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ARTIFICIAL INTELLIGENCE

S. Stoykova. Platform for Local Fine-Tuning of Large Language Models 5

Key Words: Large language models; management information systems; artificial intelligence; machine learning; local fine-tuning.

Abstract. The study presents a platform designed for local training and inference of popular large language models (LLMs), addressing the growing need for solutions that preserve the privacy of training data. The platform enables researchers and developers to further fine-tune base models using locally stored and processed data through a modular software architecture. It supports a wide range of models and tasks, offering seamless integration with existing machine learning workflows and tools within enterprise management information systems. Two alternative approaches to contextualization of LLMs' knowledge bases are implemented within the platform i.e., indirectly through model tuning (parameter-efficient fine-tuning, reinforcement learning with human feedback and tutorial fine-tuning) and directly through extending the original knowledge base via retrieval-augmented generation. The proposed hybrid solution for knowledge contextualization addresses existing challenges within the generative artificial intelligence field, namely accuracy of generated information (hallucinations), as well as transparency and traceability of generated information to source data. Benchmark results from the platform utilization demonstrate competitive performance in terms of latency, context accuracy, and resource utilization compared to cloud-based alternatives. By decentralizing model development and inference, the platform empowers institutions to maintain data sovereignty, reduce operational costs, and promote sustainable practices in the field of artificial intelligence.

AUTOMATICA

P. Petkov. Application of Differential Topology in Engineering Sciences. A Brief Survey 12

Key Words: Differential topology; smooth manifolds; smooth maps; singularities; matrix computations; regularization.

Abstract. This survey briefly reviews some fundamental concepts of differential topology and discusses their application to the solution of problems arising in engineering disciplines. The use of manifolds to represent families of mathematical models makes it possible to describe parameter-dependent problems and to study their global properties. The study of mappings between manifolds includes the investigation of singular properties of these mappings at certain points of the manifolds. Although such points are not typical, they can have a significant influence on the behavior of the corresponding mapping. The application of manifolds and the associated bifurcation diagrams in parameter space to the analysis of parameter-dependent problems is presented in brief. Examples are provided to illustrate the introduced concepts.

ENERGY SYSTEMS

M. Hadjiski, N. Deliiski, N. Tumbarkova, D. Angelski, P. Vitchev, K. Atanasova. Calculation and Approximation with the Table Curve 2D Software of the Energy Required to Defrost Logs 19

Key Words: Logs; Table Curve 2D; frozen bound water; frozen free water; defrosting; energy consumption.

Abstract. A mathematical description of the thermal energy Q_{w-defr} required for the complete defrosting of logs, i.e. for the complete melting of the ice in them, formed in the wood in winter by the natural freezing of both free and bound water in it, using the software package Table Curve 2D has been presented. This package allows for the selection of equations, which provide the best similarity between the calculated with them values of Q_{w-defr} during thermal treatment of logs containing ice and the respective data obtained experimentally or using

