Review History

RSOS-180065.R0 (Original submission)

Review form: Reviewer 1

Is the manuscript scientifically sound in its present form?
No

Are the interpretations and conclusions justified by the results?
No

Is the language acceptable?
Yes

Is it clear how to access all supporting data?
No

Do you have any ethical concerns with this paper?
No
Have you any concerns about statistical analyses in this paper?
No

Recommendation?
Reject

Comments to the Author(s)
Dear Author(s)

Ref: Submission Optimization of sand-casting process parameters and missing data prediction

Thank you for submitting your work to the International Journal of Royal Society Open Science.

We regretfully conclude that sentences in this paper seem to have been borrowed from other published articles.

We do thank you for your interest in the International Journal of Royal Society Open Science. There are the some points, which are to be taken care of.
1. On Page No. 2 line No. 25-28: is a contradictory statement, how can data be missed and would lead to waste of resources.
2. Some of the statement in “Introduction” are not relevant e.g. line No. 31-40 etc. on Page 2.
3. No source is given for all the formulas.
4. Most of the Abbreviations are not defined.
5. After giving a small description of methods, jumped to results. No problem formulation is given
6. There is no range given for the process parameters for optimization.
7. On Page 10 line No 18, GP, GCS “positive indicator” and for MC “negative indicator” on which base, how it is being decided. Line No. 21-23 self contradictory.
8. Figure No. 4 is not explained.
9. Model is not formulated.
10. Conclusion is not self explanatory.
11. Some of the references are not referred at all in the text and some are not even relevant to topic itself.

I have looked through your paper, and I have to decline it.
Respectfully,
Best Regards,

Review form: Reviewer 2

Is the manuscript scientifically sound in its present form?
No

Are the interpretations and conclusions justified by the results?
No

Is the language acceptable?
No
Is it clear how to access all supporting data?
Not Applicable

Do you have any ethical concerns with this paper?
No

Have you any concerns about statistical analyses in this paper?
No

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

Comments to the Author(s)
To optimize the process parameters in sand casting, a method based on gray relational analysis is presented and BP neural network is used to predict missing data in this paper. I have the following major concerns regarding this paper:
1. There are a lot of issues on the language expression, some sentence patterns are not used correctly.
2. The relationship between parameters optimization and data missing prediction can’t be found. It seems the two key points proposed in this paper are fragmented.
3. Both gray relational analysis and BP neural network are quite conventional methods. This paper devotes much space (about 7 pages) describing the basic principle of common methods, and there is little improvement.
4. From my point of view, BP neural network is a simple but not an effective method for missing data prediction in this paper. In fact, people are not interested in the process of network training and its parameter selection. It’s meaningless for common methods like BP NN. What is the advantage of the method proposed in this paper? There should be more comparison between different missing data predictions.
5. In chapter 4. Discussion, there should be deeper analysis but not similar content like overview.

Decision letter (RSOS-180065.R0)

01-Feb-2018

Dear Dr Xu:

Manuscript ID RSOS-180065 entitled “Optimization of sand-casting process parameters and missing data prediction” which you submitted to Royal Society Open Science, has been reviewed. The comments from reviewers are included at the bottom of this letter.

In view of the criticisms of the reviewers, the manuscript has been rejected in its current form. However, a new manuscript may be submitted which takes into consideration these comments.

Please note that resubmitting your manuscript does not guarantee eventual acceptance, and that your resubmission will be subject to peer review before a decision is made.

You will be unable to make your revisions on the originally submitted version of your manuscript. Instead, revise your manuscript and upload the files via your author centre.

Once you have revised your manuscript, go to https://mc.manuscriptcentral.com/rsos and login
to your Author Center. Click on "Manuscripts with Decisions," and then click on "Create a Resubmission" located next to the manuscript number. Then, follow the steps for resubmitting your manuscript.

Your resubmitted manuscript should be submitted by 01-Aug-2018. If you are unable to submit by this date please contact the Editorial Office.

Please note that Royal Society Open Science will introduce article processing charges for all new submissions received from 1 January 2018. Charges will also apply to papers transferred to Royal Society Open Science from other Royal Society Publishing journals, as well as papers submitted as part of our collaboration with the Royal Society of Chemistry (http://rsos.royalsocietypublishing.org/chemistry). If your manuscript is submitted and accepted for publication after 1 Jan 2018, you will be asked to pay the article processing charge, unless you request a waiver and this is approved by Royal Society Publishing. You can find out more about the charges at http://rsos.royalsocietypublishing.org/page/charges. Should you have any queries, please contact openscience@royalsociety.org.

We look forward to receiving your resubmission.

Kind regards,
Alice Power
Editorial Coordinator
Royal Society Open Science
openscience@royalsociety.org

on behalf of Professor Jun Fu (Associate Editor) and R. Kerry Rowe (Subject Editor)
openscience@royalsociety.org

Associate Editor Comments to Author (Professor Jun Fu):

The reviewers pointed out the lack of scientific novelty and effectiveness of significant techniques in this manuscript. After my carefully reading, I concur with reviewers and thus my recommendation is Reject and allow resubmission.

Reviewer: 1

Comments to the Author(s)
Dear Author(s)

Ref: Submission Optimization of sand-casting process parameters and missing data prediction

Thank you for submitting your work to the International Journal of Royal Society Open Science.

We regretfully conclude that sentences in this paper seem to have been borrowed from other published articles.

We do thank you for your interest in the International Journal of Royal Society Open Science. There are the some points, which are to be taken care of.
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9. Model is not formulated.
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11. Some of the references are not referred at all in the text and some are not even relevant to topic itself.

I have looked through your paper, and I have to decline it.

Respectfully,
Best Regards,

Reviewer: 2

Comments to the Author(s)
To optimize the process parameters in sand casting, a method based on gray relational analysis is presented and BP neural network is used to predict missing data in this paper.
I have the following major concerns regarding this paper.
1. There are a lot of issues on the language expression, some sentence patterns are not used correctly.
2. The relationship between parameters optimization and data missing prediction can’t be found. It seems the two key points proposed in this paper are fragmented.
3. Both gray relational analysis and BP neural network are quite conventional methods. This paper devotes much space (about 7 pages) describing the basic principle of common methods, and there is little improvement.
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5. In chapter 4. Discussion, there should be deeper analysis but not similar content like overview.

Author's Response to Decision Letter for (RSOS-180065.R0)
See Appendix A.

RSOS-180349.R0

Review form: Reviewer 3

Is the manuscript scientifically sound in its present form?
Yes
Are the interpretations and conclusions justified by the results?
Yes

Is the language acceptable?
No

Is it clear how to access all supporting data?
Yes

Do you have any ethical concerns with this paper?
No

Have you any concerns about statistical analyses in this paper?
No

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

Comments to the Author(s)
The English need revisions, and the process of optimization needs clarification, there is no information about the application of entropy to the available data

Decision letter (RSOS-180349.R0)

08-Oct-2018

Dear Dr Xu:

Manuscript ID RSOS-180349 entitled "Optimization of sand casting process parameters and missing data prediction" which you submitted to Royal Society Open Science, has been reviewed. The comments from reviewer(s) are included at the bottom of this letter.

