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HPC, Big Data and AI for Astrophysics in the Era of Computing

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In the next decade, current and upcoming radio-interferometers, like LOFAR, MeerKAT, MWA ASKAP in the perspective of the SKA, will produce huge volumes of rich and complex data. This will represent not only an invaluable opportunity for scientists, but also an outstanding technological challenge. The expected data volume will be hard to manage with traditional approaches. Data will have to be stored in dedicated facilities, providing the necessary capacity at the highest performance. Corresponding data processing will have to be performed local to the data, leveraging available High Performance Computing (HPC) resources. Data reduction and imaging software tools will have to be adapted, if not completely re-designed, in order to efficiently run at scale. Even more critically, the data analysis pipeline must integrate cutting-edge solutions enabled by Artificial Intelligence. This talk wants to highlight some of the challenges and the solution the are being developed (also besides the radio astronomy domain), with specific focus on those promoted within the new National Centre for HPC, Big Data and Quantum Computing. Since its establishment in 2022, INAF has played a leading role in the National Centre for HPC, Big Data, and Quantum Computing. The Centre now stands as a major national and international infrastructure for advanced computing, data management, and AI-driven research. It offers the astrophysical community a platform of excellence—positioned to support and participate in future major international projects and initiatives, and to foster innovation at the frontier of data-intensive science.

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