Түйінді сөздер: Smart-кампус, кампус, пандемия, қашықтықтан оқу, жүйе, электрондық цифрлық қолтаңба.

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Smart campus system in the university: requirements, advantages and disadvantages

Abstract. The article presents the requirements for the development of the information system "Smart Campus". To fulfill the tasks of digitalization of universities, it is necessary to develop systems for the convenient use of the university infrastructure by students that will meet their current requirements and meet the conditions of the pandemic. The system "Smart Campus" offers the implementation of functionality based on the requirements of students, which were determined on the basis of a student survey and their proposals.

Key words: Smart Campus, campus, pandemic, distance learning, system, electronic digital signature.

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MACHINE LEARNING METHOD FOR INVERSE HEAT CONDUCTION PROBLEMS

Abstract. *Investigated in this work is the potential of carrying out inverse problems with linear and non-linear behavior using machine learning methods and the neural network method. With the advent of machine learning algorithms it is now possible to model inverse problems faster and more accurately. In order to demonstrate the use of machine learning and neural networks in solving inverse problems, we propose a fusion between computational mechanics and machine learning. The forward problems are solved first to create a database. This database is then used to train the machine learning and neural network algorithms.*

The trained algorithm is then used to determine the boundary conditions of a problem from assumed measurements. The proposed method is tested for the linear/non-linear heat conduction problems in which the boundary conditions are determined by providing three, four, and five temperature measurements. This research demonstrates that the proposed fusion of computational mechanics and machine learning is an effective way of tackling complex inverse problems.

Key words*: inverse modelling, machine learning, neural network, heat conduction equation, the heat transfer coefficient, numerical methods.*

Introduction

Relevance of the research topic.

Many engineering and manufacturing processes are connected with heat transfer. Heat transfer phenomena are described by the heat equation in order to solve specific problems, boundary conditions that accurately reflect the production process. The areas of practical use of methods of inverse problems of mathematical physics are very diverse, in particular, they are used in thermophysics, geophysics, astronomy, electrodynamics, hydraulic engineering, and so forth. The need for their solution appears during various thermal investigations, the creation and operation of heat-loaded technical objects, the development of technological processes.

The purpose of our research work is to develop a machine learning method and a neural network method for finding the thermal conductivity coefficient, exactly:

- to develop a method for solving the initial boundary value problem of heat conduction equations;
- to develop an approximate method for determining the coefficients of thermal conductivity and heat capacity;
- to construct conjugate difference schemes for the problems of determining the thermal conductivity coefficients;
- to develop an algorithm for solving the inverse problem and to create a program;
- to conduct numerical calculations and show the convergence of the iterative solution methods and machine learning methods.

Research methods.

During the research, the following methods were used: mathematical modeling, iterative method, machine learning method, neural network method and computational (numerical) experiment method.

Mathematical model of the heat transfer process

The study of any physical process by mathematical methods is reduced to the establishment of analytical dependencies between the quantities that characterize this phenomenon. For complex physical processes in which the determining quantities change in space and time, it is sometimes impossible to establish a relationship between such quantities. In these cases, the methods of mathematical physics come to the rescue, which consider the course of the process not in the entire space under study, but within a certain volume of matter and over an elementary period of time.

The differential equation of thermal conductivity is understood as a mathematical dependence, usually expressed by a partial differential equation, which characterizes the flow of the physical phenomenon of heat transfer and allows it to calculate the temperature field at any internal point of the body at any time.

Then by integrating the differential equation, it is possible to obtain an analytical relationship between the values for the entire space and the entire time interval under consideration. The relationship between the variables involved in the transfer of heat by conduction, is set in case of the so-called differential heat conduction equation, based on which we construct a mathematical theory of heat conduction. The derivation of the differential equation of thermal conductivity is based on the law of conservation of energy, combined with the Fourier law.

Formulation of initial-boundary value problems.

