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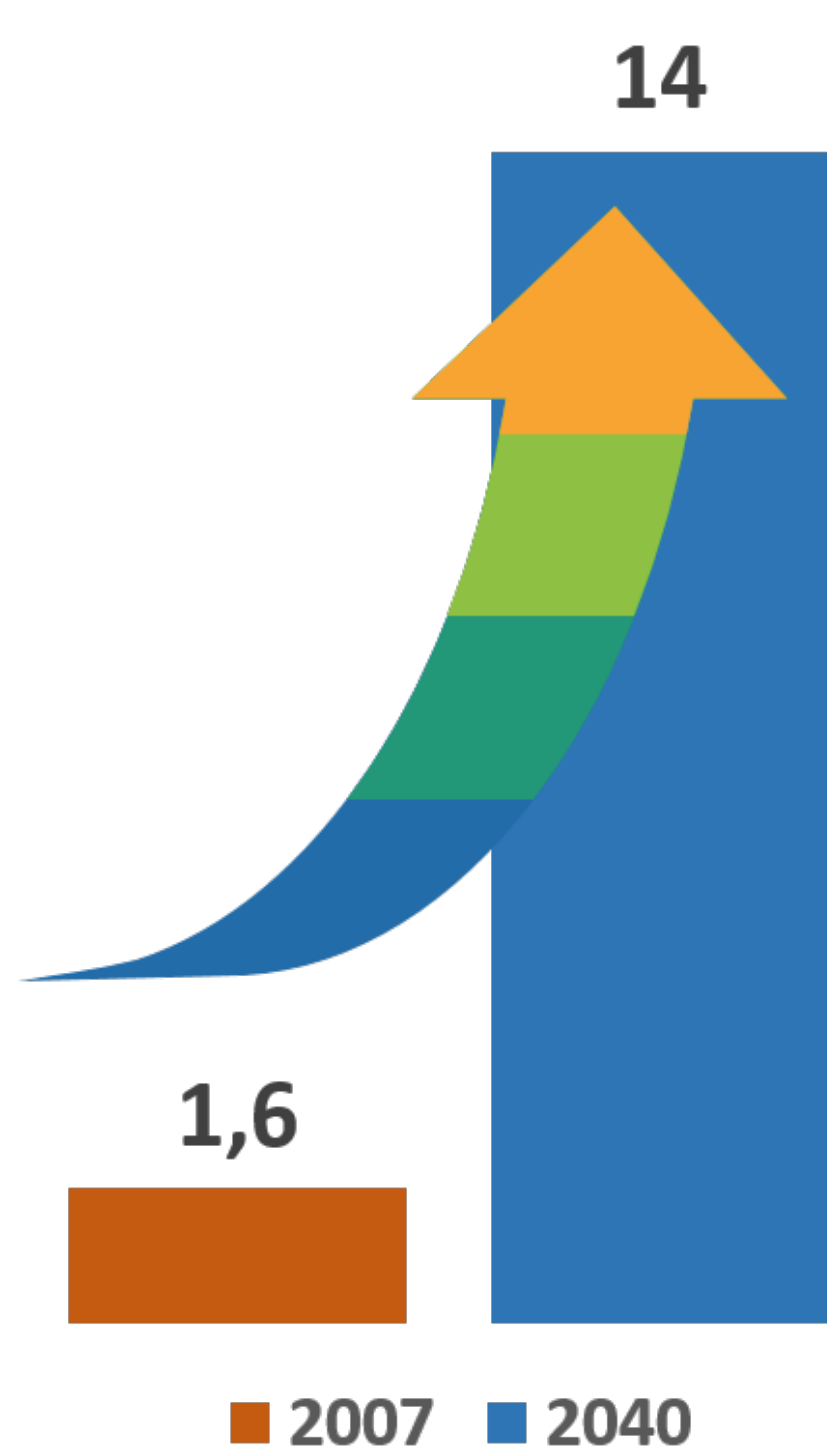
Static and Dynamic Green Semantic Model for Software

