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Contents

Cyclical Elliptical Pedal Surfaces

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Abstract: Intensive use of geometrical modelling started with the development of computer graphics and CAD/CAM technologies, comprising a wide area of mathematical disciplines. Geometrical modelling is a synthesis of the geometry and computer graphics, which enable us to develop complex mathematical models that would be rather difficult to display without using a computer. The author recognizes two basic methods of research of geometrical models, synthetic and analytic. The synthetic method makes use of geometrical constructions and in the analytic method geometrical objects are characterized by numerical data. The author uses these methods in this contribution. The aim of this research is to show central cyclides (Dupin's cyclides) as a special kind of the cyclical elliptical pedal surfaces. Firstly, applying the method of synthetic geometry, a new class of such surfaces in the 3-dimensional Euclidean space (model of the projective space) is defined. The geometrical construction of these surfaces is dependent on the given ellipse and the position of the pole *P*. It is the point at which the pencil of perpendicular planes passes to the plane of the ellipse, wherein the generating circles of the surface are lying. The parametric equations of the cyclical elliptical surface are derived applying the method of analytic geometry. The author classifies the surfaces according to the number of generating circles with a zero radius. The evolute of the ellipse divides the plane of the ellipse into two areas, Ω_1 and Ω_2. The shape of the surface depends on the position of the pole *P* in the areas of Ω_1 and Ω_2. The surface can have 4, 3 or 2 circles with a zero radius. The author then describes the relationship between these surfaces and the Dupin's cyclides, obtained in the case when the pole *P* is the point on the major axis of the ellipse. Finally, the transformation of these surfaces is shown by changing of the orthonormal base in the parameterization of the generating circles of the surface. The author visualizes the resulting surfaces obtained by the parametric approach in the MAPLE program environment.

Key words: Cyclical elliptical pedal surfaces, creation, classification, Dupin's cyclides.

1. Introduction

Several mathematicians attended to an investigation of cyclides by different ways [1-4]. A survey of various definitions of cyclide, as well as a description of the properties of different shapes of cyclides can be found in Refs. [5-6]. Our aim is to show cyclides as special type of cyclical elliptical pedal surfaces. We use the analytic geometry of curves and surfaces which is well described in Refs. [7-9].

2. Creation of Cyclical Elliptical Pedal Surface and Its Parameterization

2.1 Geometrical Way of Surface Creation

Let us have the ellipse κ and the point *P* in the plane π. Let *K* be the point of the ellipse different from a main vertex. F_1, F_2 are foci of ellipse κ. We construct accompanying lines of the point *K* and by the point *P* perpendicular line *r* to the tangent *t* of ellipse at the point *K*. We denote $L = r \cap t$, $K_1 = r \cap F_1 K$ and $K_2 = r \cap F_2 K$. *L* is the midpoint of $|K_1 K_2|$ and currently the point on the pedal curve of the ellipse κ for the pole *P* (Fig. 1).
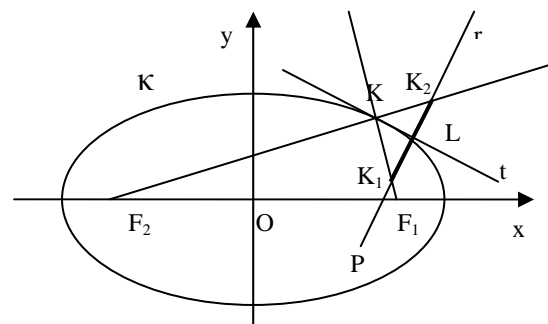

Fig. 1 Situation in the plane π.

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New Inequalities of Qi Type

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Abstract: In this paper, the author studies fractional integral inequalities which provide explicit bounds on unknown functions. By applying the Riemann-Liouville integral operator to some functions defined on the positive real axis, the author establishes sufficient conditions to generate some new fractional integral inequalities of Qi type and finally gives two main results: in the first one, the author uses only functions of independent variables; but in the second one, the author uses functions of independent variables combined with some positive functions. It is to note that in this paper, some interested classical integral inequalities can be deduced as some special cases of the paper's results. In order to illustrate a possible practical use of these results, in the last section of the paper, the author applies the proposed inequalities to the Bagley-Torvik equation which arises in modeling the motion of a rigid plate immersed in a Newtonian fluid. Some other examples that arise in applications are also presented.

Key words: Q inequality, integral inequalities, Riemman-Liouville fractional integral.