The differential equation of thermal conductivity in the one-dimensional case is written as:

$$\gamma_0 c \frac{\partial \theta}{\partial t} = \frac{\partial}{\partial z}\left(\lambda \frac{\partial \theta}{\partial z}\right) + W, \qquad (1)$$

and in the three-dimensional case

$$\gamma_0 c \frac{\partial \theta(x,y,z,t)}{\partial t} = \frac{\partial}{\partial x}\left(\lambda \frac{\partial \theta(x,y,z,t)}{\partial x}\right) + \frac{\partial}{\partial y}\left(\lambda \frac{\partial \theta(x,y,z,t)}{\partial y}\right) + \frac{\partial}{\partial z}\left(\lambda \frac{\partial \theta(x,y,z,t)}{\partial z}\right) + W(x,y,z,t) \qquad (2)$$

It is often necessary to write equations (1) for cylindrical or spherical coordinate systems. In the axially symmetric case, that is, when the solution does not depend on the polar angle, azimuth, and angle, equation (1) is written using the parameter r:

- for a flat (Cartesian) coordinate system, when r = 0;
- for a cylindrical coordinate system, when r = 1;
- for a spherical coordinate system, when r = 2.

Using the r parameter, equations (1) are written as:

$$\gamma_0 c \frac{\partial \theta}{\partial t} = \frac{1}{z^r}\frac{\partial}{\partial z}\left(\lambda z^r \frac{\partial \theta}{\partial z}\right) + W.$$

When the heat changes depending on the polar angle, the equation of thermal conductivity in the polar system is written as:

$$c\rho \frac{\partial T}{\partial r} = \lambda\left(\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial T}{\partial r} + \frac{1}{r^2}\frac{\partial^2 T}{\partial \varphi^2}\right)\right).$$

In order to use any of these equations, they must be supplemented with conditions that include:

1) setting the geometry that determines the sample (body);

2) setting the initial condition that determines the temperature distribution in the body at the initial time;

3) setting the boundary conditions of the first, second, third or fourth kind, which determine the laws of heat transfer on the boundary surfaces of the sample (body) under consideration.

For example, the heat equation complements the boundary conditions along the radius in the inner part of the volume and on the outer boundary:

$$\left[\frac{\lambda}{r}\frac{\partial T}{\partial r} + \alpha T\right]_{r=r_1,r_2} = q\big|_{r=r_1,r_2},$$

by angular coordinate:

$$\left[\frac{\partial T}{\partial \varphi}\right]_{\varphi=0,2\pi} = 0.$$

The initial conditions are usually given in the form of known values of the temperature field inside the test sample at the initial time:

$\theta(x,y,z,0) = \theta_0(x,y,z)$.

Boundary conditions can be defined as boundary conditions of the first, second, third, or fourth kind.

The boundary conditions of the first kind are usually set in the form of a known law of temperature change over time on the surface of the sample under study:

$\theta\big|_r = T_1(t)$.

The boundary conditions of the second kind are usually given in the form of known functions of the change in time of the heat flow on the surface of the body:

$$\lambda \left.\frac{\partial \theta}{\partial n}\right|_r = q(t).$$

Boundary conditions of the third kind describe the interaction of a body with the environment according to the law of convective heat transfer proposed by Newton and having the form:

$$q = \alpha\left(\theta|_r - T_b(t)\right),$$

where α – the heat transfer coefficient; $\theta|_r$ – the ground temperature on the earth's surface; $T_b(t)$ – air temperature.

In this case, the boundary condition of the third kind is written as:

$$\lambda \left.\frac{\partial \theta}{\partial z}\right|_r = -\alpha\left(\theta|_r - T_b(t)\right).$$

The boundary conditions of the fourth kind are set at the internal boundaries of the contact of two solids or at the boundaries of the solid – liquid (gas) as follows:

$$\begin{cases} \theta(h-0,t) = \theta(h+0,t) \\ \lambda_1 \dfrac{\partial \theta(h-0,t)}{\partial z} = \lambda_2 \dfrac{\partial \theta(h-0,t)}{\partial z} \end{cases}$$

According to the boundary conditions of the fourth kind, the simultaneous continuity of changes in both temperatures and heat fluxes is ensured at the contact boundary, although the derivatives of the temperature field along the coordinate may have a discontinuity.

