

# PhD Curricula - Blockchain and Distributed Ledger Technology

## Curriculum 1: Methodologies, technologies and tools

The curriculum "Methodologies, technologies and tools" focuses on foundational aspects of Blockchain and Distributed Ledger Technology, considering both theoretical and applied research.

Methodologies play an increasingly important role in managing and defining blockchain and, more in general, distributed ledger solutions. A key point is the definition of novel and fault-tolerant distributed consensus mechanisms, cryptographic primitives, and distributed protocols. In particular, consensus mechanisms ensure the integrity of the information stored in blockchains and improve system efficiency and defense against attacks. Data privacy needs to be achieved as well as the opportunities and challenges of blockchain-based self-sovereign identities to guarantee complete control over people's digital identities.

Other research aspects cover but are not limited to blockchain software architectures and novel approaches to blockchain-oriented software engineering. Novel metamodelling approaches represent the groundwork for Blockchain and Distributed Ledger solutions. They can be both domain and domain-independent. Specialized blockchain modeling notations can support the advance in blockchain-oriented software. In this regard, modeling standards, such as UML, BPMN, and other domain-specific languages, can be adopted. It is necessary to improve the state of the art in creating blockchain smart contracts in a high-level and user-friendly modeling language, breaking the technological barriers for non-expert users.

Blockchain software analysis and re-engineering need to be investigated to support the quality of blockchain infrastructure, smart contracts, and related dApp. Optimization aspects are also considered to guarantee the efficiency of smart contracts execution. Formal specification and advanced automatic verification techniques need to be defined, and novel approaches for smart contract testing and auditing of blockchain transactions.

Blockchain technologies are based on adopting different infrastructures such as Ethereum, IOTA, Hyperledger ecosystem, etc. In this regard, recent challenges for the support of security, scalability, reliability, interoperability and performance issues in blockchain and smart contracts on multiple blockchain platforms should be addressed. Certainly of interests are also tools, including open-source software, allowing new specific scenarios such as token sales.

In the curriculum, we also expect to identify and examine the blockchain application in emergent scenarios, including blockchain's role in the metaverse.

### Keywords:

- Foundational aspects of Blockchain and Distributed Ledger Technology
- Distributed ledgers
- Distributed Computing
- Metamodeling and Management
- Distributed consensus mechanisms, cryptographic primitives and distributed protocols
- Smart Contracts
- Modelling, analysis and verification
- Model-driven software development
- Dynamic Networks
- Metaverse