PhD position

Development of innovative statistical learning methods for the search of new physics signatures in the ATLAS detector at the LHC

Clermont-Ferrand, France

https://inspirehep.net/jobs/2645996

https://learning_anomalies.pages.math.cnrs.fr/position_ads/

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Imbp

LPC Particules pLasmas Univers applicationS

Searching for new phenomena

Not possible to explore all possible models and signatures

- Alternative strategy : **Generic** searches (aka Anomaly detection)
- Approach that strongly rely on (modern) **ML** methods

Anomaly detection for BSM searches

ML methods for anomaly detection

- Search for **unknown signal** (=anomaly) in data
- Derive **background** model directly from **data**
- **Select** region of phase-space potentially enriched in signal
- Scan **multiple signatures** and variables

	e	μ	τ	q/g	b	t	γ	Z/W	H	BSM → $SM_1 \times SM_1$				BSM → $SM_1 \times SM_2$				BSM → complex			
										q/g	γ/π^0's	b	⋯	tZ/H	bH		⋯	$\tau qq'$	eqq'	$\mu qq'$	⋯
e	[37,38]	[39,40]	[39]	∅	∅	∅	[41]	[42]	∅	∅	∅	∅		∅	∅	∅		∅	[43,44]	∅	
μ		[37,38]	[39]	∅	∅	∅	[41]	[42]	∅	∅	∅	∅		∅	∅	∅		∅	∅	[43,44]	
τ			[45,46]	∅	[47]	∅	∅	∅	∅	∅	∅	∅		∅	∅	∅		[48,49]	∅	∅	
q/g				[29,30,50,51]	[52]	∅	[53,54]	[55]	∅	∅	∅	∅		∅	∅	∅		∅	∅	∅	
b					[29,52,56]	[57]	[54]	[58]	[59]	∅	∅	∅		[60]	∅	∅		∅	∅	∅	
t						[61]	∅	[62]	[63]	∅	∅	∅		[64]	[60]	∅		∅	∅	∅	
γ							[65,66]	[67–69]	[68,70]	∅	∅	∅		∅	∅	∅		∅	∅	∅	
Z/W								[71]	[71]	∅	∅	∅		∅	∅	∅		∅	∅	∅	
H									[72,73]	[74]	∅	∅		∅	∅	∅		∅	∅	∅	
BSM → $SM_1 \times SM_1$: q/g										∅	∅	∅		∅	∅	∅		∅	∅	∅	
γ/π^0's											[75]	∅		∅	∅	∅		∅	∅	∅	
b												[76,77]		∅	∅	∅		∅	∅	∅	
⋮																					
⋮																					

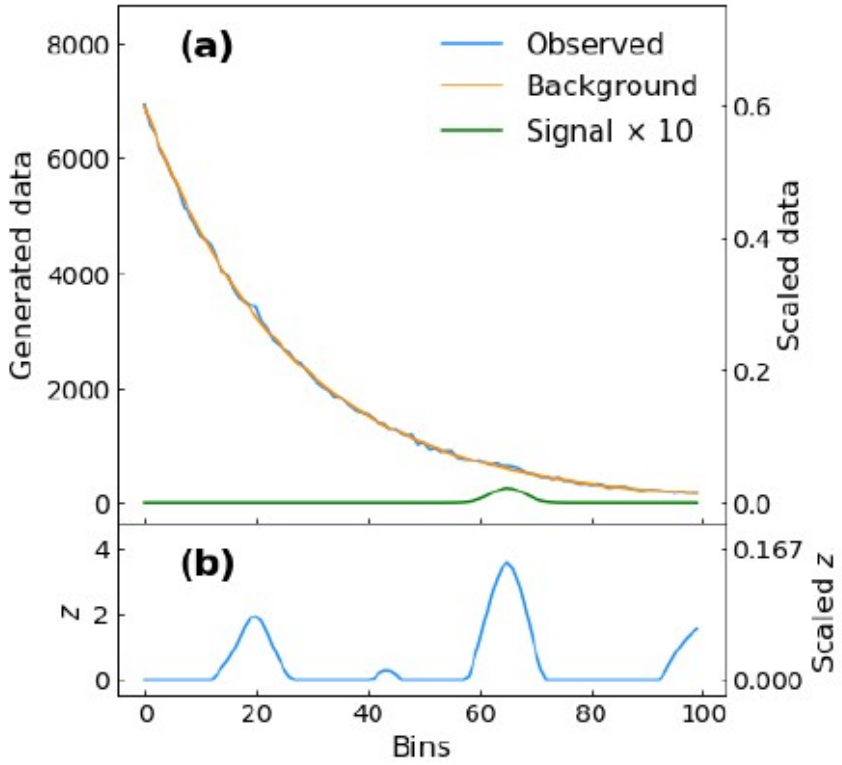
Searches for two-body resonances (arXiv:1907.06659)