an adequate temperature-energy model of Q_{w-defr} . An approach for computing the energy required for heating to defrost logs subjected to thermal treatment before their subsequent mechanical processing was applied. The approach is based on the use of two personal models. With the help of the non-stationary model, the defrosting times of beech logs with a diameter of 0.4 m, initial temperatures of $-1\text{ }^{\circ}\text{C}$, $-10\text{ }^{\circ}\text{C}$, $-20\text{ }^{\circ}\text{C}$, $-30\text{ }^{\circ}\text{C}$, $-40\text{ }^{\circ}\text{C}$, and moisture content u of $0.4\text{ kg}\cdot\text{kg}^{-1}$, $0.6\text{ kg}\cdot\text{kg}^{-1}$, and $0.8\text{ kg}\cdot\text{kg}^{-1}$ were determined at operating temperatures in the boiling or steaming equipment equal to $80\text{ }^{\circ}\text{C}$. For different combination of the specified three values of the moisture content and five values of the initial log temperature there are significant differences between the amount of both free and bound frozen water in the logs, which ensures sufficiently large differences between the calculated values of the energy required for defrosting of the logs. Furthermore, the logs with an initial temperature of $-1\text{ }^{\circ}\text{C}$ contain only frozen free water and no frozen bound water at all. Using the determined logs' defrosting durations, with the help of our second stationary model the change in the energy required for defrosting of the investigated logs was calculated. It was found that the studied energy increases from 31.66 to $58.39\text{ kWh}\cdot\text{m}^{-3}$ at $u = 0.4\text{ kg}\cdot\text{kg}^{-1}$, from 48.56 to $77.85\text{ kWh}\cdot\text{m}^{-3}$ at $u = 0.6\text{ kg}\cdot\text{kg}^{-1}$ and from 63.39 to $95.33\text{ kWh}\cdot\text{m}^{-3}$ at $u = 0.8\text{ kg}\cdot\text{kg}^{-1}$ when the initial temperature of the logs decreases from $-1\text{ }^{\circ}\text{C}$ to $-40\text{ }^{\circ}\text{C}$. The obtained results were approximated using the Table Curve 2D software package. Three quadratic equations were selected, which mathematically describe the dependence of Q_{w-defr} on the initial temperature of the frozen logs for each of the investigated three values of their moisture content. It was found that there is a very small error (within the limits of only 0.8%) between the values of Q_{w-defr} calculated with the equations proposed by Table Curve 2D and their corresponding values calculated with our energy model of Q_{w-defr} . The equations obtained can be used for development and automatic implementation of scientifically based energy-efficient regimes and technologies for defrosting by steaming or boiling of frozen logs with different properties and purposes.

P. Kesova, I. Bachkova. Overview of Intelligent Reference Frameworks, Architectures and Models in Energy Management Systems 29

Key Words: Energy Management Systems; Reference Architectures; Reference Frameworks; Conceptual Models; Semantic Interoperability; Unified Information Models; Industry 4.0; ISO 50001; SGAM; IIRA; OPC UA; IEC 62264.

Abstract. Achieving the objectives of the Industry 4.0 initiative, particularly in relation to the implementation of Energy Management Systems (EnMS) in industry, depends on the structured adoption of reference frameworks, architectures, and models capable of ensuring interoperability, scalability, and continuous enhancement of energy efficiency. In recent years, concepts such as reference frameworks and architectures, conceptual models, ontologies, meta-models, and unified information models have become increasingly prominent in the development and deployment of Energy Management Systems (EnMS). Nevertheless, their simultaneous application frequently results in conceptual uncertainty and overlapping interpretations. The growing use of these concepts requires a clear understanding of their meaning, scope, and interrelationships. This paper presents an overview of intelligent reference frameworks, architectures, and models applied in the development and implementation of industrial energy management systems. The relationships between models, reference frameworks, and architectures are analyzed, with a particular emphasis on clarifying the conceptual distinctions between conceptual models, reference models, meta-models, and meta-meta-models. Building on this analysis, the paper reviews several widely recognized standards and architectural frameworks, including ISO 50001, the Smart Grid Architecture Model (SGAM), the Industrial Internet Reference Architecture (IIRA), OPC Unified Architecture (OPC UA), and the IEC 62264 standard for enterprise control system integration. The paper highlights the contribution of reference architectures to the systematic structuring of complex energy management solutions, and emphasizes the essential role of unified information models in enabling semantic interoperability across heterogeneous systems. The practical relevance, advantages, and constraints of the examined frameworks are evaluated with respect to industrial energy management, real-time monitoring, data-driven optimization, and their integration within intelligent manufacturing environments. The study concludes that reference frameworks and architectures should be viewed as complementary layers of a unified knowledge system: frameworks provide methodological context, architectures define structural organization, models describe functional behavior, and unified information models ensure consistent data representation and exchange. This integrated approach is identified as a key enabler for the development of intelligent, adaptive, and sustainable energy management systems, supporting the transition toward Industry 5.0 and human-centric, energy-efficient industrial environments.

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