Accelerating the Search for Dark Matter with Machine Learning

Report of Contributions

https://indico.cern.ch/e/664842

Contribution ID: **1** Type: **not specified**

Introduction into Astronomical Dark Matter measurements and challenges

Contribution ID: **2** Type: **not specified**

Arrival / Registration

Monday 15 January 2018 09:00 (1 hour)

Contribution ID: **3** Type: **not specified**

Dark Matter overview

Monday 15 January 2018 10:20 (45 minutes)

Presenter: FORNENGO, Nicolao (University of Torino and INFN)

Contribution ID: **4** Type: **not specified**

Introduction into Deep Learning and Image Analysis

Monday 15 January 2018 11:05 (45 minutes)

Presenter: WELLING, Max

Contribution ID: **5** Type: **not specified**

First ideas to connect Astronomical data, Deep Learning and Image Analysis

Monday 15 January 2018 11:50 (25 minutes)

Presenters: GOMEZ VARGAS, German Arturo (Universidad Autonoma de Madrid); GOMEZ-VARGAS, German (Pontifical Catholic University of Chile)

Contribution ID: **6** Type: **not specified**

Discussion: First connections ?

Monday 15 January 2018 12:15 (20 minutes)

Contribution ID: **7** Type: **not specified**

Cross link: Deep Learning in High Energy Physics

Monday 15 January 2018 14:00 (45 minutes)

Presenter: FARBIN, Amir (University of Texas at Arlington (US))

Contribution ID: **8** Type: **not specified**

Discussion: New ideas ?

Monday 15 January 2018 14:45 (20 minutes)

Bring up projects –> Bring up a discussion ...

We can vote which one we should open.

Decide on the projects (darksurvey.com)

Suggest new application of Deep Learning / Image Analysis.
Suggest topic for brainstorming session.

Contribution ID: **9** Type: **not specified**

Work in subgroups : Finding new projects in Deep Learning / Image Analysis

Monday 15 January 2018 15:35 (55 minutes)

Person proposing the subject + Organiser + Participants
split up in 2-4 rooms.

Work on 5 min presentation about the topic.

Contribution ID: **10** Type: **not specified**

The hunt for stellar-mass DM clumps: applying the statistical machine learning techniques to strong microlensing events

Monday 15 January 2018 16:30 (15 minutes)

Strong gravitational microlensing (GM) events give us a possibility to determine some characteristics of both microlens and microlensed source. As the role of microlens can be played by a DM clump, GM can give us an important clue to understand the nature of dark matter on comparably small spatial/mass scales. In the same time, fitting the lightcurves of microlensed sources is quite time-consuming process, especially taking into account nonzero lens size. Here we test the possibility to apply the statistical machine learning techniques to distinguish high-amplification microlensing events (HAME) caused by continuously distributed DM clump from star- or black hole- induced microlensing (i.e. microlens is considered as a point-like mass). On this stage we use the set of simulated HAE amplification curves of sources microlensed by point masses and clumps of DM with various density profiles.

Presenter: FEDOROVA, Elena

Contribution ID: **11** Type: **not specified**

Fast model discrimination with Euclideanized signals

Monday 15 January 2018 16:45 (15 minutes)

Presenter: WENIGER, Christoph (University of Amsterdam)

Contribution ID: **12** Type: **not specified**

Drinks/reception with informal discussions

Contribution ID: **13** Type: **not specified**

Results of yesterdays workgroups on Deep Learning, Image Analysis and astronomical Dark Matter data

Tuesday 16 January 2018 09:00 (30 minutes)

Contribution ID: **14** Type: **not specified**

Introduction into direct and indirect Dark Matter searches and their challenges

Tuesday 16 January 2018 10:35 (45 minutes)

Presenters: REGIS, Marco; Dr REGIS, Marco (INFN - National Institute for Nuclear Physics)

Contribution ID: **15** Type: **not specified**

Introduction into unsupervised learning

Tuesday 16 January 2018 11:20 (45 minutes)

Presenter: MERÉNYI, Erzsébet

Contribution ID: **16** Type: **not specified**

First ideas to use Machine Learning in direct Dark Matter searches

Tuesday 16 January 2018 13:55 (30 minutes)

Presenters: BROWN, Andrew (MIT); BROWN, Andrew (Nikhef); Dr TUNNELL, Christopher (University of Chicago); TUNNELL, Christopher (Enrico Fermi Institute-University of Chicago-Unknown)

Contribution ID: **17** Type: **not specified**

Discussion: New ideas ?

