POPULAR SCIENTIFIC ABSTRACT

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Data-driven Assessment of Reliability for Cyber-Physical Production Systems

As one of the cornerstones of Industry 4.0, Cyber-Physical Production Systems (CPPS) have emerged as a pivotal technology in modern manufacturing. They enable the integration of physical processes with digital systems to enhance productivity, efficiency, and flexibility. As the deployment of CPPS becomes increasingly widespread, ensuring their reliability is crucial to avoid production disruptions, expensive downtime, and potential safety issues. Traditional reliability assessment approaches, however, struggle to keep up with the increasing complexity of CPPS.

Current reliability assessment approaches are labor-intensive and require expert knowledge. This requirement can become a bottleneck for complex, dynamic CPPS, often rendering manually developed reliability models obsolete. These models require frequent adjustments to accommodate changes in the physical system and struggle to capture complex behaviors inherent to a CPPS.

In this doctoral thesis, we introduce a novel framework for data-driven reliability assessment of CPPS. Our framework leverages the wealth of data collected in such systems, including data from information systems, control systems, and sensors. We leverage and combine Process Mining, Modeling and Simulation, and data analysis techniques to extract and validate accurate reliability models of CPPS. Furthermore, we demonstrate the application of our framework in three case studies.