

Algorithmic Learning Theory

Theoretical Computer Science

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Ground Rules

1. A talk each week (venue to be decided).
 - ▶ **45 mins** duration + **45 mins** for discussion
 - ▶ in German or English (with slides in English please!)
2. Show us your slides at least one week before you give your talks. Feedback!
3. A report (preferably in English and max *10 pages*). Use standard \LaTeX file format from seminar homepage. Hand in your reports within a week of giving your presentation.
4. Scoring: **50% Talk** + **50% Report**.

General Advice

1. The objective is get a general idea about Algorithmic Learning Theory.
2. Emphasis on **high-level ideas** over **domain-specific details**.
3. Feel free to look around!

General Books

- ▶ Information Theory, Inference and Learning Algorithms. David MacKay, Cambridge University Press.
- ▶ Pattern Recognition and Machine Learning. Christopher M. Bishop, Springer.

List of Topics

1. *Language Identification in the Limit* by E. M. Gold. **Already Assigned!**

This is the very first paper on Machine Learning and introduces the notion of a learnable language. Introduces many of the early ideas of machine learning.

2. *Inductive Inference of Formal Languages from Positive Data* by D. Angluin.

This work continues with the initial investigation of Gold into when a recursive formal language is inferrable from positive data.

List of Topics

3. *Finding Patterns Common to a Set of Strings* by D. Angluin. **Already Assigned!**

This work introduces the notion of pattern languages and identifying such languages using a (finite) sample of strings. The languages that can be identified as the so-called *one-variable pattern* languages.

4. *Lange and Wiehagen's Pattern Language Learning Algorithm: Average Case Analysis* by T. Zeugmann.

Lange and Wiehagen proposed an algorithm that learns all pattern languages in the limit from samples. This paper analyzes the overall time taken by this algorithm until convergence to a correct hypothesis.

List of Topics

5. *Learning One-Variable Pattern Languages Very Efficiently on Average, in Parallel, and by Asking Queries* by T. Erlebach, P. Rossmanith, H. Stadtherr, A. Steger and T. Zeugmann.
Already Assigned!

This paper studies the learnability of one-variable pattern languages in the limit with respect to the update time needed for computing a new guess and the expected total learning time until convergence to the correct hypothesis.

6. *Bayesian Inference: An Introduction to the Principles and Practice in Machine Learning* by M. E. Tipping. **Already Assigned!**

Basic introduction to the principles of Bayesian inference in the context of machine learning.

List of Topics

7. *A Theory of the Learnable* by L. G. Valiant. **Already Assigned!**

Valiant's classic paper on *Probably Approximately Correct (PAC)* learning.

8. *Learning DNF Expressions from Fourier Spectrum* by V. Feldman. **Already Assigned!**

PAC learning of DNF expressions: proposed by Jan.

9. *Neural Networks (Chapters 38 – 41)* in *Information Theory, Inference and Learning Algorithms* by D. MacKay. **Already Assigned!**

Basic introduction to neural networks.

List of Topics

10. *Hopfield Networks (Chapter 42)* in Information Theory, Inference and Learning Algorithms by D. MacKay. **Already Assigned!**
11. *Learning Topic Models—Going Beyond SVD* by S. Arora, R. Ge and A. Moitra. **Already Assigned!**

Topic modeling is an approach used for automatic comprehension and classification of data in a variety of settings. The tool that is typically used in this setting is Singular Value Decomposition (SVD). This paper formally justifies using Non-negative Matrix Factorization as a replacement for SVD.

12. *The ZPAQ Open Standard Format for Highly Compressed Data* by M. Mahoney. **Already Assigned!** A compression algorithm based on concepts of Learning Theory.

13. *Universal AI: One Decade of Universal Artificial Intelligence.*
by M. Hutter. **Already Assigned!**