Fair Universe HiggsML uncertainty challenge

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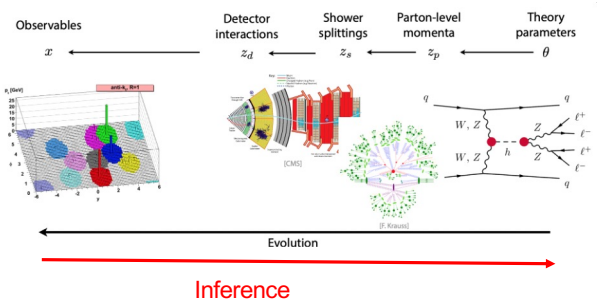
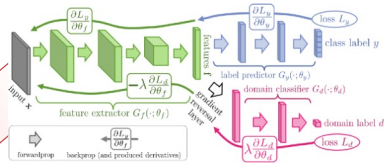
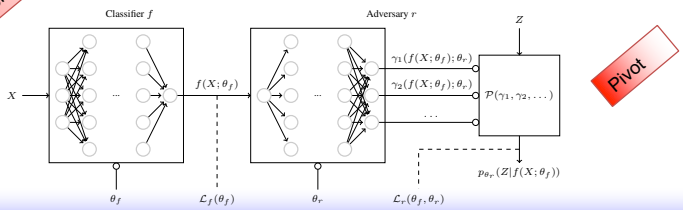
Systematic uncertainties

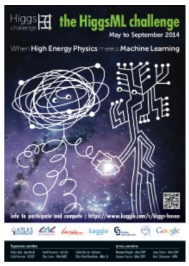


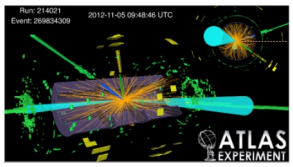
Many architectures proposed to control systematics, but no consensus

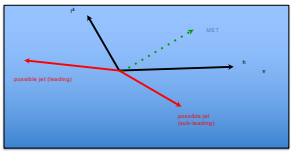




- Extension of previous HiggsML challenge from 2014
- Higgs boson decaying to Tau leptons based on final state 3-momenta and derived quantities: l,h,MissingET,up to 2 jets
- Classification problem ⇒ inference problem
- Dataset : HiggsML 2014 data set on CERN Open Data portal doi:10.7483/OPENDATA.ATLAS.ZBP2.M5T8
- ⇒new Fair Universe dataset, with following improvements
- Instead of ATLAS G4 simulation, use Pythia LO + Delphes
- Numbers of events 800.000⇒ >30 millions
- Higgs signal, Z, top and W backgrounds
- Parametrised systematics (Nuisance Parameters: NP) :
  - Tau Energy Scale : on had Tau Pt (and correlated MET)
  - Jet Energy Scale (and correlated MET impact)
  - additional randomised Soft MEt
  - background normalisation
  - W background normalisation (a subdominant poorly constrained BKG)
- Task : given a pseudo-experiment with given signal strength, provide a Confidence Interval

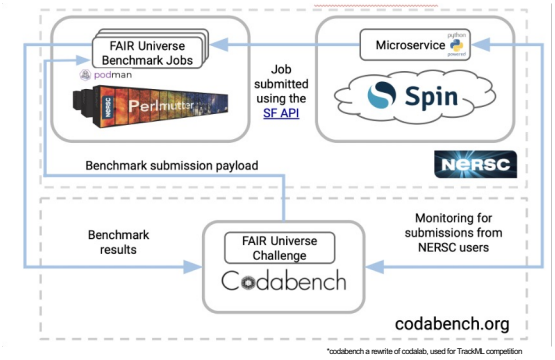






Features provided

PRI_had_pt	DER_mass_trans_met_lep
PRI_had_eta	DER_mass_vis
PRI_had_phi	DER_pt_h
PRI_lep_pt	DER_deltaeta_jet_jet
PRI_lep_eta	DER_mass_jet_jet
PRI_lep_phi	DER_prodeta_jet_jet
PRI_met	DER_deltar_tau_lep
PRI_met_phi	DER_pt_tot
PRI_met_sumet	DER_sum_pt
PRI_jet_num	DER_pt_ratio_lep_tau
PRI_jet_leading_pt	DER_met_phi_centrality
PRI_jet_leading_eta	DER_lep_eta_centrality
PRI_jet_leading_phi	
PRI_jet_subleading_pt	
PRI_jet_subleading_eta	
PRI_jet_subleading_phi	
PRI_jet_all_pt	



