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Industrial internet platform - Guidelines for the development of industrial mechanisms model

工业互联网平台 工业机理模型开发指南

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3 Terms and definitions

3.1 industrial internet platform: a system that answers the digital, networked and intelligent needs of manufacturing, that builds cloud-platform-based services for collecting, aggregating and analysing mass data, and that supports wide connection, elastic supply and efficient allocation of manufacturing resources. The definition is cited from GB/T 42569-2023, 3.1.

3.2 industrial application, industrial App: software that carries industrial knowledge and experience in the form of best practice, is aimed at the industrial field, and answers specific business needs in scenarios such as research and design, production, business

management and operation and maintenance. The definition is cited, with modification, from GB/T 42562-2023, 3.1.

3.3 industrial mechanisms model: a mathematical model built with laws, theorems and principles, covering the processes, materials, equipment and other manufacturing technology methods involved in industrial manufacturing and management, able to reveal the inherent scientific rules and technical principles of the manufacturing process, and formed into a program through algorithm development.

5 Overview

The industrial mechanisms model is described as an element of the industrial internet platform that gathers the principles, laws and theorems of an industrial production process, combines them with practical production experience, forms a mechanism and builds it into an interpretable model embedded in the platform.

By refining and encapsulating industrial experience and knowledge, such models drive the accumulation of sector knowledge in the industrial PaaS layer of the platform.

The capability description of a model expresses the elements a model needs during development and the flow it follows. Development recommendations are offered across the whole course of requirements analysis, design, development, testing, deployment with operation and maintenance, and change management.

The model management platform is the digital carrier of the models: a one-stop service platform gathering model development, management, data processing, updating and assessment, which offers the application layer a unified calling interface in the industrial PaaS layer. Recommendations are offered on the service capabilities of that platform for integrated data management, model development, model management, model service and operations management.

For ease of management, ten classification dimensions covering sector, business scope and product life cycle, application scenario and others are given in Annex A.

6 Capability description of an industrial mechanisms model

The capability description should carry the following elements, as shown in Figure 1: model name, model code, model classification, model function, model principle, model ownership, model input data, the mechanism model itself, model output result, model version, running environment and the effect of the model in use.

The model input data should include the industrial source data that can be labelled for the application scenario or object: intrinsic geometry, dynamic response, material, process, quality, management, environment and scenario.

The mechanism model should include the mathematical model built from the theorems,

laws, algorithms, principles and knowledge and experience involved in the industrial manufacturing process, and should take account of the accuracy, completeness, complexity, real-time behaviour, reliability, stability and extensibility of the model, so as to secure the effect of the model in use.

The model output result is the control parameter sent to an external output device, or the data output to an industrial scenario application, after calculation and analysis by the mechanism model.

7 Development steps of an industrial mechanisms model

7.1 Requirements analysis. The stage settles the object described, the scenario needed, the problem to be solved and the function to be delivered, so that developers and users reach a common understanding. The points listed include: making the described object clear, covering business needs and the purpose of the model object, with the mechanism relationships combed through and an initial model target set; making clear the actual state of the source data, the key performance indicators, the confirmed dimensions and the data domains; making clear the application scenario and functional needs, including the scenario, the problem solved, the expected benefit, the function, the mode of use with the degree of human involvement and interaction with the outside, the data types, the sampling frequency, the historical data available, data quality and availability, the maturity of the business, the range of application and the value of wider use, the software and hardware environment covering chip, storage, operating system and network, and the deployment environment covering temperature, humidity and noise; making clear the requirements on extensibility, performance and security; making clear the reusability and maintainability of the model, including reuse and secondary development, flexible configuration, scenario orchestration, collaboration and management needs; making clear system integration, module calls, layered interfaces, coupling and the degree of standardisation; making clear the development effort, development cycle and operating cycle; and producing a proper requirements analysis document.

7.2 Design. Working from the points of 7.1, the stage describes how the model will be realised. The points listed include: characteristic parameters, input and output variables, constraints, performance requirements and deployment conditions; the relationship between source data and the modelled object and the core mechanism the model needs, such as related principles, laws and theorems; the functions and algorithms to be implemented together with the technical justification; the soundness of the positioning, the reliability of the chosen data quality, the applicability and stability of the algorithm and the accuracy of the output; deployment and integration, including how the model is integrated and how the deployment environment is chosen and configured, with support for cloud resource scheduling and containerised deployment; a complete system architecture that is easy to optimise and extend and supports architectures such as DevOps and DataOps for

continuous iteration and automated operation; and a proper design document.

7.3 Development. Working from the points of 7.2, the stage carries out efficient and disciplined coding. The points listed include: choosing a mainstream, widely applicable and stable development environment; making clear the public libraries depended on and the models linked or combined with; making clear whether deployment and use are on the cloud, the edge, the device side or in cloud-edge coordination; supporting the ingestion and storage of multi-source heterogeneous data with unified format conversion for model development and validation; rapid encapsulation of functions and classes and rapid iteration of the model; accelerated computation through hardware and algorithm optimisation; a visual modelling development tool; attention to problems common across industrial sub-sectors so that the model suits several scenarios and duplicated development effort is cut; secondary development of the model; and a proper development document.

7.4 Testing. The stage validates that all the requirements of 7.1 have been correctly implemented and that defects are identified and handled before deployment. The points listed include: testing for functionality, performance efficiency, compatibility, usability, reliability, information security, maintainability, portability and the user documentation set, with the content verified in accordance with GB/T 25000.51-2016; validating the multi-modal data adaptation of the model; validating the soundness and accuracy of the model in different application scenarios; validating the match and smooth running of the model with the models linked or combined with it; validating performance, including computing efficiency, throughput and resource overhead; validating the stability of the algorithm against data disturbance; and a proper test document.

7.5 Deployment, operation and maintenance. The stage aims at better use of resources and a disciplined operation and maintenance process. The points listed include: making clear the duties of provider, management platform and user; supporting cloud, edge, device-side and cloud-edge coordinated deployment; supporting application creation, continuous integration, continuous release, scale-out, scale-in, monitoring and version rollback; supporting different access control capabilities, including rate limiting, request size limiting, metering, bot detection and IP geographic range; supporting calling and downloading of the model; supporting container image deployment, fast container start-up and environment isolation; meeting the network and data security protection requirements of the system; offering an effective channel for user feedback so that the model is iterated over its whole life cycle, including feedback on model accuracy and on false positive and false negative rates; offering a complete and detailed operating manual with worked guidance; and a proper deployment and operation record document.

7.6 Change management. The stage tracks and releases new iterations of the model. The points listed include: setting up mechanisms for model name, version change, release, deployment, review and calling; setting up standards for model differential management and model information management; managing the data produced during validation and