1. Introduction

It is well known that the integral inequalities involving functions of independent variables which provide explicit bounds on unknown functions play a fundamental role in the development of the theory of differential equations.

In the last few decades, much significant development of integral inequalities had been established. For details, we refer to Refs. [1-4] and the references therein. Also of importance in deferential equations theory is the study of fractional type inequalities. We refer the reader to Refs. [5-6] for further information and applications. Recall the famous integral inequality of Feng Qi type [7-8]:

$$\int_a^b [f(x)]^{n+2} dx \geq \left[\int_a^b f(x) dx \right]^{n+1} \qquad (1)$$

where

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$f \in C^n(a,b), f^{(i)} \geq 0, 0 \leq i \leq n, f^{(n)}(x) \geq n!, n \in \mathbb{N}.$

Yu and Qi [8] proved that

$$\int_a^b (f(x))^{\delta} dx \geq \left(\int_a^b f dx \right)^{\delta} \qquad (2)$$

for all

$$f \in C(a,b), \int_a^b f(x)\, dx \geq (b-a)^{\propto -1}, \propto > 1$$

Pogany [9] proved that

$$\int_a^b (f(x))^q dx \geq \left(\int_a^b f dx \right)^p \qquad (3)$$

Where f is an integrable function on

$[a,b], p > 0, q > max(1,p)$ and $f(x) \geq (b-a)^{\frac{p-1}{q-p}}.$

Many authors considered deferent generalizations of the Eq. (3), to mention a few in Refs. [10-17] and the references cited therein.

The aim of this paper is to give some new fractional results related to the Eq. (3). For our results, this interested inequality can be deduced as some special cases. Some examples of application are also presented to illustrate the proposed fractional inequalities.

Application of Neural Networks for Predictive Variables in Engineering

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Abstract: This paper proposes a method in order to detect the importance of the input variables in multivariate analysis problems. When there is correlation among predictor variables, the importance of each input variable, when adding variables in the model, can be detected from the knowledge stored in Artificial Neural Network (NN) and it must be taken into account. Neural networks models have been used with the analysis of sensibility, these models predict more accurately the relationship between variables, and it is the way to find a set of forecasting variables in order to be included in the new prediction model. The obtained results have been applied in a system to forecast the volume of wood for a tree, and to detect relationships between input and output variables.

Key words: Artificial neural networks, rule extraction, linear regression model.

1. Introduction

Knowledge acquisition is the bottle-neck in knowledge engineering. Besides being a time-consuming process that makes expert systems very difficult to build, the quality of the acquired knowledge also depends on many aspects, such as the availability of the domain experts, their expertise, their ability and aptitude to express their expertise, or relationship between knowledge engineers and domain experts, and so on [1-4].

Although neural networks have shown very good performance in many application domains, one of their main drawbacks lies in the incapacity to provide an explanation for the underlying reasoning mechanisms [5]. The "explanation capability" of neural networks can be achieved by the extraction of symbolic knowledge [6-8]. In this way, a method for symbolic knowledge extraction as production rules or for construction a predictive function model is proposed,

starting from the weights of the trained neural networks.

Tasks to follow in order to perform, a study of the importance of input variables over output variables are the following ones: the first step is used to classify using a new Bisection method where the patterns of the initial set are divided in several subsets, taking into account that this division is performed iteratively, studying the variation of the weights; the second step is used once the initial pattern set is classify in several subsets and therefore into several neural networks, the importance of each input variable should be analyzed for each different network with sensitivity analysis; and the variation domain of the input variables and the weights must be studied.

The theoretical results described in section 3 have been used in the construction of a rule-oriented knowledge base, applied on a system to predict the load demand for the next day in a power plant.

The last part of this paper presents how the theoretical results of the first part are used now, to build a prediction model. One illustrative example, that show

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Calibrating the Level of Capital: The Way We See It

