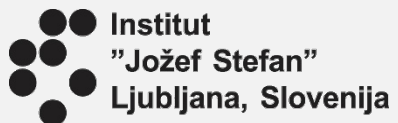




SMASH

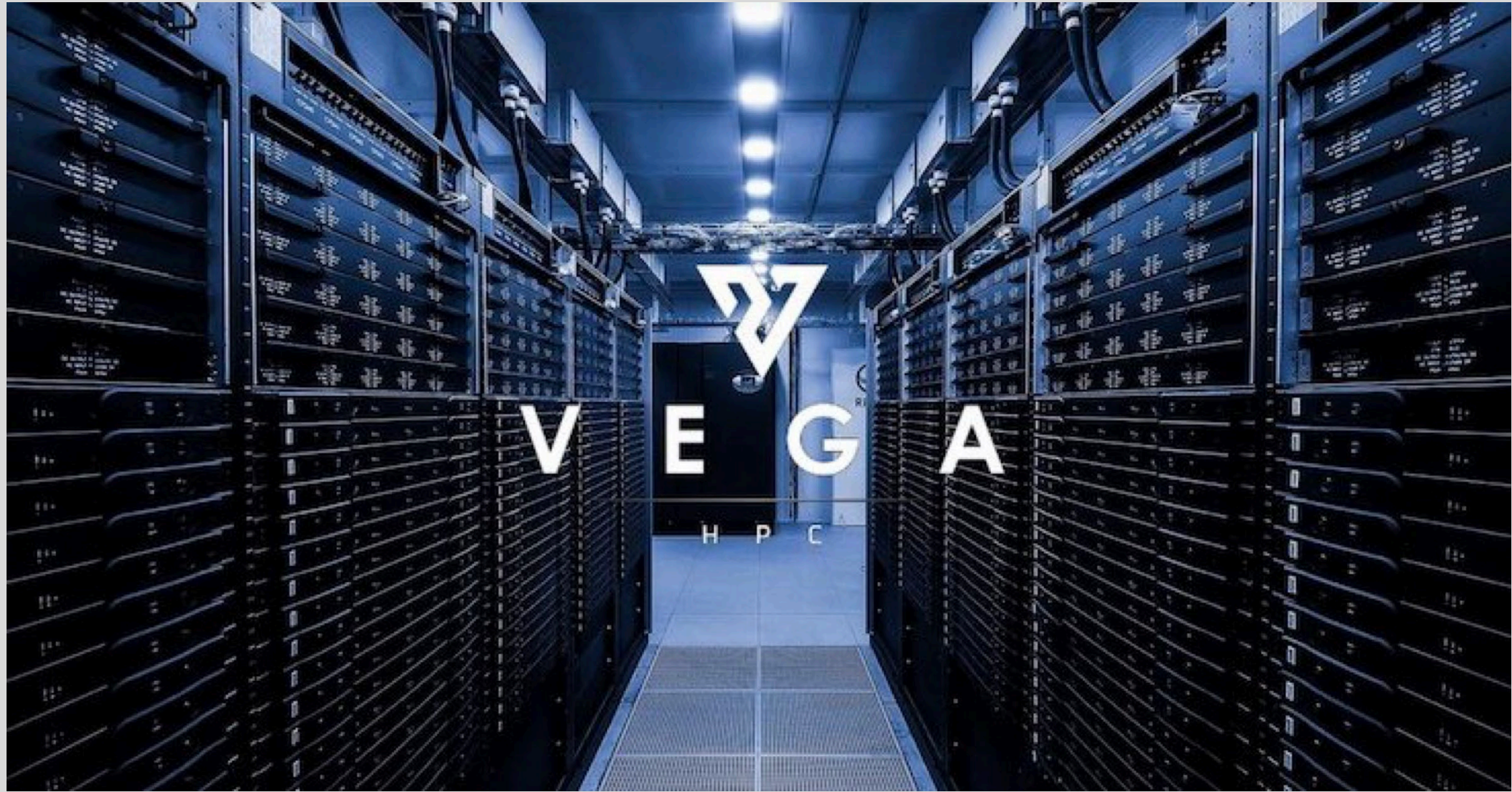
machine learning for science and humanities postdoctoral program