Tuesday 16 January 2018 14:25 (15 minutes)

Contribution ID: **18** Type: **not specified**

First ideas to use Machine Learning in indirect detection

Tuesday 16 January 2018 14:40 (30 minutes)

Presenter: HENDRIKS, Luc (Nikhef)

Contribution ID: **19** Type: **not specified**

Results of yesterdays workgroups on unsupervised learning, direct and indirect DM searches

Wednesday 17 January 2018 09:15 (30 minutes)

Contribution ID: **20** Type: **not specified**

Introduction into Large Hadron Collider searches

Contribution ID: **21** Type: **not specified**

New approaches in semi-supervised learning

Wednesday 17 January 2018 09:45 (45 minutes)

Presenter: KRISTIAAN PELCKMANS

Contribution ID: **22** Type: **not specified**

Results of yesterdays workgroups on supervised learning and DM searches at the LHC

Thursday 18 January 2018 09:00 (30 minutes)

Contribution ID: **23** Type: **not specified**

Introduction into theory models for Dark Matter particles

Thursday 18 January 2018 09:30 (45 minutes)

Presenter: DE SIMONE, Andrea

Contribution ID: **24** Type: **not specified**

OpenML/AutoML: Organizing machine learning data and learning to learn better models

Thursday 18 January 2018 10:35 (45 minutes)

Presenter: VANSCHOREN, Joaquin

Contribution ID: **25** Type: **not specified**

New projects: Astronomical DM + ML

Contribution ID: **26** Type: **not specified**

New projects: Direct and Indirect DM + ML

Contribution ID: **27** Type: **not specified**

New projects: LHC searches + ML

Contribution ID: **28** Type: **not specified**

Open discussion: what have we leart? What next?

Friday 19 January 2018 09:30 (2 hours)

Contribution ID: **29** Type: **not specified**

Follow-up Workshop, Webpage, Mailing lists...

Contribution ID: **30** Type: **not specified**

Summary of workshop and Good Bye

Contribution ID: **31** Type: **not specified**

Discussion: New ideas?

Tuesday 16 January 2018 15:10 (20 minutes)

Contribution ID: **32** Type: **not specified**

Work in subgroups

Tuesday 16 January 2018 15:50 (1 hour)

Contribution ID: **33** Type: **not specified**

Hot topics

Contribution ID: **34** Type: **not specified**

First ideas: Supervised DNNs for reconstruction in LHC data

Wednesday 17 January 2018 11:00 (45 minutes)

Presenter: STOYE, Markus (CERN)

Contribution ID: **35** Type: **not specified**

Discussion: New connections?

Contribution ID: **36** Type: **not specified**

Adversarial Games for Particle Physics

Thursday 18 January 2018 11:20 (45 minutes)

Presenter: LOUPPE, Gilles (New York University (US))

Contribution ID: **37** Type: **not specified**

Discussion: Further ideas?

Thursday 18 January 2018 12:05 (20 minutes)

Contribution ID: **38** Type: **not specified**

Miscellaneous thoughts on Machine Learning & Dark Matter

Wednesday 17 January 2018 14:00 (45 minutes)

Presenter: CRANMER, Kyle Stuart (New York University (US))

Contribution ID: **39** Type: **not specified**

Discussion: New ideas? Reinforcement Learning?

Wednesday 17 January 2018 14:45 (20 minutes)

Contribution ID: **40** Type: **not specified**

Work on projects in subgroups

Wednesday 17 January 2018 15:25 (45 minutes)

Contribution ID: **41** Type: **not specified**

Hot topics

Contribution ID: **42** Type: **not specified**

Dark Matter model exploration and first ML ideas

Thursday 18 January 2018 13:55 (45 minutes)

Presenter: WHITE, Martin John (University of Adelaide (AU))

Contribution ID: **43** Type: **not specified**

Discussion: New ideas?

Thursday 18 January 2018 15:45 (20 minutes)

Contribution ID: **44** Type: **not specified**

Work in subgroups

Thursday 18 January 2018 16:05 (55 minutes)

Contribution ID: **45** Type: **not specified**

How to find Natural Supersymmetric Dark Matter?

Thursday 18 January 2018 14:40 (15 minutes)

Supersymmetry (SUSY) is able to solve the hierarchy problem and it can provide a perfect dark matter candidate. The non-observation of SUSY particles at the LHC and dark matter particles at dedicated experiments drives the SUSY particles to be heavier and heavier, which is assumed to make it more and more difficult for SUSY to solve the hierarchy problem as it gives rise to the need of fine-tuning of the input parameters of the theory. We are studying the allowed parameter space of several SUSY models. These models typically have a large number of parameters (10-30). We aim to find the set of allowed parameters that minimize the fine-tuning of these SUSY models. This is a resource-consuming process and we would like to discuss on how to do this more efficiently.

