

R2D2: A DEEP NEURAL NETWORK SERIES FOR ULTRA-FAST HIGH-DYNAMIC RANGE IMAGING IN RADIO ASTRONOMY (BUT NOT ONLY)

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Aperture synthesis by interferometry in radio astronomy is a unique technique to image the sky at otherwise inaccessible resolutions. Image formation however requires solving challenging Fourier imaging inverse problems, with modern telescopes targeting unprecedented resolutions and dynamic ranges over wide fields of view containing complex structure, also making data volumes and image sizes extremely large. The talk will introduce R2D2, a new approach aiming to address the ultimate challenge faced by radio-interferometric imaging algorithms, towards joint precision, robustness, efficiency, and scalability. Its reconstructed image is built as a series of a residual images, iteratively estimated as outputs of DNNs taking as inputs both the estimate from the previous iteration and the associated data residual. The algorithm thus takes a hybrid structure between learned matching pursuit and forward-backward-based plug-and-play approaches. We will dive into the R2D2 algorithmic structure, including various incarnations enabled by more or less advanced DNN architectures, and discuss its validation in simulation and on real data, with comparison to bespoke optimisation and plug-and-play algorithms, as well as unfolded DNN architectures. R2D2 opens the door to ultra-fast precision synthesis imaging with the current and forthcoming generation of radio telescopes. If time allows, we will discuss a transfer of technology towards ultra-fast high-dimensional magnetic resonance imaging.