Univerza v Ljubljani

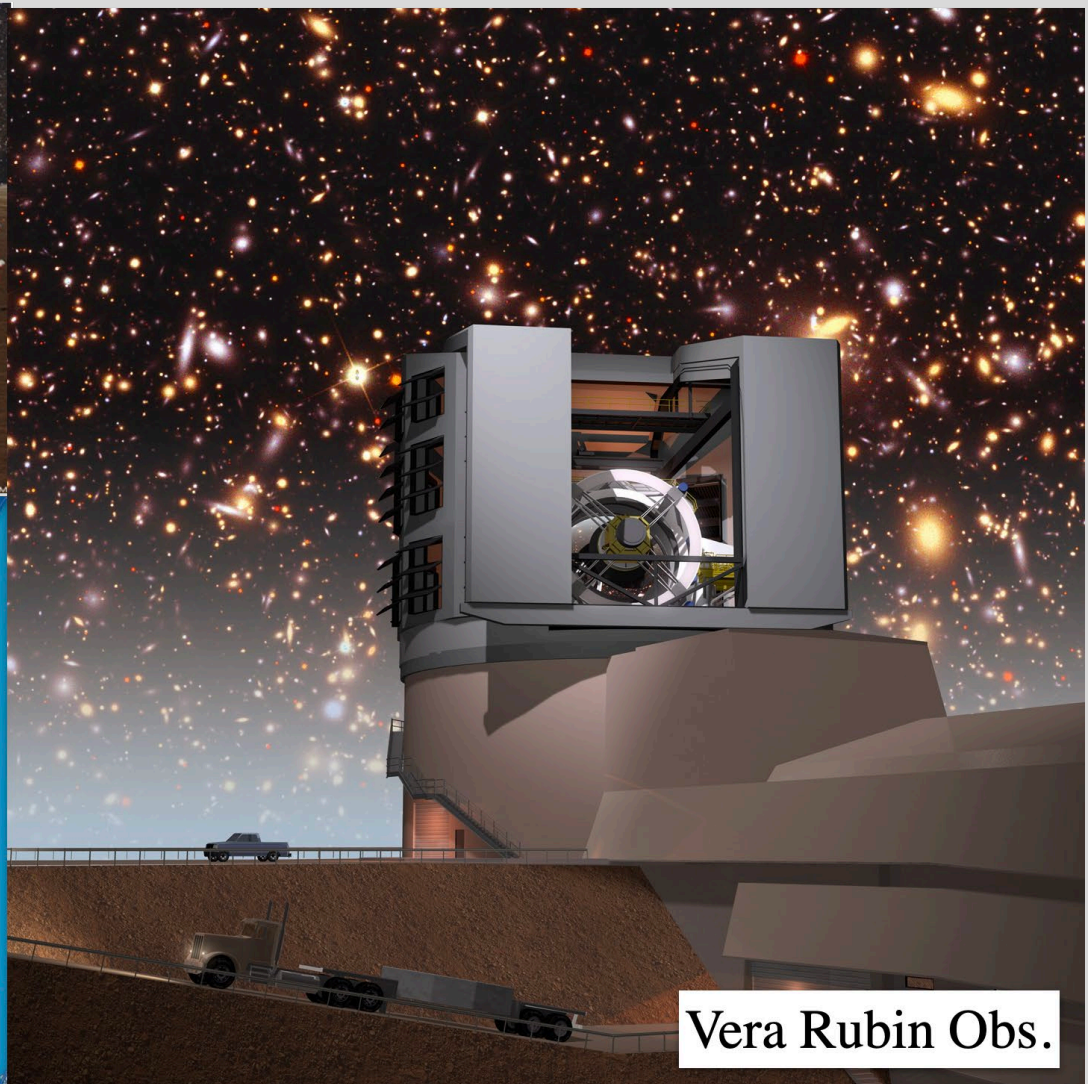
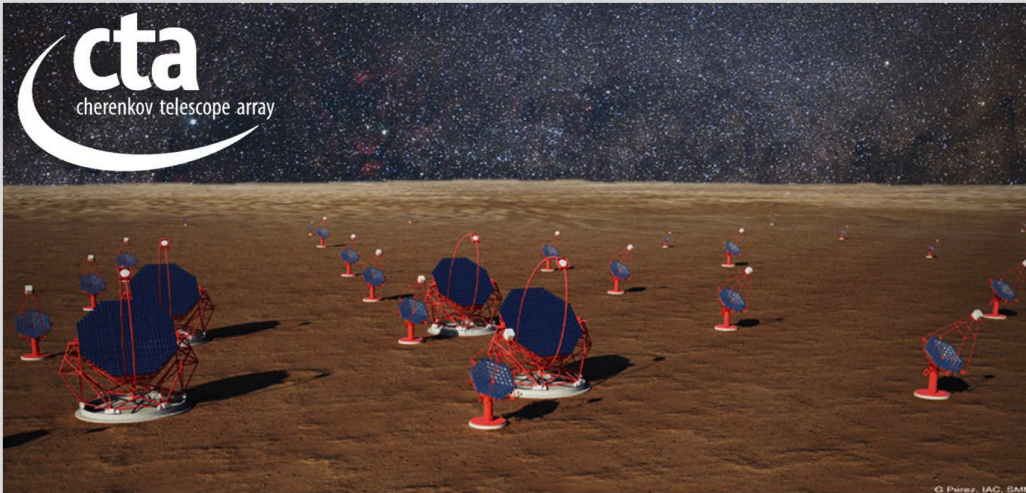


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MINISTRSTVO ZA OKOLJE IN PROSTOR
AGENCIJA REPUBLIKE SLOVENIJE ZA OKOLJE



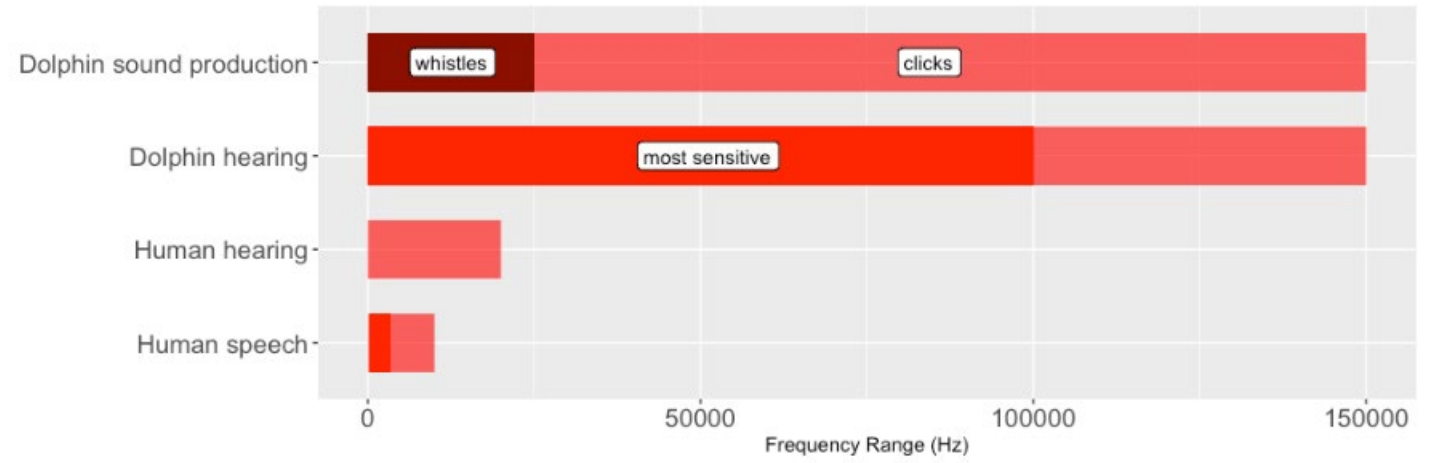


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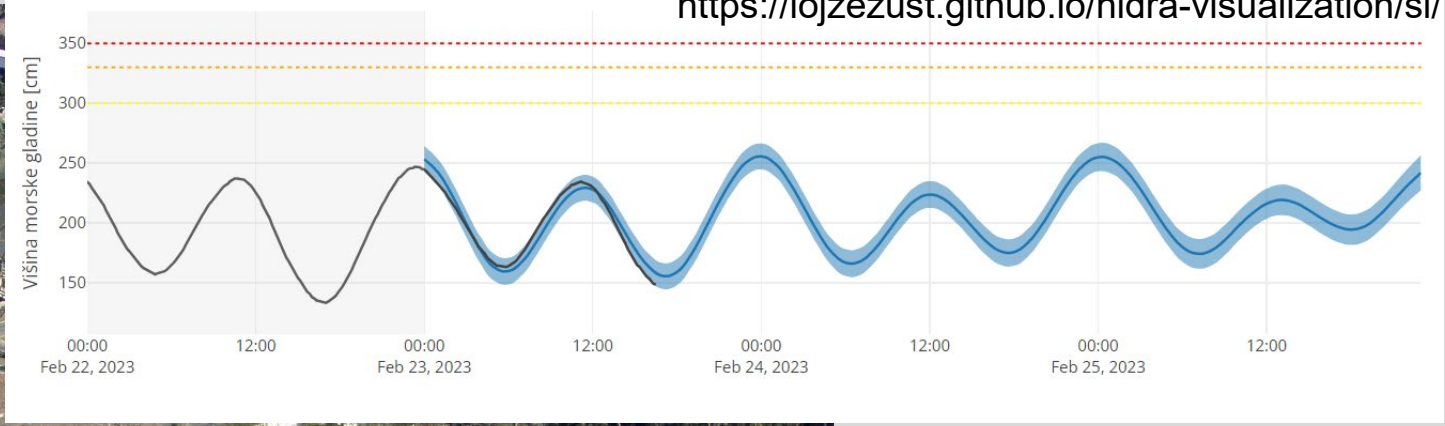
Vera Rubin Obs.

