McGill

Study of the Associated Production of $t\bar{t}$ and Higgs

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McGill ATLAS

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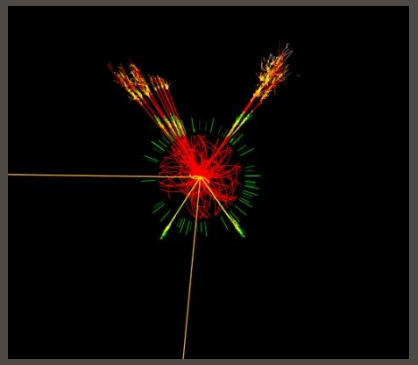
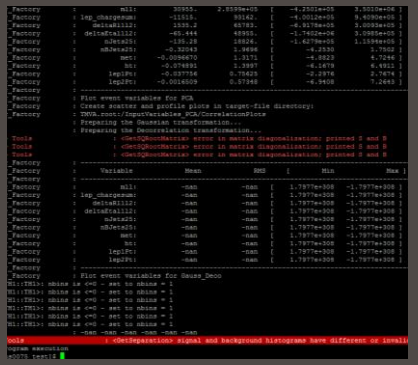
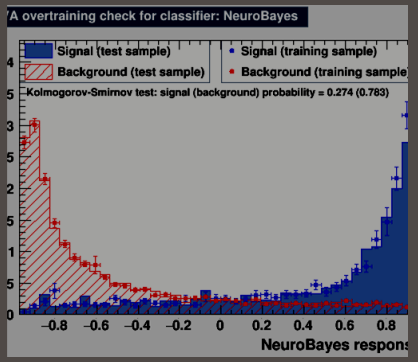




