ADVANCES IN INTELLIGENT SYSTEMS AND COMPUTING 212

Zhixiang Yin
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Proceedings of The Eighth International Conference on Bio-Inspired Computing: Theories and Applications (BIC-TA), 2013

Springer

Advances in Intelligent Systems and Computing

Volume 212

Editor-in-Chief

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ISSN 2194-5357 ISSN 2194-5365 (electronic)
ISBN 978-3-642-37501-9 ISBN 978-3-642-37502-6 (eBook)
DOI 10.1007/978-3-642-37502-6
Springer Heidelberg New York Dordrecht London

Library of Congress Control Number: 2013935491

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Preface

Bio-Inspired Computing: Theories and Applications (BIC-TA) is one of the flagship conferences on Bio-Computing bringing together the world's leading scientists from different areas of Natural Computing. Since 2006, the conferences have taken place at Wuhan (2006), Zhengzhou (2007), Adelaide (2008), Beijing (2009), Liverpool and Changsha (2010), Malaysia (2011), and India (2012). Following the successes of previous events, The Eighth International Conference on Bio-Inspired Computing: Theories and Applications (BIC-TA 2013) is being organized and hosted in China by Anhui University of Science and Technology, from 12th to 14th July, 2013. BIC-TA 2013 aims to provide a high-level international forum for researchers with different backgrounds working in the related areas to present their latest results and exchange ideas. The conference has four main sections: Evolutionary computing, Neural computing, DNA computing, and Membrane computing. In order to integrate these sections, the conference organizers invited some experts from different areas of Bio-Inspired Computing to give plenary talks. In this conference, more than 500 conference papers were received while 145 papers were recommended to be published in the Springer book series of Advances in Intelligent Systems and Computing and 60 papers were recommended to be published in SCI Journal, the adopting rate was not more than 30 %. Additionally, the growing trend in Emergent Systems has resulted into the inclusion of two other closely related fields, namely Complex Systems, and Computational Neuroscience, in the BIC-TA 2013 event.

BIC-TA 2013 has attracted a wide spectrum of interesting research papers on various aspects of Bio-Inspired Computing with a diverse range of simulation applications, theories, and techniques within the domain. We much hope that this publication will become an important reference source to many students, researchers, and academics in their educational, research, and professional activities.

The authors are to be commended for their valuable contributions. The editors would like to express their sincere gratitude to the reviewers, track chairs, and program committee members, who have done justice to the entire review process and have helped to maintain the quality and clarity of presentation of the papers.

We would like to acknowledge the members of the BIC-TA 2013 organizing committee for their efforts in organizing the conference. The organizing committee benefited from the support it received from the School of Anhui University of Science and Technology. We would also like to thank the members of the BIC-TA steering committee, especially Linqiang Pan and Xu Jin, for their guidance and advice. We are indebted to the members of the BIC-TA program committee and additional reviewers for their diligent and careful reviewing which led to valuable improvements in the accepted papers. Finally, we would like to thank all the presenters and authors for their active participation at BIC-TA 2013, which made the conference a success. Special thanks are given to Springer-Verlag for his encouragement and help to our work. We would like to acknowledge here once again all the college and co-workers who contributed to the success of this interesting and stimulating conference.

It is envisaged that the BIC-TA conference series will continue to grow and include relevant future research and development challenges in this field of Computing.

Huainan, Anhui, January 2013 Xianwen Fang

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Part I
Theories

Remarks on Invariant Method of the Second-Order Linear Differential Equations with Variable Coefficients

Linlong Zhao

Abstract Invariant method was used to solve the linear second-order equations with variable coefficients. We employ the invariant variable method to give the integrable condition of equations and to display the superiority of this method.

Keywords Second order linear differential equation · Invariant variable · Characteristics

1 Introduction

In the second order liner differential equations,

$$y'' + p(x)y' + q(x)y = f(x) \tag{1}$$

As we have already known function p(x) and q(x) with special condition, the Eq. (1) just can be solved with the elementary solution method. Therefore, it is decisive job to look for the new relation for p(x) and q(x) to make the original Eq. (1) become solvable equation. Recently, many authors have worked in this field [1–6]. This method that looking for p(x) and q(x) has no general regulation. So it becomes difficulty to give new relation.

Now, we make use of the invariant argument of the second order linear differential equations to make a discussion on these problems again.