In view of the criticisms of the reviewer(s), I must decline the manuscript for publication in Royal Society Open Science at this time. However, a new manuscript may be submitted which takes into consideration these comments.

Please note that resubmitting your manuscript does not guarantee eventual acceptance, and that your resubmission will be subject to re-review by the reviewer(s) before a decision is rendered.

You will be unable to make your revisions on the originally submitted version of your manuscript. Instead, revise your manuscript using a word processing program and save it on your computer.

Once you have revised your manuscript, go to https://mc.manuscriptcentral.com/rsos and login to your Author Center. Click on "Manuscripts with Decisions," and then click on "Create a Resubmission" located next to the manuscript number. Then, follow the steps for resubmitting your manuscript.

You may also click the below link to start the resubmission process (or continue the process if you
have already started your resubmission) for your manuscript. If you use the below link you will not be required to login to ScholarOne Manuscripts.

*** PLEASE NOTE: This is a two-step process. After clicking on the link, you will be directed to a webpage to confirm. ***

https://mc.manuscriptcentral.com/rsos?URL_MASK=140880b8211c4ec8bd0d7df9c31953ea

Because we are trying to facilitate timely publication of manuscripts submitted to Royal Society Open Science, your resubmitted manuscript should be submitted by 07-Apr-2019. If you are unable to submit by this date please contact the Editorial Office for options.

Please note that Royal Society Open Science will introduce article processing charges for all new submissions received from 1 January 2018. Charges will also apply to papers transferred to Royal Society Open Science from other Royal Society Publishing journals, as well as papers submitted as part of our collaboration with the Royal Society of Chemistry (http://rsos.royalsocietypublishing.org/chemistry). If your manuscript is submitted and accepted for publication after 1 Jan 2018, you will be asked to pay the article processing charge, unless you request a waiver and this is approved by Royal Society Publishing. You can find out more about the charges at http://rsos.royalsocietypublishing.org/page/charges. Should you have any queries, please contact openscience@royalsociety.org.

I look forward to a resubmission.

Kind regards,
Royal Society Open Science Editorial Office
Royal Society Open Science
openscience@royalsociety.org

on behalf of Professor Jun Fu (Associate Editor) and Professor R. Kerry Rowe (Subject Editor)
openscience@royalsociety.org

Associate Editor Comments to Author (Professor Jun Fu):
A reviewer pointed out that this manuscript lacked the information about the application of entropy to the available data and the clarification for the process of optimization. Additionally, sentences in this paper seem to have been borrowed from other published articles according to the result of iThenticate for plagiarism checking. Thus my recommendation is Reject & allow resubmission.

Reviewer comments to Author:
Reviewer: 3

Comments to the Author(s)
the English need revisions, and the process of optimization needs clarification, there is no information about the application of entropy to the available data

Author's Response to Decision Letter for (RSOS-180349.R0)

See Appendix B.
RSOS-181860.R0

Review form: Reviewer 4

Is the manuscript scientifically sound in its present form?  
Yes

Are the interpretations and conclusions justified by the results?  
Yes

Is the language acceptable?  
No

Is it clear how to access all supporting data?  
Yes

Do you have any ethical concerns with this paper?  
No

Have you any concerns about statistical analyses in this paper?  
I do not feel qualified to assess the statistics

Recommendation?  
Accept with minor revision (please list in comments)

Comments to the Author(s)  
Clarity of equations and figures (Like Figure 1, 3, 4) need to be improved.  
Explanation is required for each equation to improve the readability of the paper.  
Original data set need to be added as Appendix

Review form: Reviewer 5 (Manickam Ramachandran)

Is the manuscript scientifically sound in its present form?  
No

Are the interpretations and conclusions justified by the results?  
No

Is the language acceptable?  
Yes

Is it clear how to access all supporting data?  
Not Applicable

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
1. Give more importance for the experiment and not on the basis of the optimization tool
2. More justification needed on why this optimization tool is used and why not others.
3. Why authors have chosen the factors of performance parameters and what all other possible performance parameters in sand casting explain in details.

Decision letter (RSOS-181860.R0)

04-Jun-2019
Dear Dr Xu,

The Subject Editor assigned to your paper ("Optimization of sand casting performance parameters and missing data prediction") has 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 27-Jun-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 each of 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 before the reference list:
• Ethics statement
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 has 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 has 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-181860

• 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,
Alice Power
Editorial Coordinator
Royal Society Open Science
openscience@royalsociety.org

on behalf of R. Kerry Rowe (Subject Editor)
openscience@royalsociety.org

Reviewer comments to Author:
Reviewer: 4

Comments to the Author(s)
Clarity of equations and figures (Like Figure 1, 3, 4) need to be improved.
Explanation is required for each equation to improve the readability of the paper.
Original data set need to be added as Appendix

Reviewer: 5

Comments to the Author(s)
Review Comments
1. Give more importance for the experiment and not on the basis of the optimization tool
2. More justification needed on why this optimization tool is used and why not others.
3. Why authors have chosen the factors of performance parameters and what all other possible performance parameters in sand casting explain in details.

Author’s Response to Decision Letter for (RSOS-181860.R0)

See Appendix C.

RSOS-181860.R1 (Revision)

Review form: Reviewer 5 (Manickam Ramachandran)

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

Recommendation?
Accept as is

Comments to the Author(s)
Nice work done

Decision letter (RSOS-181860.R1)

15-Jul-2019

Dear Dr Xu,

I am pleased to inform you that your manuscript entitled "Optimization of sand casting performance parameters and missing data prediction" is now accepted for publication in Royal Society Open Science.

You can expect to receive a proof of your article in the near future. Please contact the editorial office (openscience_proofs@royalsociety.org and openscience@royalsociety.org) to let us know if you are likely to be away from e-mail contact. Due to rapid publication and an extremely tight schedule, if comments are not received, your paper may experience a delay in publication.

Royal Society Open Science operates under a continuous publication model (http://bit.ly/cpFAQ). Your article will be published straight into the next open issue and this will be the final version of the paper. As such, it can be cited immediately by other researchers. As the issue version of your paper will be the only version to be published I would advise you to check your proofs thoroughly as changes cannot be made once the paper is published.

On behalf of the Editors of Royal Society Open Science, we look forward to your continued contributions to the Journal.

