View Reviews

Paper ID
41

Paper Title
On the proliferation of support vectors in high dimensions

Reviewer #1

Questions

1. Summary and contributions: Briefly summarize the paper and its contributions.
The paper deals with the issue of support vector proliferation in high dimensional problems.

2. Strengths: Describe the strengths of the work. Typical criteria include: soundness of the claims (theoretical grounding, empirical evaluation), significance and novelty of the contribution, and relevance to the AISTATS community.
This addresses an interesting and important problem in SVM for high dimensional data.

3. Weaknesses: Explain the limitations of this work along the same axes as above.
Empirical results are lacking. I understand it is a theoretical work but would be good to see this verified.

4. Correctness: Are the claims and method correct? Is the empirical methodology correct?
I think it is correct, but I have not verified every part of the proof especially in the supplemental material.

5. Clarity: Is the paper well written?
Very clear.

6. Relation to prior work: Is it clearly discussed how this work differs from previous contributions?
Good introduction on the problem is given and relevant literature is cited.

7. Reproducibility: Are there enough details to reproduce the major results of this work?
3: Yes, most aspects are reproducible

9. Please provide an "overall score" for this submission.
9: Top 15% of accepted AISTATS papers. An excellent submission; a strong accept.

10. Please provide a "confidence score" for your assessment of this submission.
3: You are fairly confident in your assessment.

13. While performing my duties as a reviewer (including writing reviews and participating in discussions), I have and will continue to abide by the AISTATS'21 code of conduct. (The AISTATS'21 code of conduct can be found here: https://tinyurl.com/y32gdz7d)
Agreement accepted

Reviewer #2

Questions

1. Summary and contributions: Briefly summarize the paper and its contributions.
This paper obtains lower bounds on the probability that every training example is a support vector.

2. Strengths: Describe the strengths of the work. Typical criteria include: soundness of the claims (theoretical grounding, empirical evaluation), significance and novelty of the contribution, and relevance to

the AISTATS community.
It looks a deep topic.

3. Weaknesses: Explain the limitations of this work along the same axes as above.
Hard to say, as I am really not an expert in the topic.

4. Correctness: Are the claims and method correct? Is the empirical methodology correct?
Seems true.

5. Clarity: Is the paper well written?
Yes, it is well written.

6. Relation to prior work: Is it clearly discussed how this work differs from previous contributions?
I am really not an expert in the topic.

7. Reproducibility: Are there enough details to reproduce the major results of this work?
3: Yes, most aspects are reproducible

9. Please provide an "overall score" for this submission.
6: Marginally above the acceptance threshold.

10. Please provide a "confidence score" for your assessment of this submission.
1: Your assessment is an educated guess.

13. While performing my duties as a reviewer (including writing reviews and participating in discussions), I have and will continue to abide by the AISTATS'21 code of conduct. (The AISTATS'21 code of conduct can be found here: https://tinyurl.com/y32gdz7d)
Agreement accepted

Reviewer #3

Questions

1. Summary and contributions: Briefly summarize the paper and its contributions.
This paper studies in theory under which situation all the training data become the support vectors in hard-margin support vector machines. The major contribution of this work is to explore an equivalent condition when all the training data become the support vectors (condition 3 in Lemma 1) and use to improve the theoretical bound in Muthukumar et al (2020).

2. Strengths: Describe the strengths of the work. Typical criteria include: soundness of the claims (theoretical grounding, empirical evaluation), significance and novelty of the contribution, and relevance to the AISTATS community.
This is a theoretical paper based on the random matrix theory. The paper is related to the least-square interpolation, which is currently an active research topic. The paper is relevant to the AISTAT community.

3. Weaknesses: Explain the limitations of this work along the same axes as above.
(1) Novelty: all the main ideas in this paper are not new and have been published in Muthukumar et al (2020), whose concentration bounds are looser than this work.

(2) Significance: there are two major limitations of the practical impact. First, this paper relies on hard-margin SVM; however the hard-margin SVM is rarely used in practice, as opposed to the soft-margin SVM. Second, the paper replies on heavy distributional assumptions of training data. However, the success of SVM is mainly because of its distribution-free feature.

4. Correctness: Are the claims and method correct? Is the empirical methodology correct?
The theory is based on random matrix theory like Hanson-Wright inequality. The claims in this paper are correct.

5. Clarity: Is the paper well written?

The paper is clearly well written.

6. Relation to prior work: Is it clearly discussed how this work differs from previous contributions?

This work has done a good job to review and discuss the difference from previous work.

7. Reproducibility: Are there enough details to reproduce the major results of this work?

3: Yes, most aspects are reproducible

9. Please provide an "overall score" for this submission.

5: Marginally below the acceptance threshold.

10. Please provide a "confidence score" for your assessment of this submission.

4: You are confident in your assessment, but not absolutely certain.

13. While performing my duties as a reviewer (including writing reviews and participating in discussions), I have and will continue to abide by the AISTATS'21 code of conduct. (The AISTATS'21 code of conduct can be found here: https://tinyurl.com/y32gdz7d)

Agreement accepted

Reviewer #6

Questions

1. Summary and contributions: Briefly summarize the paper and its contributions.

The paper derives some concentration results for the phenomenon of support vectors proliferation in high-dimensional linear classification settings of two types of designs: sub-Gaussian features and Harr features. A weak converse result coupled with its implication for generalization are also presented.

2. Strengths: Describe the strengths of the work. Typical criteria include: soundness of the claims (theoretical grounding, empirical evaluation), significance and novelty of the contribution, and relevance to the AISTATS community.

* The motivation for theoretical analysis of the paper is sounded: their analysis is done in non-asymptotic regime, which differs from classical work. Their bounds on sufficient conditions on proliferation of support vector (i.e. probability of every training example is a support vector) is also an improvement on a very recent work of Muthukumar et al [2020]. This implies overall novelty of the work. Note that however I have not checked the proofs in Supplmentary Materials.

* The empirical result is a a simple simulation scheme demonstrates the support vector proliferation phenomenon, which agrees with

3. Weaknesses: Explain the limitations of this work along the same axes as above.

* A minor concern is that the settings for empirical result seems a bit too simplistic.

4. Correctness: Are the claims and method correct? Is the empirical methodology correct?

* For main theoretical analysis, the key result lies in Lemma 1 with its proof in section 4 that seems to be correct. The authors only make assumption that the kernel matrix of the dual SVM problem is non-singular, which is ok for the settings of the paper. Again note that I have not checked the proofs in Supplementary Material.

5. Clarity: Is the paper well written?

* Yes, the paper is very well written and easy to pass through.

6. Relation to prior work: Is it clearly discussed how this work differs from previous contributions?

* Yes, the connection and improvement on previous works is clearly discussed, most particularly in the latter half of Introduction section.

7. Reproducibility: Are there enough details to reproduce the major results of this work?

2: Some aspects of the work are reproducible

8. Additional feedback, comments, suggestions for improvement and questions for the authors:

* Minor comment: some references is wrongly placed in parentheses, e.g. second last paragraph of the Introduction, or second last paragraph of section 3.2.

9. Please provide an "overall score" for this submission.

7: A good submission; an accept.

10. Please provide a "confidence score" for your assessment of this submission.

3: You are fairly confident in your assessment.

13. While performing my duties as a reviewer (including writing reviews and participating in discussions), I have and will continue to abide by the AISTATS'21 code of conduct. (The AISTATS'21 code of conduct can be found here: https://tinyurl.com/y32gdz7d)

Agreement accepted