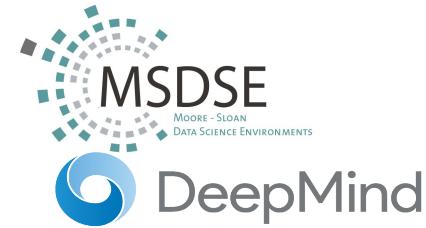


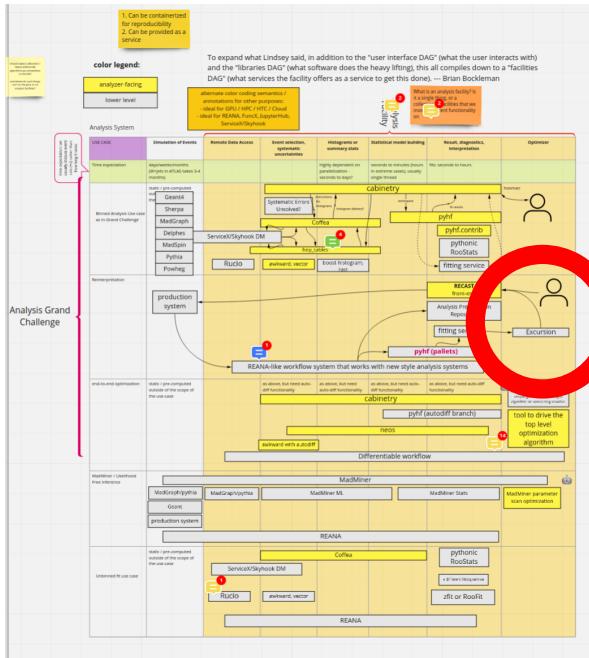
# Excursion

## Efficient Reinterpretation Campaigns with Active Learning

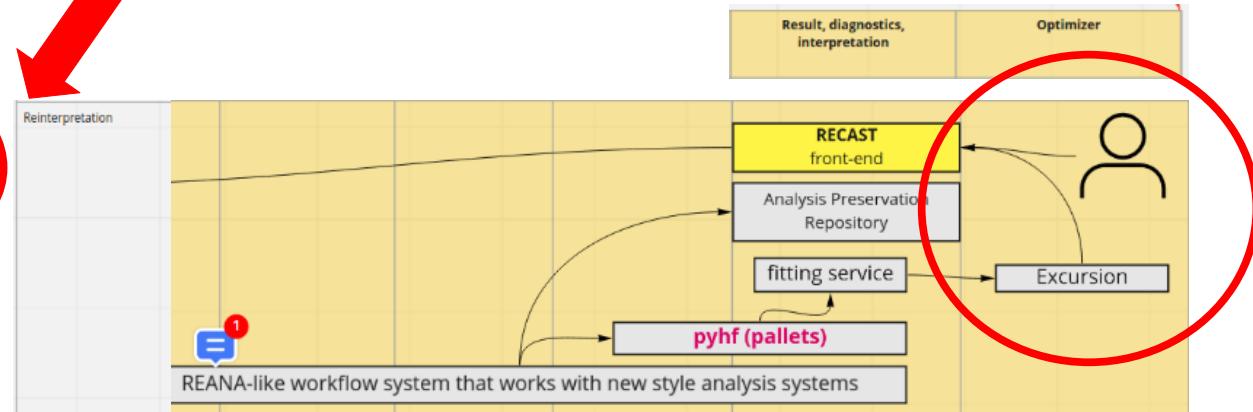
**Irina Espejo** (NYU)  
Lukas Heinrich (CERN)  
Gilles Louppe (U. Liège)  
Kyle Cranmer (NYU)



