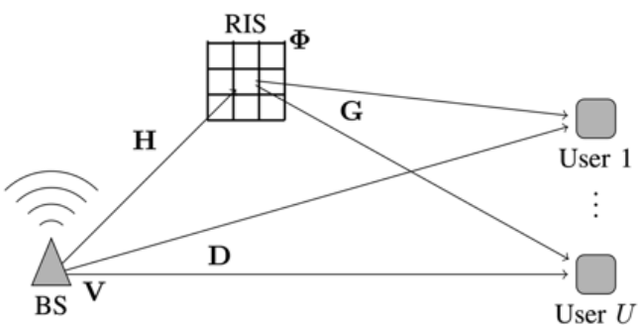
6G-RIC
Research and
Innovation Cluster

GEFÖRDERT VOM
Bundesministerium
für Bildung
und Forschung

Domain-knowledge driven neural network architecture RISnet for RIS configuration

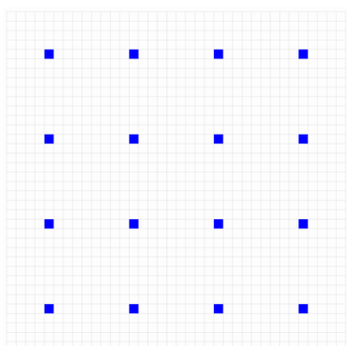
BILE PENG / EDUARD A. JORSWIECK

How can we configure a large reconfigurable intelligent surface with more than 1000 elements using partial channel state information that is easy to acquire?



(a)

The considered multi-user communication scenario assisted by a reconfigurable intelligent surface (RIS). The analytical precoders for SDMA and NOMA are jointly applied with the machine learning (ML) enabled RIS.



(b)

The proposed RIS architecture with a small portion of RIS elements performing channel estimation with the pilot signal (i.e., these RIS elements have RF frontends for signal processing). The whole RIS is configured with the small portion of channel state information (CSI), such that a good compromise between performance and hardware complexity is achieved.

KEY FINDINGS

The reconfigurable intelligent surface (RIS) stands at the forefront of next-generation wireless communication technologies, promising unprecedented advancements. However, its realization encounters two significant challenges: scalability and channel estimation due to the large number of RIS elements. Addressing these hurdles, we present RISnet, a dedicated neural network architecture that integrates domain knowledge in communication with machine learning techniques. By using the same information processing units to all RIS elements (and users), we realize a good scalability to optimize more than 1000 RIS elements. By configuring all RIS elements with partial CSI of only 16 RIS elements, the difficulty of channel estimation is reduced significantly. RISnet leverages unsupervised machine learning to autonomously explore and identify optimal configurations. By doing so, it not only mitigates the scalability issues but also tackles the complexities associated with channel estimation. This innovative approach positions RISnet as a pivotal tool in unlocking the full potential of reconfigurable intelligent surfaces, paving the way for enhanced wireless communication systems.

F. Siegismund-Poschmann, B. Peng, and E. A. Jorswieck, "Non-orthogonal multiple access assisted by reconfigurable intelligent surface using unsupervised machine learning," in European Signal Processing Conference (EUSIPCO), 2023.

B. Peng, K.-L. Besser, R. Raghunath, V. Jamali, and E. A. Jorswieck, "RISnet: A scalable approach for reconfigurable intelligent surface optimization with partial CSI," in IEEE Global Communications Conference (GLOBECOM), 2023.