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PIANO NAZIONALE DI RIPRESA E RESILIENZA

ICSC
Centro Nazionale di Ricerca in HPC, Big Data and Quantum Computing

WP3 Status

Fabio Vitello, Fabio Gargano

Spoke 3 Technical Workshop, Trieste October 9 / 11, 2023

WP3 Objectives

This WP develops a **prototype framework of data analysis, based on Machine Learning (ML) and Visualization tools** exploiting diverse computing platforms and combining them with exascale applications. The **framework will be tailored to the ACO-S community, identifying the use case** best suited to tackle high-performance visualization tools and ML techniques. Furthermore, it copes with observational data coming from challenging large experiments.

Objective 2. Big data processing and visualization, via adopting innovative approaches (e.g. Artificial Intelligence, inference via Bayesian statistics) for the analysis of large and complex data volumes and for their exploration (e.g. in-situ visualization), capable of efficiently exploiting HPC solutions. (WP3, WP4, WP5)

WP3 Objectives

- Action 2.2: To **develop new methods and/or optimize existing prototype Machine Learning applications** for the automated processing of large and complex data, produced on the Exascale systems by the ACO-S community.
- Action 2.3: To **develop and optimize existing solutions for high performance visualization**, addressing on-site and remote visualization for Exascale and post-Exascale systems.
- Action 2.4: To **develop integrated solutions starting from the outcome of the previous actions,** in order to provide a unique and optimized eco-system for Exascale platforms for big and complex data sets.

WP3 Tasks

T3.1: Requirements from AAA community

It will assess the **requirements of the community** and assess corresponding solutions in terms of Machine Learning and Visualization, exploiting the functionalities available in selected tools and/or the development of new functionalities.

WP3 Tasks

T3.1: Requirements from AAA community

Duration of the Task: September 1, 2022 - August 31, 2023

Outcome: A collection of requirement in terms of Machine Learning and Visualization exploiting the functionalities available in selected tools and/or the development of new functionalities.

The requirement will drive the development of use cases in T3.2 and T3.3.

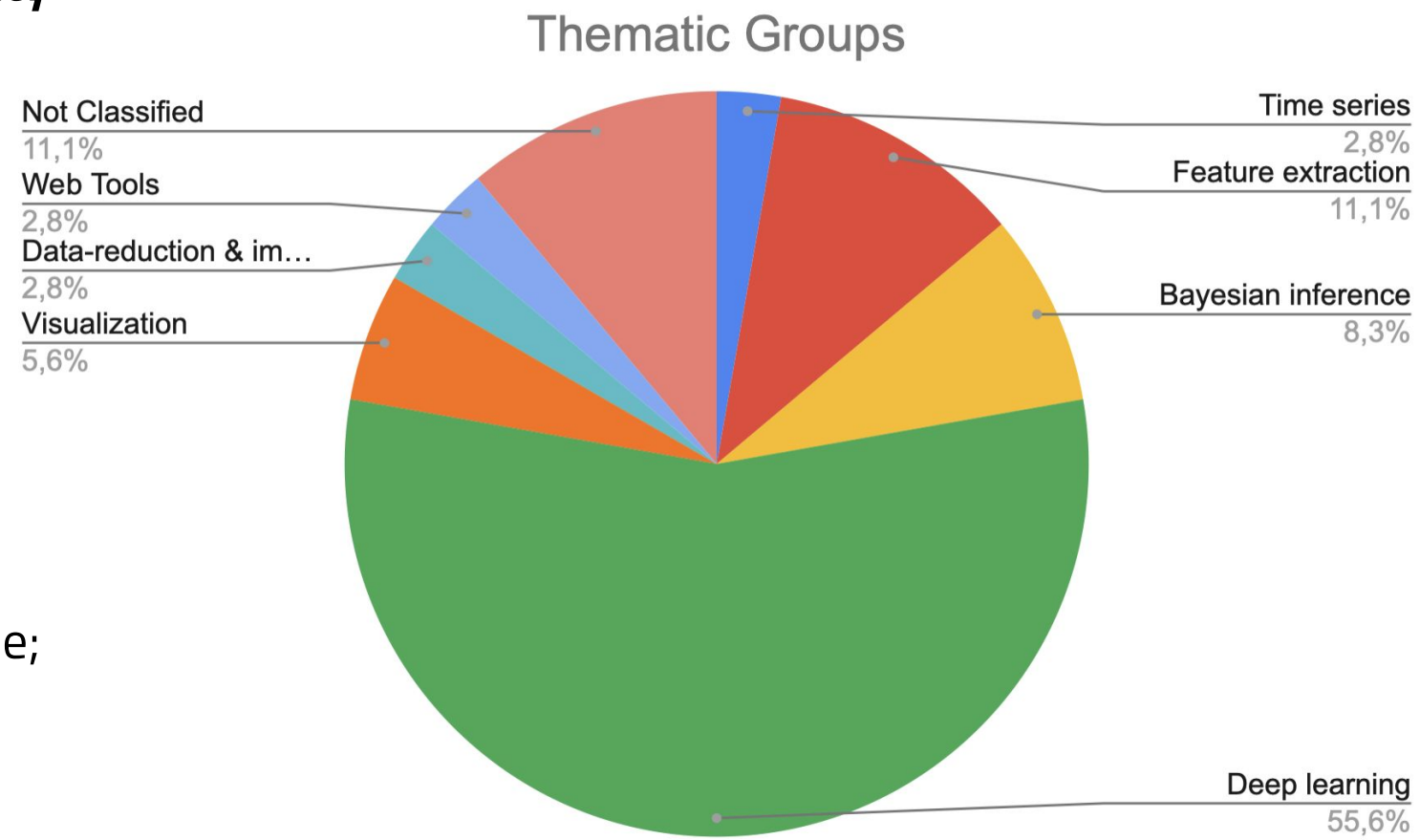
https://docs.google.com/spreadsheets/d/1yhkCVYdK92WGq_iDOtNyLoxYd2bq_c5yGEIYPIfkP5A

