done
  - tools for determining $N_h$ → 60 % done
  - tools for testing MLP performance → 50 % done
  - comparison with BDT performance → TODO
- implementation in BASF2:
  - probably via `ROOT::TMultiLayerPerceptron`
  - development starts after MATLAB work is done