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Abstract: This paper aims to propose a framework for estimating the optimal levels of capital at banks, elaborating factors such as liquidity and macroeconomic conditions. Firstly, as a preamble, the authors attempt to reorganize the variety of policy proposals for enhancing financial sector regulation. In light of the broad perspective of the prudential policy framework, the authors discuss the role of bank capital in enhancing banking-sector resilience. Secondly, the authors lay out an early warning system (EWS) to predict a financial crisis where the role of capital and liquidity are explicitly captured. Then, the authors apply the EWS as a component of a cost-benefit analysis (CBA) to gauge the benefit from raising capital and liquidity requirements, as more stringent regulations are expected to reduce the probability of financial crisis. On the other hand, financial-sector regulations should come along with certain costs. To quantify the cost, the authors employ some existing macroeconomic models to estimate the cost of raising capital and liquidity requirements. Combining the EWS (for benefit calculation) with the macroeconomic models (for cost calculation), the authors provide a full-fledged CBA framework that can determine the optimal levels of capital that strike the right balance between the costs and benefits of the financial-sector regulation. The main results indicate that the optimal level of bank capital would considerably vary depending on the level of liquidity indicators both on the asset and liability sides of banks' balance sheets as well as macroeconomic conditions, typically represented by housing market inflation. Finally, the CBA framework suggests that banks could stand in a better shape with a counter-cyclical capital buffer to be well-prepared for a prospective distress.

Key words: Capital ratio, liquidity, financial crisis, probit model, bank regulation.

1. Introduction

1.1 Capital Requirement as a (Macro) Prudential Policy Tool

This paper attempts to prepare a framework to assess the optimal level of capital in banks. A straightforward way to set the agenda is to predetermine a question to address: "What level of capital would a banking sector need to weather a (typically) severe distress?" While the question may sound sensible in light of this paper's primary purpose, the authors suggest that calibration of the target level of capital could better be coordinated more closely with other regulatory issues and tools that have been discussed in the preceding efforts to develop

new frameworks of macro-prudential policy. With this lead-off idea in mind, as the preamble, the authors aim to cast the issues revolving around capital requirements in a broader perspective of (macro-) prudential policy. In line with the authors' view, some preceding works, such as Ref. [1], encourage assessing "cumulative impacts" of the various new tools, including the policy proposal to raise the capital requirement, on the table in the policy arena to develop a comprehensive macro-prudential policy framework. This paper may, in part, echo the call by the views in Ref. [1] that taking into account the various tools and issues revolving prudential policies together, rather than dealing with each of them separately, would better calibrate the optimal level of capital in banks. At the outset, the authors discuss how we would underpin "the way we see it" as follows:

Undoubtedly, raising the level of capital (and its extra buffer) would result in certain costs and benefits,

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Data Envelopment Analysis in Estimation of Technical Efficiency Change of Regional Agriculture Production EU, 1989-2007

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Abstract: Assessment of production efficiency in economic activity is a major issue focused on by economists since the middle of the 20th century. One of the methods suitable in this respect is data envelopment analysis (DEA) facilitating the estimation of technical efficiency based on results obtained by a specified set of producers. Dynamics of changes in efficiency in agricultural production may be assessed on the basis of time series of several years. In the study, one of the variants of DEA was applied to economic results recorded in the years 1989-2007 by average farms representing selected regions of the European Union. The resulting individual dynamics of technical efficiency changes were divided into four homogeneous groups to facilitate identification of differences in production technology. These differences were then explained by classical analysis of basic factors use in agricultural production.

Key words: DEA, technical efficiency, variable return to scale, output-efficiency.

1. Introduction

Analysis of technical efficiency of production processes became the focus of interest on the part of economists since the middle of 20th century. Investigations conducted in this field searched for economic sources of competitive advantage of individual companies within specific branches of economy or in relation to countries from selected regions. Farm productivity and efficiency, in particular, was investigated in many papers recently over-viewed by Gorton and Davidova [1]. In turn, the technical and scale efficiency of agricultural production in Poland was analyzed by Latruffe, Balcombe, Davidova and Zawalinska [2] while that in Czech and Slovak by Mathijs, Blaas and Doucha [3].

In the European Union (UE), since the beginning, it has been attempted to eliminate differences between regions, either supporting economically weaker regions or strengthening specific sectors of economy. In particular, the objective of the Common Agricultural Policy (CAP) in the initial period was to assure food security, and in the course of further reforms to increase professional activity of rural communities, as well as improve efficiency of agricultural production.