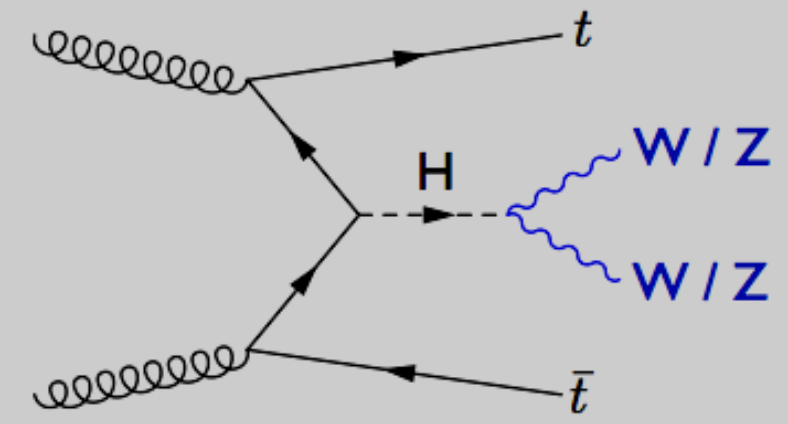


ATLAS

CERN

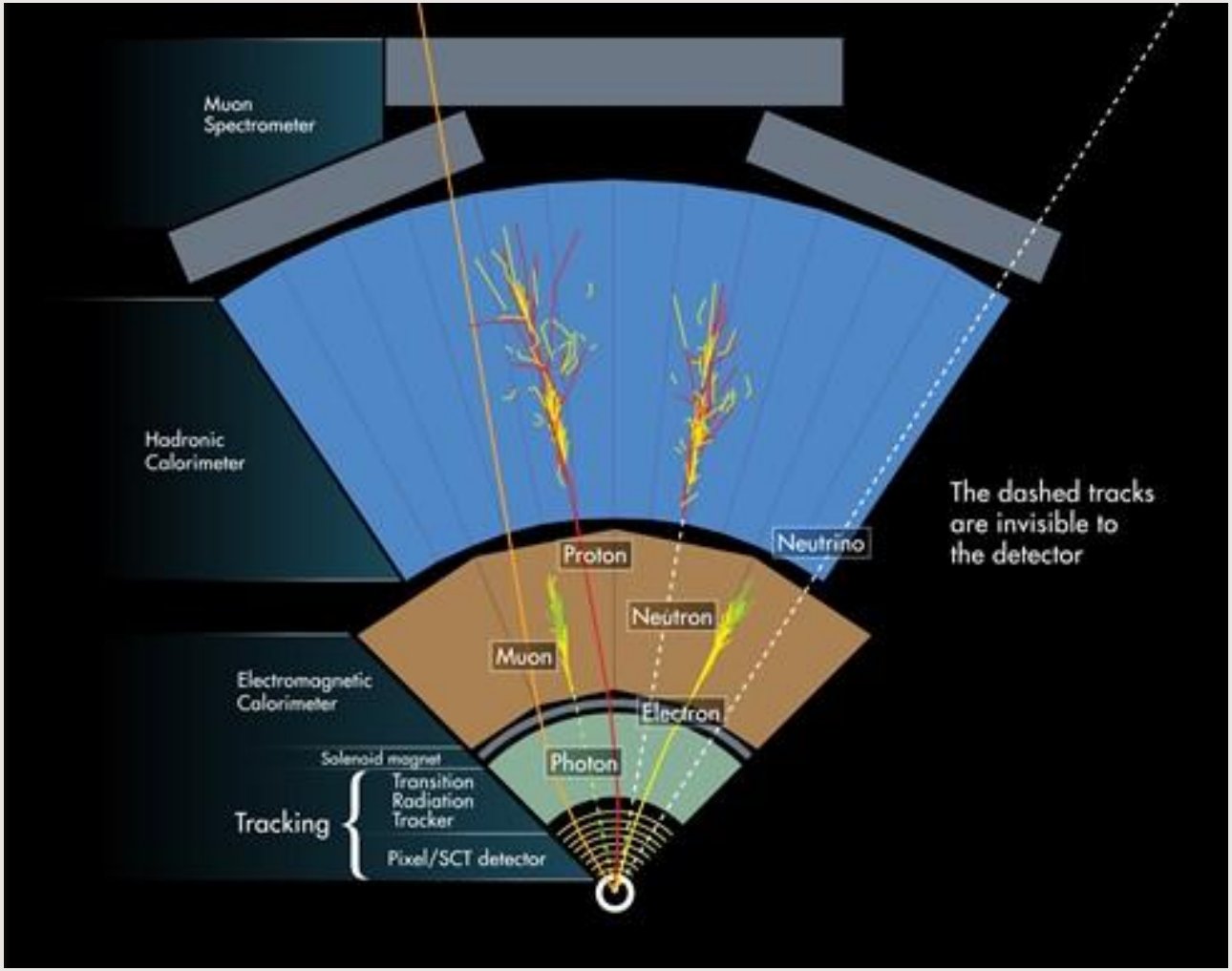
Higgs Physics at the LHC

- Probe Standard Model (and Beyond Standard Model) physics at 13/14 TeV in Run II



- Top quark:
  - Yukawa coupling
  - m_t = 173.34 ±0.27(stat) ±0.71(syst) GeV/c^2

ATLAS Detector



Can only detect *long-lived* particles

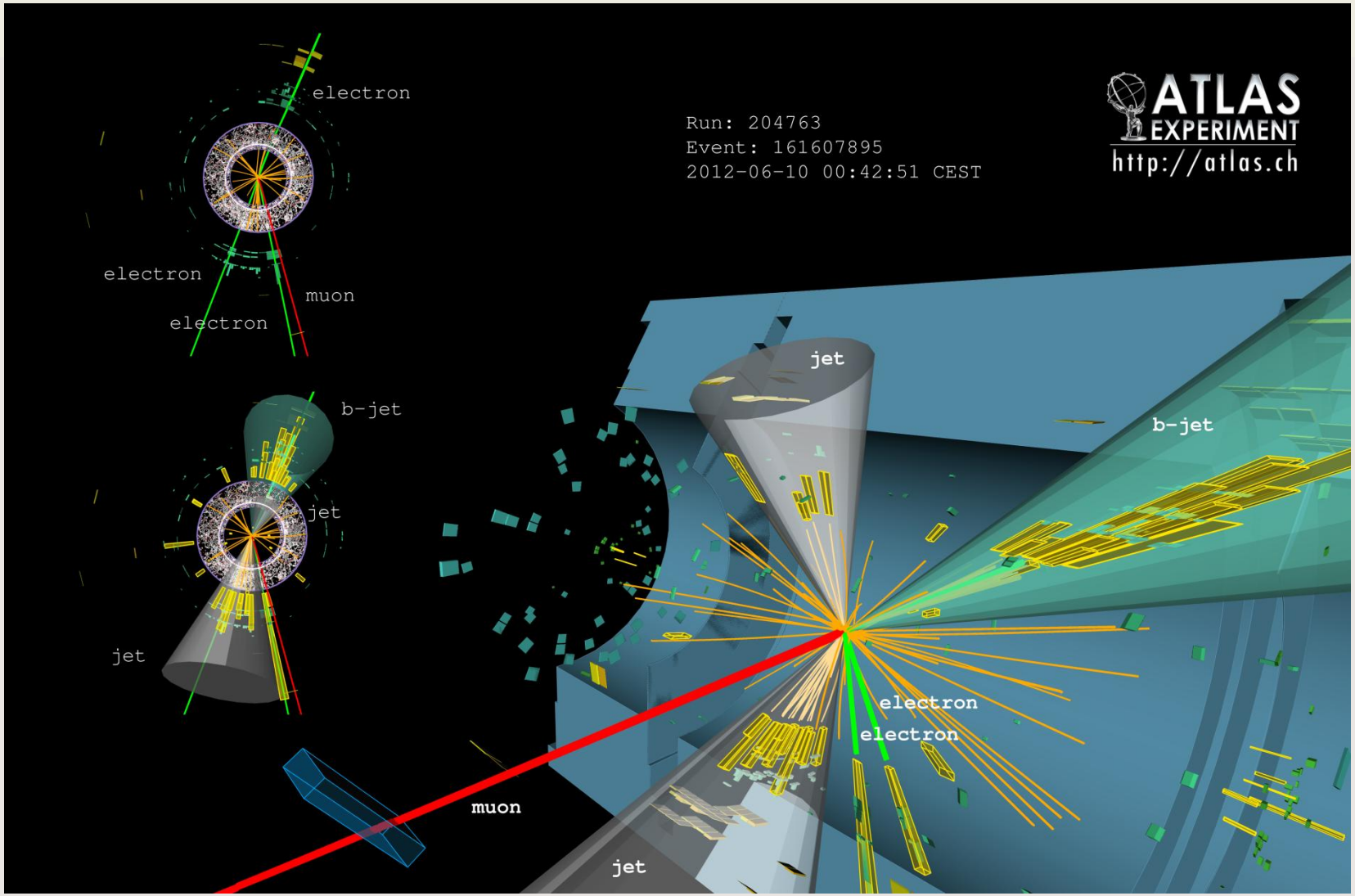
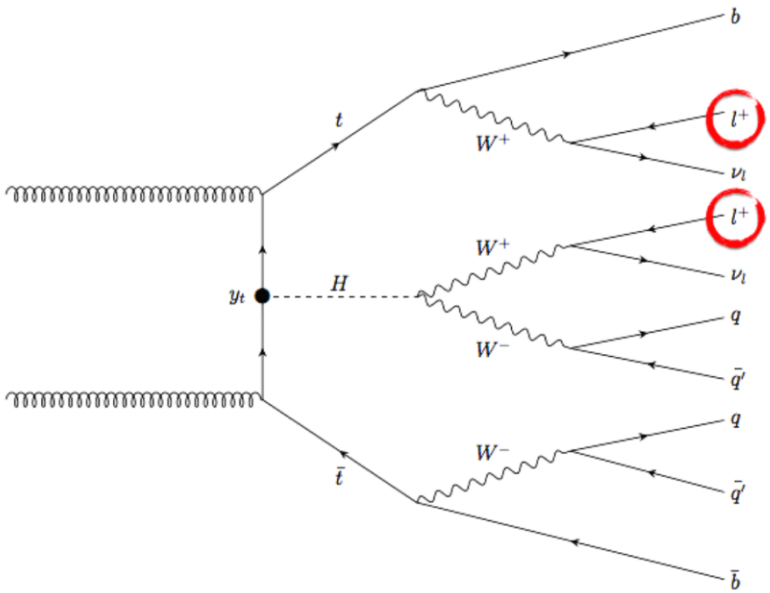