# Context



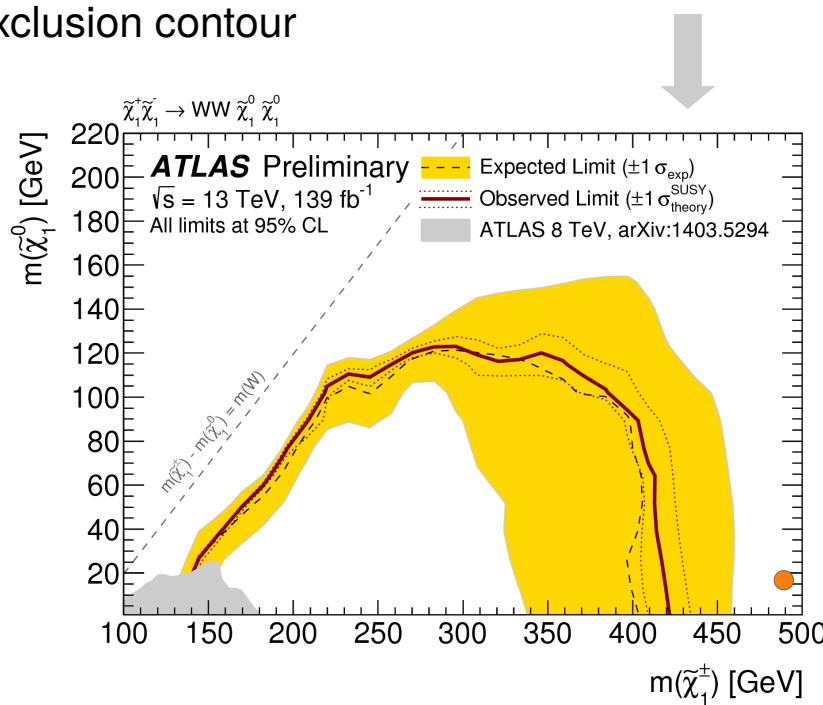
# You are here



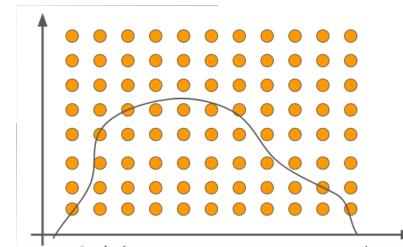
Excursion would orchestrate the sequential calls to RECAST and fitting-as-a-service

# Context

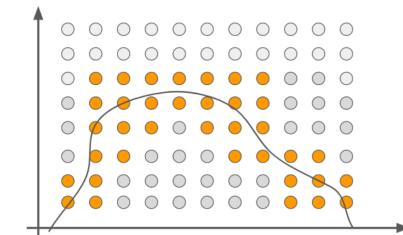
The final stage of a BSM search is often presented as an exclusion contour



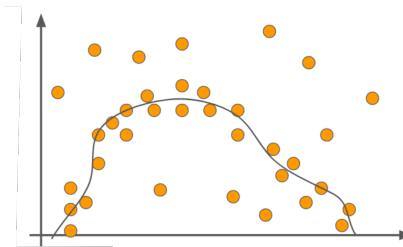
How to calculate the contour :



Regular grid  
(expensive)