WP3 Tasks

T3.1: Requirements from AAA community

Thematic groups

- Time series: 1 use case;
- Feature extraction: 4 use cases;
- Bayesian inference: 3 use cases;
- Deep learning: 20 use cases;
- Visualization: 2 use cases;
- Data-reduction & imaging: 1 use case;
- Web Tools: 1 use case;
- Not Classified: 4 use cases.



WP3 Tasks

T3.2: Innovative Machine Learning

This task is in charge of **designing, implementing and evaluating ML** components in ACO-S pipelines. Targets include off-line processes for the transformations and enrichment of data, such as classification, segmentation, reduction, and emulation. For each component targeted, the task **will provide an adequate ML model, together with an efficient and scalable implementation**. Finally, its **performance** (both in terms of task outcome and efficient computation) will be assessed, to produce a final evaluation on the advantages and disadvantages of the produced ML solutions. **Together with industrial partners** the task will address *a)* search of patterns using network analysis in very large, noisy datasets, *b)* anomaly detection, *c)* techniques of privacy preserving, deployed in federated learning services (Cybersecurity)

WP3 Tasks

T3.3: HPC/Cloud Visualization Services

The main emphasis will be on fast and **interactive visualization**, using services at the HPC facilities **near the data,** but with high speed delivery of the results to the user's desktop. Such tools will be tested and integrated on the existing open-source database as https://smart-turb.roma2.infn.it/ which will be further developed during this project such as to host a large quantity of geophysical and astrophysical datasets. The ultimate goal is to provide visualization capabilities that are fully interactive and can access and visualize large data sets at a **remote repository**.

Criticalities (From Catania's meeting)

- Lot of declared effort, what about real participation?
- **Hardware:** we need to access HPC resources to develop our codes, **ASAP***
- **Hardware:** we need precise specs to emulate the system that we will use, **ASAP***