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1. Context

Percentage of ICT GHCE emissions



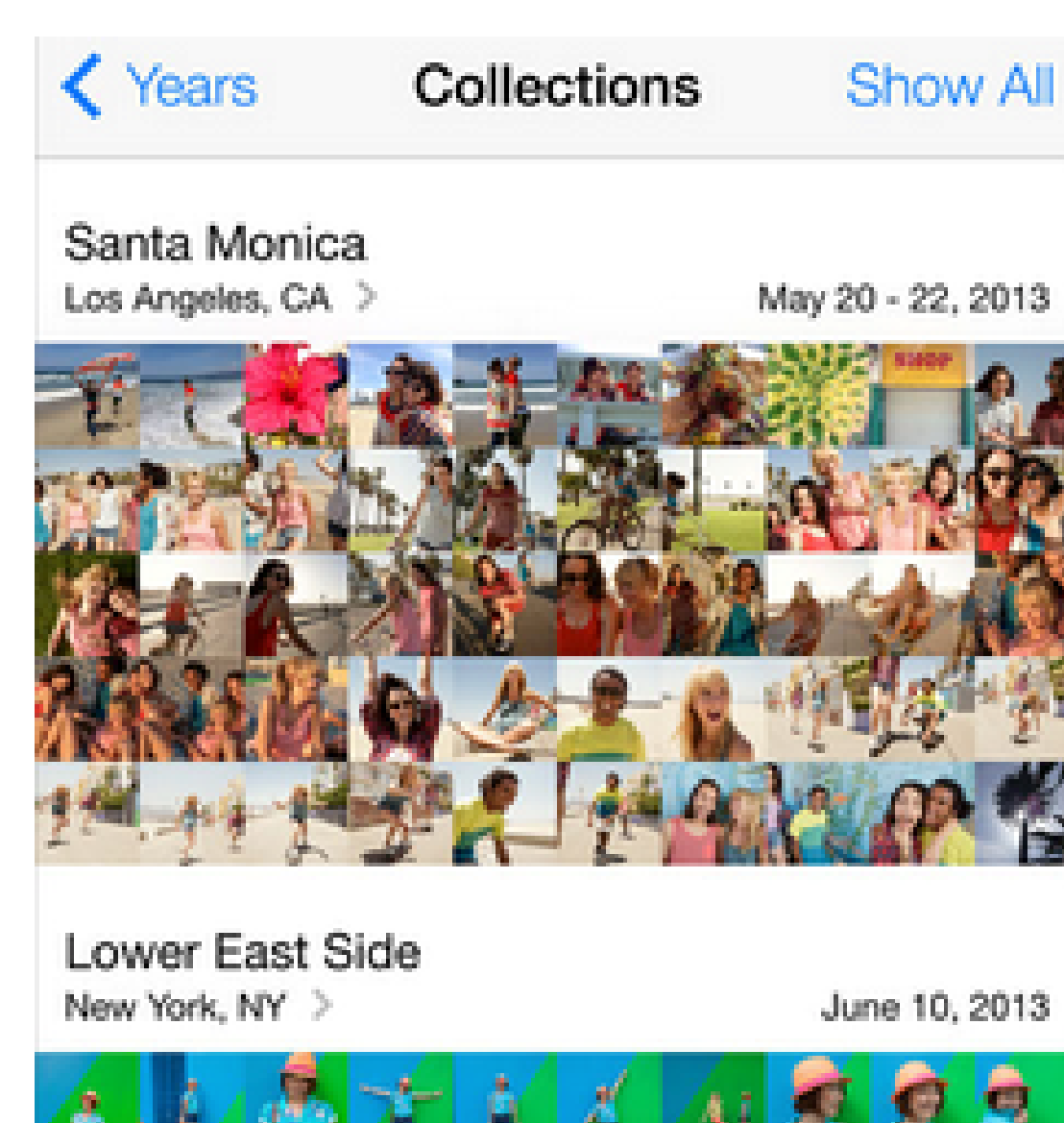
- ICT energy demands and their green house gaz emissions (GHCE) are rising exponentially [1, 2],
- Computers and data centers accounts for the majority of ICT energy consumption [3],
- Most current approaches address energy for specific use cases or individual system layers,
- There is a need to address energy holistically in computing systems.