In some cases, in practice, boundary conditions of the fourth kind of a special type are used, taking into account the presence of a surface heat source acting $p(t)\left[\frac{w}{m^2}\right]$ on the interface of neighboring layers. For example, if a heat source with a specific surface power $p(t)$ acts on the surface $z = h$, then the boundary conditions of the fourth special type can be written as:

$$\left\{\theta(h-0,t) = \theta(h+0,t),\ \ \lambda_1 \frac{\partial \theta(h-0,t)}{\partial z} - \lambda_2 \frac{\partial \theta(h-0,t)}{\partial z} = p(t).\right.$$

In practice, a mixed boundary value problem of a special type is often used:

$$\begin{cases} \gamma_0 c \dfrac{\partial \theta}{\partial t} = \dfrac{\partial}{\partial z}\left(\dfrac{\partial \theta}{\partial z}\right) \\ \theta(0,t) = T_1, \quad \lambda \left.\dfrac{\partial \theta}{\partial z}\right|_{z=H} = -\alpha\left(\theta|_{z=H} - T_b(t)\right), \ \theta(z,0) = \theta_0(z) \end{cases}$$

In this case, you specify the thermal properties of the soil (sample) $\gamma_0, c, \lambda, \alpha$ and the initial temperature distribution $\theta_0(z)$, air temperature on the earth's surface $T_b(t)$ and soil temperature at the boundary z = 0 – T_1, also sets the depth of the study and the length of time the study of land T.

By this way, it is necessary to determine the distribution of the ground temperature for any $z \in (0, H)$, at any time $t \in (0, T)$.

The resulting problem is called a direct problem, and the desired solution to the temperature distribution depends on the following parameters:

$$\theta = \theta\left(z, t, H, T, \alpha, c, \gamma_0, \lambda, \theta_0, \theta_0(z), T_1, T_b(t)\right).$$

A large number of works, including A.V. Lykov [1], E.M. Kartashov [2], [3] and electronic resources [4], [5].are devoted to the analysis and development of methods for solving boundary value problems of the heat equation.

Currently, both analytical and numerical methods are used to solve boundary value problems of the heat equation. Most analytical solutions allow us to obtain a temperature distribution in a homogeneous medium. Heat transfer processes in complex media are usually modeled by numerical methods, the most common of which are the finite difference method and the finite element method.

Among the analytical methods most often used in the practice of thermophysics, the following are distinguished: classical methods (the method of separation of variables, the method of sources); methods of integral transformations with finite and infinite integration limits (Laplace, Fourier transforms, etc.); methods using the concept of a thermal layer (the integral method of thermal balance, the Shvets method, etc.); variational methods.

Among the methods of constructing difference schemes, the following methods are most widely used: direct formal approximation; integro-interpolation method (IIM); variational-difference methods (Ritz and Galerkin method); the method of approximation of the quadratic functional; the method of summative identities (the method of approximation of the integral identity).

The unified method of approximate solution of differential equations, applicable to a wide class of equations of mathematical physics, is the finite difference method (or the grid method). It is used when it is very difficult or even impossible to present the solution of a boundary value problem in an analytical form. The results of the simulation using the finite difference method have good convergence with the experimental data. Another advantage of this method is the simplicity of its implementation and the versatility of the resulting programs.

1. Inverse problems of thermal conductivity

The solution of inverse problems is carried out within the framework of a mathematical model of the object or process under study and consists in determining the parameters of the mathematical model based on the available experimental information [6] - [8].

If we need to find one of the parameters $\gamma_0, c, \lambda, \alpha$, the resulting problem is called the coefficient inverse problem of thermal conductivity, if we need to find $\theta_0(z)$ – the retrospective inverse problem, and when determining T_1 or $T_b(t)$ it is called the boundary inverse problem.

In this paper, methods for determining the thermal conductivity coefficient are developed by machine learning according to the goal of work.

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Кері жылу өткізгіштік есептеріне арналған машиналық оқыту әдісі

Аңдатпа. Бұл жұмыста машиналық оқыту әдістері мен нейрондық желі әдісін қолдана отырып, сызықтық және сызықтық емес кері есептерді шешу мүмкіндігі зерттеледі. Машиналық оқыту алгоритмдерінің пайда болуымен кері есептерді тезірек және дәл модельдеуге мүмкіндік туды. Машиналық оқыту мен нейрондық желіні кері есептерді шешуде қолдануға болатындығын көрсету үшін есептеу механикасы мен машиналық оқытудың бірігуін ұсынамыз. Алдыңғы міндеттер, ең алдымен, мәліметтер базасын құру үшін шешіледі. Содан кейін бұл мәліметтер базасы машиналық оқыту алгоритмдері мен нейрондық желілерді оқыту үшін қолданылады. Осыдан соң оқытылған алгоритм есептелген өлшемдер бойынша мәселенің шекаралық жағдайларын анықтау үшін пайдаланылады. Ұсынылған әдіс жылу өткізгіштіктің сызықтық/сызықтық емес есептері үшін сыналды, онда шекаралық жағдайлар температураны үш, төрт және бес өлшеу арқылы анықталады. Бұл зерттеу есептеу механикасы мен машиналық оқытудың қарастырылған синтезі тиімді әдіс екенін көрсетеді.