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Informazioni cronologiche	1- Descrizione di alto livello del caso d'uso e componenti (e.g. singolo script standalone	2 - Ambiente di lavoro in container (docker et	3 - Ambiente di lavoro in Virtual Machine	4 - Utilizzo di version control	5 - Esperienza di lavoro su risorse cloud	6 - Automazione per Continous Integration	7 - Utilizzo di sistemi distribuiti batch	8 - Protocollo di accesso e storage dati	9 - Come vengono gestiti i metadati	10 - Policy su dati	11 - Quantita' risorse: per un caso tipico e	12 - Architetture supportate dalle librerie	13 - Licenze commerciali?	14 - Tipo di Acceleratori richiesti	15 - WP di appartenenza	16 - Note ed eventuali commenti
07/02/2023 9.50.	Tool di visual analitica Desktop che si connette ad una componente backend in grado di girare su sistemi HPC su più nodi e utilizzo di acceleratori (GPU)	Si	No	Github	Solo per parte del worflow	nessuna	Slurm	Locale, ma altamente richiesto utilizzo di FS paralleli	Tool dedicato di esperimento	Mista	Il limite principale è in RAM, benché il tools sia in grado di adattarsi alle risorse effettuando un downsample del dato originale	AMD64/Intel, ARM	No	GPU	WP3	Si vorrebbe esperimentare su Nodi multi-gpu classici e su sistemi quali NVIDIA EGX per sperimentazione per confronto di performance con nodi "classici". Altamente raccomandato l'utilizzo di reti a bassa latenza ed alto throughput .
08/02/2023 16.4	Development of ML algorithms for fast and robust estimation of cosmological parameters Emulators for Boltzmann codes, emulators for model comparison Standalone script, database	No	No	Github	Solo per parte del worflow	Github actions	Slurm	Cloud centralizzato dall'ente	Assenti	Pubblico (readonly world-wide)	Non quantificabile ora.	Ancora non conosciamo le librerie utilizzate.	No	GPU	WP3	
17/02/2023 12.1	Sviluppo di codici di ML per i	Pianificato (non a	Pianificato (non a	Gitlab	Esperienze prelir	nessuna esperie	HTCondor	Remoto - xrootd	Da definire	Riservato (emba	processi da circa	AMD64/Intel	No	GPU	WP3	Il progetto è in fase di definizione e molti dettagli sono ancora da definire
20/02/2023 9.41.	I progetti ruotano attorno alla Componenti: Dashiboard - Pacchetto Julia - Interfaccia web minimale - Pipeline Zoo (MongoDB) Parametric Machine - Pacchetto Julia	Pianificato (non a	Pianificato (non a	Github	Esperienze prelir	Github actions	Non applicabile	Locale	Tool dedicato di e	Pubblico (readon	16 GB RAM	AMD64/Intel, AR	No	GPU opzionale	WP3	Sebbene focalizzato su WP3 il progetto copre anche WP2,4,5
21/02/2023 16.3	Radio source analysis with s	Si	No	Github	Esperienze prelir	nessuna	Slurm	Da indagare o S	Soluzione open s	Riservato (emba	La pipeline si div	AMD64/Intel	No	GPU	WP3	
20/02/2023 16.3	Object detector frameworks	Pianificato (non a	No	Github	Esperienze prelir	nessuna	Slurm	Locale	Soluzione open s	Riservato (emba	Training: le critici Testing/inferenza	AMD64/Intel	No	GPU	WP3	
23/02/2023 11.5	distributed memory (MPI) co	Pianificato (non a	No	Github	Solo per parte de	Github actions	Slurm	Locale	Assenti	Riservato (emba	>1000 core clust	AMD64/Intel	No	GPU	WP3	

Criticalities (From Catania's meeting)

- Lot of declared effort, what about real participation?