The aim of the study is to analyze the differences between regional dynamics of changes in technical efficiency of agricultural production in EU. These differences are explained taking into consideration four basic production factors, i.e. labour, land, fixed capital and working capital. The analysis is based on economic results recorded in the years 1989-2007 by average farms representing selected EU regions. The technical efficiency in each year of the analyzed period was

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Modeling and Forecasting Malaria and Dengue Hemorrhagic Fever Incidence and Prevalence in Northern Thailand

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Abstract: Malaria and dengue hemorrhagic fever (DHF) are infectious diseases prevalent in many tropical countries, including Thailand. Thailand is located geographically in a tropical zone and the transmission of malaria and DHF is common, particularly in the upper Northern region of the country. The objective of this study is to identify the patterns of hospital-diagnosed Malaria and DHF incidences by using the previous monthly or quarterly periods of incidences occurring in the upper Northern region of Thailand. The authors use additive plus multiplicative regression models to describe these patterns. The models can be used to forecast malaria and DHF incidences, thus predicting where epidemics are likely to occur. This information can be used to prevent disease outbreaks occurring. Graphical displays showing district and period effects are presented. The results of this study show that historical malaria and DHF incidence rates can be used to provide a useful model for forecasting future epidemics. The graphical display shows the improvement of risk prediction brought about by model. The model, even if based purely on statistical data analysis, can provide a useful basis for allocation of resources for disease prevention.

Key words: Additive model, dengue hemorrhagic fever incidence, malaria incidence.

1. Introduction

Malaria is a biological phenomenon where all the three elements of the infection system, namely man, mosquito and parasite are influenced by various environmental variables. Approximately 40% of population of the world, mostly those living in the world's poorest countries, is at risk of malaria. Every year, more than 500 million people become severely ill with malaria [1].

Malaria in Thailand is endemic in forest regions and most prevalent along the national borders, particularly on the border with Myanmar to the east. Although malaria cases and deaths have fallen substantially since 1999, the disease remains a considerable public health problem.

Dengue hemorrhagic fever (DHF) is a severe disease, particularly among children age under 15 years [2]. It is estimated that there are over 2.5 billion people, or 40% of the world population, living in dengue prevalent areas of the world [3]. According to current estimates, at least 100 countries are endemic for DHF, with over 50 million infections and about 400,000 cases of DHF being reported annually. It is a leading cause of childhood mortality in several Asian countries. A recent study of Poovorawan et al. [4] found DHF to be a major cause of acute hepatic failure in Thai children.

In Thailand, DHF has been and remains a major public health concern. In 1998, it was a leading cause of hospitalization and death, with 29,954 cases diagnosed nationally [5]. This outbreak was the second largest DHF epidemic in Thailand after a similar one that occurred in 1987.

The objective of this study is to identify the patterns

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New Composite Indicator for the Business Tendency Survey

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Abstract: Short-term surveys provide precious information for economic fluctuations analysis. In short-term surveys like the business tendency survey, most of the questions are qualitative and concern the evolution of different economic factors of the business activity. They provide economic information on the present situation and short-term perspectives. Usually, the respondents have to choose between three possible evolutions: increase (improvement, favourable, level higher than the normal), stability (normal) or decrease (unfavourable, level lower than the normal). The balance of opinion is defined as the difference between the proportion of respondents expressing a positive opinion and the proportion expressing a negative opinion. To analyze these types of surveys, the methods are well standardized and use both the multidimensional approach and time series (scoring, dynamic factor analysis, etc.) In this paper, the authors propose a new method of calculating a robust composite indicator based on range median statistics, and on a lexicographical order relation of the individual data. A confidence interval is constructed around these statistics. The indicator's advantage is simplicity of calculation in comparison with the Mitchell, Smith and Weale (2004) index (MSW), while its effectiveness seems to be of the same order. It was used on a Ukrainian dataset for the construction sector. This procedure can be applied to the surveys that contain correlated ordered qualitative answers.

Key words: Business tendency survey, time series, balance of opinion, robust statistics, composite indicators.

1. Introduction

The short-term business tendency surveys (BTS)—also called business opinion or business climate surveys, are carried out to obtain qualitative information for use in monitoring the current business situation and forecasting short-term developments. Information from these surveys has proved of particular value in forecasting turning points in the business cycle. Usually they are conducted as a stratified random sample with a fixed panel. Business tendency surveys ask company managers (businessmen) about the current situation of their business (industry, construction, trade, transport, services) and about their plans and expectations for the near future.

To monitor and forecast short-term economic developments, the BTS are usually conducted with a quarterly or monthly frequency. The scope of the survey is all large and medium-sized businesses operating within a country. For inter-country comparisons, a standard set of business survey questions requires harmonisation at an international level. The system of harmonised BTS was developed and adopted by the OECD in collaboration with the European Commission [1]. General recommendations run from the first step of the process (kinds of activities to be covered, sampling, weighting, periodicity and timing, definition of the variables) through to the finalization of the survey and the treatment of non-responses.