Image from: https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNOTES/ATLAS-CONF-2015-006

ttH->2LSS Channel

Signal events: ttH

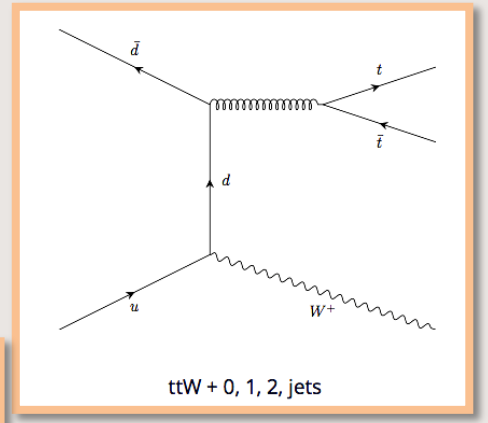


Two same sign leptons final state origin:

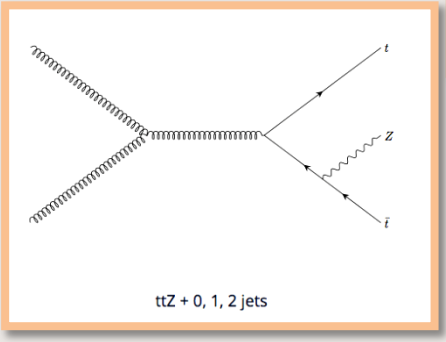
H ⟶ WW (80%), also H ⟶ ττ (15%) and H ⟶ ZZ (3%)

