SVM Activity

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Convex Optimization

It's time to see what SVMs can do. Therefore, this activity will focus on reproducing a series of exercises in Scikit Learn, one of the alternatives available to implement machine learning models in Python. Besides, it will be necessary to use Google Colab, Github, and Binder, allowing the first approach to these tools.

Introduction

After deducing and demonstrating some of the fundamental properties of SVMs, this assignment will implement these models using Python's Scikit-Learn. The first problem concerns the package's essential functions. Meanwhile, the second problem summarizes the SVM approach, ending with a simple example of image recognition.

Activities

First, consider the following Scikit-Learn's basic examples:

Problem 1: Basic Exercises of SVM in Scikit-Learn

Read and reproduce the following examples carefully, then complete the mathematical deductions and code descriptions. Upload your results to Github in the form of a Jupyter notebook, then make it interactive using Binder, hence submit your results through both links. The use of Google Colab is highly recommended.

1. First, the Support Vector Machines basics for Scikit Learn and all the examples therein.

   Some important cases of the required examples are:

2. One-class SVM with non-linear kernel (RBF).
3. SVM Margins Example.
4. Non-linear SVM.
5. SVM Tie Breaking Example.
6. SVM: Separating hyperplane for unbalanced classes.
7. SVM: Weighted samples.

8. Outlier detection on a real data set.
9. Plot different SVM classifiers in the iris dataset.

Then, reproduce the following application case:

Problem 2: Application Case

Read and reproduce carefully the example In-Depth: Support Vector Machines from the book of VanderPlas[6], then complete the mathematical deductions and code descriptions. Upload your results to Github in the form of a Jupyter notebook, then make it interactive using Binder, hence submit your results through both links. The use of Google Colab is highly recommended.

Further Lectures and Bibliography

For more information about SVM, consider the following references:

- The Smola's tutorial on SVR[4].
- The book of Abe[1], presents a comprehensive study of support vector machines.
- The book of Suykens[5], introduces the basic concepts of support vector machines.
- The book of Deisenroth[3], presents a detailed calculation of support vector machines (Chapter 12., pp. 370-394).
- The book of Bishop[2], presents a rigorous deduction of support vector machines and kernel based methods (Chapter 6 and 7., pp. 291-358).

References

[1] Shigeo Abe. *Support Vector Machines for Pattern Classification, 2 Ed.* Springer-Verlag London, 2010. ISBN 978-1-84996-097-7. URL https://www.springer.com/gp/book/9781849960977.

[2] C.M. Bishop. *Pattern Recognition and Machine Learning*. Information Science and Statistics. Springer New York, 2006. ISBN 9781493938438. URL https://www.microsoft.com/en-us/research/uploads/prod/2006/01/Bishop-Pattern-Recognition-and-Machine-Learning-2006.pdf.

[3] M.P. Deisenroth, A.A. Faisal, and C.S. Ong. *Mathematics for Machine Learning*. Cambridge University Press, 2020. ISBN 9781108470049. URL https://mml-book.github.io/book/mml-book.pdf.

[4] Alex J. Smola and Bernhard Schölkopf. A tutorial on support vector regression. *Statistics and Computing*, 14(3):199–222, 2004. ISSN 1573-1375. doi: 10.1023/B:STCO.0000035301.49549.88. URL https://alex.smola.org/papers/2004/SmoSch04.pdf.

[5] Johan A K Suykens, Tony Van Gestel, Jos De Brabanter, Bart De Moor, and Joos Vandewalle. *Least Squares Support Vector Machines*. World Scientific, 2002. ISBN 9789812381514. URL https://www.worldscientific.com/worldscibooks/10.1142/5089.

[6] Jake VanderPlas. *Python Data Science Handbook*. O'Reilly Media, Inc., 2016. ISBN 9781491912058. URL https://www.oreilly.com/library/view/python-data-science/9781491912126/.