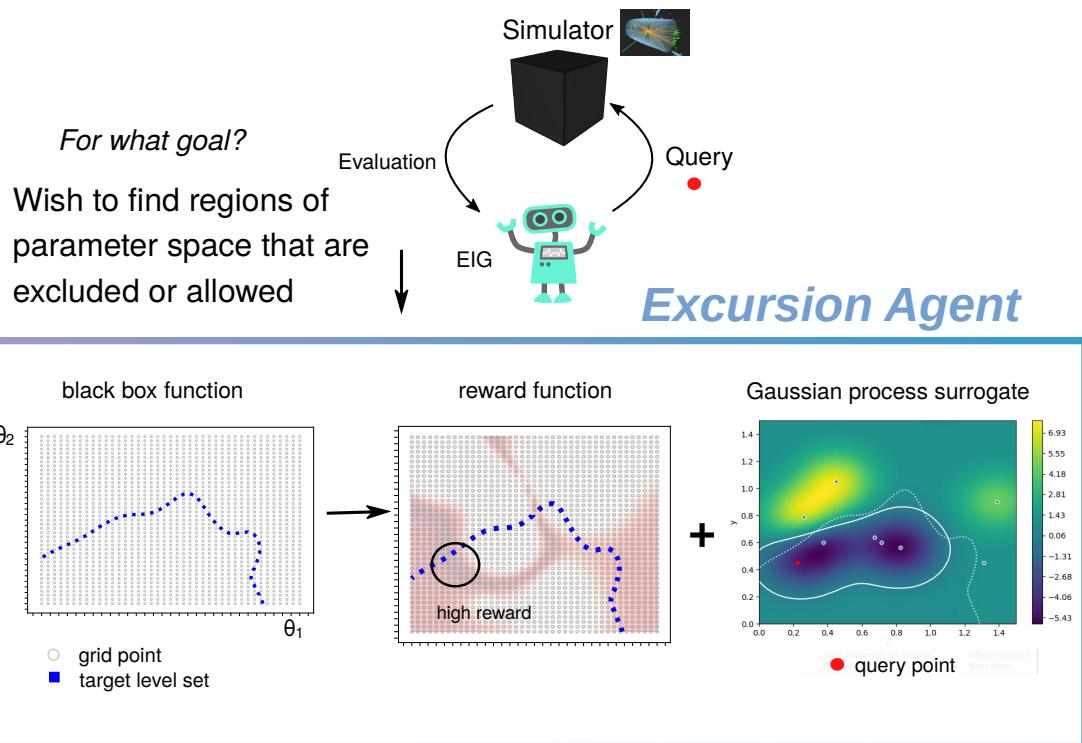


Ideal  
(but we don't  
know a priori)



Excursion  
(balance  
exploration vs  
exploitation)

# Basic idea



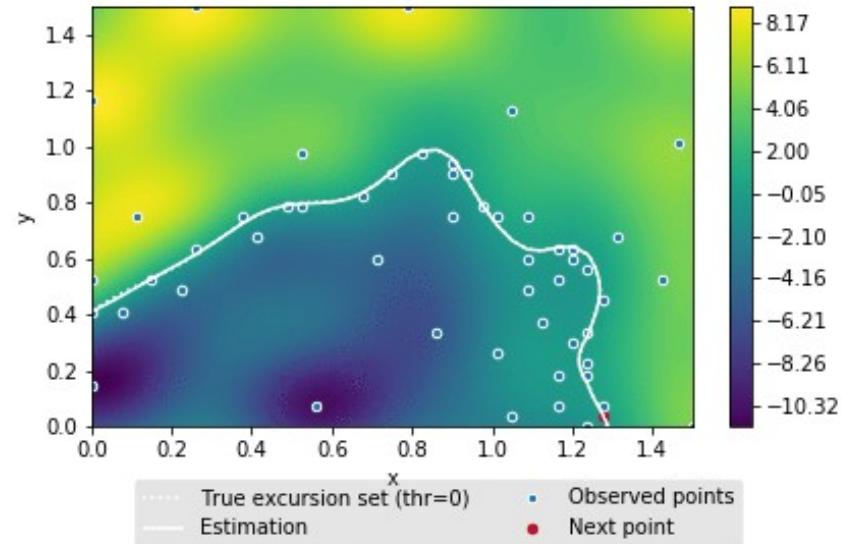
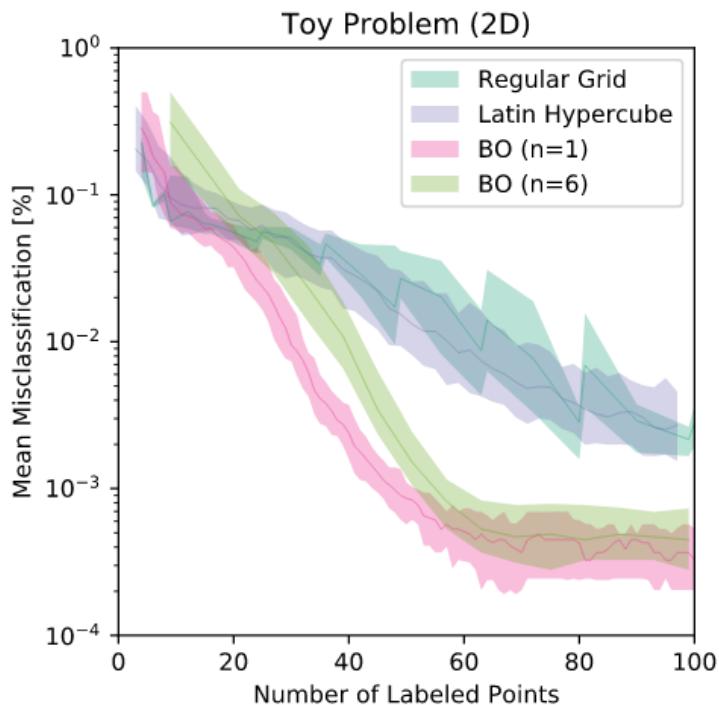
- Like Bayesian Optimization for black box functions but not trying to find a point that maximizes the function, *we are trying to find a contour, which is more difficult*

$$u_{MES}(x) = - \sum_{c_j} p_j(x) \log p_j(x) \quad \text{with } p_j(x) = \int_{t_j}^{t_{j+1}} \exp\left(-\frac{(y - \mu(x))^2}{2k(x, x')^2}\right) dy$$

