تحقیق درباره ی کاربرد هوش مصنوعی در انرژی

تهیه کننده: آرام کریمی

کارفرما: علی آقا داداشی

شرکت فن آوران شریف

فناوران شریف

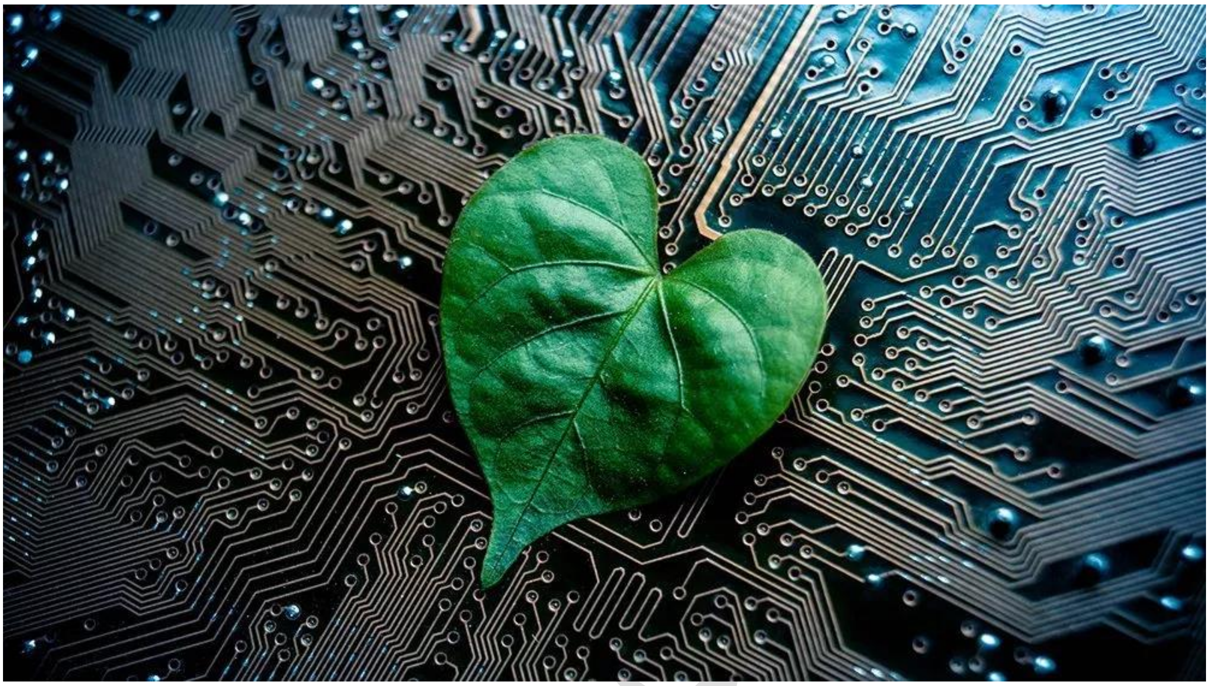
سامانه‌های راهبردی

بسم الله الرحمن الرحیم