Background events: ttW, ttZ, tt

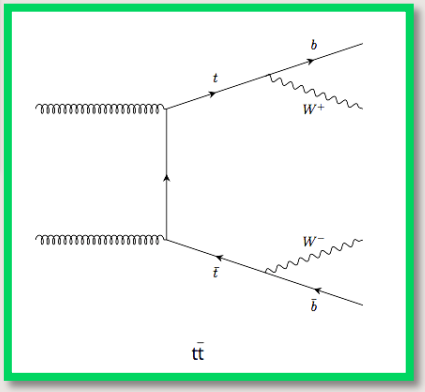
Real and fake backgrounds



ttW + 0, 1, 2, jets



ttZ + 0, 1, 2 jets

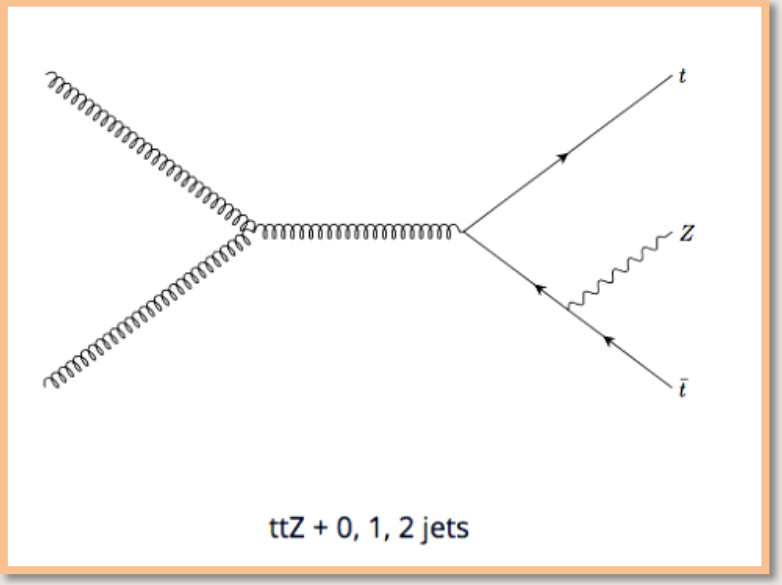


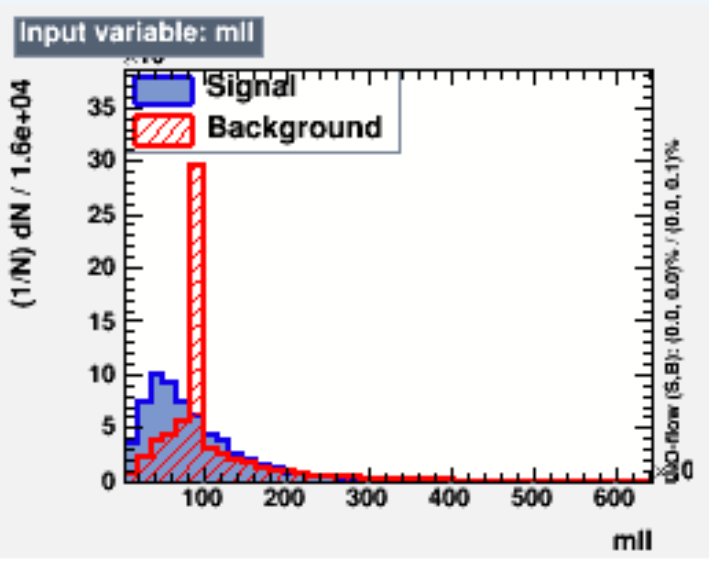
$t\bar{t}$

From: De Vasconcelos, Kevin and Hubaut, Fabrice and Liu, Kun and Pravalorio, Pascal – *Selection optimization using {MVA} for tt{H} signal in same-sign leptons channel*

Variable Selection

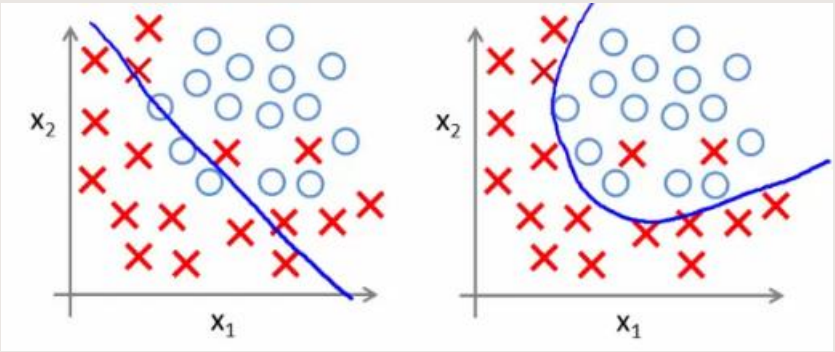
- We use kinematic variables to distinguish between signal and background events, and train our algorithms to pick up on the differences.