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Z. Yin et al. (eds.), *Proceedings of The Eighth International Conference on Bio-Inspired Computing: Theories and Applications (BIC-TA), 2013*,
Advances in Intelligent Systems and Computing 212,
DOI: 10.1007/978-3-642-37502-6_1, © Springer-Verlag Berlin Heidelberg 2013

2 The Invariant Variable of the Second Order Linear Differential Equations

For Eq. (1), let the following transformation

$$y = z(x)e^{\int \varphi(x)dx} \tag{2}$$

where $\varphi(x)$ is treat to settle function. We can obtain equation as follows

$$z'' + A(x)z' + B(x)z = f(x)e^{-\int \varphi(x)dx} \tag{3}$$

where

$$A(x) = 2\varphi(x) + p(x) \tag{4}$$

$$B(x) = \varphi'(x) + \varphi^2(x) + p(x)\varphi(x) + q(x) \tag{5}$$

Employing the conditions (4) and (5), we get equivalence relation,

$$2p'(x) + p^2(x) - 4q(x) = 2A'(x) + A^2(x) - 4B(x) \tag{6}$$

$$\text{So}, I = 2p'(x) + p^2(x) - 4q(x) \tag{7}$$

which is defined as invariant argument of Eq. (1).

3 The Invariant Method of the Second Order Liner Differential Equations

In 1998, Zhao Linlong [7, 8] obtained the invariant method of the second order linear differential equations.

Theorem 1 [7] *For Eq.* (1), *if there is differential function* $\varphi(x)$ *satisfying the following condition*,

$$I = 2p'(x) + p^2(x) - 4q(x) = 2\varphi'(x) + \varphi^2(x) \tag{8}$$

then Eq. (1) *has the solution as follows*,

$$y = z(x)e^{\frac{1}{2}\int (\varphi(x) - p(x))dx} \tag{9}$$

where $z(x)$ *satisfying the following linear differential equations*,

$$W' + \varphi(x)W = f(x)e^{-\frac{1}{2}\int (\varphi(x) - p(x))dx} \, (W = z') \tag{10}$$

4 The Superiority of Invariant Method for the Second Order Liner Differential Equations

Obviously, whether the invariant variable method of second order linear differential equations can be used is completely determined by the existence of the function $\varphi(x)$ of Eq. (8). This method make look for relation $p(x), q(x)$ with regulation to solve the function $\varphi(x)$ in the Eq. (8) instead of looking for this relation with no regulation. This method is simple and has the following advantages.

4.1 Connection Solvable Method of Second Order Linear Differential Equation Constant Coefficient with Variable Coefficient

In Eq. (1), if $p(x), q(x)$ are constants, then differential function $\varphi(x)$ for Eq. (8) satisfies the following form

$$\varphi(x) = \pm\sqrt{I}\left(I = p^2 - 4q\right) \tag{11}$$

Corollary 1 *If the invariant variable is a constant coefficient* I *for Eq.* (8), *then the solution to Eq.* (1) *has the following form*

$$y = z(x)e^{\frac{1}{2}\int(\sqrt{I}-p(x))dx} \tag{12}$$

where $I = 2p'(x) + p^2(x) - 4q(x)$, *and* $z(x)$ *satisfies one order linear differential equation*

$$W' + \sqrt{I}W = f(x)e^{-\frac{1}{2}\int(\sqrt{I}-p(x))dx}\left(W = z', I = 2p'(x) + p^2(x) - 4q(x)\right) \tag{13}$$

4.2 Connection Second Order Linear Homogeneous Differential Equation and Non-Homogeneous Equation

In Eq. (1), if $f(x)$=0, then Eq. (10) can be changed into the following form

$$W' + \varphi(x)W = 0 \tag{14}$$

where $W = z'$, $\varphi(x)$ satisfying Eq. (8) .

Corollary 2 *In the second order Euler ordinary differential equations*

$$x^2\mathrm{y}'' + axy' + by = f(x)\,(a, b) \text{ is coefficients} \tag{15}$$

If there is a constant coefficient k satisfying

$$k^2 - 2k - a^2 + 2a + 4b = 0 \tag{16}$$

then Eq. (1) *has the solution*

$$y = z(x)e^{\frac{1}{2}\int(\frac{k}{x}-p(x))dx} = x^{\frac{k}{2}}z(x)e^{-\frac{1}{2}\int p(x)dx} \tag{17}$$

where $z(x)$ satisfies the one order linear ordinary differential equation

$$W' + \frac{k}{x}W = x^{-\frac{k}{2}-2}f(x)e^{\frac{1}{2}\int p(x)dx}\,(W = z') \tag{18}$$

According to the relation of invariant variable $I = 2p'(x) + p^2(x) - 4q(x) = \frac{-2a}{x^2} + \frac{a^2}{x^2} - \frac{4b}{x^2}$,

Let $\varphi(x) = \frac{k}{x}$ *(k is coefficient, then* $I = 2\varphi'(x) + \varphi^2(x) = \frac{-2k}{x^2} + \frac{k^2}{x^2}$, *we can get Eqs.* (16) *and* (18).