فهرست مطالب

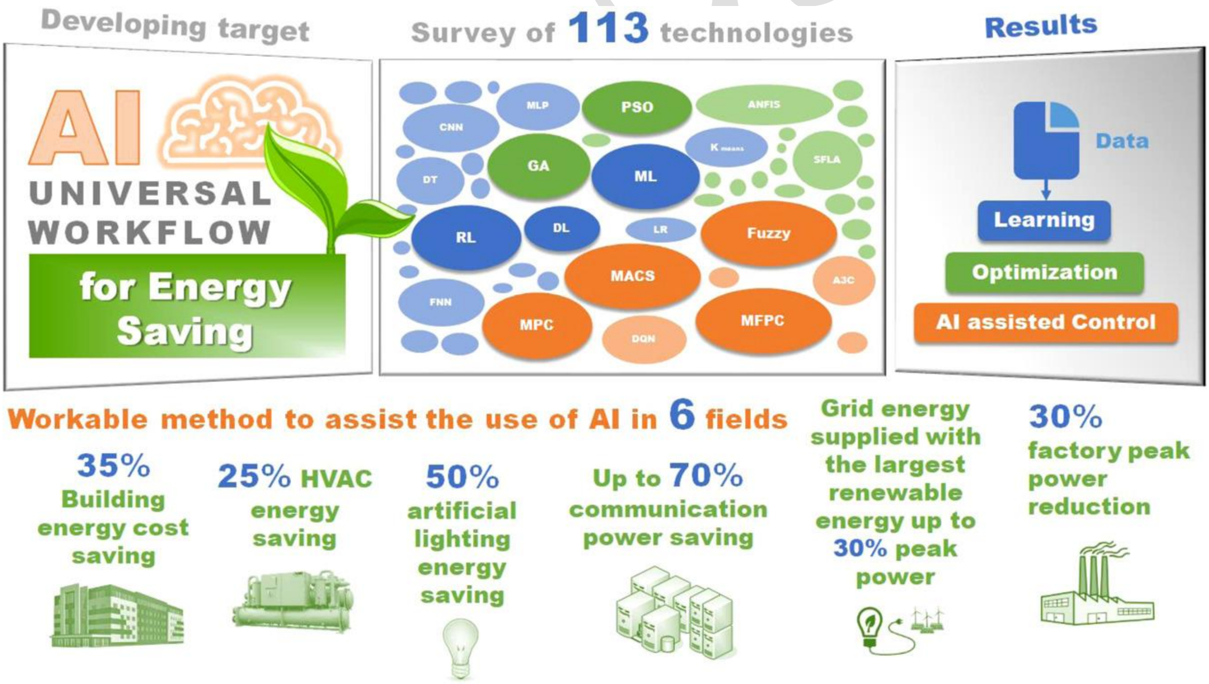
فصل اول)

AI in Energy Saving



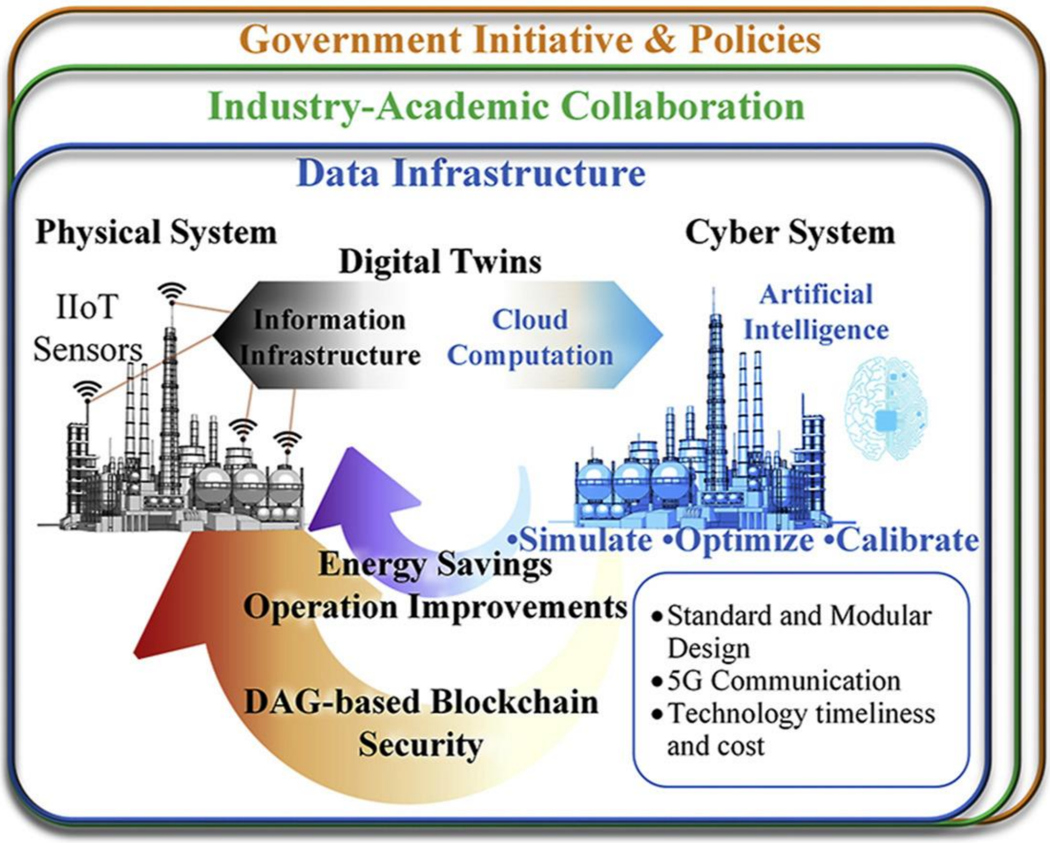
Universal workflow of artificial intelligence for energy saving