Gaussian process:  $Y(x) \sim \mathcal{N}(\mu(x), k(x, x'))$  thresholds:  $t_j$

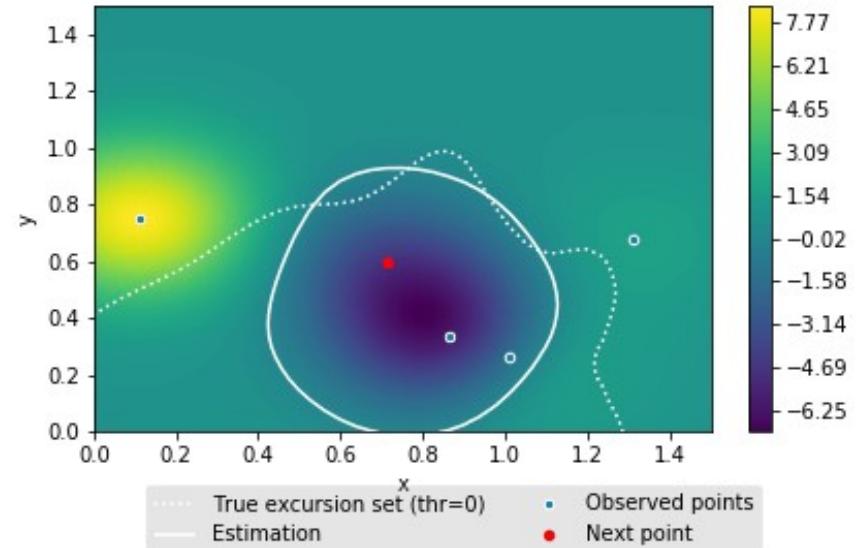
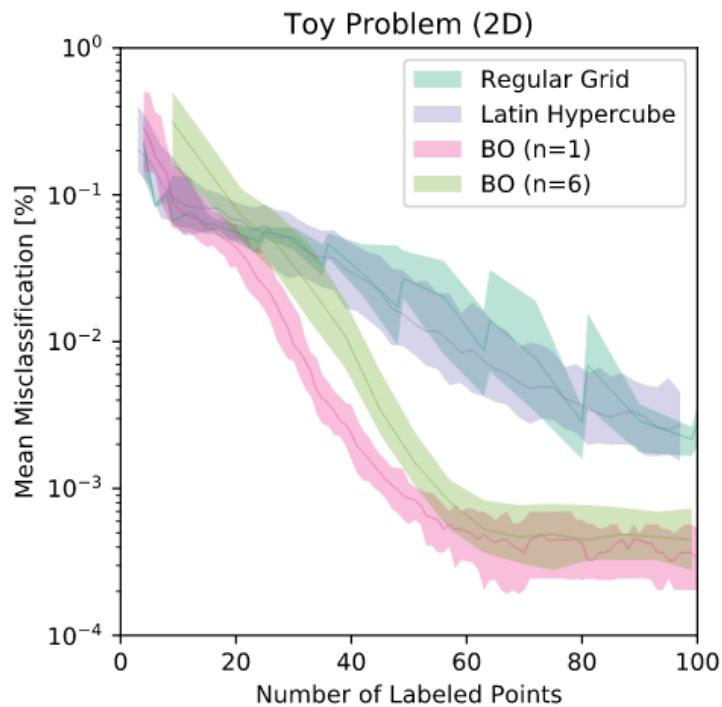
- Active Learning + Gaussian Processes
- Batches for parallelization