Kind regards,
Andrew Dunn
Royal Society Open Science Editorial Office
Royal Society Open Science
openscience@royalsociety.org

on behalf of Professor Jun Fu (Associate Editor) and R. Kerry Rowe (Subject Editor)
openscience@royalsociety.org
Reviewer comments to Author:
Reviewer: 5

Comments to the Author(s)
Nice work done

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Follow Royal Society Publishing on Facebook:
https://www.facebook.com/RoyalSocietyPublishing.FanPage/
Read Royal Society Publishing's blog: https://blogs.royalsociety.org/publishing/
Dear Editor,

We thank you and the anonymous reviewers for giving us a constructive suggestions which will help us to improve the quality of the paper. Here we submit a new version of our manuscript, which has been modified according to the reviewers' suggestions.

The point to point responds to the reviewers' comments are listed as following, and we also setting up procedure of partial content.

To Dr Power
Response: Thank you for the comments in the E-mail. As you also state as follow.

Please do NOT deposit your manuscript figure or table files in the Dryad repository (http://datadryad.org/) -- this may cause unnecessary delays. Only datasets, code, or other digital research materials not already reported in your manuscript or included as electronic supplementary information should be included in the Dryad repository.

All relevant figures and tables are provided in the paper, therefore we upload the code as the electronic supplementary materials, and revise the data accessibility as follow.

Data accessibility. The code that supporting this paper has been uploaded as electronic supplementary materials.

******************************************************************************

Reviewer: 1

Comment 1: On Page No. 2 line No. 25-28: is a contradictory statement, how can data be missed and would lead to waste of resources.
Response: Thank you for the comments on the paper. It’s our fault that wish to express as much content as possible in one sentence, which caused a misunderstanding. The recorded parameters data might be lost due to improper care, such as the tally book lost, or the storage data computer breakdown. Remeasurement of the missing data needs a lot of money, manpower and time, which would lead to a waste of resources. Therefore, those sentences are revised as follows:

In the sand casting process, a portion of the recorded parameters data might be lost due to improper care, such as the tally book lost, or the storage data computer breakdown. Remeasurement of the missing data needs a lot of money, manpower and time, which would lead to a waste of resources. In addition, it is often difficult to find sand samples from the original casting batch due to the continuous production. Therefore, it was important and necessary here to predict the missing data based on existing data.

Comment 2: Some of the statement in "Introduction" are not relevant e.g. line No. 31-40 etc. on Page 2.
Response: Thank you for your instructive suggestions. Partial content on page 2 line 31-40 does not have much relevance indeed, so we delete some content and revise those sentences by logic as follows:

The frequently used prediction techniques include BP neural network [27–29], gray system theory [30], principal component analysis [31], support vector machine [32], and Monte Carlo methods [33]. Among these prediction methods, BP neural network is a kind of nonlinear mathematical model that simulates nonlinear process of any degree. The biggest advantage of this model is that it can be trained and tested repeatedly, and finally it can approach any complicated nonlinear function. For example, Guo [29] has proposed a hybrid wind speed-forecasting method based on BP neural network.

Comment 3: No source is given for all the formulas.
Response: Thank you very much to point out this question in our manuscript. We are sorry for this mistake. The formulas sources are added in the Gray relational analysis section as follows:

The mean method was applied to nondimensionalize the evaluation indicators, shown in formula 1 [16].

(1)

After dimensionless, the original data matrix of evaluation indicators was transferred as follows.

and the ideal project be .

With dimensionless evaluation indicators, let the ideal project be the reference sequence and the evaluation project be the sequence to be compared, in which case the gray relational coefficient of the jth evaluation indicator of the ith evaluation project can be achieved according to formula 2 [18].

(2)

The significant difference between gray relational coefficients was increased and might result in data distortion, which caused by the maximum absolute value being too large. To avoid this situation, the
resolution coefficient was introduced in formula 2, and usually set to .

Let the evaluation indicator weights of projects evaluated be , in which case the GRD of projects evaluated was obtained according to formula 3 [17].

(3)
The larger the GRD, the closer the ith project evaluated was to the ideal project. Accordingly, the order of the projects evaluated was confirmed.

The formulas sources are added in the Entropy weight method section as follows:
The procedure of the objective entropy weight method was presented below [22]. From the original data matrix Y, the data proportion was calculated based on formula 4.

(4)
The entropy of evaluation indicators was achieved according to formula 5.

(5)
The entropy weight of evaluation indicators was calculated based on formula 6.

(6)
From the calculating process, the smaller the entropy, the larger the variation in evaluation indicators, the more information it provided, and the larger weight it should be given.

The formulas in the BP neural network section are mainly deduced by ourselves, therefore there is few source in this part.

Comment 4: Most of the Abbreviations are not defined.
Response: Thank you for your valuable comments. The abbreviations that don't well known are defined in the paper as follows:
Among these process parameters, VQ is the ability that gas to penetrate high molecular material under a certain degree of pressure and time; WCS refers to the ability of object to resist external pressure under the saturated water condition; MC is the percentage of water content to the total mass of the object; Com is the proportion of the volume change of the object under a certain degree of pressure.

GRD refers to the relational degree between the project evaluated and the ideal project.

Comment 5: After giving a small description of methods, jumped to results. No problem formulation is given.
Response: Thank you for your careful reading of our manuscript. The problem formulation was added in the Introduction section as follows.
When selecting the optimization sand casting process parameters, usually one parameter in batch A reach the ideal value, and another parameter in batch B reach the ideal value, but not all the parameters in one batch can reach the ideal value at the same time. Therefore, it's of great significance to select the optimization process parameters in single batch. The common optimization method of sand casting process parameters is Taguchi's method [12], but this method requires much experimentation and increases costs, which is counter to its purpose of reducing costs. Therefore, it was necessary to find a simple method for optimizing sand casting process parameters. A novel optimization method of process parameters based on gray relational analysis was introduced here. Once the optimization process parameters were achieved, sand casting should refer to that batch to ensure safe casting and improve casting quality. But if some batches have data missing, they should be deleted and can't be used for optimizing process parameters, which will have a bad influence on optimizing process parameters. What's more, the optimization process parameters are less likely to be achieved due to short of enough valid data. Remeasurement of the missing data needs a lot of money, manpower and time, which would lead to a waste of resources. In addition, it is often difficult to find sand samples from the original casting batch due to the continuous production. Therefore, it was important and necessary here to predict the missing data based on existing data. In the sand casting process, a portion of the recorded parameters data might be lost due to improper care, such as the tally book lost, or the storage data computer breakdown. Here, BP neural network [29] was introduced to predict missing data of sand casting. As there's few papers published refer to the basic principle of BP neural network, therefore correlative theory of BP neural network was deduced to let readers have a better understanding of this model.

Comment 6: There is no range given for the process parameters for optimization.
Response: Thank you for the comments on the paper. We are sorry for not describing the range for the process parameters for optimization. There is interaction effect among these process parameters. With increased compactability, the wet compressive strength of sand increased. After the compactability reached a certain level, the wet compressive strength did not increase much. However, the venting quality decreased rapidly with continued increased compactability. It needs more data support to give the range for the process parameters for optimization. Therefore, we just select the optimization batch
22 based on the given data.