The concept of a universal workflow originates from machine learning (ML). To approach an ML problem, a workflow is constructed to assist researchers in defining their problem and assembling a dataset. Through a comprehensive analysis of experimental data, the universal workflow can confirm 35% energy cost saving in the building; 25% energy saving of the heating, ventilation and air conditioning equipment; 50% artificial lighting system energy saving; up to 70% reduction of information transfer and communication power; a continuous output of 30% peak power from the renewable energy device to the microgrid(Microgrids are a competent solution for power system management, control, and integration of renewables as distributed sources within utility grids); and 20% power demand reduction in the factory.



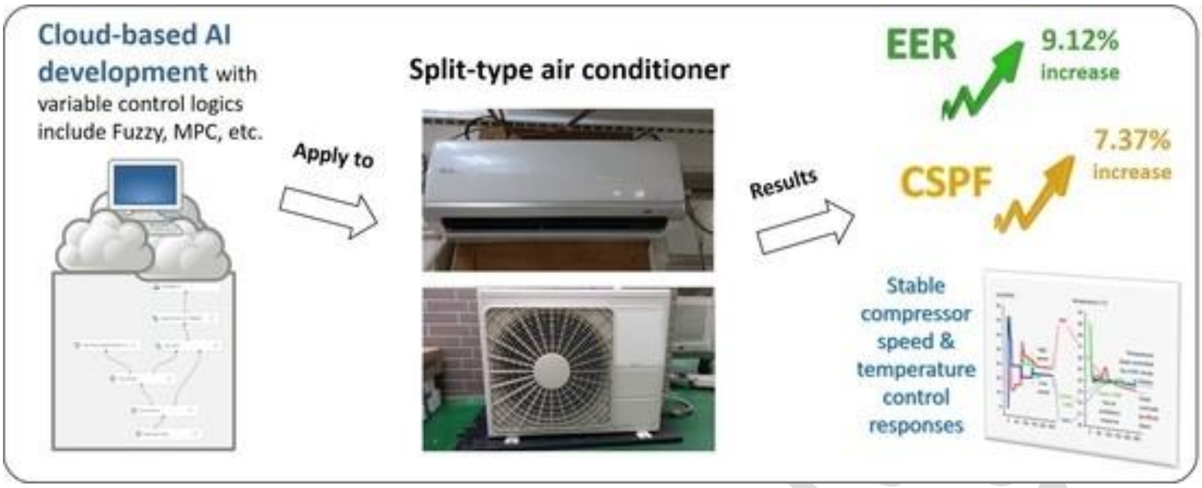
Recent advances on industrial data-driven energy savings: Digital twins and infrastructures

Data-driven models for industrial energy savings heavily rely on sensor data, experimentation data and knowledge-based data. This work reveals that too much research attention was invested in making data-driven models, as supposed to ensuring the quality of industrial data. Furthermore, the true challenge within the Industry 4.0 is with data communication and infrastructure problems, not so significantly on developing modelling techniques. Furthermore, the true challenge within the Industry 4.0 is with data communication and infrastructure problems, not so significantly on developing modelling techniques. With a few more development in enabling technologies such as 5G developments, Internet of Things (IoT) standardization, Artificial Intelligence (AI) and blockchain 3.0 utilization. It is also important to have symbiosis between researchers and industrialists to transition from traditional industry towards a digital twin-based energy-saving industry.