As mentioned above, most of the questions in BTS

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On the Use of SPH for Mechanical Engineering Structural Analyses: An Elastic Linear Case

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Abstract: In this paper the use of Smoothed Particle Hydrodynamics method is presented in the Mechanical Engineering framework. In particular a two dimensional plain strain elastic linear problem is described and solved by two different approaches. Smoothed Particle Hydrodynamics is a meshless computational scheme able to perform an integral representation of a function by means of a smoothing kernel function by involving a finite particle distribution in the discrete formulation. The first approach is derived by the variational formulation of the equilibrium equation, while the second one is a direct differential method. Numerical examples on the cantilever beam problem are implemented to verify and compare the proposed approaches.

Key words: Equilibrium equation, meshless method, smoothed particle hydrodynamics, consistency restoring, variational principle, differential method, finite element method.

1. Introduction

The equilibrium equation in solid mechanics problem is a typical example of elliptic equation and a number of methods to compute the solution have been proposed. Many of them are Finite Element Method based (see for example Refs. [1, 2]) requiring computational expensive grid generation and remeshing, when deformation is significant, resulting in a loss of accuracy.

In recent decades, many approaches to solve partial differential equations are based on meshless methods, which are a valid computational alternative to grid methods in simulating a wide problems variety, also in solid mechanics context [3-6]. Due to their Lagrangian nature, these methodologies are able to solve problems that involve large deformations and moving boundaries [7]. The meshless solvers share common features such as the avoidance of the use of grids, but are different in functions approximation and computational processes [8].

In this paper, the 2D plain strain elastic linear problem is proposed as case study to validate the use of Smoothed Particle Hydrodynamics method in the mechanical framework, considering both the variational formulation of the problem and the direct (differential) method.

Smoothed Particle Hydrodynamics (SPH) [9-12] is a meshless scheme whose attractiveness and popularity is due to the evaluation of unknown field functions and relative differential operators by means of an integral representation [13]. The integral representation is discretized by using a set of *particles* distributed in the problem domain, making the method intrinsically adaptive.

In the broad landscape of meshless methods, SPH is one of few techniques which can be really named as "truly meshless", in fact, it uses any mesh for both field variable approximation and integration. Finally it is computationally efficient and very simple to implement; it has been experimentally demonstrated that computational efficiency is mainly attributable to the mesh absence in the numerical integration.

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Study Fields Optimalization within the Programme Applied Mathematics

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Abstract: The integration of the Czech Republic into the process of European space university education formation makes many demands on the higher education system—from creating new legislation and educational conception to changes in the study programme structure. With regard to the study programme structure, permeability and modular construction of the programme and the actual European Credit Transfer and Accumulation System (ECTS) implementation are some of requirements coming to the fore. The aim of this work is to present an analysis of bachelor study programme Applied Mathematics Structure at the University of Ostrava within the context of the above mentioned requirements.

Key words: European credit transfer and accumulation system (ECTS), permeability, permanence, modularity, study programme structure.

1. Introduction

The involvement of the Czech Republic in the process of creating the European higher education area (hereinafter referred to as the EHEA) makes heavy demands on the higher education system—from creating a new concept, supporting legislation and to changes in the structure of study programmes. The demand that study programmes be of modular design, permeability of study in study programmes which is also connected with the recognition of the degree and implementation of ECTS credit system in compliance with the relevant key characteristics of this system belong to the most frequent requirements concerning the structure of study programmes.

1.1 ECTS

ECTS is a unified system of accumulation and transfer of educational credits within Europe.

The programme started in 1998 with the Sorbonne

Declaration. On the occasion of 700th anniversary of the Paris-Sorbonne, ministries from France, Germany, Italy and the United Kingdom signed the Joint Declaration on Harmonisation of the Architecture of the European higher education system. The Declaration was met with great acclaim and already in 1998 several other countries, including the Czech Republic, joined it. In June of the following year, a meeting of 31 European Education Ministers was held. They signed the Bologna Declaration, i.e. a declaration on establishing the European Higher Education Area by 2010. Among the goals defined in the declaration were claims for creating a system with three degrees of higher education and developing a credit system as a mean to promote students' mobility. At approximately two-year intervals, further conferences were held and there was discussion among ministers, political representatives, representatives of higher education institutions, and students from each country. The problem of the permeability of the system at national and European levels, cooperation in recognition of diplomas, degrees and other academic qualifications

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