# Excursion reduces computing demands for simulation



Samples concentrate around the true contour

# Excursion reduces computing demands for simulation



## ...and GPyTorch too



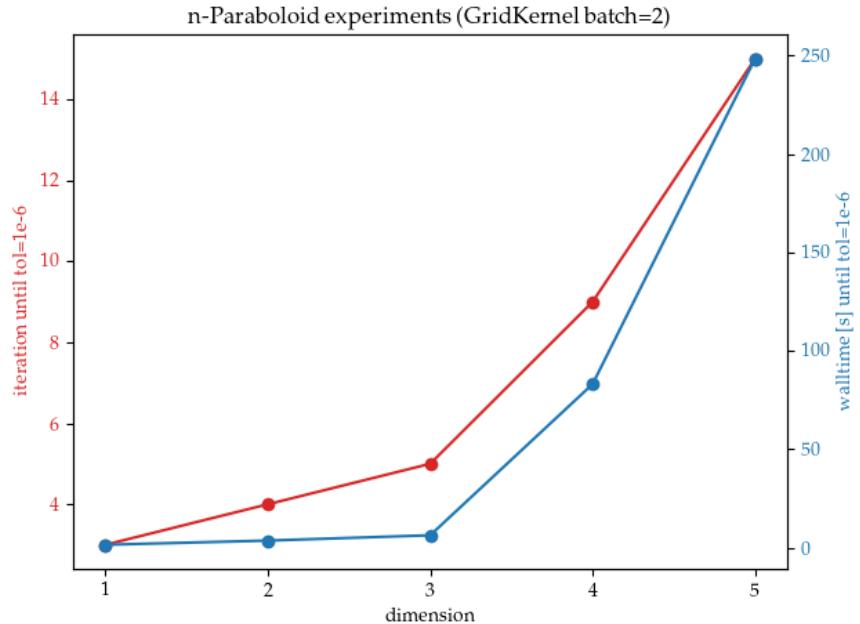
- Native GPU support
- State-of-the-art fast posterior fit techniques
- Specific kernel for data structured a grid  
GridRegressionKernel
- Flexibility with priors, kernels, noise and exact vs approximate inference
- Hyperparameter tuning is easy thanks to autograd
- Multitasking feature
- Native Lazy Covariance tensor evaluation
- Good documentation
- Anyone interested in Pyro integration?



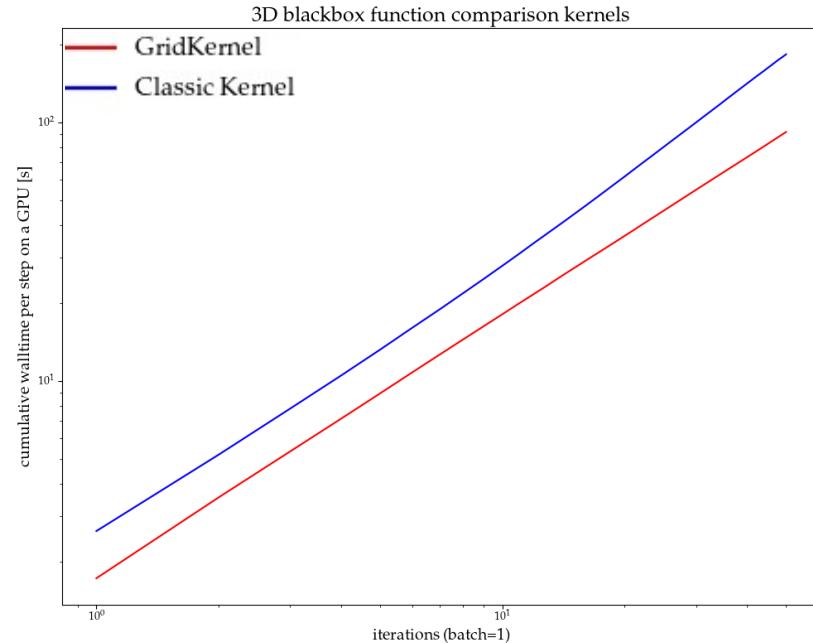
### Exact GPs with Scalable (GPU) Inference

In GPyTorch, Exact GP inference is still our preferred approach to large regression datasets. By coupling GPU acceleration with BlackBox Matrix-Matrix Inference and Lanczos Variance Estimates (LOVE), GPyTorch can perform inference on datasets with over 1,000,000 data points while making very few approximations.