Air Conditioning Energy Saving from Cloud-Based Artificial Intelligence: Case Study of a Split-Type Air Conditioner

This study developed cloud-based artificial intelligence (AI) that could run AI programs in the cloud and control air conditioners remotely from home. AI programs in the cloud can be altered any time to provide good control performances without altering the control hardware. The air conditioner costs and prices can thus be reduced by the increasing energy efficiency. Cloud control increased energy efficiency through AI control based on two conditions: (1) a constant indoor cooling rate and (2) a fixed stable range of indoor temperature control. However, if the two conditions cannot be guaranteed or the cloud signals are lost, the original proportional-integral-differential (PID) control equipped in the air conditioner can be used to ensure that the air conditioner works stably. Two technologies with the highest energy saving efficiency, a fuzzy + PID and model-based predictive control (MPC), were chosen to be developed into two control methodologies of cloud-based AI. Energy efficiency measurement involved an enthalpy differential test chamber. The two indices, namely the energy efficiency ratio (EER) and cooling season power factor (CSPF), were tested. The EER measurement is the total efficiency value obtained when testing the required electric power at the maximum cooling capacity under constantly controlled temperature and humidity. CSPF is the tested efficiency value under dynamic conditions from changing indoor and outdoor temperatures and humidity according to the climate conditions in Taiwan. By using the static energy efficiency index EER for evaluation, the fuzzy + PID control could not save energy, but MPC increased the EER value by 9.12%. By using the dynamic energy efficiency index CSPF for evaluation, the fuzzy + PID control could increase CSPF by 3.46%, and MPC could increase energy efficiency by 7.37%.


Cloud-based AI development with variable control logics include Fuzzy, MPC, etc.
Apply to
Split-type air conditioner
Results
EER
9.12% increase
CSPF
7.37% increase
Stable compressor speed & temperature control responses

فصل دوم)

AI in petroleum industry

Recent Developments in Application of Artificial Intelligence in Petroleum Engineering

With the recent interest and enthusiasm in the industry toward smart wells, intelligent fields, and real-time analysis and interpretation of large amounts of data for process optimization, our industry's need for powerful, robust, and intelligent tools has significantly increased. Operations such as asset evaluation; 3D- and 4D-seismic-data interpretation; complex multilateral-drilling design and implementation; log interpretation; building of geologic models; well-test design, implementation, and interpretation; reservoir modeling; and simulation are being integrated to result in comprehensive reservoir management. In recent years, artificial intelligence (AI), in its many integrated flavors from neural networks to genetic optimization to fuzzy logic, has made solid steps toward becoming more accepted in the mainstream of the oil and gas industry.

Application and development trend of artificial intelligence in petroleum exploration and development

Machine learning has been preliminarily applied in lithology identification, logging curve reconstruction, reservoir parameter estimation, and other logging processing and interpretation, exhibiting great potential. Computer vision is effective in picking of seismic first breaks, fault identification, and other seismic processing and interpretation. Deep learning and optimization technology have been applied to reservoir engineering, and realized the real-time optimization of waterflooding development and prediction of oil and gas production. The application of data mining in drilling, completion, and surface facility engineering etc. has resulted in intelligent equipment and integrated software. The potential development directions of artificial intelligence in petroleum exploration and development are intelligent production equipment, automatic processing and interpretation, and professional software platform. The highlights of development will be digital basins, fast intelligent imaging logging tools, intelligent seismic nodal acquisition systems, intelligent rotary-steering drilling, intelligent fracturing technology and equipment, real-time monitoring and control of zonal injection and production.

Application of artificial intelligence techniques
in the petroleum industry: a review

This survey offers a detailed literature review based on different types of AI algorithms, their application areas in the petroleum industry, publication year, and geographical regions of their development. For this purpose, we classify AI methods into four main categories including evolutionary algorithms, swarm intelligence, fuzzy logic, and artificial neural networks. Additionally, we examine these types of algorithms with respect to their applications in petroleum engineering. The review highlights the exceptional performance of AI methods in optimization of various objective functions essential for industrial decision making including minimum miscibility pressure, oil production rate, and volume of CO_2 sequestration. Furthermore, hybridization and/or combination of various AI techniques can be successfully applied to solve important optimization problems and obtain better solutions.

