Compressor performance modelling method based on support vector machine nonlinear regression algorithm

Yulong Ying, Siyu Xu, Jingchao Li and Bin Zhang

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Review timeline
Original submission: 12 September 2019
Revised submission: 20 November 2019
Final acceptance: 29 November 2019

Review History
RSOS-191596.R0 (Original submission)

Review form: Reviewer 1

Is the manuscript scientifically sound in its present form?
Yes

Are the interpretations and conclusions justified by the results?
Yes

Is the language acceptable?
Yes

Do you have any ethical concerns with this paper?
No

Have you any concerns about statistical analyses in this paper?
No
Recommendation?
Accept with minor revision (please list in comments)

Comments to the Author(s)
1) The abstract should be condensed and reorganized. The abstract should point out the contribution of the paper over some qualitative and quantitative results obtained by the proposed approach.
2) The quality of the table 2 could be improved, please edit it.
3) The written English should be modified carefully to avoid grammatical errors.

Review form: Reviewer 2

Is the manuscript scientifically sound in its present form?
No

Are the interpretations and conclusions justified by the results?
Yes

Is the language acceptable?
Yes

Do you have any ethical concerns with this paper?
No

Have you any concerns about statistical analyses in this paper?
Yes

Recommendation?
Major revision is needed (please make suggestions in comments)

Comments to the Author(s)
Review Comments
Manuscript Number: RSOS-191596
Title: Compressor characteristic modeling method based on Support Vector Machine Regression Algorithm
In this work, author proposed a novel method for representing the compressor characteristic line based on support vector machine (SVM) nonlinear regression and provide the comparative analysis with three neural network algorithm, i.e., BP, RBF and Elman neural networks to verify and validate the performance in terms of perspective of interpolation and generalization accuracy and computational time. Results show that the SVM regression algorithm has better interpolation and extrapolation performance than the other three neural networks. Additionally, the SVM regression method proposed in the article has better computational real-time performance while ensuring the required accuracy. Generally, topic is interesting and contribution has some merits but before publication in the journal I have few suggestions:
1. The title "Compressor characteristic modeling method based on Support Vector Machine Regression Algorithm" have no reflection of novelty and clarity. Well-known problem and its analysis with well-known method. Please revise if possible.
2 These sentences in abstract “The development of gas turbine industry is of essential strategic significance for promoting the adjustment, transformation and upgrading of national industrial structure and improving the quality and efficiency of economic growth. In the process of actual
thermodynamic modeling, only part of compressor characteristic lines containing design condition points can be obtained by test bed or flow analysis scheme. Therefore, it is necessary to propose a method for expressing the compressor characteristic map with perfect interpolation and generalization performance in order to accurately calculate the thermal calculation of the compressor under variable working conditions.” should not be the part of abstract, it better suited in introduction section. While elaborative quantitative and qualitative advantages of the proposed procedure should be provided in the abstract of the manuscript.

3. Introduction section is too short and mainly based on old reference (Only two to three from last five years). However, introduction can be made appropriate by segmented in the introduction into three separate subsections, (1 Introduction, 1.1 related work, 1.2 Innovative contribution, 1.3 organization. Moreover, in the introduction section salient feature of the proposed methodology should be listed in bullet form.

4. Literature review regarding the journal applications of neural networks in diversified field in lacking in the introduction section. Authors are advice to see the recent paper of Prof. Dumitru Baleanu [r1-r3] and Prof A. M. Wazwaz [r4] and see how in different applications ANN is applied such as astrophysics, plasma physics, atomic physics, thermodynamics, electromagnetic, machines, nanotechnology, fluid mechanics, electrohydrodynamics, signal processing, power, energy, bioinformatics, economic and finance are provided there.

   [r1] A new stochastic computing paradigm for the dynamics of nonlinear singular heat conduction model of the human head. The European Physical Journal Plus, 2018 133(9), p.364.
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   [r4] Neuro-heuristics for nonlinear singular Thomas-Fermi systems. Applied Soft Computing, 2018 65, pp.152-169.

5. Please provide a pseudocode of the proposed methodology in elaborative manner, i.e., statements and equations for input, output and intermediate steps.

6. Results and discussion section is too brief. Please include the elaborative description of the results and provide a comparative study on statistical analysis (T-Test, ANOVA etc) of the results.

7. Conclusion section the role of present study for future development of the research should be narrated.

Decision letter (RSOS-191596.R0)

30-Oct-2019

Dear Ms Xu,

The editors assigned to your paper (“Compressor characteristic modeling method based on Support Vector Machine Regression Algorithm”) have now received comments from reviewers. We would like you to revise your paper in accordance with the referee and Associate Editor suggestions which can be found below (not including confidential reports to the Editor). Please note this decision does not guarantee eventual acceptance.