Comment 7: On Page 10 line No 18, GP, GCS “positive indicator” and for MC “negative indicator” on which base, how it is being decided. Line No. 21-23 self contradictory.
Response: Thank you for your careful work. It’s our fault that don’t explanation clearly in the manuscript. Therefore, we add corresponding content in the paper as follows.
Assuming that all parameters were within a reasonable range, meeting the normal production of sand casting. The VQ and WCS are the larger the better assessment indicators, therefore they are positive indicators. The MC is the smaller the better assessment indicator, so it’s negative indicator. There is interaction effect among these process parameters. Com refers to the volume change of green sand under a certain degree of pressure. With increased Com, the WCS of sand increased. After the Com reached a certain level, the WCS did not increase much. But, the VQ decreased rapidly with continued increased Com. If the parameter Com was too large, the parameter VQ would be small; otherwise, if the parameter Com was too small, the parameter WCS would also be small. Therefore, Com belonged to the moderate indicator category, not too large or too small.

Comment 8: Figure No. 4 is not explained.
Response: Thank you for the comments on the paper. We have added the explanation about Figure No. 4 according to you suggestion as follows.
As was shown in Figure 4, the little circle refers to the actual fitting data, the blue line represents the function relationship between target and output of training samples, and the imaginary line represents the output was equal to the target. The function relationship between target and output of training samples was shown in formula 33.
\[
\text{Output} \approx 0.967 \times \text{Target} + 0.0033 \quad (33)
\]
The correlation coefficient of fitting function was R=0.98037. The output and target of the training samples were basically equal (Fig. 4). But due to poor correspondence between the training samples, the output and target of individual samples still had great error, which was consistent with the analysis results (Fig. 3).

Comment 9: Model is not formulated.
Response: We are grateful for your suggestion. It’s our fault that ignoring this part, therefore we add one section Procedure for model formulated as follows.
Procedure for model formulated
The main procedure for this composite model formulated based on gray relational analysis and BP neural network were as follows.
(1) Determining the weight of evaluation indicators. To avoid the influence of human factors, the weight of evaluation indicators were determined by the objective entropy weight method, which also saved a lot of manpower. The larger variation degree in the evaluation indicators, indicating that the evaluated projects had good discrimination in this regard, and a larger weight should be given to these evaluation indicators.
(2) Selecting the optimization process parameters of sand casting. The GRD can be achieved after the weight of process parameters were determined, and the larger the GRD, the closer the evaluated project was to the ideal project. Accordingly, the order of the evaluated projects was confirmed.
(3) Predicting the missing data of process parameters. Dividing the process parameters data into training samples and prediction samples. Using the training samples for training BP neural network, then predicting the missing data based on the trained BP neural network. This paper also provided a new method for determining the number of hidden neurons in a network.

Comment 10: Conclusion is not self explanatory.
Response: Thank you for the comments on this paper. We have revised the Conclusion by logic as follows.
A composite optimization and prediction model of sand casting process parameters was proposed based on gray relational analysis and BP neural network. The main conclusions were as follows.
First, to avoid the influence of human factors, the weights of evaluation indicators were achieved based on the objective entropy weight method and the results were 0.3812, 0.2231, 0.0594, and 0.3364 for the VQ, WCS, MC, and Com, respectively. The weight of parameter VQ was the biggest, indicating that the sand batch had good discrimination in this regard.
Second, the GRDs of foundry sand were obtained according to gray relational analysis after the weight of process parameters were determined, and the results showed that sample batch 22 possessed the largest GRD. Thus, it was advised that process parameters of sand castings refer to batch 22 to ensure safety casting and improve casting quality.
Third, the process parameters data were divided into training samples and prediction samples. The
mean square error of training samples was the smallest when the number of hidden neurons was 9 and
the epoch 140 when training BP neural network, and the relative error of the prediction samples was
0.62% based on this trained BP neural network. The relevant theory was deduced before predicting
missing data, such that there will be a general understanding regarding the prediction principle of BP
neural network.

Fourth, to demonstrate the validity and feasibility of BP neural network adopted in the process of
missing data prediction, gray system theory was applied to compare the result of missing data
prediction. The relative error of predictive value was 2.64% based on gray system theory. The results
showed that the predictive value of BP neural network was more precision than gray system theory.

Comment 11: Some of the references are not referred at all in the text and some are not even relevant
to topic itself.
Response: Thank you for your instructive suggestions. We looked through the references carefully to
guarantee that all the references were referred in the text, and also we substituted some less relevant
references.

Reviewer: 2
Comment 1: There are a lot of issues on the language expression, some sentence patterns are not used
correctly.
Response: Thank you for your careful reading of our manuscript. We are very sorry for our language
mistakes in the paper. According to the comments from you, we polished the manuscript with a
professional assistance in writing.

Comment 2: The relationship between parameters optimization and data missing prediction can't be
found. It seems the two key points proposed in this paper are fragmented.
Response: Thank you for your instructive suggestions. We add some transitional content to connect
these two parts as follows according to the comments from you.
Once the optimization process parameters were achieved, sand casting should refer to that batch to
ensure safe casting and improve casting quality. But if some batches have data missing, they should be
deleted and can't be used for optimizing process parameters, which will have a bad influence on
optimizing process parameters. What's more, the optimization process parameters are less likely to be
achieved due to short of enough valid data. Remeasurement of the missing data needs a lot of money,
manpower and time, which would lead to a waste of resources. In addition, it is often difficult to find
sand samples from the original casting batch due to the continuous production. Therefore, it was
important and necessary here to predict the missing data based on existing data. In the sand casting
process, a portion of the recorded parameters data might be lost due to improper care, such as the tally
book lost, or the storage data computer breakdown. Here, BP neural network [29] was introduced to
predict missing data of sand casting. As there's few papers published refer to the basic principle of BP
neural network, therefore correlative theory of the BP neural network was deduced to let readers have a
better understanding of this model.

Comment 3: Both gray relational analysis and BP neural network are quite conventional methods. This
paper devotes much space (about 7 pages) describing the basic principle of common methods, and there
is little improvement.
Response: Thank you for the comments on this paper. We really agree with your viewpoints that gray
relational analysis and BP neural network are quite conventional methods. In practical application, we
usually get the results based on the procedure of model. But if we didn't know the basic principle of
model, we could not get the right results. In addition, if we ignored the basic principle of these model in
the paper, readers will be confused about how to get results. What's more, there is few papers published
in English refer to the basic principle of BP neural network, therefore correlative theory of the BP neural
network was deduced to let readers have a better understanding of this model. Also, this paper provided
a new method for determining the number of hidden neurons in a network according to the mean square
error of training samples.