SMASH



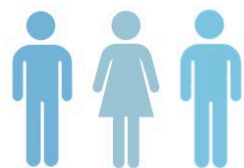
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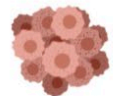


By U.S. Marine Corps photo by Staff Sgt. Julius Hawkins - This image was released by the United States Marine Corps with the ID 071120-M-8966H-005 Public Domain, <https://commons.wikimedia.org/w/index.php?curid=8234959>

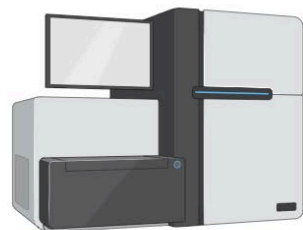
SMASH



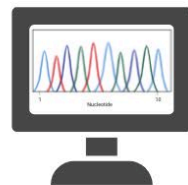
Cancer Patients



Tumour



Sequencing



Analysis,
Modeling



Personalized
Therapy

By Jeyang259 - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=87523660>

SMASH

Superračunalnik Vega in njegova vloga v programu **SMASH**

Dejan Valh, IZUM



SMASH

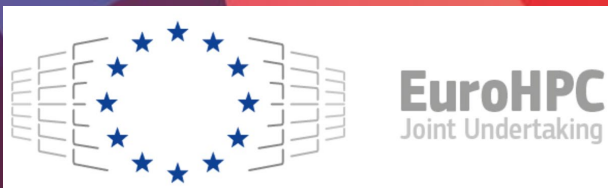
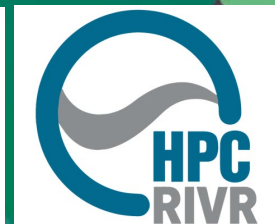
Superračunalnik Vega in njegova vloga v programu SMASH



Dejan Valh

IZUM, Institut informacijskih znanosti, Maribor, Slovenia

SMASH



30 M EUR (6 M EUR EuroHPC JU)



SMASH



APRIL 2021



PRVI DELUJOČI SISTEM

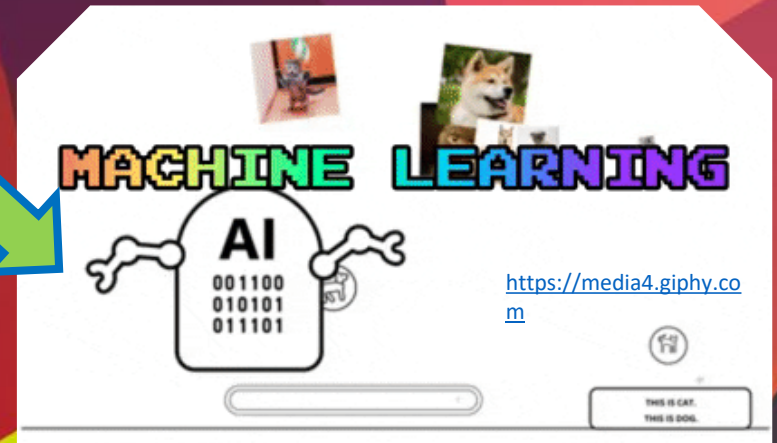
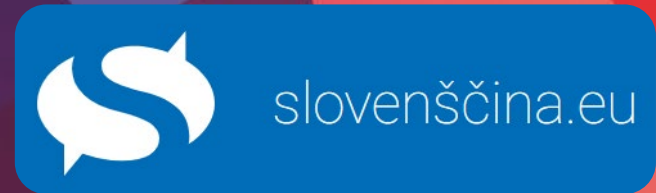


EuroHPC
Joint Undertaking



SMASH

VEČ KOT **150** PROJEKTOV IN **400** UPORABNIKOV





dCache.org

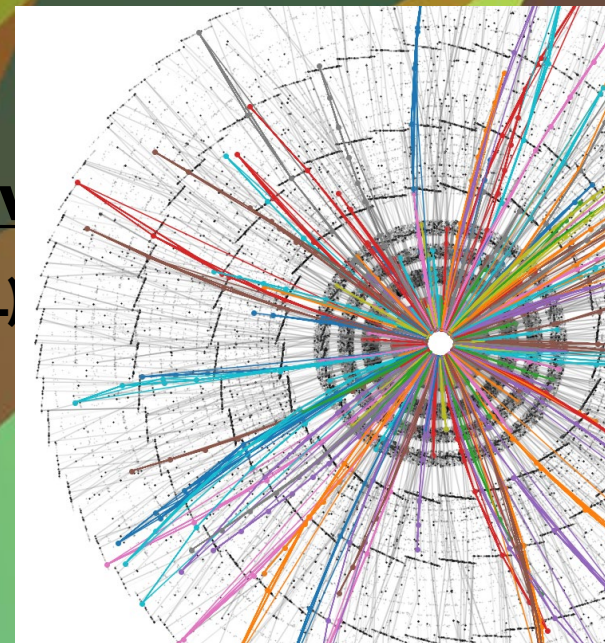
distributed storage for scientific data



SMASH in fizika na Velikem hadronskem trkalniku v CERNu

Andrej Filipčič, Jernej F. Kamenik, Borut P. Keršev

Institut "Jožef Stefan", Fakulteta za matematiko in fiziko (UL)