Please submit a copy of your revised paper before 22-Nov-2019. Please note that the revision deadline will expire at 00.00am on this date. If we do not hear from you within this time then it will be assumed that the paper has been withdrawn. In exceptional circumstances, extensions may be possible if agreed with the Editorial Office in advance. We do not allow multiple rounds
of revision so we urge you to make every effort to fully address all of the comments at this stage. If deemed necessary by the Editors, your manuscript will be sent back to one or more of the original reviewers for assessment. If the original reviewers are not available, we may invite new reviewers.

To revise your manuscript, log into http://mc.manuscriptcentral.com/rsos and enter your Author Centre, where you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions," click on "Create a Revision." Your manuscript number has been appended to denote a revision. Revise your manuscript and upload a new version through your Author Centre.

When submitting your revised manuscript, you must respond to the comments made by the referees and upload a file "Response to Referees" in "Section 6 - File Upload". Please use this to document how you have responded to the comments, and the adjustments you have made. In order to expedite the processing of the revised manuscript, please be as specific as possible in your response.

In addition to addressing all of the reviewers' and editor's comments please also ensure that your revised manuscript contains the following sections as appropriate before the reference list:

- Ethics statement (if applicable)
  If your study uses humans or animals please include details of the ethical approval received, including the name of the committee that granted approval. For human studies please also detail whether informed consent was obtained. For field studies on animals please include details of all permissions, licences and/or approvals granted to carry out the fieldwork.

- Data accessibility
  It is a condition of publication that all supporting data are made available either as supplementary information or preferably in a suitable permanent repository. The data accessibility section should state where the article's supporting data can be accessed. This section should also include details, where possible of where to access other relevant research materials such as statistical tools, protocols, software etc can be accessed. If the data have been deposited in an external repository this section should list the database, accession number and link to the DOI for all data from the article that have been made publicly available. Data sets that have been deposited in an external repository and have a DOI should also be appropriately cited in the manuscript and included in the reference list.

  If you wish to submit your supporting data or code to Dryad (http://datadryad.org/), or modify your current submission to dryad, please use the following link: http://datadryad.org/submit?journalID=RSOS&manu=RSOS-191596

- Competing interests
  Please declare any financial or non-financial competing interests, or state that you have no competing interests.

- Authors’ contributions
  All submissions, other than those with a single author, must include an Authors’ Contributions section which individually lists the specific contribution of each author. The list of Authors should meet all of the following criteria; 1) substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approval of the version to be published.
All contributors who do not meet all of these criteria should be included in the acknowledgements.

We suggest the following format:
AB carried out the molecular lab work, participated in data analysis, carried out sequence alignments, participated in the design of the study and drafted the manuscript; CD carried out the statistical analyses; EF collected field data; GH conceived of the study, designed the study, coordinated the study and helped draft the manuscript. All authors gave final approval for publication.

• Acknowledgements
Please acknowledge anyone who contributed to the study but did not meet the authorship criteria.

• Funding statement
Please list the source of funding for each author.

Once again, thank you for submitting your manuscript to Royal Society Open Science and I look forward to receiving your revision. If you have any questions at all, please do not hesitate to get in touch.

Kind regards,
Anita Kristiansen
Editorial Coordinator
Royal Society Open Science
openscience@royalsociety.org

on behalf of Dr Derek Abbott (Associate Editor) and R. Kerry Rowe (Subject Editor)
openscience@royalsociety.org

Reviewers’ Comments to Author:
Reviewer: 1

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2) The quality of the table 2 could be improved, please edit it.
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Reviewer: 2

Comments to the Author(s)
Review Comments
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1. The title "Compressor characteristic modeling method based on Support Vector Machine Regression Algorithm" have no reflection of novelty and clarity. Well-known problem and its analysis with well-known method. Please revise if possible.

2. These sentences in abstract “The development of gas turbine industry is of essential strategic significance for promoting the adjustment, transformation and upgrading of national industrial structure and improving the quality and efficiency of economic growth. In the process of actual thermodynamic modeling, only part of compressor characteristic lines containing design condition points can be obtained by test bed or flow analysis scheme. Therefore, it is necessary to propose a method for expressing the compressor characteristic map with perfect interpolation and generalization performance in order to accurately calculate the thermal calculation of the compressor under variable working conditions.” should not be the part of abstract, it better suited in introduction section. While elaborative quantitative and qualitative advantages of the proposed procedure should be provided in the abstract of the manuscript.

3. Introduction section is too short and mainly based on old reference (Only two to three from last five years). However, introduction can be made appropriate by segmented in the introduction into three separate subsections, (1 Introduction, 1.1 related work, 1.2 Innovative contribution, 1.3 organization. Moreover, in the introduction section salient feature of the proposed methodology should be listed in bullet form.

