# COS2A: Conversion from Sentinel-2 to AVIRIS Hyperspectral Data Using Interpretable Algorithm With Spectral-Spatial Duality

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ABSTRACT

The Sentinel-2 satellite, launched by the European Space Agency (ESA), offers extensive spatial coverage and has become indispensable in a wide range of remote sensing applications. However, it just has 12 spectral bands, making substances/objects identification less effective, not mentioning the varying spatial resolutions (10/20/60 m) across the 12 bands. If such a multi-resolution 12-band image can be computationally converted into a hyperspectral image with uniformly high resolution (i.e., 10 m), it significantly facilitates remote identification tasks. Though there are some spectral super-resolution methods, they did not address the multi-resolution issue on one hand, and, more seriously, they mostly focused on the CAVE-level hyperspectral image reconstruction (involving only 31 visible bands) on the other hand, greatly limiting their applicability in real-world remote sensing scenarios. We ambitiously aim to convert Sentinel-2 data directly into NASA's AVIRIS-level hyperspectral image (encompassing up to 172 visible and near-infrared (NIR) bands, after ignoring those absorption/corruption ones). For the first time, this paper solves this specific super-resolution problem (highly ill-posed), allowing all historical Sentinel-2 data to have their corresponding high-standard AVIRIS counterparts. We achieve so by customizing a novel algorithm that introduces deep unfolding regularization and Q-quadratic-norm regularization into the so-called convex/deep (CODE) small-data learning criterion. Based on the derived spectral-spatial duality, the proposed interpretable COS2A algorithm demonstrates superior spectral super-resolution results across diverse land cover types, as validated through extensive experiments.