SMASH

Fizika delcev na Velikem hadronskem trkalniku v CERNu



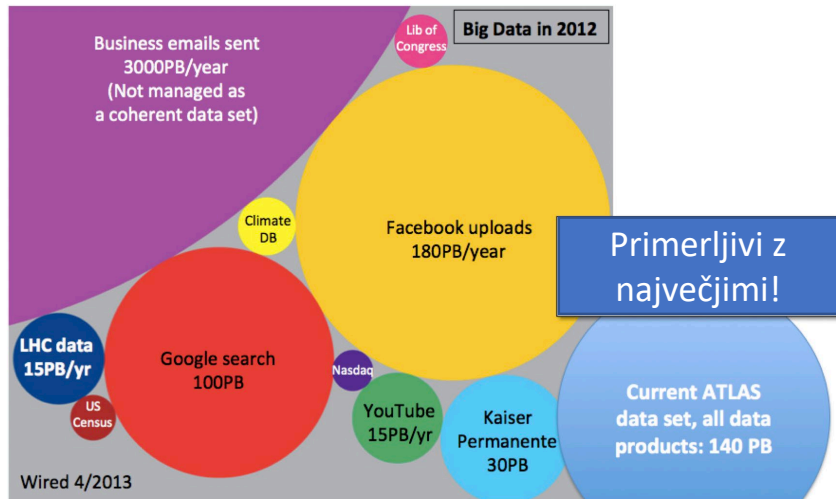
Veliki hadronski trkalnik je 27 km dolgi trkalniški obroč postavljen v tunelu 100 metrov pod zemljo v CERNu (Ženeva). V letu 2022 dosegel rekordno energijo 13.6 TeV.

Strojno učenje v fiziki delcev

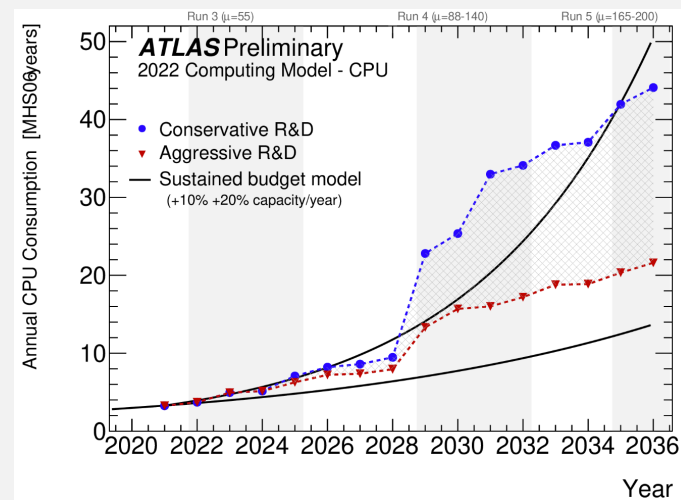
- Na LHC moramo prebrskati velikansko količino podatkov (milijarde trkov, 500 PB) in izziv se povečuje!
- Uporaba nainaprednejših (super) računalnikov in računskih metod, kot je strojno

Data Management

Where is HEP in Big Data Terms?

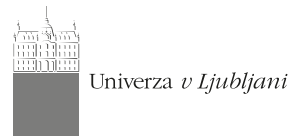


<http://www.wired.com/magazine/2013/04/bigdata/>



Strojno učenje v fiziki delcev

- **V fiziki delcev (eksperiment in teorija) je uporaba strojnega učenja nekaj povsem rutinskega.**



Co-funded by
The European Union

Strojno učenje v fiziki delcev

- V fiziki delcev (eksperiment in teorija) je uporaba strojnega učenja nekaj povsem rutinskega.**

$$Z_3^0 \begin{matrix} k_+ \\ \swarrow \\ q \\ \searrow \\ k_- \end{matrix} = i\theta \cos \theta_W [g^{W^+}(k_-, -k_+)^{\lambda} + g^{W^+}(-q - k_+)^{\lambda} + g^{W^+}(q + k_+)^{\lambda}]$$

Delo na temo doktoratu (2000)

4.5 Reconstruction of W^{\pm} Direction - Pairing of Jets

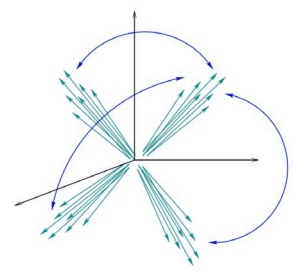
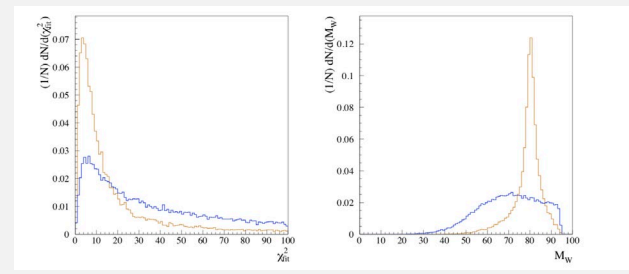
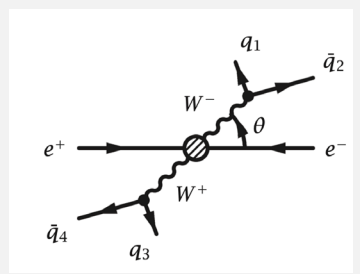


Figure 4.4: A schematic representation of the three possible pairings of jets in a four-jet topology characteristic for the $W^+ W^- \rightarrow q_1 q_2 q_3 q_4$ process.



UNIVERSITY OF LJUBLJANA
FACULTY OF MATHEMATICS AND PHYSICS

Borut Paul Kerševan

Measurement of Trilinear Gauge Boson $W^+ W^- Z/\gamma$ Couplings with the DELPHI Spectrometer