2. Problem Statement

- Huge and heterogeneous data are shared in smart environments (data centers, IoT, software),
- Software specifications (quality, performance) are rarely used in runtime adaptations.

3. What if?

Use EXIF-style metadata for software?



4. Proposition and Goals

Attach a textual model to software, with static quality description of software, and dynamic performance predictions:

- Semantic model to group static and dynamic software metrics,
- Performance and energy prediction models for software,
- Comprehensive software semantic model to be used on runtime for autonomous adaptations.

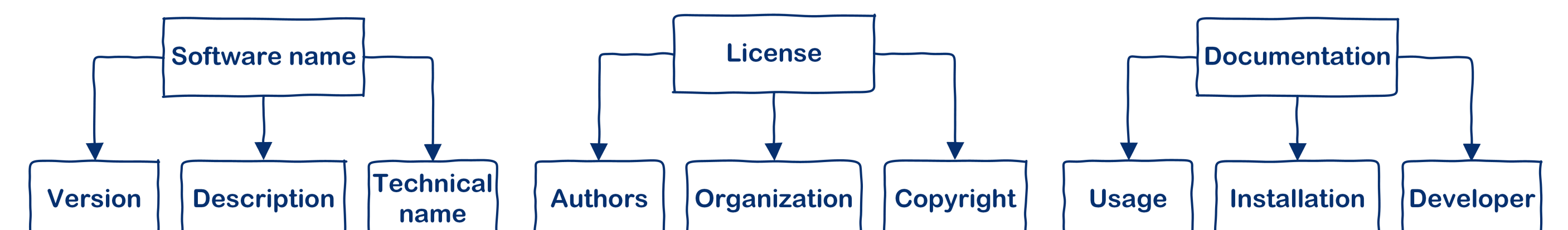
References

- [1] Lotfi Belkhir and Ahmed Elmeligi. Assessing ICT global emissions footprint: Trends to 2040 & recommendations. *Journal of Cleaner Production*, 2018.
- [2] Willem Vereecken, Ward Van Heddeghem, Didier Colle, Mario Pickavet, and Piet Demeester. Overall ICT footprint and green communication technologies. In *Final Program and Abstract Book - 4th International Symposium on Communications, Control, and Signal Processing, ISCCSP 2010*, 2010.
- [3] EU FP7 project-288021. Network of Excellence in Internet Science. D8.1 Overview of ICT energy consumption. 2013.

5. Green Software Semantic Model

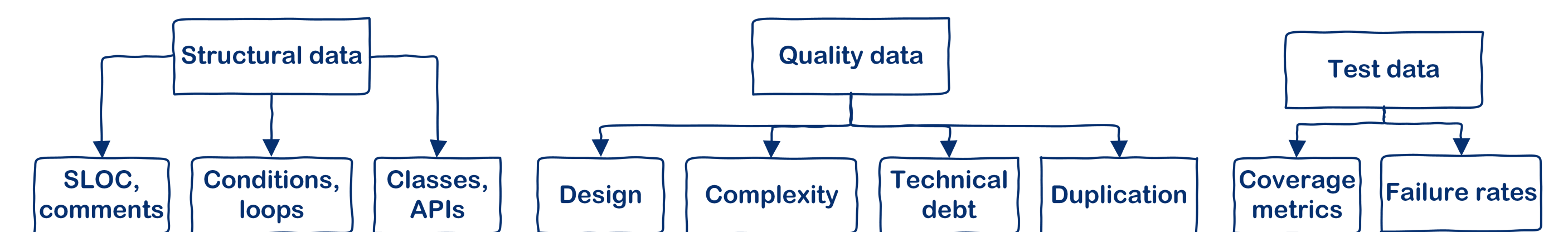
Our green software semantic model is composed of four main categories:

5.1 General metadata



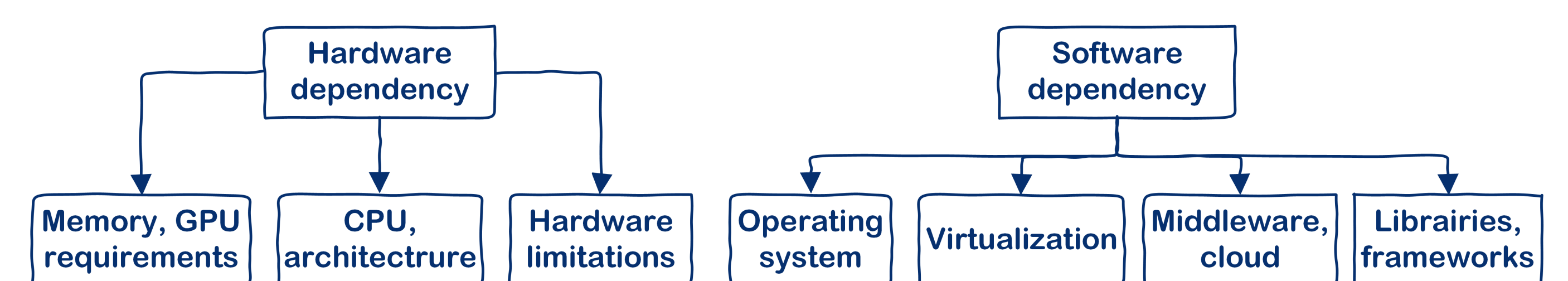
- Metadata about software, its authors, license information and copyright, or documentation,
- Data collected from source code, readme and configuration files (pom.xml, package.json, Makefile).

5.2 Software Quality Information



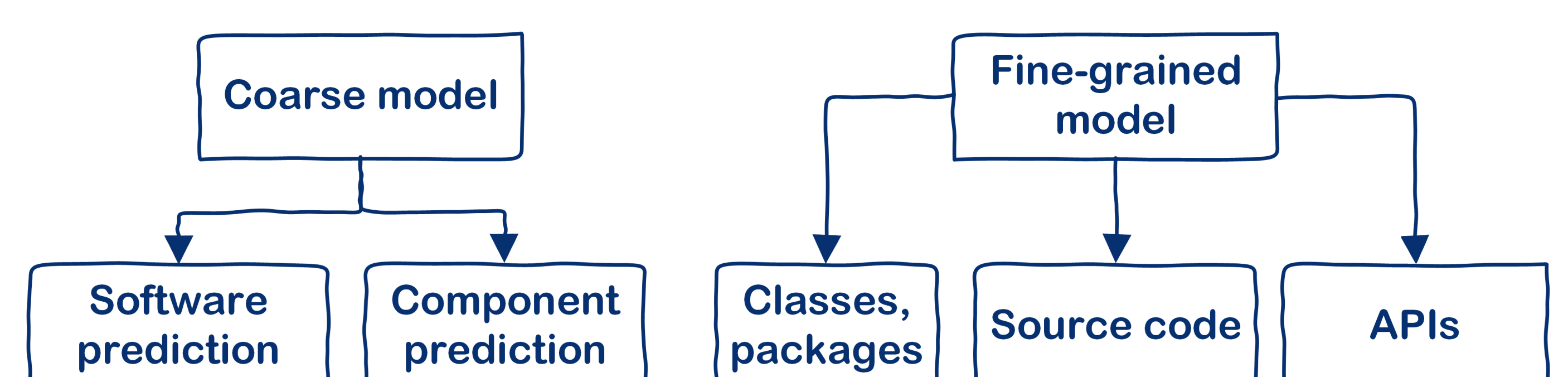
- Code quality and static software metrics,
- Gathered from source code using software analyzers (Frama-C, SonarQube),
- Structural data: metrics describing how the source code is written (SLOC, conditions, APIs),
- Quality data: how well the code is written (code complexity, duplication, technical debt),
- Test data: how well the code has been tested and covered (unit tests, coverage metrics).

5.3 Software and Hardware Dependency Information



- Dependencies upon the software/hardware ecosystem,
- Collected from readme and configuration files, and software analyzers,
- Software dependency such as libraries or frameworks, operating systems, or virtual environments,
- Hardware dependency such as material architecture, recommended or minimum requirements.

5.4 Performance and Energy Prediction Data Models



- Empirical models built using statistical and regression analysis on performance and energy traces,
- Two types of models: a coarse model for higher level components' predictions, and a fine-grained model for source code and APIs' predictions.