# ...and GPyTorch too



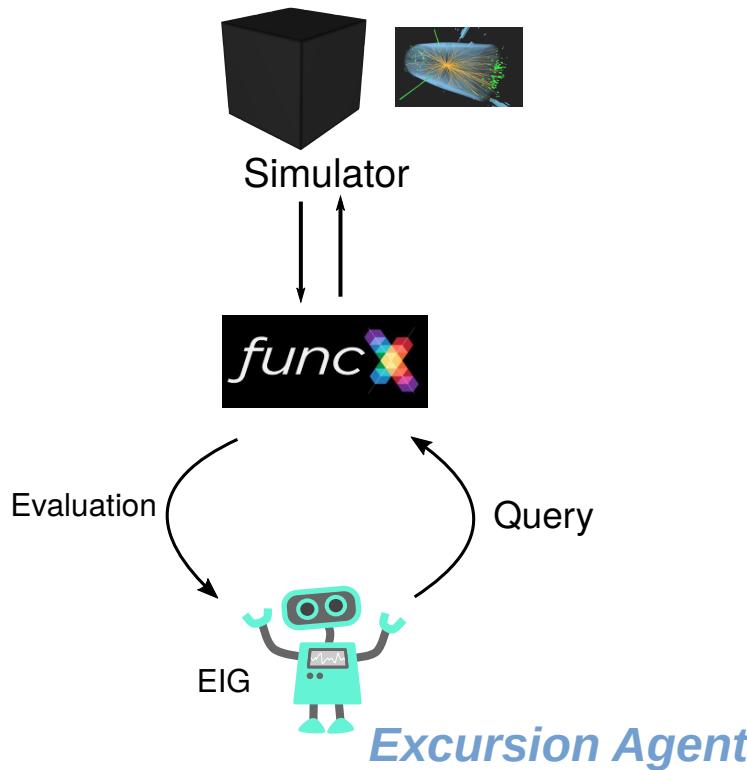
BSM theories have many parameters  
and GPyTorch GridKernel can scale to  
higher dimensions



GPyTorch GridKernel is faster than a  
regular Kernel

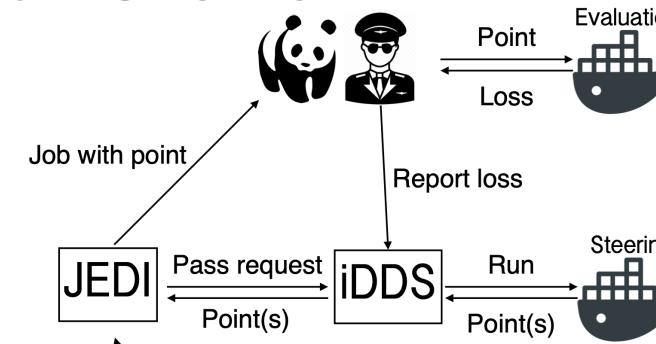
# Deploying excursion at Analysis Facilities

funcX could be used for a fast, approximate version of the full RECAST workflow



Could deploy similar to hyperparameter optimization

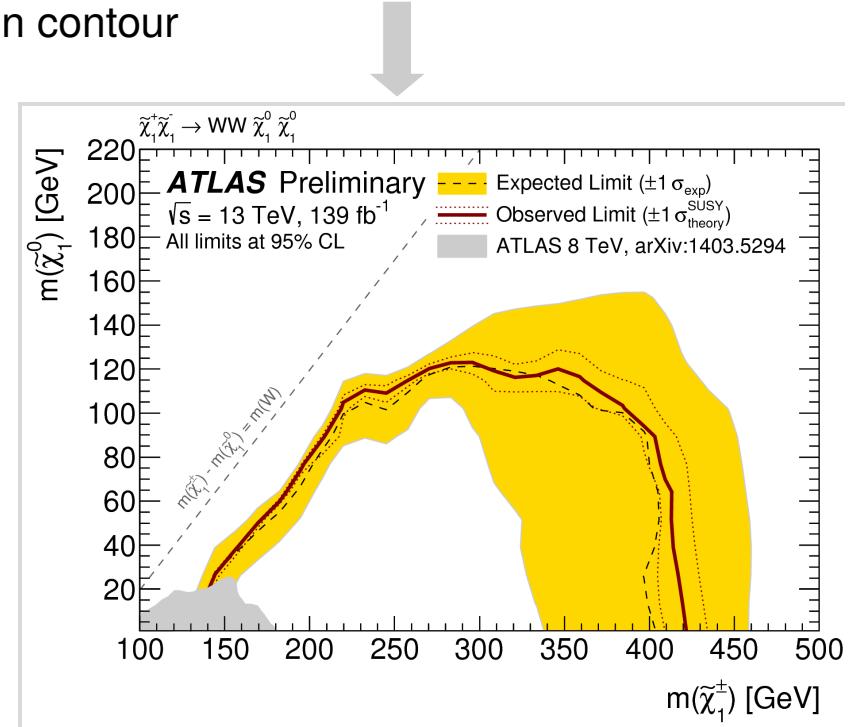
## The HPO workflow



- 1. Search space: a json file
- 2. Training code: scripts / package / gitlab repo