Doctoral Thesis

Supervisor: prof. dr. Gabrijel Kemel

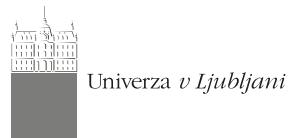
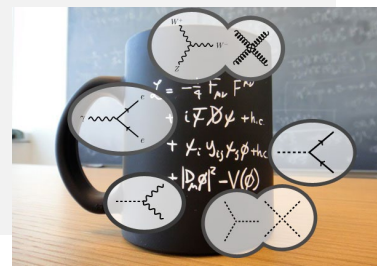
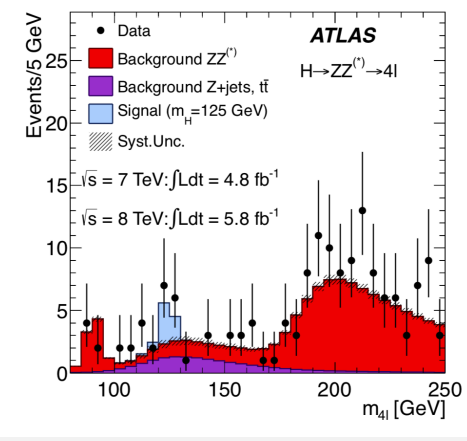
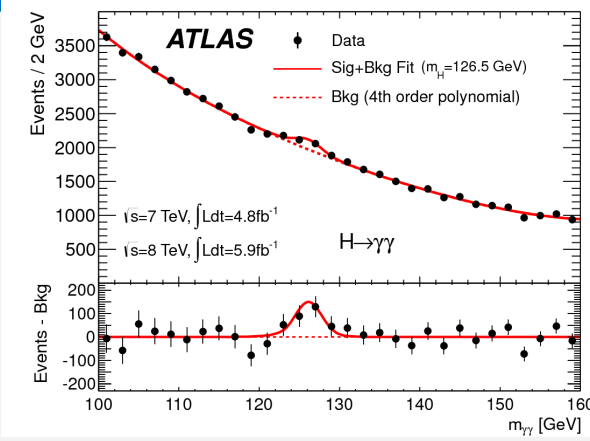
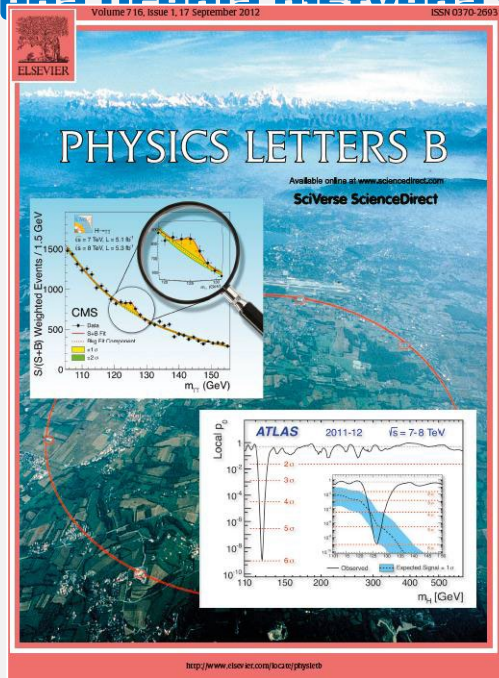
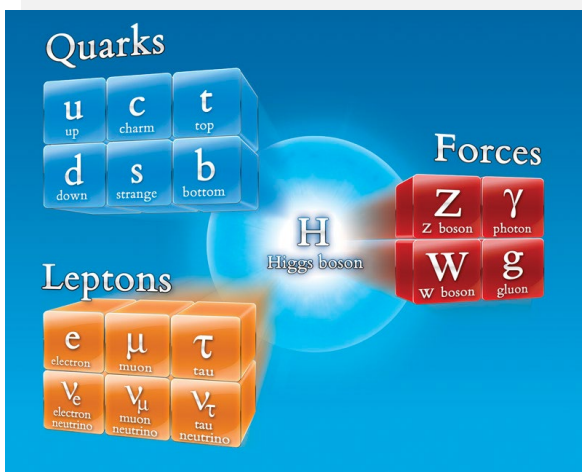
Ljubljana, 2000

Strojno učenje v fiziki delcev

- V fiziki delcev (eksperiment in teorija) je uporaba strojnega učenja nekaj povprečno rutinskega.



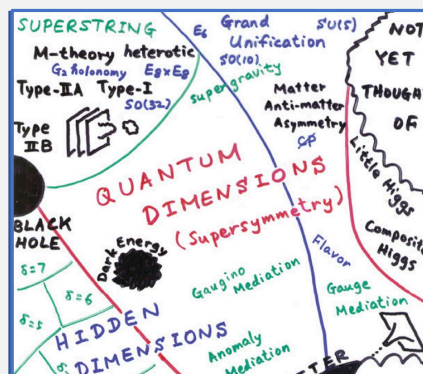
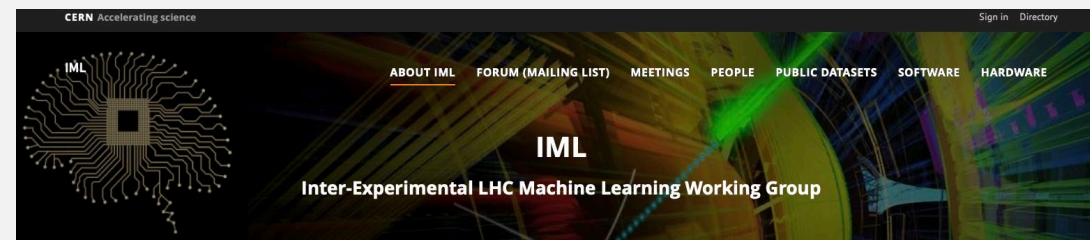
- Uporaba strojnega učenja bistvena tudi pri odkritju Higgsovega bozona pred desetimi leti ...



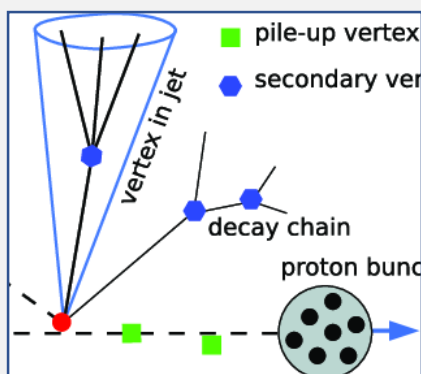
Strojno učenje v fiziki delcev

- V fiziki delcev (eksperiment in teorija) je uporaba strojnega učenja nekaj povsem rutinskega.

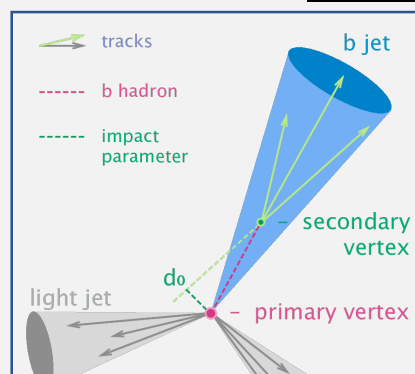
- Danes ga srečamo na vsakem koraku...



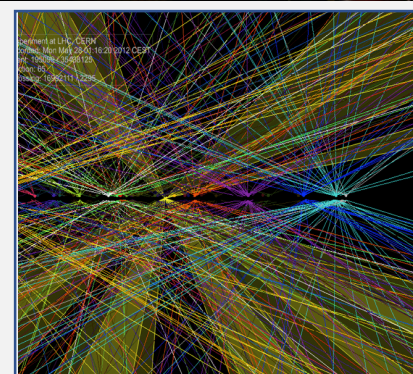
Teoretski modeli



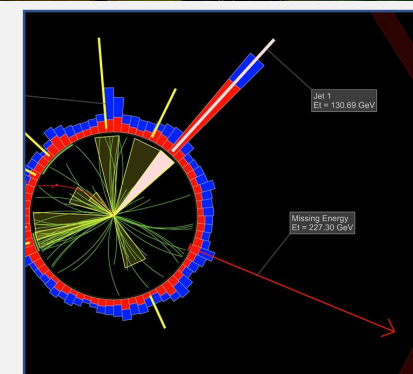
Rekonstrukcija točke trka



Dekodiranje dogajanja



Odstranjevanje šuma



Meritev fizikalnih količin

Strojno učenje v fiziki delcev

- V fiziki delcev (eksperiment in teorija) je uporaba strojnega učenja nekaj povsem rutinskega.