Presenter: VAN BEEKVELD, Melissa (R)

Contribution ID: **46** Type: **not specified**

Results of yesterdays workgroups on Active Learning and DM models

Contribution ID: **47** Type: **not specified**

Welcome, Workshop Structure and Objectives

Monday 15 January 2018 10:10 (10 minutes)

Presenter: CARON, Sascha (Nikhef National institute for subatomic physics (NL))

Contribution ID: **48** Type: **not specified**

Astronomical Dark Matter measurements and Challenges

Tuesday 16 January 2018 09:30 (45 minutes)

Presenter: HARVEY, David Richard (EPFL - EPF Lausanne)

Contribution ID: **49** Type: **not specified**

Discussion Unsupervised Leaning for Dark Matter

Tuesday 16 January 2018 12:05 (20 minutes)

Contribution ID: **50** Type: **not specified**

Fast Forecasting for Counting Experiments

Wednesday 17 January 2018 16:25 (15 minutes)

Presenter: EDWARDS, Tom

Contribution ID: **51** Type: **not specified**

Data-driven constraints on dark matter from dwarf galaxies

Wednesday 17 January 2018 16:10 (15 minutes)

Presenter: Mr ZALDIVAR, Bryan (LAPTh, Annecy)

Contribution ID: **52** Type: **not specified**

BSM-AI (SUSY-AI) and iDarkSurvey: Learning (from) high-dimensional models

Thursday 18 January 2018 14:55 (15 minutes)

Although the standard model of particle physics is successful in describing physics as we know it, it is known to be incomplete. Many models have been developed to extend the standard model, none of which have been experimentally verified. One of the main hurdles in this effort is the dimensionality of these models, yielding problems in analysing, visualising and communicating results. Because of this, most current day analyses are done using simplified models, but in this process descriptive power is lost. However, by using machine learning on simulated model points, we show that we can overcome these problems and predict both binary exclusion an continuous likelihood in any parameter space. This simulated data will be stored in our new webbased database and model visualisation tool iDarkSurvey. This tool will be open to the scientific to store all calculated model data.

Presenter: STIENEN, Bob (Radboud University)

Contribution ID: **53** Type: **not specified**

Using Deep Learning to predict Electroweakino production cross-sections at the LHC

Thursday 18 January 2018 15:10 (15 minutes)

Presenter: OTTEN, Sydney (RWTH Aachen)

Contribution ID: **54** Type: **not specified**

Recent results : Dark Matter searches at LHC

Wednesday 17 January 2018 11:45 (15 minutes)

Presenters: WANG, Renjie (LPNHE-Paris CNRS/IN2P3 (FR)); WANG, Renjie (LPNHE-Paris, CNRS/IN2P3 (FR))

Contribution ID: **55** Type: **not specified**

Machine Learning for SHiP and NEWS experiments

Wednesday 17 January 2018 12:00 (15 minutes)

Emulsion-based detectors such as ones used for OPERA experiment or planned for SHiP and NEWS experiments may reveal important characteristics of WIMP-like particles. However due to the nature of the emulsion, the signal to noise ratio tend to be rather small and hence might require special reconstruction techniques. Thus advanced data analysis approaches based on machine learning approaches might improve «physical» sensitivity of the experiments. In this talk I'll give brief overview of machine learning techniques that can be applied for dark matter searches in SHiP and NEWS experiments and present current challenges for those experiments both from physical and data analysis points of view.

Presenter: USTYUZHANIN, Andrey (Yandex School of Data Analysis (RU))

Contribution ID: **56** Type: **not specified**

Characterization of the Local Universe via angular cross-correlations

Tuesday 16 January 2018 16:50 (15 minutes)

Presenter: AMMAZZALORSO, Simone (University of Turin)

Contribution ID: **57** Type: **not specified**

Dark matter searches in dwarf irregular galaxies

Tuesday 16 January 2018 17:05 (15 minutes)

Presenter: GAMMALDI, Viviana (SISSA)

Contribution ID: **58** Type: **not specified**

Welcome from Lorentz Center

Monday 15 January 2018 10:00 (10 minutes)

Contribution ID: **59** Type: **not specified**

Estimating the parameters of gravitational lenses with deep learning

Wednesday 17 January 2018 16:40 (15 minutes)

Machine learning methods have seen a rapid expansion in the last few years. In particular, deep learning has made several breakthroughs, including beating a champion of game of Go and outperforming practicing dermatologists in the visual diagnosis of skin cancer. Although in most applications these networks have been used for classification tasks, they can also be made to predict real-valued model parameters. In this talk, I will discuss our results on using deep convolutional neural networks to estimate the parameters of strong gravitational lenses from telescope data. Estimating these parameters with traditional maximum-likelihood modeling methods is a time and resource consuming procedure, involving several data preparation steps and a difficult optimization process. With deep convolutional neural networks we are able to estimate these parameters in a fully automated way 10 million times faster than traditional modeling methods and with a similar accuracy. I will also discuss how to robustly quantify the uncertainties of these networks. This allows them to be a fast alternative to MCMC sampling. With the advent of large volumes of data from upcoming ground and space surveys and the remarkable speed offered by these networks, deep learning promises to become an indispensable tool for the analysis of large survey data.

Presenter: PERREAULT LEVASSEUR, laurence (Stanford University)

Contribution ID: **60** Type: **not specified**

White paper preparation