4.3 Connection Second Order Linear Differential Equation the General Solution with Special Solution

According to Eq. (10), we will get

$$\mathrm{z}' = (\int f(x)e^{\frac{1}{2}\int(p(x)-\varphi(x))dx}dx + c)e^{-\int(\varphi(x)dx} \tag{19}$$

$$\mathrm{z} = \int(\int f(x)e^{\frac{1}{2}\int(p(x)-\varphi(x))dx}dx + c_1)e^{-\int(\varphi(x)dx}dx + c_2 \tag{20}$$

then Eq. (1) has the general solution

$$y = (\int(\int f(x)e^{\frac{1}{2}\int(p(x)-\varphi(x))dx}dx + c_1)e^{-\int(\varphi(x)dx}dx + c_2)e^{\frac{1}{2}\int(\varphi(x)-p(x))dx} \tag{21}$$

When $c_1 = c_2 = 0$, Eq. (1) has the special solution

$$y = (\int(\int f(x)e^{\frac{1}{2}\int(p(x)-\varphi(x))dx}dx)e^{-\int(\varphi(x)dx}dx)e^{\frac{1}{2}\int(\varphi(x)-p(x))dx} \tag{22}$$

Corollary 3 *If there is differential function $\varphi(x)$ for Eq.* (1) *satisfying* (8), *then there is the special solution of Eq.* (22)

$$\int (\int f(x)e^{\frac{1}{2}\int (p(x)-\varphi(x))dx}dx)e^{-\int (\varphi(x)dx}dx \tag{23}$$

In coefficient linear differential Eq. (1), this expands the special solution of function $f(x)$ form,

$$f(x)= (A_m(x)\cos\beta x + B_n(x)\sin\beta x)e^{\alpha x} \tag{24}$$

where $A_m(x), B_n(x)$ is polynomial, α, β is real.

5 Discussion About invariant Method of the Second Order Linear Differential Equations

5.1 *The Integrable of the Second-Order Linear Differential Equation*

In 1841, Liouville proved Riccati equation

$$y' = y^2 + x^2 \tag{25}$$

which has not elementary solution. But by transformation $y = \frac{z'}{-z}$, then it become another no elementary solution equation

$$z'' + x^2 z = 0 \tag{26}$$

5.2 *Discussion for Integrable Condition of the Second Order Linear Differential Equations*

In Eq.(8), Let $\varphi(x) = p(x) + 2\mu(x)\sqrt{\varepsilon q(x)}$, $\mu'(x) = -\sqrt{\varepsilon q(x)}(\mu^2(x) + \frac{a}{2}\mu(x) + 1)$,

when $q(x) > 0$, $\varepsilon = 1$ or $q(x)<0$, $\varepsilon = -1$, a is constant, we can obtain

$$\frac{q'(x) + 2p(x)q(x)}{q^{\frac{3}{2}}(x)} = 2a \tag{27}$$

Theorem 2[3] *If Eq.* (1) *satisfies* (27), *then it can be transformed into the following equation with constant coefficient*

$$\varepsilon\frac{d^2y}{dt^2}+\frac{a}{2}\frac{dy}{dt}+y=\frac{f(x)}{q(x)}\ (q(x)>0,\varepsilon=1\,or\,q(x)<0,\varepsilon=-1) \tag{28}$$

In 2000, it was given in [8]. It is clear that the method invariant variable is general and need not to look integrable type of Eq. (1) avoiding the previous integrable type.