Machine Learning Algorithms

- Make smart decisions based on the inputs that they are given



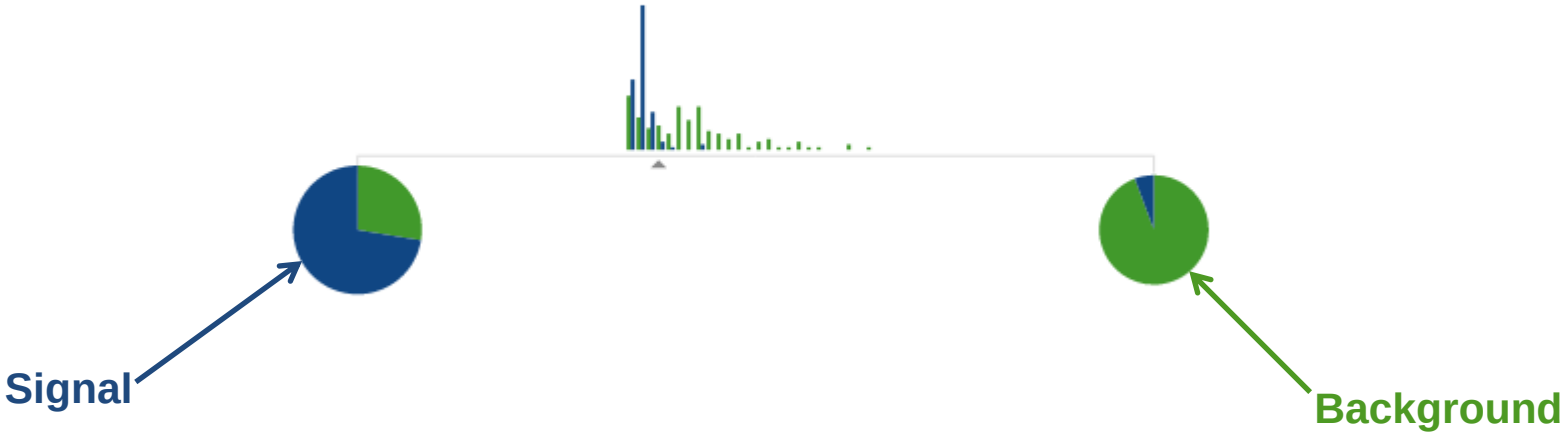
Cut-based approach

Machine Learning Algorithm

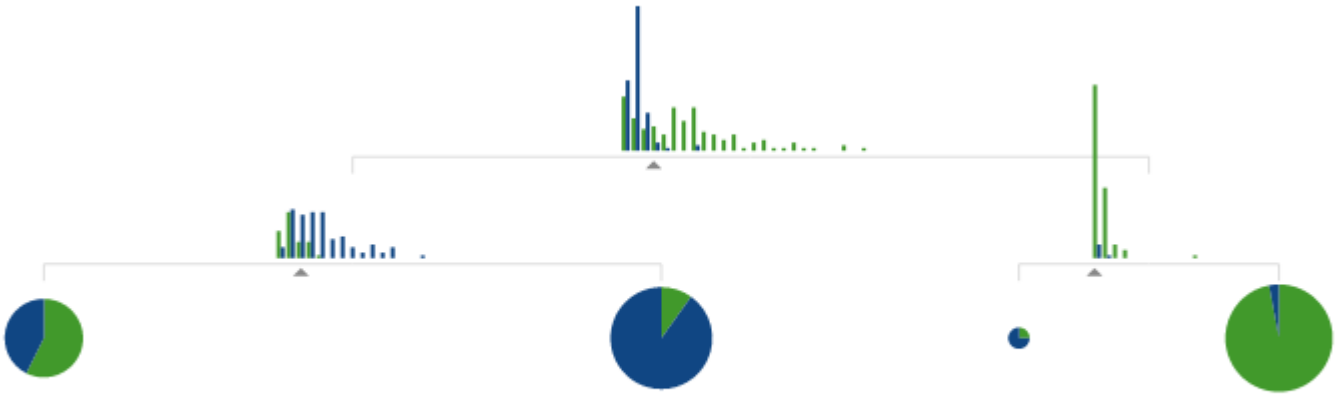
- Used in a wide array of disciplines

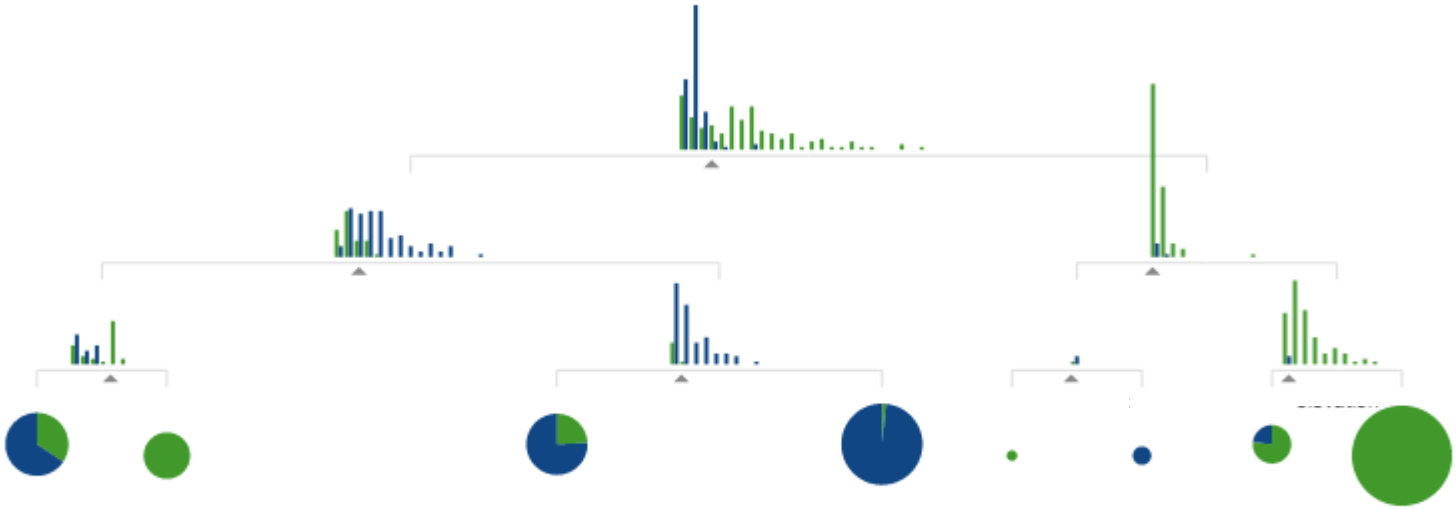
Image from: http://www.holehouse.org/mlclass/07_Regularization.html