(فصل سوم

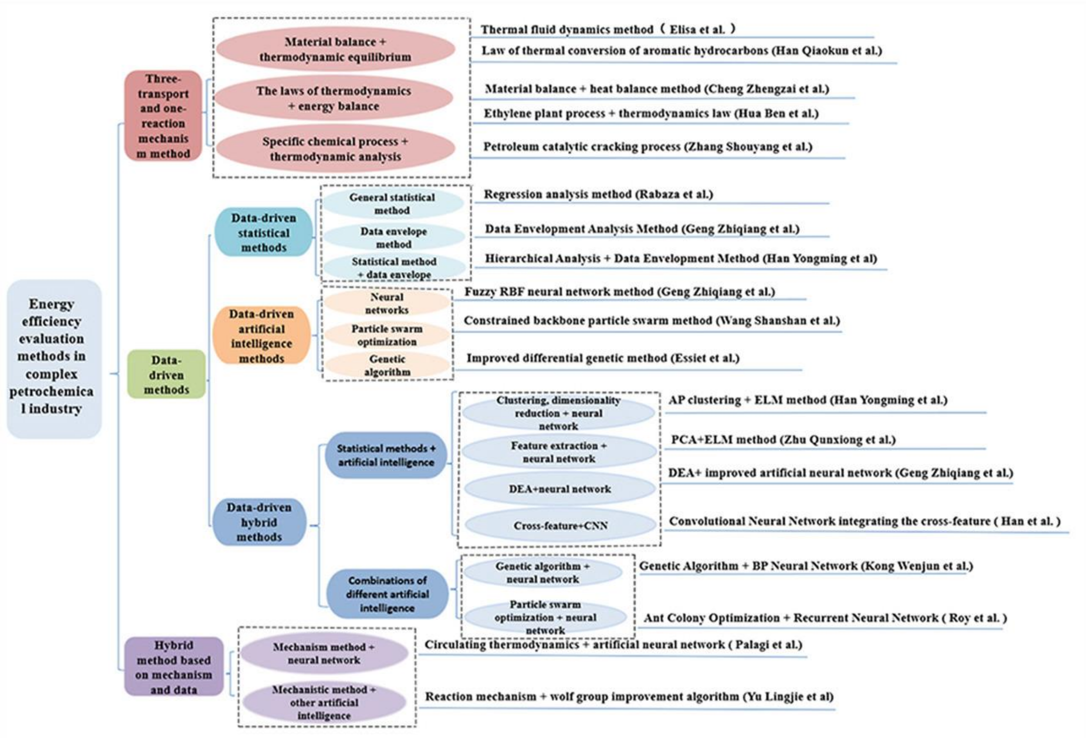
AI in Petrochemical industry

Explainable AI-driven net-zero carbon roadmap for petrochemical industry considering stochastic scenarios of remotely sensed offshore wind energy

Recently, several countries have focused on industrial decarbonization to ensure that the net emissions of carbon dioxide reach zero and contribute to decreasing the global mean temperature. This study aims to investigate the feasibility of a net-zero carbon roadmap for the petrochemical industry by 1) developing an explainable artificial intelligence (XAI)-based generative model to produce stochastic scenarios for offshore wind power in an electrical grid, and 2) conducting techno-economic and environmental assessments for forecasting models that define offshore wind power networks. Firstly, data processing techniques were utilized on remotely sensed offshore wind speed datasets and energy data obtained from petrochemical industrial parks. Second, a generative model was designed using a variational autoencoder (VAE) to produce different forecast scenarios of offshore wind power. Third, stochastic scenarios were developed by considering behavioral characteristics of offshore wind power with stochastic scenario uncertainties. Finally, we investigated the techno-economic and environmental assessments of the proposed renewable energy networks.

Review: Energy efficiency evaluation of complex petrochemical industries

As the most effective indicator for energy saving and emission reduction, energy efficiency evaluation is widely used in complex petrochemical industries. It is nowadays common to combine traditional mechanism methods based on momentum transport, energy transport, quality transport (TT) and reaction engineering (RG) (TT-RG), with data-driven artificial intelligence methods. Using the combined method to achieve production optimization and energy saving by analyzing the evaluation indicator of energy efficiency has gradually become an important part in complex petrochemical industries. Therefore, this paper introduced the main methods and the latest research results of energy efficiency evaluation of complex petrochemical industries. These methods are mainly divided into three parts, including the mechanism methods based on TT-RG, the data-driven artificial intelligence methods, and the hybrid methods combining the mechanism and the data-driven. Then, different methods are compared and described in detail.