4. Literature review regarding the journal applications of neural networks in diversified field in lacking in the introduction section. Authors are advice to see the recent paper of Prof. Dumitru Baleanu [r1-r3] and Prof A. M. Wazwaz [r4] and see how in different applications ANN is applied such as astrophysics, plasma physics, atomic physics, thermodynamics, electromagnetic, machines, nanotechnology, fluid mechanics, electrohydrodynamics, signal processing, power, energy, bioinformatics, economic and finance are provided there.

[r1] A new stochastic computing paradigm for the dynamics of nonlinear singular heat conduction model of the human head. The European Physical Journal Plus, 2018 133(9), p.364.
[r2] A new stochastic computing paradigm for nonlinear Painlevé II systems in applications of random matrix theory. 2018 The European Physical Journal Plus, 133(7), p.254.
[r3] Design of computational intelligent procedure for thermal analysis of porous fin model. 2019 Chinese Journal of Physics, 59, pp.641-655.
[r4] Neuro-heuristics for nonlinear singular Thomas-Fermi systems. Applied Soft Computing, 2018 65, pp.152-169.

5. Please provide a pseudocode of the proposed methodology in elaborative manner, i.e., statesments and equations for input, output and intermediate steps.

6. Results and discussion section is too brief. Please include the elaborative description of the results and provide a comparative study on statistical analysis (T-Test, ANOVA etc) of the results.

7. Conclusion section the role of present study for future development of the research should be narrated.

Author's Response to Decision Letter for (RSOS-191596.R0)

See Appendix A.
29-Nov-2019

Dear Ms Xu,

It is a pleasure to accept your manuscript entitled "Compressor performance modeling method based on support vector machine nonlinear regression algorithm" in its current form for publication in Royal Society Open Science.

Please ensure that you send to the editorial office an editable version of your accepted manuscript, and individual files for each figure and table included in your manuscript. You can send these in a zip folder if more convenient. Failure to provide these files may delay the processing of your proof. You may disregard this request if you have already provided these files to the editorial office.

You can expect to receive a proof of your article in the near future. Please contact the editorial office (openscience_proofs@royalsociety.org) and the production office (openscience@royalsociety.org) to let us know if you are likely to be away from e-mail contact -- if you are going to be away, please nominate a co-author (if available) to manage the proofing process, and ensure they are copied into your email to the journal.

Due to rapid publication and an extremely tight schedule, if comments are not received, your paper may experience a delay in publication.

Please see the Royal Society Publishing guidance on how you may share your accepted author manuscript at https://royalsociety.org/journals/ethics-policies/media-embargo/.

Thank you for your fine contribution. On behalf of the Editors of Royal Society Open Science, we look forward to your continued contributions to the Journal.

Kind regards,

Lianne Parkhouse
Royal Society Open Science
openscience@royalsociety.org

on behalf of Dr Derek Abbott (Associate Editor) and R. Kerry Rowe (Subject Editor)
openscience@royalsociety.org

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To: Journal Editor
Re: Response to reviewers

Dear Editor,

Thank you for allowing a resubmission of our manuscript, with an opportunity to address the reviewers’ comments.

We are uploading (a) our point-by-point response to the comments (below) (Response to Referees), (b) an updated manuscript with red highlighting indicating changes, and (c) a clean updated manuscript without highlights (main document).

**For Reviewer 1**

Recommendation: Accept (minor edits)

Comments:

1) The abstract should be condensed and reorganized. The abstract should point out the contribution of the paper over some qualitative and quantitative results obtained by the proposed approach.

   **Answer:** We have rewritten the abstract and added some simple analyses, which points out the contribution of the paper over some qualitative and quantitative results obtained by the proposed approach. Thanks for your advice.

2) The quality of the table 2 could be improved, please edit it.

   **Answer:** We have modified this part in the paper and made each table to keep a consistent number of significant digits. Thanks for your advice.

3) The written English should be modified carefully to avoid grammatical errors.

   **Answer:** We have modified basic grammatical errors in the paper with red highlighting indicating changes. Thanks for your advice.

**Reviewer 2**

Recommendation: Accept (minor edits)

Comments:

Title: Compressor characteristic modeling method based on Support Vector Machine Regression Algorithm

In this work, author proposed a novel method for representing the compressor characteristic line based on support vector machine (SVM) nonlinear regression and provide the comparative analysis with three neural network algorithm, i.e., BP, RBF and Elman neural networks to verify and validate the performance in terms of perspective of interpolation and generalization accuracy and computational time. Results show that that the SVM regression algorithm has better interpolation and extrapolation performance than the other three neural networks. Additionally, the SVM regression method proposed in the article has better computational real-time performance while ensuring the required accuracy. Generally, topic is interesting and contribution has some merits but before publication in the journal I have few suggestions:

1. The title "Compressor characteristic modeling method based on Support Vector Machine Regression Algorithm" have no reflection of novelty and clarity. Well-known problem and its analysis with well-known method. Please revise if possible.
We have changed the original title to "Compressor performance modeling method based on support vector machine nonlinear regression algorithm" with a minor change after careful consideration, which is considered to be more in line with the content of the article.