Comment 4: From my point of view, BP neural network is a simple but not an effective method for
missing data prediction in this paper. In fact, people are not interested in the process of network training
and its parameter selection. It's meaningless for common methods like BP NN. What is the advantage of
the method proposed in this paper? There should be more comparison between different missing data
predictions.
Response: Thank you for the comments on this paper. This paper provided a new method for
determining the number of hidden neurons in a network according to the mean square error of training samples, therefore we should have a better understanding of the network training process. The advantage of the method proposed were added in the paper as follows. The advantages of the composite model proposed in this paper were as follows. First, optimization process parameters can contribute to reducing foundry defects and improving casting quality as well as ensuring safety in sand casting. Second, prediction of missing data can avoid repetitive waste of resources and the difficulties of retesting. Third, this paper provided a new method for determining the number of hidden neurons in a network according to the mean square error of training samples. The added content of compare with gray system theory was as follow.

4.1 Compare with gray system theory
To demonstrate the validity and feasibility of BP neural network adopted in the process of missing data prediction, this section compare the result of missing data prediction with GM(1,1) model. GM(1,1) model is one basic and important part in the gray system theory, which refers to first order Gray Model in one variable [20]. The brief procedure of GM(1,1) model was as follows [20]. Let the original data sequence be and the accumulation data sequence , where can be calculated based on formula 34.

\[(34)\]

Suppose the matrix accord with exponential change law, and the whitenization equation of GM(1,1) model is as follow.

\[(35)\]

Let be the initial conditions, solve the equation 35 and the predictive formula of can be achieved, shown in 36.

\[(36)\]

The predictive formula of the original data sequence is shown in formula 37, calculated as .

\[(37)\]

The parameters a and b are based on the least squares estimate of GM(1,1) model, shown in formula 38.

\[(38)\]

where the matrix B and Y are as follow.

The background value is mean sequence of , calculated by formula 39.

\[(39)\]

Suppose VQ process parameters of the first 39 batches were the original data sequence, then the predictive formula was shown in formula 40 based on the above procedures.

\[(40)\]

Therefore, the VQ predictive value of the 40th batch was 180.1235 according to formula 40, and the relative error was 2.64%. It can be seen that the predictive value of BP neural network was more precision than gray system theory. It's mainly because that BP neural network takes advantage of more information, and BP neural network is a kind of nonlinear mathematical model that can simulates nonlinear process of any degree. The biggest advantage of this model is that it can be trained and tested repeatedly, and finally it can approach any complicated nonlinear function.

Comment 5: In chapter 4. Discussion, there should be deeper analysis but not similar content like overview.
Response: Thank you for your valuable advice. The Discussion was revised as follows.

4. Discussion
4.1 Compare with gray system theory
To demonstrate the validity and feasibility of BP neural network adopted in the process of missing data prediction, this section compare the result of missing data prediction with GM(1,1) model. GM(1,1) model is one basic and important part in the gray system theory, which refers to first order Gray Model in one variable [20]. The brief procedure of GM(1,1) model was as follows [20]. Let the original data sequence be and the accumulation data sequence , where can be calculated based on formula 34.

\[(34)\]

Suppose the matrix accord with exponential change law, and the whitenization equation of GM(1,1) model is as follow.

\[(35)\]

Let be the initial conditions, solve the equation 35 and the predictive formula of can be achieved, shown in 36.

\[(36)\]

The predictive formula of the original data sequence is shown in formula 37, calculated as .
The parameters $a$ and $b$ are based on the least squares estimate of GM(1,1) model, shown in formula 38.

where the matrix $B$ and $Y$ are as follow.

The background value is mean sequence of , calculated by formula 39.

Suppose VQ process parameters of the first 39 batches were the original data sequence, then the predictive formula was shown in formula 40 based on the above procedures.

Therefore, the VQ predictive value of the 40th batch was 180.1235 according to formula 40, and the relative error was 2.64%.

It can be seen that the predictive value of BP neural network was more precision than gray system theory. It’s mainly because that BP neural network takes advantage of more information, and BP neural network is a kind of nonlinear mathematical model that can simulates nonlinear process of any degree. The biggest advantage of this model is that it can be trained and tested repeatedly, and finally it can approach any complicated nonlinear function.

4.2 Discussion of results

The present results confirmed that the composite model proposed in this paper was successfully applied to sand casting. This was the first report in this field of the optimization of process parameters based on gray relational analysis and predictions of missing data based on BP neural network. The advantages of the composite model proposed in this paper were as follows. First, optimization process parameters can contribute to reducing foundry defects and improving casting quality as well as ensuring safety in sand casting. Second, prediction of missing data can avoid repetitive waste of resources and the difficulties of retesting. Third, this paper provided a new method for determining the number of hidden neurons in a network according to the mean square error of training samples.

Motivated by previous studies on gray relational analysis [15–17], this method was introduced into the field of sand casting for process parameters optimizing for the first time in this paper. The larger the GRD, the closer the project evaluated was to the ideal project. Accordingly, the order of the projects evaluated was confirmed. The GRD of sample batch 22 was the largest, so sample batch 22 was the optimization process parameters of sand casting. The results showed that gray relational analysis can be easily used for process parameters optimizing of sand casting. Different from Taguchi's method [12], which requires a lot of experimentation, gray relational analysis is less demanding on the quantity and regularity of samples and can be easily calculated without any discrepancy between calculated results and quantitative analysis results. In the process of determining assessment indicators weights, to eliminate the influence of human factors, such as subjective [19,20] and integrated [24–26] weight methods, the objective entropy weight method [22] was adopted, which also significantly decreased manpower.

In determining the number of hidden neurons, there were not consistent results [38–41]. This paper provided a new method for determining the number of hidden neurons according to the mean square error of training samples. The results showed that mean square error of training samples was the smallest when the number of hidden neurons was 9 and the epoch 140 when training BP neural network, and the relative error of the prediction samples was 0.62%. BP neural network is a widely used prediction technique, but there is few studies refer to the basic principle [27–29], which does not conducive to the improvement of the algorithm. Therefore, relevant theory of BP neural network was deduced before predicting missing data, such that there will be a general understanding of the prediction principle. To demonstrate the validity and feasibility of BP neural network adopted in the process of missing data prediction, gray system theory [20] was applied to compare the result of missing data prediction. The relative error of predictive value was 2.64% based on gray system theory. The results showed that the predictive value of BP neural network was more precision than gray system theory. The composite model proposed in this paper can be used for related research in this field.

To simplify the discussion, the identification coefficient in formula 2 was only set as 0.5. Future study should focus on the influence of the identification coefficient in optimizing process parameters as well as the influence of different training functions in BP neural network on the prediction results.