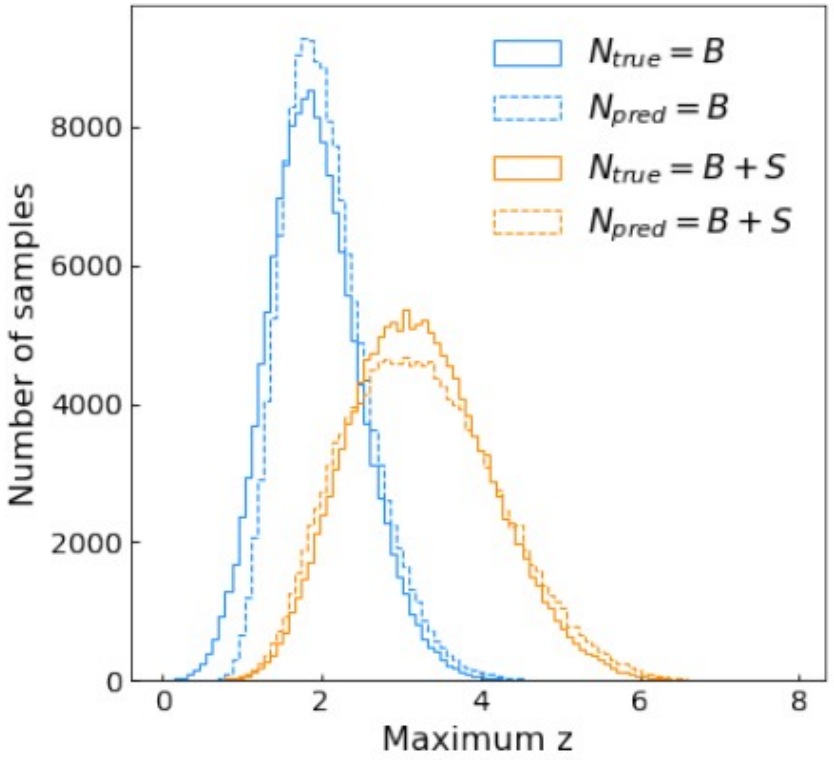
Proof of concept: Data Directed Paradigm

S. Bressler et. al., ArXiv:2107.11573

Train a NN to **identify a bump on data**, without background estimation

Current collaboration : Tel Aviv, Montreal, Clermont-Ferrand



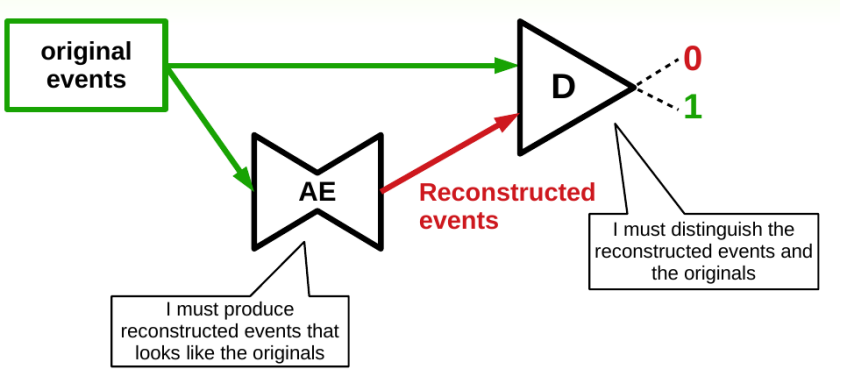


Unsupervised anomaly detection

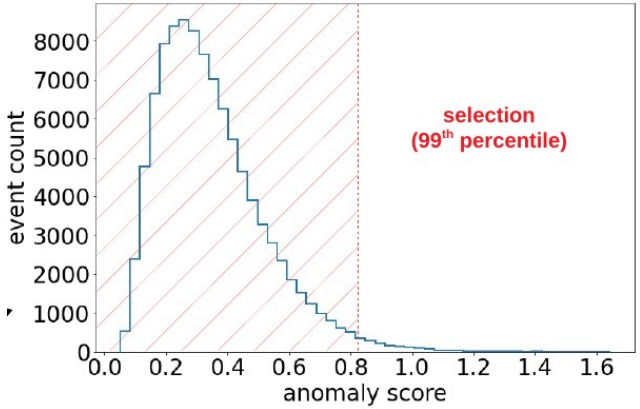
Thesis Louis Vaslin: adversarial auto-encoder

