

# CS5590: Practice Problems

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## 1 ERM with inductive bias

1. Exercises 2.1, 5.2, 9.1, 9.2, 12.1, 15.3 in [Shalev-Shwartz and Ben-David(2014)].
2. Exercises 3.2, 3.3, 7.1, 7.4 (i), 7.8 in [Scholkopf and Smola(2001)].
3. Exercises 4.3 (skip dual derivation), 10.3 in [Mohri et al.(2012)] Mohri, Rostamizadeh, and Talwalkar].
4. Exercises 14.1, 14.2 in [Murphy(2012)].

## 2 Probabilistic Modeling

Optionally do exercises 2.3-2.11, 2.16, 2.17, 4.1-4.7 in [Murphy(2012)] for revising some basics.

### 2.1 Parameter Estimation

1. Exercise 3.6, 3.8, 3.11a, 3.11b, in [Murphy(2012)].

### 2.2 Generative Models

1. Exercise 24.2 (only first of the three parts) in [Shalev-Shwartz and Ben-David(2014)].
2. Exercises 3.20, 4.18-4.23, 9.2, in [Murphy(2012)].

### 2.3 Discriminative Models

1. Exercises 7.1-7.6, 7.9, 8.3-8.7 in [Murphy(2012)].

## 3 Non-linear Modeling and Kernel Methods

1. Exercises 16.1, 16.3, 16.4, 16.6 in [Shalev-Shwartz and Ben-David(2014)].
2. Exercises 5.1, 5.2, 5.11, 5.13 in [Mohri et al.(2012)] Mohri, Rostamizadeh, and Talwalkar].

## 4 Model Selection

1. Exercise 11.2 in [Shalev-Shwartz and Ben-David(2014)].
2. Exercise 7.10 in [Hastie et al.(2001)Hastie, Tibshirani, and Friedman].

## 5 Unsupervised Learning

1. Exercise 22.2 in [Shalev-Shwartz and Ben-David(2014)].
2. Exercises 9.6,9.10, in [Bishop(2006)].
3. Exercise 11.2,11.7,11.9,11.10 in [Murphy(2012)].

## 6 Representation Learning

1. Exercises 23.1, 23.3, 23.4 in [Shalev-Shwartz and Ben-David(2014)].
2. Exercises 12.3,12.5,12.10, in [Murphy(2012)].
3. Exercises 12.4,12.25,12.26, in [Bishop(2006)].

## 7 SGD and Online Learning

1. Exercise 14.3,14.4,21.5 in [Shalev-Shwartz and Ben-David(2014)].
2. Exercise 5.18 in [Bishop(2006)].
3. Exercise 7.2,7.5 in mohri book.

## 8 Reinforcement Learning

1. Question 1 in <https://www.cse.iitb.ac.in/~shivaram/teaching/old/cs747-a2018/resources/midsem.pdf>.
2. Question 1 in <https://www.cse.iitb.ac.in/~shivaram/teaching/cs747-a2019/resources/midsem.pdf>.
3. Questions 1, 2a, 2b in <https://www.cse.iitb.ac.in/~shivaram/teaching/old/cs747-a2017/resources/cs747-a2017-midsem.pdf>.

## 9 Boosting

1. Exercises 6.3, 6.6, 6.8 a-d in mohri book.
2. Exercises 10.3 in [Shalev-Shwartz and Ben-David(2014)].

## References

- [Bishop(2006)] Christopher M. Bishop. *Pattern Recognition and Machine Learning (Information Science and Statistics)*. Springer-Verlag, Berlin, Heidelberg, 2006. ISBN 0387310738.
- [Hastie et al.(2001)] Hastie, Tibshirani, and Friedman] Trevor Hastie, Robert Tibshirani, and Jerome Friedman. *The Elements of Statistical Learning*. Springer Series in Statistics. Springer New York Inc., New York, NY, USA, 2001.
- [Mohri et al.(2012)] Mohri, Rostamizadeh, and Talwalkar] Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar. *Foundations of Machine Learning*. The MIT Press, 2012. ISBN 026201825X, 9780262018258.
- [Murphy(2012)] Kevin P. Murphy. *Machine Learning: A Probabilistic Perspective*. The MIT Press, 2012. ISBN 0262018020, 9780262018029.
- [Scholkopf and Smola(2001)] Bernhard Scholkopf and Alexander J. Smola. *Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond*. MIT Press, Cambridge, MA, USA, 2001. ISBN 0262194759.
- [Shalev-Shwartz and Ben-David(2014)] Shai Shalev-Shwartz and Shai Ben-David. *Understanding Machine Learning: From Theory to Algorithms*. 2014.