nature

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nature reviews physics

Review | Published: 01 August 2018

Machine learning at the frontiers of particle physics

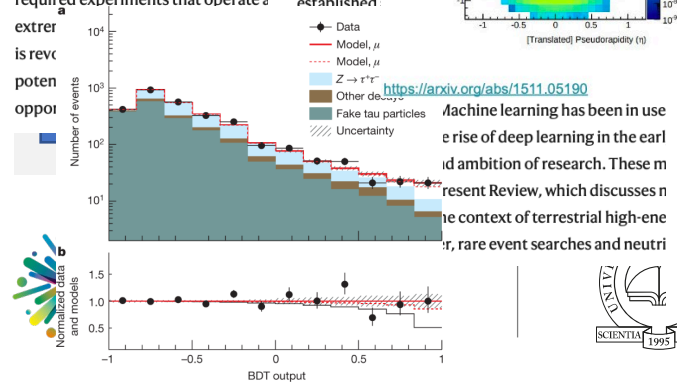
Alexander Radovic, Mike Williams, Michael Himmel, Adam Aurisano, Kazuhiro Terao

Nature 560, 41–48 (2018) | Cite this article

18k Accesses | 192 Citations | 171 Articles

Abstract

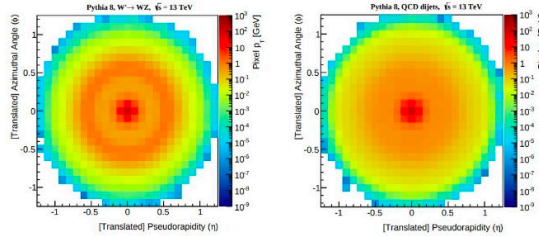
Our knowledge of the fundamental properties of the standard model of particle physics is being extended by required experiments that operate at the frontiers of particle physics.



Deep Learning and Its Application to LHC

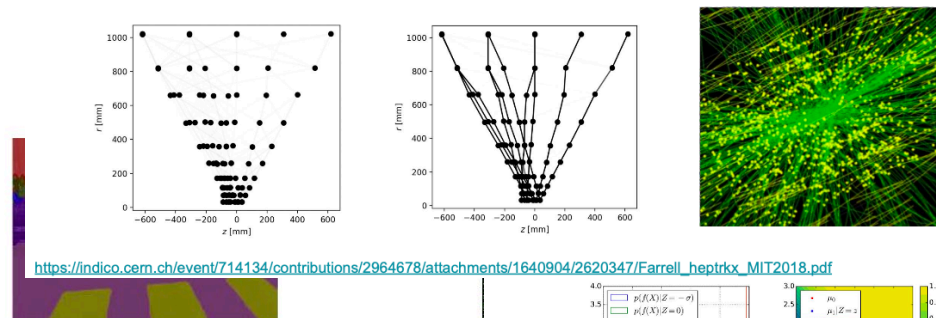
Convolutional neural networks

- **Convolution:** "Sliding window" over an image
- **Usage in industry:** Heavily used in computer vision
- **Usage in HEP:** Detector similar to 3D image

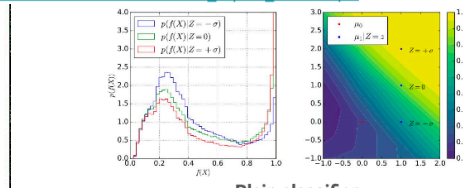
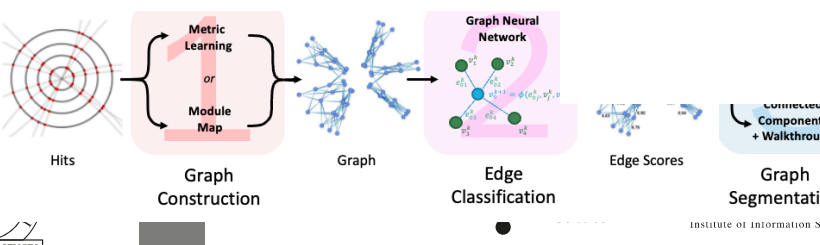


Graph neural networks

- Neural networks that can process graphs
- **Usage in industry:** Combinatorial optimization, prediction of molecule properties, node classification, ...
- **Usage in HEP:** Tracking of detector hits



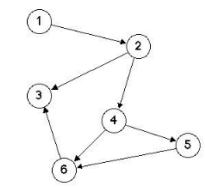
https://indico.cern.ch/event/714134/contributions/2964678/attachments/1640904/2620347/Farrell_heptrkx_MIT2018.pdf



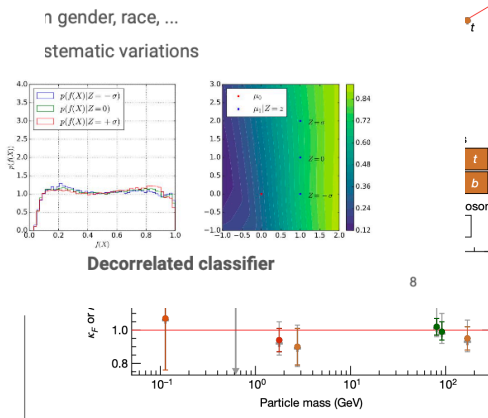
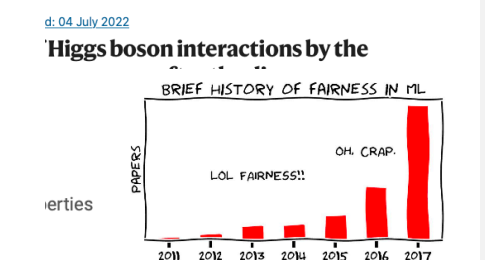
Plain classifier

Decorrelated classifier

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MINISTRY OF THE ENVIRONMENT
AND SPATIAL PLANNING
SLOVENIAN ENVIRONMENT AGENCY



Journal ▾ Publish with us ▾

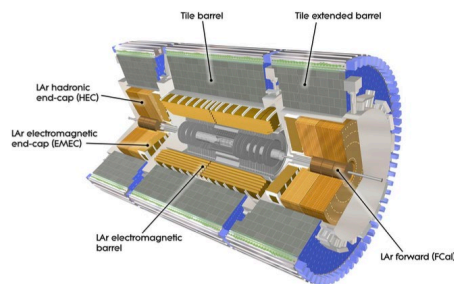


Uporaba specifičnih znanj

- V eksperimentih na LHC uporabljamo in razvijamo vrhunsko elektroniko in imamo vrhunske raziskovalce na teh področjih
- V to elektroniko pa lahko vgradimo tudi metode strojne celice: FPGA - izjemno hitri algoritmi!