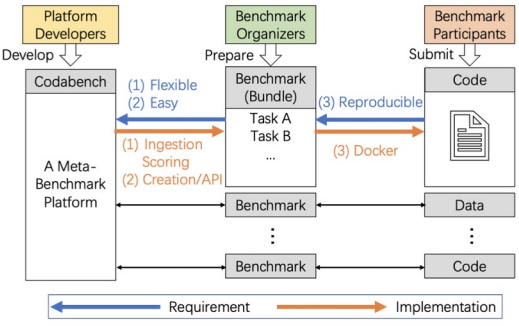
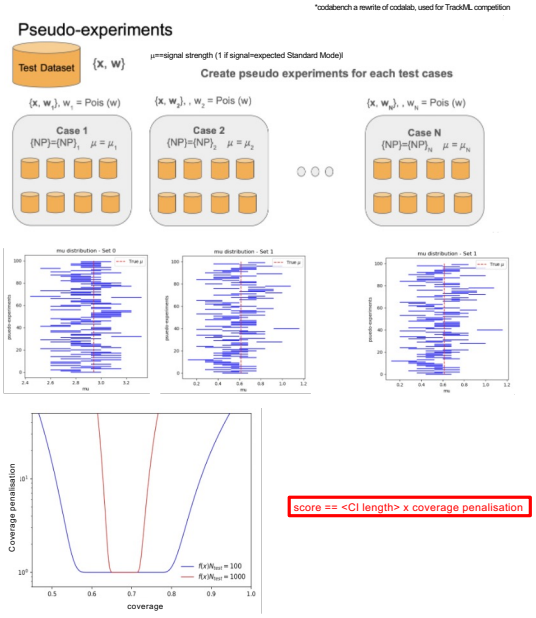


Figure 2: Overview of the core proposed platform (based on Codabench from [5]). A benchmark platform has three types of contributors: platform developers (in yellow), benchmark organizers (in green) and benchmark participants (in red). Codabench is designed to support diverse benchmarks. Each benchmark is implemented by a benchmark bundle that contains one or more tasks (wrapping around datasets).



score == <CI length> x coverage penalisation

Task:

#	Participant	Entries	Date of last entry	Fact Sheet Answers: Method Name	Higgs Uncertainty Challenge: Quantile Score	Interval	Coverage	Detailed Results
	ragansu	30	2024-01-22	Histogram_10	**1.45**	0.226	0.57	
	ragansu	30	2024-01-22	One_bin NLL	**1.07**	0.333	0.57	
	laurenssiu	20	2023-12-01	cheat7	**0.68**	0.504	0.63	
	laurenssiu	20	2023-12-01	cheat7	**0.61**	0.544	0.68	
	laurenssiu	20	2023-12-01	cheat4	**0.31**	0.732	0.61	
6	laurenssiu	20	2023-12-01	cheat4	**0.16**	0.852	0.71	
7	laurenssiu	20	2023-12-01	Cheat2	**-0.44**	1.55	0.62	
8	laurenssiu	20	2023-12-01	Cheat2	**-0.74**	1.375	0.55	
9	ragansu	30	2024-01-22	tes_finder	**-0.95**	1.124	0.54	
10	laurenssiu	20	2023-12-01	Cheat2	**-1.59**	1.325	0.53	
11	Ihsan Ullah	4	2024-01-18	Sascha sys aware 8	**-2.69**	0.329	0.47	
12	Rafal Maselek	10	2023-12-01	1binNLL	**-2.9**	1.233	0.5	
13	ihsanchaleam	16	2023-12-18	1 bin NLL	**-2.9**	1.233	0.5	
14	Rafal Maselek	10	2023-12-01	1binNLL	**-2.9**	1.233	0.5	
15	ihsanchaleam	16	2023-12-18	Sascha sys aware 8	**-3.01**	0.33	0.46	

- a major new scientific competition on measuring Higgs cross-section,
  - taking into account/minimizing impact from modelisation systematics
  - winner to provide a narrow confidence interval with good coverage
- on Codabench platform with NERSC back-end
- to run June-Sep 2024
- applying for NeurIPS 2024 competition
- to be announced on usual : lhc-machinelearning-wg@cern.ch
- a cosmology challenge (weak-lensing) is also in the pipeline