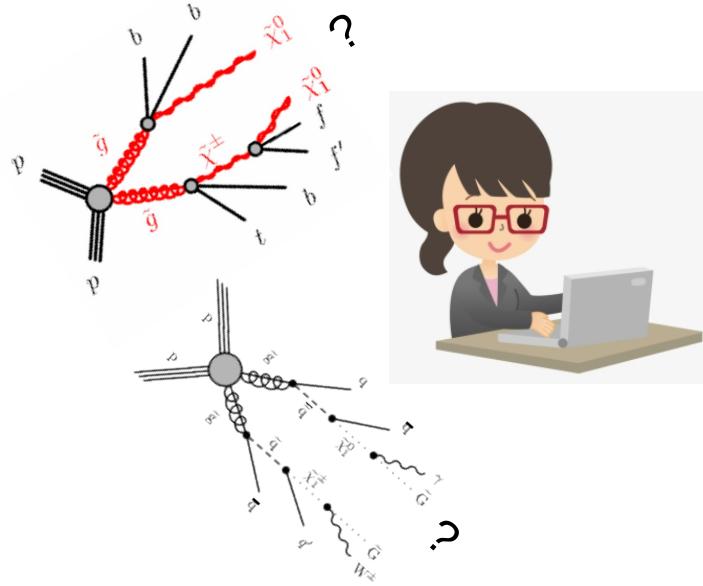
# Going one level up in abstraction

The final stage of a BSM search is often presented as an exclusion contour



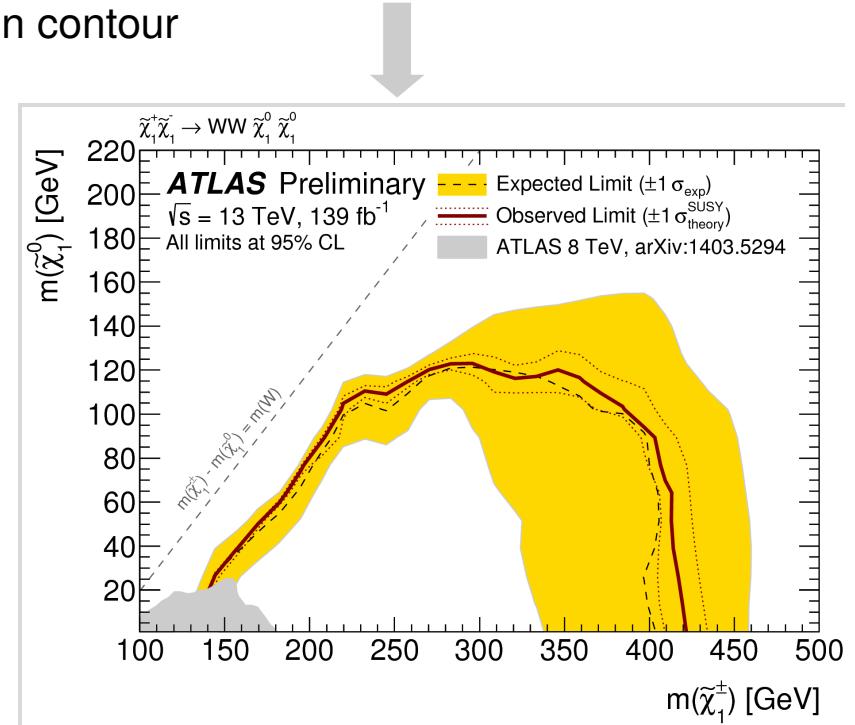
# Going one level up in abstraction

The initial stage of a BSM search looks like this



Active Learning

The final stage of a BSM search is often presented as an exclusion contour





**Thank you**