ATLAS Liquid Argon Calorimeter

- Recurrent Neural Networks (RNN) for real-time energy reconstructions
- Latency ~200 ns on Intel Stratix-10 FPGA



DOI:10.1007/s41781-021-00066-y

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Home > Computing and Software for Big Science > Article

Original Article | Open Access | Published: 02 October 2021

Artificial Neural Networks on FPGAs for Real-Time Energy Reconstruction of the ATLAS LAr Calorimeters

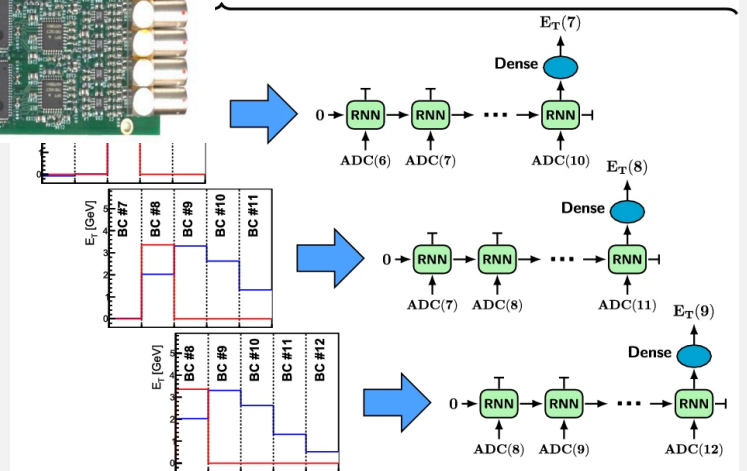
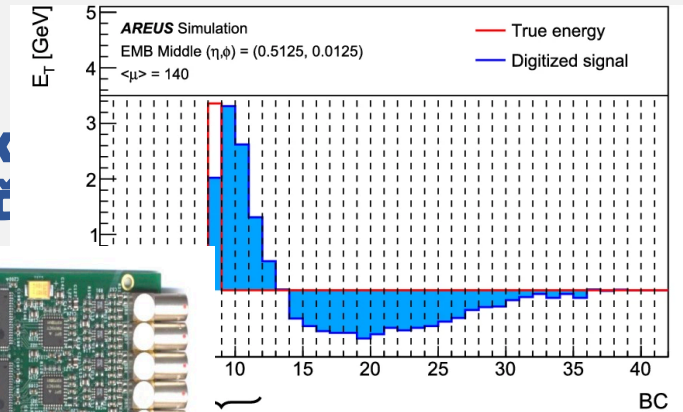
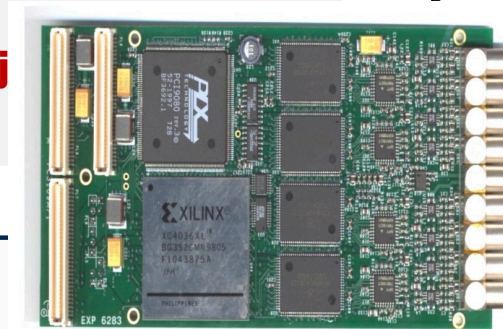
Georges Aad, Anne-Sophie Berthold, Thomas Calvet, Nemer Chiedde, Etienne Marie Fortin, Nick Fritzsche, Rainer Hentges, Lauri Antti Olavi Laatu, Emmanuel Monnier, Arno Straessner & Johann Christoph Voigt

Computing and Software for Big Science 5, Article number: 19 (2021) | Cite this article

1903 Accesses | 4 Citations | Metrics

Abstract

The ATLAS experiment at the Large Hadron Collider (LHC) is operated at CERN and measures proton–proton collisions at multi-TeV energies with a repetition frequency of 40



Prenos znanja iz fizike delcev v industrijo

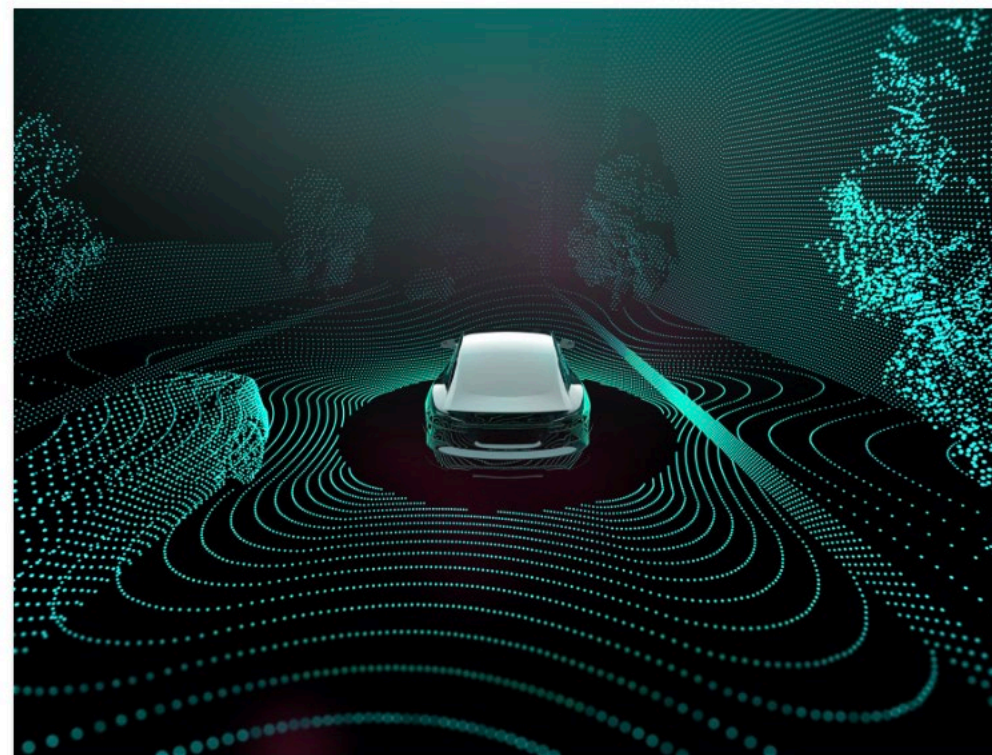
- **Zgleden primer prenosa znanja!**



Colliding particles not cars: CERN's machine learning could help self-driving cars

CERN and software company Zenseact wrap up a joint research project that could allow autonomous-driving cars to make faster decisions, thus helping avoid accidents

25 JANUARY, 2023 | By [Priyanka Dasgupta](#)



CERN's expertise in machine learning could help the field of autonomous driving (Image: Zenseact)



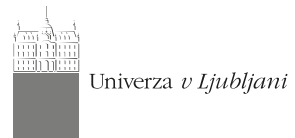
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Jožef
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Institute



Hvala!