Thanks for your advice.

2. These sentences in abstract “The development of gas turbine industry is of essential strategic significance for promoting the adjustment, transformation and upgrading of national industrial structure and improving the quality and efficiency of economic growth. In the process of actual thermodynamic modeling, only part of compressor characteristic lines containing design condition points can be obtained by test bed or flow analysis scheme. Therefore, it is necessary to propose a method for expressing the compressor characteristic map with prefect interpolation and generalization performance in order to accurately calculate the thermal calculation of the compressor under variable working conditions.” should not be the part of abstract, it better suited in introduction section. While elaborative quantitative and qualitative advantages of the proposed procedure should be provided in the abstract of the manuscript.

We have moved the sentences in abstract to introduction section and provided elaborative quantitative and qualitative advantages of the proposed procedure in the abstract, such as the analyses of root mean square error values and calculation time.

Thanks for your advice.

3. Introduction section is too short and mainly based on old reference (Only two to three from last five years). However, introduction can be made appropriate by segmented in the introduction into three separate subsections, (1) Introduction, 1.1 related work, 1.2 Innovative contribution, 1.3 organization. Moreover, in the introduction section salient feature of the proposed methodology should be listed in bullet form.

We have modified the introduction section and added several new articles from last five years. The related works are recombined according to the suggestions. The shortcomings of the traditional methods in predicting the interpolation and extrapolation performance of compressor characteristic maps are explained, and the novelty and advantages of the proposed method are introduced in this paper, which is listed in bullet form.

Thanks for your advice.

4. Literature review regarding the journal applications of neural networks in diversified field in lacking in the introduction section. Authors are advice to see the recent paper of Prof. Dumitru Baleanu [r1-r3] and Prof A. M. Wazwaz [r4] and see how in different applications ANN is applied such as astrophysics, plasma physics, atomic physics, thermodynamics, electromagnetic, machines, nanotechnology, fluid mechanics, electrohydrodynamics, signal processing, power, energy, bioinformatics, economic and finance are provided there.

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[r4] Neuro-heuristics for nonlinear singular Thomas-Fermi systems. Applied Soft Computing, 2018 65, pp.152-169.

We have read the journal applications of neural networks in diversified field and added the suggested literatures as well as new literature [r19] in the introduction section.

Thanks for your advice.

5. Please provide a pseudocode of the proposed methodology in elaborative manner, i.e., statements and equations for input, output and intermediate steps.

The pseudocode of the proposed methodology as follows:
Input: the pressure ratio and the rotational speed in compressor characteristic parameters
Output: the mass flow rate and the isentropic efficiency in compressor characteristic parameters
Steps:
(1) All sample data must be normalized.
(2) Establishment of the SVM model.
1) The best width parameter (which is represented by the letter g in the program) and balance factor (which is represented by the letter c in the program) are determined by a grid optimization method.
   ① The value range of c and g is from -10 to 10, and the interval is 0.5.
   ② The cg is set to a zero matrix of 41x41(41 is the dimension of c and g). The initialization of best c
and best $g$ are zero. Set five-fold cross validation mode, and the error is Inf. Set tolerance of termination criterion is 0.0001.

③ Generate $c_{g(i,j)}$ within the value range using for loop ($i=1:41, j=1:41$).

④ Substitute into SVM model for training and judge whether $c_{g(i,j)}$ at this time meets the termination conditions.

⑤ If the ④ met, the cycle is terminated to obtain the best $c$ and best $g$. Otherwise, step ③ continues.

2) The insensitive coefficient is 0.01.

(3) Simulation Prediction of the SVM algorithm.

(4) The model output data subjects to an inverse normalization process.

(5) The experimental results are compared and analyzed.

Thanks for your advice.

6. Results and discussion section is too brief. Please include the elaborative description of the results and provide a comparative study on statistical analysis (T-Test, ANOVA etc) of the results.

**Answer:** We have added the elaborative description of the results and a comparative study on statistical analysis with red highlighting indicating changes, such as the analyses of root mean square error values and calculation time.

Thanks for your advice.

7. Conclusion section the role of present study for future development of the research should be narrated.

**Answer:** We have modified the part in conclusion section and narrated the advantages of the present study for future development of the research.

Thanks for your advice.

**Additional Statement:**

In addition to addressing all of the reviewers' and editor's comments please also ensure that your revised manuscript contains the sections as appropriate before the reference list:

**Answer:** We have revised the manuscript and contained the required sections as appropriate before the reference list.

Thanks.