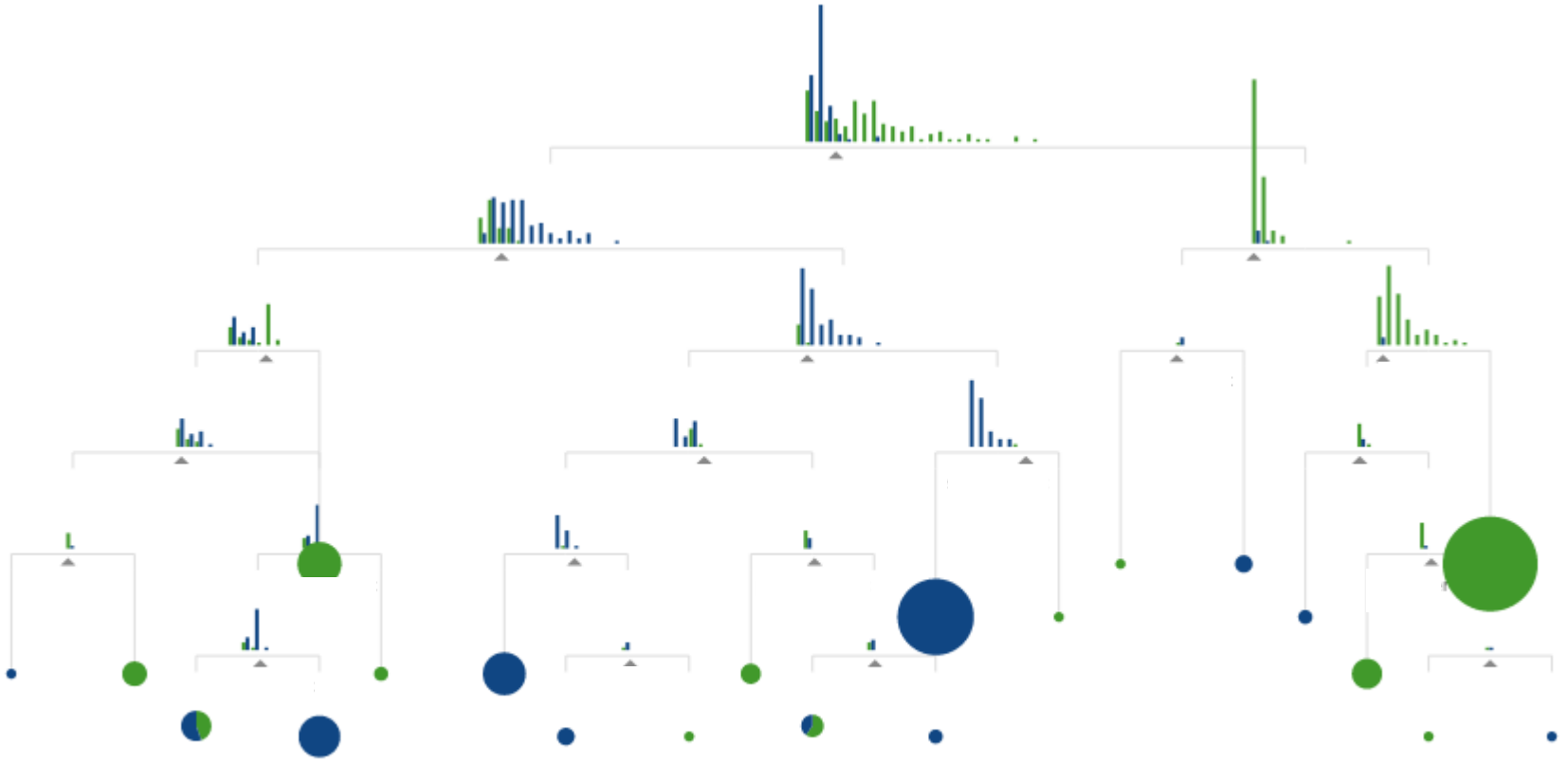
Boosted Decision Trees

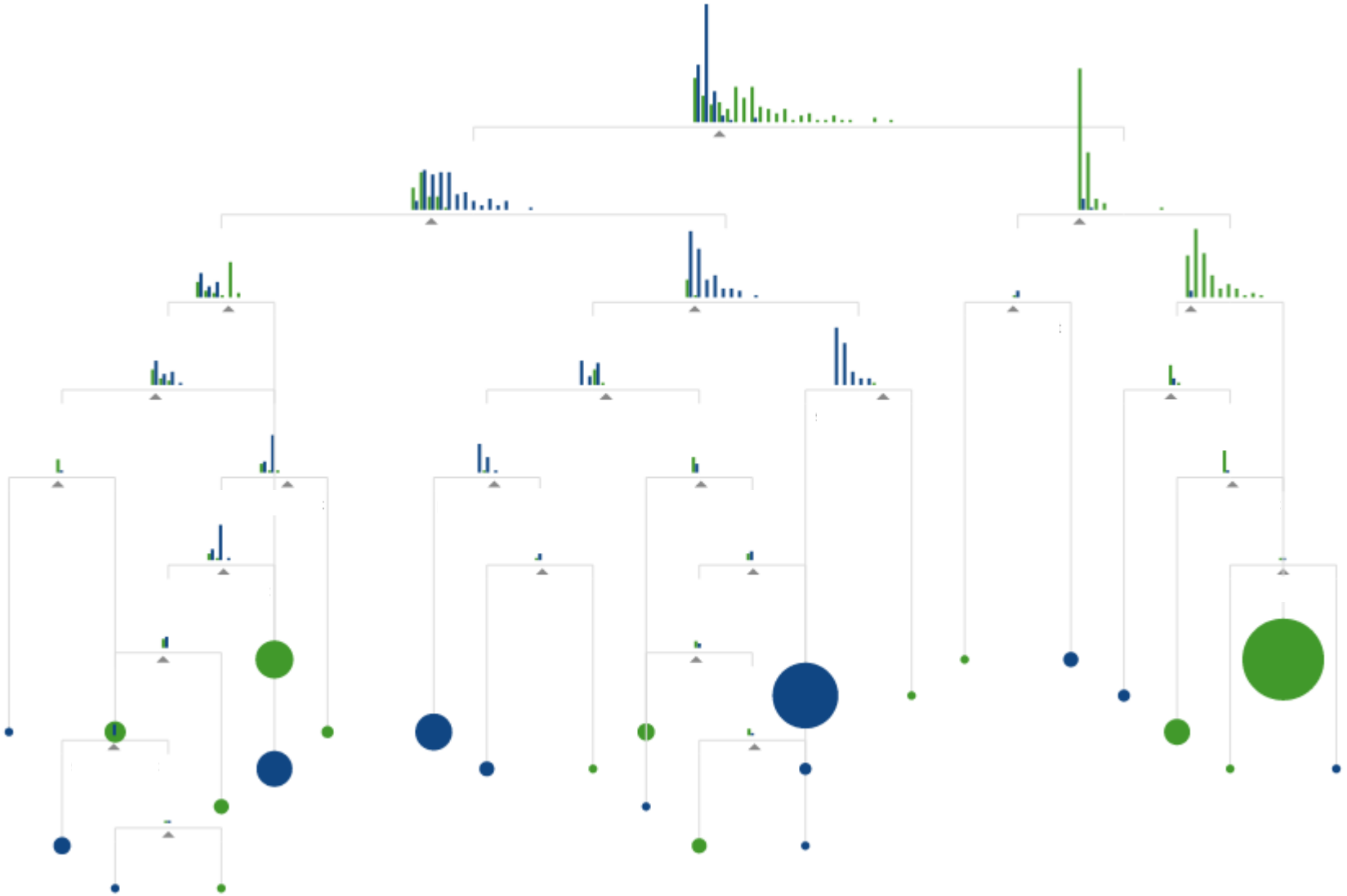


From: http://www.r2d3.us/visual-intro-to-machine-learning-part-1/

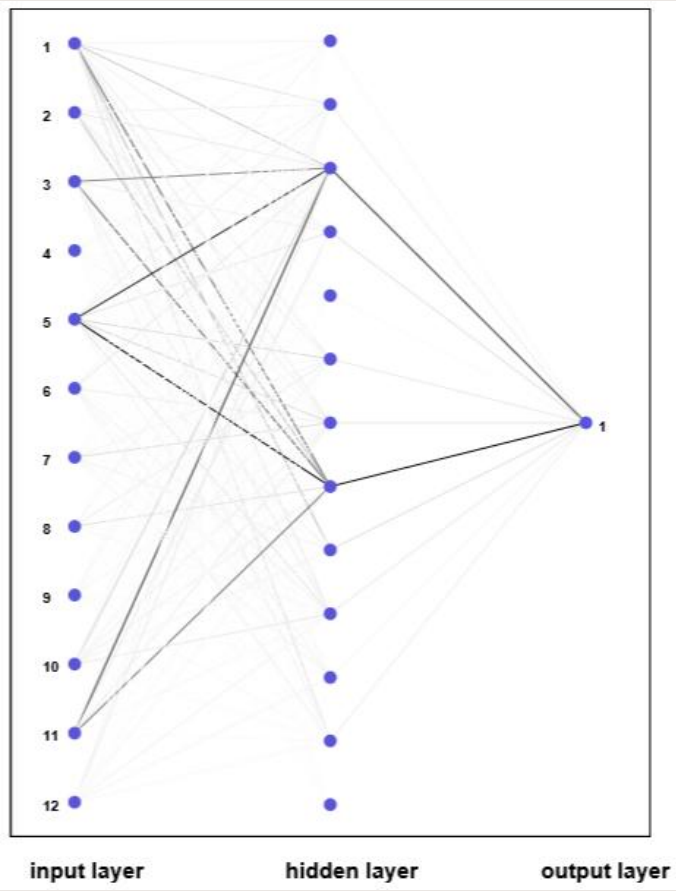




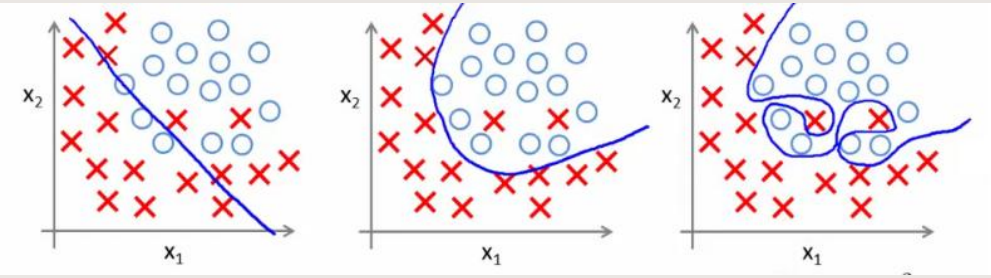




NeuroBayes®



- Non-linear algorithm
  - Has more built-in safety measures

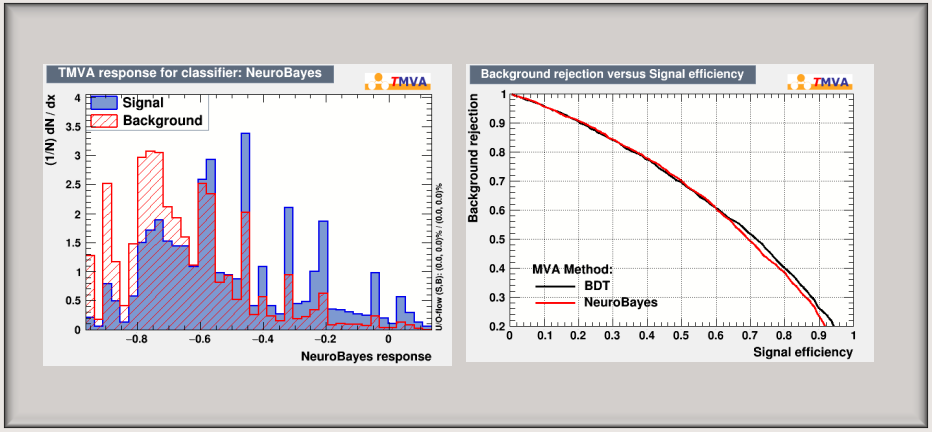


overtrained

  - Variable selection is much more important

Classification and Outputs

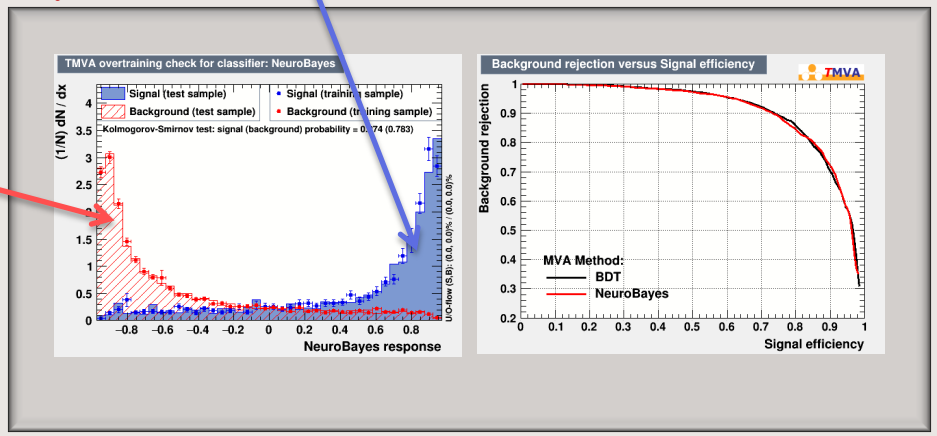
1.



Signal