Co-funded by
The European Union

Vloga strojnega učenja v napovedovanju višine gladine morja

Matjaž Ličer, ARSO



SMASH

Raziskovanje komunikacije delfinov in kako pri tem pomaga strojno učenje

Artur Stepanov, UNG



SMASH



Precision Medicine – Personalised Medicine and Life Sciences

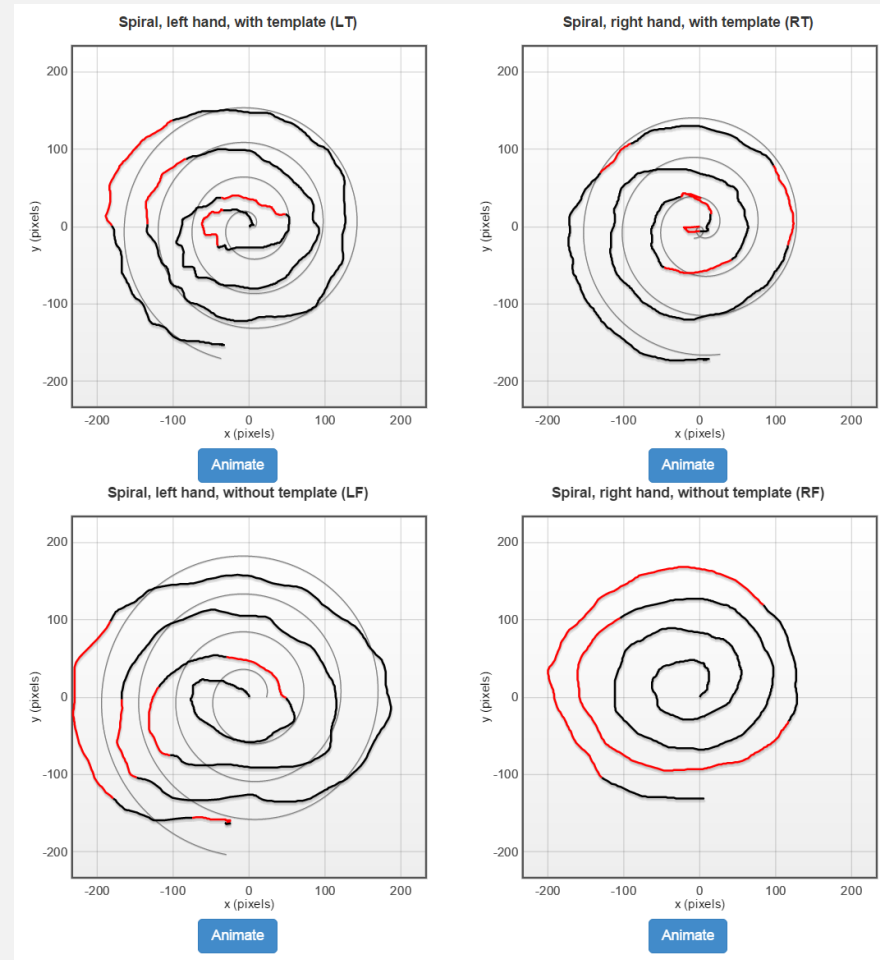
**Vida Groznik / University of Ljubljana & NEUS
Diagnostics**



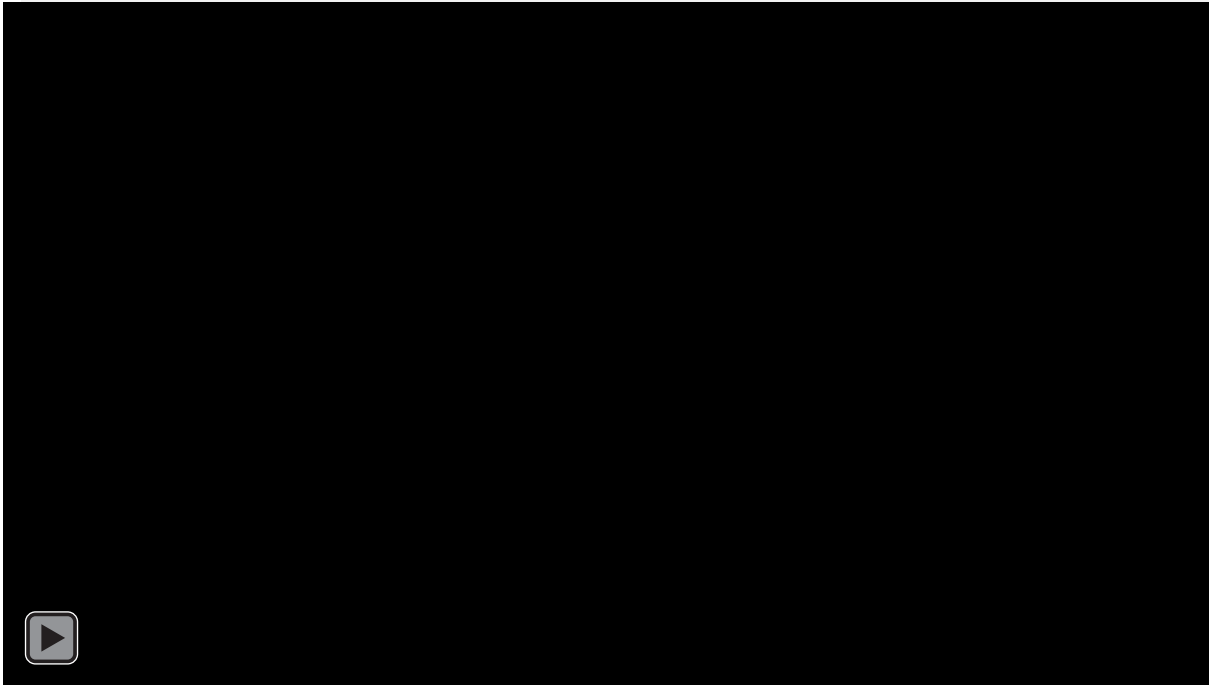
SMASH



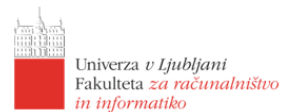
<https://www.parkinsoncheck.net/>



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The PARENT project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie – Innovative Training Network 2020, Grant Agreement N° 956394



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THANK YOU!



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