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Dear Editor and Reviewers,

We thank you for giving us constructive suggestions which will help us to improve the quality of the paper. Here we submit a new version of our manuscript, which has been modified according to the your instructive suggestions. The point to point responds to the your comments are listed as following:

Comments to Authors:

Associate Editor Comments to Author (Professor Jun Fu):
A reviewer pointed out that this manuscript lacked the information about the application of entropy to the available data and the clarification for the process of optimization. Additionally, sentences in this paper seem to have been borrowed from other published articles according to the result of iThenticate for plagiarism checking. Thus my recommendation is Reject & allow resubmission.

Reviewer comments to Author:
Reviewer: 3

Comments to the Author(s)
the English need revisions, and the process of optimization needs clarification, there is no information about the application of entropy to the available data

Response: Thank you for your instructive suggestion. The manuscript has been revised according to your advice as follows.

(1) there is no information about the application of entropy to the available data
Response: Thank you for your valuable advice. The information about the application of entropy to the available data has been added in the manuscript as follows.

In order to get the GRD of evaluation indicators, their weights should be know first. The weights of the evaluation indicators, including VQ, WCS, MC, and Com, were achieved by entropy weight method based on formulas (4)–(6), shown in Table 2.

| Indicators | VQ   | WCS  | MC   | Com  |
|------------|------|------|------|------|
| e_j        | 0.946| 0.9505| 0.9501| 0.9498|
| w_j        | 0.252| 0.2475| 0.2495| 0.251|

(2) the process of optimization needs clarification,
Response: Thank you for your valuable and thoughtful comment. The process of optimization has been added in the manuscript as follows.

3.1. Optimization of performance parameters based on gray relational analysis

Sand casting performance parameters have a significant impact on casting quality, such that selection of the appropriate performance parameters was needed. Taking 40 batches of floor sand
in the casting line, the original data of performance parameters in this foundry sand sample were measured, including venting quality (VQ), wet compressive strength (WCS), moisture content (MC), and compactability (Com) (Table 1) [37]. Among these performance parameters, VQ is the ability that gas to penetrate high molecular material under a certain degree of pressure and time; WCS refers to the ability of object to resist external pressure under the saturated water condition; MC is the percentage of water content to the total mass of the object; Com is the proportion of the volume change of the object under a certain degree of pressure.

| Batch No. | Original data | Gray relational coefficient |
|-----------|---------------|-----------------------------|
|           | VQ (m³N⁻¹S⁻¹) | WCS (MPa) | MC (%) | Com (%) | VQ | WCS | MC | Com |
| 1         | 170           | 0.155     | 3.69   | 40      | 0.4286 | 0.7218 | 0.674 | 0.705 |
| 2         | 175           | 0.16      | 3.56   | 38      | 0.5    | 1     | 0.9394 | 0.5036 |
| 3         | 160           | 0.15      | 3.65   | 40      | 0.3333 | 0.5647 | 0.7382 | 0.705 |
| 4         | 175           | 0.155     | 3.63   | 40      | 0.5    | 0.7218 | 0.7751 | 0.705 |
| 5         | 170           | 0.155     | 3.6    | 40.5    | 0.4286 | 0.7218 | 0.8379 | 0.7833 |
| 6         | 165           | 0.16      | 3.66   | 42      | 0.375  | 1     | 0.721 | 0.8704 |
| 7         | 170           | 0.15      | 3.68   | 41      | 0.4286 | 0.5647 | 0.689 | 0.8812 |
| 8         | 180           | 0.155     | 3.6    | 41.5    | 0.6    | 0.7218 | 0.8379 | 0.993 |
| 9         | 170           | 0.16      | 3.72   | 43      | 0.4286 | 1     | 0.6327 | 0.698 |
| 10        | 175           | 0.16      | 3.67   | 42      | 0.5    | 1     | 0.7046 | 0.8704 |
| 11        | 185           | 0.15      | 3.61   | 42.5    | 0.75   | 0.5647 | 0.8158 | 0.7747 |
| 12        | 175           | 0.155     | 3.64   | 41      | 0.5    | 0.7218 | 0.7562 | 0.8812 |
| 13        | 180           | 0.155     | 3.67   | 43      | 0.6    | 0.7218 | 0.7046 | 0.698 |
| 14        | 170           | 0.155     | 3.71   | 42      | 0.4286 | 0.7218 | 0.6459 | 0.8704 |
| 15        | 180           | 0.15      | 3.64   | 42      | 0.75   | 0.5647 | 0.8379 | 0.8704 |
| 16        | 175           | 0.15      | 3.59   | 41.5    | 0.5    | 0.5647 | 0.8611 | 0.993 |
| 17        | 180           | 0.15      | 3.54   | 41      | 0.6    | 0.5647 | 1     | 0.8812 |
| 18        | 175           | 0.155     | 3.64   | 42      | 0.5    | 0.7218 | 0.7562 | 0.8704 |
| 19        | 180           | 0.155     | 3.62   | 42      | 0.6    | 0.7218 | 0.7949 | 0.8704 |
| 20        | 175           | 0.15      | 3.6    | 38      | 0.5    | 0.5647 | 0.8379 | 0.5036 |
| 21        | 190           | 0.155     | 3.66   | 41.5    | 1      | 0.7218 | 0.721 | 0.993 |
| 22        | 170           | 0.15      | 3.66   | 39.5    | 0.4286 | 0.5647 | 0.721 | 0.6409 |
| 23        | 185           | 0.15      | 3.63   | 41      | 0.75   | 0.5647 | 0.7751 | 0.8812 |
| 24        | 180           | 0.16      | 3.72   | 43      | 0.6    | 1     | 0.6327 | 0.698 |
| 25        | 180           | 0.15      | 3.62   | 40.5    | 0.6    | 0.5647 | 0.7949 | 0.7833 |
| 26        | 170           | 0.155     | 3.7    | 41.5    | 0.4286 | 0.7218 | 0.6596 | 0.993 |
| 27        | 175           | 0.15      | 3.66   | 42.5    | 0.5    | 0.5647 | 0.721 | 0.7747 |
| 28        | 180           | 0.15      | 3.58   | 40      | 0.6    | 0.5647 | 0.8857 | 0.705 |
| 29        | 180           | 0.15      | 3.74   | 44      | 0.6    | 0.5647 | 0.6079 | 0.5826 |
| 30        | 180           | 0.15      | 3.67   | 43      | 0.6    | 0.5647 | 0.7046 | 0.698 |
| 31        | 185           | 0.145     | 3.62   | 41      | 0.75   | 0.4637 | 0.7949 | 0.8812 |
| 32        | 180           | 0.15      | 3.7    | 42      | 0.6    | 0.5647 | 0.6596 | 0.8704 |

Table 1. Original data and gray relational coefficient of foundry sand
In Table 1, assuming that all parameters were within a reasonable range, meeting the normal production of sand casting. The VQ and WCS are the larger the better assessment indicators, therefore they are positive indicators. The MC is the smaller the better assessment indicator, so it’s negative indicator. There is interaction effect among these performance parameters. Com refers to the volume change of green sand under a certain degree of pressure. With increased Com, the WCS of sand increased. After the Com reached a certain level, the WCS did not increase much. But, the VQ decreased rapidly with continued increased Com. If the parameter Com was too large, the parameter VQ would be small; otherwise, if the parameter Com was too small, the parameter WCS would also be small. Therefore, Com belonged to the moderate indicator category, not too large or too small.