6 Applications

Example 1 [3] *Solve an equation* $y''+\frac{2}{x}y'+y=\frac{1}{x}\cos x$, *where* $r(x)=\frac{\sin x}{x}$ *is special solution of equation.*

Solve: $I=2(\frac{2}{x})'+(\frac{2}{x})^2-4=-4$. *By Corollary 1, we has the equation,*

$$W'+2iW=\frac{1}{x}\cos xe^{-\frac{1}{2}\int(2i-\frac{2}{x})dx}=\cos xe^{-ix}$$

$$\begin{aligned}z'=W&=(\int\cos xe^{ix}dx+c)e^{-2ix}=(\int(\cos^2x+i\cos x\sin x)dx+c)e^{-2ix}\\&=\frac{x}{2}e^{-2ix}-\frac{i}{4}+ce^{-2ix}\end{aligned}$$

$$\begin{aligned}z&=\int(\frac{x}{2}e^{-2ix}-\frac{i}{4}+ce^{-2ix})dx=\frac{ix}{4}e^{-2ix}+\frac{1}{8}e^{-2ix}-\frac{i}{4}x+c_1e^{-2ix}+c_2\\&=\frac{ix}{4}e^{-2ix}-\frac{i}{4}x+c_1e^{-2ix}+c_2\end{aligned}$$

Then we obtain the general solution of equation,

$$y=z(x)e^{\frac{1}{2}\int(2i-\frac{2}{x})dx}=\frac{i}{4}e^{-ix}-\frac{i}{4}e^{ix}+\frac{c_1}{x}e^{-ix}+\frac{c_2}{x}e^{ix}=\frac{\sin x}{2}+\frac{c_1}{x}e^{-ix}+\frac{c_2}{x}e^{ix}$$

The new method for solving the linear second-order equations displays the superiority that it solves method without the special solution of equation.

Example 2 [2] *Solve an equation* $y''-\frac{2}{x}y'+\frac{2}{x^2}y=x(cosx-xsinx)$.

Solve: *In Euler differential equation, by Corollary 2, has the equation* $k^2-2k-4-4+8=k^2-2k=0$, *Let* $k=0$, *then has the equation*

$$W'=x^{-2}f(x)e^{\frac{1}{2}\int p(x)dx}=x(cosx-xsinx)e^{-\int\frac{1}{x}dx}=cosx-xsinx\,(W=z')$$

$$w=z'=xcosx+\mathrm{c},z=xsinx-cosx+c_1x+c_2$$

$$\begin{aligned} y =& z(x)e^{-\frac{1}{2}\int p(x)dx} = (xsinx - cosx + c_1x + c_2)e^{\int \frac{1}{x}dx} \\ =& x(xsinx - cosx + c_1x + c_2) \end{aligned}$$

Example 3 [6] *Solve an equation* $y'' - 4y' + 4y = (3x^2 - 2x + 1)\mathrm{e}^{2x}$.

Solve: Since $I = 16 - 16 = 0$. *By corollary 1, we has the equation*

$$W' = f(x)e^{\frac{1}{2}\int p(x)dx} = \left(3x^2 - 2x + 1\right)\mathrm{e}^{2x}\mathrm{e}^{-2x} = 3x^2 - 2x + 1$$

$$Z' = W = x^3 - x^2 + x + c,\ z = \frac{1}{4}x^4 - \frac{1}{3}x^3 + \frac{1}{2}x^2 + c_1x + c_2$$

Then we has the general solution of equation

$$y = z(x)e^{-\frac{1}{2}\int p(x)dx} = (\frac{1}{4}x^4 - \frac{1}{3}x^3 + \frac{1}{2}x^2 + c_1x + c_2)e^{2x}$$

Acknowledgments Supported by the National Science Foundation of China under Grant Nos (61152003).

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Convergence Analysis on Immune Optimization Solving CCP Problems

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Abstract This work concentrates on studying the property of convergence of a sample allocation-based immune optimization approach used in solving linear or nonlinear chance-constrained programming (CCP) with general random variables. First, we make some theoretical studies about existence of optimal reliable solutions and give an approximate relation between the true CCP and the sample average approximation problem, depending on some statistic and analysis theory. Second, a bio-inspired immune optimization approach is developed to assume solving CCP problems. Our theoretical analysis shows that such approach, which is capable of being formulated by a non-homogeneous Markov model, is convergent. Experimentally, performance searching curves reveal that the approach can obtain valuable performances including the optimized quality, noisy suppression and convergence.

Keywords Chance-constrained programming · Immune optimization · Sample average approximation · Convergence

1 Introduction

In practical optimization problems, objective functions and constraints are often inevitably perturbed by uncertainty, and hence a search procedure becomes extremely difficult when searching for their solutions [1]. CCP is a kind of

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Z. Yin et al. (eds.), *Proceedings of The Eighth International Conference on Bio-Inspired Computing: Theories and Applications (BIC-TA), 2013*,
Advances in Intelligent Systems and Computing 212,
DOI: 10.1007/978-3-642-37502-6_2, © Springer-Verlag Berlin Heidelberg 2013