



Potential applications of machine learning in particle physics

See <http://gambit.hepforge.org/>

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Monash University

Particle physics

We study the most fundamental particles — building blocks of matter



The most recent discovery was the Higgs boson at the LHC. We have many theories involving new undiscovered states!

GAMBIT: The Global And Modular BSM Inference Tool

gambit.hepforge.org

- Fast definition of new datasets and theoretical models
- Plug and play scanning, physics and likelihood packages
- Extensive model database – not just SUSY
- Extensive observable/data libraries
- Many statistical and scanning options (Bayesian & frequentist)
- *Fast* LHC likelihood calculator
- Massively parallel
- Fully open-source

ATLAS
LHCb
Belle-II
Fermi-LAT
CTA
CMS
IceCube
XENON/DARWIN
Theory

F. Bernlochner, A. Buckley, P. Jackson, M. White
M. Chrzęszcz, N. Serra
F. Bernlochner, P. Jackson
J. Conrad, J. Edsjö, G. Martinez, P. Scott
C. Balázs, T. Bringmann, M. White
C. Rogan
J. Edsjö, P. Scott
B. Farmer, R. Trotta
P. Athron, C. Balázs, S. Bloor, T. Bringmann,
J. Cornell, J. Edsjö, B. Farmer, A. Fowlie, T. Gonzalo,
J. Harz, S. Hoof, F. Kahlhoefer, S. Krishnamurthy,
A. Kveltestad, F.N. Mahmoudi, J. McKay, A. Raklev,
R. Ruiz, P. Scott, R. Trotta, A. Vincent, C. Weniger,
M. White, S. Wild



31 Members in 9 Experiments, 12 major theory codes, 11 countries

Exploring the high-dimensional parameter spaces requires millions of evaluations.

Every point must be classified as allowed or forbidden, or assigned a likelihood.

Classification?

Is this screaming ML to you?

We could train a ML algorithm to classify points as excluded or allowed.

We could train ML regression to predict the likelihood of a point.

This would accelerate our work!

Visualise high-dimensional space

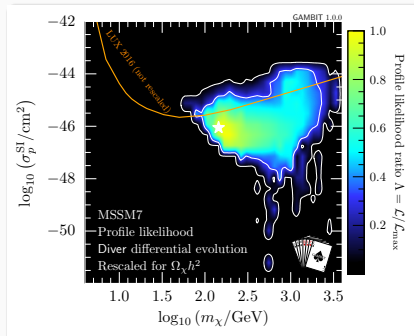
Once we have the results, we want to understand them.

The allowed/excluded regions may involve complicated relations in many dimensions.

How can we understand it?

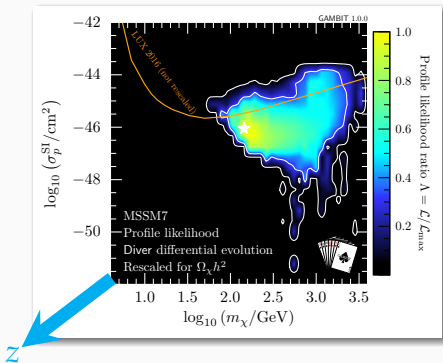
Visualise high-dimensional space

We can profile onto two dimensions.



Visualise high-dimensional space

We can profile onto two dimensions.



What about the others?

Clustering & Dimensional reduction?

Can we use **clustering** to understand distinct types of allowed points and their properties?

Can we use **dimensional reduction** to see the important relationships?

Some work already on this in the literature.

Let's discuss at the coffee breaks! Have a look at our public codes and datasets if you are interested

<http://gambit.hepforge.org/pubs>