Select data: mostly background since signal is expected to be very **rare**

Train GAN-AE algorithm on data to calculate **anomaly score**

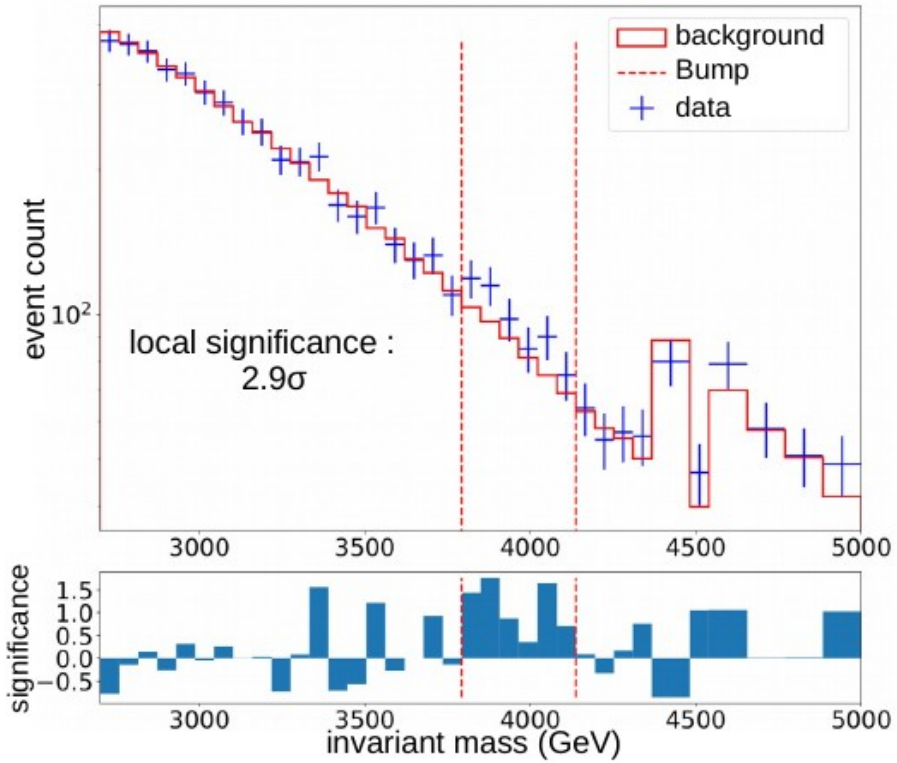


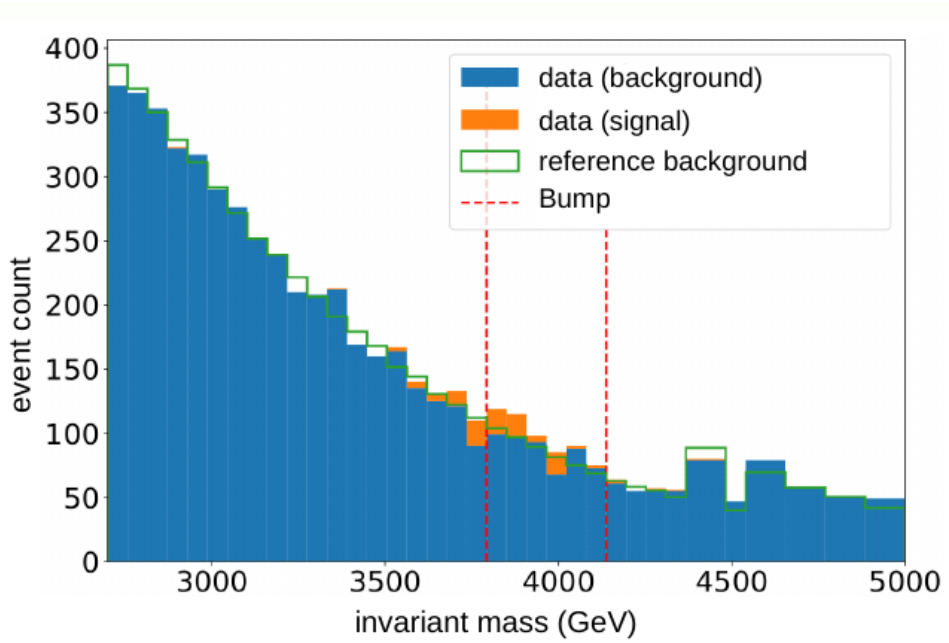
Selecting “anomalous” data **expected to be rich in signal**



Proof of concept: LHC Olympic 2020

Proof of concept on realistic simulated data with injected **unknown** signal





Work published in community paper Rep. Prog. Phys. 84 124201

Thesis objective

Exploit the **huge amount of data** collected by the ATLAS detector for the **search for new physics** using modern statistical analysis methods.

Promising proof of concepts allow an **exploitation of the data in an original and new way**

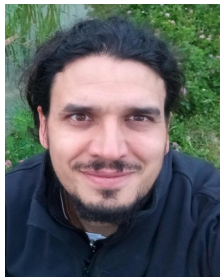
Look at types of collisions difficult to model and often **overlooked**

Clermont-Ferrand ?

More information about LPC ATLAS team:
https://atlas-clermont.web.cern.ch/atlas-clermont/

Supervisors

Manon Michel (manon.michel@cnrs.fr)
CNRS researcher at the **Mathematics** Laboratory Blaise Pascal



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Professor at the Univeristy Clermont Auvergne, **ATLAS** team

How to apply ?

Applicants should submit:

- a CV
- copies of relevant certificates and diplomas
- Description of their research experience and interests
- 2 letters of recommendation.

For full consideration, please send your application by **May 30**.

Knowledge in experimental particle physics and practice of modern Machine Learning techniques is **recommended**.

Inquiries about the position and applications should be sent by email to:

julien.donini@cern.ch