The original data matrix was nondimensionalized according to formula (1), and the ideal project $D^* = [1.0765 1.0483 0.9702 1]$ was achieved, where the optimal value of Com was the average of the nondimensionalized data.

The gray relational coefficient of evaluation indicators can be obtained based on formula (2), shown in Table 1.

In order to get the GRD of evaluation indicators, their weights should be know first. The weights of the evaluation indicators, including VQ, WCS, MC, and Com, were achieved by entropy weight method based on formulas (4)–(6), shown in Table 2.

Table 2. Weights of the evaluation indicators (using original data of evaluation indicators in Table 1)

| Indicators | VQ          | WCS         | MC          | Com          |
|------------|-------------|-------------|-------------|--------------|
| $e_j$      | 0.9496      | 0.9505      | 0.9501      | 0.9498       |
| $w_j$      | 0.252       | 0.2475      | 0.2495      | 0.251        |

The GRD of foundry sand was achieved based on formulas (3) and the weights of the evaluation indicators (Table 3).

Table 3. GRD of foundry sand

| Batch No. | GRD | Batch No. | GRD | Batch No. | GRD | Batch No. | GRD |
|-----------|-----|-----------|-----|-----------|-----|-----------|-----|
| 1         | 0.6318 | 11 | 0.7678 | 21 | 0.6012 | 31 | 0.642 |
| 2         | 0.7343 | 12 | 0.7268 | 22 | 0.8598 | 32 | 0.7233 |
| 3         | 0.5849 | 13 | 0.7145 | 23 | 0.5885 | 33 | 0.674 |
| 4         | 0.675 | 14 | 0.6808 | 24 | 0.7433 | 34 | 0.6852 |
| 5         | 0.6923 | 15 | 0.6663 | 25 | 0.7318 | 35 | 0.7522 |
| 6         | 0.7404 | 16 | 0.7563 | 26 | 0.6859 | 36 | 0.7241 |
| 7         | 0.6409 | 17 | 0.7299 | 27 | 0.7005 | 37 | 0.657 |
| 8         | 0.7881 | 18 | 0.7616 | 28 | 0.6401 | 38 | 0.5738 |
| 9         | 0.6886 | 19 | 0.7118 | 29 | 0.6889 | 39 | 0.6756 |
| 10        | 0.6307 | 20 | 0.7466 | 30 | 0.5889 | 40 | 0.6981 |

As shown in Table 2, the GRD of sample batch 22 was the largest, which was the closest to the
ideal project. Thus, it was advised that the performance parameters of sand casting refer to batch 22 to ensure safe casting and improve casting quality.

(3) the English need revisions
Response: Thank you for your careful reading of our manuscript. The grammatical errors in the manuscript have been revised.

(4) Additionally, sentences in this paper seem to have been borrowed from other published articles according to the result of iThenticate for plagiarism checking.
Response: Thank you for your comment. The repetitive contents in the manuscript have been revised.
Appendix C

Dear Editor and Reviewers,

We thank you for giving us constructive suggestions which will help us to improve the quality of the paper. Here we submit a new version of our manuscript, which has been modified according to your instructive suggestions.

The point to point responds to the your comments are listed as following

**Reviewer: 4**

Comments to the Author(s)

**Comment 1:** Clarity of equations and figures (Like Figure 1, 3, 4) need to be improved.

**Response:** Thank you for your careful reading of our manuscript, and sorry for our improper written in the paper. All the equations in the manuscript have been improved. But after I submit the revised paper to the system, part of the equations in the PDF version were still messy code (the capital letters L and M are ellipsis). If this manuscript can be accepted for publication, the publishing editor will handle these issues.

In addition, all the figures in the manuscript have been improved, and the resolution ratio of these original figures are 600 DPI * 600 DPI, shown as follows. But after I submit the revised paper to the system, the resolution ratio of the figures in the PDF version were transformed into 300 DPI * 300 DPI.

**Figure 1.** Structural chart of BP neural network.
Figure 2. Relationship between mean square error and number of hidden neurons.

Figure 3. Relationship between mean square error and epoch.
**Figure 4.** Regression analysis of training samples.

**Comment 2:** Explanation is required for each equation to improve the readability of the paper.  
**Response:** Thank you for your instructive suggestion. Explanation is added for each equation to improve the readability of the paper. Following each equation, corresponding explanations have been added (highlighted in blue in Main Document (tracked changes).doc).

**Comment 3:** Original data set need to be added as Appendix  
**Response:** Thank you for your valuable advice. The original data of foundry sand have been added as Appendix A (Table S1), shown as follows.

**Appendix A**

| Table S1. Original data of foundry sand |
|----------------------------------------|
| Batch No. | VQ (m⁴·N⁻⁵·S⁻³) | WCS (MPa) | MC (%) | Com (%) |
|-----------|----------------|-----------|--------|---------|
| 1         | 170            | 0.155     | 3.69   | 40      |
| 2         | 175            | 0.16      | 3.56   | 38      |
| 3         | 160            | 0.15      | 3.65   | 40      |
| 4         | 175            | 0.155     | 3.63   | 40      |
| 5         | 170            | 0.155     | 3.6    | 40.5    |
| 6         | 165            | 0.16      | 3.66   | 42      |
| 7         | 170            | 0.15      | 3.68   | 41      |
| 8         | 180            | 0.155     | 3.6    | 41.5    |
|   |    |   |   |   |
|---|----|---|---|---|
| 9 | 170| 0.16| 3.72| 43 |
|10 | 180| 0.15| 3.7 | 43 |
|11 | 175| 0.16| 3.67| 42 |
|12 | 185| 0.15| 3.61| 42.5|
|13 | 175| 0.155| 3.64| 41 |
|14 | 180| 0.155| 3.67| 43 |
|15 | 170| 0.155| 3.71| 42 |
|16 | 180| 0.15| 3.64| 42 |
|17 | 175| 0.15| 3.59| 41.5|
|18 | 180| 0.15| 3.54| 41 |
|19 | 175| 0.155| 3.64| 42 |
|20 | 180| 0.155| 3.62| 42 |
|21 | 175| 0.15| 3.6 | 38 |
|22 | 190| 0.155| 3.66| 41.5|
|23 | 170| 0.15| 3.66| 39.5|
|24 | 185| 0.15| 3.63| 41 |
|25 | 180| 0.16| 3.72| 43 |
|26 | 180| 0.15| 3.62| 40.5|
|27 | 170| 0.155| 3.7 | 41.5|
|28 | 175| 0.15| 3.66| 42.5|
|29 | 180| 0.15| 3.58| 40 |
|30 | 180| 0.15| 3.74| 44 |
|31 | 180| 0.15| 3.67| 43 |
|32 | 185| 0.145| 3.62| 41 |
|33 | 180| 0.15| 3.7 | 42 |
|34 | 180| 0.15| 3.67| 42 |
|35 | 175| 0.155| 3.62| 41.5|
|36 | 175| 0.15| 3.6 | 41.5|
|37 | 175| 0.155| 3.72| 42.5|
|38 | 175| 0.145| 3.72| 43 |
|39 | 175| 0.15| 3.64| 41 |
|40 | 185| 0.15| 3.6 | 42 |