Түйінді сөздер: кері модельдеу, машиналық оқыту, нейрондық желі, жылуөткізгіштік теңдеуі, жылуөткізгіштік коэффициенті, сандық әдістер.

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Метод машинного обучения для обратных задач теплопроводности

Аннотация. В данной работе исследуется потенциал решения обратных задач с линейным и нелинейным поведением с использованием методов машинного обучения и нейросетевого метода. С появлением алгоритмов машинного обучения стало возможным моделировать обратные задачи быстрее и точнее. Чтобы продемонстрировать, что машинное обучение и нейронная сеть могут быть использованы при решении обратных задач, мы предлагаем слияние вычислительной механики и машинного обучения. Передние задачи решаются в первую очередь для создания базы данных. Эта база данных используется для обучения алгоритмов машинного обучения и нейронных сетей. Обученный алгоритм используется для определения граничных условий задачи по предполагаемым измерениям. Предложенный метод апробирован для линейных/нелинейных задач теплопроводности, в которых граничные условия определяются путем проведения трех, четырех и пяти измерений температуры. Это исследование показывает, что предложенное слияние вычислительной механики и машинного обучения является эффективным способом.

Ключевые слова: обратное моделирование, машинное обучение, нейронная сеть, уравнение теплопроводности, коэффициент теплоотдачи, численные методы.

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ЦЕННОСТЬ IT-АУТСОРСИНГА ДЛЯ КЛИЕНТА

Аннотация. *Клиенты ожидают, что ИТ-аутсорсинг превратит ИТ-функции в компактные и динамичные инструменты, которые быстро реагируют на потребности и возможности бизнеса. Но это лишь абстрактные желания. Под ними скрываются множество деталей, на которые клиент обращает внимание: время ответа на запрос, приемлемая цена, качество, коммуникативные навыки специалистов, их вежливость, насколько специалисты понимают проблему клиента с полуслова и так далее.*

В статье были описаны, рассчитаны и проанализированы результаты опроса административно-управленческого персонала IT-аутсорсинговой компании с целью понять, что для клиентов является основной ценностью, на что клиенты обращают наибольшее внимание и как улучшить существующую систему, если основной целью компании является масштабирование и переход в сегмент обслуживания крупного бизнеса.

Ключевые слова*: ценность для клиента, ИТ-аутсорсинг, библиотека инфраструктуры информационных технологий (ITIL), бизнес-процесс, корреляция Пирсона.*

Введение

Первоначально аутсорсинг рассматривался как переход к передаче ответственности за весь ИТ-отдел третьей стороне. Но в последние годы, по мере углубления опыта и знаний, аутсорсинг стал вариантом, который можно применять выборочно или широко к ИТ-деятельности в соответствии с общей стратегией поиска поставщиков [1].

Размер мирового рынка аутсорсинга информационных технологий (ИТ) оценивается в 200–500 миллиардов долларов. Ясно, что клиенты больше не задаются вопросом, стоит ли им отдавать ИТ на аутсорсинг, а скорее задаются вопросом, как им лучше всего использовать этот огромный рынок. Теперь заказчики ожидают от ИТ-аутсорсинга многих бизнес-преимуществ, включая снижение затрат, более качественное обслуживание, внедрение новых технологий, преобразование фиксированных ИТ-бюджетов в переменные ИТ-бюджеты, улучшение бизнес-процессов и даже увеличение доходов [2].

Определение ценности для клиента

Ценность товара или услуги в глазах клиента – это то, насколько успешно будут решены его проблемы и удовлетворены его потребности посредством товара или услуги. Поэтому сформулировать ценности нужно именно с точки зрения клиентов, понимая их так, как понимают их клиенты, и говоря о них то, что говорят об этом сами клиенты.