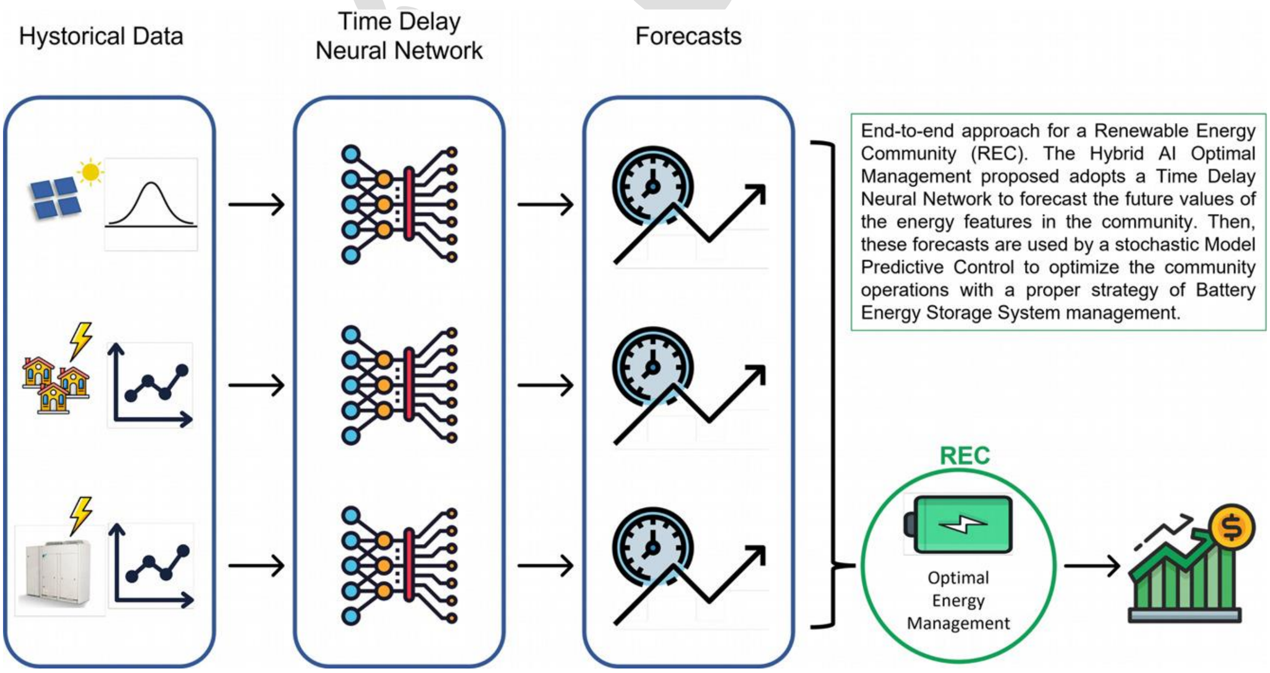


فصل چهارم)

AI in Energy management

A new hybrid AI optimal management method for renewable energy communities

In this study, we propose a hybrid AI optimal method to improve the efficiency of energy management in a smart grid such as Renewable Energy Community. This method adopts a Time Delay Neural Network to forecast the future values of the energy features in the community. Then, these forecasts are used by a stochastic Model Predictive Control to optimize the community operations with a proper control strategy of Battery Energy Storage System. The results of the predictions performed on a public dataset with a prediction horizon of 24 h return a Mean Absolute Error of 1.60 kW, 2.15 kW, and 0.30 kW for photovoltaic generation, total energy consumption, and common services, respectively. The model predictive control fed with such predictions generates maximum income compared to the competitors. The total income is increased by 18.72% compared to utilizing the same management system without exploiting predictions from a forecasting method.