**Reviewer: 5**

Comments to the Author(s)

**Comment 1**: Give more importance for the experiment and not on the basis of the optimization tool.

**Response**: Thank you for your valuable and thoughtful comment. More importance for the experiment have been added in the manuscript as follows.

Among these performance parameters, VQ is the ability that gas to penetrate high molecular material under a certain degree of pressure and time. The venting capacity of sand casting is not only increased by the riser and gas vent, but also by the VQ of the foundry sand. The VQ of foundry sand should not be too low, so as to avoid the occurrence of boiling and pore defects in
the casting process. But, the VQ of foundry sand should not be too high, so as to prevent the molten metal from infiltrating into the porosity, which will cause rough surface or abreuvage of casting. Therefore, the VQ of the foundry sand needs to be within an appropriate range, and should not be too high or too low. For high density molding, the VQ of foundry sand should be high. For low and medium density molding, the VQ of foundry sand should be low.

WCS refers to the ability of object to resist external pressure under the saturated water condition. If the WCS of foundry sand is insufficient, the sand mould may be damaged or collapsed during the process of drawing and mould assembling; in the pouring process, the sand mould may not withstand the impact of molten metal, which will cause blisters or even molten metal discharging from the parting surface. However, the WCS of foundry sand is not the higher the better. The higher WCS of foundry sand needs more bentonite, which not only affects the MC and VQ of foundry sand, but also increases the cost of casting. In addition, the higher WCS of foundry sand brings difficulties to the process of sand milling and shakeout.

MC is the percentage of water content to the total mass of the object. If the MC of foundry sand is low, the VQ of foundry sand will be high, and the casting is prone to sand burning. If the MC of foundry sand is high, a large amount of gas will be generated in the cavity due to evaporation of moisture during the pouring process. Once the gas in the cavity cannot be discharged smoothly within a limited time, an explosion accident may occur. Therefore, the MC of foundry sand should have a suitable range according to the filed practice.

Com is the proportion of the volume change of the object under a certain degree of pressure. On the one hand, the Com of foundry sand should not be too small, otherwise the bentonite will be insufficiently wetted, leading the foundry sand to brittleness, low surface strength and difficulty in drawing. On the other hand, the Com of foundry sand should not be too large, otherwise the castings are prone to boiling and pore defects.

In Table S1, assuming that all the performance parameters were within a reasonable range, meeting the normal production of sand casting. From the above analysis, it is know that all the performance parameters, namely VQ, WCS, MC and Com, belonged to the moderate indicator category, not too large or too small.

**Comment 2:** More justification needed on why this optimization tool is used and why not others.  
**Response:** Thank you for your valuable advice. More justification have been added in the manuscript on why this optimization tool is used and why not others, shown as follows.

When optimization the sand casting performance parameters, usually one parameter in batch A reach the ideal value, and another parameter in batch B reach the ideal value, but not all the parameters in one batch can reach the ideal values at the same time. Therefore, it's of great significance to optimization the performance parameters in single batch. The common optimization method of sand casting performance parameters is Taguchi's method [14], but this method has some disadvantages. First, the test number of orthogonal array in Taguchi's method is too much, which requires much experimentation and increases costs, and this is counter to its purpose of reducing costs. Second, the purpose of Taguchi's method is to reduce the effects of mutagenic factors rather than removing the mutagenic factors to improve quality. Third, despite the large amount of data, we are still unable to obtain any information about the interaction between controllable variable factors. Fourth, if there is no interaction between the controllable factors and interference factors, then a sound design does not exist. Therefore, it's necessary to
find a simple method for optimizing sand casting performance parameters. A novel optimization method of performance parameters based on gray relational analysis was introduced here.

Gray relational analysis is a very active branch in gray system theory. Its basic idea is to determine the gray relational degree between different sequences according to the geometrical shape of the sequence curves [15]. The larger the gray relational degree, the closer the project evaluated was to the ideal project. Accordingly, the order of the projects evaluated can be confirmed. Gray relational analysis does not require too many samples, nor does the sample have a typical distribution law, and the workload of calculation is relatively small. The gray relational analysis results are in good agreement with the qualitative analysis results. Gray relational analysis has been applied to many fields, such as decision-making [16], green supplier selection [17], and quality evaluation of red wine [18]. Wei [16] has investigated the dynamic hybrid multiple attribute decision-making problems based on gray relational analysis. In this study, gray relational analysis was used for optimization of sand casting performance parameters. During the process of gray relational analysis, assessment indicator weights should first be calculated.

Comment 3: Why authors have chosen the factors of performance parameters and what all other possible performance parameters in sand casting explain in details.

Response: Thank you for your instructive suggestion. All other possible performance parameters in sand casting have been added in the revision paper, and explanation has been added on why we chose these four factors of performance parameters, shown as follows.

3.1. Selection of Sand casting performance parameters

The foundry sand has many performance parameters, and each of them has an impact on the casting quality. However, the influence of each performance parameter on the casting quality is not the same, and the testing frequency is smaller for the performance parameter which is more important for improving the casting quality. The sand casting performance parameters and their testing frequency are shown in Table 1.

| performance parameters                                      | sampling spot                  | testing frequency               |
|------------------------------------------------------------|--------------------------------|--------------------------------|
| venting quality (VQ), wet compressive strength (WCS),      | discharge port of sand mill, or | once every half to two hours    |
| moisture content (MC), compactability (Com)                | conveyer of foundry sand        |                                |
| content of effective braize, content of effective bentonite| under the hopper of molding     | once every four to five hours   |
| tensile strength                                           | machine                        |                                |
| content of clay, content of lump, grain composition        | under the hopper of molding     | once a day                      |
| sand temperature, availability of bentonite, mobility,     | machine                        | once a week                     |
| fracture and heat shock time                               |                                | in case of need                 |

As is shown in Table 1, the sand casting performance parameters such as VQ, WCS, MC and Com are the most important factors for improving the casting quality, and the testing frequency is also the smallest. Therefore, this study optimizes the performance parameters such as VQ, WCS, MC and Com for improving casting quality.