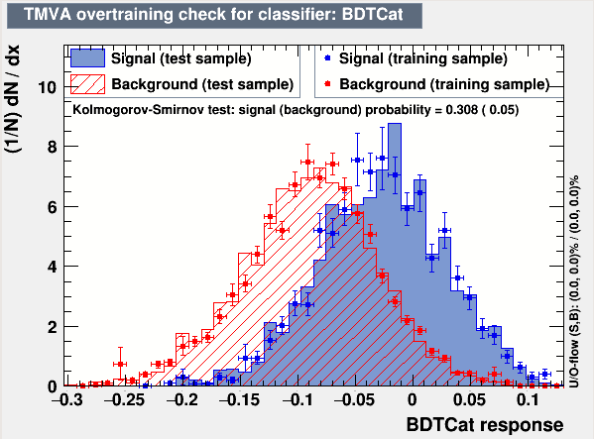
2.

Background

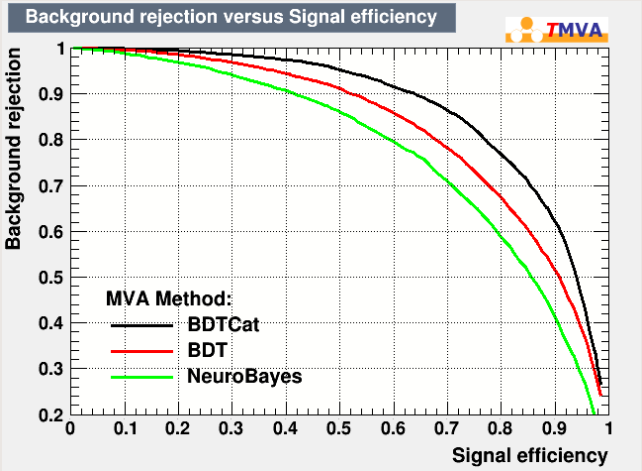


Summary and Next Steps

- Optimized the algorithms with variables currently available



- Next steps:
  - Create new variables
  - Compare algorithms' performance
  - Create a classification algorithm for Run II data



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Thank you!
Merci!

Questions?

Special thank you to :

- Tamara Vázquez Schröder
- François Corriveau

NSERC CRSNG

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