AI and Data Democratization for Intelligent Energy Management

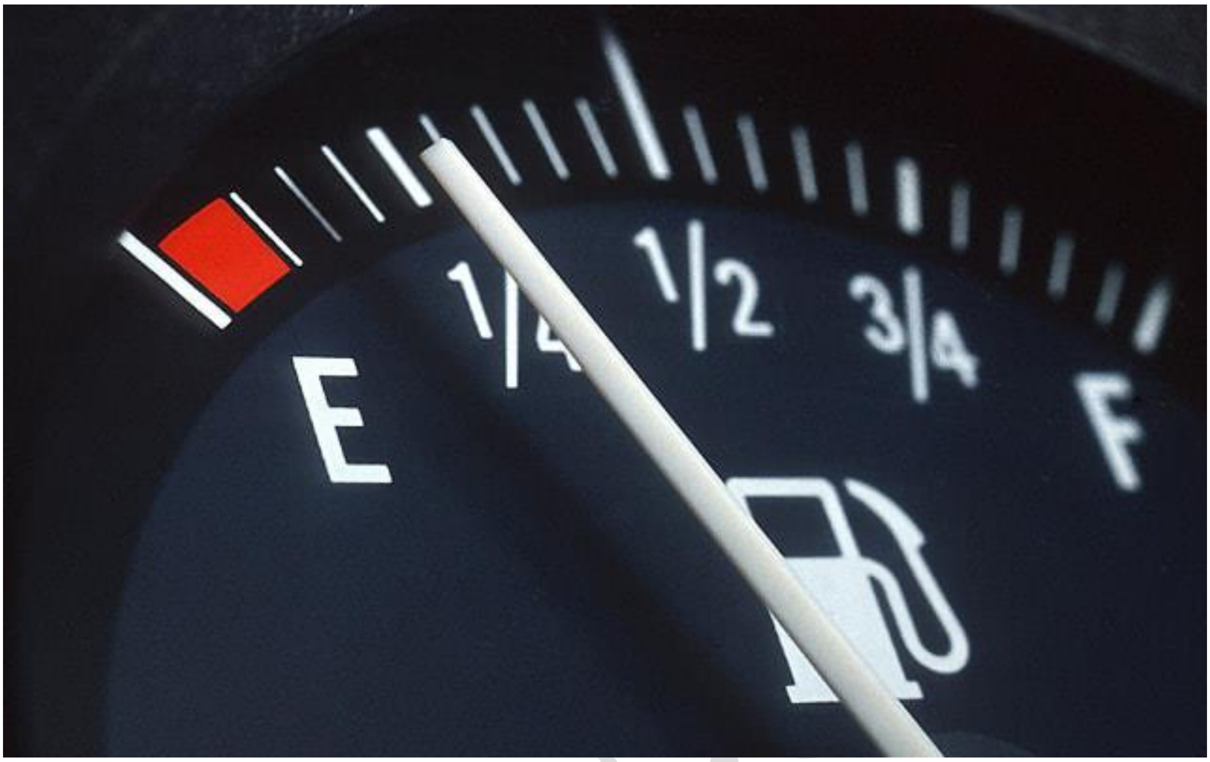
Despite the large number of technology-intensive organizations, their corporate know-how and underlying workforce skill are not mature enough for a successful rollout of Artificial Intelligence (AI) services in the near-term. However, things have started to change, owing to the increased adoption of data democratization processes, and the capability offered by emerging technologies for data sharing while respecting privacy, protection, and security, as well as appropriate learning-based modelling capabilities for non-expert end-users. This is particularly evident in the energy sector. In this context, the aim of this paper is to analyse AI and data democratization, in order to explore the strengths and challenges in terms of data access problems and data sharing, algorithmic bias, AI transparency, privacy and other regulatory constraints for AI-based decisions, as well as novel applications in different domains, giving particular emphasis on the energy sector. A data democratization framework for intelligent energy management is presented. In doing so, it highlights the need for the democratization of data and analytics in the energy sector, toward making data available for the right people at the right time, allowing them to make the right decisions, and eventually facilitating the adoption of decentralized, decarbonized, and democratized energy business models.