Ente	Posizione (TD/PhD/AdR)	Numero di Anni	Referente	Data Assunzione (Effettiva o Prevista)	WPs	% FTE WP1-WP2	% FTE WP3	% FTE WP4	% FTE WP5	Nominativo	E-mail
INAF	TD	2	Gheller/Brunetti	1 novembre 2023			100%				
INAF	PHD	3	Riggi OACT	1 novembre 2022	WP3		100%			Thomas Cecconello	thomas.cecconello@unimib.it
UNITO	RTDa	2	Susanna Terracini	01/04/2023	(WP3)					Irene De Blasi	irene.deblasi@unito.it
INFN	TD	2	Fabio Gargano	15/5/2023	WP3		100%			Federica Cuna	federica.cuna@ba.infn.it
INFN	TD	2	Massimiliano Lattanzi	1/6/2023	WP1-WP3	50%	50%			Paolo Campeti	paolo.campeti@fe.infn.it
INFN	Borsa Tecnologica	2	Stefano Della Torre	1/9/2023	WP1-WP3	50%	50%			Giovanni Cavallo	giovanni.cavallotto@mib.infn.it
INFN	Borsa Tecnologica	2	Pasquale Lubrano	1/9/2023	WP3-WP4		60%	40%		Andrea Adelfio	andrea.adelfio@pg.infn.it
UNITOV	Tecnologo	2,5		07/03/2023	WP1-WP2-WP3					Simone Ferretti	simone.ferretti@roma2.infn.it
UNITOV	Tecnologo	2,5		07/03/2023	WP1-WP2					Marco Faltelli	faltelli@roma2.infn.it
UNITOV	PhD	3		08/02/2023	WP1-WP2-WP3					Avinash Anand	1729.avinash@gmail.com
UNITOV	PhD	3		01/06/2023	WP3						
UNICT	RTDa	3		01/03/2023	WP3					Grassia Marco	marco.grassia@unict.it
SISSA	AdR	2	Roberto Trotta	01/05/2023	WP2-WP3					Chiara Moretti	chiara.moretti@inaf.it
SNS	3 PhD	3			WP1, WP2, WP3						
SNS	2 PhD	3			WP1, WP2, WP3						

Criticalities (From Catania's meeting)

From just one talk at the Catania meeting to 13 talks!

11:00 → 13:00 **Session 3: WP3** — Aula 1A - Conference

11:30	**WP3 Status** **Speaker**: Fabio Roberto Vitello	15m
11:45	**Machine Learning/Deep Learning algorithms for Gaia mission data analysis** **Speaker**: Dr Lorenzo Monti (Istituto Nazionale di Astrofisica (INAF))	15m
12:00	**ML for Cluster Cosmology analysis** **Speaker**: Matteo Costanzi Alunno Cerbolini (Istituto Nazionale di Astrofisica (INAF))	15m
12:15	**Object detection, self-supervision and XAI using real and synthetic astronomical data** **Speaker**: Dr Thomas Cecconello (INAF)	15m
12:30	**Symmetric solutions for the N-body problem: a computational approach** **Speaker**: Dr Irene De Blasi (UniTorino)	15m
12:45	**Improving photo-z estimation under covariate shift with StratLearn** **Speaker**: Prof. Roberto Trotta (SISSA)	15m

14:00 → 16:00 **Session 3: WP3** — Aula 1A - Conference

14:00	**Allucinating molecular cloud emission with Neural nets** **Speaker**: Giuseppe Puglisi (UniCT)	15m
14:15	**Deep learning of 87A-like supernovae progenitor characteristics: training the Inception model on synthetic data** **Speaker**: Giuseppe Puglisi (UniCT) icsc_Trieste2023_G...	15m
14:30	**Graph neural network for track reconstruction in space experiments** **Speaker**: Dr Federica Cuna (INFN) icsc_trieste_cuna.p...	15m
14:45	**Map-level Emulation of CMB experimental systematics** **Speaker**: Dr Paolo Campeti (INFN)	15m
15:00	**Generative adversarial neural network for cosmic rays background simulations** **Speaker**: Giovanni Cavallotto (INFN)	15m
15:15	**"Chemical tagging of field RR Lyrae to constrain the early formation and evolution of the Milky Way"** **Speaker**: Dr Karina Baeza Villagra (UniTOV)	15m
15:30	**Optimal compression and Simulation-Based Inference of the cosmic 21-cm signal** **Speaker**: Mr David Prelogovic (SNS)	15m
15:45	**The Euclid survey: Improving cosmological constraints via BAO reconstruction** **Speaker**: Dr Elena Sarpa (SISSA)	15m

Criticalities (Updated)

~~Lot of declared effort, what about real participation?~~

- **Hardware:** we need to access HPC resources to develop our codes, **ASAP***
- **Hardware:** we need precise specs to emulate the system that we will use, **ASAP***
- Repository and instruction on the deployment of the developed softwares.
- Do we need to implement CI/CD pipelines?