AI-Based Home Energy Management System Considering Energy Efficiency and Resident Satisfaction

Demand-side energy management is becoming increasingly important owing to concerns related to global warming and energy shortages. In particular, as the development of Internet of Things (IoT) enables the precise control of home appliances, the demand for home energy management systems (HEMSs) is expected to increase. This article proposes an artificial intelligence-based HEMS (AI-HEMS) that provides both energy efficiency and resident satisfaction. To this end, we implemented three prediction mechanisms: 1) derivation of comfort temperature; 2) device-free sleep prediction; and 3) occupancy-probability-based outing prediction. Based on these mechanisms, we present four intelligent heater control strategies: 1) outing; 2) occupancy; 3) comfort; and 4) sleep-based control. For evaluation, an experimental testbed was constructed and measurements were taken. To increase the reliability of the evaluation by excluding natural energy fluctuation factors, a treatment group (100 households) and a control group (2281 households) were recruited to measure the energy savings of the treatment group compared to the control group. In a 48-day evaluation, AI-HEMS was found to provide an energy-saving rate of approximately 14% and resident satisfaction of approximately 91%. These results imply that the proposed system can save energy while maintaining a high level of satisfaction.

فصل پنجم

AI in fuel consumption



AI in fuel consumption optimization

Energy saving has become an important aspect of every business activity as it is important in terms of cost savings and greenhouse gas emission reduction. This study aims to develop a comprehensive artificial intelligence model for reducing energy consumption in the mining industry. Many parameters influence the fuel consumption of surface mining haul trucks. This includes, but not limited to, truck load, truck speed and total haul road resistance. In this study, a fitness function for the haul truck fuel consumption based on these parameters is generated using an Artificial Neural Network (ANN). This function is utilised to generate a multi-objective model based on Genetic Algorithm (GA). This model is used to estimate the optimum values of the haulage parameters to reduce fuel consumption. The developed model is generated and tested using real data collected from four large surface mines. It is found that for all four mines considered in this study, the haul truck fuel consumption can be reduced by optimising truck load, truck speed and total haul road resistance using the developed artificial intelligence model.

Multilayer Perceptron Method to Estimate Real-World Fuel Consumption Rate of Light Duty Vehicles

The actual driving condition and fuel consumption rate gaps between lab and real-world are becoming larger. In this paper, we demonstrate an approach to determine the most important factors that may influence the prediction of real-world fuel consumption rate of light-duty vehicles. A multilayer perceptron (MLP) method is developed for the prediction of fuel consumption since it provides accurate classification results despite the complicated properties of different types of inputs. The model considers the parameters of external environmental factors, the manipulation of vehicle companies, and the drivers' driving habits. Based on the BearOil database in China, 2,424,379 samples are used to optimize our model. We indicate that differences exist between real-world fuel consumption and standard fuel consumption under simulation conditions. This study enables the government and policy-makers to use big data and intelligent systems for energy policy assessment and better governance.

Impact of Driver Behavior on Fuel Consumption: Classification, Evaluation and Prediction Using Machine Learning

Driving behavior has a large impact on vehicle fuel consumption. Dedicated study on the relationship between the driving behavior and fuel consumption can contribute to decreasing the energy cost of transportation and the development of the behavior assessment technology for the ADAS system. Therefore, it is vital to evaluate this relationship in order to develop more ecological driving assistance systems and improve the vehicle fuel economy. However, modeling driving behavior under the dynamic driving conditions is complex, making a quantitative analysis of the relationship between the driving behavior and the fuel consumption difficult. In this paper, we introduce two kinds of machine learning methods for evaluating the fuel efficiency of driving behavior using the naturalistic driving data. In the first stage, we use an unsupervised spectral clustering algorithm to study the macroscopic relationship between driving behavior and fuel consumption, using the data collected during the natural driving process. In the second stage, the dynamic information from the driving environment and natural driving data is integrated to generate a model of the relationship between various driving behaviors and the corresponding fuel consumption features. The dynamic environment factors are coded into a processable, digital form using a deep learning-based object detection method so that the environmental data can be linked with the vehicle's operating signal data to provide the training data for the deep learning network. The training data are labeled according to its fuel consumption feature distribution, which is obtained from the road segment data and historical driving data. This deep learning-based model can then be used as a predictor of the fuel consumption associated with different driving behaviors. Our results show that the proposed method can effectively identify the relationship between the driving behavior and the fuel consumption on both macro and micro levels, allowing for end-to-end fuel consumption feature prediction, which can then be applied in the advanced driving assistance systems.

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با تشکر از توجه شما